NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Data-Driven Strategies for Efficient Pavement Systems

September 5, 2025

10:30 AM – 12:00 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING RCEP REGISTERED CONTINUING EDUCATION PROGRAM

AICP Credit Information

1.5 American Institute of Certified Planners Certification Maintenance Credits

You must attend the entire webinar

Log into the American Planning Association website to claim your credits

Contact AICP, not TRB, with questions

Purpose Statement

This webinar will explore ways to integrate these considerations with construction best practices to promote efficient pavement systems. Presenters will provide insights on key challenges and potential solutions for advancing the current state-of-the-art in pavement design, construction, and management.

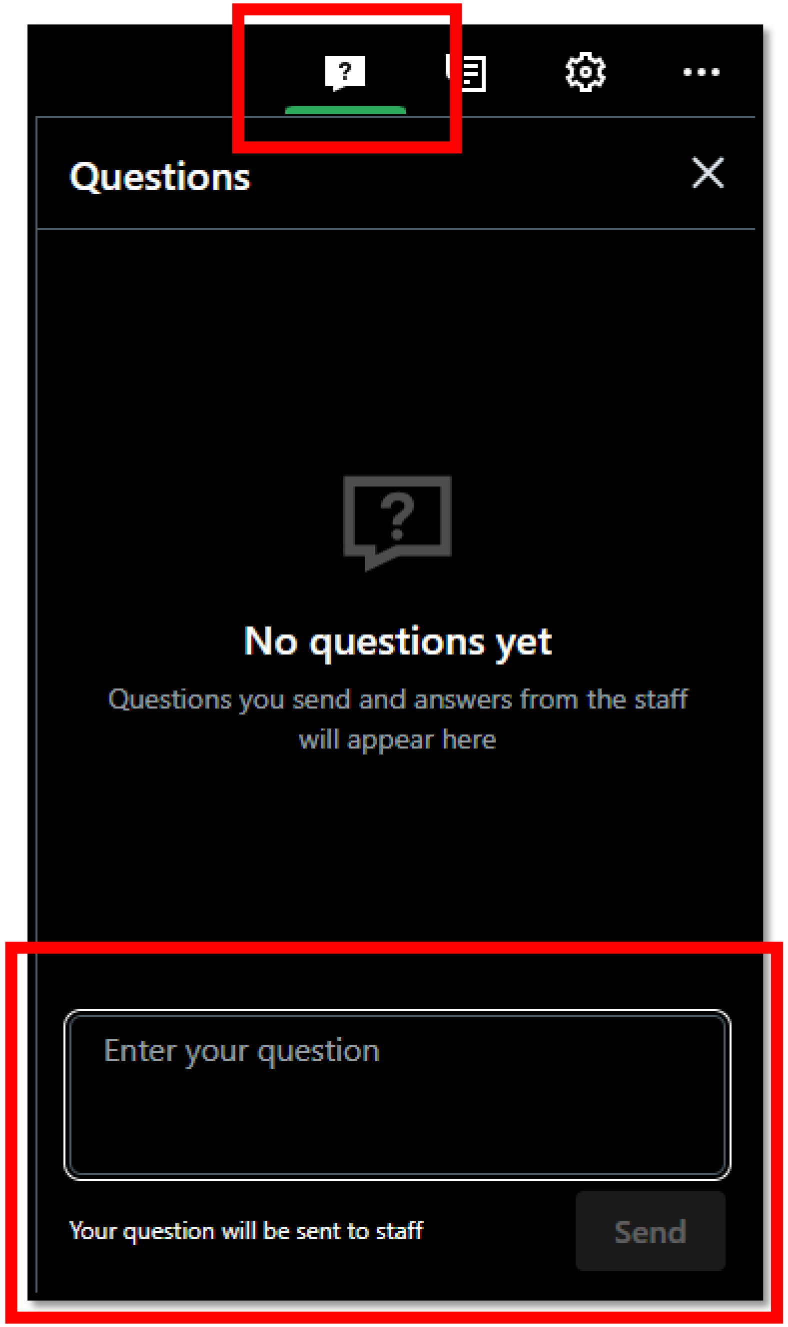
Learning Objectives

At the end of this webinar, you will be able to:

- Understand the benefits of integrating diverse datasets for efficient pavement management
- Use strategies for overcoming challenges in systemic data integration
- Apply real-world insights from experts on best practices and emerging technologies

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Acknowledgements

Dr. DingXin Cheng

California State University, Chico

Former committee chair of the TRB Standing Technical Committee on Pavement Preservation (AKT20)

Jenna Bowers

Ingevity

Former committee chair of the TRB Standing Technical Committee on Asphalt Materials Selection and Mix Design (AKM30)

Dr. David Mensching

Federal Highway Administration

Former committee chair of the TRB Standing Technical Committee on Binders for Flexible Pavement (AKM20)

Today's presenters

NATIONAL ACADEMIES Sciences Engineering Medicine

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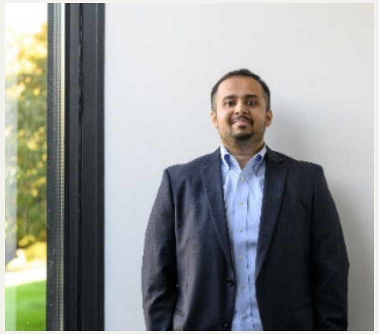

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Data-Driven Strategies for Efficient Pavement Systems

Transportation Research Board Webinar

Introduction

5 September 2025

Krishna Prapoorna Biligiri
Professor
Civil & Environmental Engineering
Indian Institute of Technology Tirupati, India

Augusto Cannone Falchetto
Associate Professor
Civil, Environmental & Architectural Engineering
University of Padua, Italy

Origin

- ***TRB Subcommittee Meeting AKT20(1) - Integrating the Flexible Pavement Life Cycle***
- ***Webinar proposed as part of the TRB Committee AKT20 - Pavement Preservation, formerly led by Dr. DingXin Cheng***

Webinar conceived in the TRB subcommittee committee during January 2025 in Washington, DC., USA as a step in the direction of reorganizing the activity of the past subcommittee AKT20(1): final goal of increasing attention to the area and eventually launching a call for papers

Motivation & Purpose of Webinar

- *Current context for roadway infrastructure management*
  - *Static decision trees*
  - *Expert judgment*
  - *Pros: Structured guidance*
  - *Cons: Optimizing solutions for multiple objectives such as performance & cost efficiency*
- *Strategy for management of efficient pavement systems*
  - *context-specific, &*
  - *data-driven decision-making processes*

Purpose: explore the critical role of integrating materials/products, designs, best construction practices, and pavement management databases, to promote efficient pavement systems

Learning Objectives: Key Takeaways

- ***Understand the benefits of integrating diverse datasets for efficient pavement management***

- ***Use strategies for overcoming challenges in systemic data integration***

- ***Apply real-world insights from experts on best practices and emerging technologies***

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Pavement Management – Florida's Perspective and Progress

Leverage Data and Technology for Strategic Alignment

Sue Zheng And Howard Moseley
September 5, 2025

A Robust Pavement Management System

The Key to Preserving our Pavement Investments,

The Key to Maintaining the Serviceability at Lowest Life-cycle Cost.

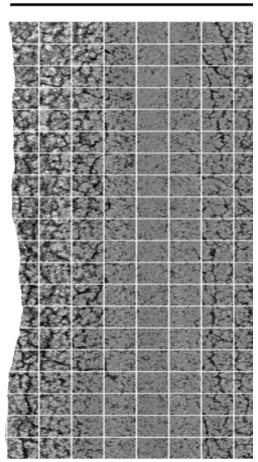
Key Element 1 - Pavement Condition Assessment: Accurate and Continuous

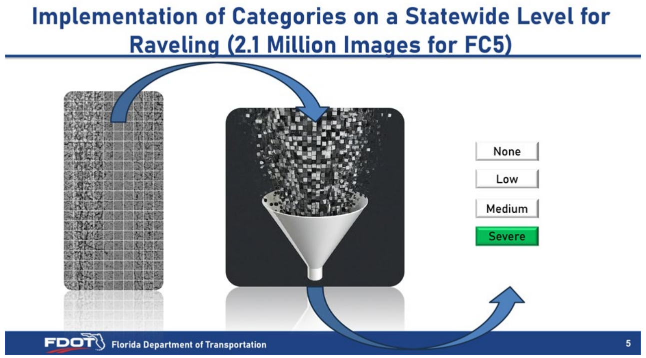
Leveraging advanced data collection and analysis tools, integrating AI and ML for automated assessment and reporting to achieve precision, digitalization, and automation.

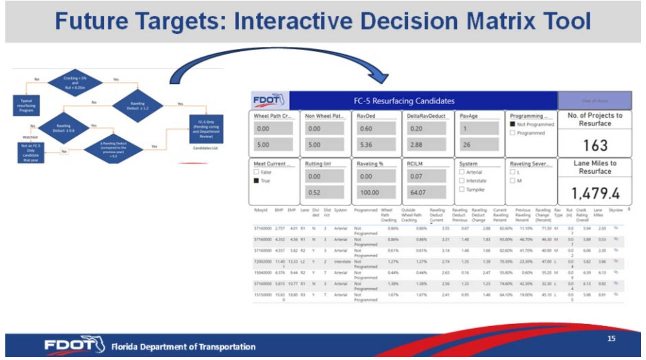
Key Element 2 - Pavement Performance Modeling: Intelligent and Efficient

Connecting materials, design, construction, and maintenance decisions to anticipated pavement performance and their financial implications.

Address agency needs at the project, network, and strategic levels







Pavement Condition Assessment - FDOT's Achievements

Implementation of High-speed 3D Pavement Data Technologies – Quality Data as Lifeblood

Data Digitalization - Foundation for leveraging Computing and Analytics Tools

AI & ML Integration – Pathway for Complete Automation

Interactive Condition Reporting Tools – Final Step from AI to BI

The Ongoing Struggle

Identifying the Root Causes of Premature Pavement Distresses: Despite the vast datasets at our disposal, pinpointing the specific causes remains elusive.

Forecasting the Impact of Design Changes: Whether altering materials or modifying installation methods, predicting performance outcomes is still fraught with uncertainty.

We have plenty, but not what we need most:

Hidden correlation and patterns between policy/practices and pavement performance

Experiencing Thirst In a Vast Ocean of Data

Where to Begin?

In an Ever-Changing World:

- A vast array of options can be overwhelming.

- Constant changes can be too intimidating to act.

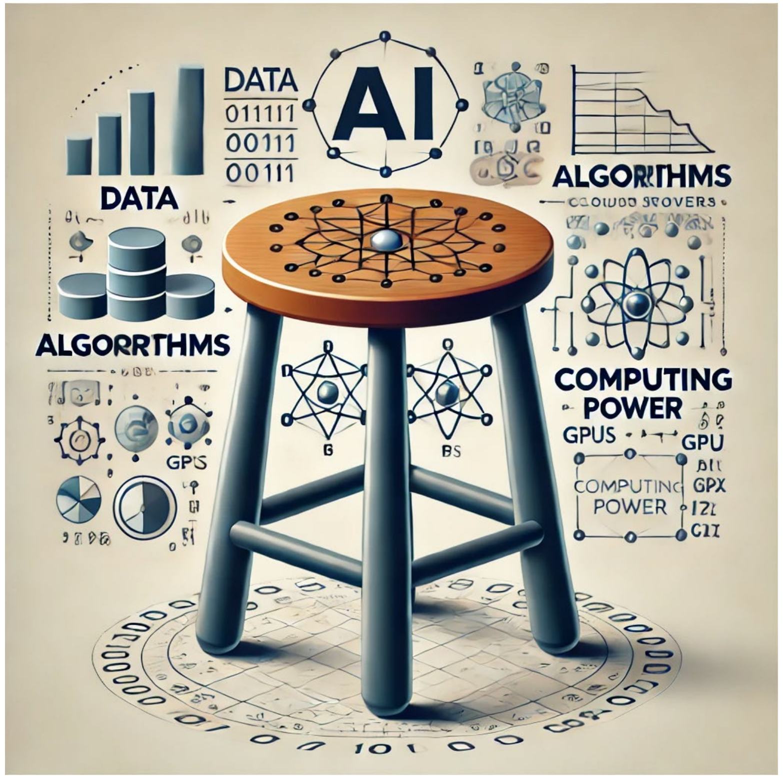
Find the Constant:

"In an exponentially changing world, focusing on things that do not change provides a strong foundation for long-term success." (*Jeff Bezos*)

What are the things that are stable and foundational in the era of technology?

Constants
Data is Lifeblood of AI
Data is Fuel of AI engine

Integrate the Temporal, Multidimensional, and Cross-function Data by Breaking Down Data Silos



Four-Stage Life Cycle

1

Planning and Engineering: Collect geotechnical borings, drainage studies, and other preliminary data.

2

Design: Utilize Falling Weight Deflectometer (FWD), Ground Penetrating Radar (GPR), and coring data to define pavement structure and layer thickness.

3

Construction and Acceptance: Record mix designs, material testing data, core densities, and final acceptance data to ensure construction quality.

4

Maintenance and Operations: Document repair records, traffic data, and weather data to manage ongoing pavement performance.

An Intelligent Pavement Management System

Pavement (Actor)
Create a digital version “twin” of the pavement with design and construction data, its DNA

Working Conditions (Stage)
Create a digital version of its working condition with environmental and mechanical loading data

Performance
Create a digital version of its performance as characterized by “biomarkers”(cracking, raveling, rutting, smoothness, friction) during maintenances and operation.

A Vision

- **Create a dynamic digital twin of pavement that integrates diverse engineering data from the physical world into a virtual replica.**
- The built-in capabilities to continuously learn, calibrate, and improve its predictive accuracy, enabling smarter decisions for pavement design, construction, and maintenance.

