Improving Freight Investment Decision-making with Big Data and Effective Communication Techniques

Bill Eisele, Ph.D., P.E., PMP
Senior Research Engineer & Mobility Division Head
Texas A&M Transportation Institute

May 5, 2022
Freight Mobility Research Institute (FMRI)
Boca Raton, Florida
Our Conversation Today

• A brief TTI Introduction
• The typical freight data
• Selected projects and visualizations
• Freight challenges (and opportunities)
• Some final thoughts
• Discussion
**Vision**

TTI leads in the creation of knowledge that transforms transportation for the benefit of society.

**Mission**

TTI delivers practical, innovative and sustainable solutions to improve the movement of people, data, and goods through research, education, and technology transfer.
Legacy
Established 1950
State Agency
Early Focus: roadside safety, pavements, bridges
Current Research Emphases

Technology
CAV
Mobility
Human Behavior
Our Research Portfolio

- Mobility
- Economics
- Infrastructure
- Workforce Development
- Human Interaction
- Connected Transportation
- Safety
- Policy
- Planning and Operations
- Freight
- Environment
- Security
I want you to…

• ...keep in mind why informed system performance is important – decision-making, accountability, transparency, and “it’s the right thing to do.”

• ...understand that data are available (and constantly improving) to help tell the story of person and goods movement (and related investment needs) across modes.

• ...understand that supply chain data are the “Holy Grail” of freight data to inform modal data integration.

• ...know that there are many on-going successful national, state and local mobility analyses activities and visualizations (several examples are provided) from which we can build for improved decision-making.
Why Care about Freight Transportation?

• It’s only important if you eat…. 
• ….or buy anything 
• The backbone of our economy (supply chains, logistics systems) 
• All modes are critical to freight transportation 
  • Trucks (big and small), rail, air, ports (ships), bikes, robots, etc. 
• Explosion in e-commerce 
• And so much more…. 
Fixing the Problem Starts with Understanding It
Understanding System Performance to Improve Planning and Investment Decisions

With improved understanding, we can…

• …identify when, where, and how people and goods are moving
• …identify congested locations & bottlenecks in the system
• …inform policy, program, and project prioritization/selection
• …identify impacts of situations & solutions
• …inform performance management (system monitoring)
• …and because it’s the right thing to do!
  • Accountability and transparency
The (Freight) Data

• **Travel Time & Travel Time Reliability (“Easiest”)**
  Highway monitoring systems; National Performance Management Research Dataset; company/vendor probe datasets; Automatic Identification System (AIS)

• **Cost (using value of time, cost of unreliability) (“Moderately Easy”)**
  Business-to-business information; survey input; industry input/trends; Consumer Price Index

• **Volume of goods (“More Difficult”)**
  Commodity Flow Survey; Freight Analysis Framework; Economic Census; Highway Performance Monitoring System; Lloyd’s Register; industry input
The (Freight) Data (cont.)

- **Origin-Destination Data ("Getting Easier")**
  Travel surveys; vendor datasets (QA/QC); Electronic Logging Devices (ELDs)

- **Supply Chain End-to-End Data (across modes) ("Difficult")**
  The “Holy Grail”; business-to-business information; supply chain survey input; industry input

*Evolving technologies (AV/CV, robots, drones, etc.) will provide future data sources…*
2021 Urban Mobility Report

- Evaluates mobility conditions in urban areas
- Freeway and principal arterial street networks
- 101 urban areas from 1982 to 2020
- 393 <mostly smaller> urban areas from 2014 to 2020
- Uses a suite of performance measures

https://mobility.tamu.edu/umr
### National Congestion Statistics

- Annual 2020 congestion costs and travel delays were half the 2019 levels

<table>
<thead>
<tr>
<th>Measure</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Delay Per Auto Commuter (hours)</td>
<td>54</td>
<td>27</td>
</tr>
<tr>
<td>Wasted Fuel Per Auto Commuter (Gallons)</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Congestion Cost Per Auto Commuter (in 2020$)</td>
<td>$1,170</td>
<td>$605</td>
</tr>
</tbody>
</table>

