# Decision Support Systems for Transportation System Management and Operations (TSM\&O) 

FDOT Project BDV29-977-09<br>Presented by<br>Mohammed Hadi, Ph.D., PE<br>Florida International University

February 29, 2015

## ITSDCAP Functionality

- Aggregation and cleaning of data from multiple sources
- Grouping and clustering of data
- Performance measurements and dashboard
- Real-time information sharing
- Prediction of system performance and impacts
- Decision support tools
- Benefit-cost analysis of advanced strategies
- Transportation model support


## Support of TSM\&O Performance Dashboard

- Estimation of performance measurements including mobility, reliability, safety and environmental impacts
- Agency specific dashboard format
- Broward County
- Miami-Dade County (SW 8 ${ }^{\text {th }}$ Street will be expanded to other corridors)
- Soon Palm Beach County
- Others


## Mobility




## Reliability



## Reliability Utilization in DS on Freeways



## Reliability Utilization in DS on Arterials



National Operations Center of Excellence

## Safety (Based on CARS, FHP, or Incident Database



## Fuel Consumption and Emissions

- EPA MOVES

|  |  |
| :---: | :---: |
| File Edit Pre Processing Action Post Processing Iools Settings Help |  |
| Description <br> Scale <br> Time Spans <br> Geographic Bounds <br> Vehicles/Equipment <br> Road Type <br> Pollutants And Processes <br> Manage Input Data Sets | Domain/Scale <br> National Use the default national database with default state and local allocation factors. <br> Caution: Do not use this scale setting for SIP or conformity analyses. The allocation factors and other defaults applied at the state or county level have not been verified against specific state or county data and do not meet regulatory requirements for SIPs and conformity determinations. County Select or define a single county that is the entire domain. <br> Note: Use this scale setting for SIP and regional conformity analysis. Use of this scale setting requires user-supplied local data for most activity and fleet inputs. Project Use project domain inputs. <br> Note: Use this scale setting for project-level analysis for conformity, NEPA, or any other regulatory purpose. Use of this scale setting requires user-supplied data at the link level for activity and fleet inputs that describe a particular transportation project. |
| Strategies <br> Output | Calculation Type Irventory Mass and/or Energy within a region and time span. Emission Rates Mass and/or Energy per unit of activity. <br> MOVESScenariolD: |
|  | Caution: Changing these selections changes the contents of other input panels. These changes may include losing previous data contents. <br> 1 $\square$ III |
| Stop execution of active RunSpec |  |

## Broward and Palm Beach County Dashboard



## Miami-Dade County Dashboard System-Wide

Million Vehicle
Miles (MVM)
Traveled

N/A

Average Hours with

N/A


Estimated Benefits Summary

| Performance Measure | Monthly (Dollars) | Year-to-date (Dollars) |
| :--- | :--- | :--- |
| Travel Time/Delay Saving N/A | N/A |  |
| Reduction in Emissions | N/A | N/A |
| Reduction in Fuel | N/A | N/A |
| Consumption | N/A | N/A |
| Safety Benefits | N/A |  |
| Reliability Benefits | N/A | N/A |
| Total Benefits | N/A |  |

## Estimated Cost Summary

| Performance Measure | Monthly (Dollars) | Year-to-date (Dollars) |
| :--- | :--- | :--- |
| Average Monthly Initial <br> Cost | N/A | N/A |
| Average Monthly <br> Maintainence Cost | N/A | N/A |


|  | Device Type | Number of Devices |
| :---: | :---: | :---: |
| - | Signals | N/A |
|  | Adaptive Signals | N/A |
|  | Adaptive Signals Satisfying Minimum Requirments | N/A |
|  | Wi-Fi Devices | N/A |
|  | Wi-Fi Devices Satisfying Minimum Requirments | N/A |
|  | Maintenance Calls | N/A |
|  | Detection Failures | N/A |
|  | Communication System Percentage of Failure Time fro KIDS | N/A | Nami-Dadde County Adaptive Signal Control Program

FDOT District 6 in collaboration with Miami-Dade County started the Adaptive Signal Control Program in 2015 to actively monitor manage, and improve arterial operations along SW 8th Street between 67th and 142nd Avenue. As part of this initiative, FDOT District 6 installed several Adaptive Signal Control and Wi-Fi vehicle detection devices along the corridor to monitor traffic conditions and collect singal adaptively in real-time

# Miami-Dade County Dashboard 

Corridor-based and Segment-based


## Intersection-Level Dashboard

## 


ast


## Benefit-Cost Module

- Two types of support
- Provide data to sketch planning tools
- Estimation of benefits based on data (currently only for incident management)
- Incident management benefits
- Originally only for freeways - Now for freeways and arterials



## Benefit-Cost Module



## Estimation of Construction Impacts

- Two types of support
- Assessment based on real-world data
- Providing the required inputs for external work zone analysis tools (e.g., demand and capacity values at the work zone).



