Performance of a Single Route

Outline

Dwell Time Models

Dwell Times

- **Vehicle dwell time affects:**
  - system performance
  - service quality
- **A critical element in vehicle bunching resulting in:**
  - high headway variability
  - high passenger waiting times
  - uneven passenger loads
- **Dwell time impact on performance depends on:**
  - stop/station spacing
  - mean dwell as proportion of trip time
  - mean headway
  - operations control procedures

EXAMPLES:

Commuter rail ---> little impact of dwell time on performance

Long, high-frequency bus route ---> major impact

Light rail ?

Dwell Time Theory

- **Dwell time depends on many factors:**
  - **Human, modal, operating policies & practices, mobility, weather, etc.**

- **For a given system we have the following possible models:**

1. **Single door, no congestion and interference:**

   DOT = a + b(DONS) + c(DOFFS)

2. **Single door with congestion and interference:**

   DOT = a + b(DONS) + c(DOFFS)
   + d(DONS+DOFFS)(DTD)

Dwell Time Theory (cont'd)

- For a given system we have the following possible models ...

3. Single car with m doors:

   $DT = \max(DOT_1 \ldots, DOT_m)$

   With balanced flows:

   DT = a + b/m(CONS) + c/m(COFFS) + d/m(CONS+COFFS)(STD)

4. *n*-car train:

   $DT = \max(DT_1, \ldots, DT_n)$

   With balanced flows:

   DT = a + b/nm(TONS) + c/nm(TOFFS) + d/nm(TONS+TOFFS)(STD)

MBTA Green Line Analysis

- Branching network of 28 miles (45 km) and 70 stations
- 52-seat ALRVs operate in 1-, 2-, and 3-car trains
    - high floor, low platform configuration
    - 3 doors per car on each side
    - single side boarding/alighting
- Trunk service in central subway:
    - 10 or 14 stations on round-trip
    - 1- to 2-minute headways
    - peak flows ≈10,000 passengers/hour

Models with Crowding Term

A. One-car trains:

$$DT = \underset{(8.94)}{12.50} + \underset{(3.76)}{0.55*TONS} + \underset{(2.03)}{0.23*TOFFS}$$

$$+ \underset{(6.70)}{0.0078*SUMASLS} \qquad (R^2 = 0.62)$$

SUMASLS = TOFFS*AS + TONS*LS

B. Two-car trains:

$$DT = \underset{(7.43)}{13.93} + \underset{(2.92)}{0.27*TONS} + \underset{(3.79)}{0.36*TOFFS}$$

$$+ \underset{(2.03)}{0.0008*SUMASLS} \qquad (R^2 = 0.70)$$

Predicted Dwell Times

ONS	LPL	1-Car DT	2-Car DT
0	any #	12.5	13.9
10	<53	20.3	20.2
10	150	35.6	21.0
20	<53	28.1	26.5
20	150	58.7	28.1
30	<53	35.9	32.8
30	150	81.8	35.1

Findings

- Dwell times for ALRVs are quite sensitive to:
  - Passenger flows
  - Passenger loads
- The crowding effect may well be non-linear.
- Dwell times for multi-car trains are different form those for one-car trains.
- The dwell time functions suggest high sensitivity of performance to perturbations
- Effective real-time operations control essential
- Running mixed train lengths dangerous
- Simulation models of high frequency, high ridership light rail lines need to include realistic dwell time functions.