# Data-Driven Statistical Approaches for Modern Traffic Analysis

TexITE Meeting, Houston, April 10, 2026

# Presenters

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**Senior Project Manager, WSB**

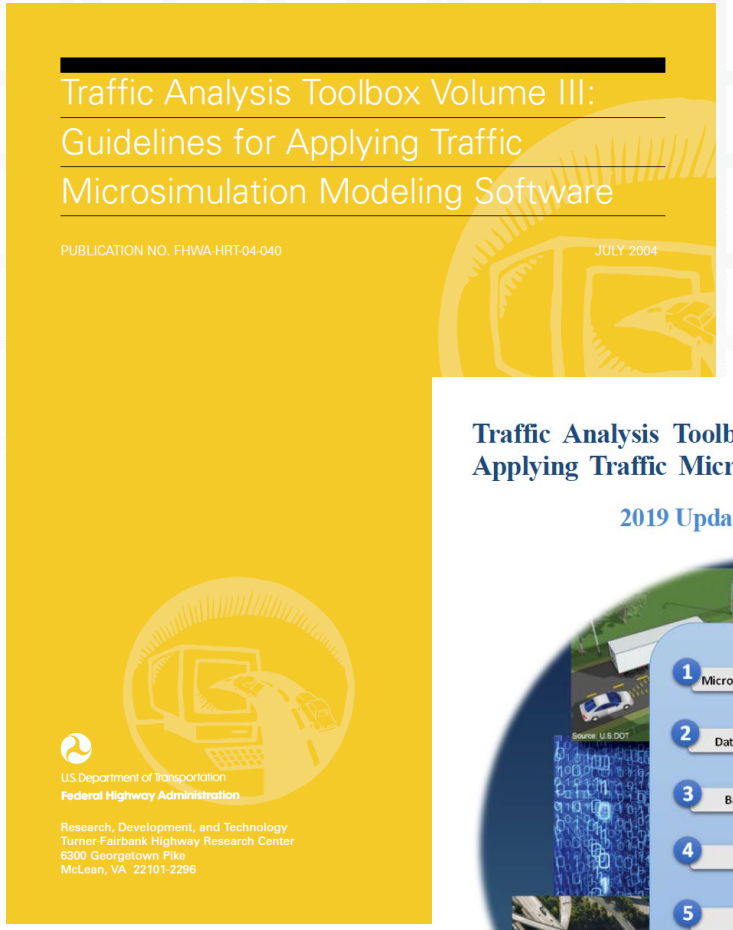
**Professor Emeritus, University of Florida**

# Outline

- FHWA TAT Vol. 3
  - Background
  - Cluster analysis process—conceptual overview and data needs
  - Level of adoption
- Software tool development
  - Overview
  - Future possibilities

# Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software

- 2004 Version
- 2019 Update




## 2004 Version

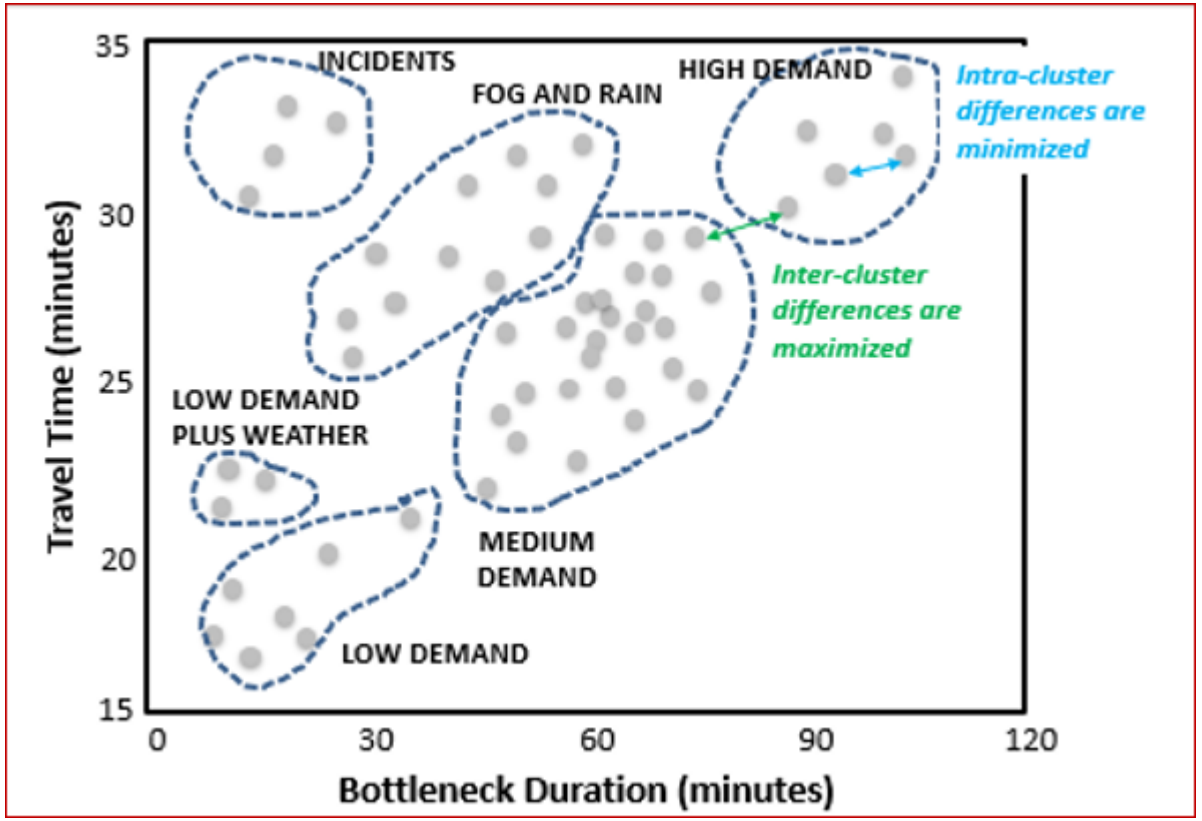
- 'Typical' day
  - Limits traffic volume variability
  - Network traffic volume inconsistency
  - Usually excludes impacts of adverse weather conditions and incidents
  - Analysis input conditions often do not correspond to any actual day
- GEH 'statistic'
- Some subjective calibration criteria (e.g., "To analyst's satisfaction")

## 2019 Update

- 365 days of data
  - Accounts for full year of traffic volume variability
  - Includes impacts of adverse weather conditions and incidents
  - Can also include other factors as desired (e.g., work zones)
- Use cluster analysis
  - Identifies logical groupings of conditions for given performance
  - Identifies days within clusters with conditions representative of the given cluster
- Variation envelopes and acceptability criteria for simulation calibration

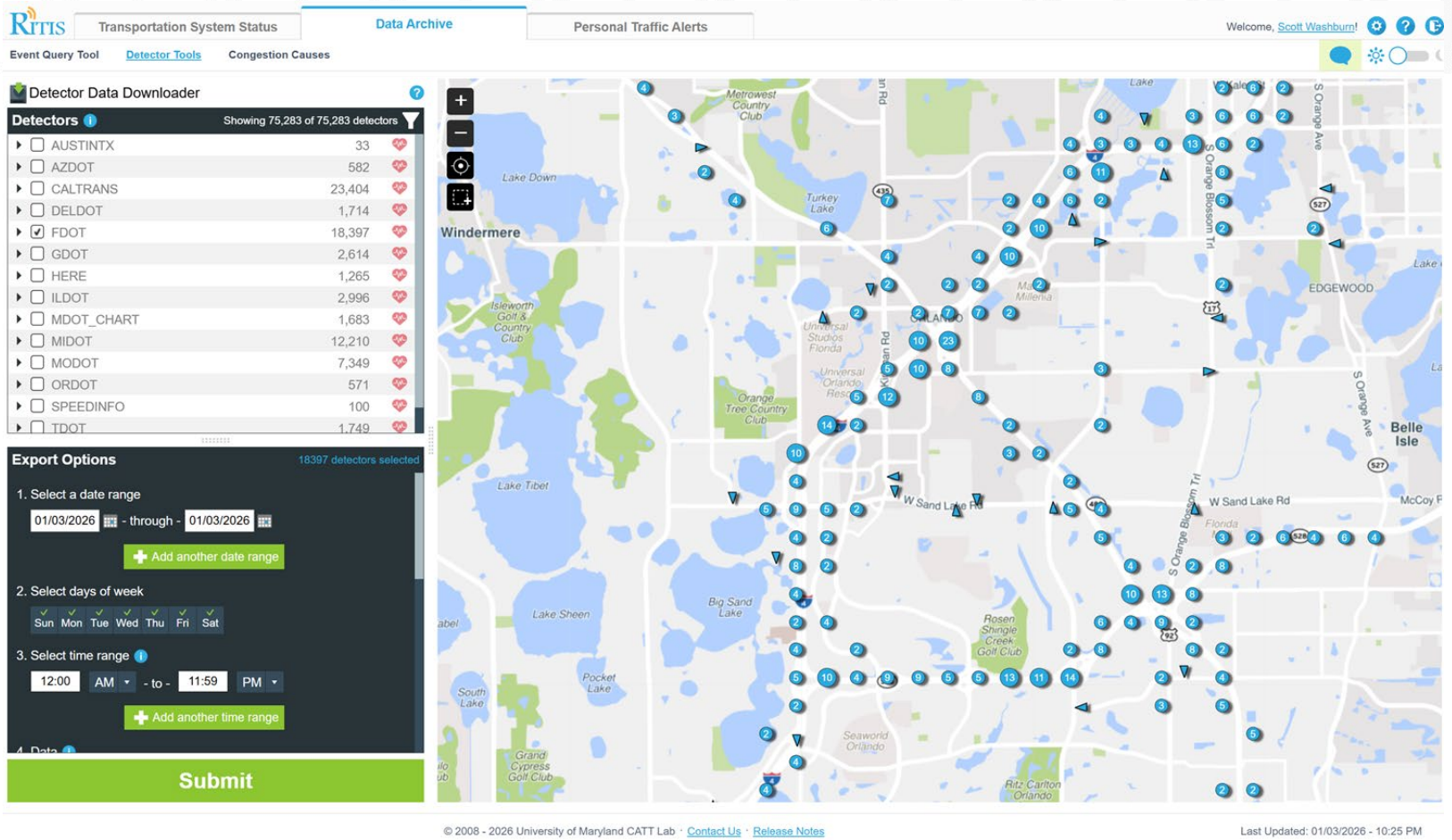
# Conceptual Overview of Cluster Analysis Process

- Method to automatically sort items into similar groups
  - Typically without a priori specification of group settings
  - Unsupervised learning method; i.e., no training data set and data are not “labeled”
  - Grouping is based on similarity of data attributes
  - ‘Similarity’ often defined by distance to cluster centroid



