NATIONAL ACADEMIES Sciences Engineering Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Capturing and Integrating Cost Data into Maintenance Management Systems

September 26, 2024

2:00 – 3:30 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
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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 help agencies navigate the process of integrating cost data into the MMS to effectively manage and track maintenance expenditures. Presenters will share two cases studies from mature users of MMS, North Carolina Department of Transportation (NCDOT) and West Virginia DOT.

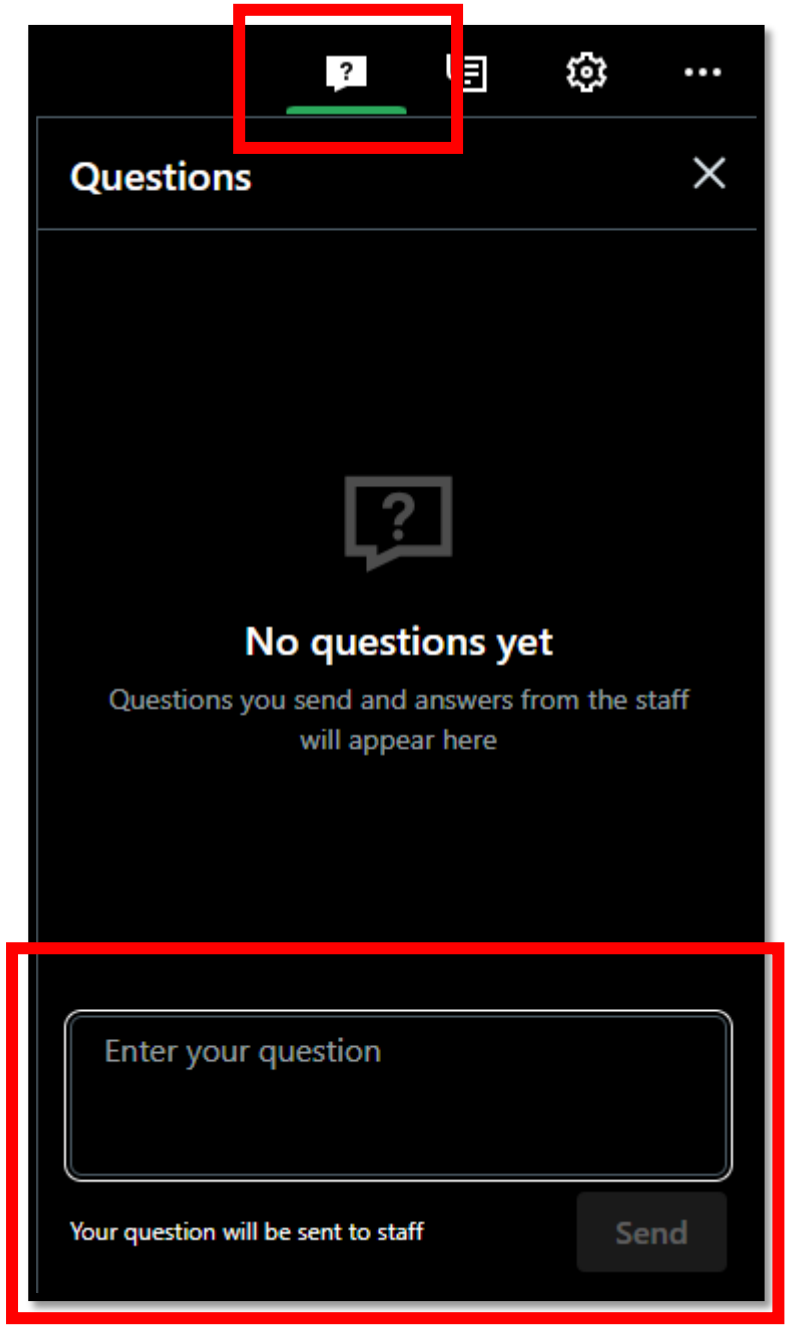
Learning Objectives

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

- Identify practices for capturing maintenance costs in MMS, including the level of detail, data quality, integration, operational and business value, and barriers
- Evaluate the specific pathways and details of integrations with agency financial systems
- Understand the practical implementation and challenges of cost data integration in MMS

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



Today's presenters

Omidreza Shoghli
Oshoghli@charlotte.edu
University of North Carolina

Charles Pilson
Charles.Pilson@mottmac.com
Mott MacDonald

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Steven Griffith
steve_griffith@royjorgensen.com
Roy Jorgensen Associates, Inc.

Matthew Whitley
Mpwhitley@ncdot.gov
NCDOT

Christopher Chau
Chris.Chau@deighton.com
Deighton Associates Ltd.

Practices for Capturing and Integrating Cost Data in Maintenance Management Systems

Omidreza Shoghli, University of North Carolina at Charlotte
Charles Pilson, Mott MacDonald

September 26, 2024

Background

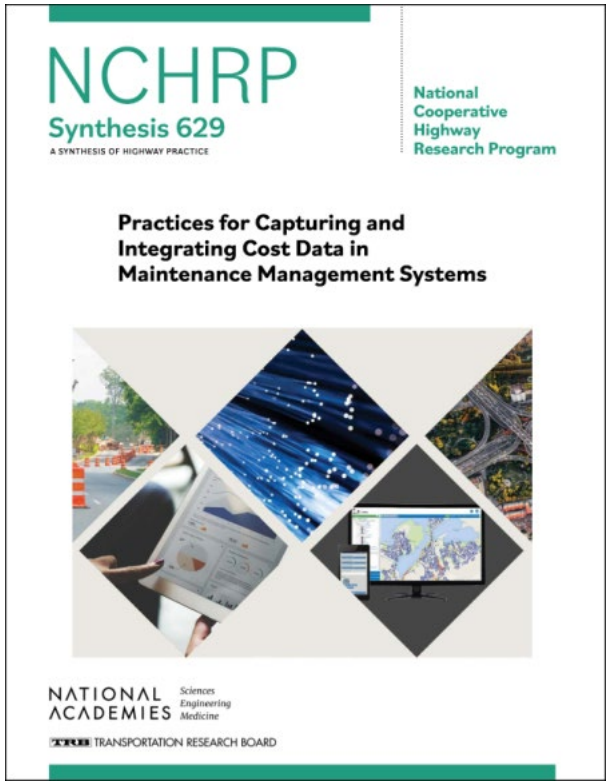
- A key **objective of an MMS** is to **capture maintenance costs** at an appropriate level of detail for analysis and planning.
- **Level of detail**, **quality**, and **accuracy** of captured cost data **varies** across DOTs.
- **TAMP** under MAP-21 **mandates** the **inclusion of maintenance costs** for asset management and planning.
- DOTs use **various systems for cost data capture**, including **in-house** or **commercial** MMS, with **varying integration levels with ERP** systems.
- **Accurate cost data** supports **reimbursement claims** for emergency relief (e.g., FEMA) and **insurance claims** for damages.
- Advances in cost capture **technology**, including mobile field entry and system integration, **influence the accuracy and timeliness** of cost data.

Objective and Scope

The Objective of the Synthesis Study was to:

- Documents state DOT practices for capturing maintenance costs in their MMS.
- Describe DOT practices regarding the
  - Level of detail captured,
  - Quality of the data,
  - Level of integration with other agency systems,
  - Operational and business value of the data, and
  - Barriers in capturing these data.

Synthesis Report Available



Download the Synthesis Report

https://nap.nationalacademies.org/catalog/27810/practices-for-capturing-and-integrating-cost-data-in-maintenance-management-systems

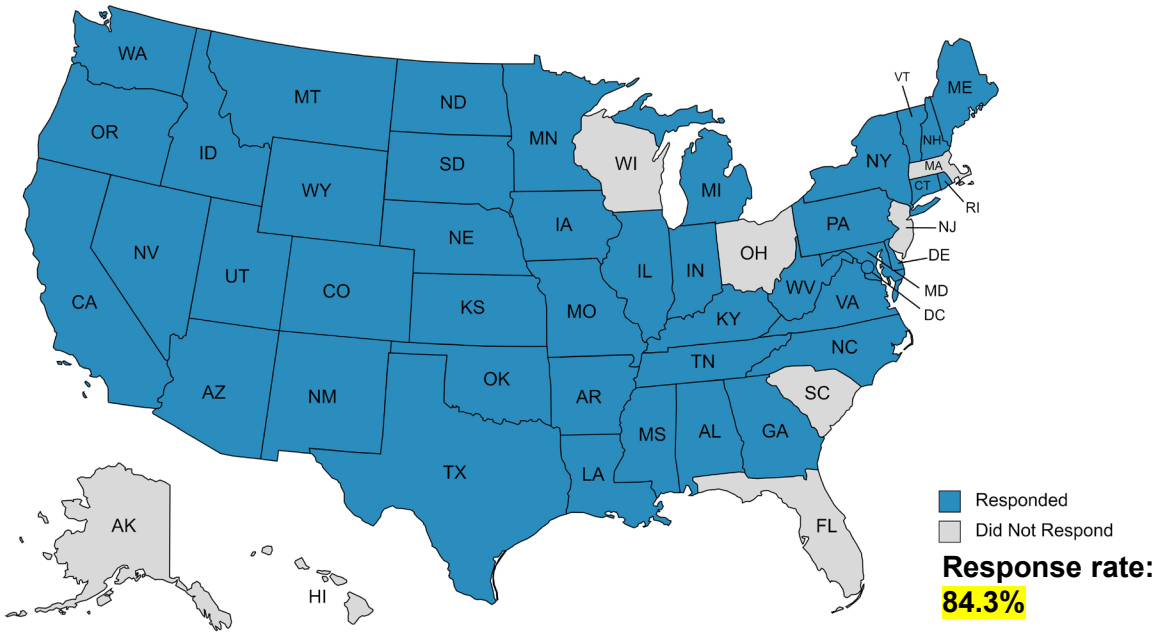
Synthesis Methodology

- **Literature review:** Current state of research and practice regarding maintenance cost data capture in MMS
- **Survey:** Devised to capture the state of the practice of maintenance cost data management within DOTs
- **Survey Distribution:** All voting members of the AASHTO Committee on Maintenance
- **Case Examples:** In-depth understanding of the successes, challenges, and barriers to using an MMS in managing costs of maintenance

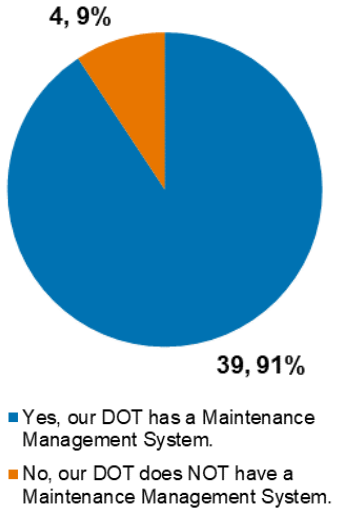
key Categories of the survey

1. Details of In-house Maintenance Cost Data Capturing Strategies
2. Details of Contractors' Maintenance Cost Data Capturing Strategies
3. Detail Levels in Tracking and Recording Maintenance Costs and System Interfaces
4. Quality Assurance Strategies
5. Use Cases of Maintenance Cost Data
6. Maintenance Cost Reimbursement
7. Barriers in Maintenance Management System Implementation/Operation

Geographical Distribution of Responding DOTs and MMS Adaption rates



Geographical distribution of DOTs that responded to the survey (N= 43)

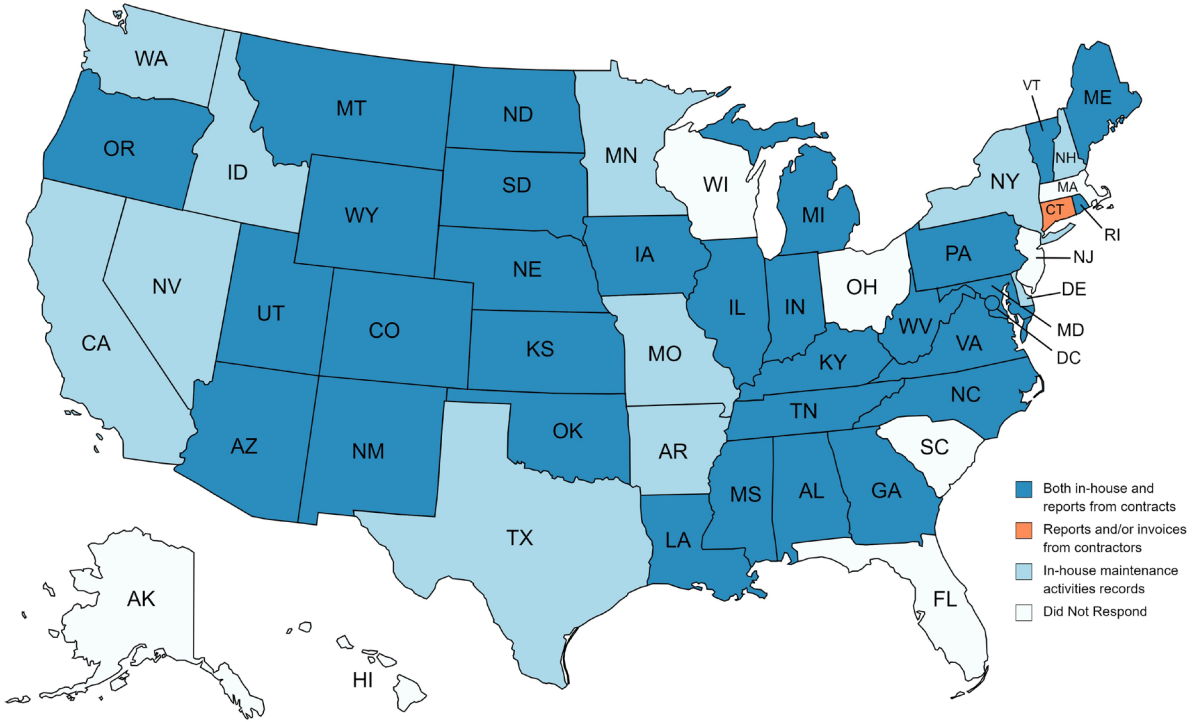


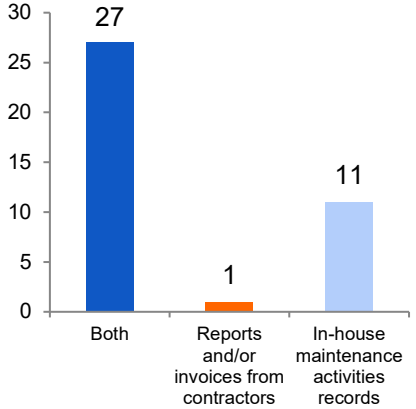
Adoption rates of MMSs among surveyed DOTs (N= 43).

1.

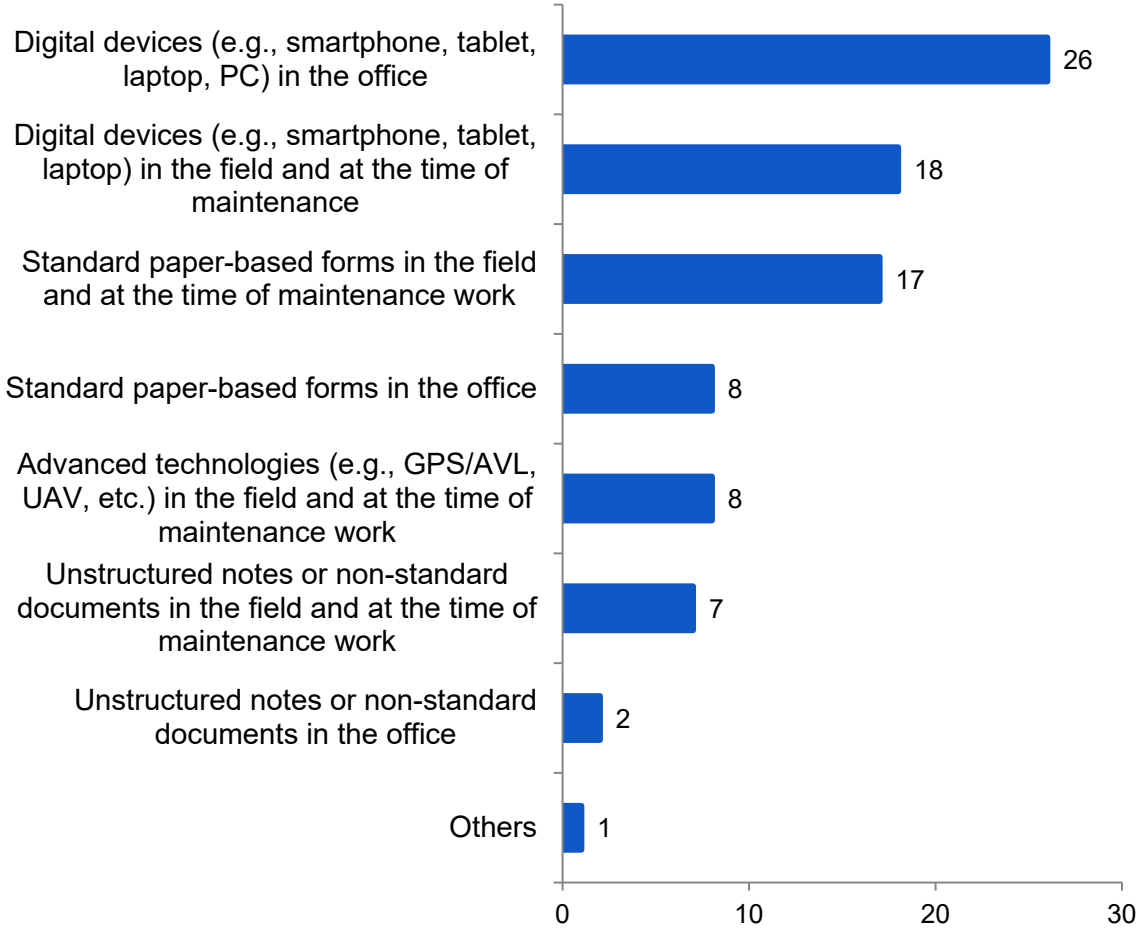
Details of In-house Maintenance Cost Data Capturing Strategies

Sources of Maintenance Cost Data





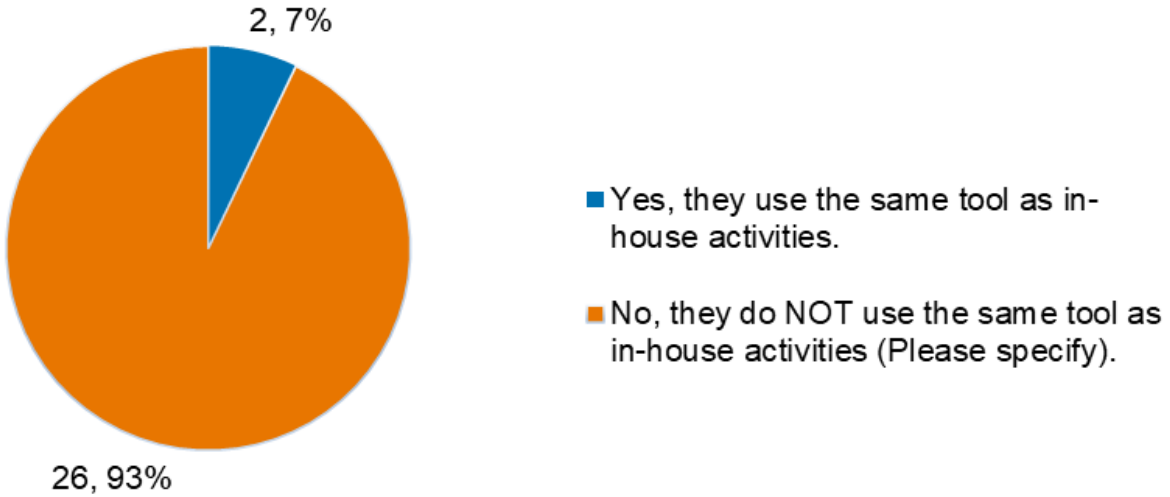
Tools used by DOTs for initially recording the maintenance information



2.