A Roadmap

Architect the Platform

- Develop a robust GIS platform capable of integrating diverse data sets.
- Ensure data interoperability and real-time data updating capabilities

Digitalize - Create Digital Versions

- **Pavement Digital Twin:** Integrate design and construction data to create a digital representation of the pavement.
- **Service Conditions Digital Twin:** Incorporate environmental and traffic data to simulate service conditions.
- **Performance History Digital Twin:** Compile historical performance data to track and predict future pavement conditions

Develop Correlations and Causations through Machine Learning

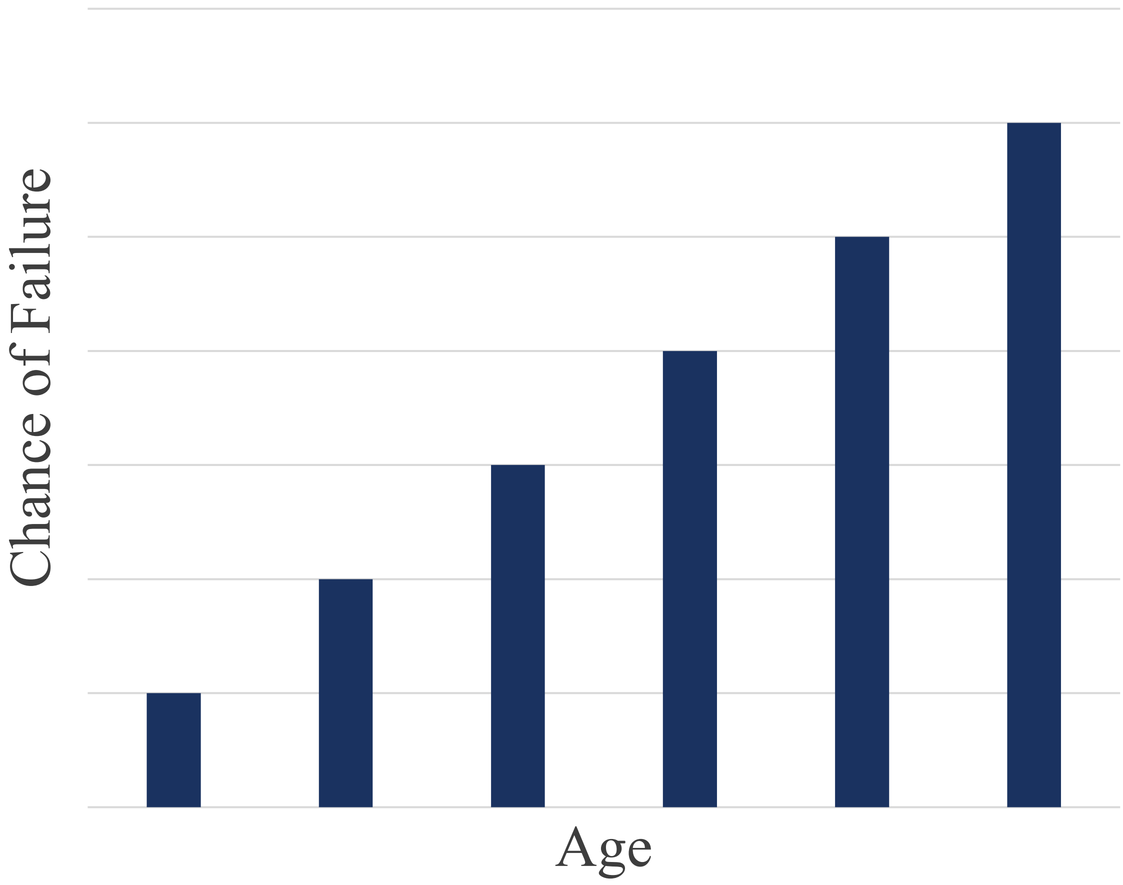
- Implement machine learning algorithms to analyze the integrated data.
- Develop new models for design, impact analysis, and forecasting based on the identified patterns and correlations

Improved Pavement Deficiency Forecasting with Artificial Intelligence

LEVERAGE DATA AND TECHNOLOGY FOR STRATEGIC ALIGNMENT

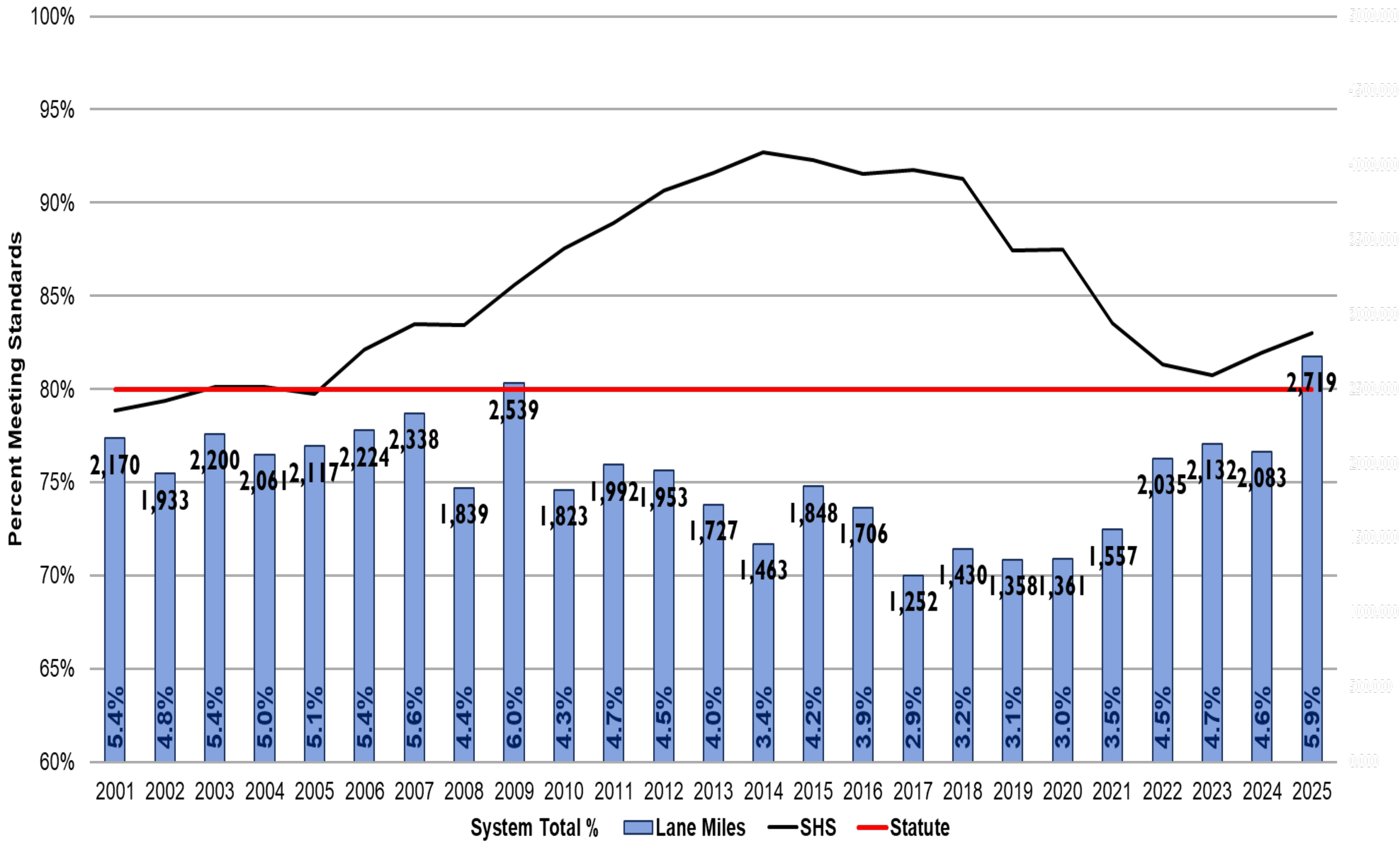
BACKGROUND: CURRENT FORECASTING MODEL

- Network level probabilistic model
- Data:
  - PCS Pavement Performance Rating
  - Pavement Age
  - District
  - System (Arterial, Interstate, or Turnpike)
  - Surface Type (Open or Dense)



ANNUAL PAVEMENT PERFORMANCE FORECASTING GOAL

- Accurately predict future pavement deficiency
  - Recommend lane mile targets for resurfacing
  - Provide stable long term resurfacing targets
  - Ensure statewide sufficiency remains above the mandated 80%



LIMITATIONS OF CURRENT FORECASTING MODEL

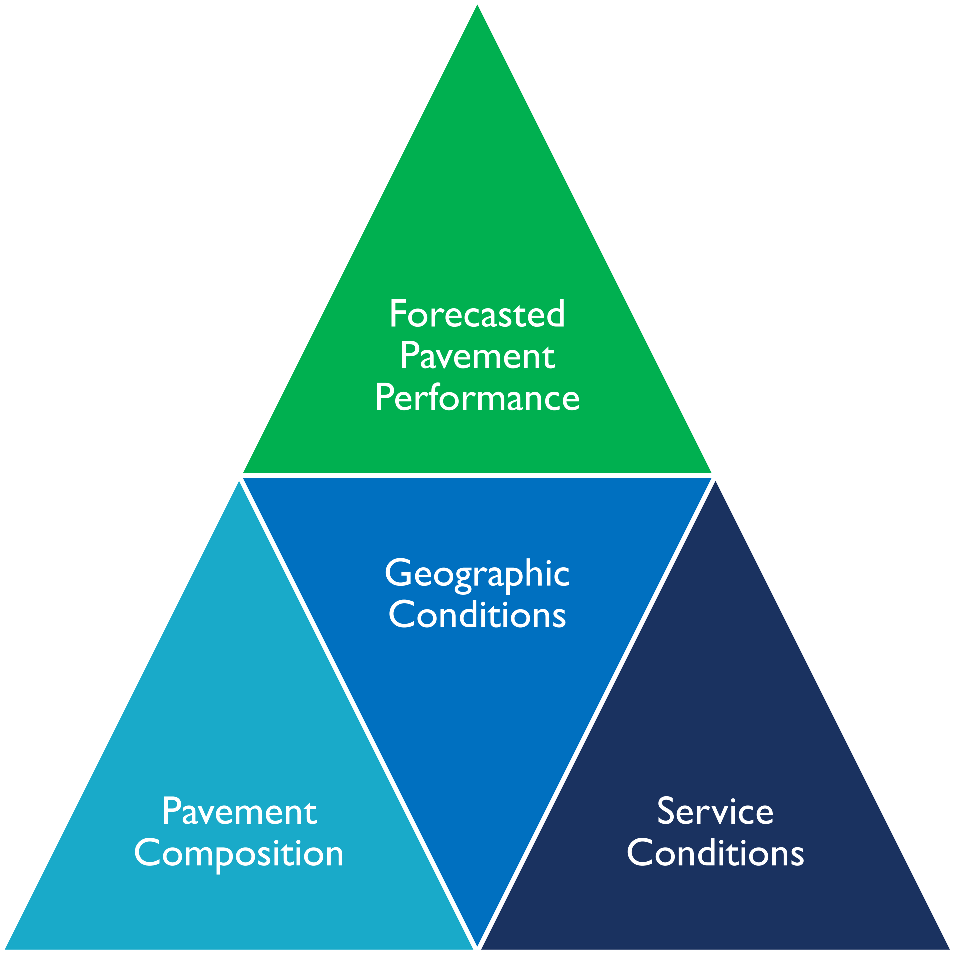
- FDOT's current **probabilistic model** for estimating deficient lane miles is empirical and relies heavily on historical performance data. This limits its ability to account for dynamic interactions between pavement performance factors.
- Key factors such as the **pavement design**, **traffic loads**, **weather**, **construction materials/quality**, and **maintenance practices** are not comprehensively integrated, leading to less accurate predictions.
- The current forecasting approach poses risks for long-term sustainability and resource allocation, necessitating an **engineering-based, and advanced analytical model**.

THE AI EFFICIENCY PROJECT

- **Objective**: To enhance efficiency and reduce costs by utilizing artificial intelligence (AI) and machine learning (ML) to improve the Department's pavement forecasting model.
- **Benefits:**
  - Integration of all Available & Relevant Pavement Data
  - Improved Accuracy and Reliability of Pavement Performance Predictions
  - Optimized Resource Allocation

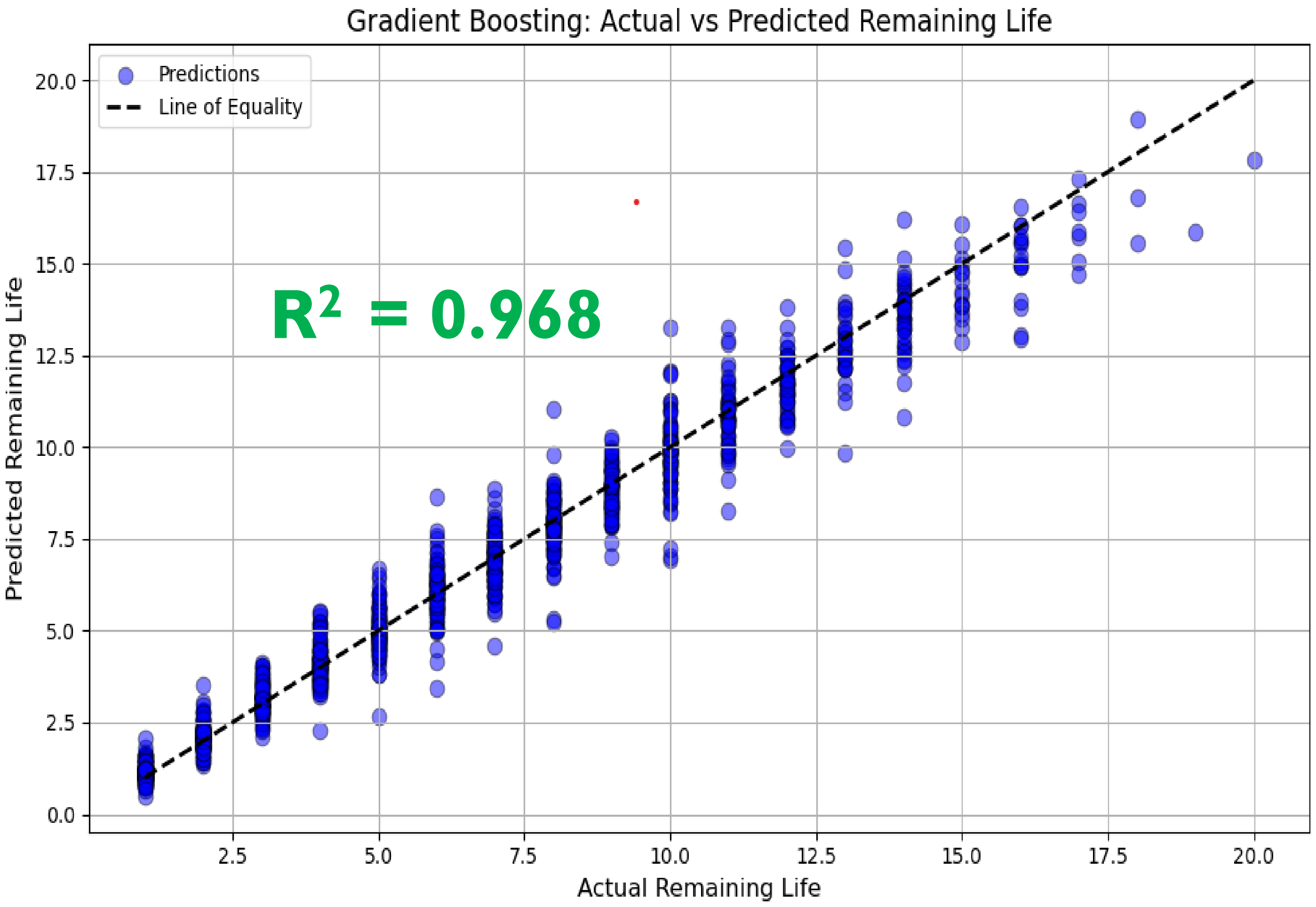
AI POWERED MODEL

- Predict pavement performance using the underlying engineering characteristics
- Pavement performance is determined by:
  1. Pavement Composition
  2. Geographic Conditions
  3. Service Conditions
- Our model aims to characterize those three categories and use them to more accurately predict pavement performance