[https://mobility.tamu.edu/umr](https://mobility.tamu.edu/umr)
National Congestion Statistics

<table>
<thead>
<tr>
<th>Measure</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of Extra Travel Time (Billions)</td>
<td>8.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Gallons of Fuel Wasted (Billions)</td>
<td>3.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Cost to Society (Billions)</td>
<td>$190</td>
<td>$101</td>
</tr>
<tr>
<td>Truck Congestion Cost (Billions)</td>
<td>$20</td>
<td>$11</td>
</tr>
<tr>
<td>Tons of Extra CO2 Due to Congestion (Million)</td>
<td>36</td>
<td>18</td>
</tr>
</tbody>
</table>

- Total congestion delay was similar to 1997

https://mobility.tamu.edu/umr
## Selected Florida Congestion Statistics

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>Delay per Auto Commuter 2020, 2019</th>
<th>Cost per Auto Commuter 2020, 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami, FL</td>
<td>27 (42), 74 (10)</td>
<td>$608 (35), $1,606 (11)</td>
</tr>
<tr>
<td>Orlando, FL</td>
<td>22, 61</td>
<td>$471, $1,261</td>
</tr>
<tr>
<td>Jacksonville, FL</td>
<td>21, 53</td>
<td>$448, $1,089</td>
</tr>
<tr>
<td>Tampa-St. Petersburg, FL</td>
<td>18, 53</td>
<td>$401, $1,125</td>
</tr>
<tr>
<td>Cape Coral, FL</td>
<td>15, 45</td>
<td>$337, $938</td>
</tr>
<tr>
<td>Sarasota-Bradenton, FL</td>
<td>12, 35</td>
<td>$247, $695</td>
</tr>
</tbody>
</table>

*Bold = 2020 values*

[https://mobility.tamu.edu/umr](https://mobility.tamu.edu/umr)
Miami Visualization

Miami Mobility Report 2021

Miami's 2020 delay is 37% of 2019 delay levels.

What Time Did Congestion Happen in 2020?

2020 Congestion
- Total Annual Delay: 112,879K Hours
- Annual Delay/Commuter: 27 Hours
- Congested Weekday: 45

Economic
- Annual Congestion Cost: $2.491M
- Congestion Cost/Commuter: $608

Cost Components
- Value of Time: $20.17/Hour
- Commercial Value of: $55.24/Hour
- Avg State Gasoline Cost: $2.26/Gallon
- Avg State Diesel Cost: $2.71/Gallon

Environmental
- Excess Fuel Consumed: 44,167K Gallons
- Excess Fuel Consumed/Commuter: 8 Gallons
- Wasted Fuel/Commuter: 13 Gallons
- Excess CO2 from Congestion: 440K Tons
- Excess CO2 from Congestion: 8

Delay Split

Cost Comparisons
FHWA Freight Mobility Trends (FMT) Tool

Freight Mobility Trends and Highway Bottlenecks

The Federal Highway Administration’s (FHWA) Office of Operations has created a Freight Mobility Trends Analysis Tool to present national freight statistics and identify freight highway bottlenecks on the Interstate System, National Highway System (NHS), National Highway Freight Network (NHFN), and Strategic Highway Network (SHANET). This page provides information on Freight Mobility Trends.

Freight Mobility Trends Report

The Freight Mobility Trends Report provides high-level, national trends in freight mobility and assesses freight movement over a range of locations based on truck travel data:

- Measures of freight mobility at the National, State, regional, or corridor level.
- Freight mobility around major ports, intermodal facilities, and border crossings.
- Identification of freight highway bottlenecks.

The Freeway Mobility Report uses large vehicle probe-based travel time data from FHWA’s National Performance Management Research Data Set (NPMRDS). The report is produced annually and compares data from the most recent year to the previous year.

