Development of Statewide Model Post-Processors for Traffic and Economic Forecasting

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Outline

- Introduction
- Part 1 – INDOT Traffic Forecasting Tool (TFT)
- Part 2 – KYTC TREDIS Post-Processor
Introduction
Currently in Mid-West …

- **Indiana Department of Transportation (INDOT)**
  - On-call Long Range Transportation Planning Service, e.g., TFT
  - Update Indiana Statewide Travel Demand Model (ISTDM)

- **Kentucky Transportation Cabinet (KYTC)**
  - On-call Travel Demand Modeling Services, e.g., TREDIS post-processor
  - Update Kentucky Statewide Traffic Model (KYSTM)
Part 1

INDOT Traffic Forecasting Tool (TFT)
Overview

- INDOT maintains a TFT to facilitate traffic forecasting activities.
- Old TFT v2.0 – developed in 2006
- TFT v3.0 (completed under current INDOT On-Call LRTP contract)
  - Compatible with the latest Indiana Statewide Travel Demand Model (ISTDM 7) in TransCAD 6
  - The most current traffic count data
  - Enhanced GUI
  - Improved traffic forecasting models
  - Multiple links (up to 15) for analysis at a time
  - More key link attributes
  - More effective & manageable outputs (.BIN reports & graphs)
ISTDM 7

- 4-step model (TransCAD 6)
- Coverage – entire IN + partial IL, KY, MI, OH
- 4879 zones & 46780 links
- Modes
  - auto, freight, LD transit
  - tolling
- Model years 2010 – 2035 with 5-year increment
- Currently being updated.

TFT v3.0 uses ISTDM7 2015 & 2035 model run results.
Traffic Data

- INDOT’s Traffic Count Database System (TCDS)
- Use recent data (2001 – current)
- Tag count stations GIS layer & data to ISTDM 7 network

11,558 links has data
Forecasting Models in TFT v3.0

- Linear
- Linear Regression
- Exponential
- Adjusted Exponential
  - Indiana Traffic Growth Profile
- NCHRP 255 Calibration Procedure
Indiana Traffic Growth Profile

- A set of reasonable ranges of traffic growth rates – improve the Exponential model in TFT v3.0
- In current TCDS, 69% of count stations and 76% of AADT records only have data of 2010 or later.
- Short-term historical counts may introduce abnormal growth rates (outliers) that are associated with transient events.
Use Q-Q plot to filter outliers (normally distributed data should follow a straight line with correlation coef. = 1.0)

Example: Rural Interstate (raw data)

Example: Rural Interstate (cleaned data)

correlation coef. = 0.89

correlation coef. = 0.99
### Indiana Traffic Growth Profile (cont.)

<table>
<thead>
<tr>
<th>Functional Classification</th>
<th>Rural</th>
<th></th>
<th></th>
<th>Urban</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>99% CI -</td>
<td>Mean</td>
<td>99% CI -</td>
<td>99% CI -</td>
<td>Mean</td>
<td>99% CI -</td>
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<td>Upper</td>
<td>Lower</td>
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<td>Upper</td>
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<tr>
<td>1 - Interstate</td>
<td>0.46%</td>
<td>0.88%</td>
<td>1.31%</td>
<td>1.04%</td>
<td>1.28%</td>
<td>1.52%</td>
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<tr>
<td>2 - Other Freeway or Expressway</td>
<td>0.88%</td>
<td>1.89%</td>
<td>2.90%</td>
<td>0.59%</td>
<td>1.13%</td>
<td>1.67%</td>
</tr>
<tr>
<td>3 - Other Principal Arterial</td>
<td>0.07%</td>
<td>0.26%</td>
<td>0.46%</td>
<td>-0.02%</td>
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<tr>
<td>4 - Minor Arterial</td>
<td>-0.08%</td>
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<tr>
<td>5 - Major Collector</td>
<td>-0.06%</td>
<td>0.02%</td>
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<td>0.07%</td>
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<td>-1.39%</td>
<td>-0.56%</td>
<td>0.26%</td>
<td>1.01%</td>
<td>1.44%</td>
<td>1.87%</td>
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**Cleaned Data**
Indiana Traffic Growth Profile (cont.)

<table>
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<tr>
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Cleaned Data vs. Raw Data

Additional table showing raw data MIN, MEAN, and MAX values for each functional classification.
### Indiana Traffic Growth Profile (cont.)