Details of Contractors’ Maintenance Cost Data Capturing Strategies

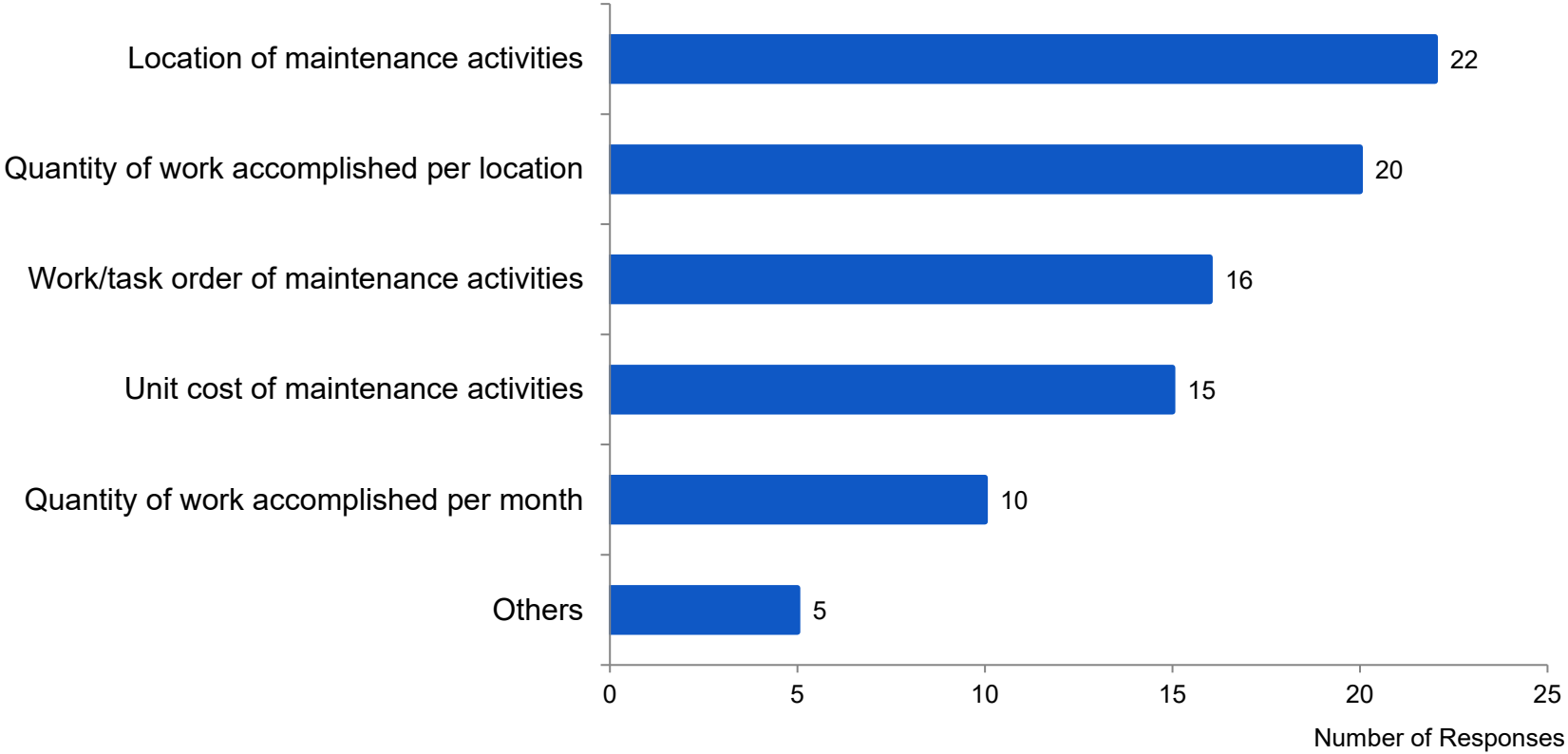
Similarity of the Tools Used by Contractors for Maintenance Data Recording



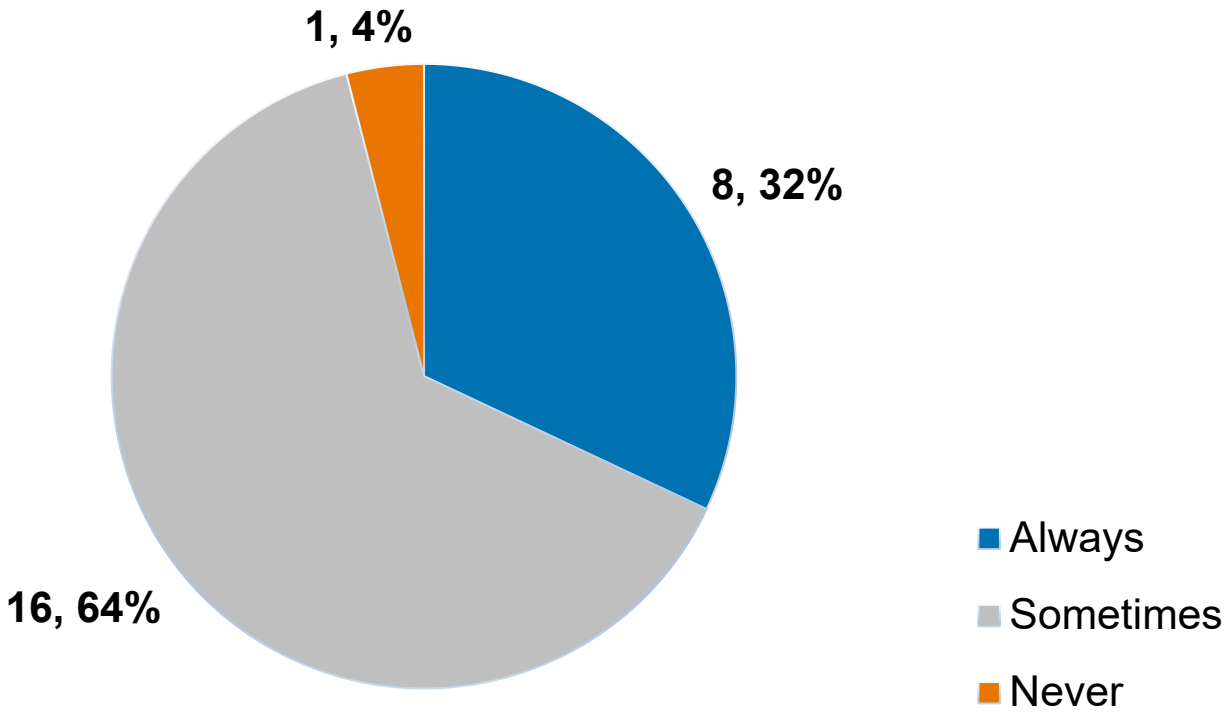
Outsourced Maintenance Activities

Outsourced Maintenance Activities	Number of Responses
Guardrail Repair	25
Striping	20
Vegetation Management	19
Drainage Repair	16
Mowing	15
Debris Removal	15
Bridge Inspection	12
Plowing / Snow and Ice Operation	11
Pothole Repair	8

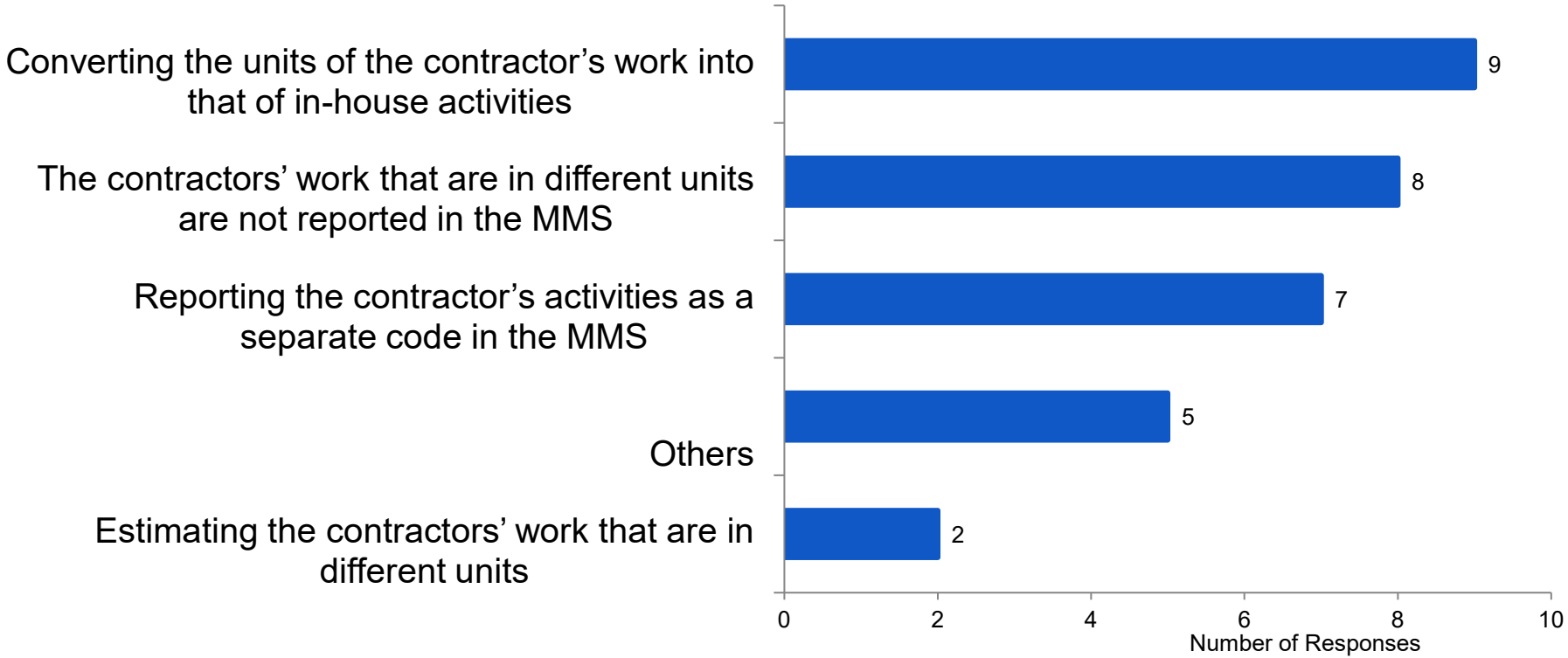
Level of Details in Contractors Reports/Invoices



Similarity of Unit of Measures used by Contractors to that of DOTs



Approaches to Accounting for Contractors' Work with Different Units



3.

Details of Tracking and Recording Maintenance Costs and System Interfaces

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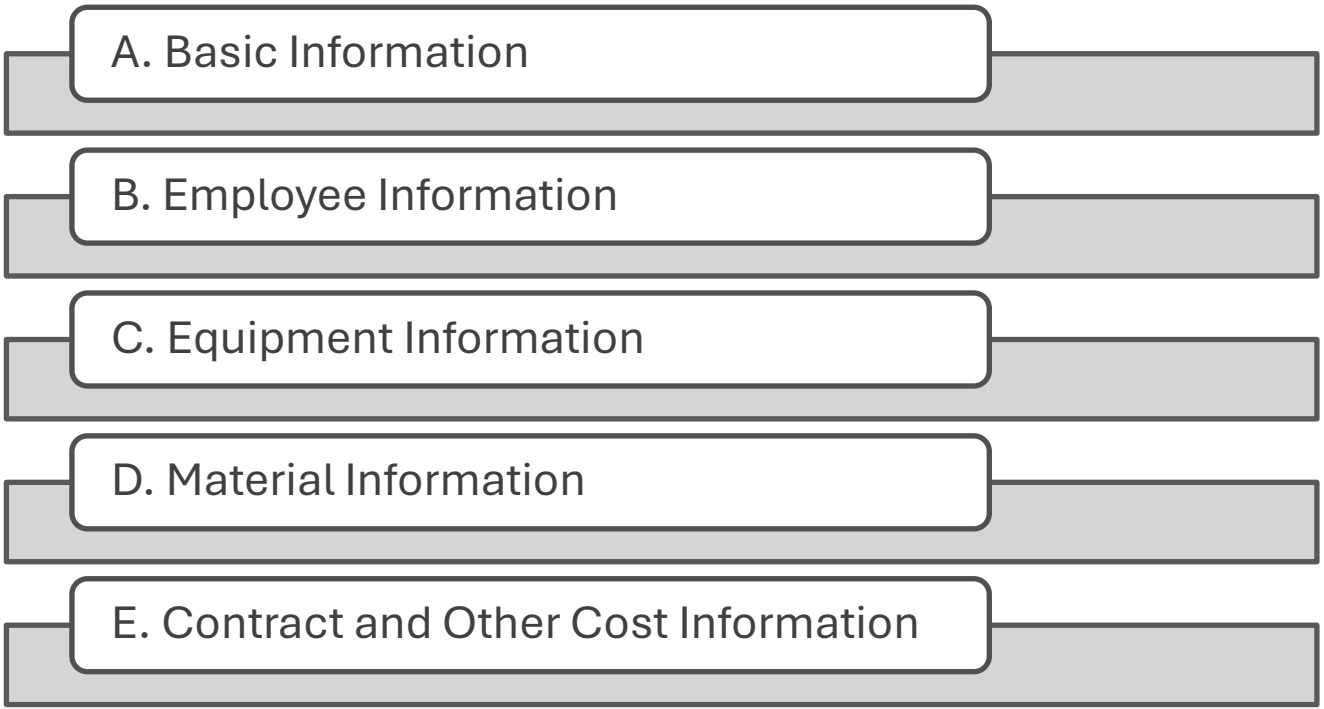
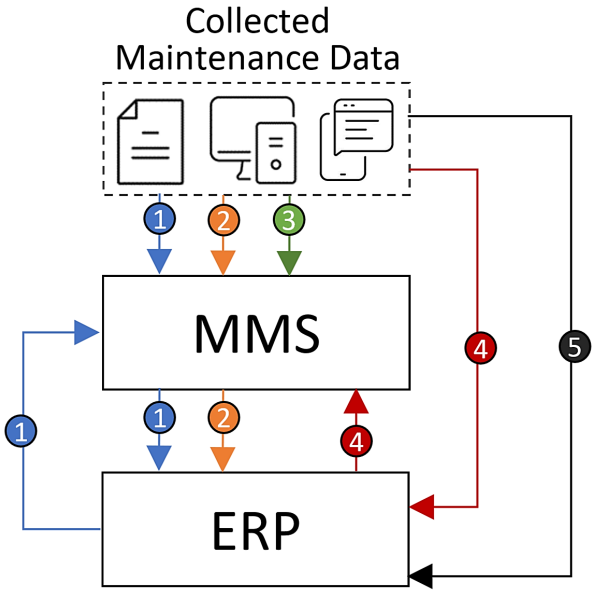


Data Recording and Interface Paths



0 0- Not recorded in MMS or ERP at all

1 1- First recorded in MMS, next costed in ERP, and finally interfaced back to MMS

2 2- First recorded in MMS, then interfaced with ERP

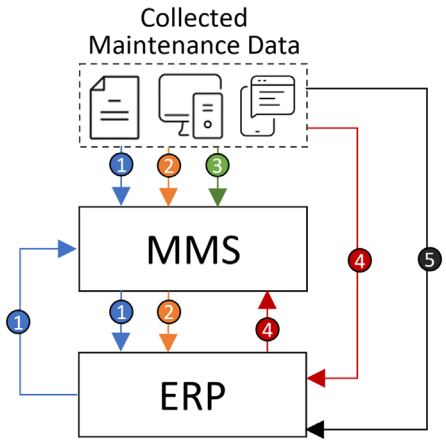
3 3- First recorded in MMS, then NOT interfaced with ERP

4 4- First recorded in ERP, then interfaced with MMS

5 5- First recorded in ERP, then NOT interfaced with MMS

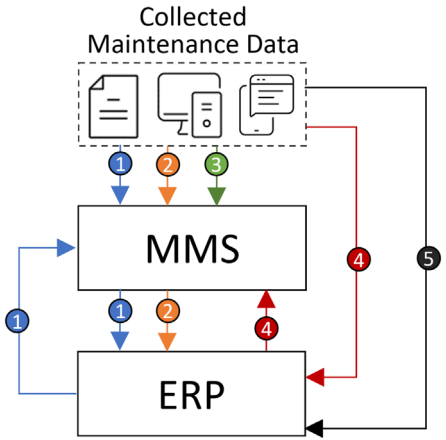
Six potential options from initial entry to possible interfacing scenarios

A. Recording and Interfacing of Basic Work Order Information in MMS and ERP Systems



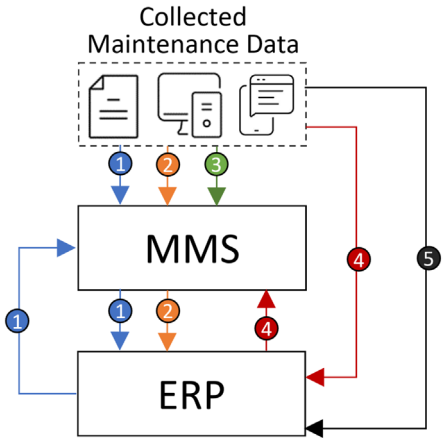
	First Recorded in MMS then			First Recorded in ERP then		Not Recorded
	...interfaced with ERP, next costed in ERP, and finally interfaced back to MMS (1)	...interfaced with ERP (2)	...NOT interfaced with ERP (3)	...interfaced with MMS (4)	...NOT interfaced with MMS (5)	...in MMS or ERP (0)
Work/Task Order Number	3	11	13	5	3	4
Date Work Accomplished (Date cost incurred)	3	18	11	5	2	
Cost Center (e.g., District/ Division/ Unit/ County/ Maintenance Yard)	3	17	9	6	2	2
Authorization/ Budget Account Code Information	2	13	3	6	9	6
Maintenance Activity Code	4	17	13	2	3	
Maintenance Sub-activity Code		9	17	1	2	10
Route Number	1	7	23	3	4	1
Route Direction	1	4	19	3	3	9
Route Lane		3	15	1	4	16
Latitude and Longitude		4	14		3	18
Begin and End Mile Posts		5	23	2	3	6
Perpendicular Offset	1		11		3	24
Quantity of Work Accomplished	2	8	23	3	3	
Unit of Measure for Work Accomplished		9	25	3	1	1
Category of Work	1	7	18	4	1	8

B. Recording and Interfacing of Employee Information in MMS and ERP Systems



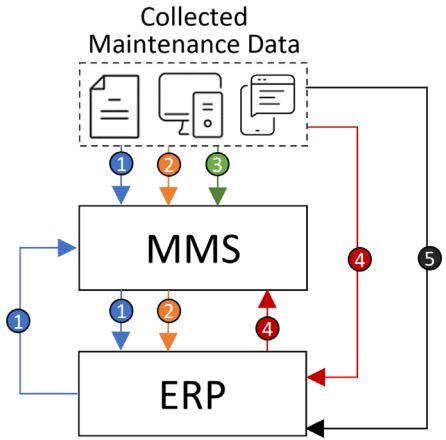
	First Recorded in MMS then			First Recorded in ERP then		Not Recorded
	...interfaced with ERP, next costed in ERP, and finally interfaced back to MMS (1)	...interfaced with ERP (2)	...NOT interfaced with ERP (3)	...interfaced with MMS (4)	...NOT interfaced with MMS (5)	...in MMS or ERP (0)
Work/Task Order Number	3	10	15	2	4	5
Date Work Accomplished (Date cost incurred)	4	16	12	4	2	1
Employee Name/ID	6	11	5	11	4	2
Wage Rate ($s/hr)	6	4	7	10	8	4
Hours Reported	5	17	7	6	3	1

C. Recording and Interfacing of Equipment Information in MMS and ERP Systems



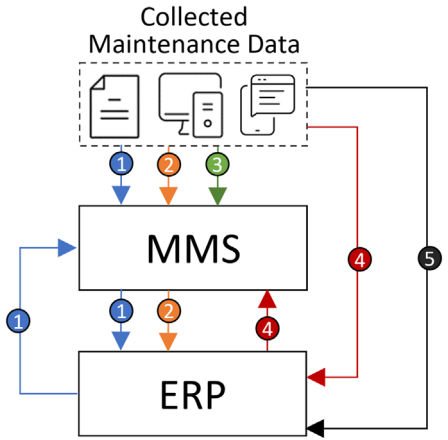
	First Recorded in MMS then			First Recorded in ERP then		Not Recorded
	...interfaced with ERP, next costed in ERP, and finally interfaced back to MMS (1)	...interfaced with ERP (2)	...NOT interfaced with ERP (3)	...interfaced with MMS (4)	...NOT interfaced with MMS (5)	...in MMS or ERP (0)
Work/Task Order Number	2	9	15	2	5	6
Date of Usage (Date cost incurred)	3	13	14	2	5	2
Equipment Name/ID	3	11	11	7	5	2
Equipment Type	2	7	14	8	4	4
Equipment Start Meter	2	4	10		8	15
Equipment End Meter	2	4	10		9	14
Equipment Status (Owned/Leased)	1	2	9	5	9	13
Total Hours Reported	3	12	14	3	4	3
Total Miles Reported	2	10	11	1	6	9
Equipment Operator	1	4	19		7	8

D. Recording and Interfacing of Material Information in MMS and ERP Systems



	First Recorded in MMS then			First Recorded in ERP then		Not Recorded
	1 …interfaced with ERP, next costed in ERP, and finally interfaced back to MMS	2 …interfaced with ERP	3 …NOT interfaced with ERP	4 …interfaced with MMS	5 …NOT interfaced with MMS	0 …in MMS or ERP
Work/Task Order Number	2	9	17	1	4	5
Date of Usage (Date cost incurred)	3	12	16	3	3	1
Inventory Stock Bin/Stockpile/ID/Original Location (Source)	5	8	14	2	5	4
Material Type	4	10	14	3	5	2
Material Unit Cost	4	5	14	6	5	4
Material Manufacturer		2	9	1	8	18
Total Quantity Reported	5	10	15	5	2	1

E. Recording and Interfacing of Contract and Other Cost Information in MMS and ERP Systems

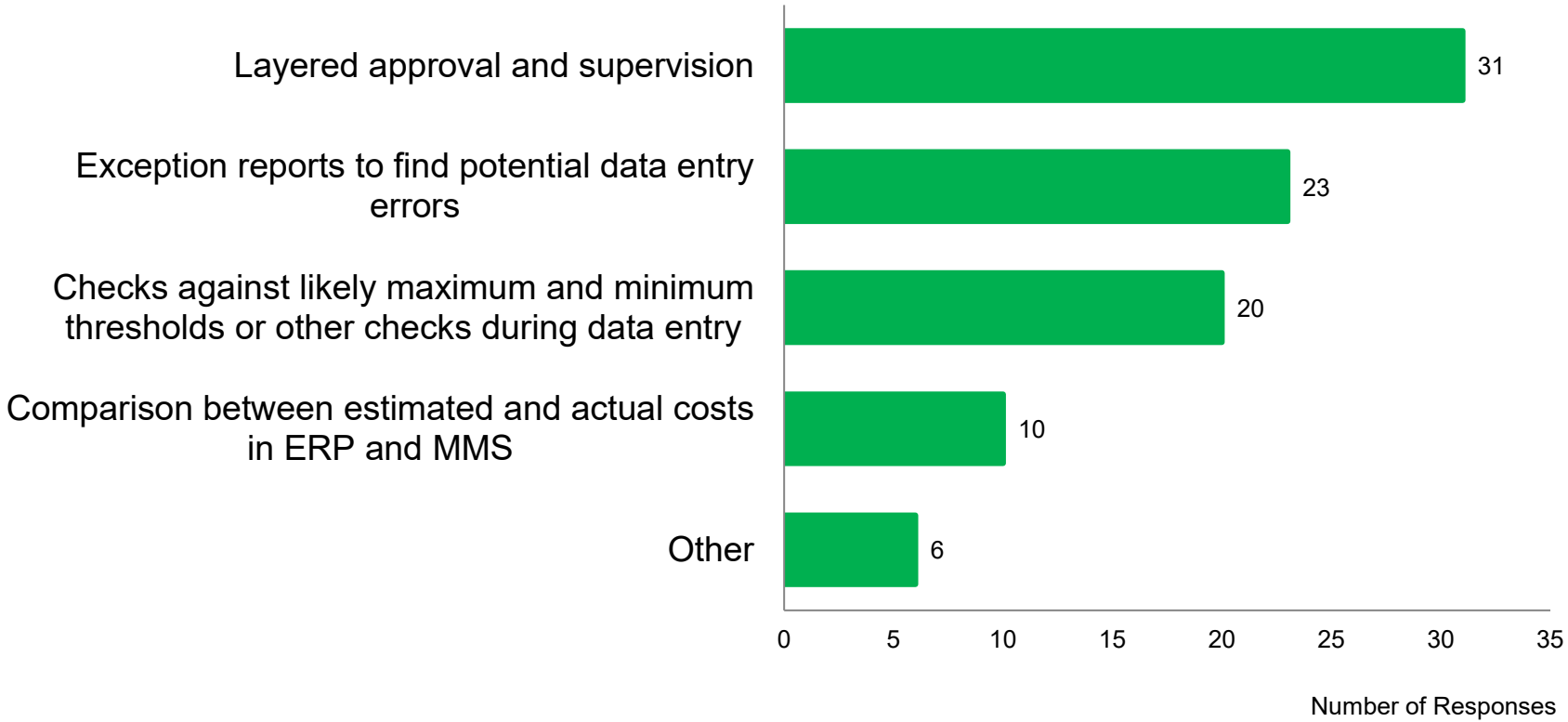


	First Recorded in MMS then: ...interfaced with ERP, next costed in ERP, and finally interfaced back to MMS (1)	First Recorded in MMS then: ...interfaced with ERP (2)	First Recorded in MMS then: ...NOT interfaced with ERP (3)	First Recorded in ERP then: ...interfaced with MMS (4)	First Recorded in ERP then: ...NOT interfaced with MMS (5)	Not Recorded: ...in MMS or ERP (0)
Work/Task Order Number	2	7	12	1	6	10
Date Work Accomplished (Date cost incurred)	2	7	12	4	5	8
Contract or PO (Including line item)	2	4	7	4	14	7
Product/Service Type (e.g., Labor, Equipment, Material, Contract Work)	1	3	12	5	10	7
Quantity	2	5	11	6	9	5
Cost	3	3	9	9	8	6

4.

