Implementation of a Trip-based Time-of-Day Choice Model in FSUTMS

presented to
Advanced Model Structures Committee

presented by
Heinrich McBean, Parsons Brinckerhoff

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Objective

• Application of a trip-based time-of-day choice model in a congested region using FSUTMS
Test Model

- Central Florida region selected for test case.
- Test model based on CFRPM 5.0
  - 2005 Base Year
  - 4,549 zones
  - 9 standard trip purposes
    - HBW, HBSH, HBSR, HBO, NHB, LTK, HTK, Taxi, EI
  - 21 Special trip purposes
    - (Resident + Tourist + External) * (7 Major Attractions)

Approach for Trip-based TOD Choice Model

- Static TOD model after Trip Generation
  - Fixed TOD factors for initial stratification
  - TOD factors developed from observed local data

- TOD choice feedback model
  - Incremental logit model
  - Estimate TOD period choice after Highway Assignment
  - Feedback of TOD choice to Trip Distribution
CFRPM 5.0 – Basic Structure

- Highway pre-assignment congested travel time for HBW
- Free-flow travel time for HBNW and NHB

- FORTRAN executable
- HBW, HBNW and NHB trip purposes
- Mode choice output trip tables not segmented by household markets

CFRPM 5.0 – Time-of-Day Choice Structure

Future Year Model

Trip Generation (Daily)

Time-of-Day Zoning (in Periods)

Trip Distribution (by Household, Day Period)

Mode Choice (by Time-of-Day Period)

Highway Assignment (by Time-of-Day Period)

Trip Assignment

Basel Year Level of Service (Start and End Year Model)
**Time-of-Day Factors**

- Provides initial temporal stratification
- Adopted from work done previously by CSI
  - 2009 NHTS Florida Add-on data

- Developed for four time periods
  - AM Peak: 6:30 AM – 8:59 AM, 2.5 hours
  - MD: 9:00 AM – 3:29 PM, 6.5 hours
  - PM Peak: 3:30 PM – 6:29 PM, 3.0 hours
  - NT: 6:30 AM – 6:29 PM, 12.0 hours
- More periods were tested (and preferred) but increased runtime and exposed caused hardware issues

- Stratified by trip purpose and direction

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**TOD Choice Feedback Model**

- Incremental logit model
- Driven by difference in travel impedance
  - Forecast year compared to base year
- Applied for each trip purpose independently
  - For all Time-of-Day periods
- Estimates switch in trips for each Time-of-Day period
- Feedback through trip distribution, mode choice and assignment:
  - Estimated TOD period trip tables
  - Travel impedance
  - Provides consistency in supply and demand assumptions and final forecast

\[
Z^TOD(n+1) = \frac{Z^TOD(n=0) \times \exp(x \times \Delta I(n+1))}{\sum Z^TOD(n=0) \times \exp(x \times \Delta I(n+1))}
\]

Where:

\(- C_{ij} \in I \) = Origin and destination TAZs
\(- x \) = Trip purpose from 1 through 9
\(- g \) = TOD period from 1 through 4
\(- \Delta I \) = Global iteration with TOD choice feedback

\[
Z^TOD(n=0) = \sum Z^TOD(n=0) \times \exp(x \times \Delta I(0))
\]

\[
\Delta I(n+1) = \text{TOD choice trips by TOD period, before the first global iteration}
\]

\[
\Delta I(n+1) = \text{Difference in TAZ impedance between the current iteration and the base year scenario}
\]

\[- \Delta E \text{ = Estimated calibrated dispersion coefficient (peak spreading elasticity)} \]
**Time-of-Day Choice Model**

- Difference in LOS ($\Delta L$), forecast year compared to base year
  - Mode choice log sums, or
  - Destination choice utilities, or
  - Generalized cost

- Generalized cost used as impedance for test model
  - Travel time + Toll Plaza Delay + Toll Equivalent Time

- Mode choice log sums essential when evaluating rail and fixed guideway transit

- Dispersion coefficient ($\lambda$)
  - Requires data from Panel survey or “Before and After” survey for estimation/calibration
  - Default values used for test model
  - May be calibrated for local conditions

**Effects of Changes**

- Temporal stratification of all model components (except trip generation)

- Home-based trips by direction
  - Outbound (O) – from home
  - Inbound (I) – to home

- Period-specific networks and congested travel times for all model components (except transit)
  - Transit Peak: AM Peak period network and travel time
  - Transit Off-Peak: MD period network and travel time

- Model sensitivity to change in LOS
 Effects of Changes

• Internal trip purposes by direction maintained in all model components, except transit
  – HBWO, HBWI, HBSHO, HBSHI, HBSRO, HBSRI, HBSRO, NHB

• Requires greater calibration/validation effort
  – More time-of-day periods
  – Time-of-Day choice model
  – Panel data for calibration

• Longer model run time
  – More time periods
  – More trip purposes
  – Feedback loop

 Issues for Consideration

• Consistency in TAZ structure across all model scenarios (Required)

• Trip Distribution
  – Destination choice mode vs. gravity model

• Mode Choice
  – Same trip purpose as TOD choice model
  – Output trips by household markets
Issues for Consideration

- No trip-chaining information
- No disaggregate household/person/trip variables
- Trip-based model with time-of-day choice vs. activity-based model

2005 Base Year Forecast: Time-of-Day

- Time-of-day Factoring
- Four Time-of-Day periods
Time-of-Day Results: 2035 No-Build

- 2035 No-Build Future Year
  - 2005 highway and networks
  - 2035 socioeconomic data

Time-of-Day Results: 2035 No-Build

- Initial Mode Choice estimate of person trips by auto modes
  - Not including, taxi, trucks or special trips
Time-of-Day Results: 2035 Forecast

• Percent change in peak period person trips by auto modes, after 6 iterations of time-of-day choice feedback

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Time-of-Day Results: 2035 Forecast

• Percent change in peak period trips after 6 iterations of time-of-day choice feedback

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**Time-of-Day Modeling Toolbox**

- **Static Time-of-Day Model**
  - Fixed Time-of-Day factors
    - Relatively easy to implement
    - Assumes travel patterns will remain the same in the future
    - Not sensitive to change in LOS
  - Adequate for regions with limited or negligible congestion growth

- **Trip-based Time-of-Day Choice Model**
  - Dynamic model
  - Predicts shifts in time-of-day period of travel
  - Can model peak spreading
  - Sensitive to trip purpose and changes in LOS
  - May be sensitive to household markets
  - Useful in regions where peak period congestion is significant and growing
  - Aggregate
• Activity-based Travel Models
  – Disaggregate Time-of-Day Choice is built-in

Questions?

• Thank you.