Note: Results from polling questions asked during this web meeting are at the bottom of the document.

Spotlight Presentation: National Capital Region Twelve-Year Bottleneck Analysis

Q: **Michael Iacono (Minnesota DOT):** Were the results of the rankings sensitive to the switch from NPMRDS/HERE to NPMRDS/INRIX between 2016 and 2017?

A: Michael Pack (University of Maryland CATT Lab): This analysis did not use the NPMRDS data set. They used the 1-minute real-time INRIX data set that VA, MD, and DC purchase separately from the NPMRDS. Therefore, there was a single, consistent data provider throughout all the years. There was no switch in providers.

Q: **Kelly Wells (North Carolina DOT):** Did you have locations where you had overlapping bottlenecks? If so, how did you handle this?

A: Andrew Meese (MWCOG): Those results are determined through the tool's mathematics - the head of a queue and how long it lasts. If you're looking at this analysis over time the head of the queue may shift a little bit. With a construction zone, it would catch people off a mile ahead and suddenly that bottleneck would change. In terms of what the bottleneck is, we do what the mathematics of the tool told us that it would be.

Q: Kelly Wells (North Carolina DOT): Did you do anything special to denote bottlenecks that were caused by long-term construction?

A: Andrew Meese (MWCOG): Not specifically other than to try to cross-compare with some of those major improvement lists. When a bottleneck location would come and go for a year or two over 12 years, it was likely a construction zone.

Q: **Matt Glasser (Arcadis):** When you analyzed the bottleneck are you looking at all of the legs or are you only looking at a single approach?

A: Andrew Meese (MWCOG): We put our network in RITIS and it outputs what it thinks are the top bottlenecks. It goes through a complex analysis of sewing together different TMCs to get a bottleneck. I think that methodology favors the main lines as opposed to ramps. It's a mixed answer. If you've got a big enough ramp and it has more than enough congestion, it's going to show up. If you're doing a different type of analysis and you want to look at the ramps you might find that. I'm not sure that those shake out in this region-wide analysis.

A: Patrick Zilliacus (MWCOG): The network will have ramps where they are available. In some cases, the ramps are not there.

Q: **Sooraz Patro (Capital Region Planning Commission):** Did you analyze recurring or non-recurring congestion?

A: Andrew Meese (MWCOG): We only analyzed recurring congestion. We were looking at data by year therefore, the non-recurring congestion is probably going to wash out in year-by-year analyses.

Q: **Mohamed Kaddoumi (City of Charlotte, NC):** Did you develop an intersection score combining all TMCs, especially at signalized intersections?

A: Andrew Meese (MWCOG): I don't remember any discussion of signalized intersections. We have a network of TMCs with INRIX data which goes into the tool and the reversible lanes are removed and we use that to obtain our list of bottlenecks. I think the mathematics of the tool tends to favor limited-access highways. In 2020, we saw different results due to the travel changes from the pandemic. When we looked quarter by quarter during 2020, we started to see more arterial highways. Commuting time was down and bottlenecks such as in front of shopping centers started bubbling up on the list. But that phenomenon came and went quickly during 2020. The bottlenecks on major freeway commute routes and intercity travel routes keep dominating the list. If we were to look at the top 50 or top 100 and did lots of studies, we would get into that more.

A: Patrick Zilliacus (MWCOG): No specific analysis of signalized intersections. Most of these top congested points were indeed on freeways and federal parkways and expressways. US-301 comes on the list several times as a principal arterial with signals.

User Delay Cost (UCD) Calculation Methodologies & Potential Improvements

Q: **Harun Rashid (Northern Virginia Transportation Authority):** Does the car following model consider transit vehicles? How about vehicle occupancies?

A: Mark Franz (University of Maryland CATT Lab): It does not include transit vehicles. The full algorithm for our UDC has just passenger vehicles and commercial vehicles and they are based on percentages, so it doesn't directly handle transit vehicles like buses.

