

Calibrating Travel Demand Model Volume-Delay Functions Using Bottleneck and Queuing Analysis

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A blue-toned map of the Glenwood Springs area in Colorado. The map shows major roads like I-70 and US-86, and various landmarks including the UNC Campus, Old UNC Cemetery, Glenwood Springs, Glenwood Plummer School, and Glenwood. The title 'Overview' is overlaid in large white text on the left side of the map.

Overview

- Literature Review
- Motivation
- Approach
- Results
- Conclusions and Future Research

A blue-tinted map of the UNC Chapel Hill area is visible in the background of the top section. Labels on the map include 'UNC Campus', 'Old UNC Cemetery', 'Glen Lenoir', 'HAMILTON', 'BRUNNEN TEE', '86', and '5'.

Literature Review

BPR, Conical, HCM, Akcelik

Adjustments made during highway assignment

Some agencies use locally collected data, most rely on defaults

Need for more research on methods for using locally collected data



Motivation

Challenge:

- Models heavily dependent on data
- Highway assignment relies primarily on traffic counts
- How to represent demand greater than capacity

Solution:

- Freeway detector data
- Bottleneck and Queue Analysis
- Approach for estimating demand beyond capacity

Data



Approach

Processing: Density

$$k = \left(\frac{52.8}{L_v + L_d} \right) * \%OCC$$

K=density (pc/mile)

L_v = average vehicle length (feet)

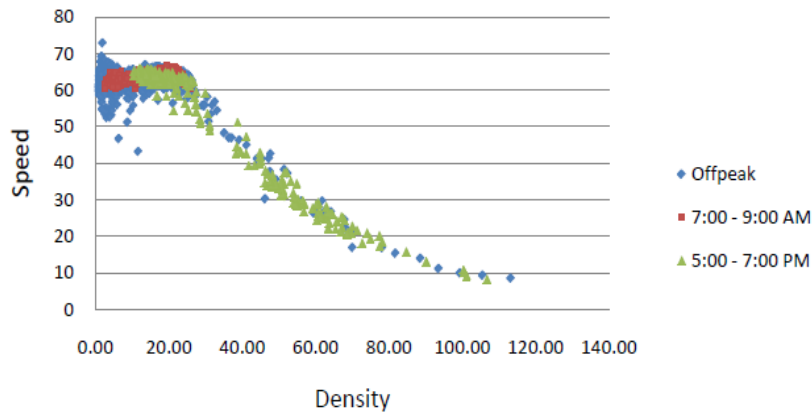
L_d = detection zone length (feet)