Freight Mobility Trends Tool

The FHWA Freight Mobility Trends Analysis Tool is an interactive dashboard that presents national freight statistics and identifies freight highway bottlenecks on the Interstate System, NHS, NHFN, and SHANET. This program uses a Freight Mobility Trends dashboard with indicators to assess freight movement based on truck travel data. The three dashboards are as follows:

- National, State, and Urban Area Freight Statistics: This view provides a national overview of freight performance indicators, State and urban area/Metropolitan Planning Organization (MPO) performance, and a comparison tool to view State and urban area/MPO trends.
- National Freight Bottlenecks: This view provides a ranked list of specific freight bottlenecks nationally or by state in addition to more detailed information. The visualization also includes a separate view of the freight bottlenecks around airports, border areas, intermodal facilities, and ports.
- National Freight Commodity Corridors: This view provides an overview of national freight corridors.

General instructions are available at: Freight Mobility Trends instructions.

Freight Highway Bottlenecks

The Freight Mobility Trends Analysis Tool has been used to identify major freight highway bottlenecks and congested corridors based on annual truck-hours of delay per mile. Delay per mile is calculated for each Interstate segment using the INFOTRANS travel time data. The delay per mile measures capacity performance over the entire Interstate System and across all States for corridors of different lengths.

The following Freight Highway Bottlenecks Reports list the top 100 Interstate bottlenecks and congested corridors in the United States. FHWA conducts this analysis on an annual basis to update the list, track trends, and gain insight into successful transportation management techniques to address congestion at major bottlenecks.

2019 National List of Major Freight Highway Bottlenecks and Congested Corridors (HTML, PDF, 636KB)
2018 National List of Major Freight Highway Bottlenecks and Congested Corridors (HTML, PDF, 510KB)

This analysis uses delay per mile to assess bottlenecks over the entire Interstate System. Individual State Departments of Transportation (DOTs) and MPOs use a variety of bottleneck identification methods based upon their local traffic characteristics, infrastructure constraints, and impediments to efficient freight movement. These methods include congestion, delay,
FHWA Freight Mobility Trends (FMT) Tool
FHWA Freight Mobility Trends (FMT) Tool
FHWA Freight Mobility Trends (FMT) Tool

Select Port Area Roadway Statistics

Click a facility to see how its corridors performed.

Top 336 Freight Bottlenecks around Port Areas based on Delay/Mile

Segment Trend (Hover or click a road in the table)
### Texas Department of Transportation
**100 Most Congested Roads**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Truck Rank</th>
<th>Roadway</th>
<th>From</th>
<th>To</th>
<th>County</th>
<th>Annual Hrs of Delay per Mile</th>
<th>Annual Hrs of Truck Delay per Mile</th>
<th>TI</th>
<th>PTI</th>
<th>CSI</th>
<th>Annual Congestion Cost (M)</th>
<th>Annual Truck Congestion Cost (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>IH 610</td>
<td>IH 10 / US 90</td>
<td>US 59 / IH 69</td>
<td>Harris</td>
<td>1,112,917</td>
<td>68,897</td>
<td>2.45</td>
<td>3.89</td>
<td>3.25</td>
<td>$90.63</td>
<td>$20.99</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>IH 35</td>
<td>US 290 N</td>
<td>SH71</td>
<td>Travis</td>
<td>1,085,136</td>
<td>108,645</td>
<td>2.71</td>
<td>4.73</td>
<td>3.54</td>
<td>$215.22</td>
<td>$72.33</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>US 59</td>
<td>IH 610</td>
<td>SH 288</td>
<td>Harris</td>
<td>870,291</td>
<td>51,604</td>
<td>2.12</td>
<td>3.36</td>
<td>2.17</td>
<td>$105.83</td>
<td>$23.64</td>
</tr>
<tr>
<td>4</td>
<td>44</td>
<td>Woodall Rodgers Pkwy</td>
<td>US 75</td>
<td>N Beckley Ave</td>
<td>Dallas</td>
<td>748,546</td>
<td>14,976</td>
<td>2.03</td>
<td>3.06</td>
<td>2.31</td>
<td>$21.31</td>
<td>$1.81</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>IH 10 / US 90</td>
<td>N Eldridge Pkwy</td>
<td>Sam Houston Tollway W</td>
<td>Harris</td>
<td>659,959</td>
<td>48,855</td>
<td>1.95</td>
<td>3.33</td>
<td>2.30</td>
<td>$50.23</td>
<td>$13.43</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>IH 45</td>
<td>Sam Houston Tollway W</td>
<td>IH 610</td>
<td>Harris</td>
<td>656,582</td>
<td>39,713</td>
<td>1.69</td>
<td>2.33</td>
<td>2.01</td>
<td>$135.37</td>
<td>$31.08</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>IH 635</td>
<td>IH 35E / US 77</td>
<td>US 75</td>
<td>Dallas</td>
<td>584,661</td>
<td>49,538</td>
<td>1.86</td>
<td>2.58</td>
<td>2.34</td>
<td>$112.58</td>
<td>$33.59</td>
</tr>
<tr>
<td>8</td>
<td>14</td>
<td>IH 35E / US 77</td>
<td>SH 183</td>
<td>IH 30</td>
<td>Dallas</td>
<td>555,861</td>
<td>32,302</td>
<td>1.72</td>
<td>2.62</td>
<td>2.14</td>
<td>$67.3</td>
<td>$14.81</td>
</tr>
</tbody>
</table>