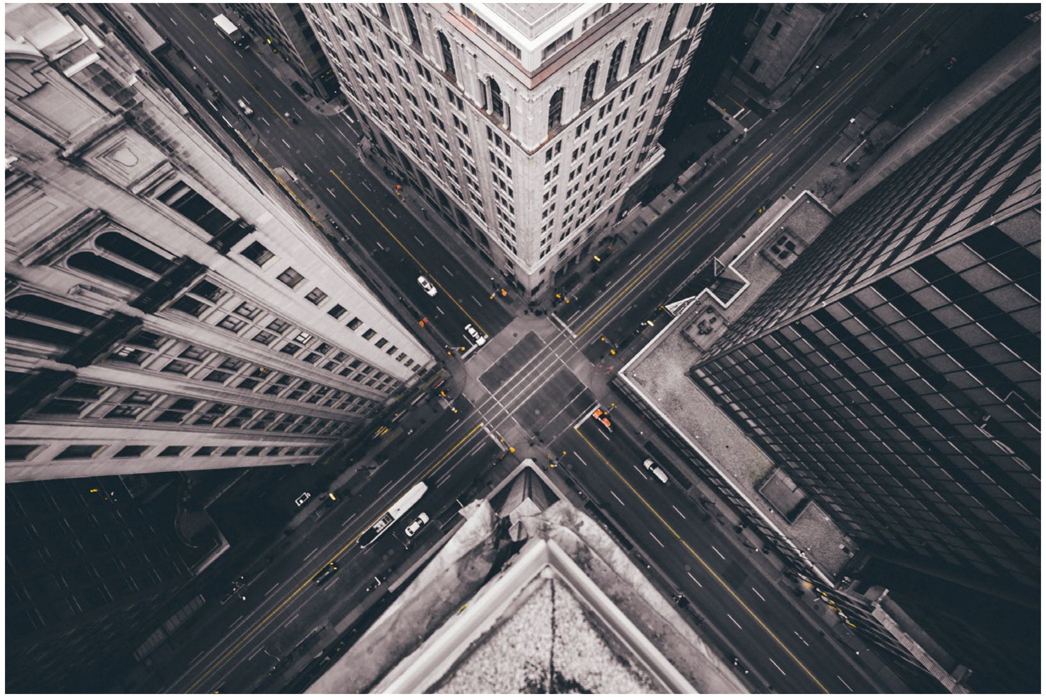
PROOF OF CONCEPT

- Models cracking for Interstates and Turnpike
- Project level modeling for remaining life
- Data:
  - Crack Rating
  - Age
  - Past Service Life
  - Location (Latitude)
  - Truck %
  - Base Deflection Index (FWD)
  - FWD Data
  - Embankment Resilient Modulus
- Gradient Boosting Regression Model

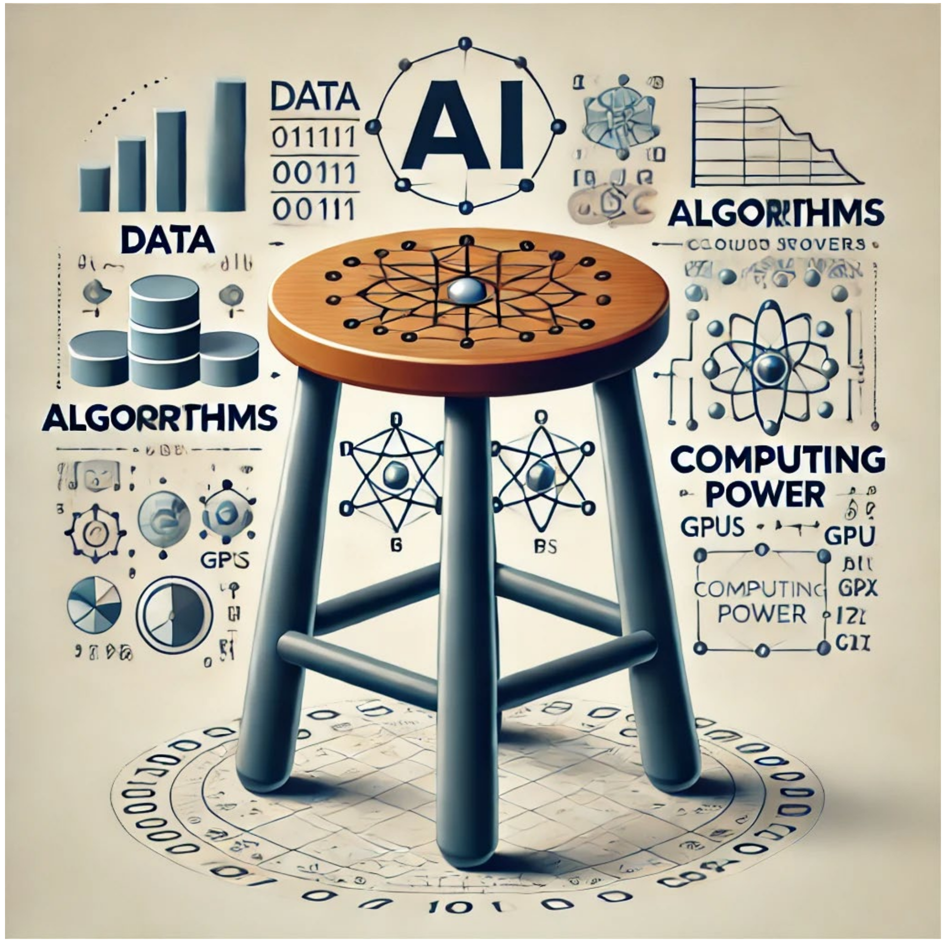


ADDING ARTERIALS

- Arterials make up ~75% of the State Highway System
- Arterial pavement composition can be more variable
- Accounting for this variability will improve the reliability of our model



IDENTIFYING KEY VARIABLES

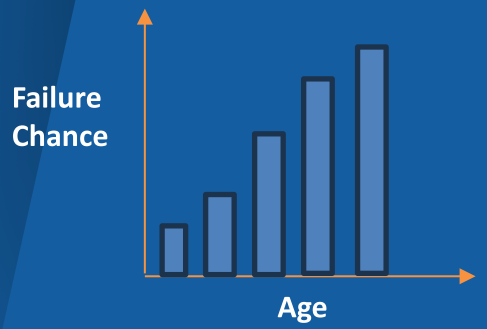


- Comprehensive, quality, datasets are essential
- Perfect world: Integrate all datasets and determine data for model from there
- Real World: Use engineering judgement to identify most important datasets first
- Work has begun to integrate 17 key datasets identified by statewide engineers

Improved Data Integration

Current Model

- Rutting Rating
- Cracking Rating
- Surface Type
- Smoothness Rating
- Age
- District Location



AI Powered Model

Age	Crack Depth	Design ESALS	Pavement Thickness	Binder Grade	Texture	Milling Depth
Raveling	Rutting	Embankment Modulus	Cross slope	Pavement Density	Water Table	Stabilized Subgrade
Location	Ride	Base Type	Base Thickness	Effective Binder	Air Voids	Pavement Design
	BDI	Base Modulus	Mix Design	Weather	Gradation	Traffic
	Surface Type	Binder Content	Aggregate Type	RAP	Design Life	VMA

KEY ENGINEERING VARIABLES IDENTIFIED

Pavement Composition

- Surface Texture
- In-place Mixture Binder Content
- In-place Mixture Volumetrics
- In-place Mix Design Properties
- In-place Density
- FWD Data
- Crack Type / Depth prior to Resurfacing
- Pavement Design / Milling Depth

Geographic Condition

- Location
- Weather

Service Conditions

- Design / Cumulative ESALS
- Historic Service Life
- PCS Ratings (Crack, Rut, Ride, Ravel)
- Pavement Age Since Last Resurfacing
- Traffic Patterns (Urban versus rural / Arterial versus Limited Access)

INTEGRATING DATA

- Each Office in the Department has its own "Data Silo(s)"
- These silos are not inherently connected and require "cross-walks" to connect
- Our objective:
  - Integrate data by standardizing and connecting data silos

DATA AVAILABILITY

Pavement Composition

- Surface Texture
- In-place Mixture Binder Content
- In-place Mixture Volumetrics
- In-place Mix Design Properties
- In-place Density
- FWD Data
- Crack Type / Depth prior to Resurfacing
- Pavement Design / Milling Depth

Geographic Condition

- Location
- Weather

Service Conditions

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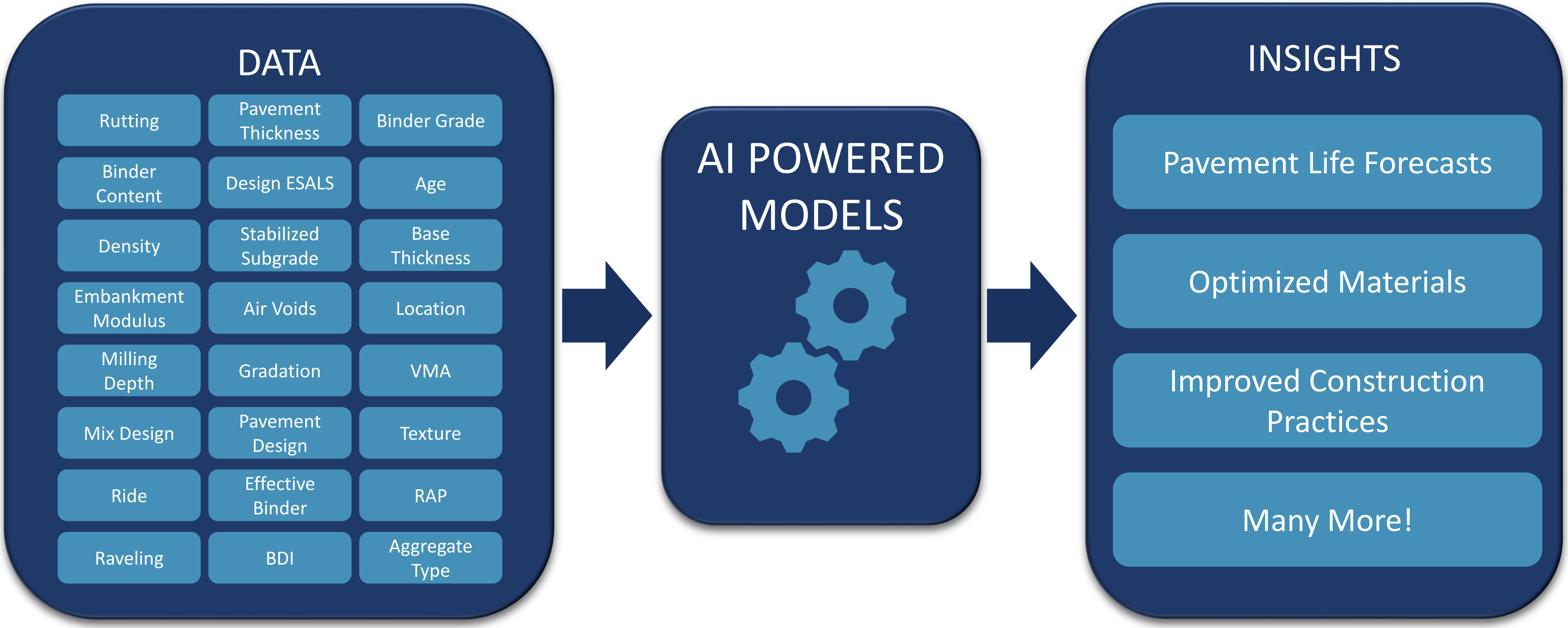
GROUNDWORK FOR THE FUTURE



PATH FORWARD

- Continue working with other offices to access data
- Develop paths to connect data sources
- Review datasets for accuracy and completeness
- Leverage connected datasets to develop a new AI based model
- Develop real-time reporting tool

Paving the Way to Better Roads: A Unified Approach to Material, Construction, Maintenance, and Performance Data

Syeda Rahman, Andre Smit, Enad Mahmoud, Amit Bhasin

Texas Department of Transportation

September 4, 2025

Authors’ Disclaimer

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Layout

Motivation

Goals

Methodology

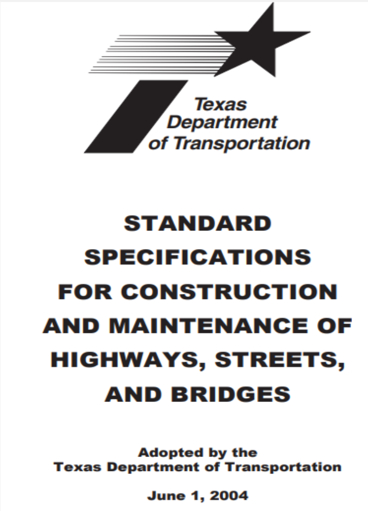
System Development

Achievements

Motivation

A system evaluating the performance of specification Items

- 200,000 lane-miles
- > 15 million tons/yr of hot mix asphalt



Goal

Develop an online application with statewide accessibility

- Evaluate the performance of specification Items
- Incorporate maintenance activities

Methodology

Identified and integrated data

Analyzed data

Developed dashboards

Developed text and video guides

Sought feedback from Divisions/Districts

Identified and integrated data

Identified and integrated data

QCQA/mix design data

Refresh Workbook

2014 QC/QA Design Data

TX2QCQA1

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MATERIAL NAME:			
PRODUCER:			
AREA ENGINEER:		PROJECT MANAGER:	

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Identified and integrated data

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COURSE\LIFT:		STATION:		DIST. FROM CL:	

ACP RUT AVERAGE WP DEPTH (INCH)	0.0848
CONDITION SCORE CLASSIFICATION	A - VERY GOOD 90-100
DISTRESS SCORE CLASSIFICATION	A - VERY GOOD 90-100

Pavement condition data

Identified and integrated data

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Refresh Workbook

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ACTIVITY

P05 - Full Width Seal Coat

DCIS/MMS project location archive

ACP RUT AVERAGE WP DEPTH (INCH)

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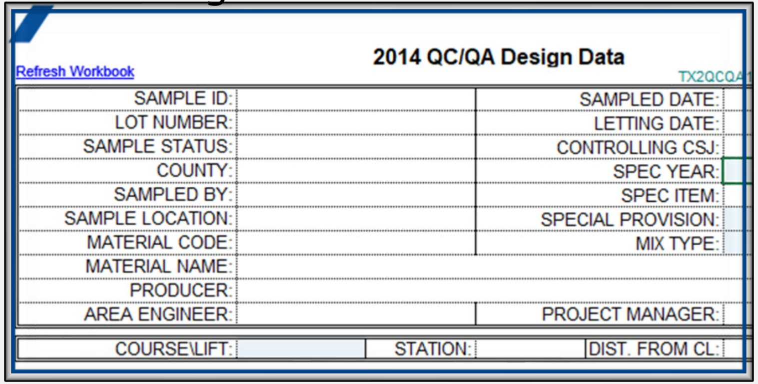
Refresh Workbook