# 2019 TAT Vol. 3 Recommended Data Items

## Traffic Volumes

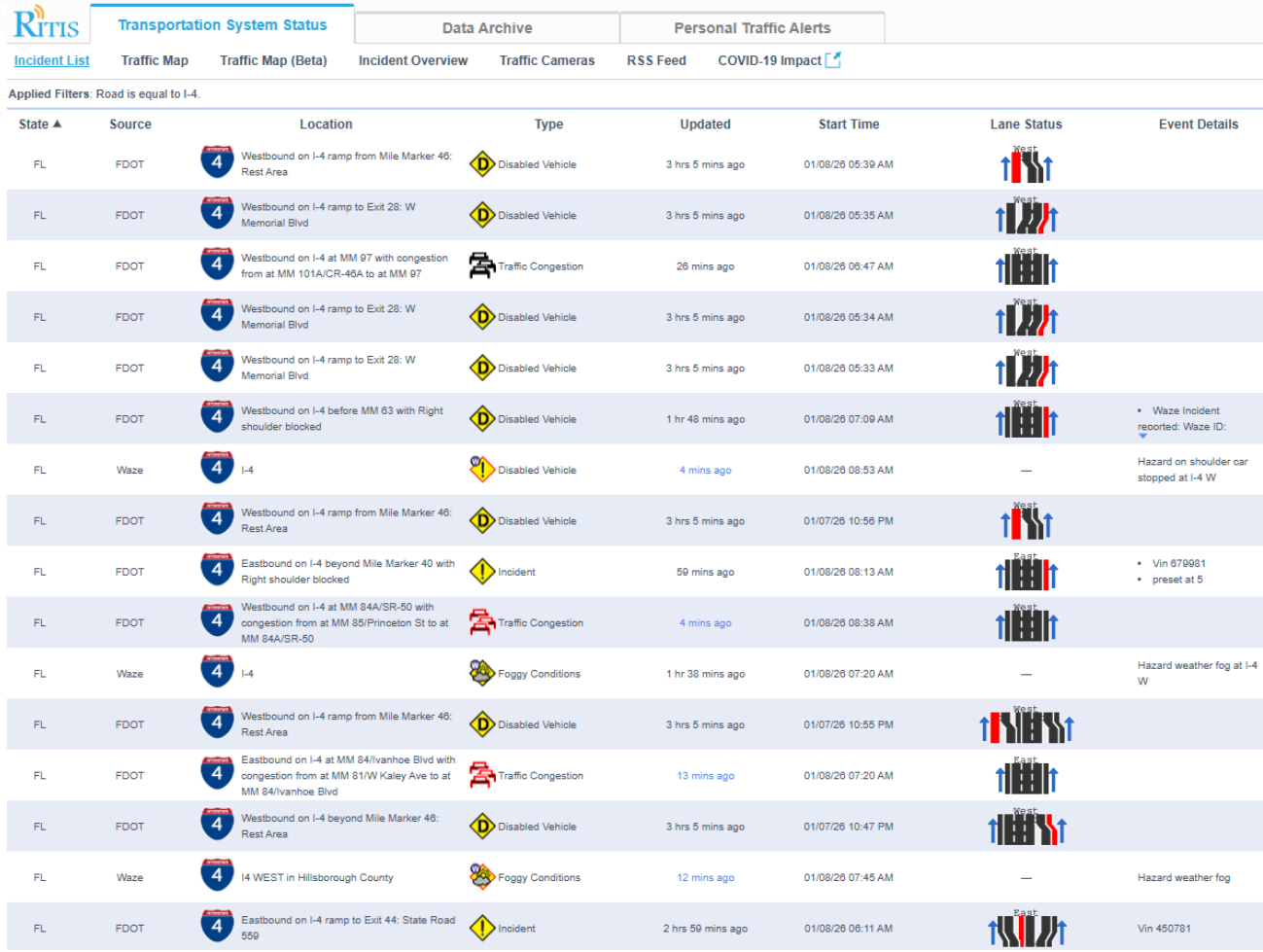


# 2019 TAT Vol. 3 Recommended Data Items

## Weather Events

# 2019 TAT Vol. 3 Recommended Data Items

## Incident Events



RITIS | Transportation System Status | Data Archive | Personal Traffic Alerts

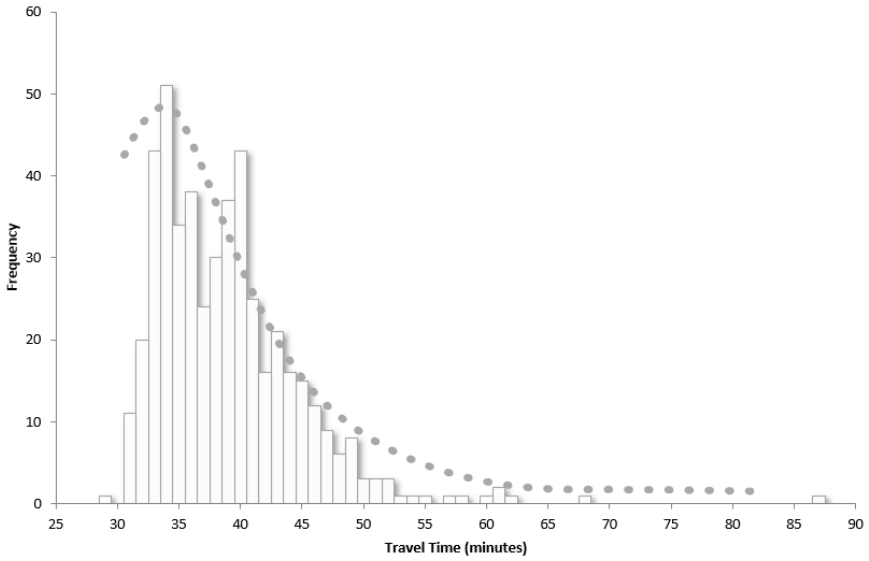
Incident List | Traffic Map | Traffic Map (Beta) | Incident Overview | Traffic Cameras | RSS Feed | COVID-19 Impact

Applied Filters: Road is equal to I-4.

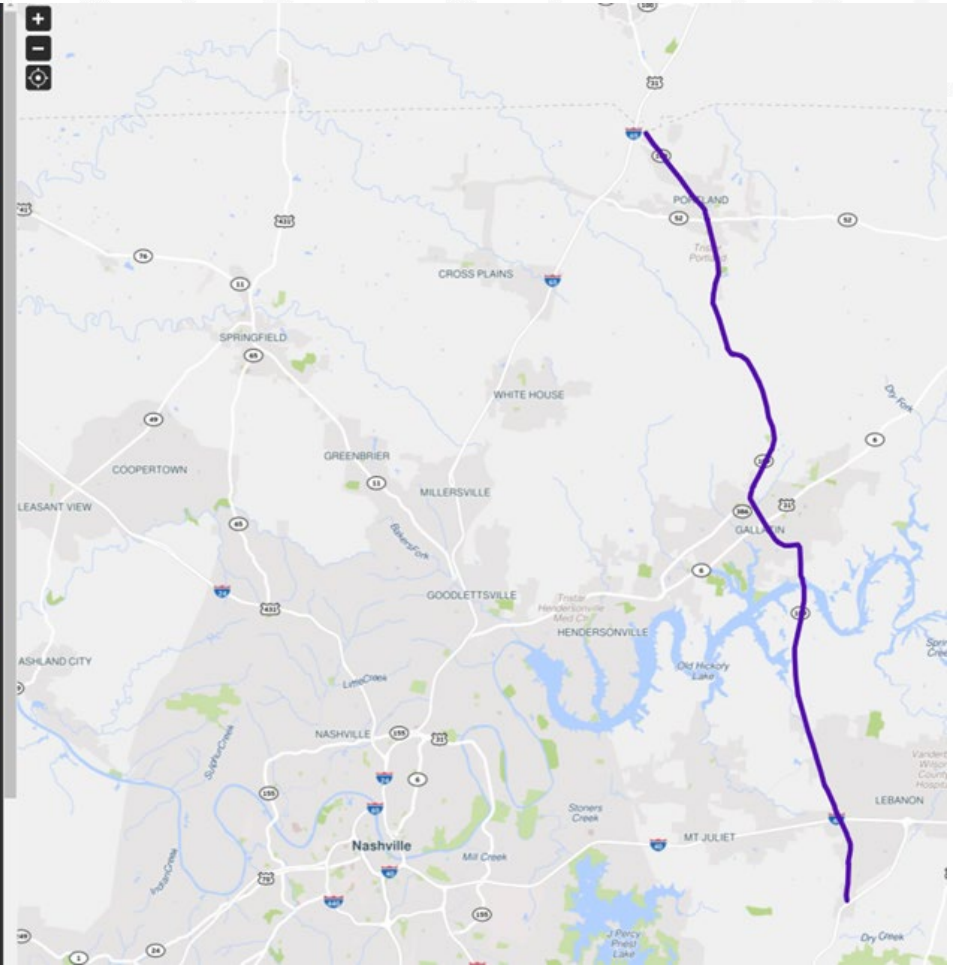
| State ▲ | Source | Location | Type | Updated | Start Time | Lane Status | Event Details |
|---|---|---|---|---|---|---|---|
| FL | FDOT | Westbound on I-4 ramp from Mile Marker 46: Rest Area | Disabled Vehicle | 3 hrs 5 mins ago | 01/08/26 05:39 AM | | |
| FL | FDOT | Westbound on I-4 ramp to Exit 28: W Memorial Blvd | Disabled Vehicle | 3 hrs 5 mins ago | 01/08/26 05:35 AM | | |
| FL | FDOT | Westbound on I-4 at MM 97 with congestion from at MM 101A/CR-46A to at MM 97 | Traffic Congestion | 28 mins ago | 01/08/26 06:47 AM | | |
| FL | FDOT | Westbound on I-4 ramp to Exit 28: W Memorial Blvd | Disabled Vehicle | 3 hrs 5 mins ago | 01/08/26 05:34 AM | | |
| FL | FDOT | Westbound on I-4 ramp to Exit 28: W Memorial Blvd | Disabled Vehicle | 3 hrs 5 mins ago | 01/08/26 05:33 AM | | |
| FL | FDOT | Westbound on I-4 before MM 63 with Right shoulder blocked | Disabled Vehicle | 1 hr 48 mins ago | 01/08/26 07:09 AM | | • Waze Incident reported: Waze ID: |
| FL | Waze | I-4 | Disabled Vehicle | 4 mins ago | 01/08/26 08:53 AM | — | Hazard on shoulder car stopped at I-4 W |
| FL | FDOT | Westbound on I-4 ramp from Mile Marker 46: Rest Area | Disabled Vehicle | 3 hrs 5 mins ago | 01/07/26 10:56 PM | | |
| FL | FDOT | Eastbound on I-4 beyond Mile Marker 40 with Right shoulder blocked | Incident | 59 mins ago | 01/08/26 08:13 AM | | • Vin 679981<br>• preset at 5 |
| FL | FDOT | Westbound on I-4 at MM 84A/SR-50 with congestion from at MM 85/Princeton St to at MM 84A/SR-50 | Traffic Congestion | 4 mins ago | 01/08/26 08:38 AM | | |
| FL | Waze | I-4 | Foggy Conditions | 1 hr 38 mins ago | 01/08/26 07:20 AM | — | Hazard weather fog at I-4 W |
| FL | FDOT | Westbound on I-4 ramp from Mile Marker 46: Rest Area | Disabled Vehicle | 3 hrs 5 mins ago | 01/07/26 10:55 PM | | |
| FL | FDOT | Eastbound on I-4 at MM 84/Ivanhoe Blvd with congestion from at MM 81/W Kaley Ave to at MM 84/Ivanhoe Blvd | Traffic Congestion | 13 mins ago | 01/08/26 07:20 AM | | |
| FL | FDOT | Westbound on I-4 beyond Mile Marker 46: Rest Area | Disabled Vehicle | 3 hrs 5 mins ago | 01/07/26 10:47 PM | | |
| FL | Waze | I4 WEST in Hillsborough County | Foggy Conditions | 12 mins ago | 01/08/26 07:45 AM | — | Hazard weather fog |
| FL | FDOT | Eastbound on I-4 ramp to Exit 44: State Road 559 | Incident | 2 hrs 59 mins ago | 01/08/26 06:11 AM | | Vin 450781 |