The UDC algorithm has a default occupancy of 1.25 people per passenger vehicle and 1 person per commercial vehicle. We're also considering updating that because the NPMRDS recommendation is 1.7 people per vehicle. Vehicle occupancy is not adjustable in the calculations, it happens in the background.

Q: **Kelly Njord (Utah DOT):** Did you compare the car following model results with measured capacities in the field? How did they compare?

A: Mark Franz (University of Maryland CATT Lab): We did not look at any capacity analysis. That's a really good idea and as we continue our analysis, we'll certainly consider incorporating roadway capacity into our estimations.

Q: James Li (MWCOG): I was wondering if it is possible for sharing the set of parameters for the car following the model mentioned.

A: Mark Franz (University of Maryland CATT Lab): I'm happy to share those in additional slides.

This information can be found in the presentation and at the end of the Q&A summary.

PDA Suite Performance Measures Working Group Update

Q: **Jawad Paracha (Federal Highway Administration):** Seems in the Ohio DOT example, work zone-related delays remained the same during and before closure. Is this correct? Also, do these reports get into safety too?

A: Michael Pack (University of Maryland CATT Lab): I can't speak to the delay question as I'm not sure if that was a mockup or a real report. But when it comes to safety--some of the reports touch on that. However, we don't have a safety-only report yet. If you have specific examples of things you'd like to see in these reports, please let us know. We are constantly trying to make them better.

A: John Allen (University of Maryland CATT Lab): If you look at the increase of vehicle-hours of delay box, there was a 3.9k to 12.2k delay during the weekend closure vs typical weekend conditions. It appears that the text underneath the graphic isn't correct. I'll confirm that with Rick and get back to you. If that doesn't answer your question, please email me (jallen35@umd.edu) and we can set up a call.

RITIS Product Enhancement Working Group Update

Q: **Ed Stylc (Baltimore Metropolitan Council):** The Causes of Congestion is a great new tool. Just worked up a presentation utilizing it for the CMP group at my MPO. It is basic. I used vehicle hours of delay to look at pre- and post-pandemic conditions in the region.

A: Michael Pack and John Allen (University of Maryland CATT Lab): Great Ed! Would you be able to share it with us?

Note: Ed Stylc (Baltimore Metropolitan Council): Absolutely. The results were surprising. It is reported that traffic volumes in the region are only 5% below 2019 levels. Vehicle Hours of Delay are like half of the previous levels in most of our local jurisdictions. I present it next Tuesday. Still tinkering with it a bit.

Q: **Kelly Njord (Utah DOT):** What information have you found to be most useful in the Automated Work Zone Report? Are your construction engineers using this report to enforce Maintenance of Traffic requirements?

A: Bob Frey (Massachusetts DOT): I haven't worked directly with the report yet, but the biggest concern/need expressed by the group is the length and duration of queues.

Q: **Michael Iacono (Minnesota DOT):** Is the work zone analysis restricted to the roadway where the work is taking place? Is it also capable of capturing the spillover effects of delays taking place on parallel routes or connecting routes?

A: Bob Frey (Massachusetts DOT): I think it’s just restricted to the work zone roadway right now.