[https://mobility.tamu.edu/texas-most-congested-roadways/]
https://mobility.tamu.edu/texas-most-congested-roadways/
Truck Delay in Austin, Texas
Select Link Analysis - Heat Maps

Truck Trip Patterns (for All Trucks Using I-35W Northbound in Downtown Fort Worth)

Density of truck trips that used northbound I-35W between SH 183 and I-30 between 5:00PM & 6:00PM.
- Texas 100 Section delay per mile rank:
  - Truck-only: 11,
  - All-vehicle: 23
- Datetime range: 11 JAN 2016 to 9 APR 2016

Analysis Section
- Trip Density
  - Many Trucks
  - Few Trucks
Unique Waypoint Data Application

Identifying Pop-up Intersections
- Map-match passive data to road network
- Filter data for US 285 N:
  - 300,000 trips
  - 37 million waypoints
- Visualize trip density
- Draw pop-up intersections
The Concept of “Freight Fluidity”

Freight Fluidity is the performance of the trips for goods moving in your state or region

- Awareness of goods moving in the region
- Understanding of current economic conditions and supply chain opportunities
- Use of awareness and economic/supply chain intel to identify key trip routes for freight
- Assessment of freight mobility and bottlenecks along these trip routes
Guidebook Provides Examples and Resources

What are the key goods and how are they transported?
- Texas Freight Mobility Plan
- Regional Freight Transportation Plans
- Freight Analysis Framework

Where Is the Economic Opportunity?
- Census Bureau Commodity Flow Survey
- Bureau of Economic Analysis (industries, production, consumption)

How Well Are Freight Corridors Moving Freight?
- "TX100", TCAT, UMR
- In-Depth, Location-Specific Information using NPMRDS
- Multimodal: Port and Border Crossing Analysis
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight Fluidity in Detail</td>
<td>Framework Development</td>
<td>22</td>
<td>Port</td>
<td>27</td>
<td>Texas 100</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texas Freight Mobility Plan</td>
<td>Bottlenecks</td>
<td>23</td>
<td>Border</td>
<td>28</td>
<td>COMPAT/TCAT</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional or Local Plans</td>
<td>Performance Measurement/ Visualization</td>
<td>24</td>
<td>Next Steps</td>
<td>34</td>
<td>FHWA Freight Mobility Trends</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight Analysis Framework</td>
<td>Multimodal Trip Connections</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Who Is the User? |
|------------------|-----------------|-----------------|-------------------|-----------------|-----------------|-----------------|
| Leadership/Decision Maker                                   | Main User       | Main User       | Main User         | Secondary User  | Secondary User  |
| Planner/Policy Analyst                                       | Main User       | Main User       | Main User         | Main User       | Main User       |
| Operator                                                    | Secondary User  | Secondary User  | Main User         | Main User       | Main User       |
| Industry Partners                                           | Main User       | Secondary User  | Main User         | Secondary User  | Secondary User  |
Developing and Implementing a Freight Fluidity Management Framework for U.S. Ports (U.S. Army Corps of Engineers)
AIS Plot of All Vessels (Port of Baltimore)
Dwell Time at Terminal Areas
(Port of Baltimore)
Port Fluidity Analysis