# 2019 TAT Vol. 3 Recommended Data Items

## Travel Times

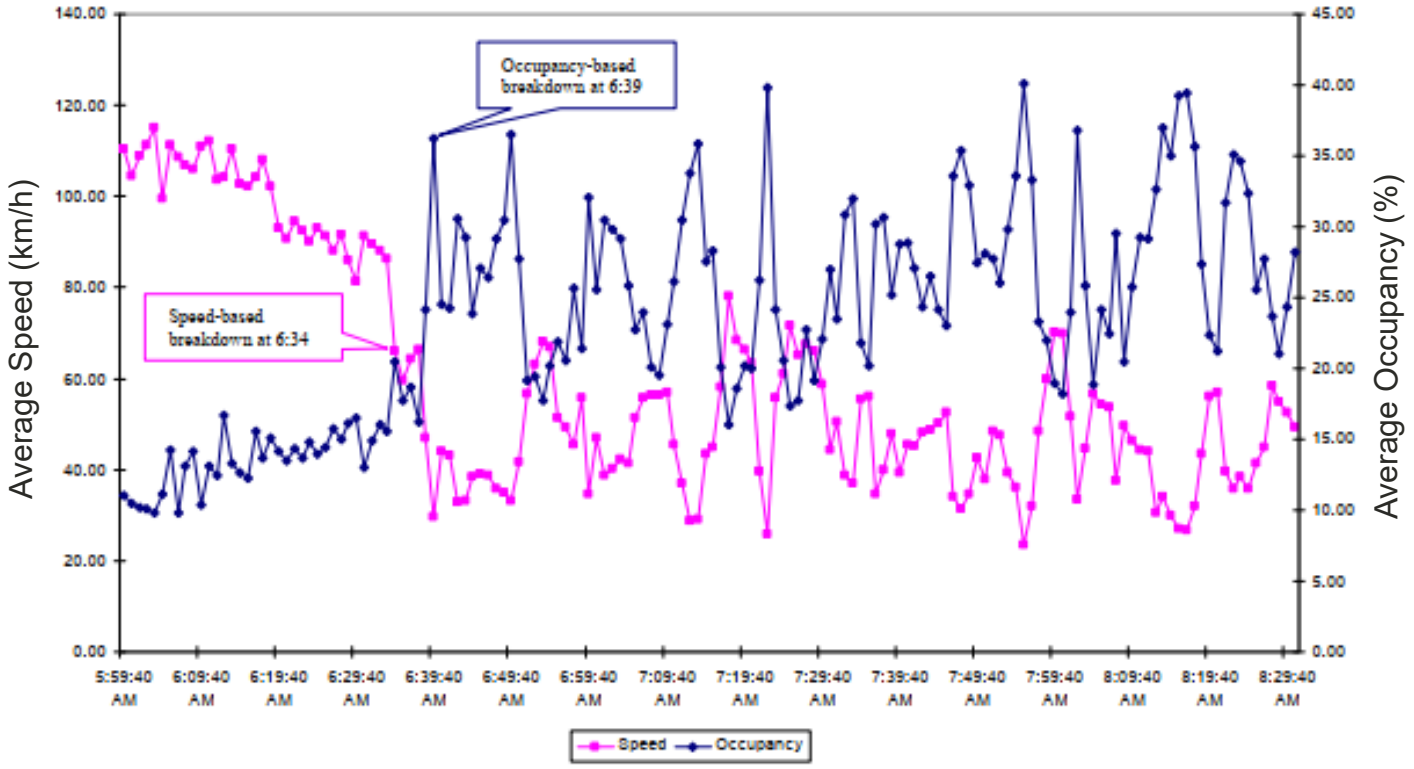






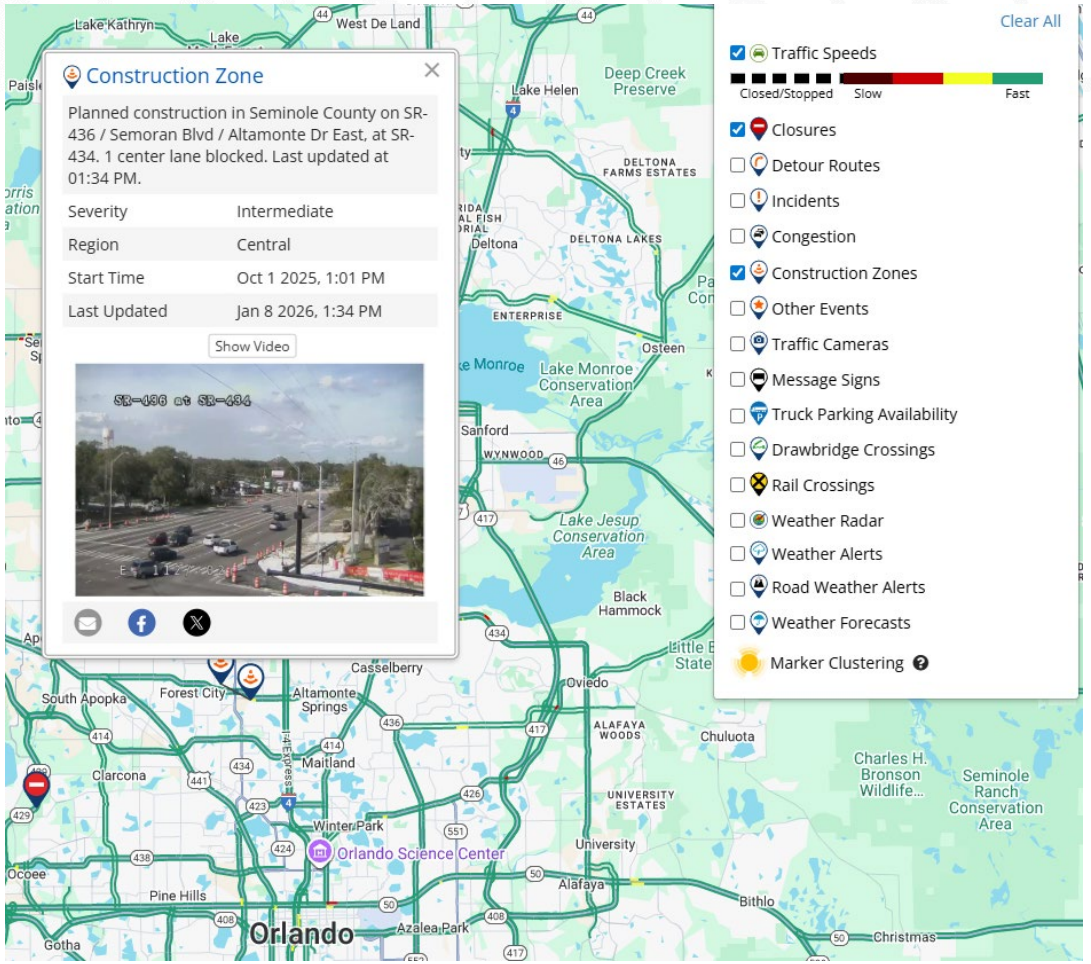
# 2019 TAT Vol. 3 Recommended Data Items

## Bottleneck Throughput Volumes



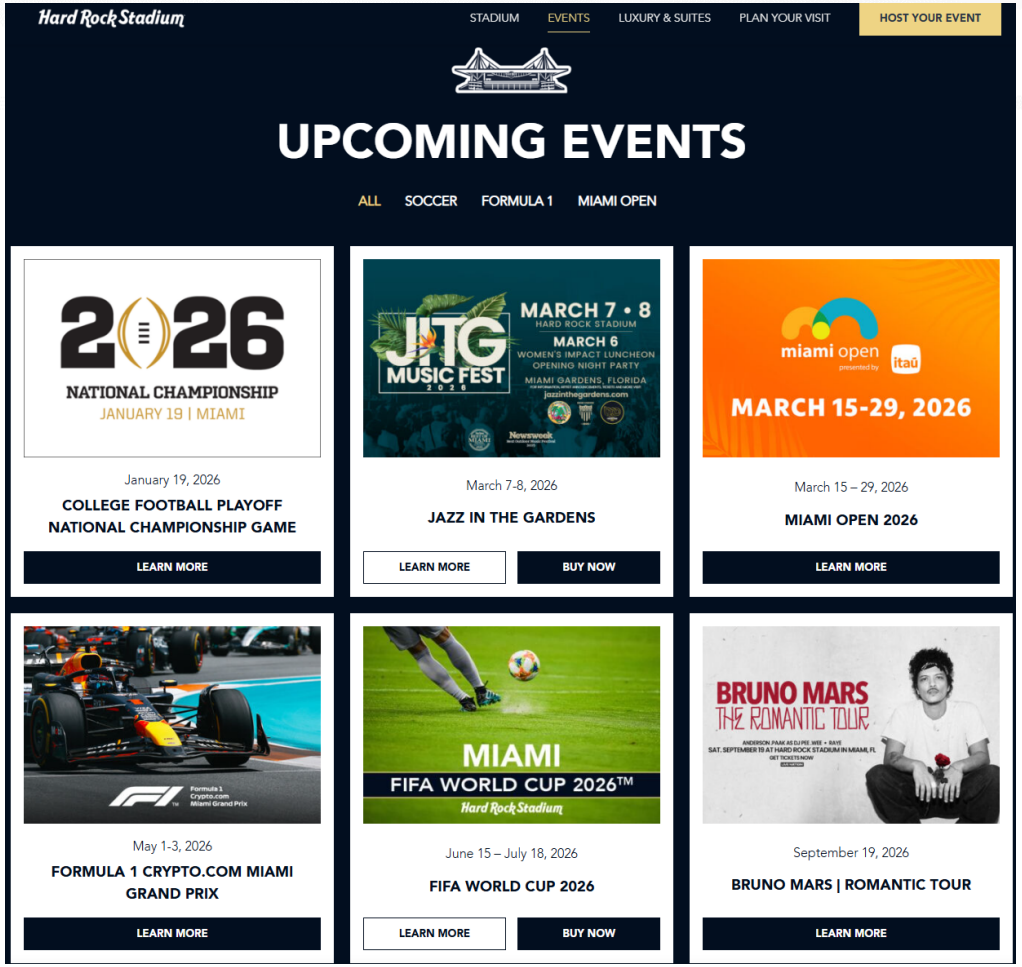
# 2019 TAT Vol. 3
# Other Potential Data Items