Quality Assurance Strategies

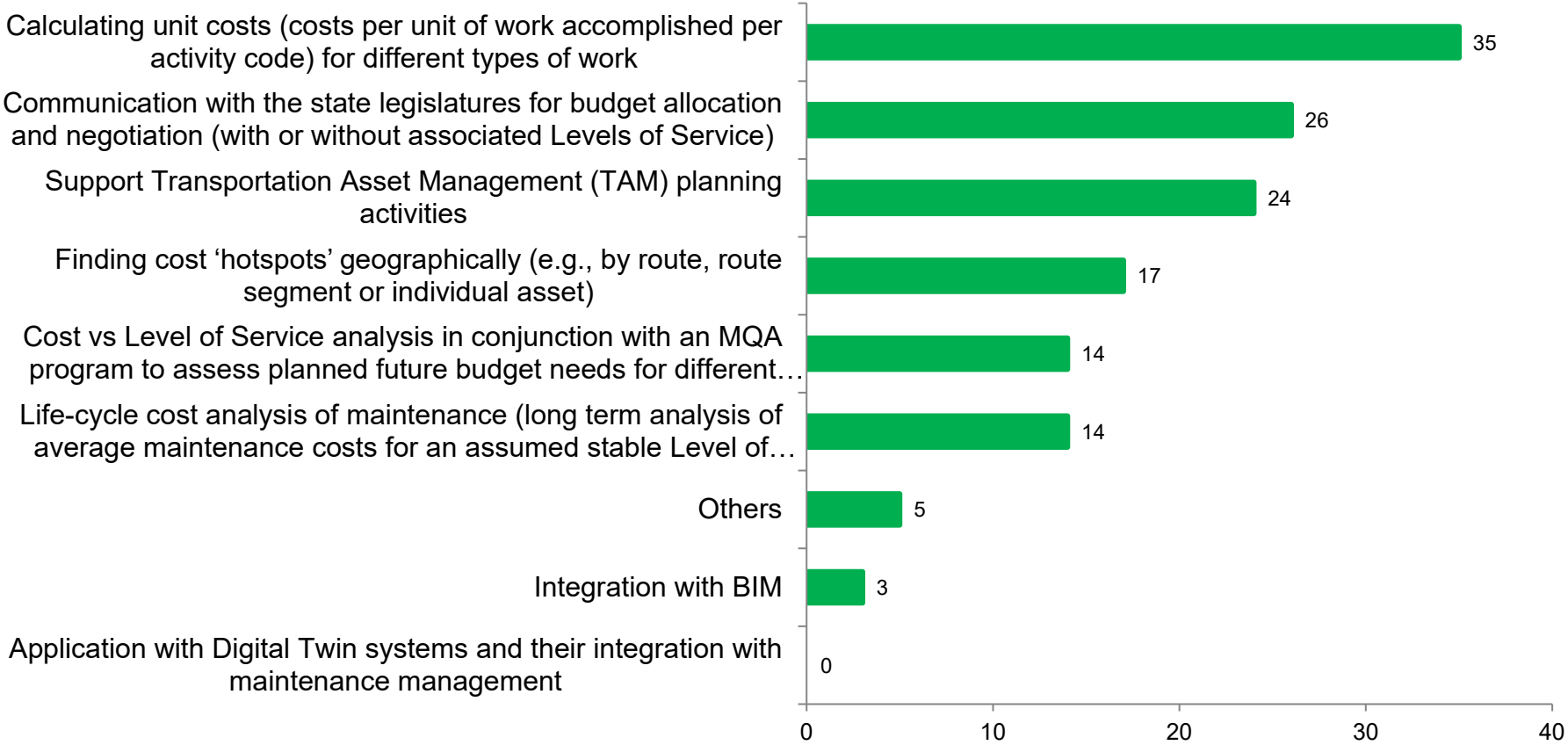
Quality Assurance Strategies within Maintenance Management Systems



5.

Use Cases of Maintenance Cost Data

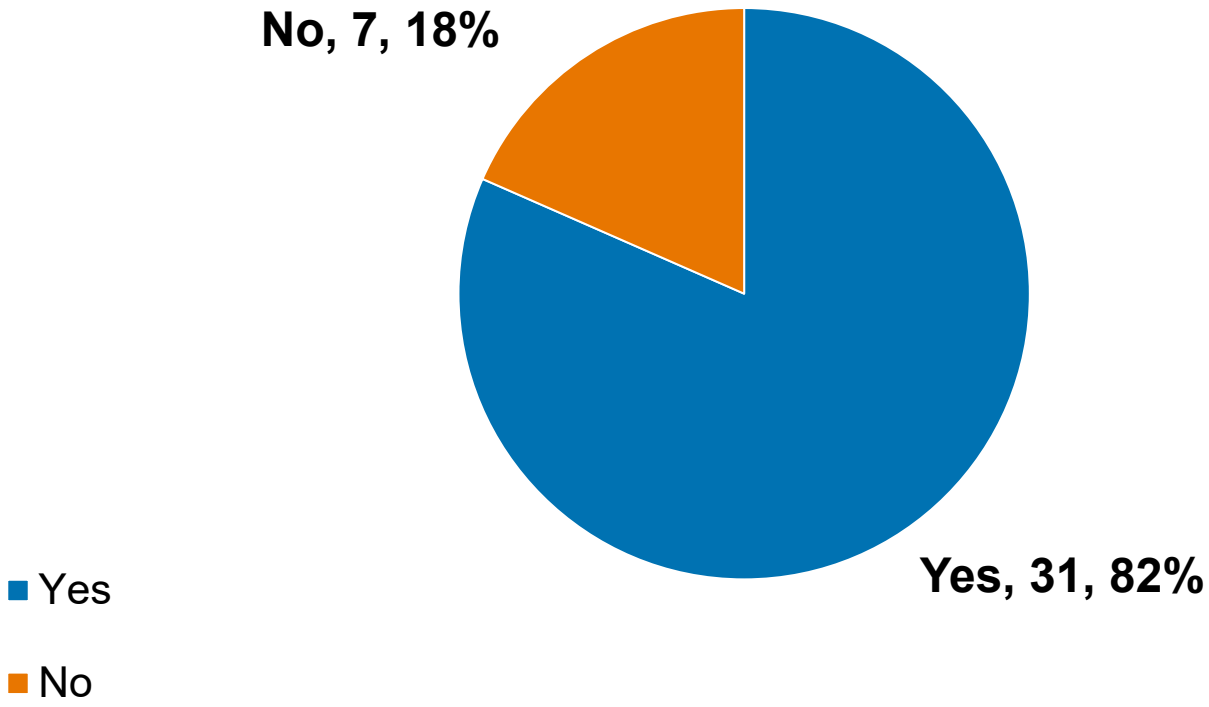
Use Cases of Maintenance Cost Data



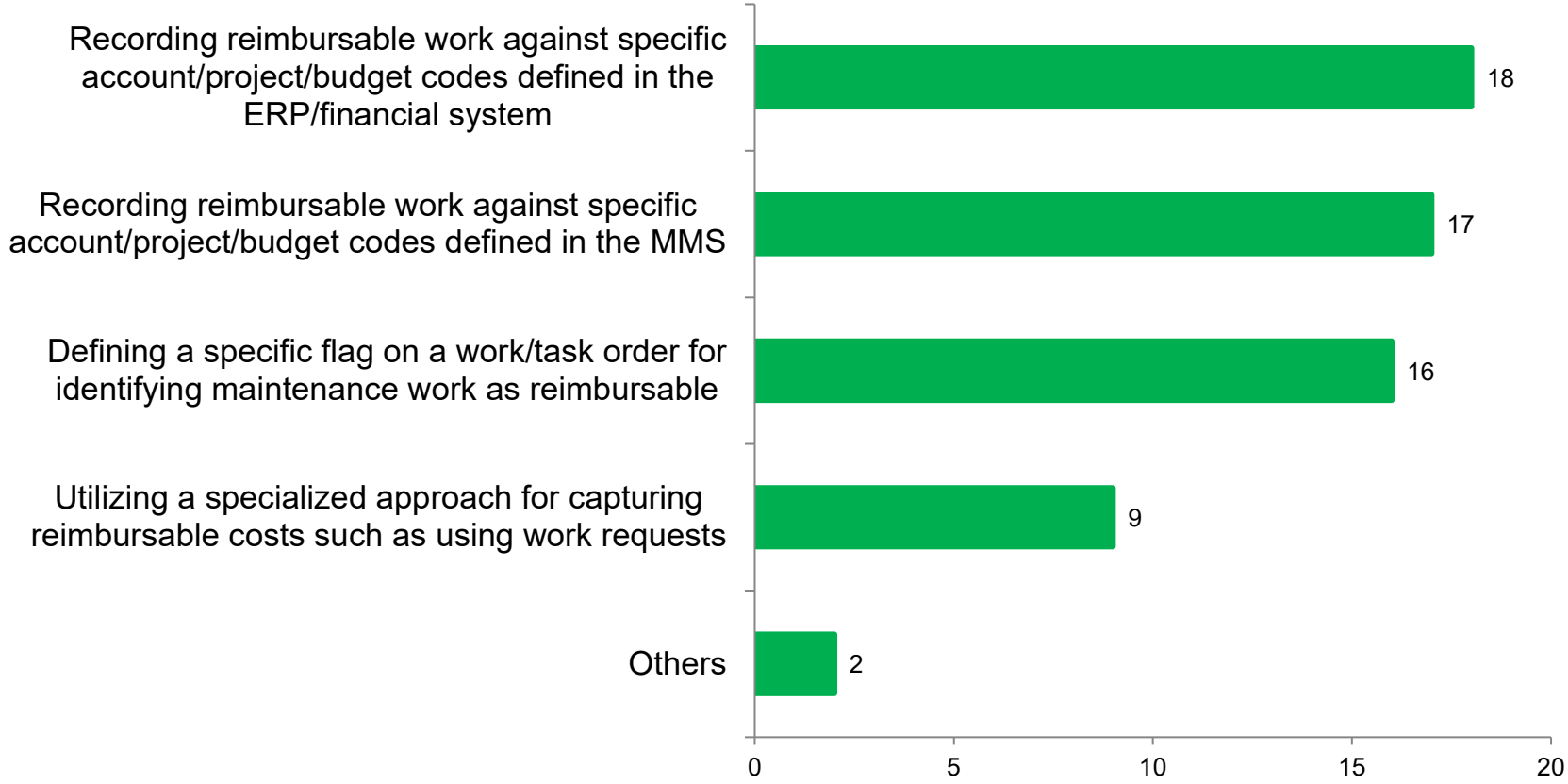
6.

MMS to Capture Cost Data for Reimbursement

Use of MMS for Capturing Data for Reimbursement Requests



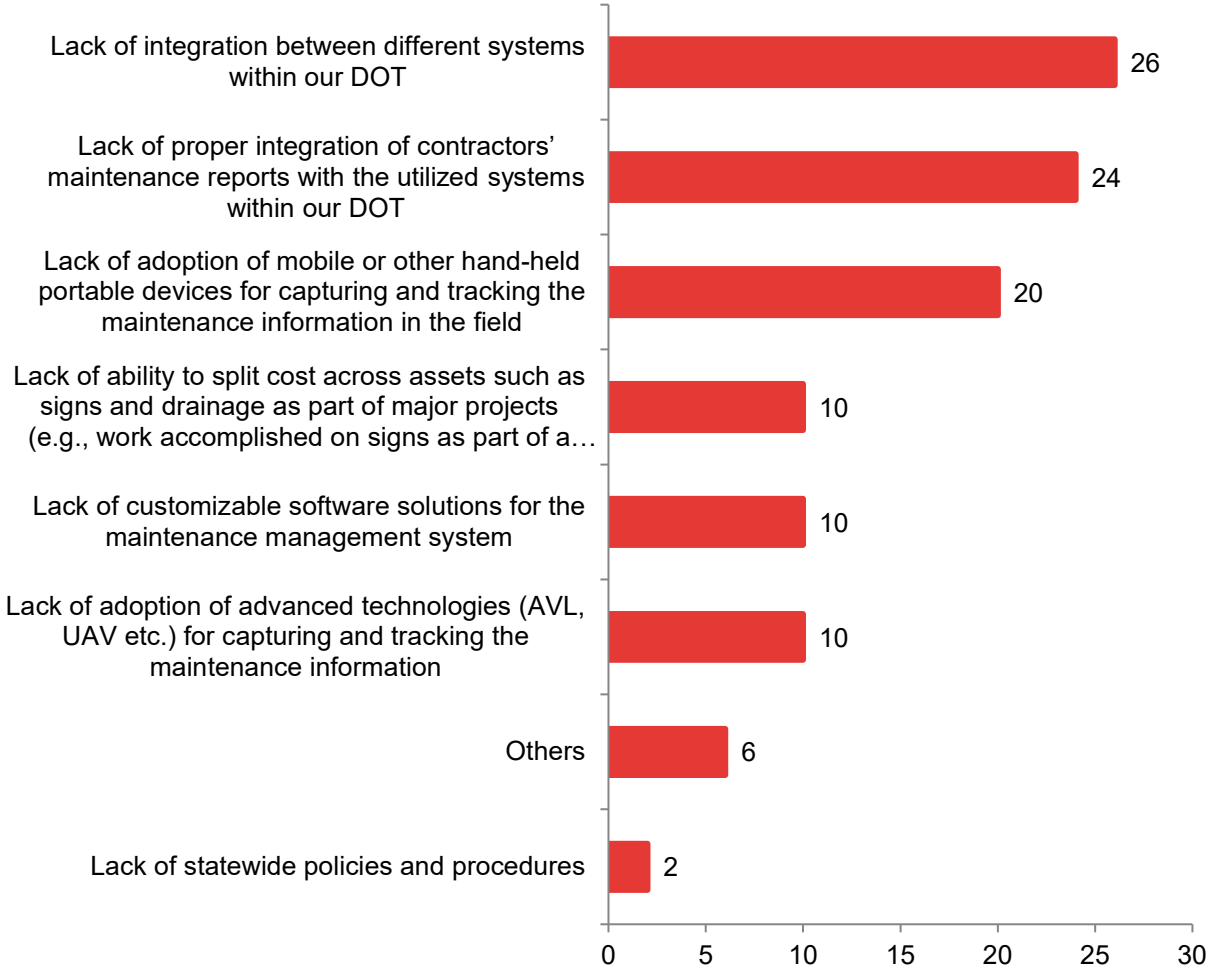
DOTs Approach for Specifying the Reimbursable Maintenance Work



7.

Barriers in Capturing the Cost of Maintenance

Barriers in Capturing the Cost of Maintenance



Summary of Findings & Conclusion

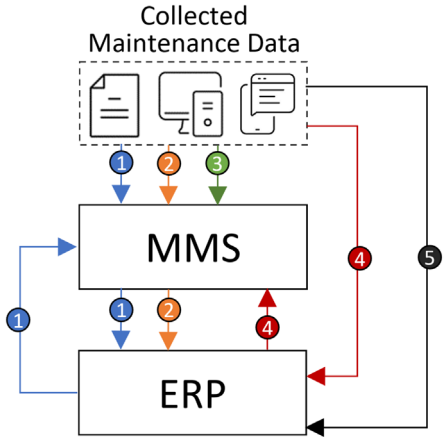
Maintenance Cost Data Capturing Strategies

- **Sources and frequency of maintenance cost data:** Most DOTs are capturing a combination of in-house maintenance activity-based LEM costs, and contractor costs daily
- **Initial Input of daily cost data:** Mix of paper forms and mobile devices
- **Advanced Technologies**: GPS, AVL, UAVs being used
- **Input by In-House and Contractor:** Typically different tools/systems
- **Activities performed by Contract**: Many maintenance activities are outsourced
- **Level of detail for Contract data capture**: Higher level needed but date, quantity and location important. Units of measure commonly the same.

Details of Tracking and Recording Maintenance Costs and System Interfaces

- **Basic WO/TO Information:**
  - Basic and location Work/Task Order is commonly first recorded in the MMS (1, 2, 3).
  - In some cases basic WO/TO info is interfaced with the ERP (1, 2).

- **Employee, Equipment, Materials and Other Cost Information:**
  - Most commonly, LEM master data is duplicated in both the ERP and MMS.
  - Cost data is either just calculated in the MMS (3), or entered in the ERP and interfaced to MMS (4, 5).
  - Only 3 DOTs enter LEM in MMS, interface to ERP, and get costs back (1).



Quality Assurance Strategies

- **Layered approval and supervision:** This was by far the most common method
- **Exception reports to find potential data entry errors:** Also a common method
- **Checks against likely maximum and minimum thresholds during data entry:** Data entry checks against ranges was third
- **Comparison between estimated and actual costs in ERP and MMS:** Ten DOTs reported this comparison
- **Other strategies:** Training and Support, Quality Assurance Reviews, Dedicated Performance Management Groups, etc.

Barriers in Capturing the Cost of Maintenance

- **System Integration Issues**
- **Contractors' Report Integration**
- **Technology Adoption Challenges:** Mobile devices, advanced technologies like Automated Vehicle Location (AVL) or Unmanned Aerial Vehicles (UAV)
- **Customizable Software Needs:** Configurability and difficulty in splitting costs across assets.

Future Research Needs

Future Research Needs

- Integration of Systems within DOTs
- Use of Mobile Digital Devices for Data Capture
- Cost Capture and Level of Service

NORTH CAROLINA
Department of Transportation

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems

Matthew P. Whitley, PE, MPA
NCDOT – Division 7 Division Maintenance Engineer

September 26, 2024

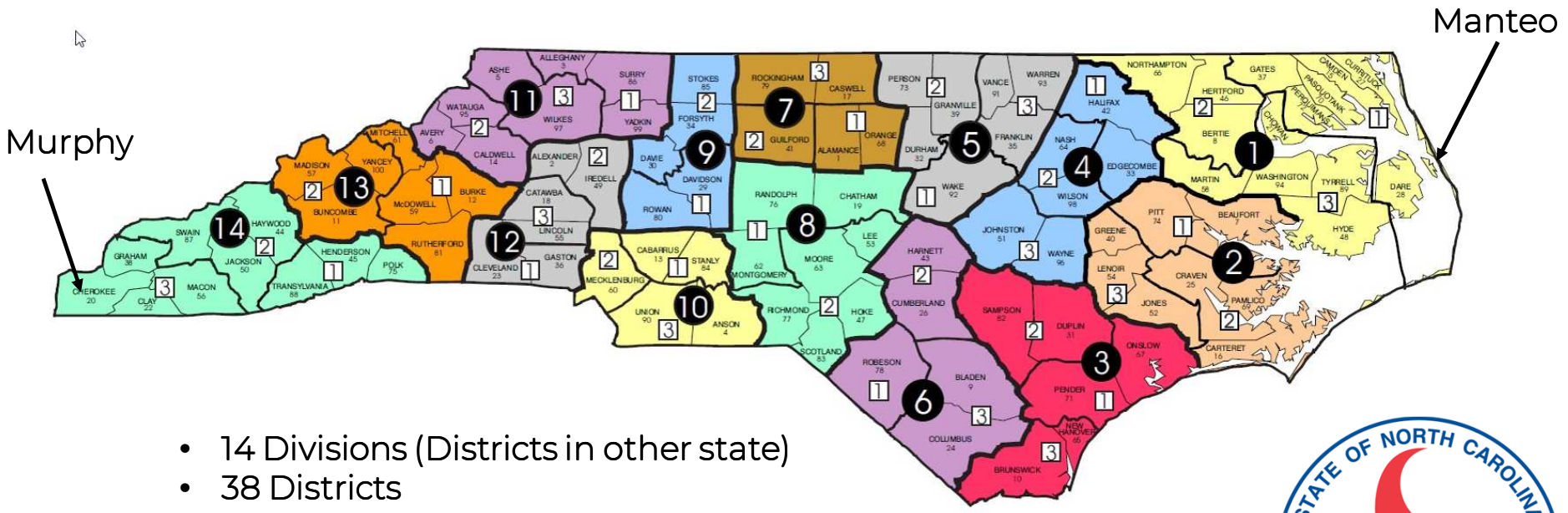
Connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina

Discussion Topics

- NC / NCDOT Statistics
- NCDOT – AMS and Financial System
- Cost Capture
  - Past, Present, and Future
- Lessons Learned

NCDOT – Statistics

NCDOT – Division / District



- 14 Divisions (Districts in other state)
- 38 Districts
- 100 Counties
- 560 miles wide
- Murphy to Manteo Distance is 544 miles
- Over 10 million residents

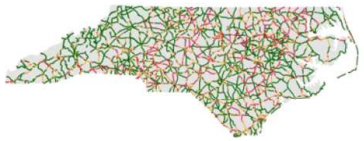
NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems

Interstate Routes

3% of lane miles

6,600 lane miles

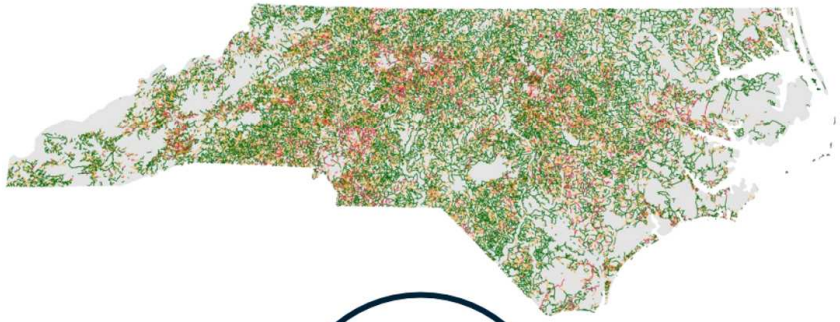
Primary Routes



31% of lane miles

68,200 lane miles

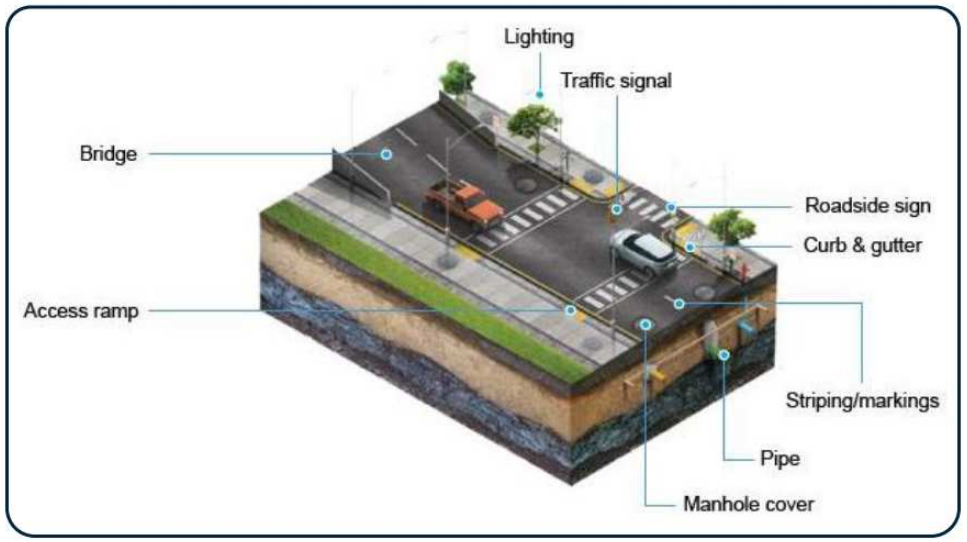
Secondary Routes

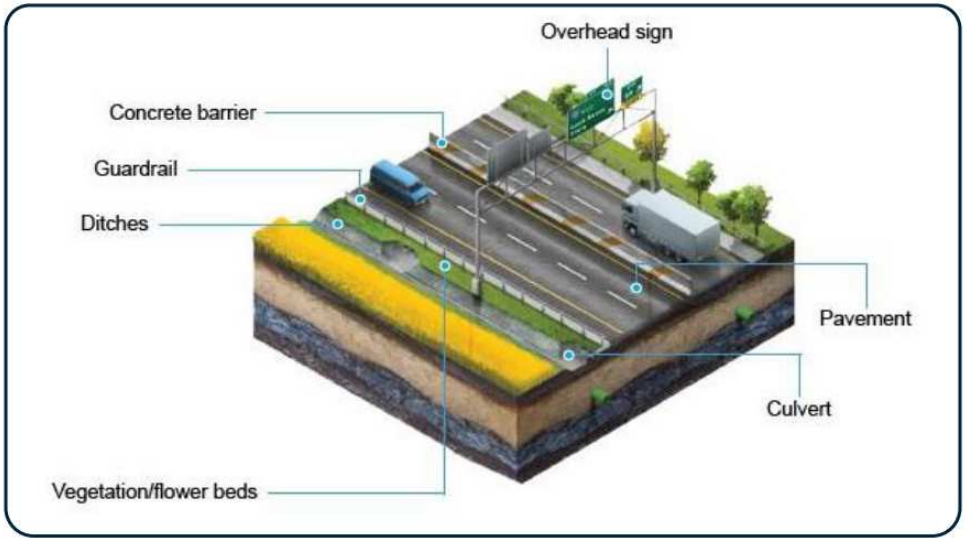


65% of lane miles

143,000 lane miles

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems





Structural Assets

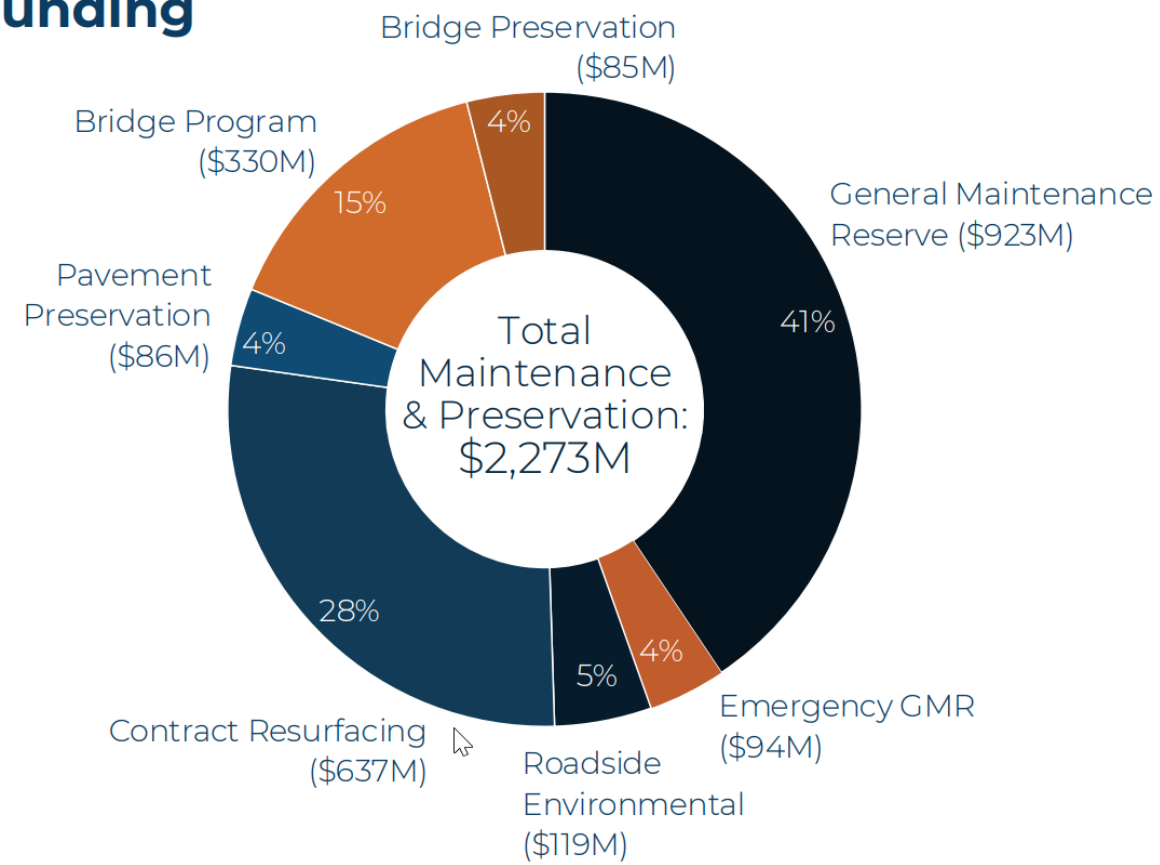
- 220,000 lane miles of pavement
- 13,600+ bridges (deck area of ~120M sft.)
- 300,000 pipes

Functional Assets

- 850,000 road signs
- 150,000 roadway lights
- 110,000 traffic signals
- 120,000 drop inlets
- 2,000 miles of curb and gutter
- 4,000 shoulder-miles of guardrails and barriers

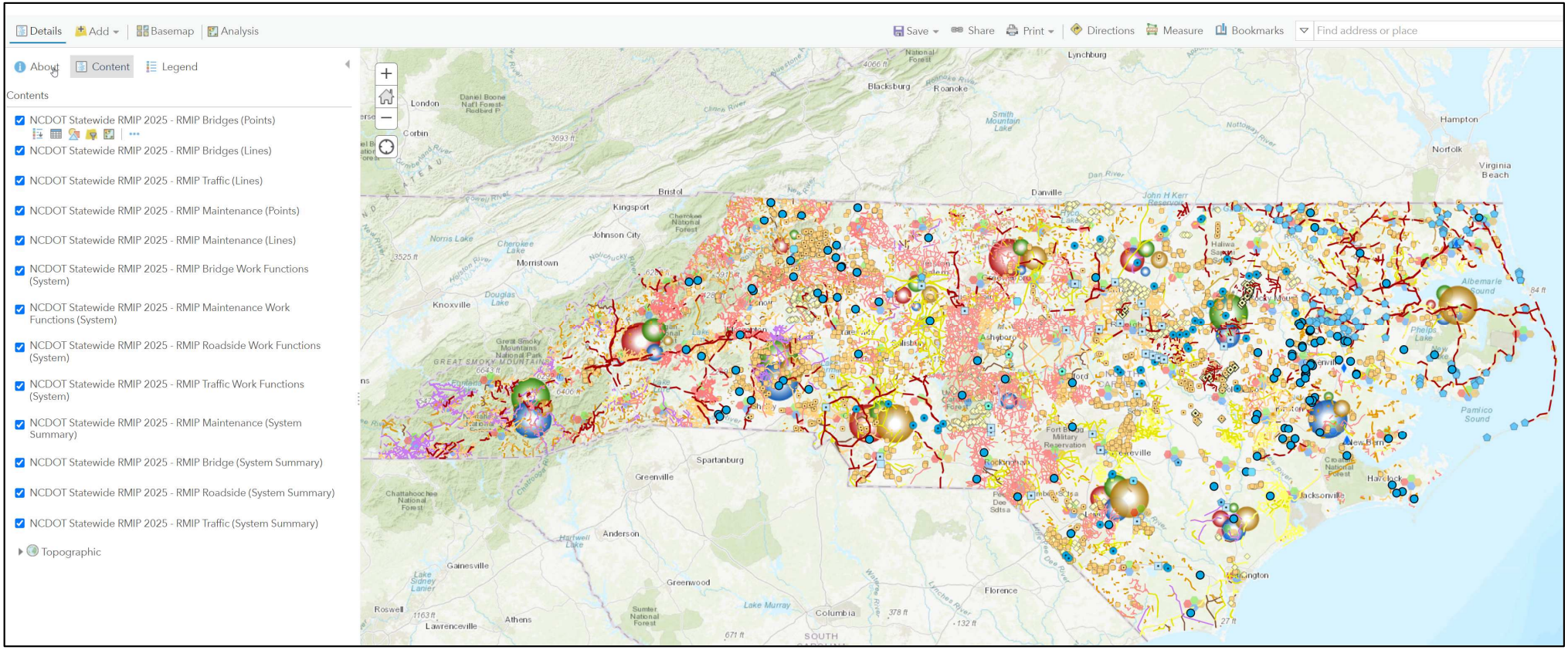
Maintenance Funding

FY 2025



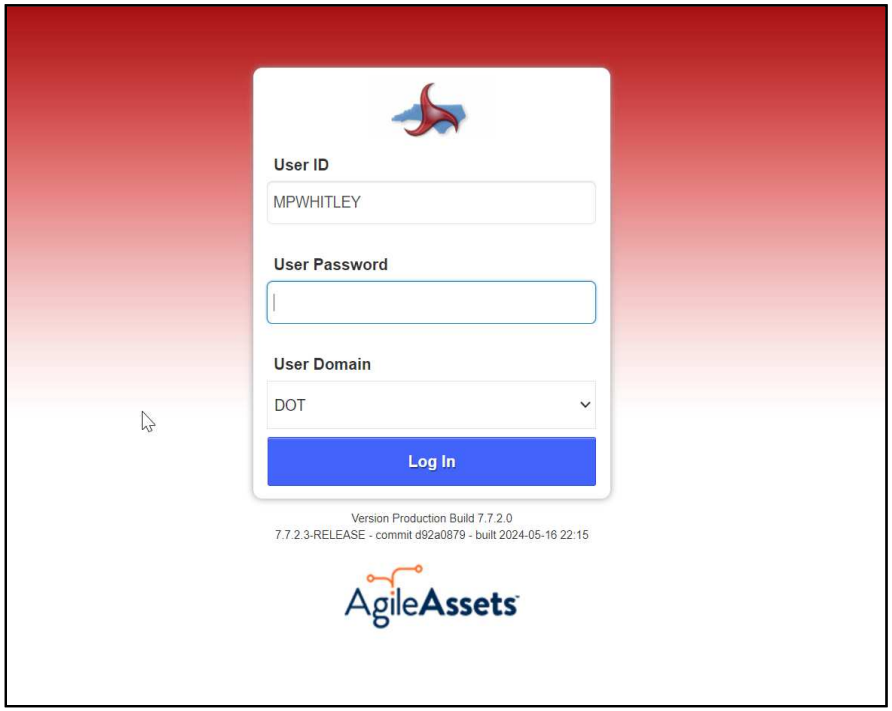
Allocations based on Year 2 of 2025 Biennium Budget (FY 25 includes NR funds)

Cost Capture Goal – Display on a map!



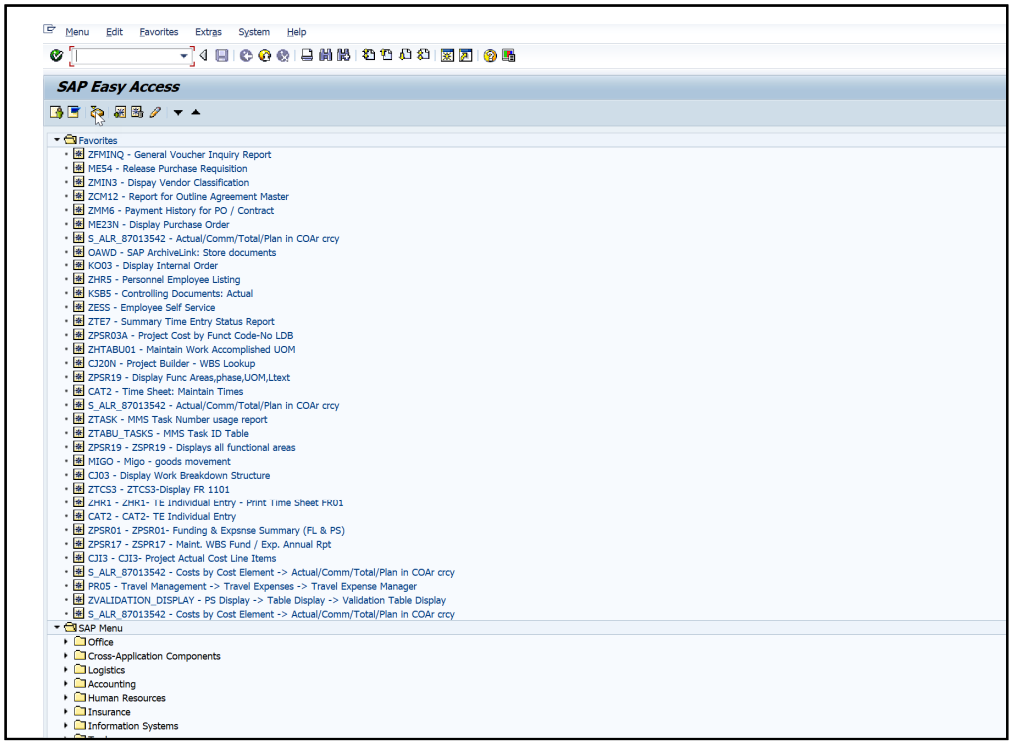
NCDOT – Maintenance Management / Financial System

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems



AMS - Trimble / Agile Assets Product

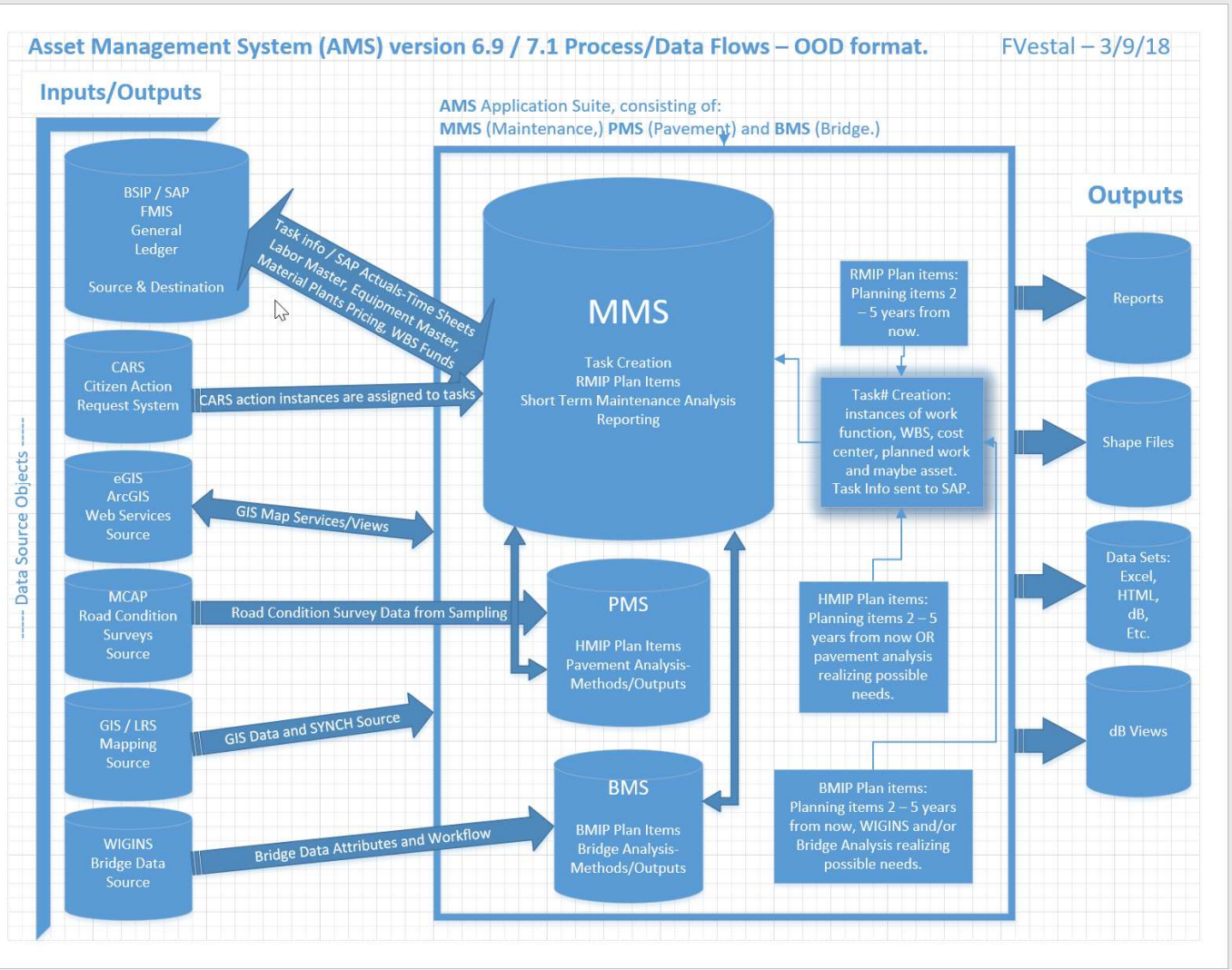
Implemented – early 2000



SAP – Financial Management System of Record

Implemented – early 2000

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems

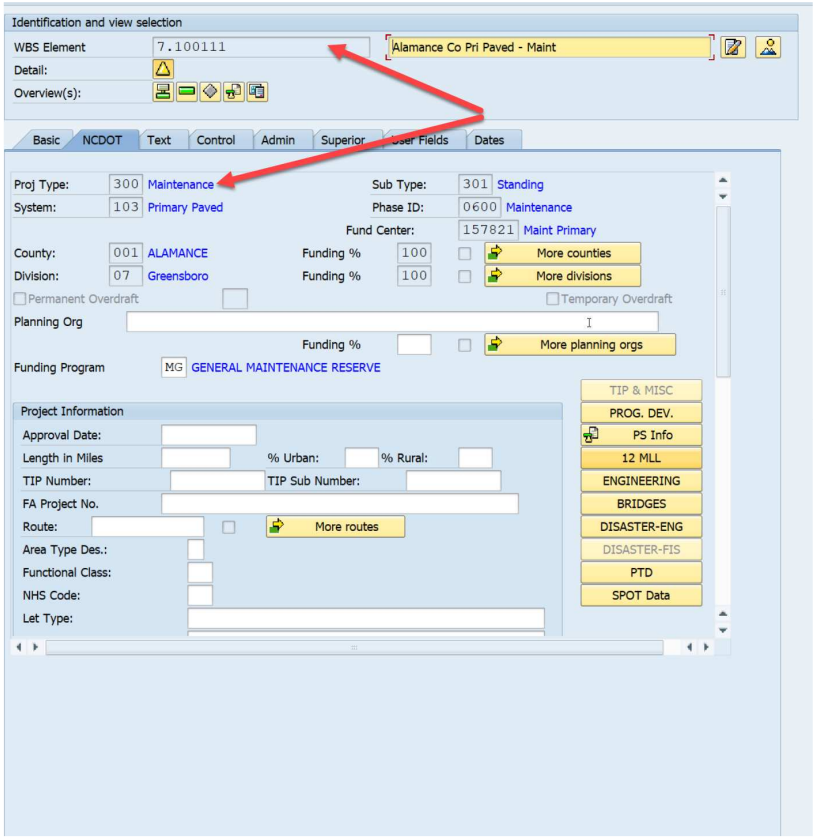


- This runs at 2am each morning
- SAP is the accounting system of record
- Cost data comes in several interface files that include:
  - Labor, Equipment, Materials, and Other Costs

SAP Filter of Costs Passed to Asset Management System

- AMS receives cost information from several types of expenditures
  - WBS Type / Subtype – Maintenance

- Not all expenditure data is tied to a work order
  - Expenditures not tied to Work Order / Tasks are still available for reporting purposes



Labor, Equipment, Materials, Accomplishments, and Other

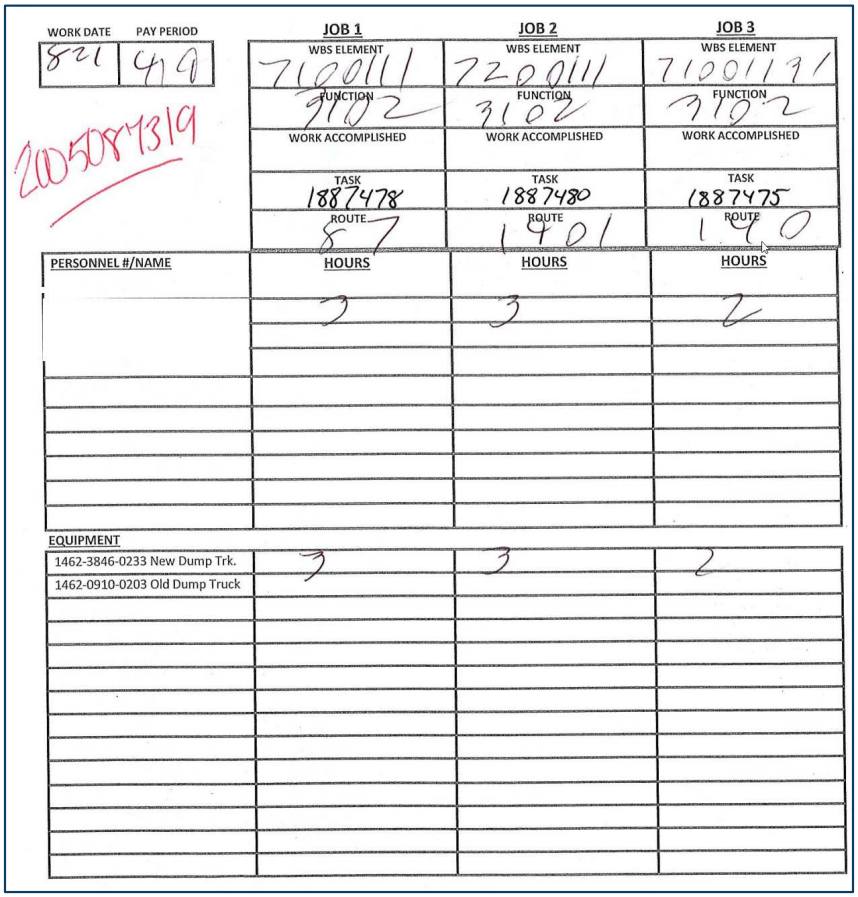
- Labor Cost - True Dollars Expended (From SAP / ERP System)
- Equipment Cost - True Dollars Expended (From SAP / ERP System)
- Material Cost- True Dollars Expended (From SAP / ERP System)
- Other Costs – Costs outside of (L,E,M). Cost to replace a mailbox purchased at home retailer.