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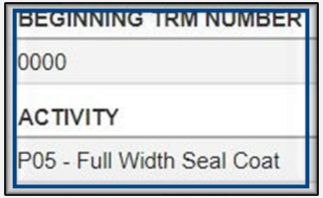
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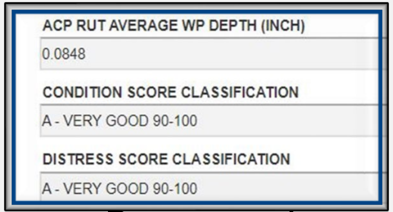
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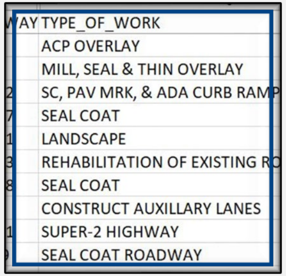
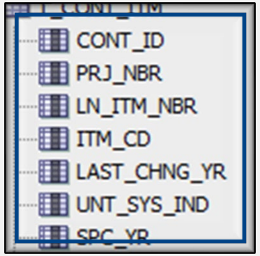

TYPE_OF_WORK
ACP OVERLAY
MILL, SEAL & THIN OVERLAY
SC, PAV MRK, & ADA CURB RAMP
SEAL COAT
LANDSCAPE
REHABILITATION OF EXISTING R
SEAL COAT
CONSTRUCT AUXILLARY LANES
SUPER-2 HIGHWAY
SEAL COAT ROADWAY

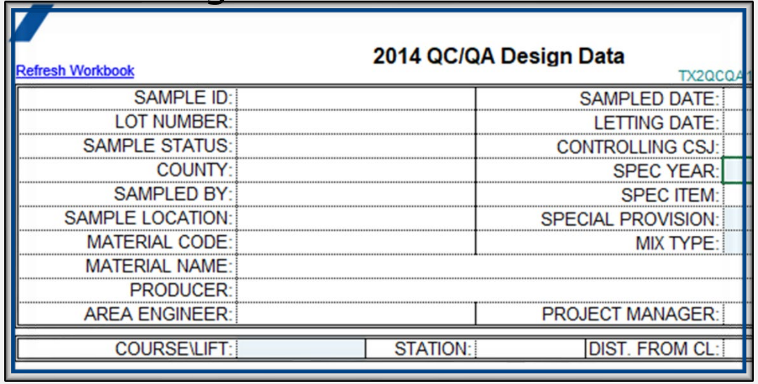
Seal coat project test data

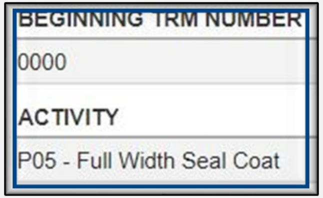
Identified and integrated data



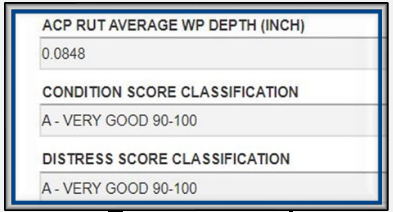
DCIS project data

QCQA/mix design data

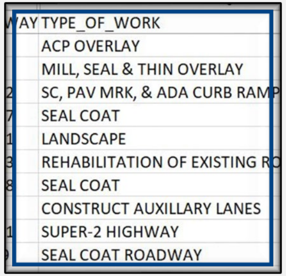




DCIS/MMS project location archive



Pavement condition data



Seal coat project test data

Identified and integrated data

T_CONT_ITM
- CONT_ID
- PRJ_NBR
- LN_ITM_NBR
- ITM_CD
- LAST_CHNG_YR
- UNT_SYS_IND
- SPC_YR

DCIS project data

QCQA/mix design data

2014 QC/QA Design Data

Refresh Workbook

TX2QCQA

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ACTIVITY
P05 - Full Width Seal Coat

DCIS/MMS project location archive

Route and roadbed shape files

ACP RUT AVERAGE WP DEPTH (INCH)
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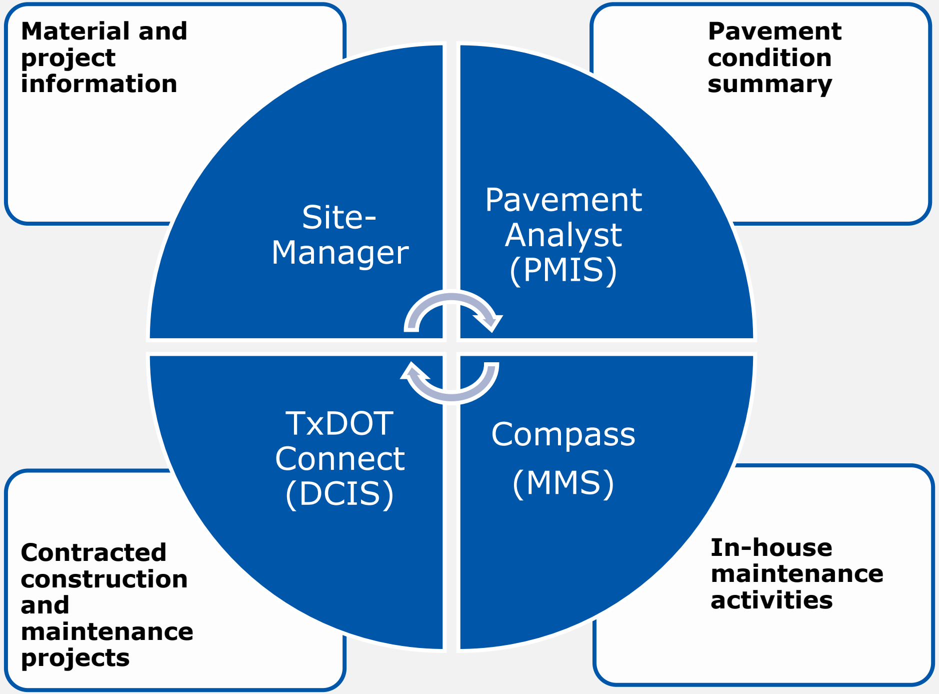
Pavement condition data

TYPE_OF_WORK
ACP OVERLAY
MILL, SEAL & THIN OVERLAY
SC, PAV MRK, & ADA CURB RAMP
SEAL COAT
LANDSCAPE
REHABILITATION OF EXISTING RO
SEAL COAT
CONSTRUCT AUXILLARY LANES
SUPER-2 HIGHWAY
SEAL COAT ROADWAY

Seal coat project test data

Developed a unified system

Developed a unified system that integrates pavement performance, specification Items, maintenance activities, and construction projects