## Work Zone Activity



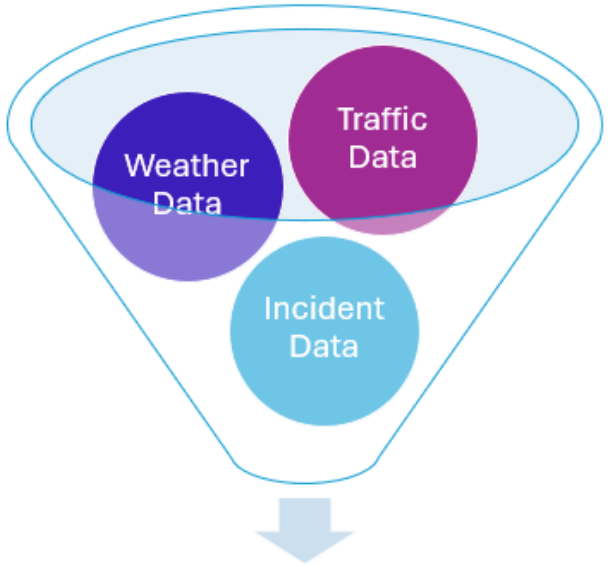
# 2019 TAT Vol. 3
# Other Potential Data Items

## Special Events



# Data Aggregation

- The disparate data sets must be aggregated into a single dataset to facilitate the calculations




# Data Aggregation

- For example…

TAT Vol. 3, 2019 Update

Table 1. Data Assembled for Travel Conditions Identification

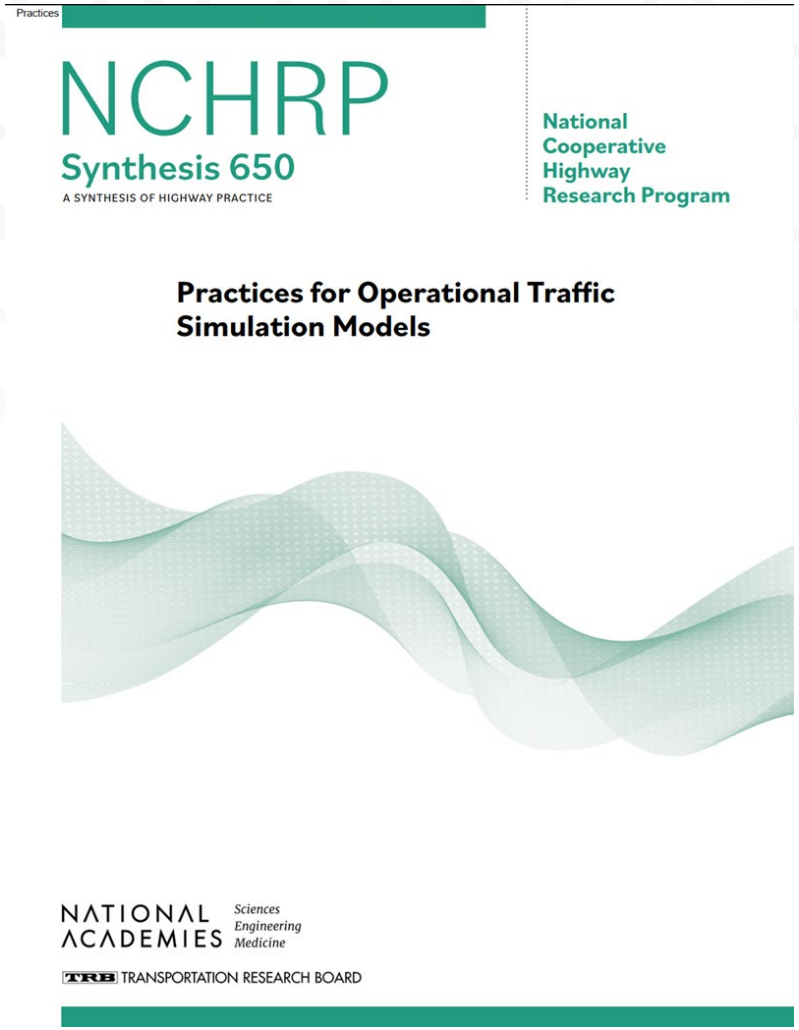
| DAY | Day of Week | AM Peak (6-9 AM) Demand (vph) | AM Peak (6-9 AM) Weather | | AM Peak (6-9 AM) Incident | | AM Peak (6-9 AM) Travel Time (min) | | | AM Peak (6-9 AM) Bottleneck Throughput (vph) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Detector #2; Avg. Count (vph) | Precipitation (mm) | Wind Speed (mph) | Incident Type | Lanes Blocked | WH to CBD (VIB) | WH to CBD (Tunnel-GP) | WH to CBD (Tunnel-HOV) | Marine Causeway-V.I.Bridge Link | V. I. Bridge Exit at Moseley Street | Komodo Tunnel Exit at Osceola Ave |
| 2-Jan-12 | 2 | 4650 | 0.034 | 4.54 | Disabled | Single Lane | 36 | 32 | 27 | 2525 | 1934 | 2042 |
| 3-Jan-12 | 3 | 4557 | 0.192 | 5.62 | Non-Injury Collision | Single Lane | 46 | 39 | 33 | 2015 | 1767 | 1652 |
| 4-Jan-12 | 4 | 4253 | 0.006 | 4.34 | Debris | Multiple Lane | 44 | 35 | 30 | 2478 | 1835 | 1760 |
| 5-Jan-12 | 5 | 5126 | 0.016 | 4.77 | Non-Injury Collision | Shoulder/Median | 26 | 24 | 21 | 2756 | 2105 | 2344 |
| 6-Jan-12 | 6 | 3529 | 0.04 | 6.18 | Debris | Multiple Lane | 43 | 36 | 32 | 2013 | 1843 | 1742 |
| 16-Jan-12 | 2 | 2875 | 0.07 | 1.55 | Non-Injury Collision | HOV | 49 | 40 | 36 | 1524 | 1690 | 1594 |
| 17-Jan-12 | 3 | 2783 | 0 | 3.08 | Injury Collision | Single Lane | 51 | 44 | 38 | 2183 | 1664 | 1418 |
| 18-Jan-12 | 4 | 3071 | 0.034 | 4.60 | Disabled | Single Lane | 35 | 32 | 28 | 1735 | 1956 | 2052 |
| 19-Jan-12 | 5 | 4348 | 0.298 | 6.13 | Debris | Multiple Lane | 44 | 36 | 32 | 1957 | 1820 | 1720 |
| 20-Jan-12 | 6 | 4119 | 0 | 3.39 | Debris | Single Lane | 30 | 27 | 22 | 2517 | 2084 | 2258 |
| 23-Jan-12 | 2 | 3799 | 0.37 | 10.23 | Abandoned Vehicle | Shoulder/Median | 60 | 53 | 42 | 2352 | 1550 | 1287 |
| 24-Jan-12 | 3 | 4872 | 0.076 | 1.70 | Disabled | HOV | 40 | 34 | 33 | 1753 | 1919 | 1943 |
| 25-Jan-12 | 4 | 3302 | 0 | 4.73 | Disabled | Shoulder/Median | 26 | 22 | 21 | 1586 | 2166 | 2431 |
| 26-Jan-12 | 5 | 3952 | 0 | 2.39 | Non-Injury Collision | Single Lane | 46 | 39 | 32 | 1957 | 1796 | 1681 |
| 27-Jan-12 | 6 | 3913 | 0 | 1.77 | Abandoned Vehicle | Shoulder/Median | 56 | 52 | 41 | 2722 | 1551 | 1272 |
| 30-Jan-12 | 2 | 4052 | 0.014 | 2.23 | Debris | Multiple Lane | 43 | 34 | 31 | 2723 | 1858 | 1795 |
| 31-Jan-12 | 3 | 4704 | 0 | 4.01 | Disabled | Single Lane | 35 | 32 | 28 | 1694 | 1940 | 2033 |

# 2019 TAT Vol. 3 Process Guidance

- Generally silent on:
  - Data collection, formatting, and management process
  - Data QC process
  - Identification of bottlenecks and determination of bottleneck throughput
- Statistical software tool used for example calculations, WEKA, (https://waikato.github.io/weka-wiki/), is somewhat obscure in the U.S.

# 2019 TAT Vol. 3 Adoption

- From page 2…
  - Synthesis findings indicate that responding DOTs most often use their own state-specific guidance (19 DOTs), followed by ad hoc project-based decisions (15 DOTs) for the calibration of operational traffic simulation models.
  - 6 responding DOTs primarily use the 2004 version of the TAT.
  - 4 responding DOTs primarily employ the 2019 version.
  - 5 responding DOTs use resources from other states.
  - Although there is general movement toward the use of the guidelines in the 2019 TAT, data availability for the cluster analysis is viewed as a significant challenge to broader implementation.




Henry Brown, Praveen Edara, Dae Yeol Chang, Britton Johnson (Hammit), and Ahmad Abdallah. Practices for Operational Traffic Simulation Models. National Academies Press, Washington, D.C., May 2025. ISBN 978-0-309-73560-5. doi: 10.17226/29076. URL https://nap.nationalacademies.org/catalog/29076.

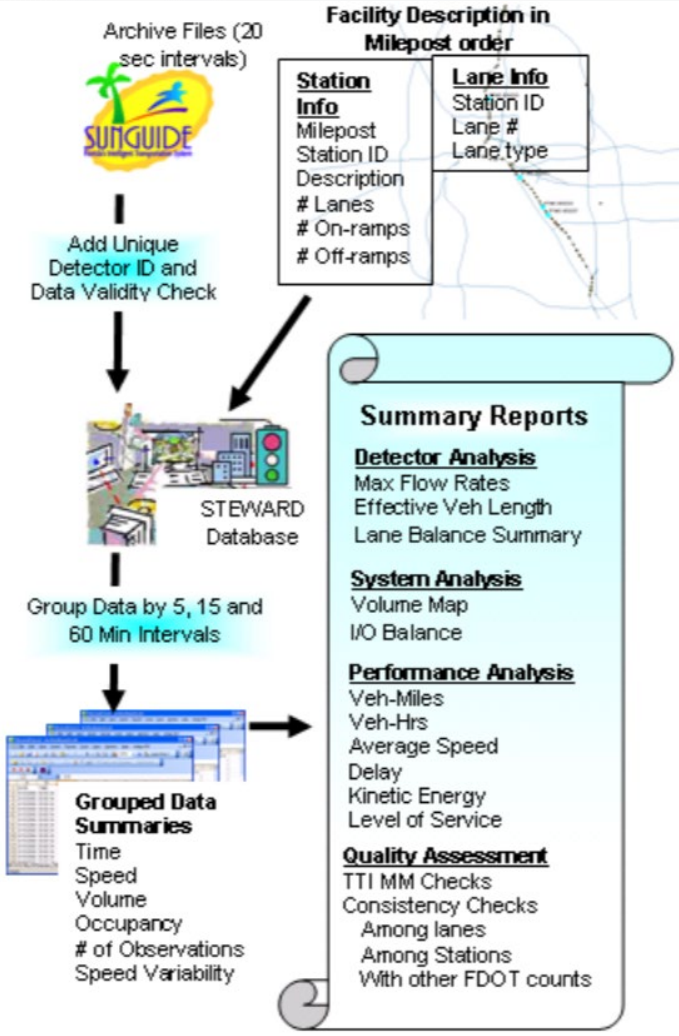
# Software Tool Development

- WSB is developing a purpose-built software tool to reduce burden of performing 2019 TAT Vol. 3 cluster analysis process
- Initial effort is being done in support of Reno ‘spaghetti bowl’ operations analysis for Nevada DOT
- Building upon several previous software development efforts and adding cluster analysis process

# Software Tool Development

- Development and management of FDOT Central Data Warehouse (aka STEWARD) before turning over to RITIS