  Contract Costs, etc.
- Work Accomplishments – Amount of work (captured in Work Function Unit of Measure)

NCDOT – Cost Capture (Past, Present, Future)

NCDOT – Cost Capture – Past/Present

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems



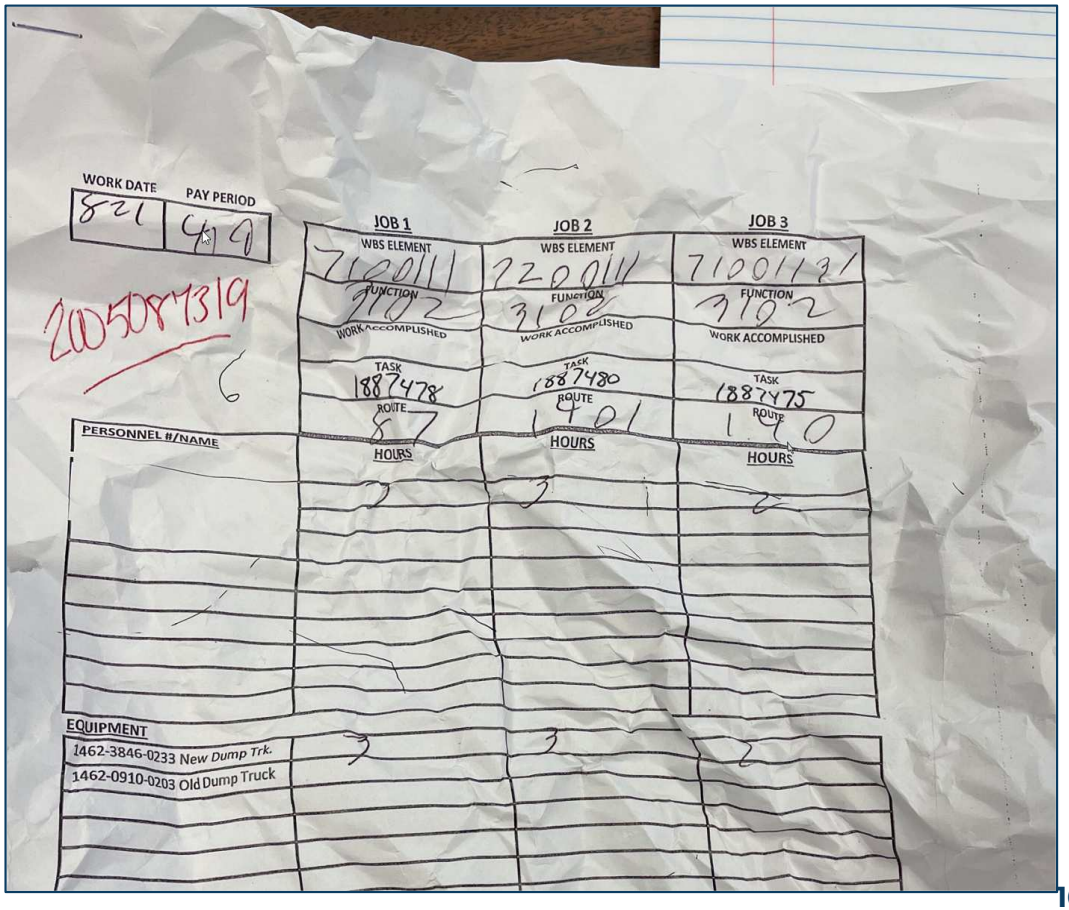
WORK DATE	PAY PERIOD
821	49

2050873319

	JOB 1	JOB 2	JOB 3
WBS ELEMENT	7100111	7200111	7100131
FUNCTION	3102	3102	3102
WORK ACCOMPLISHED			
TASK	1887478	1887480	1887475
ROUTE	87	1401	140

PERSONNEL #/NAME	HOURS	HOURS	HOURS
	3	3	2

EQUIPMENT			
1462-3846-0233 New Dump Trk.	3	3	2
1462-0910-0203 Old Dump Truck			



WORK DATE	PAY PERIOD
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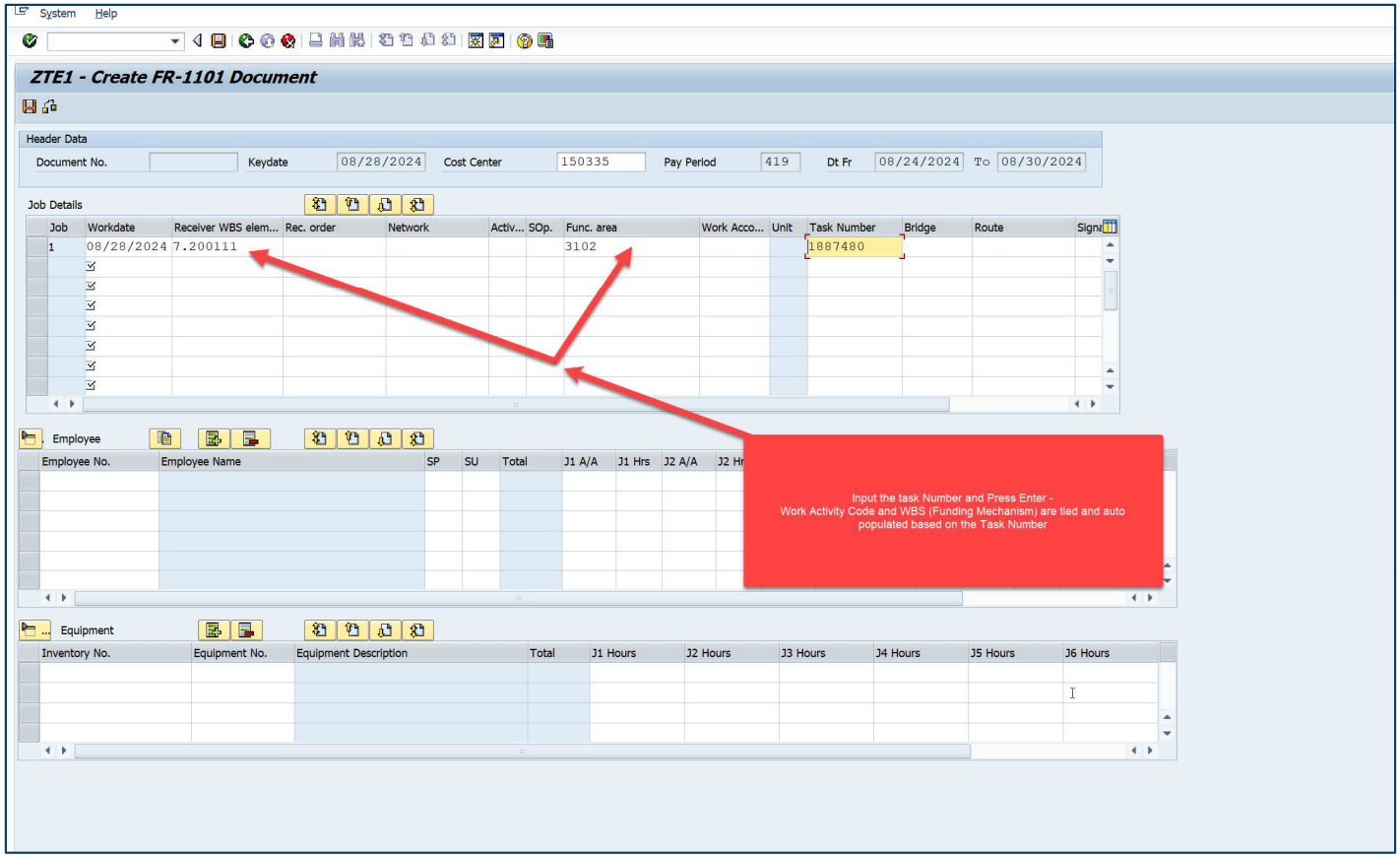
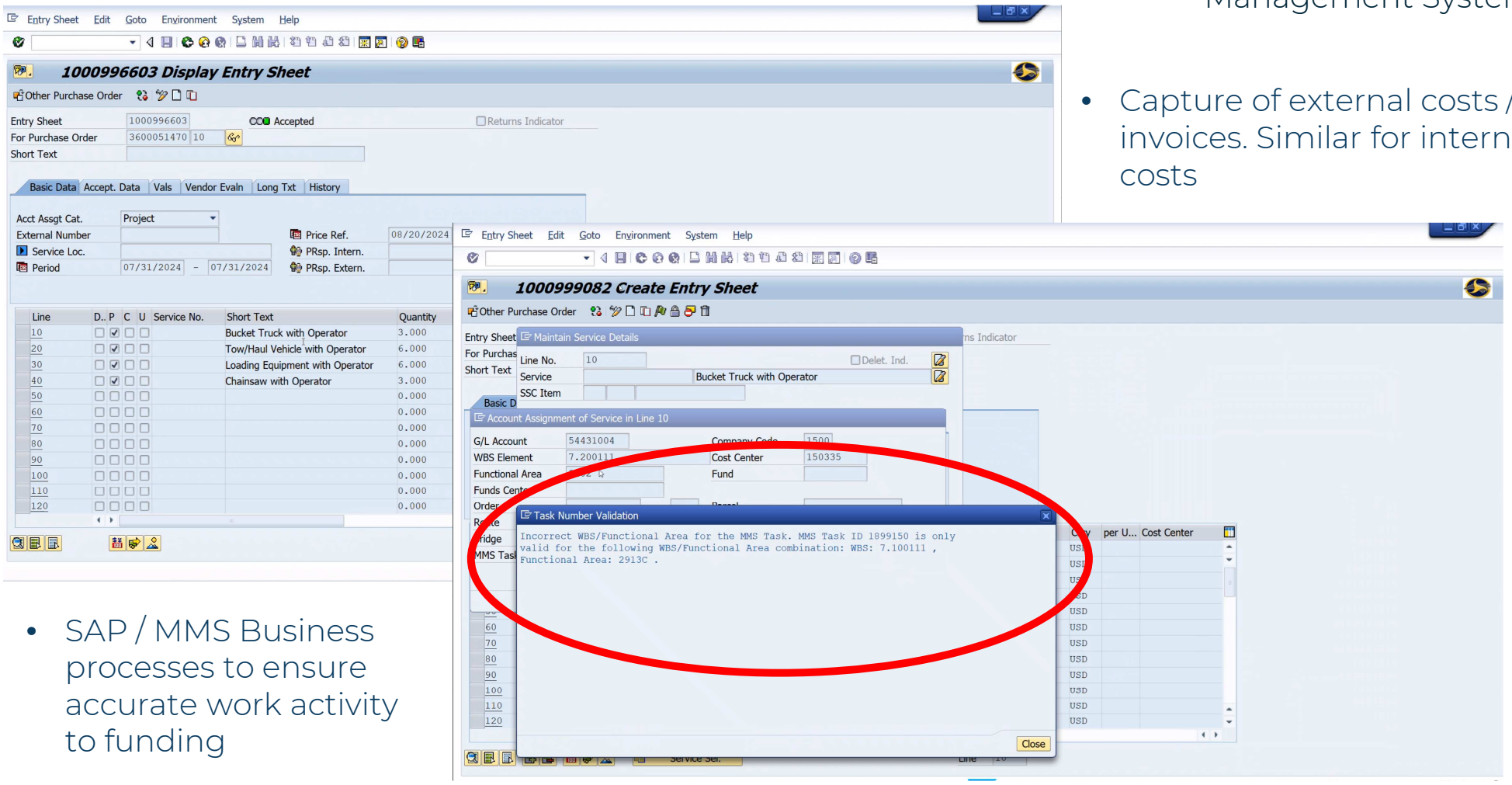
NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems



- Originally – All Data was manually entered
- System Improvement – Creation of database trigger in AMS to send WO data to SAP and auto populate.
- Task Data Prepopulated – Data Improvement

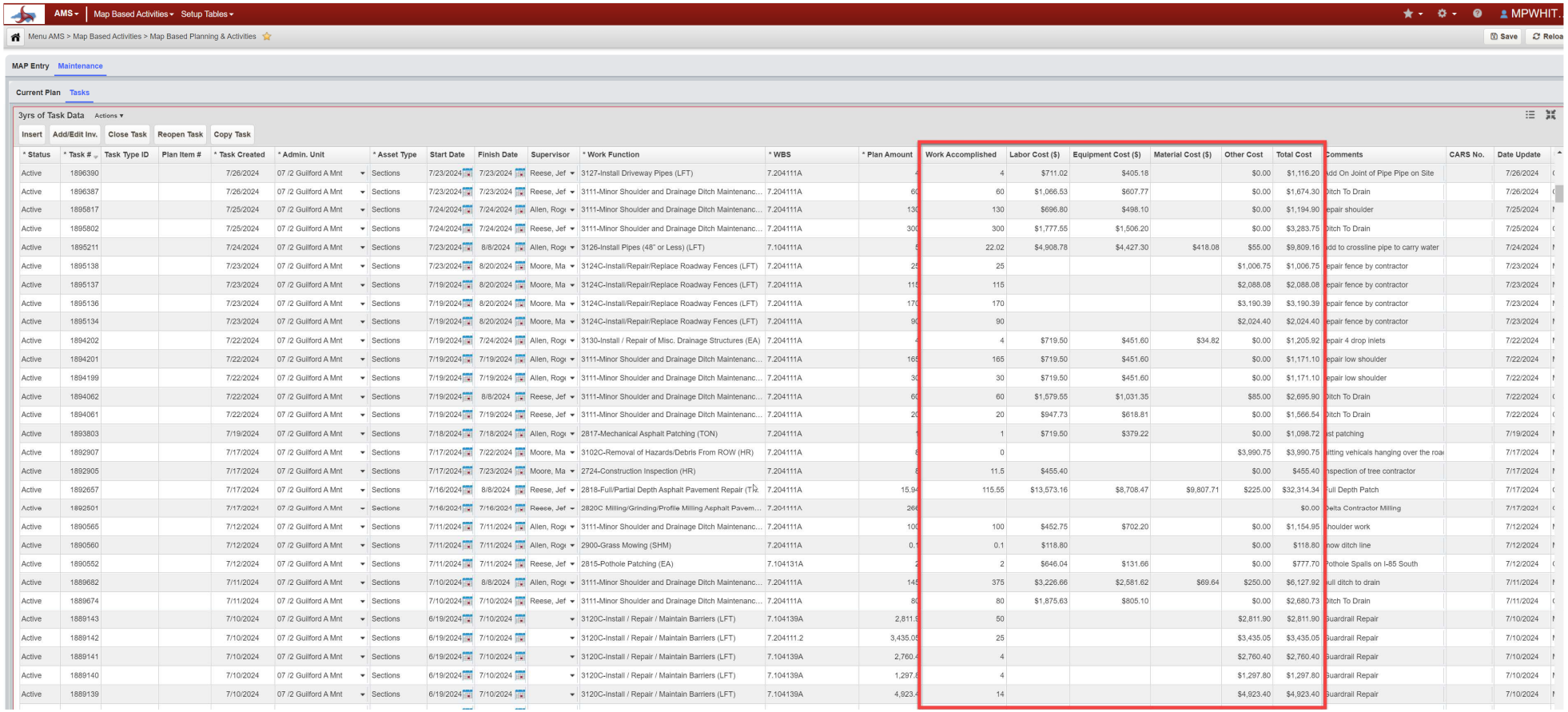
NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems

- Capture of external costs / invoices. Similar for internal costs



- SAP / MMS Business processes to ensure accurate work activity to funding

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems



AMS | Map Based Activities | Setup Tables

Menu AMS > Map Based Activities > Map Based Planning & Activities

MAP Entry | Maintenance

Current Plan | Tasks

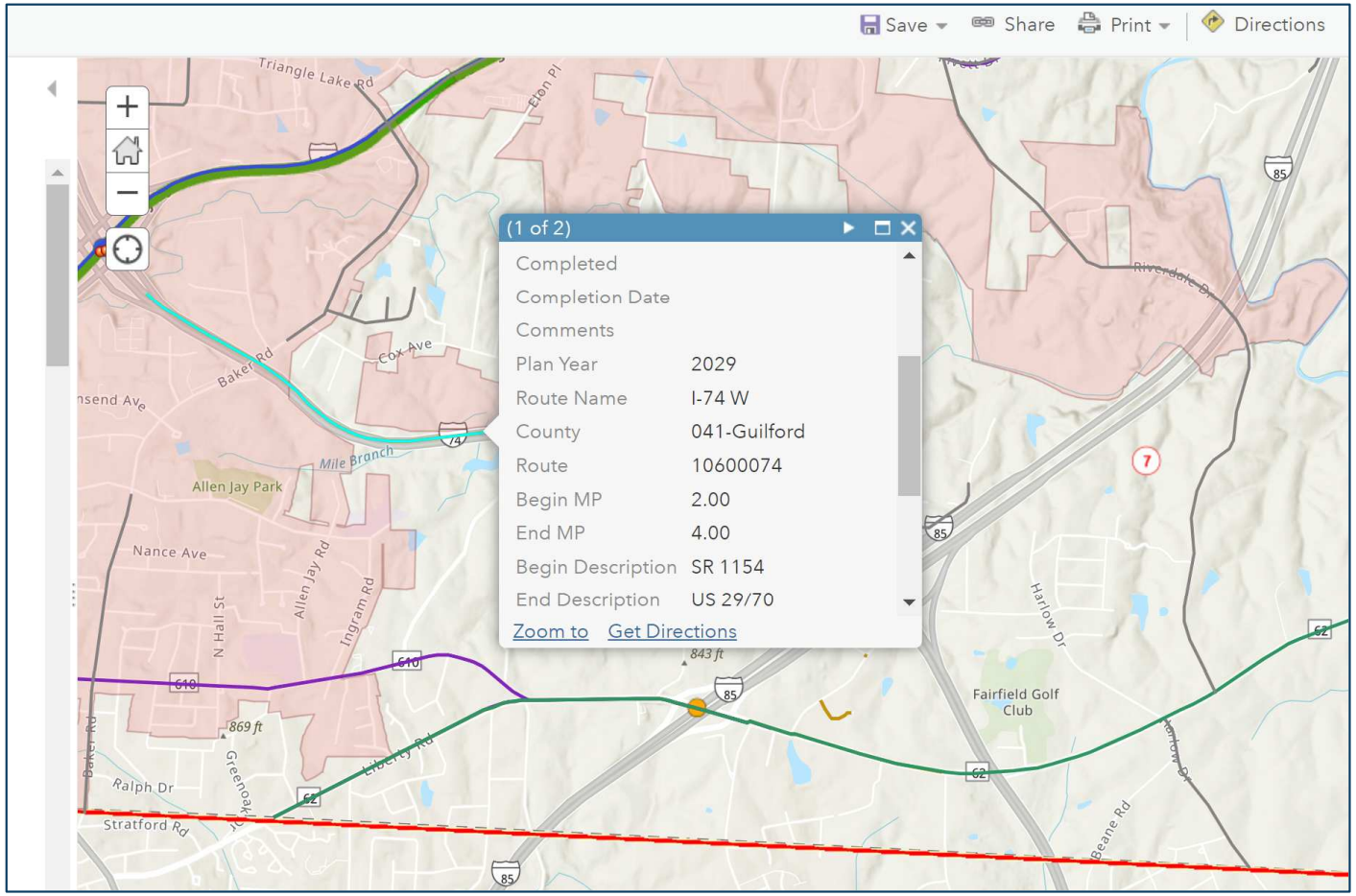
3yrs of Task Data — Actions

Insert | Add/Edit Inv. | Close Task | Reopen Task | Copy Task

* Status	* Task #	Task Type ID	Plan Item #	* Task Created	* Admin. Unit	* Asset Type	Start Date	Finish Date	Supervisor	* Work Function	* WBS	* Plan Amount	Work Accomplished	Labor Cost ($)	Equipment Cost ($)	Material Cost ($)	Other Cost	Total Cost	Comments	CARS No.	Date Update
Active	1896390			7/26/2024	07 /2 Guilford A Mnt	Sections	7/23/2024	7/23/2024	Reese, Jef	3127-Install Driveway Pipes (LFT)	7.204111A	4	4	$711.02	$405.18		$0.00	$1,116.20	Add On Joint of Pipe Pipe on Site		7/26/2024
Active	1896387			7/26/2024	07 /2 Guilford A Mnt	Sections	7/23/2024	7/23/2024	Reese, Jef	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	60	60	$1,066.53	$607.77		$0.00	$1,674.30	Ditch To Drain		7/26/2024
Active	1895817			7/25/2024	07 /2 Guilford A Mnt	Sections	7/24/2024	7/24/2024	Allen, Rogi	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	130	130	$696.80	$498.10		$0.00	$1,194.90	epair shoulder		7/25/2024
Active	1895802			7/25/2024	07 /2 Guilford A Mnt	Sections	7/24/2024	7/24/2024	Reese, Jef	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	300	300	$1,777.55	$1,506.20		$0.00	$3,283.75	Ditch To Drain		7/25/2024
Active	1895211			7/24/2024	07 /2 Guilford A Mnt	Sections	7/23/2024	8/8/2024	Allen, Rogi	3126-Install Pipes (48" or Less) (LFT)	7.104111A	5	22.02	$4,908.78	$4,427.30	$418.08	$55.00	$9,809.16	dd to crossline pipe to carry water		7/24/2024
Active	1895138			7/23/2024	07 /2 Guilford A Mnt	Sections	7/23/2024	8/20/2024	Moore, Ma	3124C-Install/Repair/Replace Roadway Fences (LFT)	7.204111A	25	25				$1,006.75	$1,006.75	epair fence by contractor		7/23/2024
Active	1895137			7/23/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	8/20/2024	Moore, Ma	3124C-Install/Repair/Replace Roadway Fences (LFT)	7.204111A	115	115				$2,088.08	$2,088.08	epair fence by contractor		7/23/2024
Active	1895136			7/23/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	8/20/2024	Moore, Ma	3124C-Install/Repair/Replace Roadway Fences (LFT)	7.204111A	170	170				$3,190.39	$3,190.39	epair fence by contractor		7/23/2024
Active	1895134			7/23/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	8/20/2024	Moore, Ma	3124C-Install/Repair/Replace Roadway Fences (LFT)	7.204111A	90	90				$2,024.40	$2,024.40	epair fence by contractor		7/23/2024
Active	1894202			7/22/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	7/24/2024	Allen, Rogi	3130-Install / Repair of Misc. Drainage Structures (EA)	7.204111A	4	4	$719.50	$451.60	$34.82	$0.00	$1,205.92	epair 4 drop inlets		7/22/2024
Active	1894201			7/22/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	7/19/2024	Allen, Rogi	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	165	165	$719.50	$451.60		$0.00	$1,171.10	epair low shoulder		7/22/2024
Active	1894199			7/22/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	7/19/2024	Allen, Rogi	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	30	30	$719.50	$451.60		$0.00	$1,171.10	epair low shoulder		7/22/2024
Active	1894062			7/22/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	8/8/2024	Reese, Jef	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	60	60	$1,579.55	$1,031.35		$85.00	$2,695.90	Ditch To Drain		7/22/2024
Active	1894061			7/22/2024	07 /2 Guilford A Mnt	Sections	7/19/2024	7/19/2024	Reese, Jef	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	20	20	$947.73	$618.81		$0.00	$1,566.54	Ditch To Drain		7/22/2024
Active	1893803			7/19/2024	07 /2 Guilford A Mnt	Sections	7/18/2024	7/18/2024	Allen, Rogi	2817-Mechanical Asphalt Patching (TON)	7.204111A	1	1	$719.50	$379.22		$0.00	$1,098.72	st patching		7/19/2024
Active	1892907			7/17/2024	07 /2 Guilford A Mnt	Sections	7/17/2024	7/22/2024	Moore, Ma	3102C-Removal of Hazards/Debris From ROW (HR)	7.204111A	6	0				$3,990.75	$3,990.75	itting vehicals hanging over the roa		7/17/2024
Active	1892905			7/17/2024	07 /2 Guilford A Mnt	Sections	7/17/2024	7/23/2024	Moore, Ma	2724-Construction Inspection (HR)	7.204111A	6	11.5	$455.40			$0.00	$455.40	nspection of tree contractor		7/17/2024
Active	1892657			7/17/2024	07 /2 Guilford A Mnt	Sections	7/16/2024	8/8/2024	Reese, Jef	2818-Full/Partial Depth Asphalt Pavement Repair (TN	7.204111A	15.94	115.55	$13,573.16	$8,708.47	$9,807.71	$225.00	$32,314.34	ull Depth Patch		7/17/2024
Active	1892501			7/17/2024	07 /2 Guilford A Mnt	Sections	7/16/2024	7/16/2024	Reese, Jef	2820C Milling/Grinding/Profile Milling Asphalt Pavem...	7.204111A	266						$0.00	elta Contractor Milling		7/17/2024
Active	1890565			7/12/2024	07 /2 Guilford A Mnt	Sections	7/11/2024	7/11/2024	Allen, Rogi	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	100	100	$452.75	$702.20		$0.00	$1,154.95	houlder work		7/12/2024
Active	1890560			7/12/2024	07 /2 Guilford A Mnt	Sections	7/11/2024	7/11/2024	Allen, Rogi	2900-Grass Mowing (SHM)	7.204111A	0.1	0.1	$118.80			$0.00	$118.80	now ditch line		7/12/2024
Active	1890552			7/12/2024	07 /2 Guilford A Mnt	Sections	7/11/2024	7/11/2024	Reese, Jef	2815-Pothole Patching (EA)	7.104131A	2	2	$646.04	$131.66		$0.00	$777.70	Pothole Spalls on I-85 South		7/12/2024
Active	1889682			7/11/2024	07 /2 Guilford A Mnt	Sections	7/10/2024	8/8/2024	Allen, Rogi	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	145	375	$3,226.66	$2,581.62	$69.64	$250.00	$6,127.92	ull ditch to drain		7/11/2024
Active	1889674			7/11/2024	07 /2 Guilford A Mnt	Sections	7/10/2024	7/10/2024	Reese, Jef	3111-Minor Shoulder and Drainage Ditch Maintenanc...	7.204111A	80	80	$1,875.63	$805.10		$0.00	$2,680.73	Ditch To Drain		7/11/2024
Active	1889143			7/10/2024	07 /2 Guilford A Mnt	Sections	6/19/2024	7/10/2024		3120C-Install / Repair / Maintain Barriers (LFT)	7.104139A	2,811.9	50				$2,811.90	$2,811.90	Guardrail Repair		7/10/2024
Active	1889142			7/10/2024	07 /2 Guilford A Mnt	Sections	6/19/2024	7/10/2024		3120C-Install / Repair / Maintain Barriers (LFT)	7.204111.2	3,435.05	25				$3,435.05	$3,435.05	Guardrail Repair		7/10/2024
Active	1889141			7/10/2024	07 /2 Guilford A Mnt	Sections	6/19/2024	7/10/2024		3120C-Install / Repair / Maintain Barriers (LFT)	7.104139A	2,760.4	4				$2,760.40	$2,760.40	Guardrail Repair		7/10/2024
Active	1889140			7/10/2024	07 /2 Guilford A Mnt	Sections	6/19/2024	7/10/2024		3120C-Install / Repair / Maintain Barriers (LFT)	7.104139A	1,297.8	4				$1,297.80	$1,297.80	Guardrail Repair		7/10/2024
Active	1889139			7/10/2024	07 /2 Guilford A Mnt	Sections	6/19/2024	7/10/2024		3120C-Install / Repair / Maintain Barriers (LFT)	7.104139A	4,923.4	14				$4,923.40	$4,923.40	Guardrail Repair		7/10/2024

- Verified / validated data into AMS from SAP

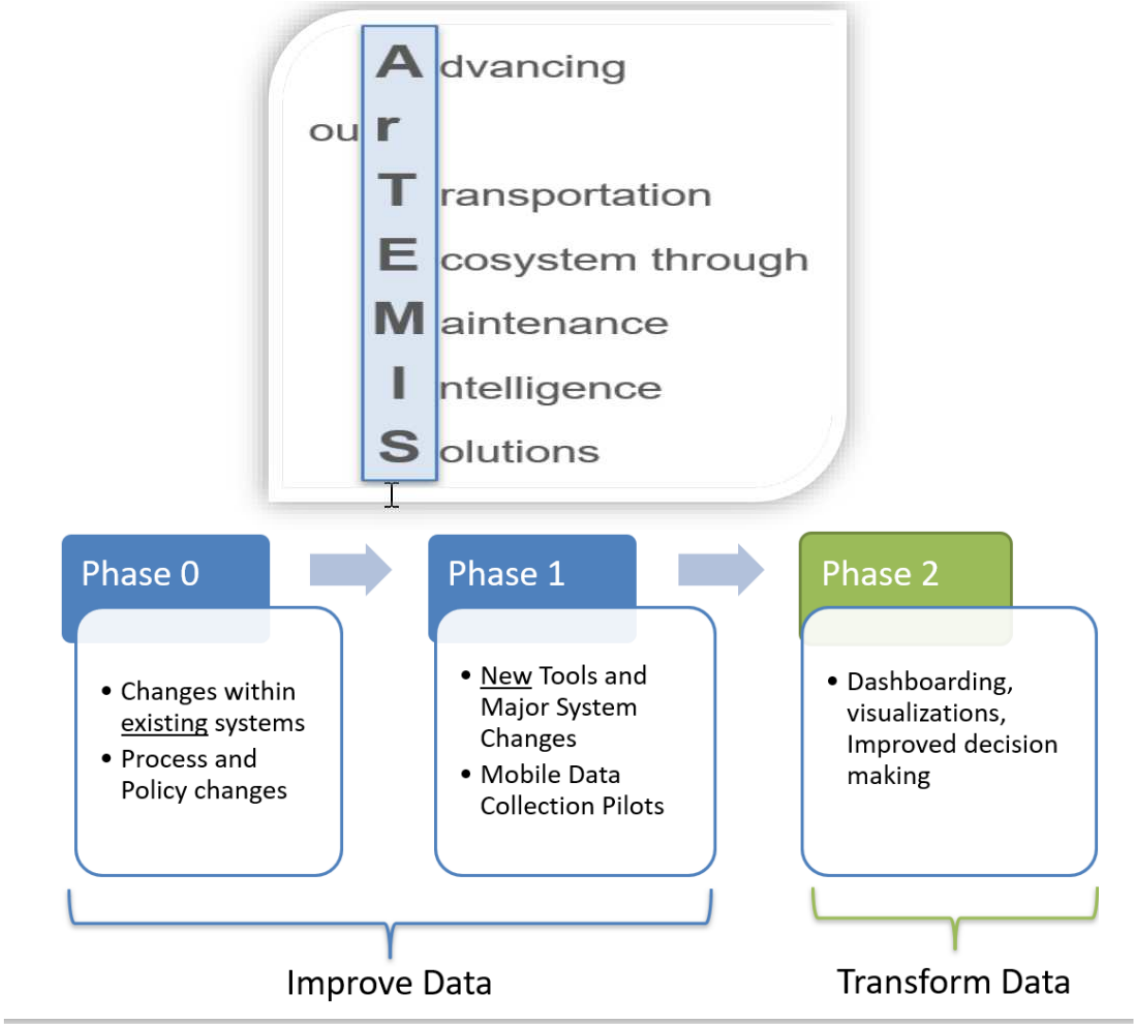
NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems



- NCDOT Goal – Cost data to Route / Asset
- Creation and capture of Cost data

NCDOT – Cost Capture - Present

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems



Work Activity Required Location Granularity

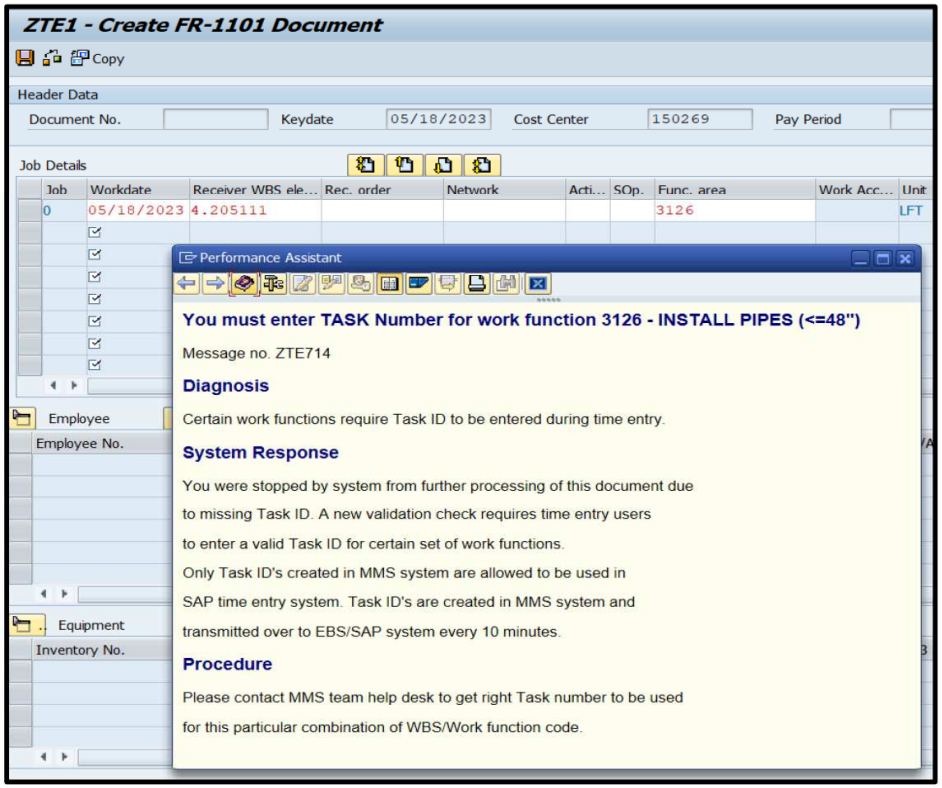
- Short list of critical work functions sent to all Division Offices Statewide
- Field crews are required to task these activities within AMS system
- Required level of granularity is listed as a minimum requirement when using these work functions

ArTEMIS Work Function List

Functional Area	Functional Area Name	ArTEMIS (Granularity)
2817	Mechanical Asphalt Patching (TON)	Y (Route)
2817C	Mechanical Asphalt Patching (TON)	Y (Route)
2818	Full / Partial Depth Asphalt Pavement Repair (TON)	Y (Route)
2818C	Full / Partial Depth Asphalt Pavement Repair (TON)	Y (Route)
2908	Brush and Tree Control /Herbicides (SHM)	Y (Route)
2911	Manual Brush and Tree Control (SF)	Y (Route)
2912	Mechanical Brush and Tree Control (SHM)	Y (Route)
3108	Drainage Ditch Maintenance (SHM)	Y (Route)
3109	Maintenance of Shoulders AND Ditches (SHM)	Y (Route)
3111	Minor Shoulder and Drainage Ditch Maintenance (LF)	Y (Route)
3112	Shoulder Maintenance / Reconstruction (SHM)	Y (Route)
3115	Slope Repair (EA)	Y (Route-MP)
3115C	Slope Repair (EA)	Y (Route-MP)
3120C	Install / Repair / Maintain Barriers (LF)	Y (Route-MP)
3122C	Maintenance Repair and Replacement of Attenuators (EA)	Y (Route-MP)
3126	Install Pipes (48" or Less) (LFT)	Y (Inventory or Route-MP)
3126C	Install Pipes (48" or Less) (LFT)	Y (Inventory or Route-MP)

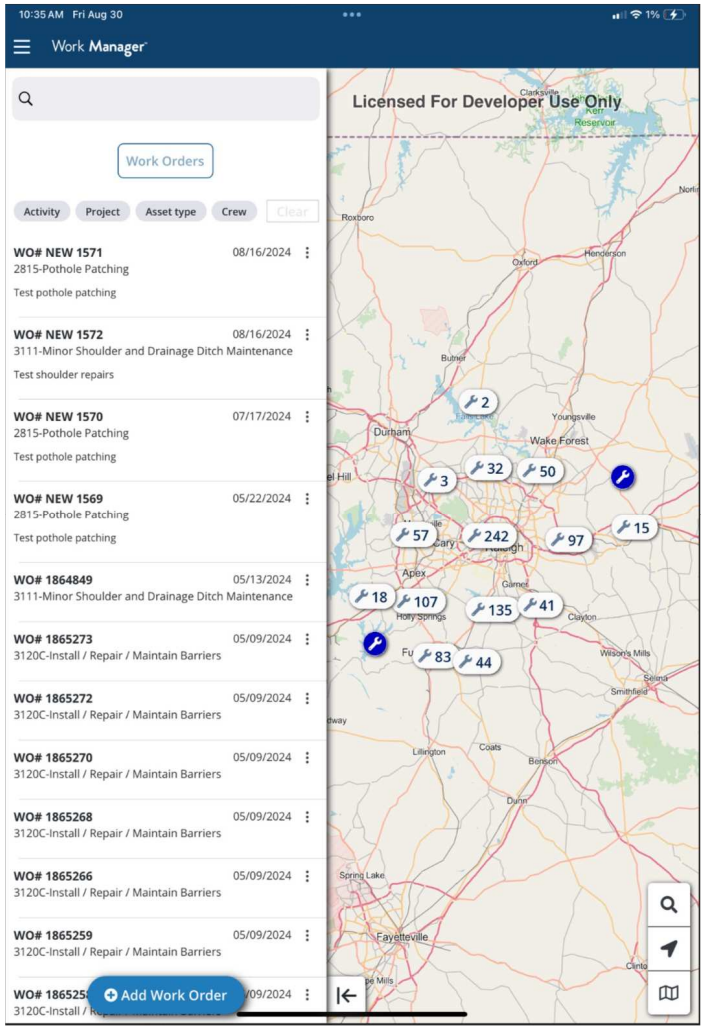
Work Activity Location Validation - System Error Message

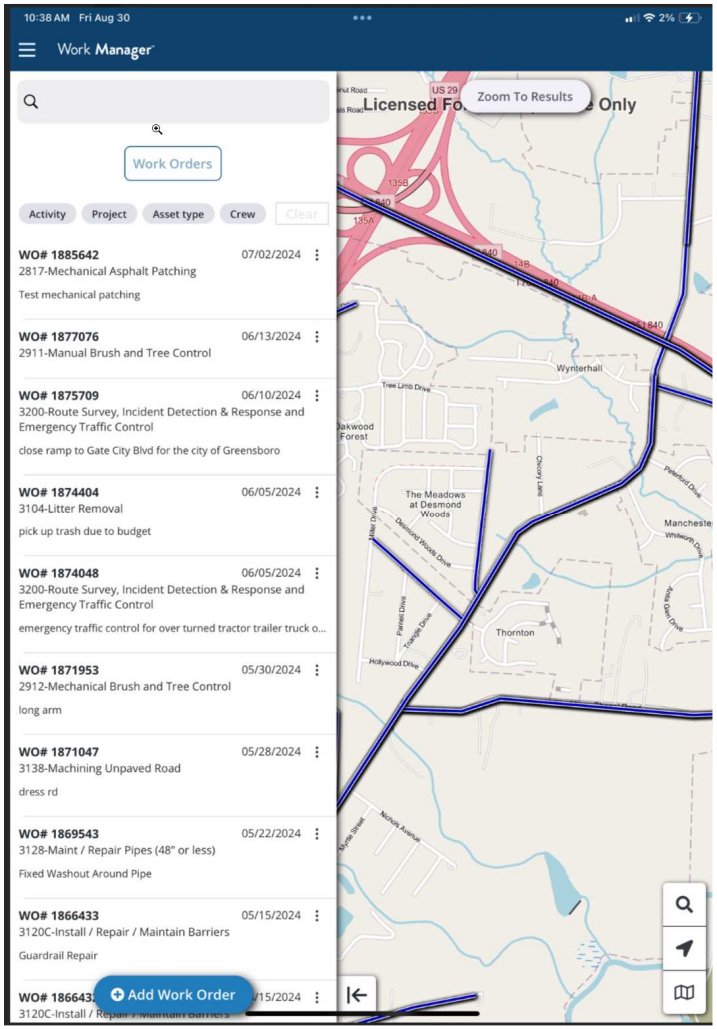
- Error message generated if conditions for entry are not met
- Text box pop-up explains to field user that certain work functions require a Task ID to be entered
- Response / Procedure is conveyed to the users so that the error can be fixed
- This "hard-stop" ensures that charges to certain work activities are tied to a mappable location



NCDOT – Cost Capture - Future

NCDOT - Capturing and Integrating Cost Data into Maintenance Management Systems





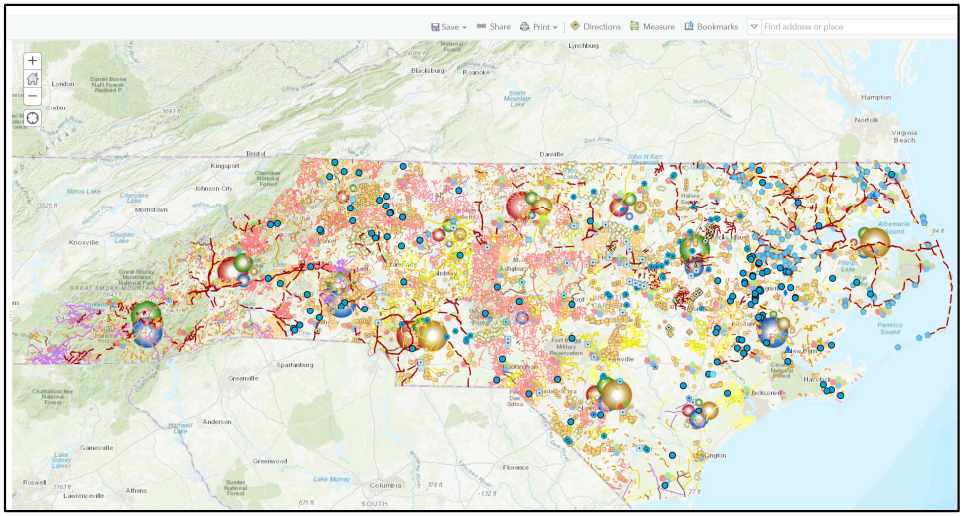
Cost Capture – Continuous Process Improvement

- Continue to review ideas to simplify cost capture process
- Review management system process changes / latest technology
  - Automated capture – Tablets / Phones
  - New tools – SAP
- Pre-Populate Time Entry Documents – Auto populate SAP from MMS
- Combining processes to prevent loss of data (combining CARS & Work Orders processes)
- Combining capture of employee time / equipment hours with Work Order creation
- Reviewing/Adding to Work Activity lists that require Work Orders

NCDOT – Cost Capture – Lesson Learned

Lessons Learned

- Make Cost Capture Easy – Think purchasing something online
  - Automate as much as possible (RFID, Bar Code, GPS location, etc.)
- Keep your goal in mind – Map!
  - Data Granularity alignment (asset level, road, etc.)
  - Input = Output
  - Don't capture unless you need it!
- Create data validation processes
  - Compare SAP to MMS – Good for both Systems
  - Improve data transparency –
    - More eyes = Additional validation
- Capture data as soon as possible
  - Data in field as it is occurring



Thank you!