System Development

Project Performance

Project level analysis

Item/mix Performance

Item/mix level analysis

Material Performance

Material specific analysis

STATE

DISTRICT

MAINTENANCE SECTION

Tableau dashboards

2 Dash-board systems

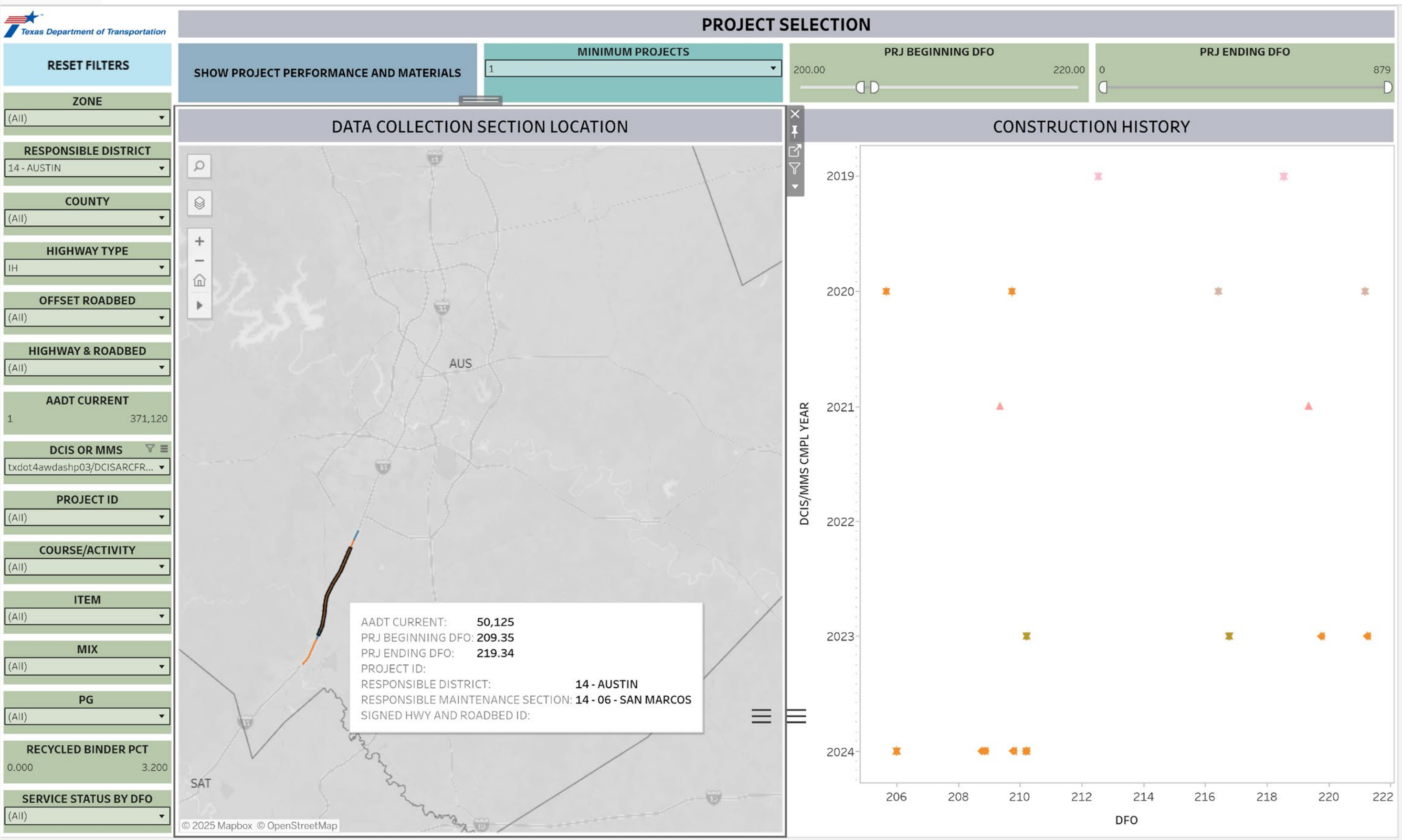
10 Dash-boards each

121 Fields

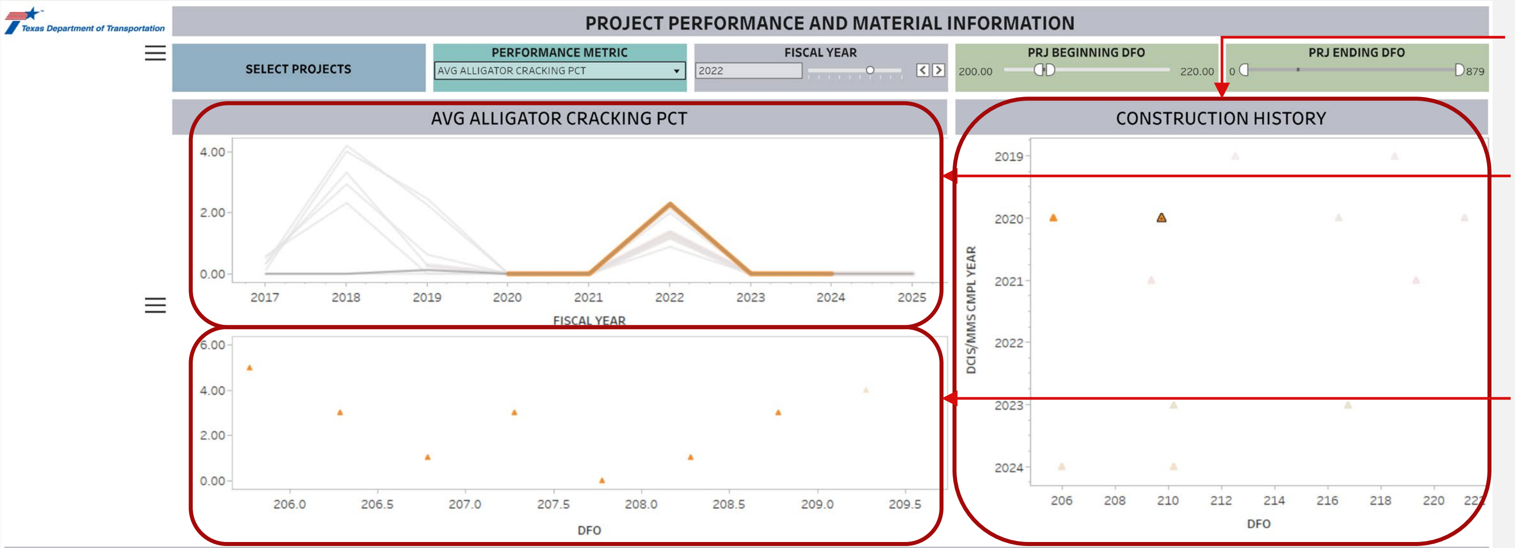
>128M Rows

8 Data sources

A first-ever unified system



A first-ever unified system

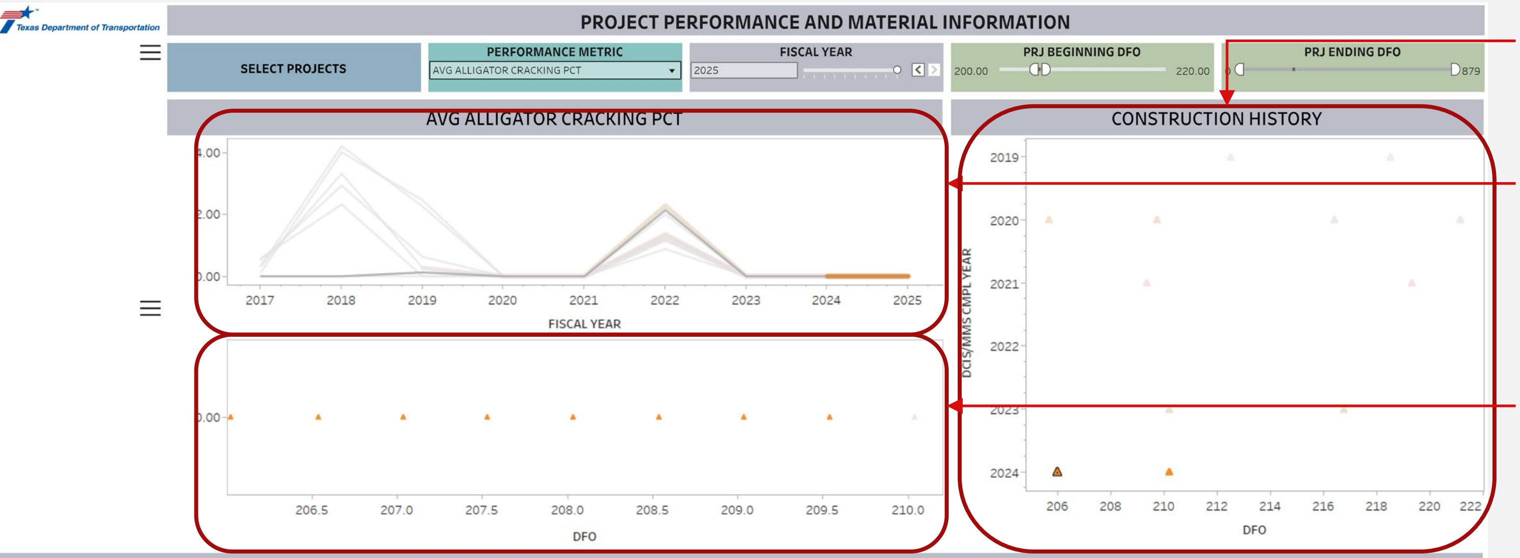


MATERIAL INFORMATION

D	LN ITM NBR	COURSE/ ACTIVITY	Year of SMGR C..	MIX	BINDER SOURCE	AGG SOURCE	SAC_ est	PG	WMA_ USED	REC B INDE..	PRD AC PRJ AVG	PRD AC PRJ STDEV	PRD AVF PRJ AVG	PRD AVF PRJ STDEV	PLC PF PRJ AVG	PLC PF PRJ STDEV	PRJ ITM QTY	
0	0081	Surface	2019	342-PFC-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	20,536	[illegible]
	0095	Surface	2019	347-TOM-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	2,882	[illegible]
	0100	Base	2019	340-DG-B	Null	Null	Null	PG 64-22	Yes	1.30	Null	Null	Null	Null	Null	Null	153	$4,748
	0335	Surface	2019	342-PFC-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	23,304	[illegible]
4	Null	Overlay	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	$2,173,500
5	Null	Overlay	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	$2,042,000
3	0075	Surface	2021	347-TOM-C	Null	Null	Null	PG 76-22	Yes	0.00	Null	Null	Null	Null	Null	Null	8,189	$739,010
	0080	Base	2021	340-DG-B	Null	Null	Null	PG 64-22	Null	0.80	Null	Null	Null	Null	Null	Null	12,404	$0
1	0190	Surface	2023	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Null	0.00	6.93	0.027	6.02	0.423	1.05	0.020	25,281	$4,597,810
0	0218	Surface	2024	SS-3076-DG-D	Null	Null	Null	PG 76-22	Yes	0.50	Null	Null	Null	Null	Null	Null	1,560	$222,711
	0220	Surface	2024	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Yes	0.00	Null	Null	Null	Null	Null	Null	3,188	$540,837
	0221	Surface	2024	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Yes	0.00	6.49	0.037	5.18	1.000	Null	Null	10,064	$1,263,292
						Grand Total												$15,804,545

Contracted maintenance projects

A first-ever unified system



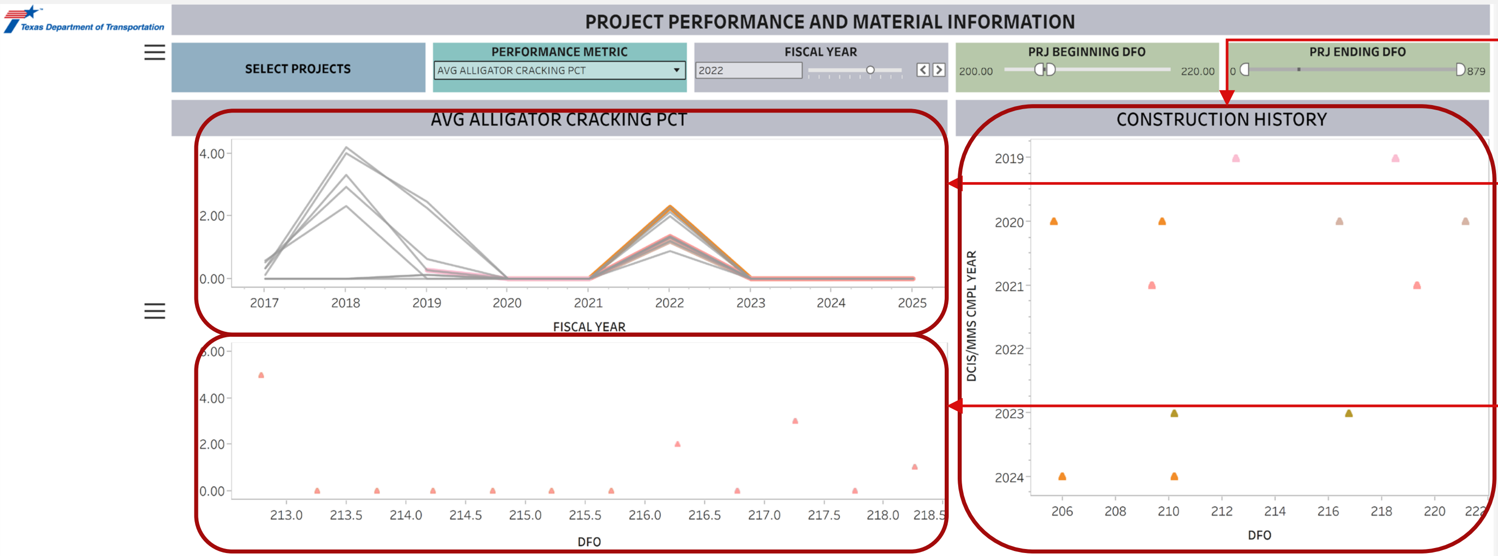
MATERIAL INFORMATION

D	LN ITM NBR	COURSE/ ACTIVITY	Year of SMGR C..	MIX	BINDER SOURCE	AGG SOURCE	SAC_ est	PG	WMA_ USED	REC B INDE..	PRD AC PRJ AVG	PRD AC PRJ STDEV	PRD AVF PRJ AVG	PRD AVF PRJ STDEV	PLC PF PRJ AVG	PLC PF PRJ STDEV	PRJ ITM QTY	
0	0081	Surface	2019	342-PFC-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	20,536	[illegible]
	0095	Surface	2019	347-TOM-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	2,882	[illegible]
	0100	Base	2019	340-DG-B	Null	Null	Null	PG 64-22	Yes	1.30	Null	Null	Null	Null	Null	Null	153	$4,748
	0335	Surface	2019	342-PFC-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	23,304	[illegible]
4	Null	Overlay	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	$2,173,500
5	Null	Overlay	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	[illegible]
3	0075	Surface	2021	347-TOM-C	Null	Null	Null	PG 76-22	Yes	0.00	Null	Null	Null	Null	Null	Null	8,189	$739,010
	0080	Base	2021	340-DG-B	Null	Null	Null	PG 64-22	Null	0.80	Null	Null	Null	Null	Null	Null	12,404	$0
1	0190	Surface	2023	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Null	0.00	6.93	0.027	6.02	0.423	1.05	0.020	25,281	$4,597,810
0	0218	Surface	2024	SS-3076-DG-D	Null	Null	Null	PG 76-22	Yes	0.50	Null	Null	Null	Null	Null	Null	1,560	$222,711
	0220	Surface	2024	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Yes	0.00	Null	Null	Null	Null	Null	Null	3,188	$540,837
	0221	Surface	2024	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Yes	0.00	6.49	0.037	5.18	1.000	Null	Null	10,064	$1,263,292
					Grand Total													$15,804,545

Contracted maintenance projects

Material information

A first-ever unified system



MATERIAL INFORMATION

LN ITM NBR	COURSE/ ACTIVITY	Year of SMGR C..	MIX	BINDER SOURCE	AGG SOURCE	SAC_ est	PG	WMA_ USED	REC B INDE..	PRD AC PRJ AVG	PRD AC PRJ STDEV	PRD AVF PRJ AVG	PRD AVF PRJ STDEV	PLC PF PRJ AVG	PLC PF PRJ STDEV	PRJ ITM QTY	
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0095	Surface	2019	347-TOM-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	2,882	$231,247
0100	Base	2019	340-DG-B	Null	Null	Null	PG 64-22	Yes	1.30	Null	Null	Null	Null	Null	Null	153	$4,748
0335	Surface	2019	342-PFC-C	Null	Null	Null	PG 76-22	Null	0.00	Null	Null	Null	Null	Null	Null	23,304	$2,120,634
Null	Overlay	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	$2,173,500
Null	Overlay	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	Null	$2,042,000
0075	Surface	2021	347-TOM-C	Null	Null	Null	PG 76-22	Yes	0.00	Null	Null	Null	Null	Null	Null	8,189	$739,010
0080	Base	2021	340-DG-B	Null	Null	Null	PG 64-22	Null	0.80	Null	Null	Null	Null	Null	Null	12,404	$0
0190	Surface	2023	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Null	0.00	6.93	0.027	6.02	0.423	1.05	0.020	25,281	$4,597,810
0218	Surface	2024	SS-3076-DG-D	Null	Null	Null	PG 76-22	Yes	0.50	Null	Null	Null	Null	Null	Null	1,560	$222,711
0220	Surface	2024	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Yes	0.00	Null	Null	Null	Null	Null	Null	3,188	$540,837
0221	Surface	2024	SS-3080-SMA-D	Null	Null	Null	PG 76-22	Yes	0.00	6.49	0.037	5.18	1.000	Null	Null	10,064	$1,263,292
					Grand Total												$15,804,545