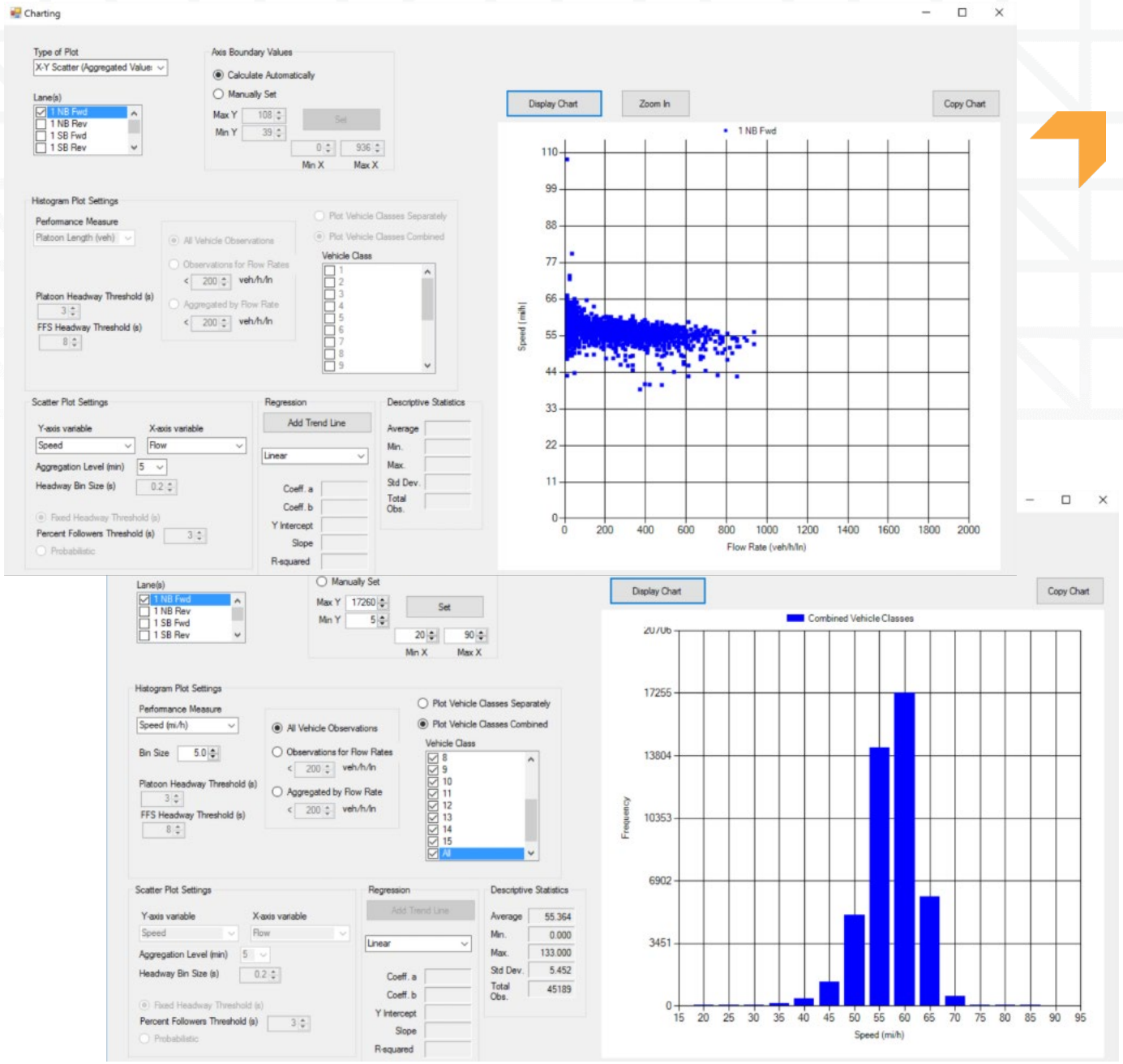
| | Criterion | Threshold Value(s) | Action | |
|---|---|---|---|---|
| 1 | Communication failures – controller error codes | If VOLUME or OCCUPANCY (OCC) or SPEED equals "-1" or "255" or missing | Set values with error codes to missing/null, assign missing value flag/code | Remove record |
| 2 | Zero SPEED (or OCC) when VOLUME is non-zero | If SPEED=0 & VOLUME>0 (or OCC=0) | **Flag and remove entire record**; write failed record to off-line database | Remove record |
| 3 | Zero VOLUME when SPEED is non-zero | If VOLUME=0 & SPEED>0 (or OCC>0) | **Flag and remove entire record** write failed record to off-line database | Remove record |
| 4 | Zero SPEED and VOLUME when OCC is non-zero | If VOLUME=SPEED=0 & OCC>0 | **Flag and remove entire record** write failed record to off-line database | Remove record |
| 5 | Maximum OCCUPANCY exceeded | If OCC > 95% for 20-30 sec<br>If OCC > 80% for 1-5 min | **Flag and remove entire record**; write failed record to off-line database | Remove record |
| 6 | Maximum estimated DENSITY exceeded | IF ((VOLUME*(3600/ELAPSED_TIME))/SPEED) > 220 where ELAPSED_TIME is the nominal polling cycle length in seconds | **Flag and remove entire record**; write failed record to off-line database | Remove record |
| 7 | Too many consecutive identical VOLUME&OCC&SPEED values (including VOLUME=OCC=SPEED=0) | No more than 8 consecutive identical VOLUME, OCC, SPEED values | **Flag and remove entire record**; write failed record to off-line database | Remove record |
| 8 | Zero SPEED when no vehicles present (No vehicles passed the detection zone during the time period) | If VOLUME=SPEED=OCC=0 | **Flag and remove entire record**; write failed record to off-line database | Remove record |
| 9 | Maximum VOLUME exceeded | If VOLUME> 17 veh/20sec/ln<br>If VOLUME> 25 veh/30sec/ln<br>If VOLUME> 50 veh/min/ln | Flag VOLUME,<br>write failed record to off-line database,<br>**interpolate** between intervals to obtain VOLUME value | Impute entry |
| 10 | Maximum SPEED exceeded | If SPEED > 100 mph for 20-30 sec<br>If SPEED > 80 mph for 1-5 min | Flag SPEED,<br>write failed record to off-line database,<br>**interpolate** between intervals to obtain SPEED value | Impute entry |
| 11 | Negative VOLUME | If VOLUME < 0 veh/h/ln | Flag VOLUME,<br>**interpolate** between intervals to obtain VOLUME value | Impute entry |
| 12 | SPEED too low | If SPEED < 5 mph | Flag SPEED,<br>**interpolate** between intervals to obtain SPEED value | Impute entry |




- Automate downloading of data from FDOT SunGuide system
- Transform data
- Perform data quality checks
- Calculate performance measures
- Generate reports