![Cleaned Data](image)

**Functional Classification**

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<td>-0.56%</td>
<td>0.26%</td>
<td>1.01%</td>
</tr>
</tbody>
</table>

\[
GF_{adj} = \begin{cases} 
CI_{99\%}, l, & \text{if } GF < CI_{99\%}, l \\
GF, & \text{if } CI_{99\%}, l \leq GF \leq CI_{99\%}, u \\
CI_{99\%}, u, & \text{if } GF > CI_{99\%}, u 
\end{cases}
\]
NCHRP 255 Adjustment Procedure

- **Ratio adjustment**
  
  \[ A_{ratio} = \frac{COUNT}{A_b} \times A_f \]

- **Difference adjustment**
  
  \[ A_{difference} = (COUNT - A_b) + A_f \]

- **Final adjustment**
  
  \[ RA_f = \frac{A_{ratio} + A_{difference}}{2} \]

where:

- \( COUNT = \) base year traffic count
- \( A_b = \) base year model volume
- \( A_f = \) future year model volume
- \( A_{ratio} = \) future year volume based on ratio adjustment
- \( A_{difference} = \) future year volume based on difference adjustment
- \( RA_f = \) final adjusted future year volume
TFT v3.0 – “About” Tab
TFT v3.0 “Preprocess” Tab

- **All-in-one button**
  - **Joins:**
    - 2015 ISTDM loaded network
    - 2035 ISTDM traffic loads
    - Historical traffic counts
  - **Green**-highlights links with historical traffic data.
  - Displays centroid connectors as grey dashed lines
A message box confirms the completion of pre-processing data.
TFT v3.0 “Estimation” Tab

- Select link(s)
- Remove link(s)
- Methods used for estimation
- Generate traffic estimation report
- Generate historical counts report
- Generate traffic estimation graph
- Generate traffic estimation graph adjusted by IN growth profile
Select & Clear Links

- "Select Link" button
  - select links.
  - TFT3 automatically red-highlights selected links and label link IDs.

- "Clear Link" button
  - remove all selected links
**TFT v3.0 – Historical Counts Report**

- **“Historical Counts” button** – generate traffic count report
  - Info organized by link
  - Key link attributes
  - 2001-2015 AADT
- Report must be closed before having another one.
- “Save As…” as needed
TFT v3.0 - Estimation Report

- **“Report” button** – generate traffic estimation report
- Report must be closed before having another one. “Save As…” as needed.

### Historical data

<table>
<thead>
<tr>
<th>Name</th>
<th>Estimation</th>
<th>History</th>
<th>ISTDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link ID</td>
<td>Linear</td>
<td>Linear</td>
<td>Linear</td>
</tr>
<tr>
<td>Count Station</td>
<td>Y = 70124 + 3398.00 (X - 2007)</td>
<td>Y = 90071.53 + 240.32 (X - 2015)</td>
<td></td>
</tr>
<tr>
<td>County</td>
<td>R-Square 124.17% **</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Route Name</td>
<td>Regression</td>
<td>Regression</td>
<td>Regression</td>
</tr>
<tr>
<td># of Lanes</td>
<td>Y = -5607123.60 + 2929.10 X</td>
<td>Y = -394163.77 + 240.32 X</td>
<td></td>
</tr>
<tr>
<td>Area Type</td>
<td>R-Square 92.20%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Beginning Point</td>
<td>Exponential</td>
<td>Exponential</td>
<td>Exponential</td>
</tr>
<tr>
<td>K Factor</td>
<td>Estimated Line Y = 70124 (1 + 4.18%)^n</td>
<td>Y = 90071.53 (1 + 0.260%)^n</td>
<td></td>
</tr>
<tr>
<td>% Truck</td>
<td>R-Square 124.30%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>ISTDM 2015 Volume</td>
<td>Annual Growth Rate 4.108%</td>
<td>0.260%</td>
<td></td>
</tr>
<tr>
<td>ISTDM 2035 Volume</td>
<td>Annual Growth Rate - adj. 1.516%</td>
<td>1.516%</td>
<td></td>
</tr>
</tbody>
</table>