## Real-Time Information Sharing

1 i) AB A Intelligent Transportation System Data Capture and Performance Management


## Incident Impacts and Index



## Estimation of Rain Impacts

- Utilization of HCM procedures for the estimation of travel time with consideration of rain impacts

| Scenario | Medium Rain |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | MAPE | RMSE | NRMSE | MSPE | RMSPE |
| No Prediction | 15 min | 0.107 | 13.326 | 0.132 | 0.016 | 0.127 |
|  | 30 min | 0.117 | 18.668 | 0.192 | 0.012 | 0.108 |
|  | 45 min | 0.111 | 15.890 | 0.175 | 0.010 | 0.101 |
|  | 60 min | 0.210 | 43.012 | 0.391 | 0.050 | 0.223 |
| Prediction Using "Normal" <br> Day Demands as Input | 15 min | 0.096 | 17.294 | 0.171 | 0.010 | 0.099 |
|  | 30 min | 0.103 | 23.187 | 0.239 | 0.013 | 0.115 |
|  | 45 min | 0.097 | 19.867 | 0.218 | 0.011 | 0.104 |
|  | 60 min | 0.219 | 46.868 | 0.426 | 0.050 | 0.223 |
| Prediction Using Instantaneous Demands as Input | 15 min | 0.059 | 12.111 | 0.125 | 0.004 | 0.063 |
|  | 30 min | 0.061 | 12.561 | 0.127 | 0.004 | 0.063 |
|  | 45 min | 0.043 | 8.513 | 0.094 | 0.002 | 0.045 |
|  | 60 min | 0.148 | 34.157 | 0.311 | 0.024 | 0.155 |
| Prediction with Forecasted <br> Demands as Input | 15 min | 0.048 | 10.700 | 0.106 | 0.003 | 0.055 |
|  | 30 min | 0.045 | 8.913 | 0.098 | 0.002 | 0.047 |
|  | 45 min | 0.045 | 6.087 | 0.072 | 0.004 | 0.061 |
|  | 60 min | 0.088 | 11.627 | 0.117 | 0.008 | 0.092 |
|  | Heavy Rain |  |  |  |  |  |
| No Prediction | 15 min | 0.126 | 17.103 | 0.244 | 0.019 | 0.139 |
|  | 30 min | 0.208 | 32.016 | 0.508 | 0.051 | 0.227 |
|  | 45 min | 0.121 | 11.597 | 0.153 | 0.009 | 0.096 |
|  | 60 min | 0.160 | 21.840 | 0.240 | 0.019 | 0.138 |
| Prediction Using "Normal" <br> Day Demands as Input | 15 min | 0.116 | 16.347 | 0.234 | 0.014 | 0.118 |
|  | 30 min | 0.108 | 16.523 | 0.262 | 0.013 | 0.116 |
|  | 45 min | 0.100 | 14.874 | 0.196 | 0.010 | 0.100 |
|  | 60 min | 0.146 | 26.217 | 0.288 | 0.022 | 0.149 |
| Prediction Using <br> Instantaneous Demands as Input | 15 min | 0.015 | 2.948 | 0.042 | 0.000 | 0.017 |
|  | 30 min | 0.086 | 16.895 | 0.268 | 0.008 | 0.092 |
|  | 45 min | 0.028 | 3.619 | 0.048 | 0.001 | 0.031 |
|  | 60 min | 0.044 | 10.675 | 0.117 | 0.003 | 0.054 |
| Prediction with Forecasted <br> Demands as Input | 15 min | 0.015 | 2.948 | 0.042 | 0.000 | 0.017 |
|  | 30 min | 0.043 | 7.432 | 0.118 | 0.003 | 0.056 |
|  | 45 min | 0.020 | 2.658 | 0.035 | 0.000 | 0.021 |
|  | 60 min | 0.036 | 6.768 | 0.078 | 0.001 | 0.037 |

## Probability of Breakdown for Freeways



## Probability of Breakdown on Arterials


*Where, $T=$ Time of Day, $\mathrm{S}_{\text {down }}=$ Downstream Speed, $\mathrm{O}_{\mathrm{up}}=$ Upstream Occupancy, $\mathrm{V}_{\text {up }}=$ Upstream Volume

## Ramp Metering Warrants

- On-going effort
- Currently based on simple characteristics including mainline volume, mainline speed, ramp volume, sum of mainline and ramp volume, ramp storage and acceleration distance.
- Researching utilization of dynamic traffic characteristics and measures such as the probability of breakdown, bottleneck attributes, and travel time reliability


## CCTV and DMS Location Prioritization

- Incident statistics
- Reliability - travel time index
- Ranking utilizing a utility index


## Potential Extensions

- Additional support for:
- ATDM
- ICM
- Multi-modal
- Planning for operations
- Predictive modeling