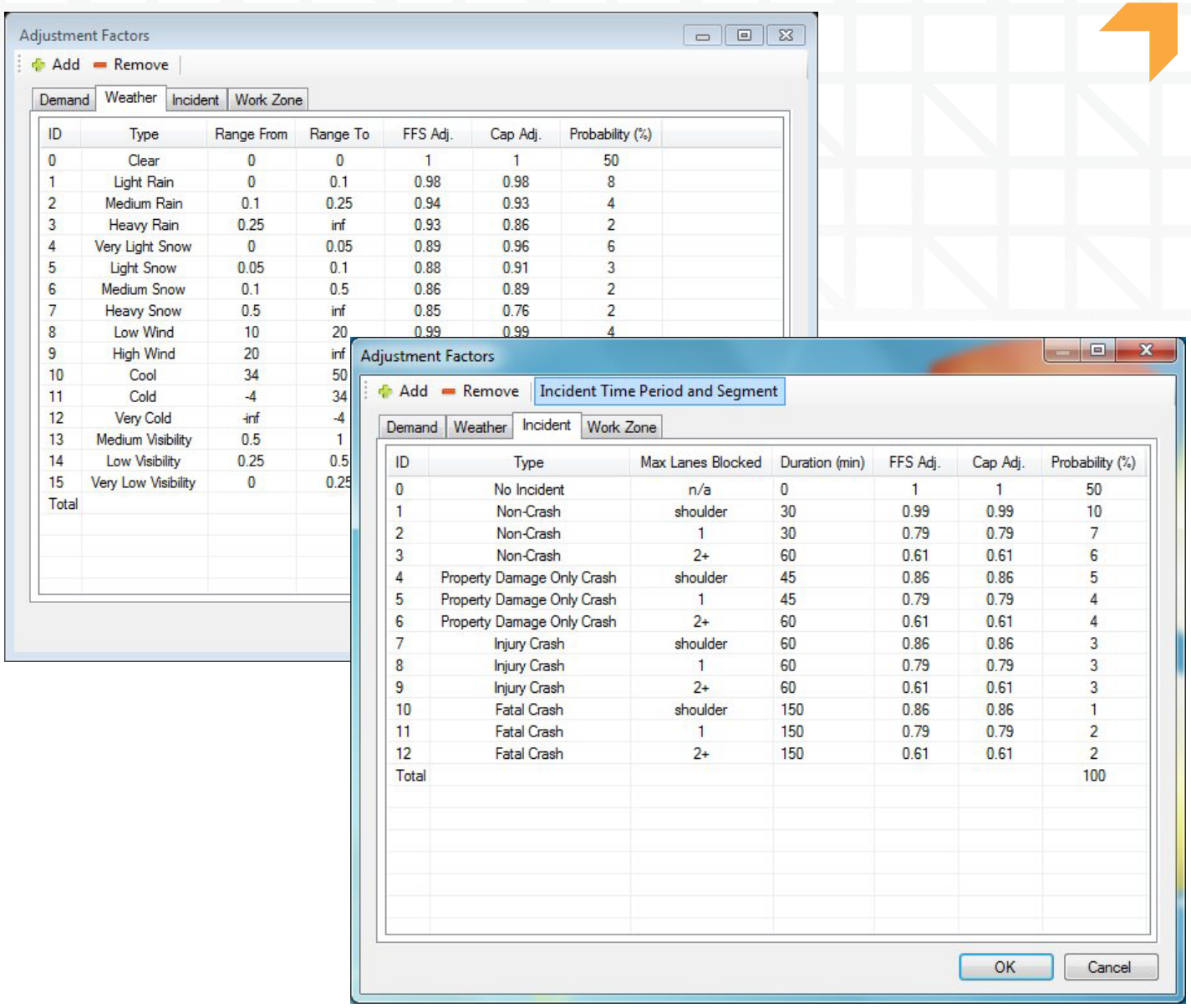
# Software Tool Development

- Detector and probe vehicle data processing software



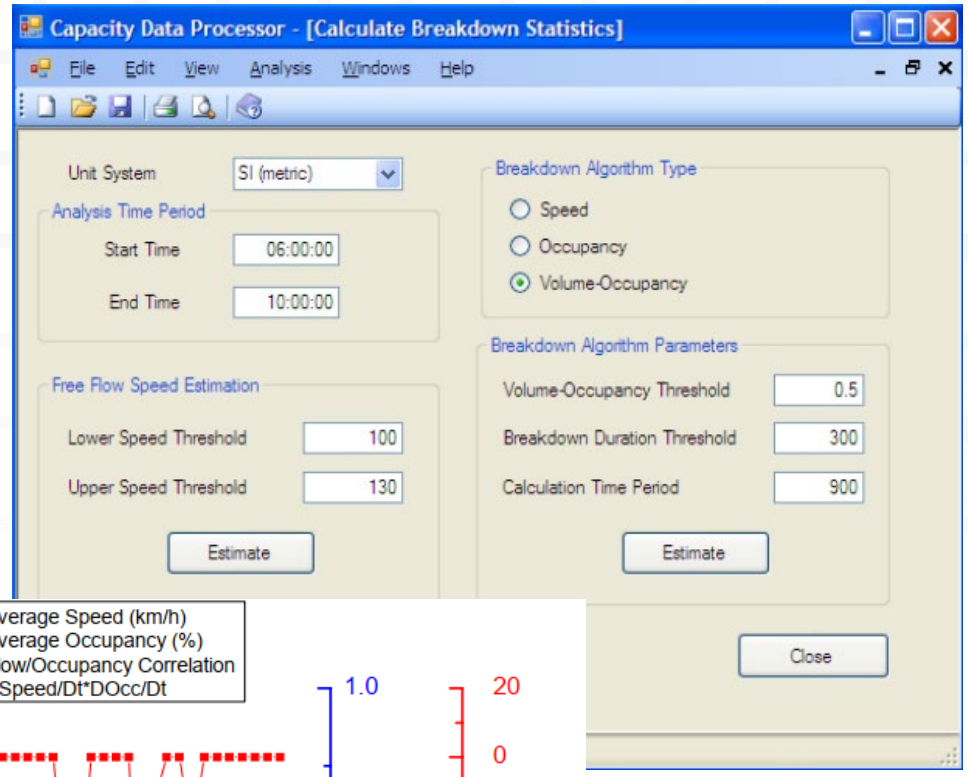
# Software Tool Development

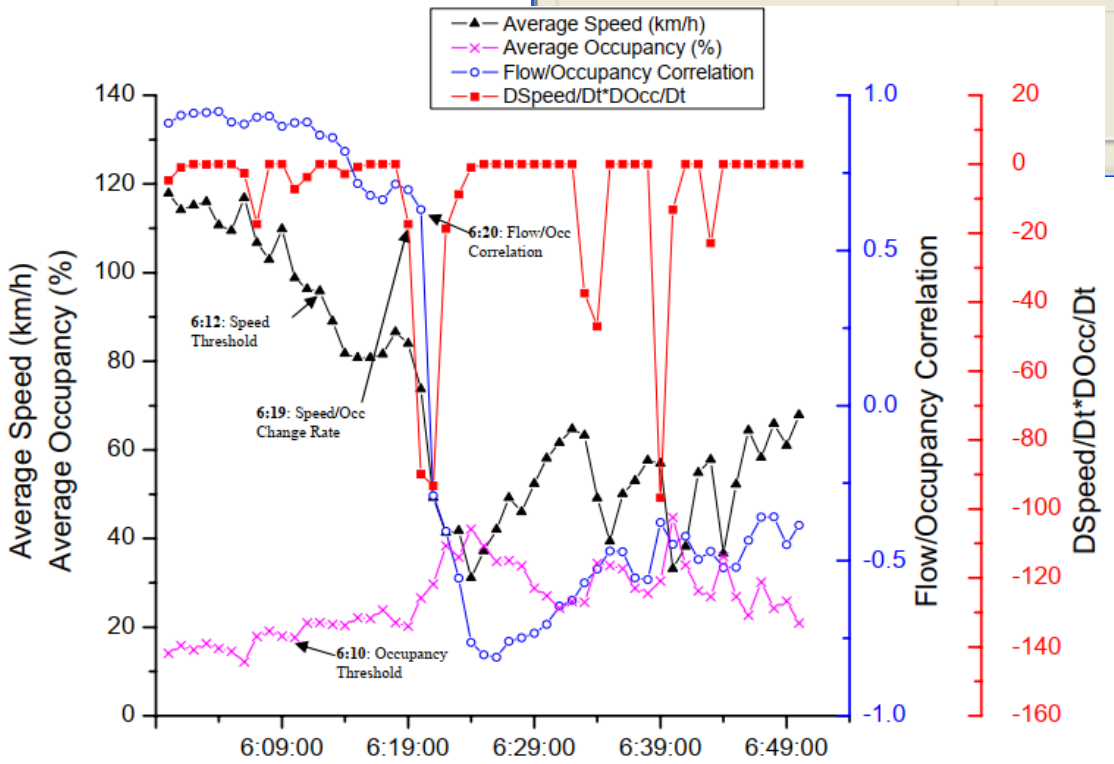
- HCM TTR and ATDM analysis software



# Software Tool Development

- Bottleneck identification and throughput calculation software



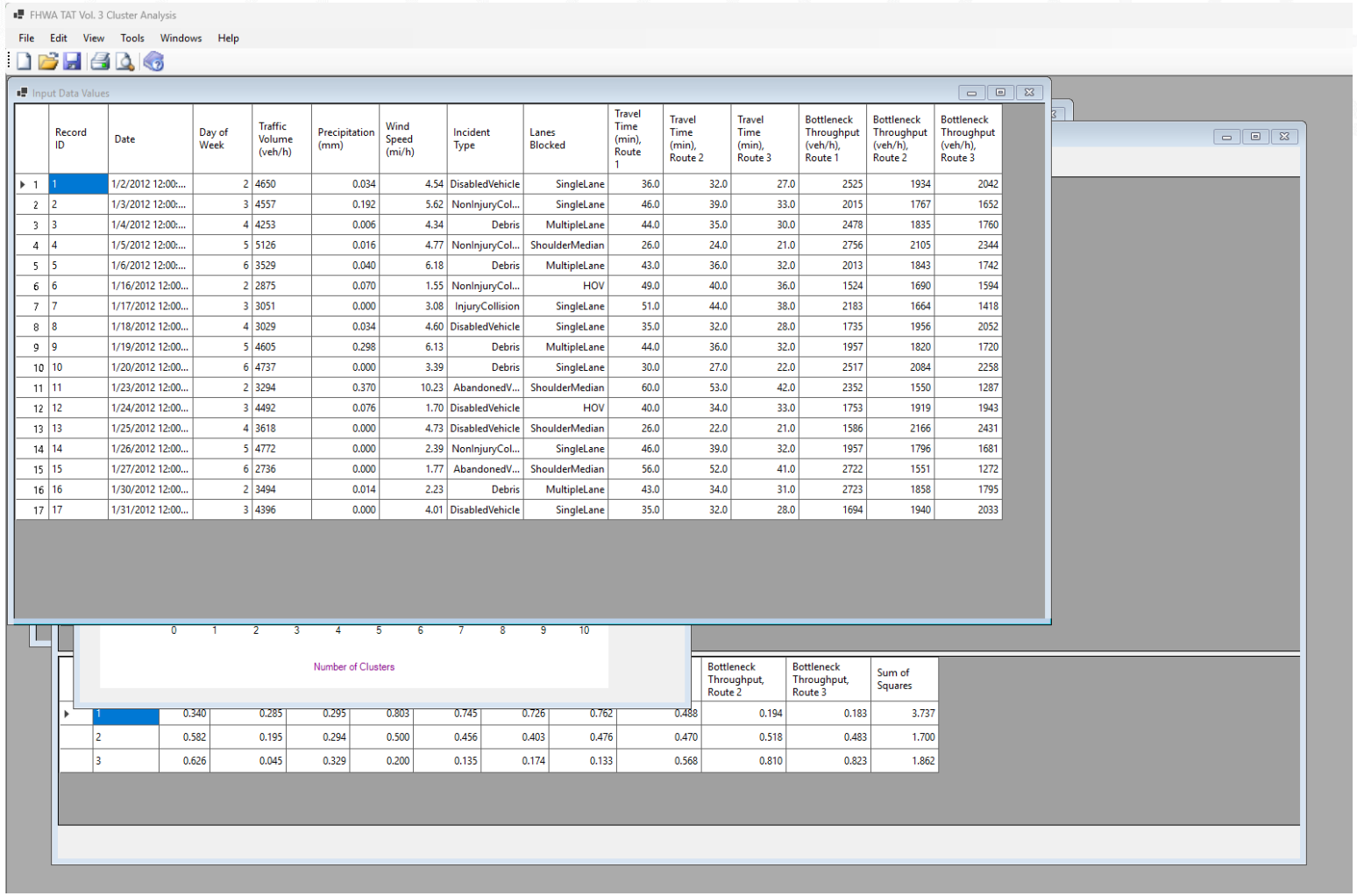
# Software Tool Development

- Cluster analysis and variation envelope calculations will be incorporated
- No need for Excel spreadsheets
- No need for separate statistical analysis software
- Thus, an all-in-one purpose-built software tool
- Written in C#/.NET—among many advantages, it offers much faster execution speed over scripting type languages such as Excel VBA and Python
- Tool can eventually be customized to meet needs/desires of other DOTs or agencies

# Software Tool Development—Future Possibilities

- With this purpose-built software tool, agencies may be more likely to apply the 2019 method
- Such a tool can facilitate further evaluation of the 2019 method, for example…
  - Quality of simulation calibration results relative to 2004 approach
  - Cluster analysis method variations (initial clustering, stopping criterion, partitional vs hierarchical vs Bayesian algorithms, etc.)
  - Variation envelopes and acceptability criteria for simulation calibration
- Additional application areas (e.g., TSMO, IJR, TTR)