New RITIS Tools and Recent Enhancements

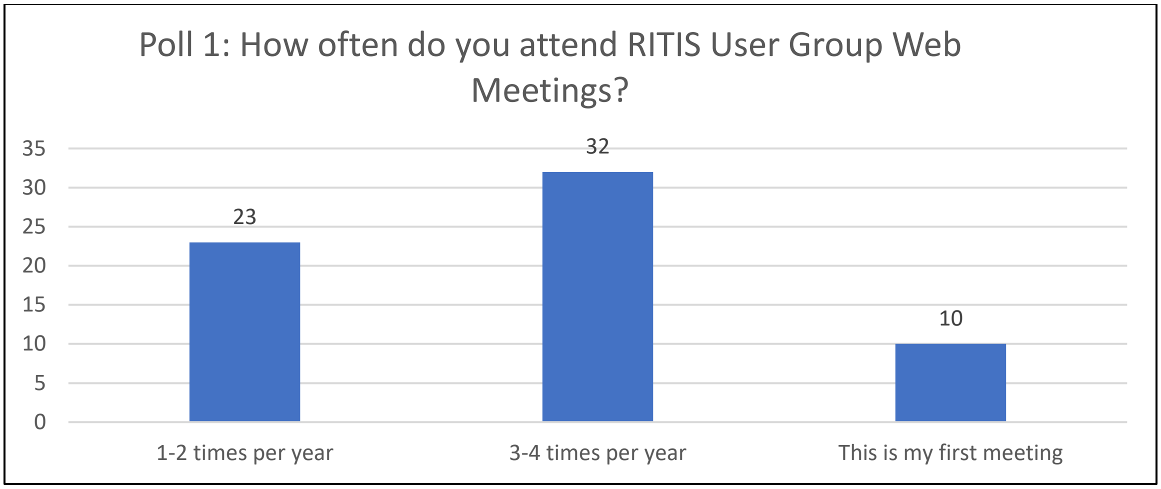
Q: **Bert Lahrman (North Central Planning and Development Commission (RPO)):** Where is the intersection analytics located?

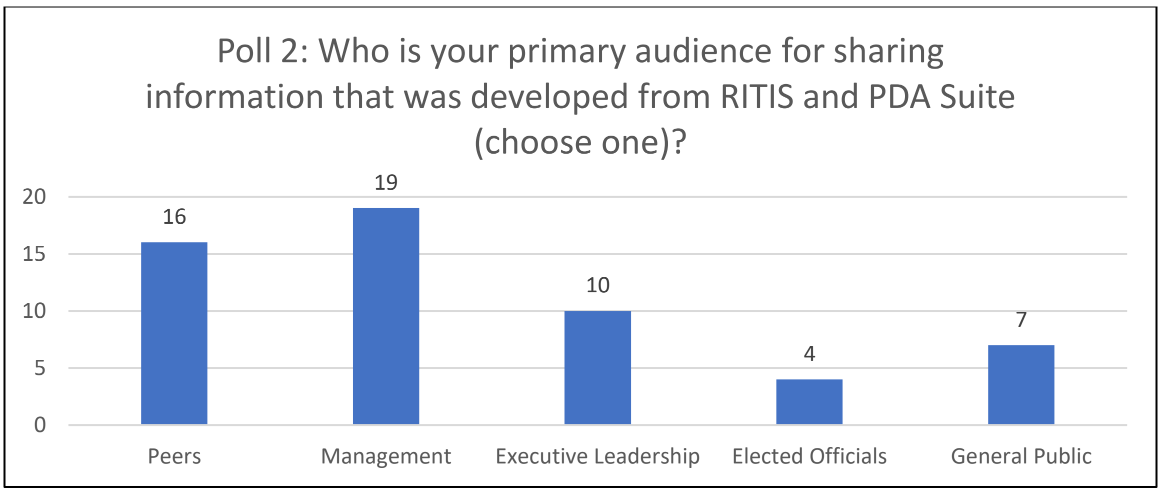
A: Michael Pack (University of Maryland CATT Lab): It is under the "Data Archive" tab in RITIS. It can also be accessed directly at signals.ritis.org (assuming your agency has purchased the right data for it).