Project locations with construction year

Performance History

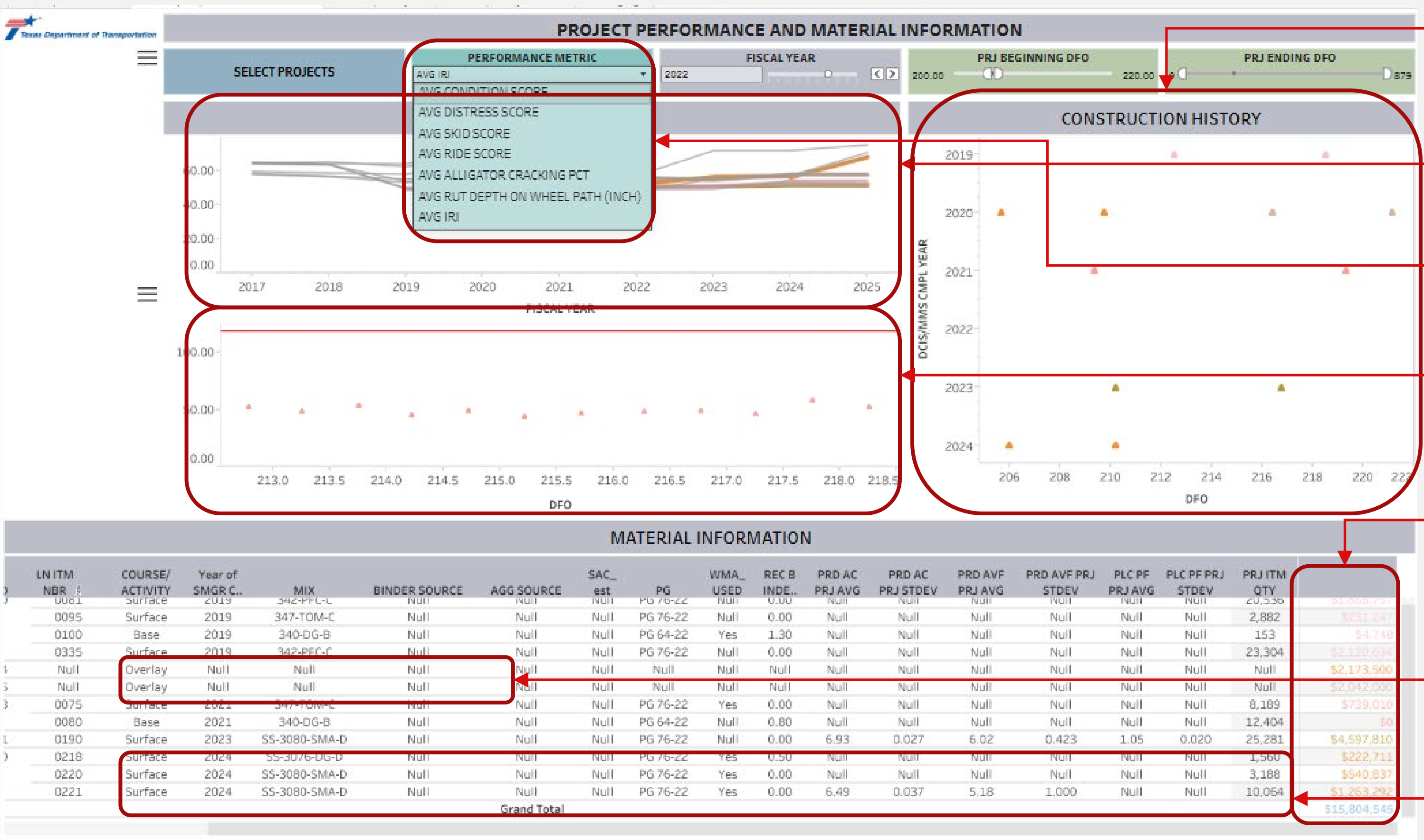
Project local performance

Total dollar value spent on the selected section

Contracted maintenance projects

Material information

A first-ever unified system



Project locations with construction year

Performance History

Performance measure

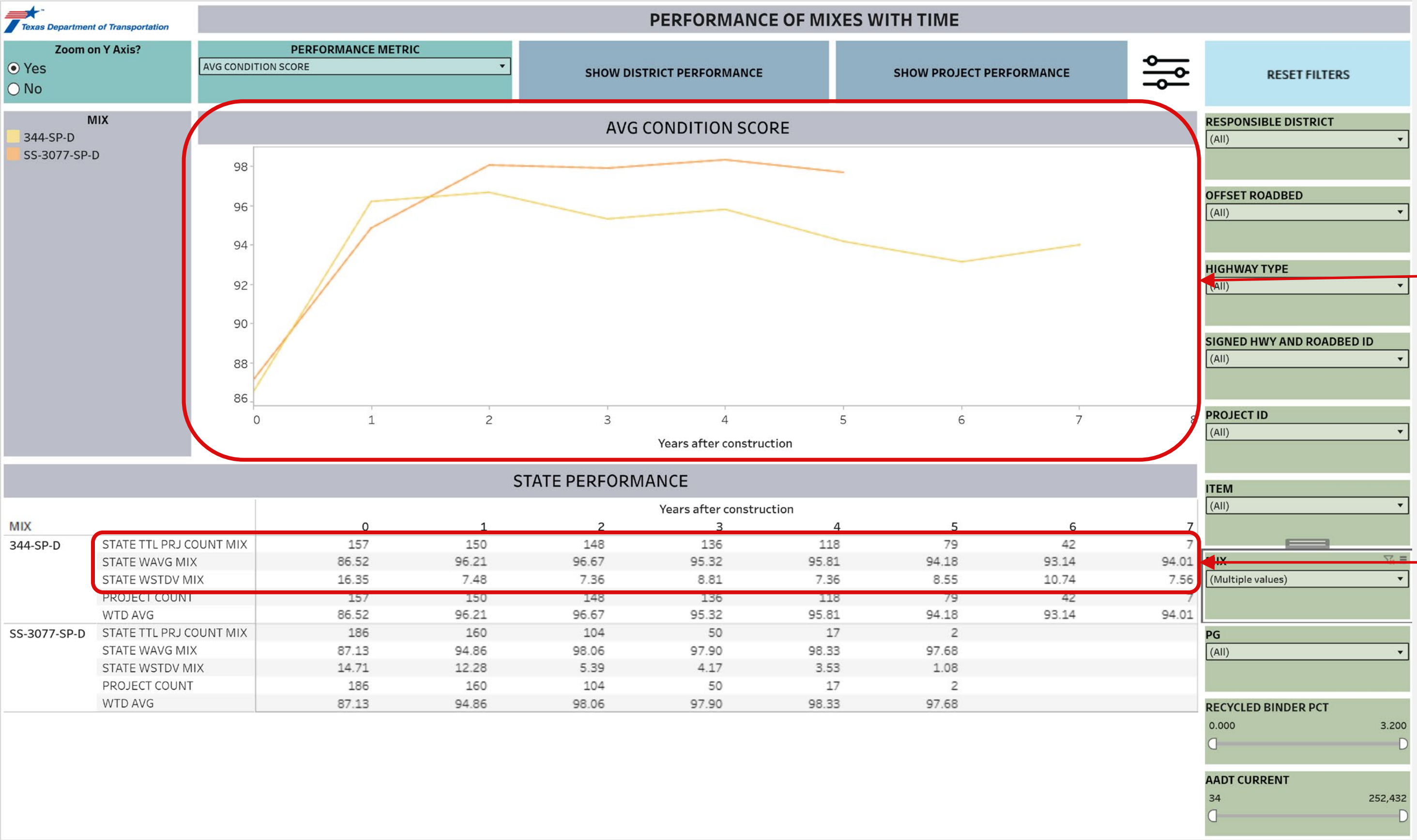
Project local performance

Total dollar value spent on the selected section

Contracted maintenance projects

Material information

A benchmarking tool



STATE PERFORMANCE

MIX		0	1	2	3	4	5	6	7
344-SP-D	STATE TTL PRJ COUNT MIX	157	150	148	136	118	79	42	7
	STATE WAVG MIX	86.52	96.21	96.67	95.32	95.81	94.18	93.14	94.01
	STATE WSTDV MIX	16.35	7.48	7.36	8.81	7.36	8.55	10.74	7.56
	PROJECT COUNT	157	150	148	136	118	79	42	7
	WTD AVG	86.52	96.21	96.67	95.32	95.81	94.18	93.14	94.01
SS-3077-SP-D	STATE TTL PRJ COUNT MIX	186	160	104	50	17	2		
	STATE WAVG MIX	87.13	94.86	98.06	97.90	98.33	97.68		
	STATE WSTDV MIX	14.71	12.28	5.39	4.17	3.53	1.08		
	PROJECT COUNT	186	160	104	50	17	2		
	WTD AVG	87.13	94.86	98.06	97.90	98.33	97.68		

Years after construction

Comparative analysis of specification items with time

Statewide item performance

A near real-time web application

Overview | Connections | Scheduled Tasks | **Run History** | Subscriptions | Lineage

Output step	Run type	Parameters	↓ Run start	Run end	Duration	Status	Rows generated	Errors
SMGR_PA_DCIS_MMS_SHP	Full refresh		Aug 11, 2025, 3:20 PM	Aug 11, 2025, 3:46 PM	00:26:11	Succeeded	128,794,982	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Aug 11, 2025, 1:14 PM	Aug 11, 2025, 1:37 PM	00:22:47	Succeeded	114,781,852	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Aug 11, 2025, 10:07 AM	Aug 11, 2025, 10:32 AM	00:25:40	Succeeded	128,451,710	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Aug 5, 2025, 5:13 PM	Aug 5, 2025, 5:32 PM	00:18:48	Succeeded	106,166,569	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Aug 5, 2025, 4:06 PM	Aug 5, 2025, 4:26 PM	00:19:59	Succeeded	92,336,872	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Aug 5, 2025, 3:20 PM	Aug 5, 2025, 3:39 PM	00:18:49	Succeeded	92,336,872	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Apr 4, 2025, 4:41 PM	Apr 4, 2025, 4:54 PM	00:12:52	Succeeded	68,819,247	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Apr 4, 2025, 2:46 PM	Apr 4, 2025, 2:46 PM	00:00:00	Failed	0	1 error
SMGR_PA_DCIS_MMS_SHP	Full refresh		Mar 11, 2025, 12:53 PM	Mar 11, 2025, 1:08 PM	00:14:45	Succeeded	68,660,228	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Mar 9, 2025, 10:27 PM	Mar 9, 2025, 10:42 PM	00:15:53	Succeeded	68,660,228	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Mar 2, 2025, 10:27 PM	Mar 2, 2025, 10:43 PM	00:15:14	Succeeded	68,642,971	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Feb 23, 2025, 10:28 PM	Feb 23, 2025, 10:44 PM	00:15:58	Succeeded	68,588,182	
SMGR_PA_DCIS_MMS_SHP	Full refresh		Feb 16, 2025, 10:27 PM	Feb 16, 2025, 10:42 PM	00:15:12	Succeeded	68,569,337	

Pavement condition data and new planned project update

Regular updates

Key accomplishments

A first-ever unified system

A near real-time web application

A benchmarking tool

An investigative tool

A Foundational framework

Thank you!

Tom Schwerdt, RTI

Ryan Barborak, MTD

Jorge Hernandez, BRG

Sarah Horner, FTW

Travis Patton, MTD

Kimberly Garner, ATL

Lacy Peters, ATL

Kevin Rhinevault, ITD

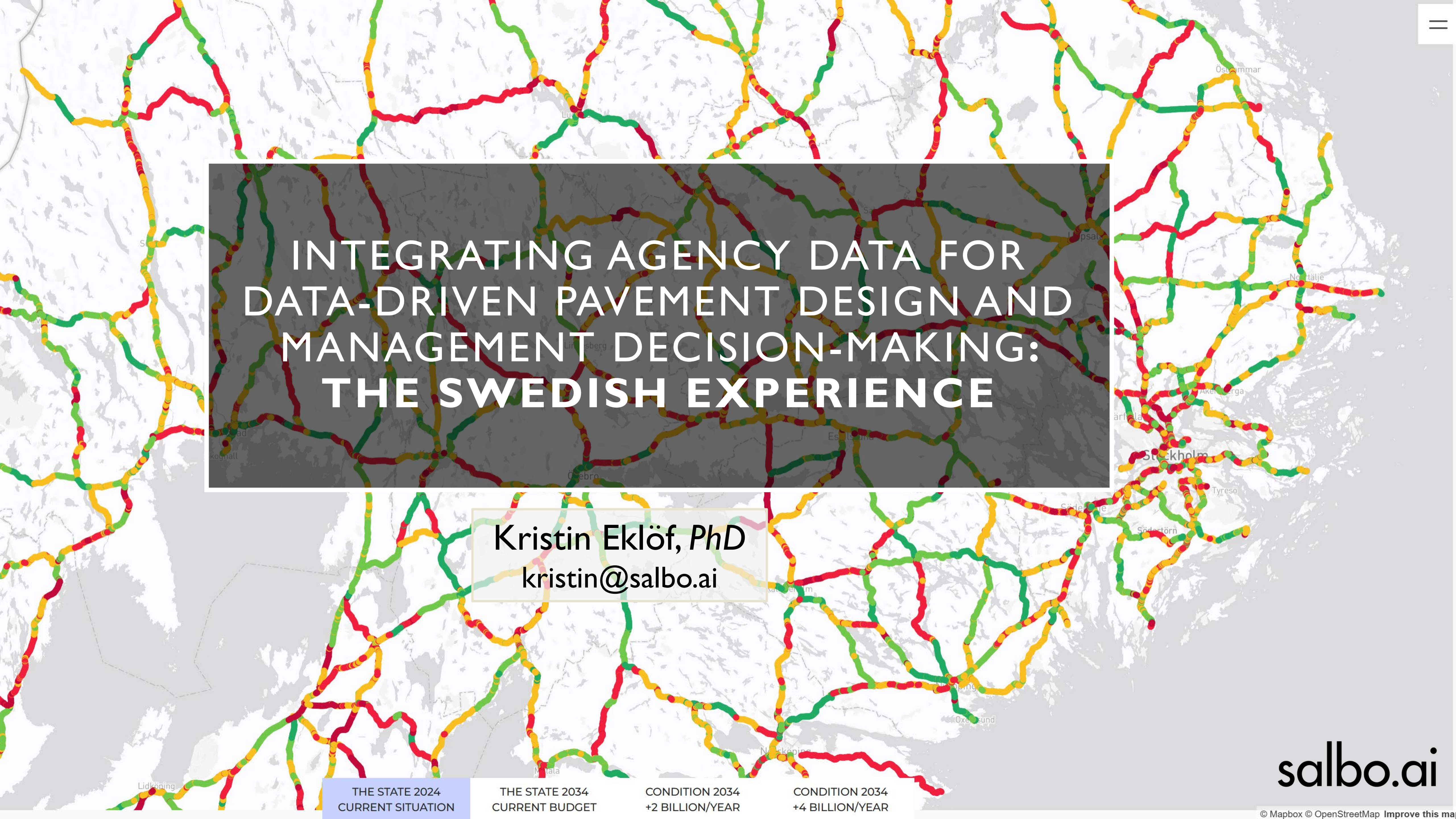
Taehoon Lim, MNT

Pravat Karki, MTD

Benjamin Mcculloch, STR

INTEGRATING AGENCY DATA FOR DATA-DRIVEN PAVEMENT DESIGN AND MANAGEMENT DECISION-MAKING: **THE SWEDISH EXPERIENCE**

Kristin Eklöf, *PhD*
kristin@salbo.ai



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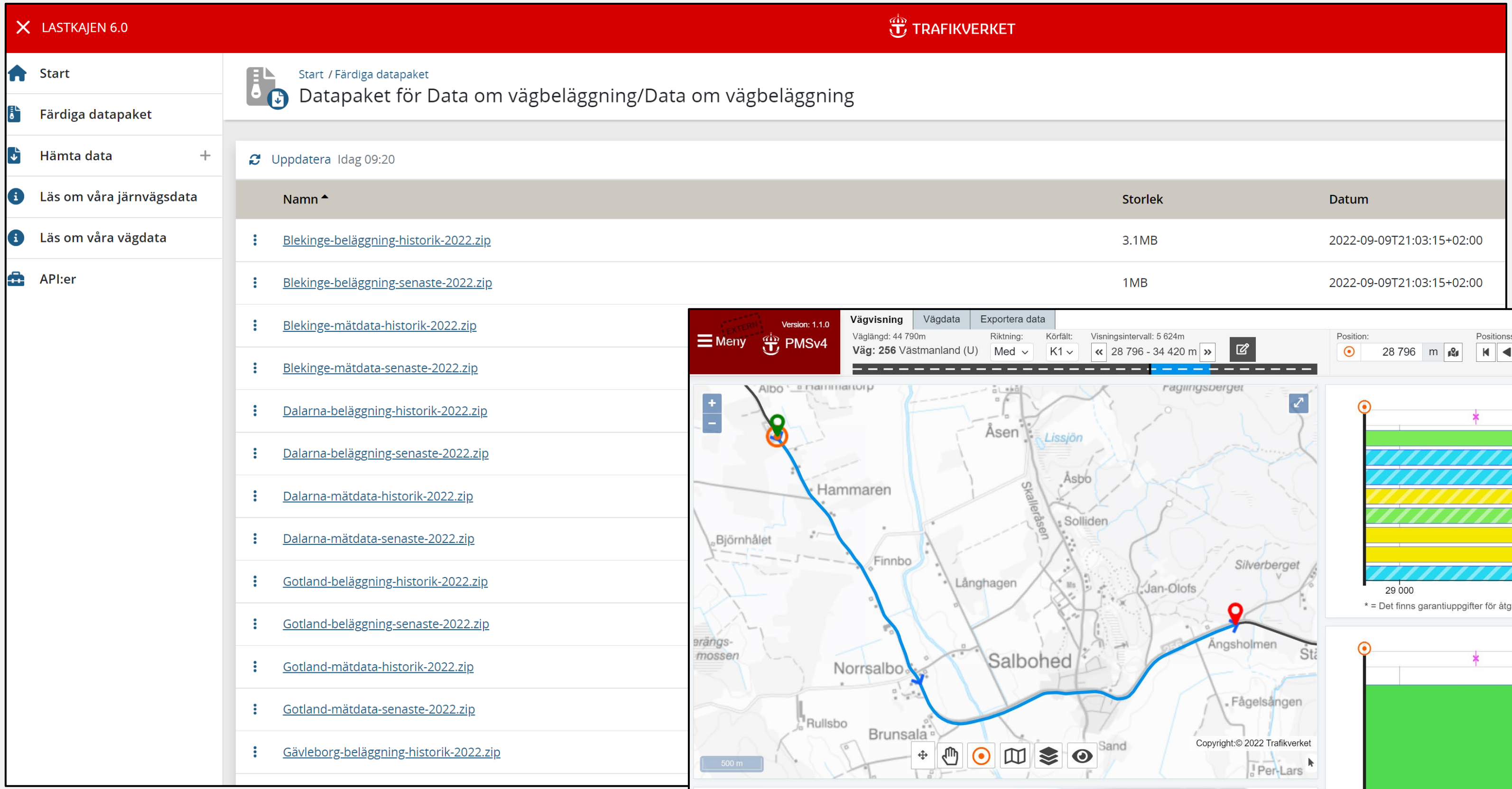
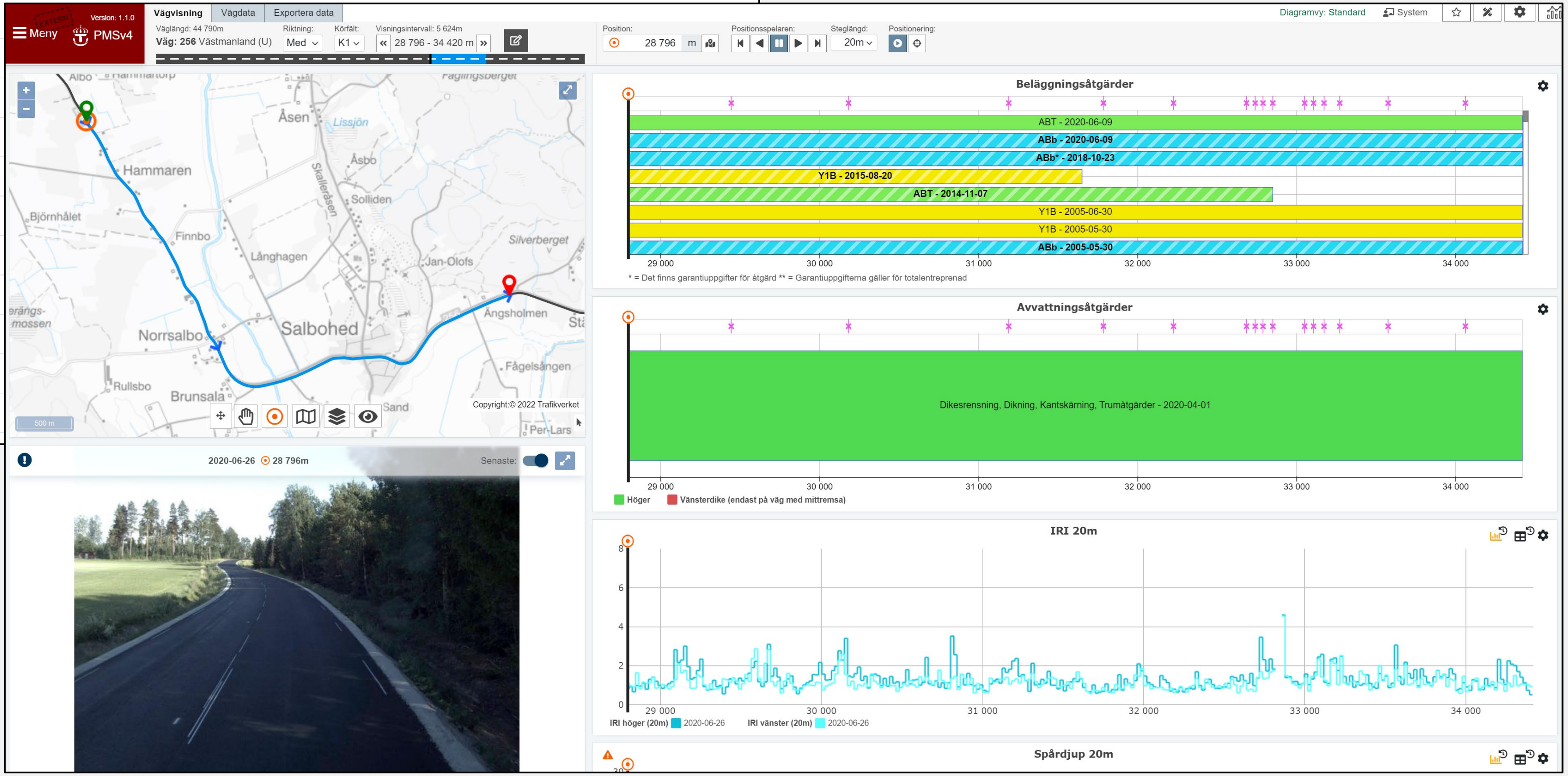
THE SWEDISH NATIONAL ROAD NETWORK

