COVID-19 and Its Effect on the Transportation System

Overview
- Broad Impacts
  - Transit, Air, Freight, Rail, ...
- Focus
  - Roadway Volume / Safety Metrics
- Detailed Analysis: Travel Time
  - Travel Time Reliability
  - Case Study: Major Arterials
- Concluding Remarks

PART 1 – COVID-19
Roadways - “The Big Picture”

By the end of March 2020, global road transport activity declined ~50% (IEA, 2020).

In Birmingham, Alabama:
- Estimated VMT decreased by 35%, 20% and 10% in April, May, June 2020 (ALDOT).

US Monthly Vehicle Miles Traveled: 2019 vs 2020 (2nd Quarter)

APRIL: Passenger Cars: -46% Commercial Vehicles -13%
Typically ~2% fluctuation; 2008 ~3.5%

What happened in 2020?
- Traffic Volume
  - 3.3 trillion vehicle-miles traveled (VMT) in 2019
  - 2.83 trillion VMT in 2020
  - Decrease of 13.2%
- Motor Vehicle Fatalities
  - Increase of 7.2%
- Traffic Fatality Rate
  - Traffic fatality rate per 100 million VMT ~1.37
    fatalities per 100 million VMT
  - Attributable: speeding, impaired/distracted driving, failure to wear seatbelts, …
What happened in 2021?

- “US Road Deaths Rise at Record Pace as Risky Driving Persists”, Hope Yen, Associated Press, February 5, 2022
- “U.S. Road Deaths Keep Breaking Records”, Sean Tucker, Kelley Blue Book February 2, 2022
- “Soaring US road deaths reflect the same lawlessness as Murder Surge Does” Nicole Gelinas, New York Post, February 6, 2022

First 9 Months of 2021

- Motor Vehicle Fatalities: 12% increase (31,720 deaths versus 28,325)
- VMT: 11.7% increase (244 billion miles)
- Crash fatality rate: remained relatively unchanged
  - 2021 (1.34) versus 2020 (1.28)
  - Declined in 2nd and 3rd quarters compared to the same two quarters in 2020

Lessons Learned: Big Picture

- COVID – 19 impacted
  - VMT, crashes
  - All modes (Transit down, bicycles up/down, air traffic, etc.)
  - Some ~unexpected
    - Risky behavior increased
    - 2020: Fatality rate increased
      - Originally: Volume decreased faster than decrease in fatalities

PART 2 – COVID-19

TRAVEL TIME RELIABILITY (TTR)

“A Deep Dive”
Q: What is travel time reliability (TTR)?

- Historically, transportation engineers have measured system performance by point estimates
  - Mean travel time
  - 95th percentile travel time
- Recently
  - Travel Time Reliability (TTR)

Q: What is travel time reliability (TTR)?

- FHWA
  - TTR measures the extent of unexpected delay to drivers
  - “the consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day”

Q: What is travel time reliability (TTR)?

- Highway Capacity Manual (HCM-6)
  - "Travel time reliability reflects the distribution of trip travel time over an extended period."
  - Function of weather events, incidents, and work zones, ...
- Highway Capacity Manual 6
  - New TTR Estimation Methodology (Arterials)

Does the HCM6 TTR Procedure Work?

- No longer measure performance by single measure
  - Mean, 95th percentile, etc.
- Reliability: Function of travel time distribution
  - Mean, median, variance, 95th percentile…
- No clear definition of TTR
- HCM6 uses simulation to model travel time
  - Not calibrated to any empirical data

Lessons Learned

- No longer measure performance by single measure
  - Mean, 95th percentile, etc.
- Reliability: Function of travel time distribution
  - Mean, median, variance, 95th percentile…
- No clear definition of TTR
- HCM6 uses simulation to model travel time
  - Not calibrated to any empirical data

ASCE JTE 2020 DOI: 10.1061/JTEPBS.0000451
COVID 19 PANDEMIC: Natural Experiment

- Is travel on US roadways “safer”?
  - Number of deaths, crash rate
- Did the pandemic result in more reliable arterial roadway travel times?
  - If so, which of the commonly used travel time reliability (TTR) metrics is ‘best’?