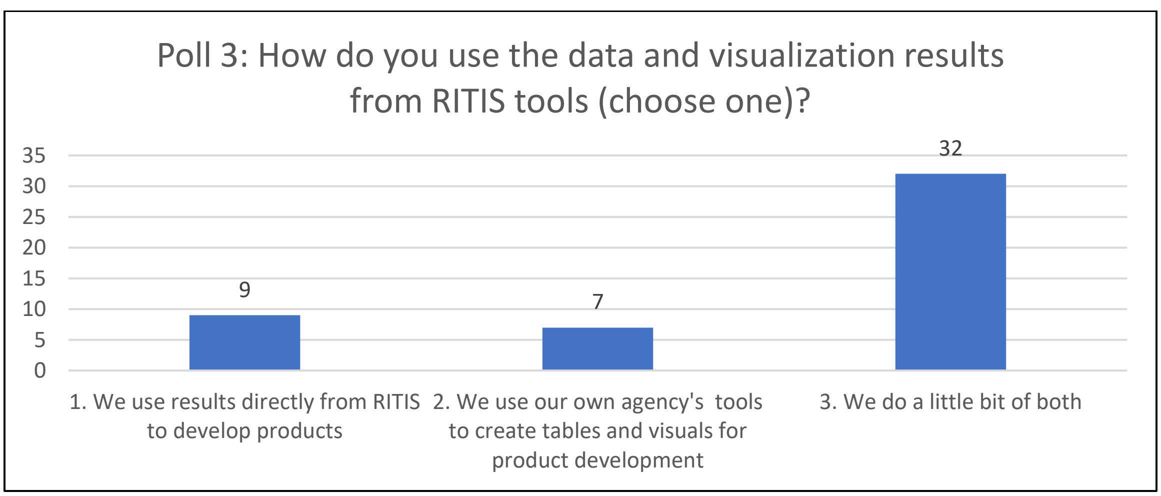
Q: **Jawad Paracha (Federal Highway Administration): We would like hard braking data.**

A: Michael Pack (University of Maryland CATT Lab): Wejo has that data. Agencies that purchase Wejo data can have us integrate it into RITIS. There are a couple of agencies working with us on this right now.

Note: **Mohamed Kaddoumi (City of Charlotte, NC):** I would suggest map interactivity for selecting geographies (including Trip lengths along a link) for Trips Analytics.


Poll 1: How often do you attend RITIS User Group Web Meetings?
35
30
25
20
15
10
5
0
23
32
10
1-2 times per year
3-4 times per year
This is my first meeting


Poll 2: Who is your primary audience for sharing information that was developed from RITIS and PDA Suite (choose one)?
20
15
10
5
0
16
19
10
4
7
Peers
Management
Executive Leadership
Elected Officials
General Public


Poll 3: How do you use the data and visualization results from RITIS tools (choose one)?
35
30
25
20
15
10
5
0
9
7
32
1. We use results directly from RITIS to develop products
2. We use our own agency's tools to create tables and visuals for product development
3. We do a little bit of both

Theoretical Example

- Example

<u>Useful Conversion Factors</u>
1 hour = 3600 seconds
1 mile = 5280 feet

Driver reaction time: $\beta = 1 \text{ sec}$
Pass max Deceleration: $\gamma_p = 32$ ft/sec^2 = 78545.4545 mi/h^2
Truck max Deceleration: $\gamma_T = 20$ ft/sec^2 = 49090.9091 mi/h^2
Pass length: $\alpha_p = 15 \text{ ft} = 0.00284091 \text{ mi}$
Truck length: $\alpha_T = 50\ ft$ = 0.0094697 mi
% of Pass: $\delta_P = 90\%$
% of Truck: $\delta_T = 10\%$

Speed: $V = 10, 20, 30, 40\ mph$ (the detailed calculation procedure is shown only for 10mph. The other data points are provided for validation purposes)

Segment length: $\theta = \frac{1}{3}\ mi$
Number of Lanes: $N = 3$

0.00277

Step 2.1: Estimating Vehicles in Queue

- Step 2.1:Vehicle Spacing: Steady-State Following Model

$$S_{i,j}(t) = \beta V_j(t) + \gamma_i V_j^2(t)$$

$S_{i,j}(t)$ = vehicle spacing for vehicle type i in segment j at time t
β = driver reaction time
γ_i = the reciprocal of twice the maximum average deceleration of a following vehicle
$V_j(t)$ = vehicle velocity in segment j at time t

$$S_P = \frac{1}{3600} \times 10 + \frac{1}{2 \times 78545.4545} \times 10^2 = 0.003414\, mi$$
$$S_T = \frac{1}{3600} \times 10 + \frac{1}{2 \times 49090.9091} \times 10^2 = 0.003796\, mi$$