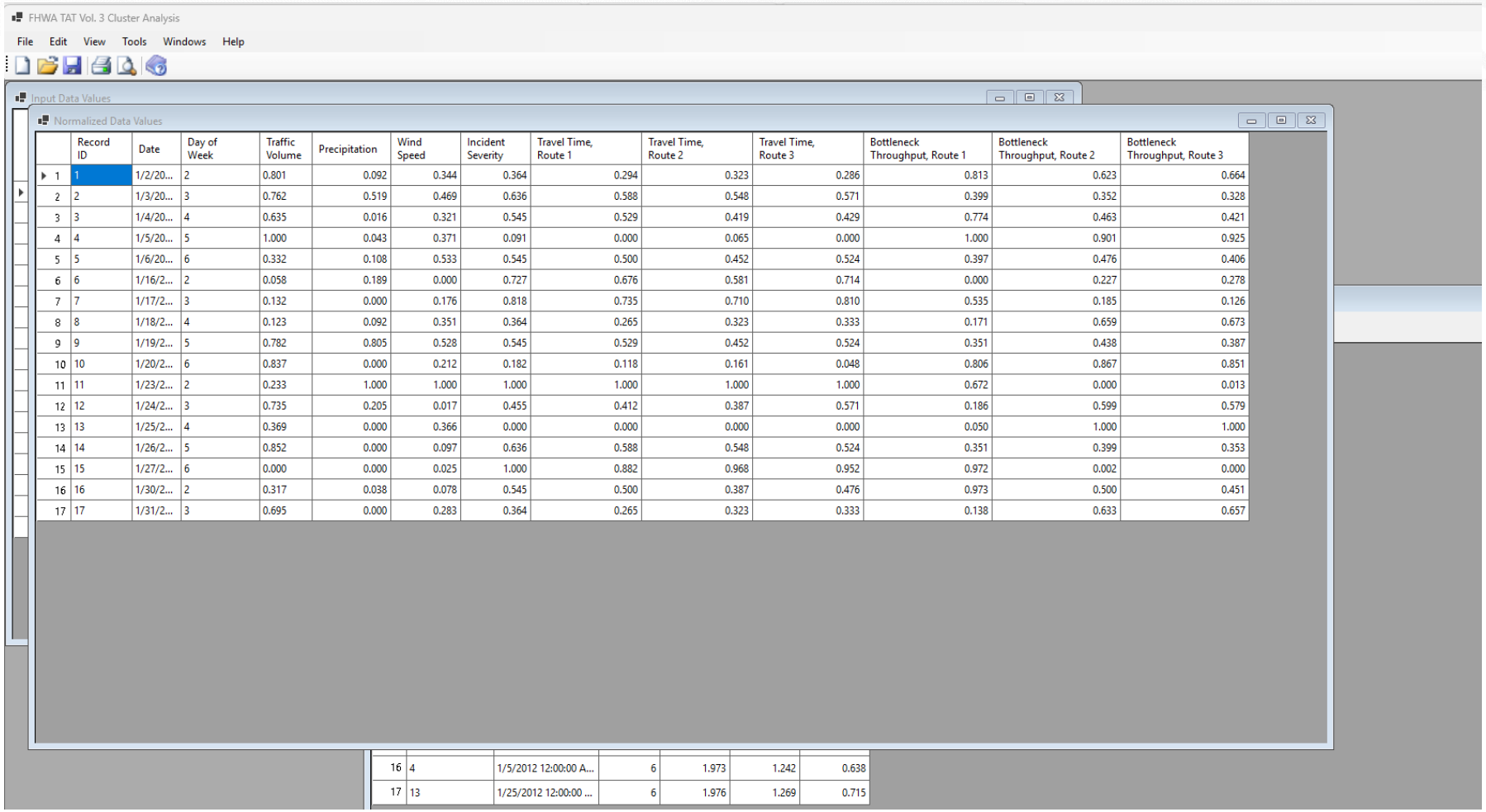
# Software Tool Development




| | Record ID | Date | Day of Week | Traffic Volume (veh/h) | Precipitation (mm) | Wind Speed (mi/h) | Incident Type | Lanes Blocked | Travel Time (min), Route 1 | Travel Time (min), Route 2 | Travel Time (min), Route 3 | Bottleneck Throughput (veh/h), Route 1 | Bottleneck Throughput (veh/h), Route 2 | Bottleneck Throughput (veh/h), Route 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1/2/2012 12:00:... | 2 | 4650 | 0.034 | 4.54 | DisabledVehicle | SingleLane | 36.0 | 32.0 | 27.0 | 2525 | 1934 | 2042 |
| 2 | 2 | 1/3/2012 12:00:... | 3 | 4557 | 0.192 | 5.62 | NonInjuryCol... | SingleLane | 46.0 | 39.0 | 33.0 | 2015 | 1767 | 1652 |
| 3 | 3 | 1/4/2012 12:00:... | 4 | 4253 | 0.006 | 4.34 | Debris | MultipleLane | 44.0 | 35.0 | 30.0 | 2478 | 1835 | 1760 |
| 4 | 4 | 1/5/2012 12:00:... | 5 | 5126 | 0.016 | 4.77 | NonInjuryCol... | ShoulderMedian | 26.0 | 24.0 | 21.0 | 2756 | 2105 | 2344 |
| 5 | 5 | 1/6/2012 12:00:... | 6 | 3529 | 0.040 | 6.18 | Debris | MultipleLane | 43.0 | 36.0 | 32.0 | 2013 | 1843 | 1742 |
| 6 | 6 | 1/16/2012 12:00... | 2 | 2875 | 0.070 | 1.55 | NonInjuryCol... | HOV | 49.0 | 40.0 | 36.0 | 1524 | 1690 | 1594 |
| 7 | 7 | 1/17/2012 12:00... | 3 | 3051 | 0.000 | 3.08 | InjuryCollision | SingleLane | 51.0 | 44.0 | 38.0 | 2183 | 1664 | 1418 |
| 8 | 8 | 1/18/2012 12:00... | 4 | 3029 | 0.034 | 4.60 | DisabledVehicle | SingleLane | 35.0 | 32.0 | 28.0 | 1735 | 1956 | 2052 |
| 9 | 9 | 1/19/2012 12:00... | 5 | 4605 | 0.298 | 6.13 | Debris | MultipleLane | 44.0 | 36.0 | 32.0 | 1957 | 1820 | 1720 |
| 10 | 10 | 1/20/2012 12:00... | 6 | 4737 | 0.000 | 3.39 | Debris | SingleLane | 30.0 | 27.0 | 22.0 | 2517 | 2084 | 2258 |
| 11 | 11 | 1/23/2012 12:00... | 2 | 3294 | 0.370 | 10.23 | AbandonedV... | ShoulderMedian | 60.0 | 53.0 | 42.0 | 2352 | 1550 | 1287 |
| 12 | 12 | 1/24/2012 12:00... | 3 | 4492 | 0.076 | 1.70 | DisabledVehicle | HOV | 40.0 | 34.0 | 33.0 | 1753 | 1919 | 1943 |
| 13 | 13 | 1/25/2012 12:00... | 4 | 3618 | 0.000 | 4.73 | DisabledVehicle | ShoulderMedian | 26.0 | 22.0 | 21.0 | 1586 | 2166 | 2431 |
| 14 | 14 | 1/26/2012 12:00... | 5 | 4772 | 0.000 | 2.39 | NonInjuryCol... | SingleLane | 46.0 | 39.0 | 32.0 | 1957 | 1796 | 1681 |
| 15 | 15 | 1/27/2012 12:00... | 6 | 2736 | 0.000 | 1.77 | AbandonedV... | ShoulderMedian | 56.0 | 52.0 | 41.0 | 2722 | 1551 | 1272 |
| 16 | 16 | 1/30/2012 12:00... | 2 | 3494 | 0.014 | 2.23 | Debris | MultipleLane | 43.0 | 34.0 | 31.0 | 2723 | 1858 | 1795 |
| 17 | 17 | 1/31/2012 12:00... | 3 | 4396 | 0.000 | 4.01 | DisabledVehicle | SingleLane | 35.0 | 32.0 | 28.0 | 1694 | 1940 | 2033 |

| | | | | | | | | | Bottleneck Throughput, Route 2 | Bottleneck Throughput, Route 3 | Sum of Squares |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.340 | 0.285 | 0.295 | 0.803 | 0.745 | 0.726 | 0.762 | 0.488 | 0.194 | 0.183 | 3.737 |
| 2 | 0.582 | 0.195 | 0.294 | 0.500 | 0.456 | 0.403 | 0.476 | 0.470 | 0.518 | 0.483 | 1.700 |
| 3 | 0.626 | 0.045 | 0.329 | 0.200 | 0.135 | 0.174 | 0.133 | 0.568 | 0.810 | 0.823 | 1.862 |