%OCC = percent occupancy

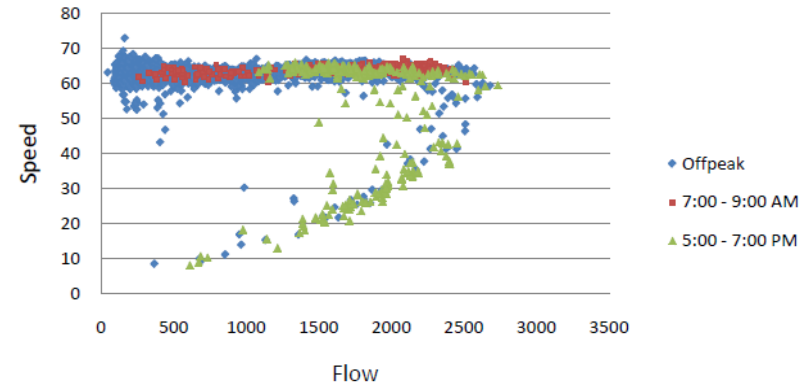
Approach

Processing: Reasonableness Checks

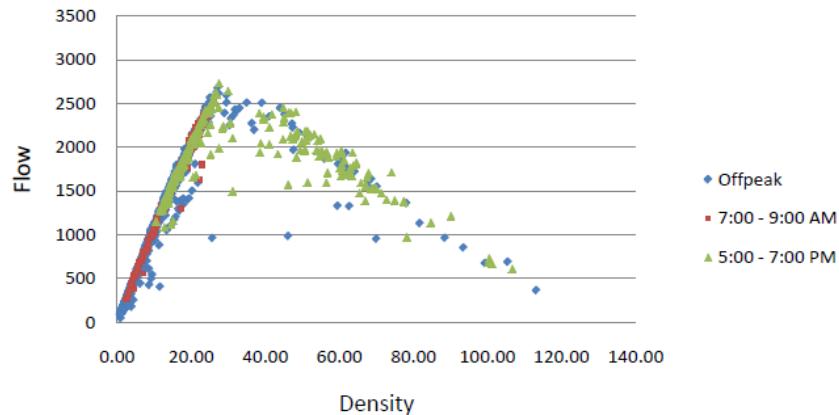
Location 3 Speed-Density



Location 3 Speed-Flow



Location 3 Flow-Density

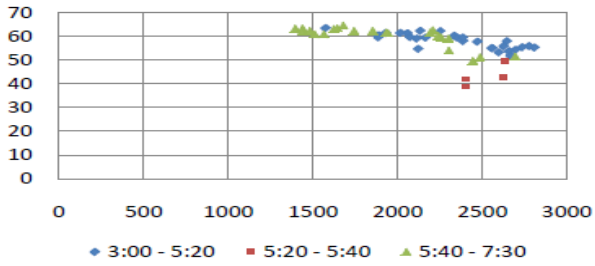


Approach

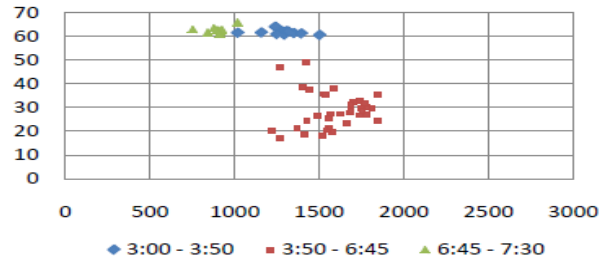


Identification of Bottleneck

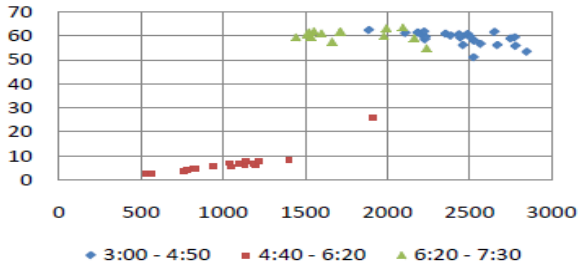
Location 1 (lanes=5)



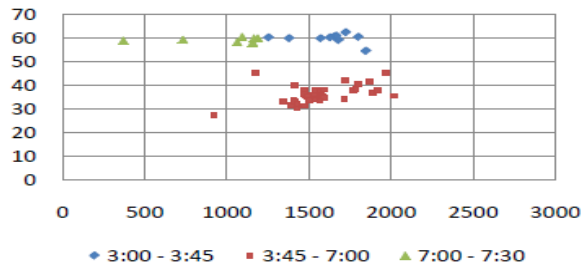
Location 5 (lanes=4)



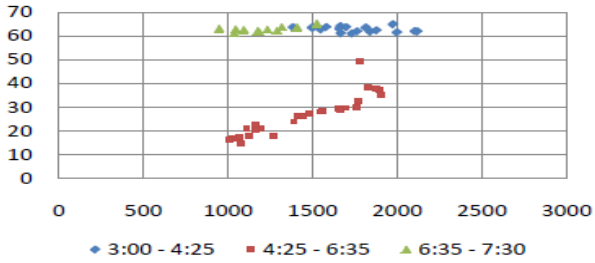
Location 2 (lanes=4)



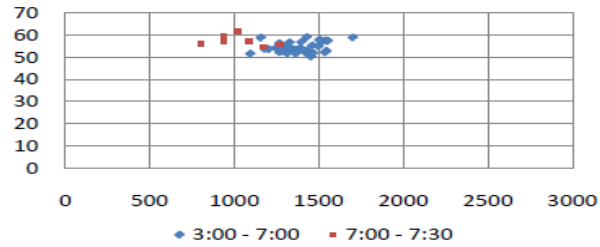
Location 6 (lanes=4)



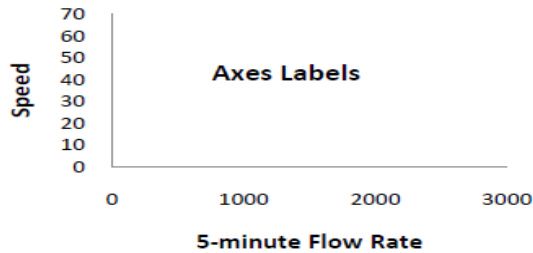
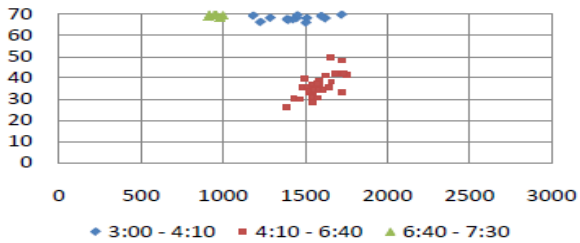
Location 3 (lanes=5)