### ISTDM data

<table>
<thead>
<tr>
<th>Name</th>
<th>Estimation</th>
<th>History</th>
<th>ISTDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link ID</td>
<td>Linear</td>
<td>Linear</td>
<td>Linear</td>
</tr>
<tr>
<td>Count Station</td>
<td>Y = 98298 + 1715.92 (X - 2002)</td>
<td>Y = 9450.93 + 1306.59 (X - 2015)</td>
<td></td>
</tr>
<tr>
<td>County</td>
<td>R-Square 217.76%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Route Name</td>
<td>Regression</td>
<td>Regression</td>
<td>Regression</td>
</tr>
<tr>
<td># of Lanes</td>
<td>Estimated Line Y = -2130727.26 + 1112.79 X</td>
<td>Y = -2530178.15 + 1306.59 X</td>
<td></td>
</tr>
<tr>
<td>Area Type</td>
<td>R-Square 49.89%</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Beginning Point</td>
<td>Exponential</td>
<td>Exponential</td>
<td>Exponential</td>
</tr>
<tr>
<td>K Factor</td>
<td>Estimated Line Y = 98290 (1 + 1.58%)^n</td>
<td>Y = 94503.93 (1 + 1.22%)^n</td>
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<tr>
<td>% Truck</td>
<td>R-Square 209.50% **</td>
<td>N/A</td>
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<tr>
<td>ISTDM 2015 Volume</td>
<td>Annual Growth Rate 1.506%</td>
<td>1.227%</td>
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<tr>
<td>ISTDM 2035 Volume</td>
<td>Annual Growth Rate - adj. 1.516%</td>
<td>1.516%</td>
<td></td>
</tr>
</tbody>
</table>

---

**Link #1**

**Link #2**

- Linear model
- Regression model
- Exponential model
- Adjusted AGR based on “IN traffic growth profile”
Graph(s) show:
- Historical traffic counts
- Fitted traffic volumes by selected method
TFT v3.0 “Forecast” Tab

- Select link(s)
- Remove link(s)
- Future year (>= 2030, default 2040)
- Methods used for forecasting
- Generate traffic forecast report
- Generate traffic forecast graph
- Adjusted by IN growth profile
- Linear
- Exponential
- Regression
- Exponential adjusted

Generate traffic forecast report

Close
### TFT v3.0 - Forecast Report

- **“Report” button** – generate traffic forecast report
- Report must be closed before having another one. “Save As…” as needed.

#### Link #1

<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
<th>Link #1</th>
<th>Link #2</th>
<th>Link #3</th>
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<tbody>
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<td>90312</td>
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<td>County</td>
<td>Marion</td>
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<td>97800</td>
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<tr>
<td>Route Name</td>
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<td>116814</td>
<td>91949</td>
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<td>0.96032</td>
<td>121543</td>
<td>92234</td>
<td>99550</td>
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<td>% Truck</td>
<td>17.249%</td>
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<td>92475</td>
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<td>127402</td>
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<td>ISTDM 2035 Volume</td>
<td>94878</td>
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<td>92855</td>
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#### Linear Regression

- Based on historical data
- NCHRP 255 adjustment

#### Exponential Regression

- Based on ISTDM data
- NCHRP 255 adjustment

#### Adjusted Exponential Regression

- Based on ISTDM data
- NCHRP 255 adjustment

### Link #2

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<td>95820</td>
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<td>115958</td>
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<td>117107</td>
<td>101127</td>
<td>126029</td>
<td>117107</td>
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### Data analysis

- The Traffic Forecasting Tool (TFT) v3.0 provides options for generating traffic forecast reports.
- Users can choose to generate reports based on linear or exponential regression models.
- Adjusted exponential regression models are also available, based on ISTDM data and NCHRP 255 adjustment.
- The report button allows users to generate traffic forecasts.
- Reports must be closed before generating another one.
- Users can save reports as needed.
Graph(s) show:
- Traffic forecast by historical data and selected method
- ISTDM 7 traffic forecast
- ISTDM 7 traffic forecast adjusted by NCHRP 255
- Capacities of LOS A - E
Potential Improvements to TFT v3.0

- Cover all segments of state owned roads by creating and using a new linear reference system.
- Compatible with the newer version of ISTDM (being updated)
- Incorporate more information in the tool to meet INDOT’s traffic forecasting needs
Questions?