Step 2.2: Calculating consumed lane length

- Step 2.2: Calculate total lane length consumed by each vehicle (based on observed speed)

$$L_{i,j}(t) = \alpha_i + S_{i,j}(t)$$

$L_{i,j}(t)$ = lane length consumed by vehicle type i in segment j at time t
α_i = length of vehicle type i
$S_{i,j}(t)$ = vehicle spacing for vehicle type i in segment j at time t

$$L_P = 0.00284091 + 0.005619 = 0.006255\, mi$$
$$S_T = 0.0094697 + 0.003796 = 0.013266\, mi$$

Step 2.3: Estimating Vehicles in Queue

- Step 2.3: Compute # of passenger and commercial vehicles on each segment in the queue

Considering two types of vehicles

(P: passenger, T: commercial),

$$n_{P,j}(t)^{*}\, L_{P,j}(t) + n_{T,j}(t)^{*}\, L_{T,j}(t) = \theta_j \qquad \text{(Eqn 2.3.1)}$$

$$\frac{n_{P,j}(t)}{n_{T,j}(t)} = \frac{\delta_P}{\delta_T} \qquad \text{(Eqn 2.3.2)}$$

θ_j = length of segment j

$n_{i,j}(t)$ = # of vehicle type i in the queue

δ_i = percentage of vehicle type i

$$n_P \times 44.56 + n_T \times 84.1 = 1760$$

$$\frac{n_P}{n_T} = 9$$

Step 2.3: Estimating Vehicles in Queue

- Step 2.3: Compute # of passenger and commercial vehicles on each segment in the queue

Solving the system of equations (Equ 2.3.1 and Eque 2.3.2) we get:

$$n_{P,j}(t) = \frac{\frac{\delta_P}{\delta_T} * \theta_j}{\frac{\delta_P}{\delta_T} * L_{P,j}(t) + L_{T,j}(t)}$$

$$n_P = \frac{9 \times \frac{1}{3}}{9 * 0.006255 + 0.013266} = 43.13$$

$$n_{T,j}(t) = \frac{\theta_j}{\frac{\delta_P}{\delta_T} * L_{P,j}(t) + L_{T,j}(t)}$$

$$n_T = \frac{\frac{1}{3}}{9 * 0.006255 + 0.013266} = 4.79$$

Step 2.4: Estimating Vehicles Traversing the segment

- Step 2.4: Compute # of passenger and commercial vehicles Traversing the segment

$$f_{i,j}(t) = \frac{n_{i,j}(t) * V_j(t)}{\theta_j * 60} * N_j$$

$f_{i,j}(t)$ = # of vehicles of type i traversing segment j at time t (per minute)
N_j = lanes on segment j

$$f_P = \frac{43.13 \times 10}{\frac{1}{3} \times 60} \times 3 = 64.69$$

$$f_T = \frac{4.79 \times 10}{\frac{1}{3} \times 60} \times 3 = 7.19$$

$$\sum_i^I f_{i,j}(t) = 46.69 + 7.19 = 71.88$$

Values based on other speeds

Speed (mph)	L_pass (mi)	L_truck (mi)	n _pass (veh)	f_pass (veh/min)	n _truck (veh)	f_truck (veh/min)	flow total (veh/min)
10	0.006255	0.013266	43.12616	64.68924	4.791795	7.187694	71.87694
20	0.010943	0.019099	25.51363	76.54091	2.834848	8.504546	85.04546
30	0.016903	0.02697	16.75038	75.37673	1.861154	8.375192	83.75192
40	0.024137	0.036877	11.80582	70.83492	1.311758	7.870547	78.70547