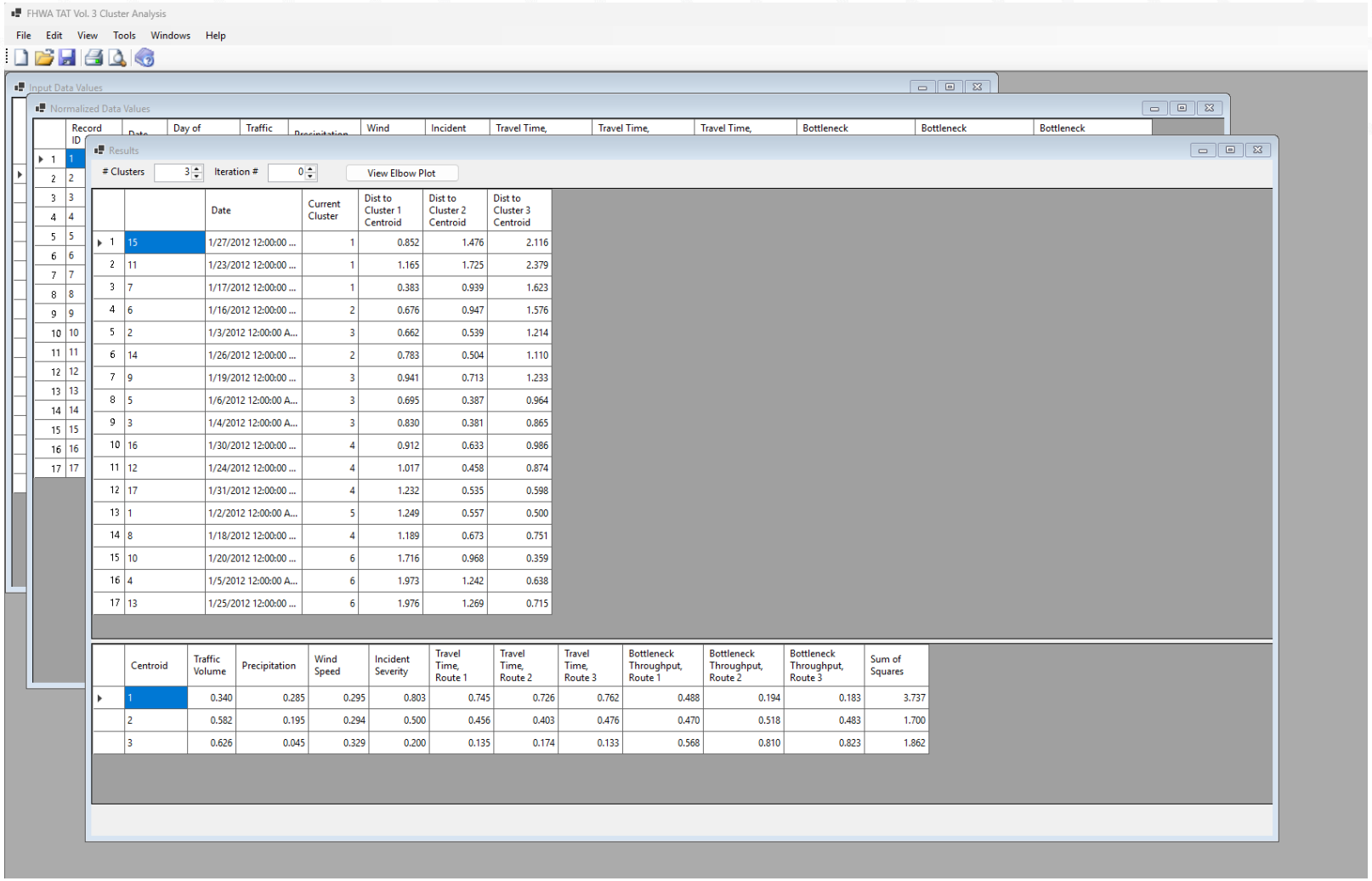
# Software Tool Development




| | Record ID | Date | Day of Week | Traffic Volume | Precipitation | Wind Speed | Incident Severity | Travel Time, Route 1 | Travel Time, Route 2 | Travel Time, Route 3 | Bottleneck Throughput, Route 1 | Bottleneck Throughput, Route 2 | Bottleneck Throughput, Route 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1/2/20... | 2 | 0.801 | 0.092 | 0.344 | 0.364 | 0.294 | 0.323 | 0.286 | 0.813 | 0.623 | 0.664 |
| 2 | 2 | 1/3/20... | 3 | 0.762 | 0.519 | 0.469 | 0.636 | 0.588 | 0.548 | 0.571 | 0.399 | 0.352 | 0.328 |
| 3 | 3 | 1/4/20... | 4 | 0.635 | 0.016 | 0.321 | 0.545 | 0.529 | 0.419 | 0.429 | 0.774 | 0.463 | 0.421 |
| 4 | 4 | 1/5/20... | 5 | 1.000 | 0.043 | 0.371 | 0.091 | 0.000 | 0.065 | 0.000 | 1.000 | 0.901 | 0.925 |
| 5 | 5 | 1/6/20... | 6 | 0.332 | 0.108 | 0.533 | 0.545 | 0.500 | 0.452 | 0.524 | 0.397 | 0.476 | 0.406 |
| 6 | 6 | 1/16/2... | 2 | 0.058 | 0.189 | 0.000 | 0.727 | 0.676 | 0.581 | 0.714 | 0.000 | 0.227 | 0.278 |
| 7 | 7 | 1/17/2... | 3 | 0.132 | 0.000 | 0.176 | 0.818 | 0.735 | 0.710 | 0.810 | 0.535 | 0.185 | 0.126 |
| 8 | 8 | 1/18/2... | 4 | 0.123 | 0.092 | 0.351 | 0.364 | 0.265 | 0.323 | 0.333 | 0.171 | 0.659 | 0.673 |
| 9 | 9 | 1/19/2... | 5 | 0.782 | 0.805 | 0.528 | 0.545 | 0.529 | 0.452 | 0.524 | 0.351 | 0.438 | 0.387 |
| 10 | 10 | 1/20/2... | 6 | 0.837 | 0.000 | 0.212 | 0.182 | 0.118 | 0.161 | 0.048 | 0.806 | 0.867 | 0.851 |
| 11 | 11 | 1/23/2... | 2 | 0.233 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.672 | 0.000 | 0.013 |
| 12 | 12 | 1/24/2... | 3 | 0.735 | 0.205 | 0.017 | 0.455 | 0.412 | 0.387 | 0.571 | 0.186 | 0.599 | 0.579 |
| 13 | 13 | 1/25/2... | 4 | 0.369 | 0.000 | 0.366 | 0.000 | 0.000 | 0.000 | 0.000 | 0.050 | 1.000 | 1.000 |
| 14 | 14 | 1/26/2... | 5 | 0.852 | 0.000 | 0.097 | 0.636 | 0.588 | 0.548 | 0.524 | 0.351 | 0.399 | 0.353 |
| 15 | 15 | 1/27/2... | 6 | 0.000 | 0.000 | 0.025 | 1.000 | 0.882 | 0.968 | 0.952 | 0.972 | 0.002 | 0.000 |
| 16 | 16 | 1/30/2... | 2 | 0.317 | 0.038 | 0.078 | 0.545 | 0.500 | 0.387 | 0.476 | 0.973 | 0.500 | 0.451 |
| 17 | 17 | 1/31/2... | 3 | 0.695 | 0.000 | 0.283 | 0.364 | 0.265 | 0.323 | 0.333 | 0.138 | 0.633 | 0.657 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 16 | 4 | 1/5/2012 12:00:00 A... | 6 | 1.973 | 1.242 | 0.638 |
| 17 | 13 | 1/25/2012 12:00:00 ... | 6 | 1.976 | 1.269 | 0.715 |

# Software Tool Development

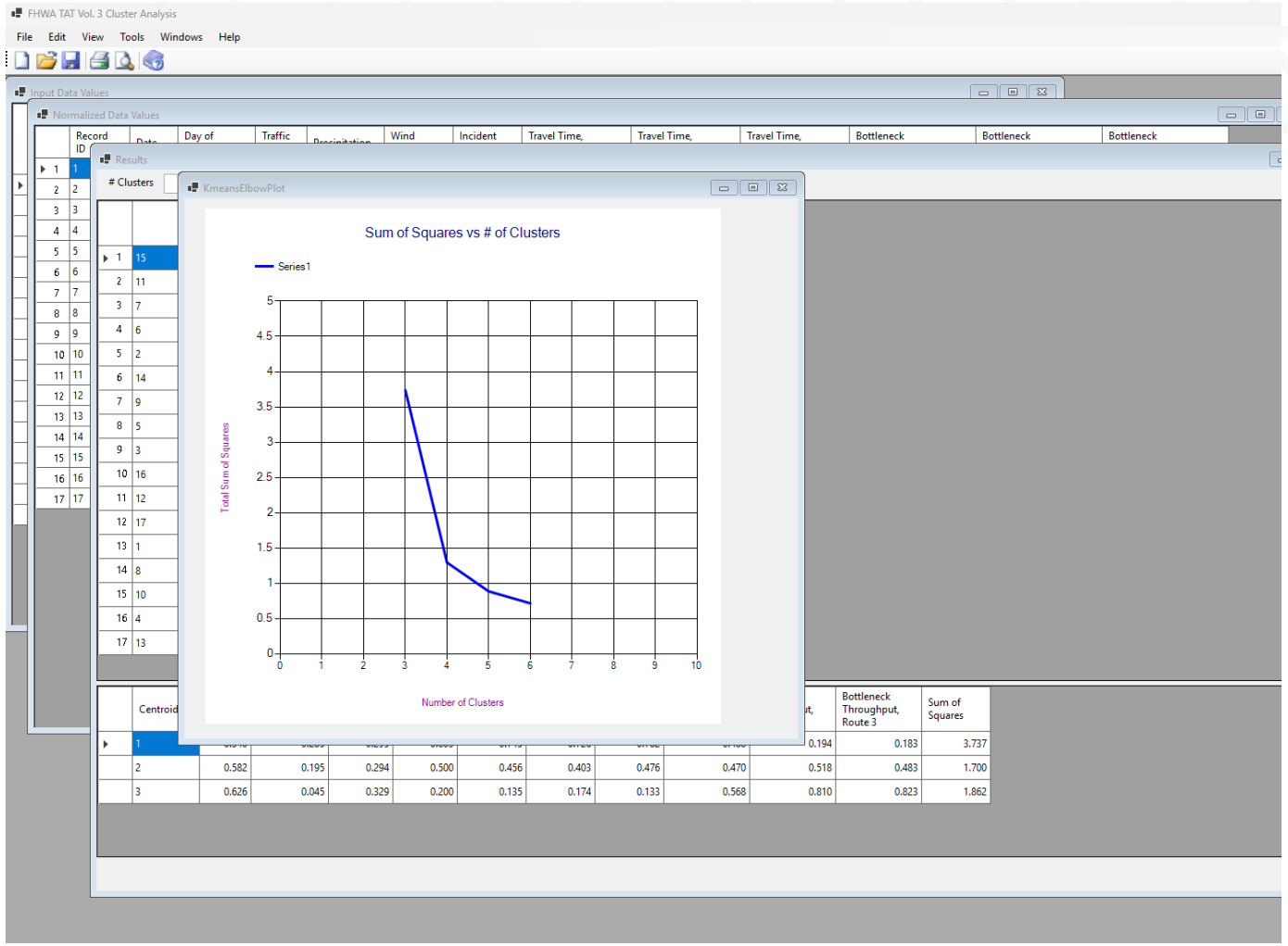



| | Record ID | Date | Day of | Traffic | Precipitation | Wind | Incident | Travel Time, | Travel Time, | Travel Time, | Bottleneck | Bottleneck | Bottleneck |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | | | | |
| 2 | 2 | | | | | | | | | | | | |
| 3 | 3 | | | | | | | | | | | | |
| 4 | 4 | | | | | | | | | | | | |
| 5 | 5 | | | | | | | | | | | | |
| 6 | 6 | | | | | | | | | | | | |
| 7 | 7 | | | | | | | | | | | | |
| 8 | 8 | | | | | | | | | | | | |
| 9 | 9 | | | | | | | | | | | | |
| 10 | 10 | | | | | | | | | | | | |
| 11 | 11 | | | | | | | | | | | | |
| 12 | 12 | | | | | | | | | | | | |
| 13 | 13 | | | | | | | | | | | | |
| 14 | 14 | | | | | | | | | | | | |
| 15 | 15 | | | | | | | | | | | | |
| 16 | 16 | | | | | | | | | | | | |
| 17 | 17 | | | | | | | | | | | | |

| | | Date | Current Cluster | Dist to Cluster 1 Centroid | Dist to Cluster 2 Centroid | Dist to Cluster 3 Centroid |
|---|---|---|---|---|---|---|
| 1 | 15 | 1/27/2012 12:00:00 ... | 1 | 0.852 | 1.476 | 2.116 |
| 2 | 11 | 1/23/2012 12:00:00 ... | 1 | 1.165 | 1.725 | 2.379 |
| 3 | 7 | 1/17/2012 12:00:00 ... | 1 | 0.383 | 0.939 | 1.623 |
| 4 | 6 | 1/16/2012 12:00:00 ... | 2 | 0.676 | 0.947 | 1.576 |
| 5 | 2 | 1/3/2012 12:00:00 A... | 3 | 0.662 | 0.539 | 1.214 |
| 6 | 14 | 1/26/2012 12:00:00 ... | 2 | 0.783 | 0.504 | 1.110 |
| 7 | 9 | 1/19/2012 12:00:00 ... | 3 | 0.941 | 0.713 | 1.233 |
| 8 | 5 | 1/6/2012 12:00:00 A... | 3 | 0.695 | 0.387 | 0.964 |
| 9 | 3 | 1/4/2012 12:00:00 A... | 3 | 0.830 | 0.381 | 0.865 |
| 10 | 16 | 1/30/2012 12:00:00 ... | 4 | 0.912 | 0.633 | 0.986 |
| 11 | 12 | 1/24/2012 12:00:00 ... | 4 | 1.017 | 0.458 | 0.874 |
| 12 | 17 | 1/31/2012 12:00:00 ... | 4 | 1.232 | 0.535 | 0.598 |
| 13 | 1 | 1/2/2012 12:00:00 A... | 5 | 1.249 | 0.557 | 0.500 |
| 14 | 8 | 1/18/2012 12:00:00 ... | 4 | 1.189 | 0.673 | 0.751 |
| 15 | 10 | 1/20/2012 12:00:00 ... | 6 | 1.716 | 0.968 | 0.359 |
| 16 | 4 | 1/5/2012 12:00:00 A... | 6 | 1.973 | 1.242 | 0.638 |
| 17 | 13 | 1/25/2012 12:00:00 ... | 6 | 1.976 | 1.269 | 0.715 |

| | Centroid | Traffic Volume | Precipitation | Wind Speed | Incident Severity | Travel Time, Route 1 | Travel Time, Route 2 | Travel Time, Route 3 | Bottleneck Throughput, Route 1 | Bottleneck Throughput, Route 2 | Bottleneck Throughput, Route 3 | Sum of Squares |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.340 | 0.285 | 0.295 | 0.803 | 0.745 | 0.726 | 0.762 | 0.488 | 0.194 | 0.183 | 3.737 |
| 2 | 2 | 0.582 | 0.195 | 0.294 | 0.500 | 0.456 | 0.403 | 0.476 | 0.470 | 0.518 | 0.483 | 1.700 |
| 3 | 3 | 0.626 | 0.045 | 0.329 | 0.200 | 0.135 | 0.174 | 0.133 | 0.568 | 0.810 | 0.823 | 1.862 |

# Software Tool Development




# THANK YOU

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