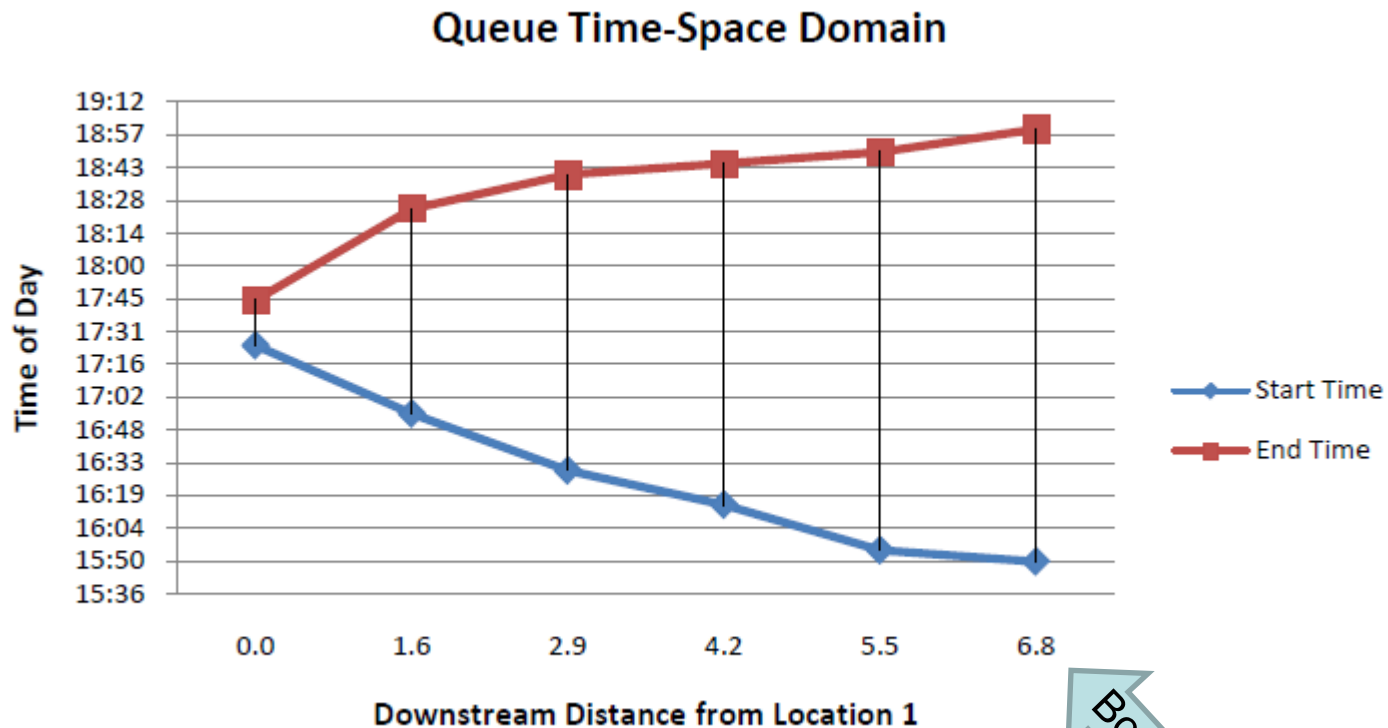
Location 7a (lanes = 3)



Location 4 (lanes=4)



Spatial Extent of Queue



Bottleneck

Approach

Length of Queue

$$A = (.5d_{ud} * L) + (.5d_{dd} * L)$$

A = area of influence

d_{ud} = distance to upstream detector (mi)

d_{dd} = distance to downstream detector (mi)

L = number of lanes

Approach

Queue per Time Interval

$$Queue_T = \sum_{i=1}^n [(k_{Ti}) * (A_i)]$$

T = time interval of interest (min)

i = detector

n = maximum number of detectors

k_{Ti} = density at time interval T for detector i (pc/mi)