TRB Webinar: Capturing and Integrating Cost Data into Maintenance Management Systems

Implementing cost interfaces in WV MMS

Christopher Chau, P.Eng
Deighton Associates Limited

September 26, 2024

Agenda

- Project Background
- Implementation Details
- Lessons Learned

Project Goal

Create a state-of-the-art Transportation Asset Management System (TAMS)

- *Expand* existing dTIMS implementation and establish a comprehensive Asset Registry “TAI” that is integrated with the LRS
- *Replace* MMS functionalities in REMIS with dTIMS OM that is integrated with the state’s financial system “wvOASIS”

…to further the mission of data driven asset management at WVDOT

state-of-the-*art*

Expand existing dTIMS implementation and establish a comprehensive Asset Registry "TAI" that is integrated with the LRS

- Integrate the LRS in dTIMS with R&H
- Synchronize LRS changes from R&H into dTIMS
- Locate assets on the LRS when appropriate

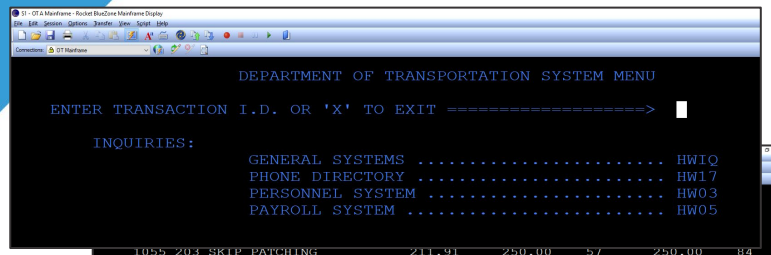
The underlying goal is to enable an asset-based approach to maintenance management.

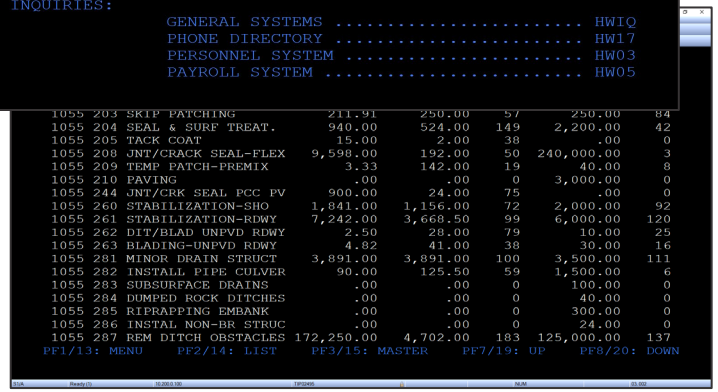
state-of-the-*art*

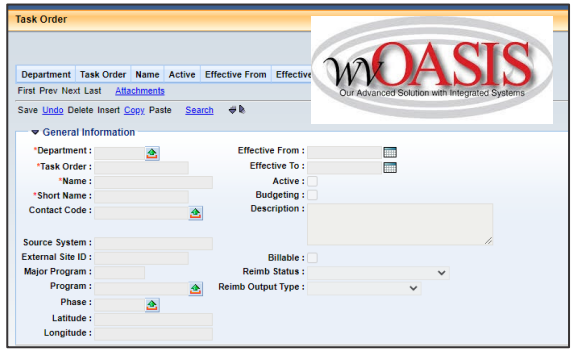
Replacement of the MMS functionalities in REMIS with dTIMS OM that is integrated with the state's financial system "wvOASIS"

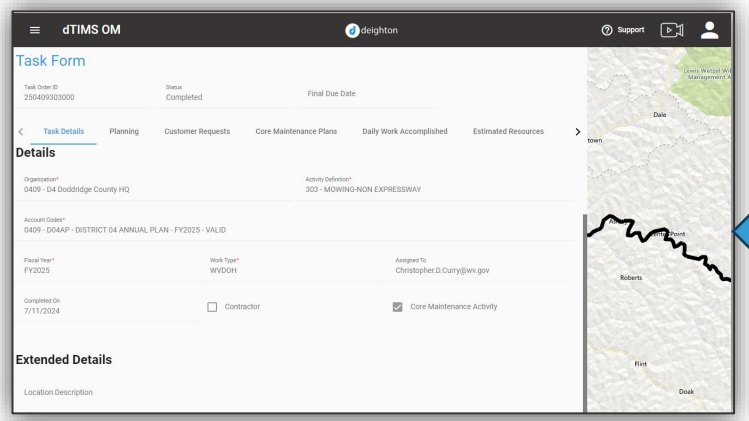
- Configure and enhance the dTIMS OM module
- Track activities
  - Against assets / network location, Against maintenance needs.
- Provide activity estimates
  - Based on statewide and/or localized Performance Standards.
- Capture and centralize actual costs of maintenance activities
  - Including Labor, Equipment, Material, and *Other* costs via data interfaces / data integrations.
- Integrated with wvOASIS
  - System Integration via Web Services where available.
  - Data Integration via other methods where possible.

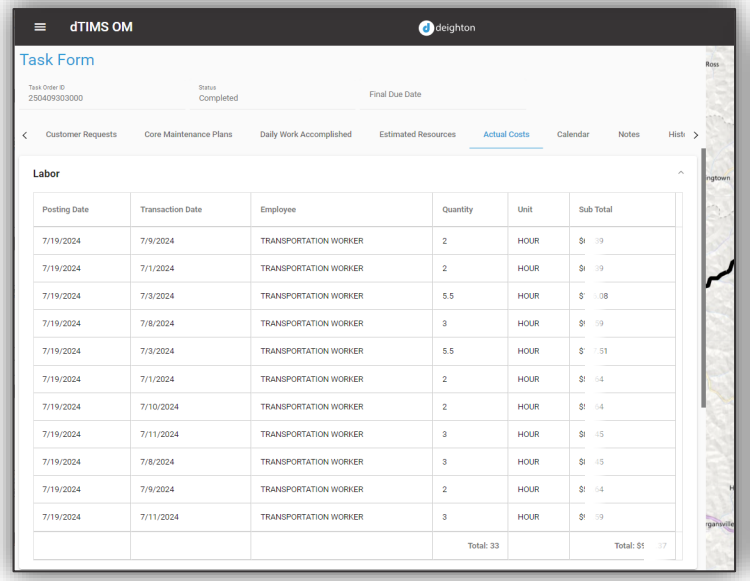
Project Overview

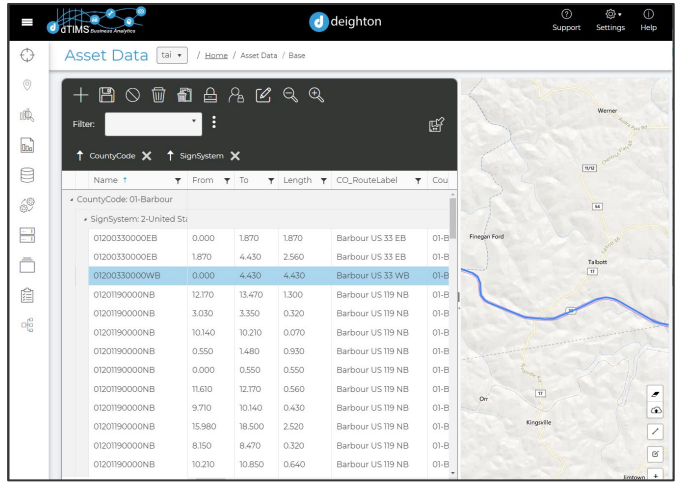


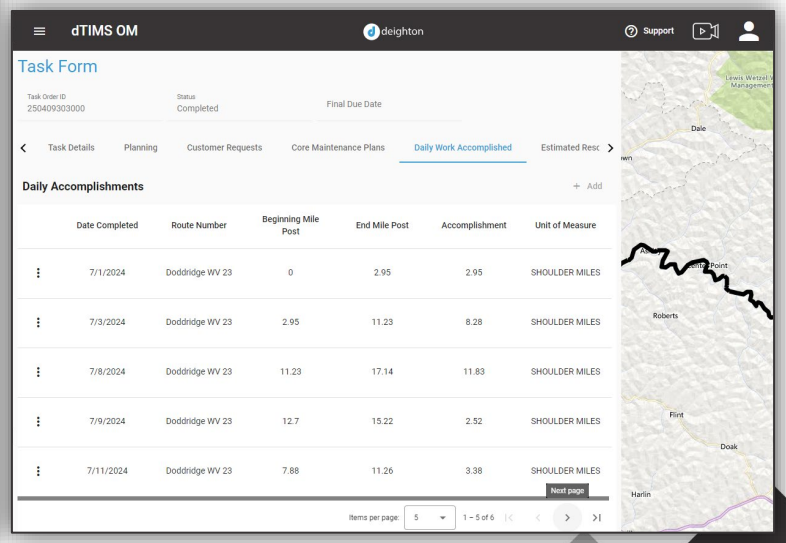












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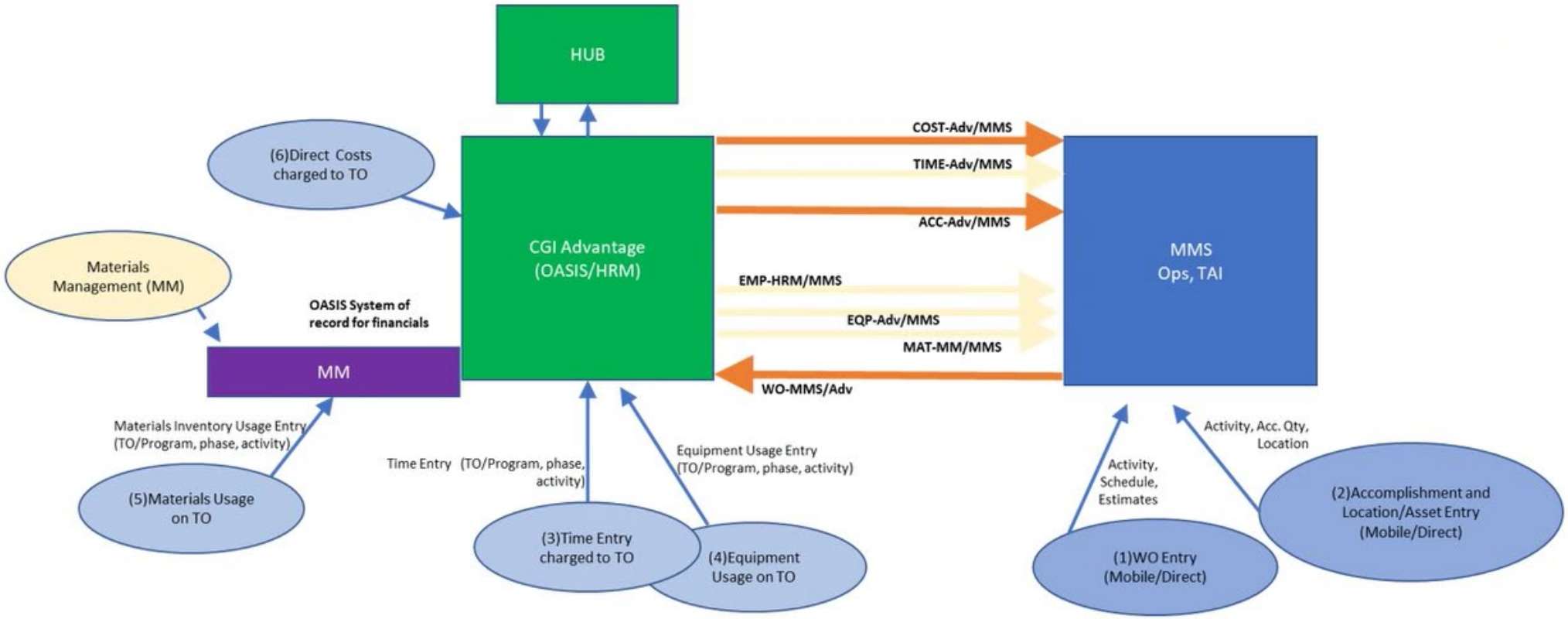
Cost Interface: Vision/Concept



Assumed Interfaces to Support Closing of Work in MMS, Mott MacDonald, 2020

Integration Interface Goals

- Ensure all costs incurred on Task Orders are tracked back into the MMS
- Consolidate actual costs of maintenance activities from the various pathways (Labor, Equipment, Materials, *Other*)
- Support the transition from Activity-based to Asset-based maintenance management
- Provide ground truth data to support the continuous improvement of maintenance activity performance standards

Systems Overview

CGI Advantage Financial

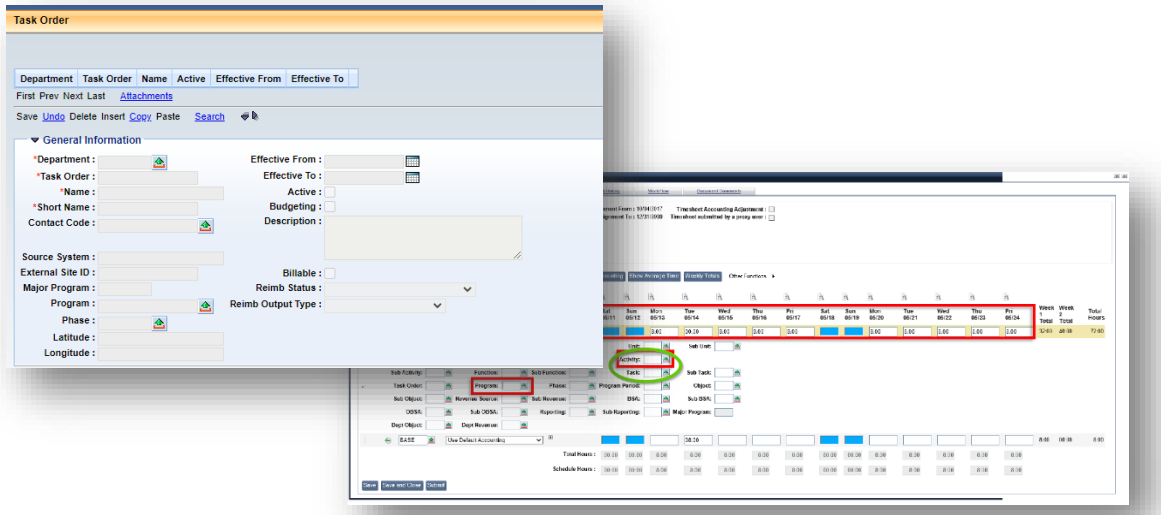
CGI Advantage HRM

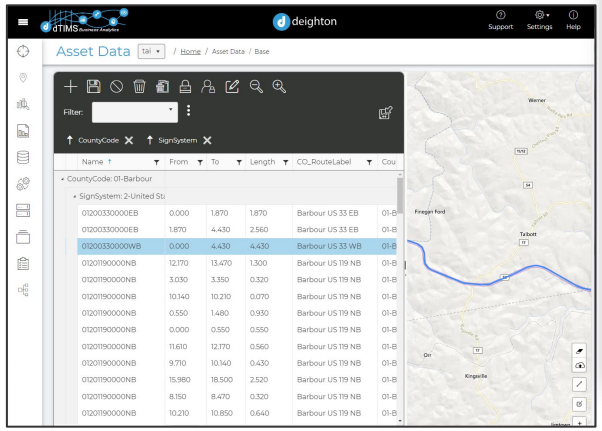
wvOASIS

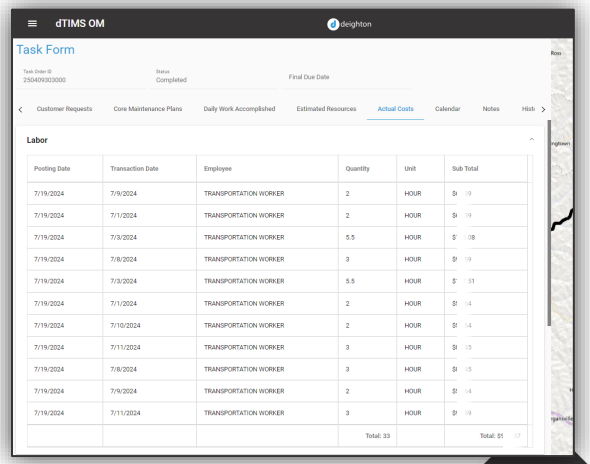
dTIMS — Transportation Asset Inventory
Temporal LRS, R&H Integration

dTIMS OM — Maintenance Management System

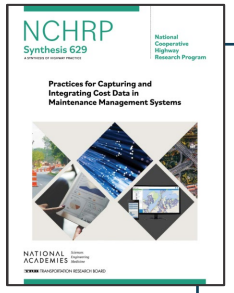
dTIMS BA — Pavement Management System
Bridge Management System



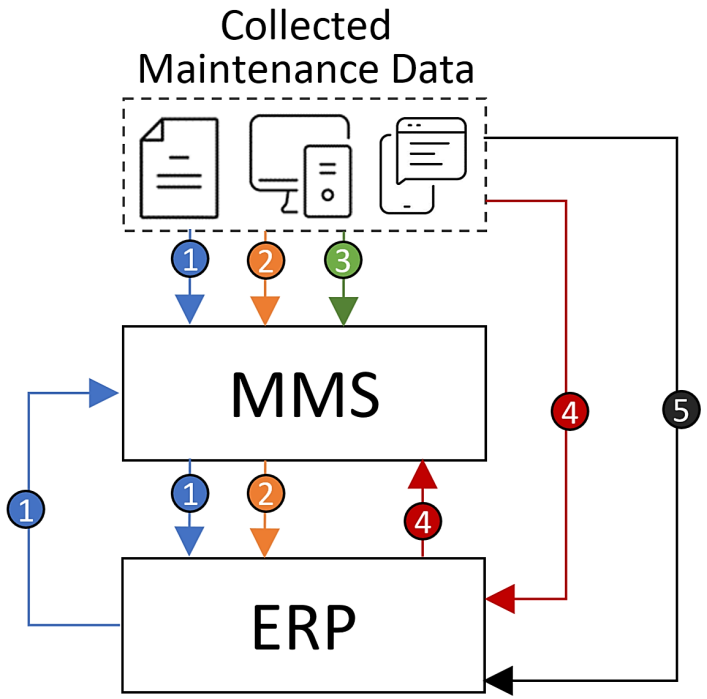




Data/Interface Path



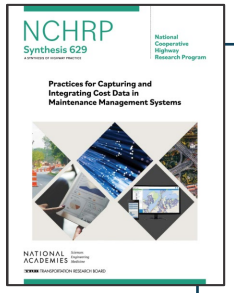
Data Recording and Interface Paths illustrating the six potential options from initial entry to possible interfacing scenarios



- ⓪ 0- Not recorded in MMS or ERP at all
- 1 1- First recorded in MMS, next costed in ERP, and finally interfaced back to MMS
- 2 2- First recorded in MMS, then interfaced with ERP
- 3 3- First recorded in MMS, then NOT interfaced with ERP
- 4 4- First recorded in ERP, then interfaced with MMS
- 5 5- First recorded in ERP, then NOT interfaced with MMS

National Academies of Sciences, Engineering, and Medicine. 2024. *Practices for Capturing and Integrating Cost Data in Maintenance Management Systems*. Washington, DC: The National Academies Press. https://doi.org/10.17226/27810.