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Part 2
KYTC TREDIS Post-Processor
Kentucky Statewide Model
Traffic Analysis Zone Structure

- Cover U.S. mainland (5,843 zones)
Traffic Analysis Zone Structure

- Detailed zones in Kentucky (4,624 zones)
Model Network Structure

- More than 86,000 total links
More than 71,000 links in Kentucky
KYSTM Structure

- A 4-step daily model in TransCAD Version 6
- Model Run Steps
  - Speed/Capacity calculation
  - Truck trip generation, distribution and assignment
    - Single Unit Trucks
    - Combination Trucks
  - Auto trip generation, distribution and assignment (MMA)
    - HBW, HBO, NHB, Business, Tourist, Other long distance trips
  - Highway Evaluation
Kentucky Statewide Model 
User Interface
Travel Demand Model Post-Processor

- Developed for Kentucky Transportation Cabinet (KYTC) to prepare the required inputs for TREDIS (Transportation Economic Development Impact System)
  - Automatic process
  - Minimal manual effort
- The post-processor uses TDM output files. Therefore, the user must run the model for the desired scenario first.
TREDIS

• Transportation Economic Development Impact System modeling software
  ➢ Economic impact analysis,
  ➢ Benefit-cost analysis,
  ➢ Financial analysis,
  ➢ Freight and trade impact analysis

• The only system applicable for all modes – covering passenger and freight transport via aviation, marine and rail modes, as well as truck, car, bus, bicycle, and pedestrian travel

• TREDIS can be used to make an assessment of the transportation and economic benefits of the different projects and helps in the project selection process
<table>
<thead>
<tr>
<th>Alternative</th>
<th>Region</th>
<th>Period</th>
<th>Mode</th>
<th>Purpose</th>
<th>Period Veh-Trips</th>
<th>Period VMT</th>
<th>Period VHT</th>
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</table>
Unique ID of the project to be analyzed

Scenario Name (Build, NB, …)

Fraction of congested miles based on this V/C threshold will be reported in the output file

Default values for the parameters as shown in the figure are suggested by KYTC

Two options to analyze either single or multiple counties

Annual factors to convert daily trips

Project Completion Year 2020

V/C Threshold 0.8

Auto Annual Factor 260

Truck Annual Factor 300
TREDIS User Interface – Selecting Multiple Counties
TREDIS User Interface – Running the Post-Processor
Post-Processor Run Completion

Note

Output bin and csv files are saved under the following folder:
C:\Models\KYSTMv17\2025_B\Results

OK
Output Files

- Output files are saved in .bin and .csv format

- The values from the output files can be directly used as inputs to TREDIS

### Purpose
- # of Trips
- VMT/VHT
- II/EI/IE Trips
- II/EI/IE Fractions
Output Files – Cont’d

- **Basic Info & Value**: These two fields include the basic information about the scenario model run including the fraction of congested miles which is calculated based on the V/C Threshold parameter.
- **Modes**: A list of all modes (The new KYSTMv17 processes 6 different auto trip purposes as well as two truck trip purposes):
  - **Auto Trip purposes**
    - Short Distance
      - HBW
      - HBO
      - NHB
    - Long Distance
      - Business
      - Tourist
      - OtherLD
  - **Truck Trip Purposes**
    - Long Distance (Combination Trucks)
    - Short Distance (Single Unit Trucks)
- **Vehicle Trips**: Total number of vehicle trips by vehicle types and trip purposes
- **Person Trips**: Total Number of person trips by vehicle types and trip purposes
- **VMT**: Total vehicle miles traveled by each vehicle type and trip purpose
- **VHT**: Total vehicle miles traveled by each vehicle type and trip purpose
Output Files – Cont’d

- **I-I Trips**: Total internal-internal vehicle trips made by each vehicle type and trip purpose
- **E-I Trips**: Total external-internal vehicle trips by each vehicle type and trip purpose
- **I-E Trips**: Total internal-external vehicle trips by each vehicle type and trip purpose
- **Fraction of I-I Trips**: Fraction of total internal-internal vehicle trips by each vehicle type and trip purpose
- **Fraction of E-I Trips**: Fraction of total external-internal vehicle trips by each vehicle type and trip purpose
- **Fraction of I-E Trips**: Fraction of total internal-external vehicle trips by each vehicle type and trip purpose
Questions ?

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