A_i = number of lanes

Approach



Demand

$$Demand_B = (DemandAtCapacity) + (Queue_T)$$

D_B = demand at the bottleneck

DemandAtCapacity = calculated as the average of the top 1% measured flow rate

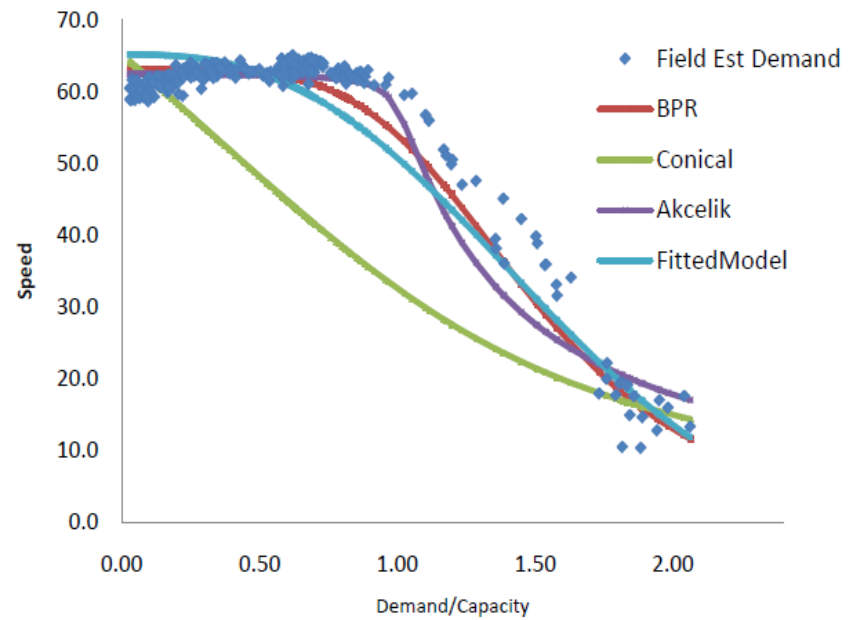
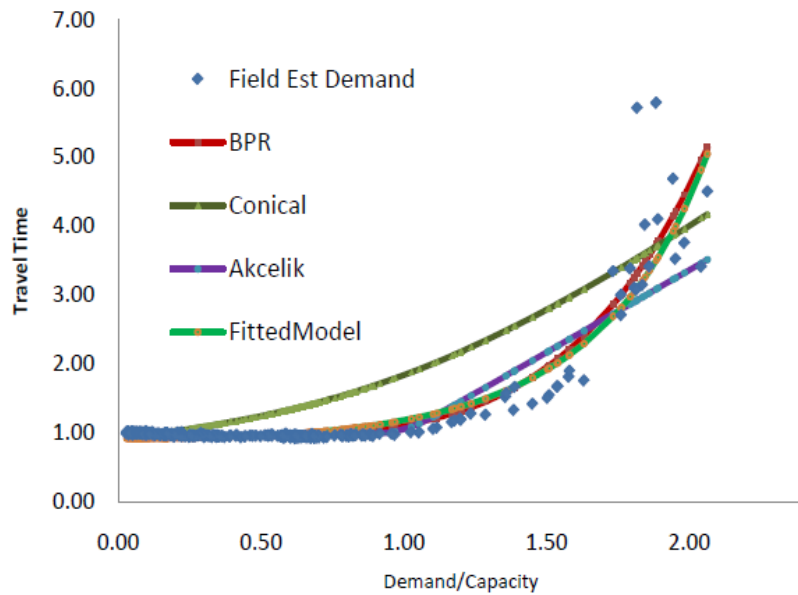
Queue_T = queue per time interval

Finally:

$$D / C = (Demand_B) / (Capacity)$$

Approach

Model Fitting



Results

Model Fitting

Function	t_0 (hrs)	FFS (mph)	Alpha	Beta	J	R^2	MSE (mph) ²	T- test	F- test
BPR	0.95	63.4	0.17	4.50		0.88	.06	1.0	0.29
Conical	0.92	65.2	1.68			0.72	.23	0	0.73
Akcelik	0.96	61.4			0.10	0.85	.09	1.0	0.0
Exponential	0.92	65.2	0.25	2.65		0.86	.07	0.97	0.19

Results

A blue-tinted map of the UNC Chapel Hill area, showing roads, landmarks like 'UNC Campus' and 'Old UNC Cemetery', and a highlighted route. The map is partially obscured by the title and the list below.

Findings

- Models perform well
- Parameters are within expected range
- Akcelik, BPR, and exponential acceptable models
- Bottleneck and queuing analysis effective approach

A map of the UNC campus area is visible in the background of the top section. Labels include 'UNC Campus', 'Old UNC Cemetery', 'Glen Lenoir', 'HAMILTON', 'BRUNNEN TIER', 'Kearney', 'Lenoir Community School', and 'Newtown'. A road with the number '86' is also shown.

Conclusions / Future Research

Conclusions:

- Analysis tools needed
- Visualize demand > capacity
- Straightforward approach

Future Research:

- Transferability
 - Other freeways in Raleigh-Durham
 - Other freeways in other areas
 - Multi-lane highways

Thank You!