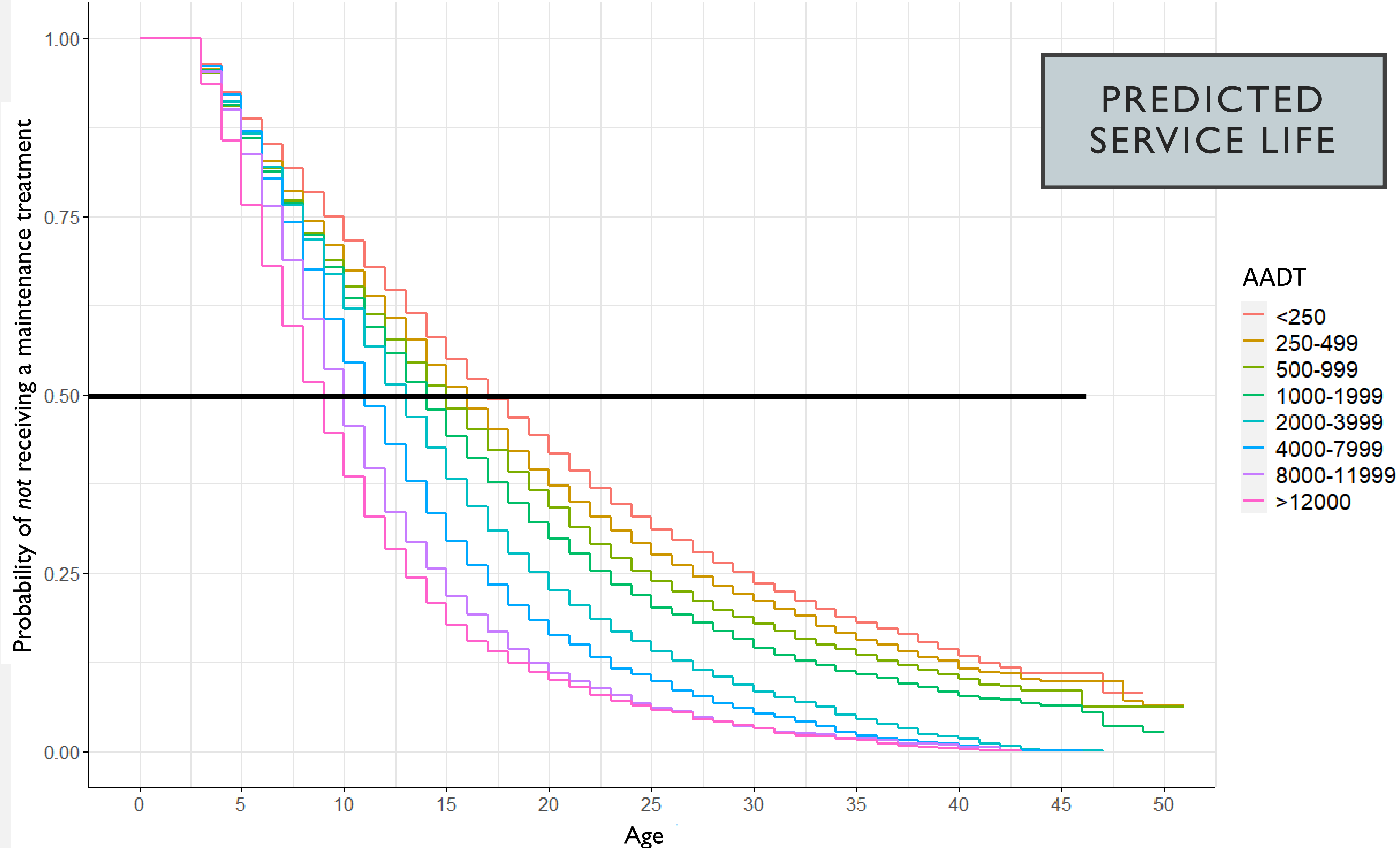
- 84,000 kilometers (52,000 miles) of paved roads
- On 30 percent of the road network traffic is less than 250 vehicles/day
- Approximately 60 % of vehicles in Sweden use studded tires wintertime (90 % in the North)




SWEDISH TRANSPORT ADMINISTRATION OPEN DATA



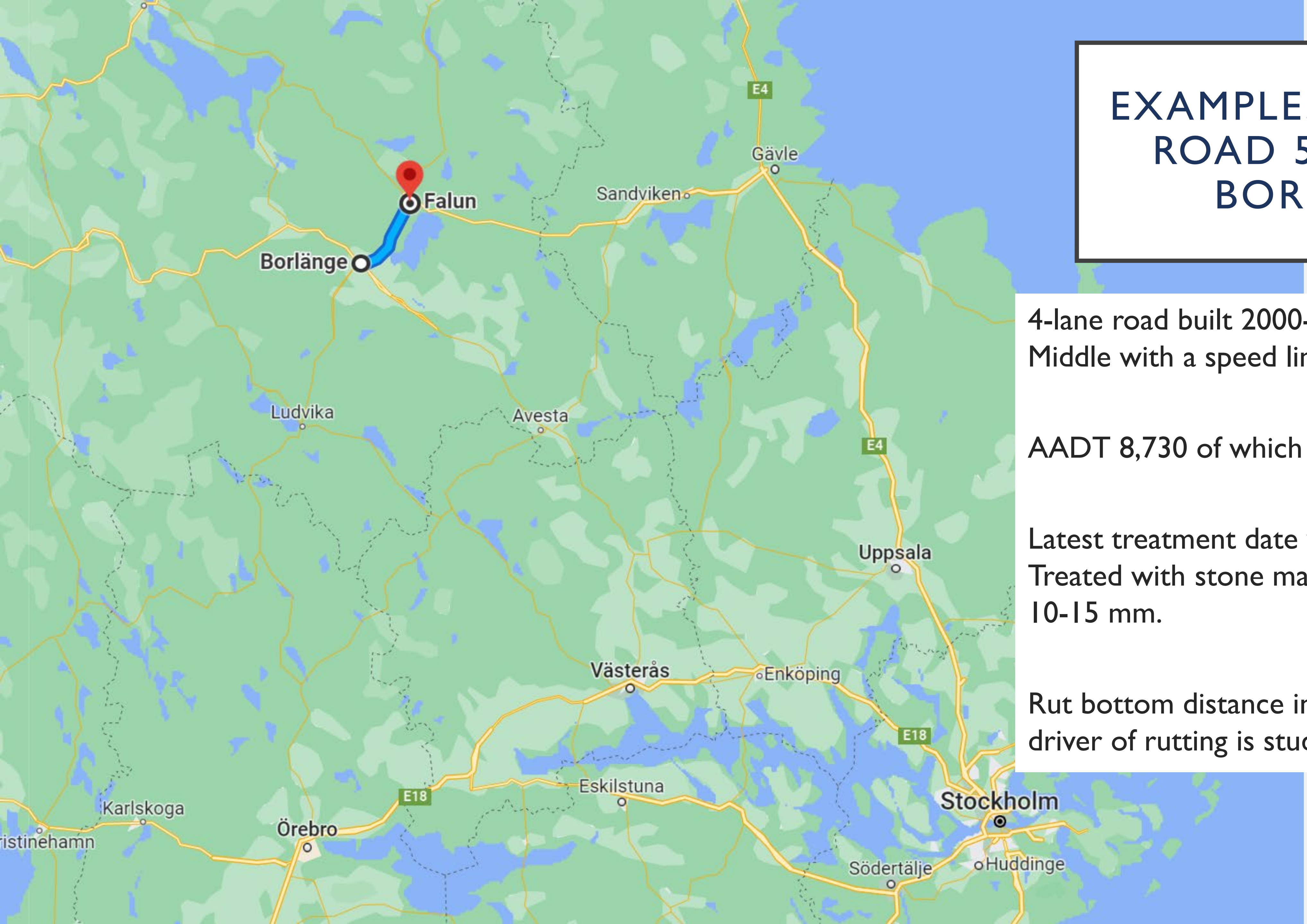



PREDICTED SERVICE LIFE
Probability of *not* receiving a maintenance treatment
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
35
40
45
50
Age
AADT
<250
250-499
500-999
1000-1999
2000-3999
4000-7999
8000-11999
>12000

Variables

- Traffic (AADT)
- Heavy traffic (AADT heavy)
- Region
  - North
  - Middle
  - Stockholm
  - East
  - West
  - South
- Pavement type
  - Asphalt concrete
  - Seal coat
  - Grouted macadam
  - Half-warm mix
  - Ultra-thin bonded wearing course
  - Surface dressing bituminous
  - Surface dressing on gravel
- Stone size
  - <10 mm
  - 10-15 mm
  - 15-20 mm
  - >20 mm
- Road width
- Speed limit
- Bearing capacity class
  - Max 64 metric tonnes
  - Max 51.5 metric tonnes
  - Max 37.5 metric tonnes
  - Max 74 metric tonnes
- Binder (layer 1 and layer 2)
  - Bitumen
  - Viscosity grade bitumen
  - Bitumen emulsion
  - Polymer-modified bitumen
  - Cut-back
  - Asphalt rubber
  - Polymer-modified emulsion
- Road type
  - Ordinary road
  - 2+1 road
  - Motorway
  - 4-lane road
- Construction year
  - 1950-1959
  - 1960-1969
  - 1970-1979
  - 1980-1989
  - 1990-1999
  - 2000-2009
  - 2010-
- Rut bottom distance
  - Mix: <1500 mm
  - Studded tyres: 1500-1700 mm
  - Mix: 1700-2000 mm
  - Heavy traffic: >2000 mm

EXAMPLE: NATIONAL ROAD 50 FALUN-BORLÄNGE

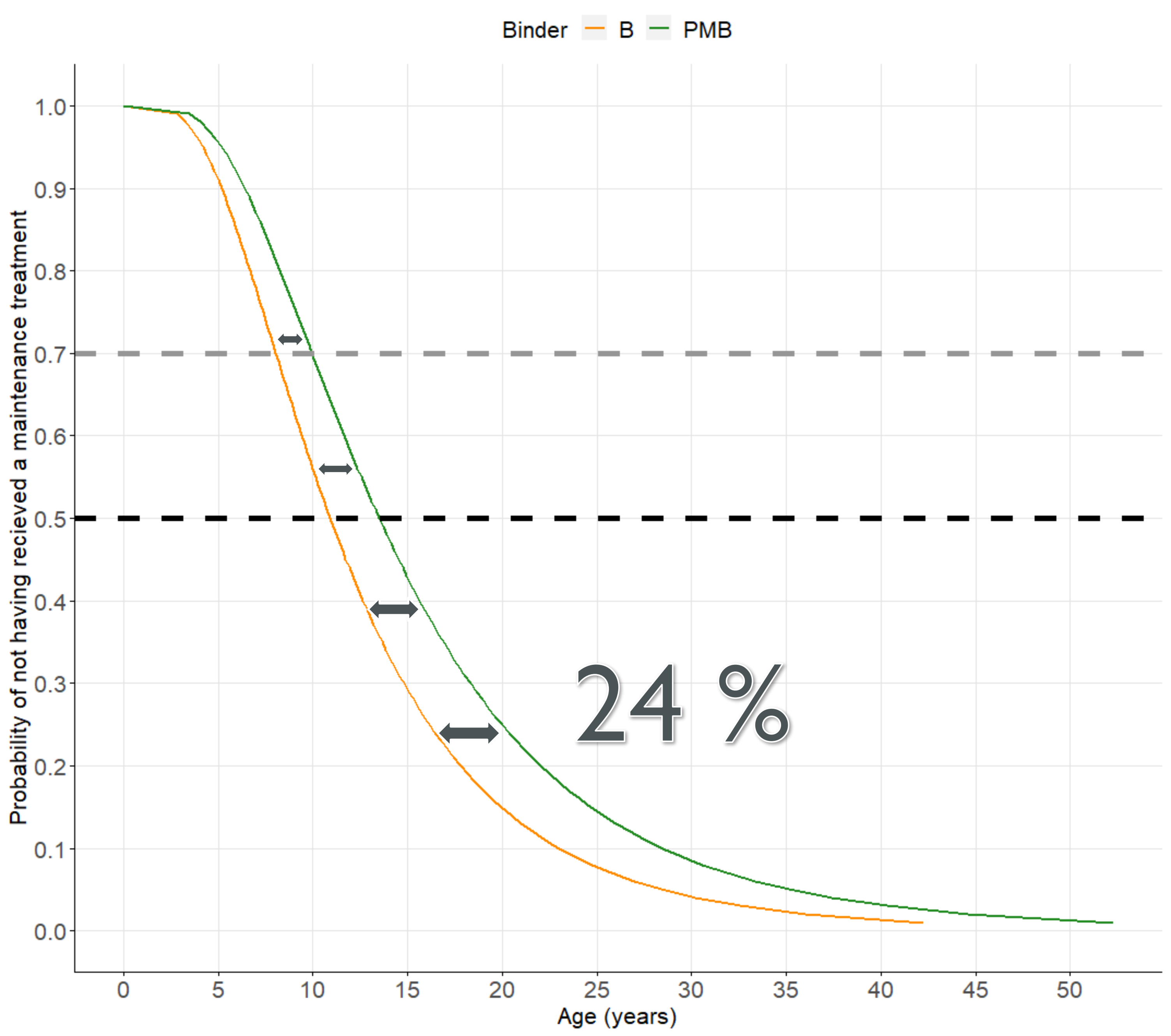


4-lane road built 2000-2009, located in region Middle with a speed limit of 110 km/h.