INRIX Travel Time Data

- Private sector
- Spatial: arterial roadway corridors (Nebraska)
- Time of day:
  - AM peak, PM, peak
  - 15 minute sub-periods
- Aggregation:
  - Average travel times
- March, April and May
  - 2018, 2019 and 2020 (Pandemic)

Testbeds (4 corridors, 2 Peak Periods, 2 directions) → 16 scenarios

Testbed 1: Omaha - Dodge Street (3.05 miles)

Part of National Highway System (US 6)

Max. AADT = 79,800 veh. PM Peak LOS = F

What Happened: WB Dodge Street AM Peak

<table>
<thead>
<tr>
<th>Period of TTD</th>
<th>Average Travel Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar18-May18</td>
<td>12</td>
</tr>
<tr>
<td>Mar19-May19</td>
<td>11</td>
</tr>
</tbody>
</table>

What Happened: WB Dodge Street AM Peak

<table>
<thead>
<tr>
<th>Period of TTD</th>
<th>Average Travel Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar18-May18 2018</td>
<td>12</td>
</tr>
<tr>
<td>Mar19-May19 2018</td>
<td>11</td>
</tr>
<tr>
<td>Mar20-May20 2020</td>
<td>14</td>
</tr>
</tbody>
</table>
The COVID-19 Pandemic and Its Effects on the Transportation System

**What Happened: WB Dodge Street AM Peak**

- Mean: -16.7%
- Standard Deviation: -46.8%

**All 16 scenarios (4 corridors, 2 Peaks, 2 Directions)**

- Mean (μ):
  - 7.1% to 23.2%; Average: -14.0%
- Standard Deviation (σ):
  - 16.5% to 69.4%; Average: -43.4%
- Coefficient of Variation (σ/μ):
  - -7.8% to -60.3%; Average: -34.3%
- Conclusion?
  - Travel times became more reliable
  - Regardless of definition

**US Transportation Agencies**

- Do not use common statistical metrics
  - Mean, standard deviation, etc.
  - “Users don’t understand”
- Have created a wide range of metrics
  - Travel Time Index (TTI)
  - Planning Time Index (PTI)
  - Level of Travel Time Reliability (LOTTR)
  - Buffer Index (BI)

**Travel Time Index**

\[ TTI = \frac{\text{Mean Travel Time}}{\text{Free Flow Travel Time}} \]

- “How much more time will I need to travel corridor compared to free flow conditions”
- Only considers mean travel time

**Planning Time Index**

\[ PTI = \frac{95^{th} \text{Percentile Travel Time}}{\text{Free Flow Travel Time}} \]

- “How much more time will I need to travel corridor compared to free flow conditions”
- Only considers mean travel time

**Travel Time Index**

- Difference (2020 to 2018/2019)
  - -7.1% to -23.2%; Average -14.0%
  - Same as mean analysis
The COVID-19 Pandemic and Its Effects on the Transportation System

**Planning Time Index**

\[ PTI = \frac{95^{th} \text{Percentile Travel Time}}{\text{Free Flow Travel Time}} \]

- “How much more time will I need to travel corridor and be less than 95 percent of the travel times compared to free flow conditions”
- Only considers 95th percentile travel time

**Level of Travel Time Reliability (LOTTR)**

\[ LOTTR = \frac{80^{th} \text{Percentile Travel Time}}{50^{th} \text{Percentile Travel Time}} \]

- Mandated: US National Highway System
- Difference (2020 to 2018/2019)
  - 0.5% to – 12.6%; Average: -3.1%
  - 80th Percentile and 50th Percentile
  - Changed at same rate
  - ~ No change in travel time reliability?

