USING ARCHIVED TRUCK GPS DATA FOR FREIGHT PERFORMANCE ANALYSIS ON INTERSTATE I-94/I-90 FROM THE TWIN CITIES TO CHICAGO

Chen-Fu Liao
Minnesota Traffic Observatory
Department of Civil Engineering
Objectives

- Use available truck AVL data from ATRI to analyze freight activity along I-94/I-90
- Compare variations of truck speed and travel time to identify potential freight bottleneck and forecast future freight demand
- Identify the needs of local highway infrastructure improvement to sustain growing freight demand
Data Summary

- FAF2 Data from FHWA
- 12 months (May 08 ~ Apr. 09) of Truck AVL/GPS Data from ATRI
- Highway Speed Data from MNDOT, Wisconsin DOT and IL State Toll Highway Authority

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<tr>
<th>Month</th>
<th># of Trips</th>
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<td>57165</td>
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Data Processing Flow Chart

- **Segmentation Script**
  - Generate Segment Speed
  - Generate Network Segment Speed
  - Segmented Truck Speed
  - Generate Truck Speed Statistics

- **Create Route DB**
  - Locate Features
  - Generate AVL Data on Route
  - Data Quality Filtering
  - Truck Stops and Stop Durations

- **Raw Truck GPS Data**
Data Analysis

• Speed By Location
• Speed By Hour Of Day
• Speed and Volume at Location
• Performance Index
• Trip Destinations
• Truck vs. General Traffic
• Truck Stops & Durations
Average Truck Speed By Location

I-94/90 (TWIN CITIES – CHICAGO)
Average Truck Speed of April 2009

I-94 (St. Paul-Chicago) - 2009/04 (6:00-9:00) - Mean

St. Paul  Tomah  Madison  Chicago

Mile

Speed (MPH)

I-90 Toll Highway

Truck EB  Truck WB
Average Truck Speed STDEV of April 2009

I94 (St. Paul-Chicago) - 2009/04 (6:00-9:00) - Std. Dev.

- St. Paul
- Tomahawk
- Madison
- Chicago

Mile

Speed (MPH)

Truck EB
Truck WB

Department of Civil Engineering (MTO)
University of Minnesota
Average Speed (EB)
Average Speed (WB)

Average Speed Westbound

St. Paul  Tomah  Madison  Chicago

I-90 Toll Highway

Speed MPH

Mile

ITS INSTITUTE
Intelligent Transportation Systems

Department of Civil Engineering (MTO)
University of Minnesota
Truck Speed and Volume Variation By Time of Day

I-94/90 (Twin Cities – Chicago)
St. Paul, MN

Speed Distribution at US52, EB

Mean=46.9, Median=57.7, N=33,610

Speed Distribution at US52, WB

Mean=46.4, Median=54.6, N=33,788
Performance Index

Reliability Measure

Buffer Time Index (BTI) = \frac{95\% \text{ TT} - \text{Avg. TT}}{\text{Avg. TT}}

Buffer Speed Index (BSI) = \frac{95\% \text{ Speed} - \text{Avg. Speed}}{\text{Avg. Speed}}

Congestion Measure

Travel Time Index (TTI) = \frac{\text{Peak Travel Time}}{\text{Free Flow Travel Time}}
Buffer Time Index (BTI) of Apr. 2009

\[ \text{BTI} = \frac{95\% \text{ TT} - \text{Avg. TT}}{\text{Avg. TT}} \]

- St. Paul
- Tomah
- Madison
- Chicago

I-90 Toll Highway

Madison

Toll Highway

Tollway

- 95\% TT
- Avg. TT
- Avg. TT

Eastbound

Westbound

Mile

Buffer Index
BTI by Hour of Day at US52 (MM18)

Buffer Time Index Nearby St. Paul (MM18), APR. 09

\[ \text{BTI} = \frac{95\% \text{ TT} - \text{Avg. TT}}{\text{Avg. TT}} \]
BTI by Hour of Day at MM393

Buffer Time Index Nearby O'Hare (MM393), APR. 09

\[
BTI = \frac{95\% \text{ TT} - \text{Avg. TT}}{\text{Avg. TT}}
\]
Travel Time Index (TTI) of Jan. 2009

Travel Time Index (TTI) = \( \frac{\text{Peak Travel Time}}{\text{Free Flow Travel Time}} \)
Travel Time Index (TTI) of Jan. 2009

Travel Time Index (TTI) = \frac{\text{Peak Travel Time}}{\text{Free Flow Travel Time}}
Trip Destinations Analysis

I-94/90 (TWIN CITIES – CHICAGO)
Distribution of Trip Destinations
Truck vs. General Traffic

I-94 (TWIN CITIES-HUDSON, WI)
I-94 Annual Average Speed (EB)

Average Free Flow Speed Obtained from Mn/DOT
I-94 Annual Median Speed (EB)

I-94 EB Annual Median Speed (St. Paul - Hudson)

All Traffic Free Flow Speed

Posted Speed Limit 65 MPH

Truck

Mile Marker

Average Free Flow Speed Obtained from Mn/DOT
I-94 Annual Average Speed (WB)

Average Free Flow Speed Obtained from Mn/DOT
I-94 Annual Median Speed (WB)

Average Free Flow Speed Obtained from Mn/DOT
Truck vs. General Traffic

I-90 (S. BELOIT – O’HARE)
I-90 Annual Average Speed (EB)

General Traffic Speed (Segment Speed) Derived from Illinois Toll Highway Authority Inter-Plaza Travel Time

[Graph showing annual average speeds along I-90 EB from S. Beloit to O'Hare, with different lines representing various years and traffic types, and a speed limit of 55 MPH highlighted.]
I-90 Annual Average Speed (WB)

**General Traffic Speed (Segment Speed) Derived from Illinois Toll Highway Authority Inter-Plaza Travel Time**
Truck Stops

I-94/90 (TWIN CITIES - CHICAGO)
EB Truck Stops (Apr. 2009)

Truck Speed < 5MPH and Travel Distance < 100 meters, N=72,543
WB Truck Stops (Apr. 2009)

Truck Speed < 5MPH and Travel Distance < 100 meters, N=74,405
Truck Stop Durations

I-94/90 (TWIN CITIES - CHICAGO)
Traffic Volume

I-90 (S. BELOIT- CHICAGO)
I-90 EB Truck Volume (Tier 4)
I-90 WB Truck Volume (Tier 4)
Summary

- FPM data can be used to measure performance over time and by location
- Truck travel time reliability and level of congestion
- Truck volume variation and impact
- Performance Index (BTI, TTI)
- Truck Destinations
- Truck Stops and Rest Durations
Possible Causes of Bottlenecks

- Top 30 freight bottlenecks occurred at highway interchange (ATRI Report)
- Roadway geometry (grade, sight distance)
- Capacity (number of lanes), Toll booths
- Required lane of travel for trucks
- Speed limit and free flow speed
- Volume ratio of truck vs. general traffic
- Weather and Others
Potential Applications

- Truck travel time reliability and impact of congestion on cost of freight
- Identify truck stop facility needs
- Speed gap between general traffic and truck influenced by traffic volume
- Need national standard to report freight performance measures regularly
- Use FPM data for freight study in metro area
Acknowledgements

- USDOT, FHWA
- Minnesota DOT and ATRI
- Illinois State Toll Highway Authority
- CTS, University of Minnesota (UMN)
- Minnesota Traffic Observatory (MTO), Department of Civil Engineering, UMN
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