• Practical Interpretation of Results (Port of Brownsville, Texas):
  • The coefficients represent unitary increments of traffic per roadway and direction by a unit of change in sea import or export flows.
  • Example:
    • Model 1 B2out (SH 48 Outbound), a unit of sea cargo (e.g., one ton) arriving at the Port of Brownsville, is expected to be associated with an increase of outgoing traffic (from the port) in SH 48 (B2) in the same week (“lag0” model) by 0.095%, and by 0.070% two weeks before (“lag2” model) vessel arrival.

• For a single vessel visit carrying 1,000 TEUS, this translates into 15 more trucks per week in the same week, and 11 more trucks per week two weeks before going out of the port on SH 48.
Understanding the ‘why’ (of what is happening): Implications of Urgent Deliveries

- Strain on supply chains and logistics
- Strain on the multi-modal transportation system (world-wide)
- Bottlenecks in the system

- Need for transportation projects, programs and policies to mitigate the impacts
Private-sector Demands/Solutions

• Carriers (and shippers) must make their delivery windows!
• “Next-day delivery” or “same day delivery” means must get product closer to customers before you click “add to cart” and “purchase now”
  • Warehouse and/or distribution centers closer to customers
• More trucks to “make their turns”
• Access to the curb
Amazon Patents – a glimpse into the future?

An underground warehouse

A hive of drones

“Multi-level fulfillment center for unmanned aerial vehicles”

Source: www.businessinsider.com
Amazon Patents – a glimpse into the future?

An underwater warehouse

A floating airship, or a blimp

Source: www.businessinsider.com
Amazon Patents – a glimpse into the future?

An accordion-like drone chute

Source: www.businessinsider.com
Technological Solutions are Coming Here

- Delivery robots
- Autonomous vehicles – beginning in the freight delivery, long-haul being tested (showing promise)
- “Space-age” deliveries

- What about technology xx?...

- …if it reliably and safely helps the private-sector hit delivery windows, it will be in the running.

- How do we plan transportation systems for this? (land use, city planning implications)
- How do we successfully engage the private sector for data sharing opportunities?
Some (More) Final Thoughts

• Data considerations
  • What do you really need and how often?
  • Data governance
  • Public-private partnerships
  • Non-disclosure Agreements (NDAs) (with vendor data)

• Needed human resources
  • Data scientists!!
  • Understanding of transportation systems (typical data ranges)
  • GIS, analytics within GIS
  • Bright students & young professionals!

• Visualization / Communication
  • Begin with the end in mind (what questions are you trying to answer)
  • Simple visualizations can often get it done (vs. more complex analytics)
  • Tie decision-informing results to economics (dollars, benefit/costs)
Contact Info & Selected Resources

Bill Eisele, Ph.D., P.E., b-eisele@tti.tamu.edu, 979-317-2461
(find me on LinkedIn)
Texas A&M Transportation Institute Mobility Division
http://mobility.tamu.edu

• TTI 2021 Urban Mobility Report, https://mobility.tamu.edu/umr/
• Transportation Research Board, Urban Freight Transportation Committee
  • http://urbanfreight.tti.tamu.edu
  • “Urban Freight Transportation Committee Centennial Paper: Embracing the Future with Insights from the Past”