AADT 8,730 of which 935 are heavy vehicles.

Latest treatment date was 2016-06-15. Treated with stone mastic and a stone size of 10-15 mm.

Rut bottom distance indicates that the main driver of rutting is studded tires.



MODEL ESTIMATED LIFETIMES FOR NATIONAL ROAD 50

Layer 1	Layer 2	Lifetime	Mean error
B	B	10 y 6 m	5 m
B	PMB	11 y 4 m	9 m
PMB	B	12 y	6 m
PMB	PMB	12 y 11 m	11 m

Assessing Sweden's Greenhouse Gas Emissions from Road Maintenance using Environmental Product Declarations (EPDs) and Network Lifecycle Optimization

Where?

What?

Is Sweden's pavement maintenance aligned with the emission target of the Paris Agreement?

How?

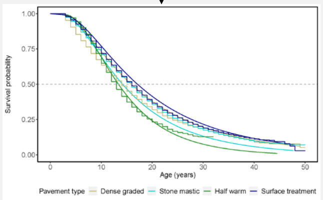
Scenario 1: Calculating CO_2e of 2010 (LFO)

Scenario 2: Calculating CO_2e of 2024 (Biofuel)

Scenario 3: Calculating CO_2e of 2024 with 5% biogenic binder (TOP 5%)

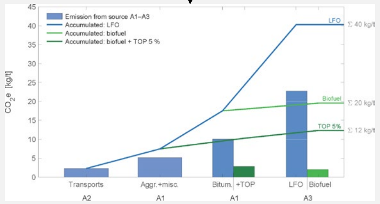
Models?

Pavement lifetime estimated using survival analysis to assess pavement durability.

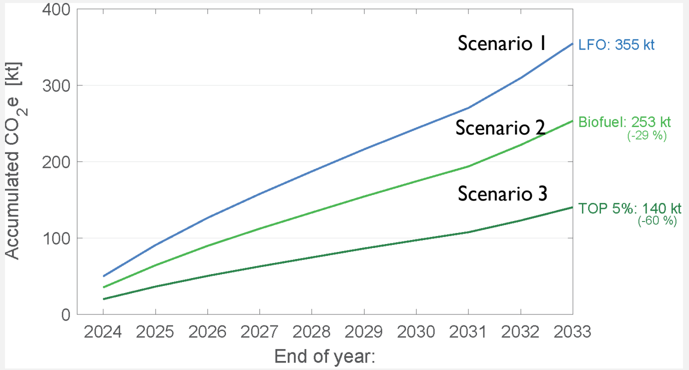


Network optimization to ensure equivalent road condition 2023-2033.

CO_2e from asphalt production and transportation using a statistical model based on published EPDs to ensure framework consistency over time.



Accumulated CO2e in metric tons for an optimized ten-year pavement management program with maintained road condition.



Summary

Sweden has lowered its emissions from pavement maintenance with 29 % since 2010, primarily by increasing the usage of biofuel in asphalt plants and increasing the amount of reclaimed asphalt.

Sweden can reach 60 % emission reduction by incorporating 5 % biogenic binders in its asphalt.

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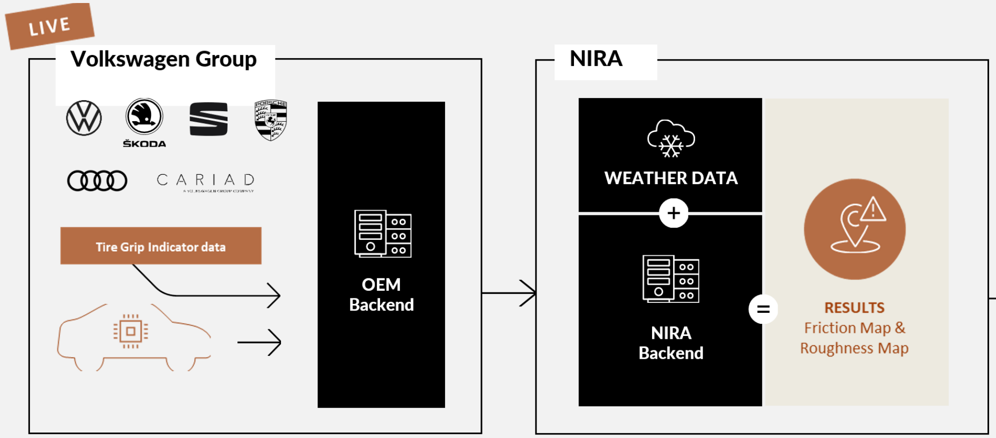
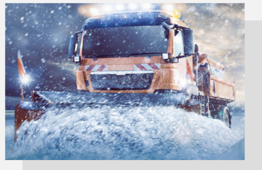
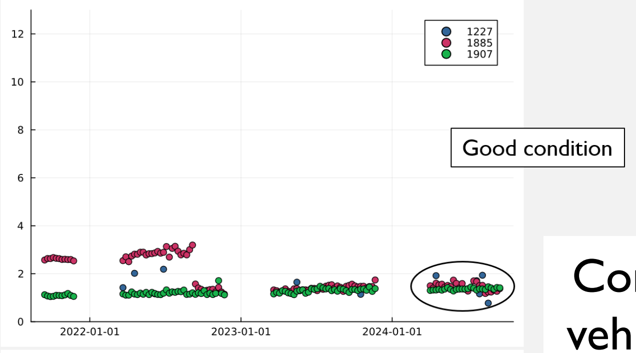
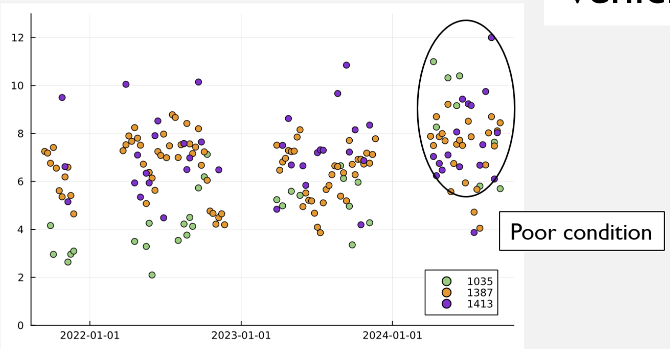
Jonas Ekblad, Assoc. Prof., Ph.D., jonas.ekblad@ncc.se
Linda Löwhagen, Lic., linda.lowhagen@ncc.se

EMERGING TOPICS

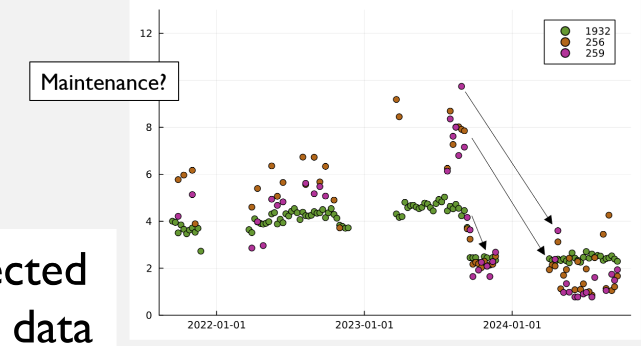


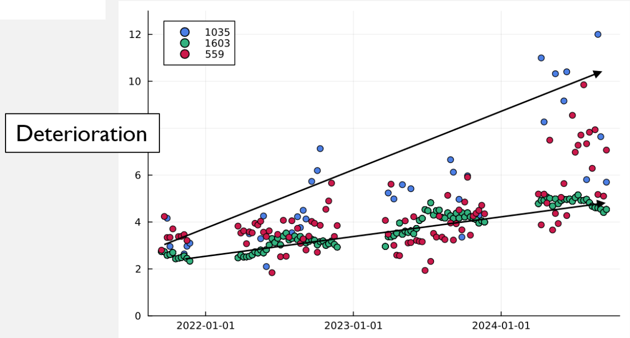




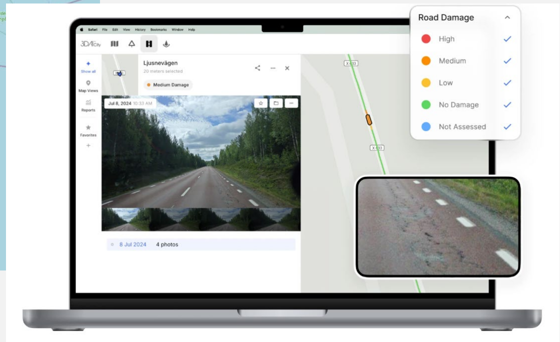


Connected vehicle data





LCAA informed by AI classified road damages

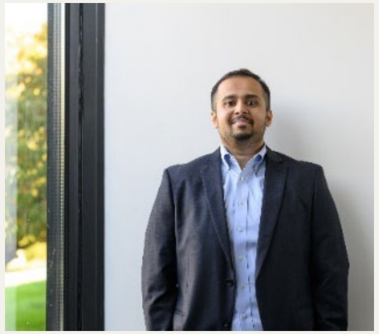


Tack!

Contact: kristin@salbo.ai

salbo.ai

Today's presenters



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Texas Department of Transportation

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Upcoming events for you

September 29, 2025

TRB Webinar: Advancing Unpaved Roads and Airfields Through Graduate Research

October 2, 2025

TRB Webinar: Quality Construction Begins with Certified Sampling and Testing Personnel

https://www.nationalacademies.org/trb/events

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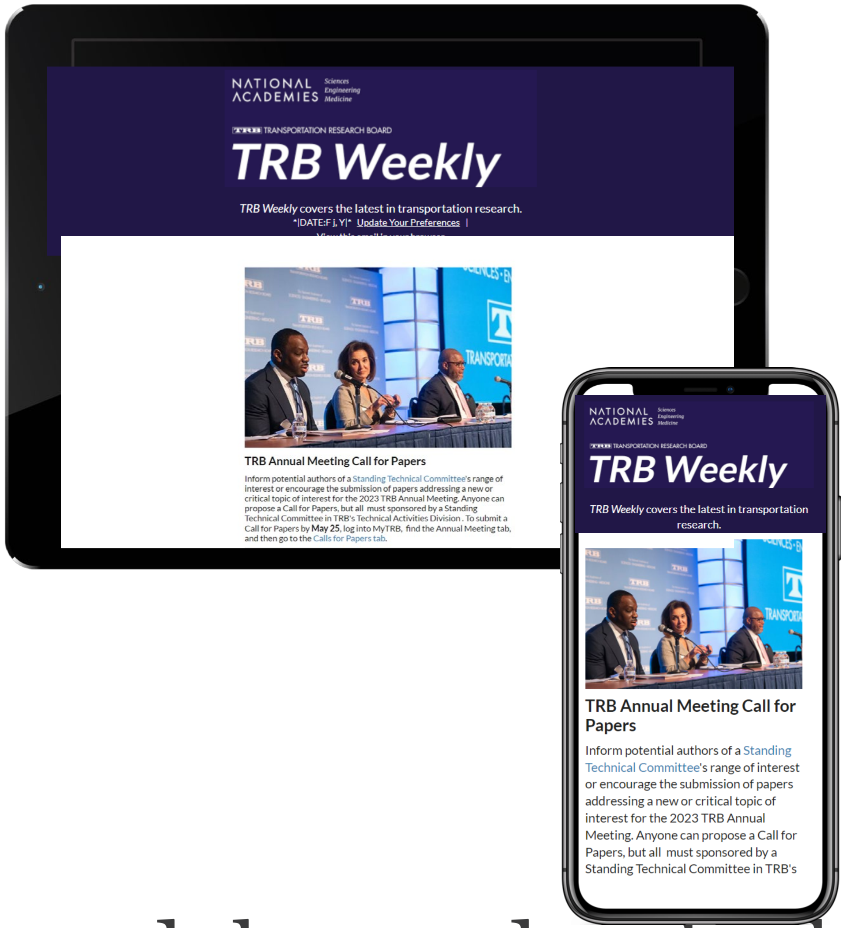

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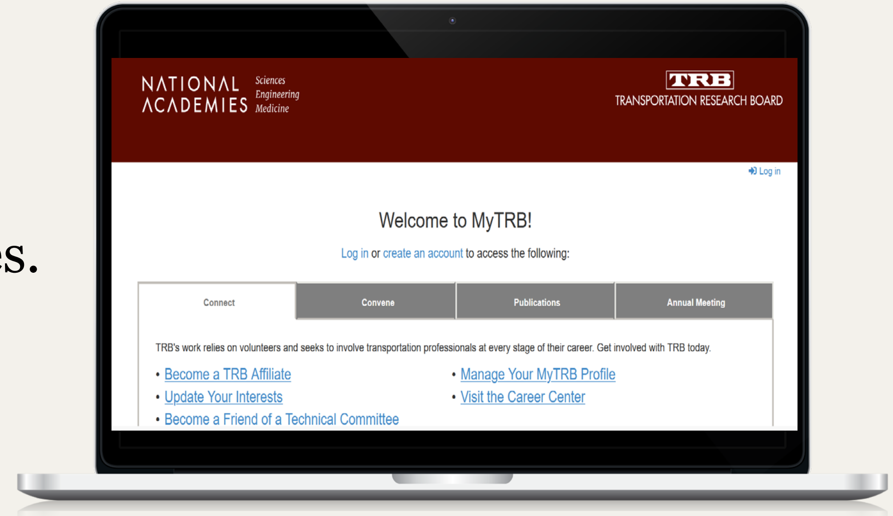

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