**Buffer Index**

\[ BI = \frac{95^{th} \text{Percentile Time} - \text{Mean Travel Time}}{\text{Mean Travel Time}} \]
The COVID-19 Pandemic and Its Effects on the Transportation System

Buffer Index

• Ratio
  • Measure of Dispersion to Measure of Central Tendency
  • Similar to COV

\[ BI = \frac{95th \ Percentile \ Time}{Mean \ Travel \ Time} \]

• Were the arterial roadways more reliable?
• Average across all 16 scenarios:
  - TTI: -14.0%
  - PTI: -19.6%
  - LOTTR: -3.1%
  - BI: -34.3%

• Answer: Depends what metric you use

Lessons Learned

• COVID 19
  • Profound effect on the transportation system
• Natural Experiment: How do we measure system performance
  • Crash rate up – we are less safe?
  • Travel Time Reliability ~ same (LOTTR)?
• Lesson
  • Reducing complex system to simple metrics can be misleading
  • Know your data, know your statistics in order to make meaningful inferences
The COVID-19 Pandemic and Its Effects on the Transportation System

All models are wrong but some are useful

Acknowledgements
- City of Lincoln, Nebraska DOT
- Data
- Paper Reviewers
- Great comments
- Graduate Students and Colleagues
- Dr. Jianan Zhou, Dr. Ernest Tufour, Dr. Antonio Hurbel, Dr. Li Zhao, Dr. George List*, Dr. Nagui Rouphail*, Dr. Elizabeth Jones, Dr. Jim Bonneson*, Mr. Sean Murphy, …
- * HCM6 Developers

THANK YOU!

Transportation Research Institute

Any Questions?

Travel Time Data Collection in US
- Government
  - Speed detectors (Radar, video)
  - Loop detectors
- Private Sector
  - Cell phone location, Bluetooth
  - StreetLight, ClearGuide, INRIX*

Example: EB Dodge Street, Omaha, NE (2019)
- Omaha - Dodge Street (1.55 miles)
- AADT Range (45700-79800 veh.)
- Posted Speed Limit (35-45 mph)
- LOS PM Peak (F)
**Findings**

- 5 test corridors / 9 scenarios
- Underestimated:
  - mean: 10.6% (1%, 31%)
  - variance: 51% (14%, 83%)
- In general, more congested the larger the differences

**Lessons Learned**

- HCM-6: Very innovative
- Simulation (Monte-Carlo)
- Importance
- Validation
- Calibration
- Next Steps
- Transferability of Calibrated Model
- Temporal, Spatial
- New approaches for TTR
- micro-simulation

**Bike Travel**

- Areas that are not known for bicycle commuting e.g. Knoxville (TN), Provo (UT)
- doubled in bike activity during May and June
- Others Metro areas that are well known for cycling to work
- had a decline but at a much lower rate than the decline in the VMT
The COVID-19 Pandemic and Its Effects on the Transportation System

**65th Annual Alabama Transportation Conference**

**February 9-10, 2022**

---

**Bike Travel % Change**

Source: streetlightdata.com

---

**US Monthly Urban Rail Trips: 2019 vs 2020**

FTA: Urban transit dropped 85% -- still not rebounded

---

**Traffic Volume Effect – Air Transport**

- Commercial flight activity declined approximately 75% (IEA, 2020)
- Decrease of 50% in airport revenue and two-fifths of passenger traffic (ACI 2020)
- 47% to 58% reduction of airline seats; loss of operating revenues of US$112 to 135 billion (ACI 2020)

---

**Traffic Volume Effect – Air Transport**

- Over the past years, US VMT fluctuate within 1 to 2% each year
- 2008 (great recession) VMT declined by 3.5%
- Covid-19 caused a 40.2% decrease in VMT by April 2020 compared to 2019

---

**2nd Quarter 2020**

- Traffic Volume
  - Total traffic volume decreased by more than 16%
- Fatalities
  - 8,870 people died in motor vehicle crashes
  - Decrease of 3.3% compared to 2019
  - Speeding, impaired/distracted driving, failure to wear seatbelts …
- Traffic Fatality Rate Increased
  - Traffic volumes decreased more significantly than did the number of fatal crashes
  - Traffic fatality rate per 100 million VMT ~ 1.37

---
Travel Time Data Collection in US

- Government
  - Speed detectors (Radar, video)
  - Loop detectors
- Private Sector
  - Cell phone location, Bluetooth
  - StreetLight, ClearGuide, INRIX*

Q: What is travel time reliability (TTR)?

- F-SHRP program defined TTR
  - as the variation in travel times over a time period, for example, an hour-to-hour or day-to-day variations