Project Data/Interface Path



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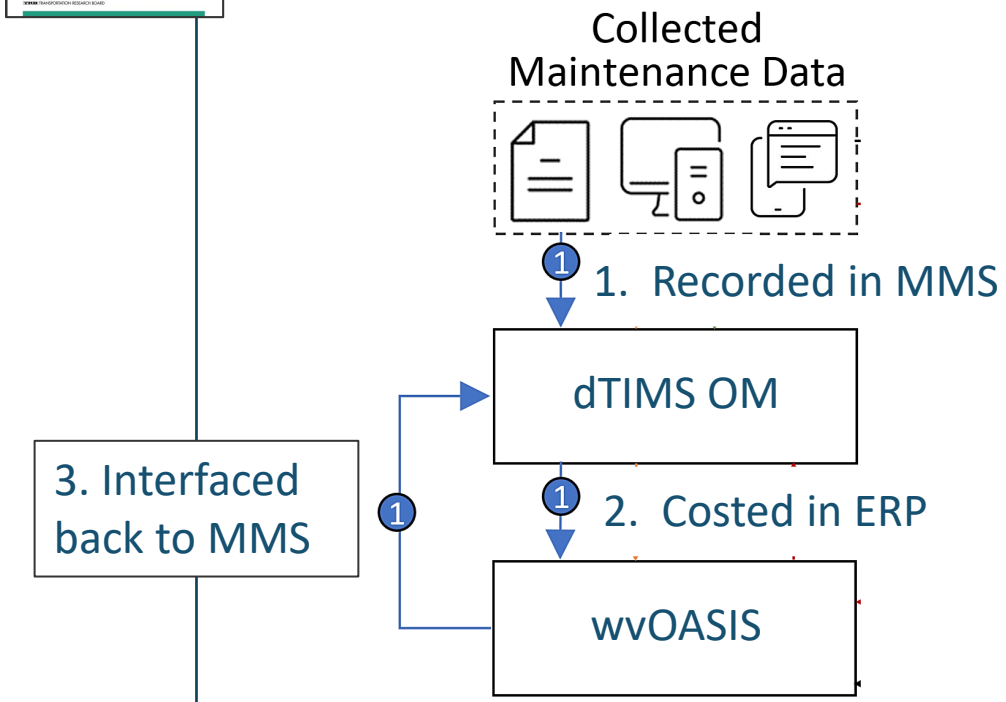

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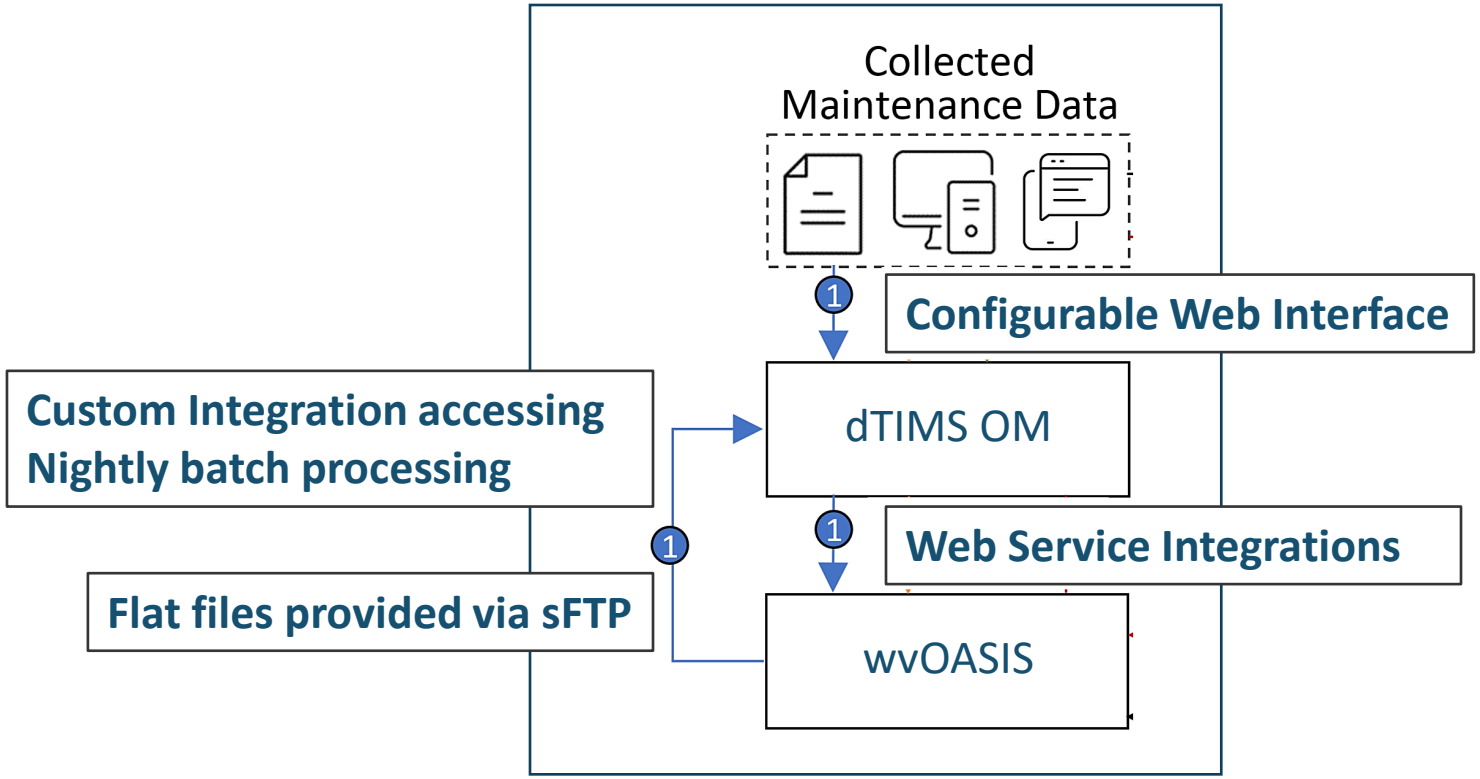
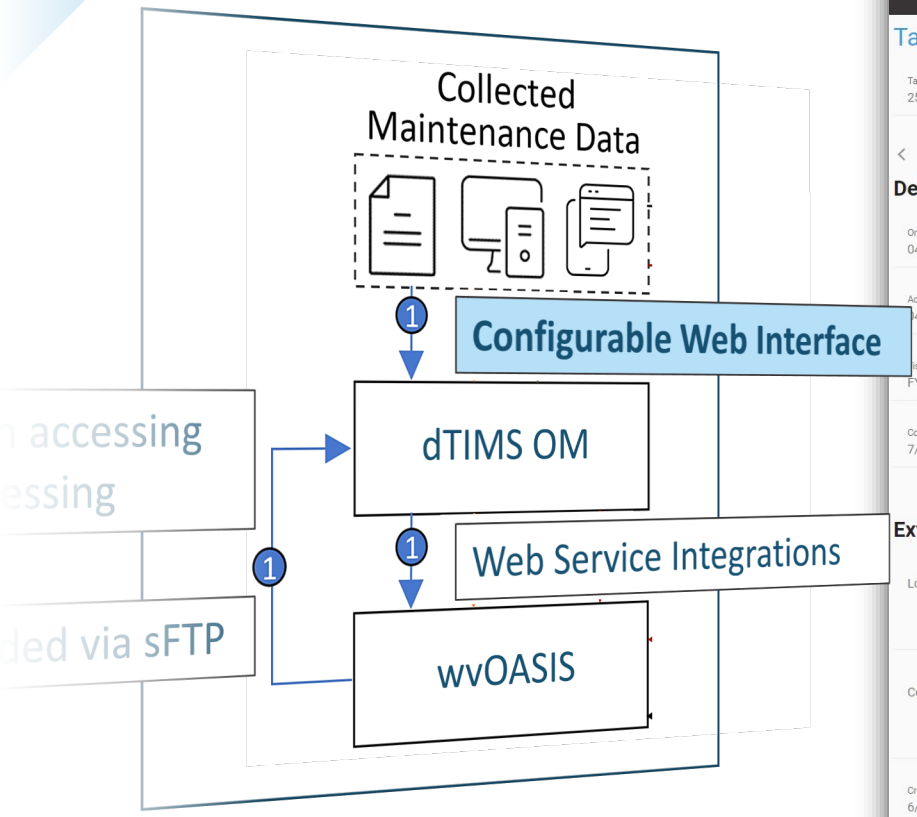
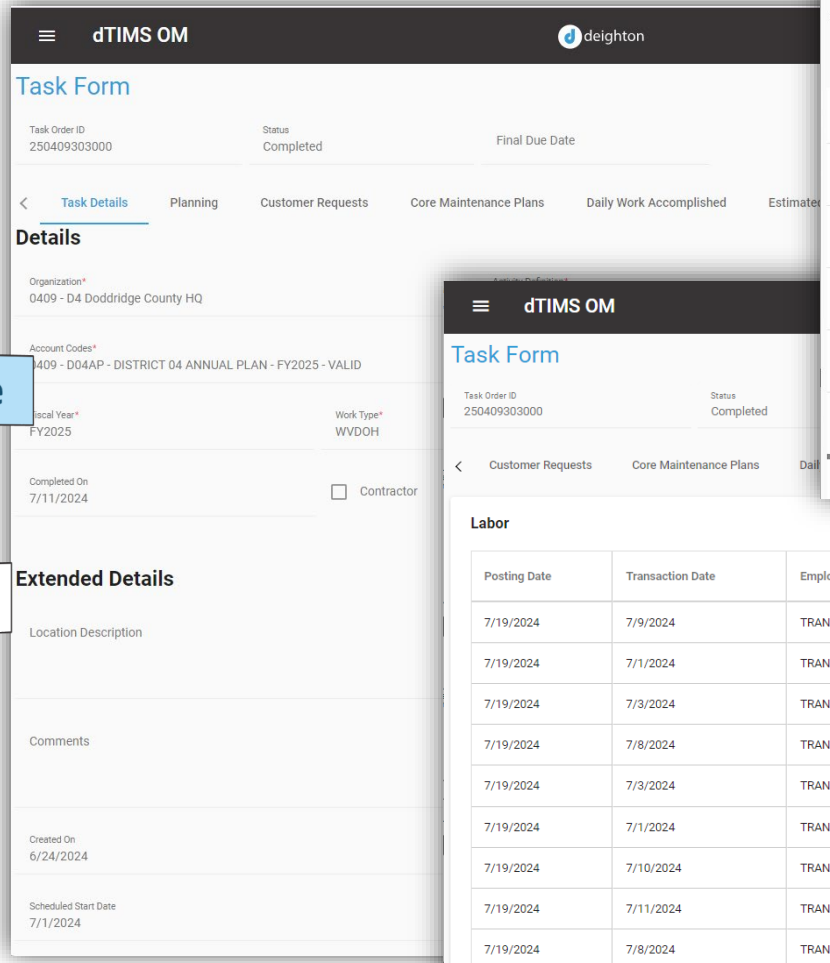
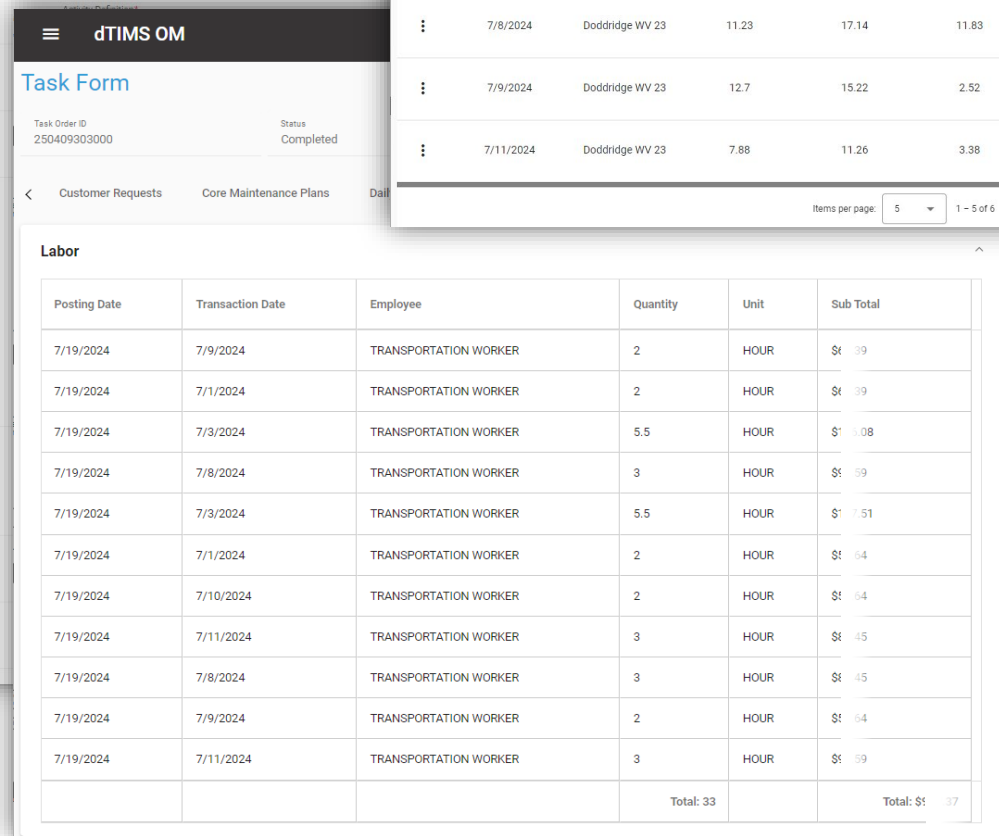
Phase 1 Implementation

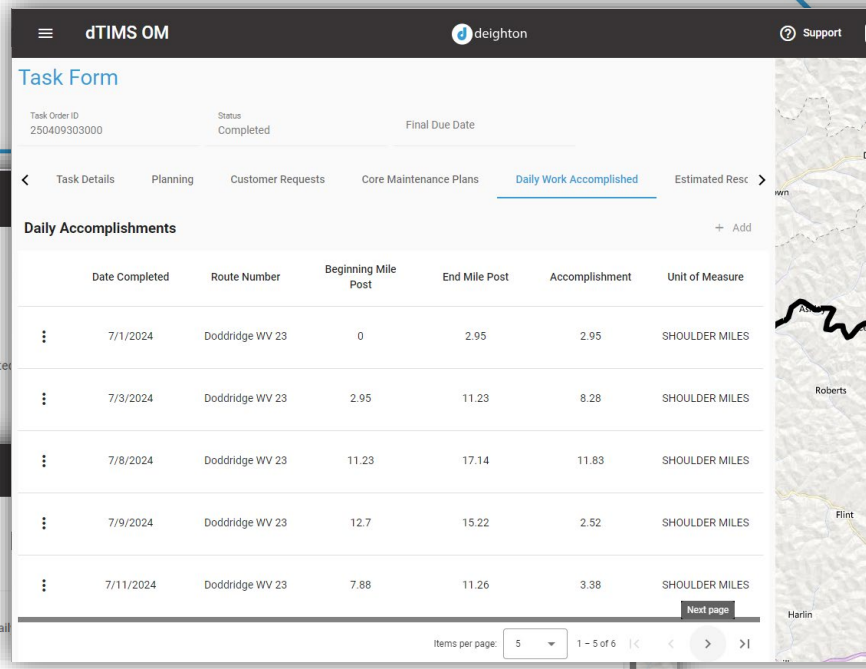


Interface Details









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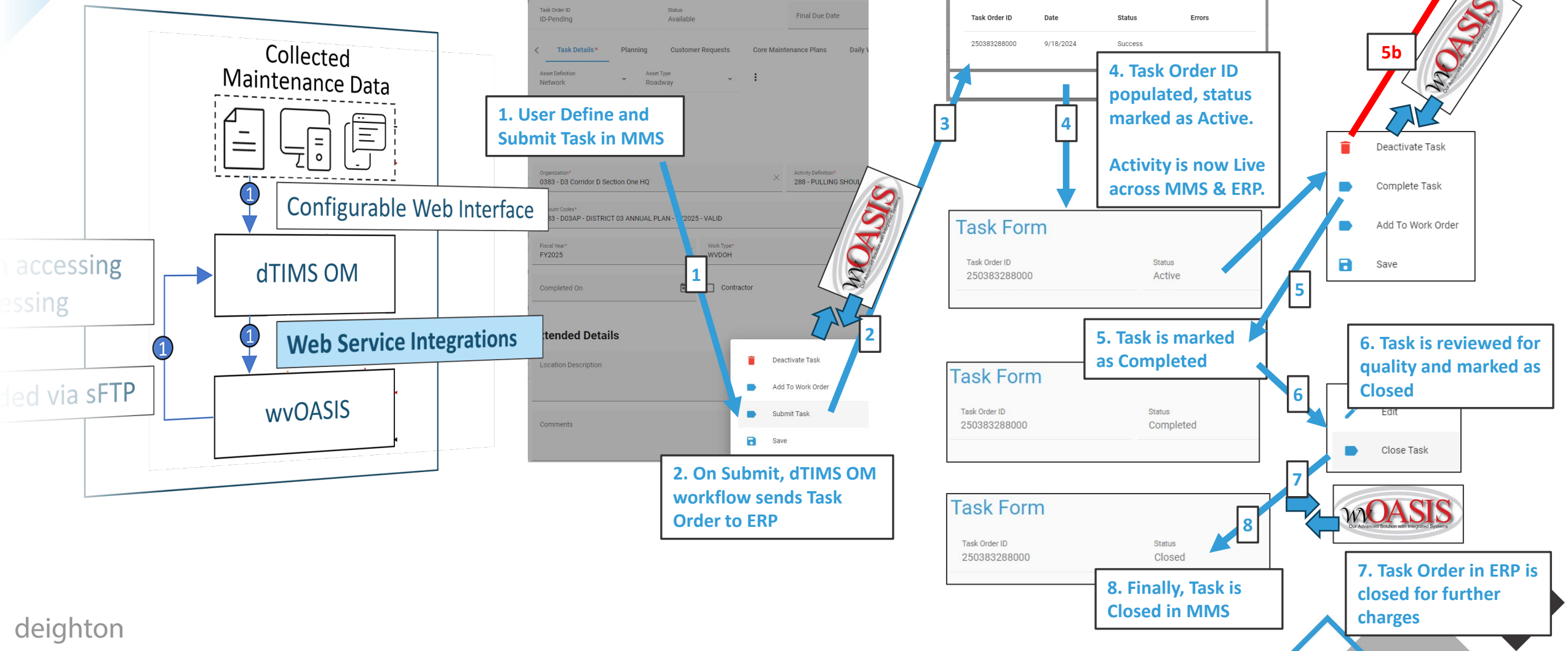
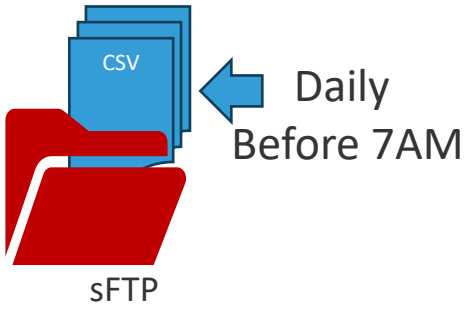
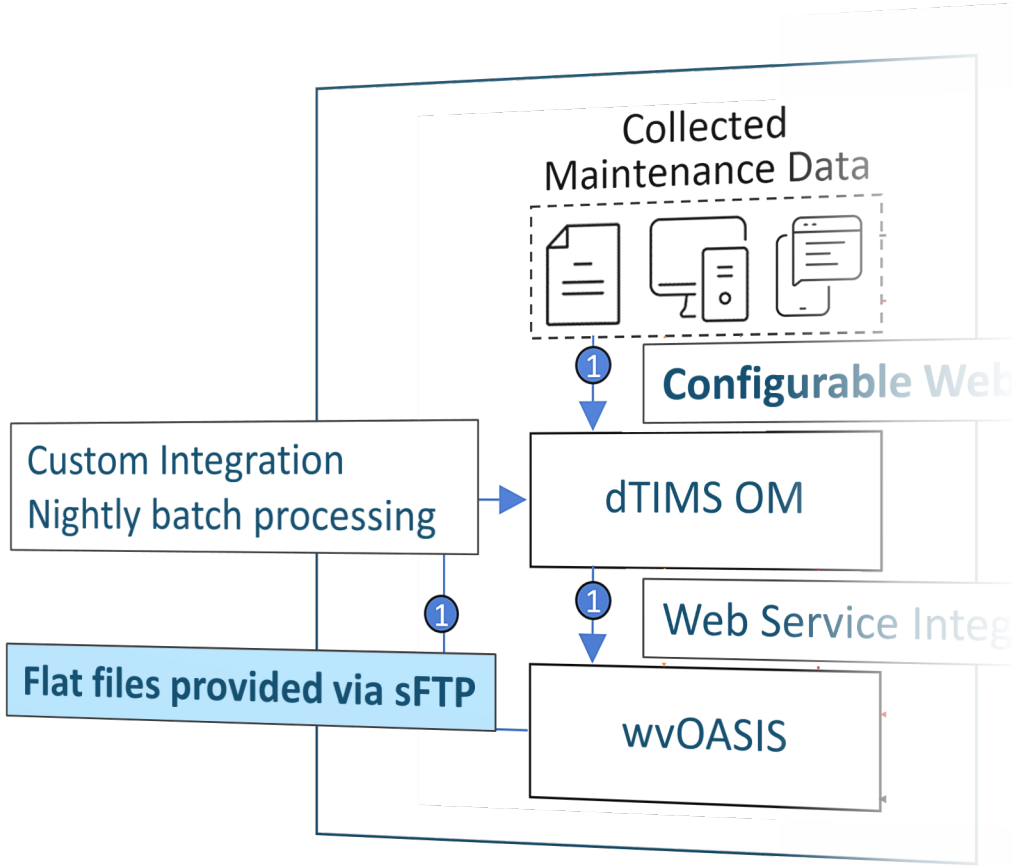


Interface Details

wvOASIS



- (ACC) Account Codes and Relationships
- (EMP) Employee List
- (EQP) Equipment List
- (MAT) Material Inventory List
- (COST_PYRL) Payroll Cost
- (COST FIN) Equipment and Material Transactions



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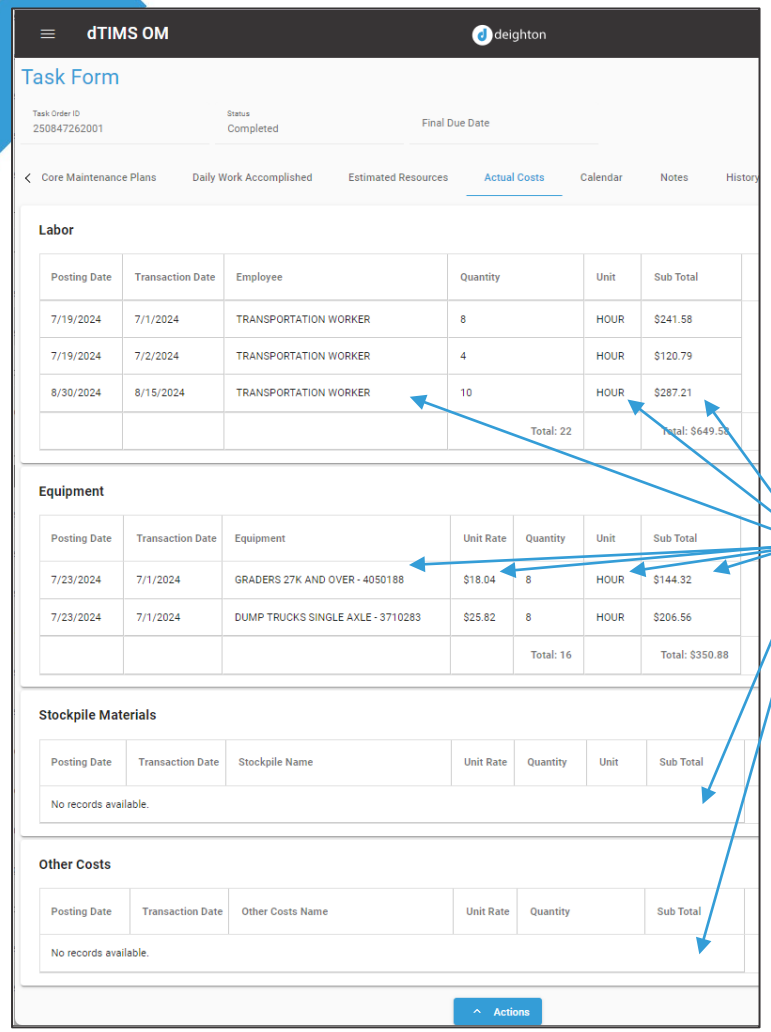
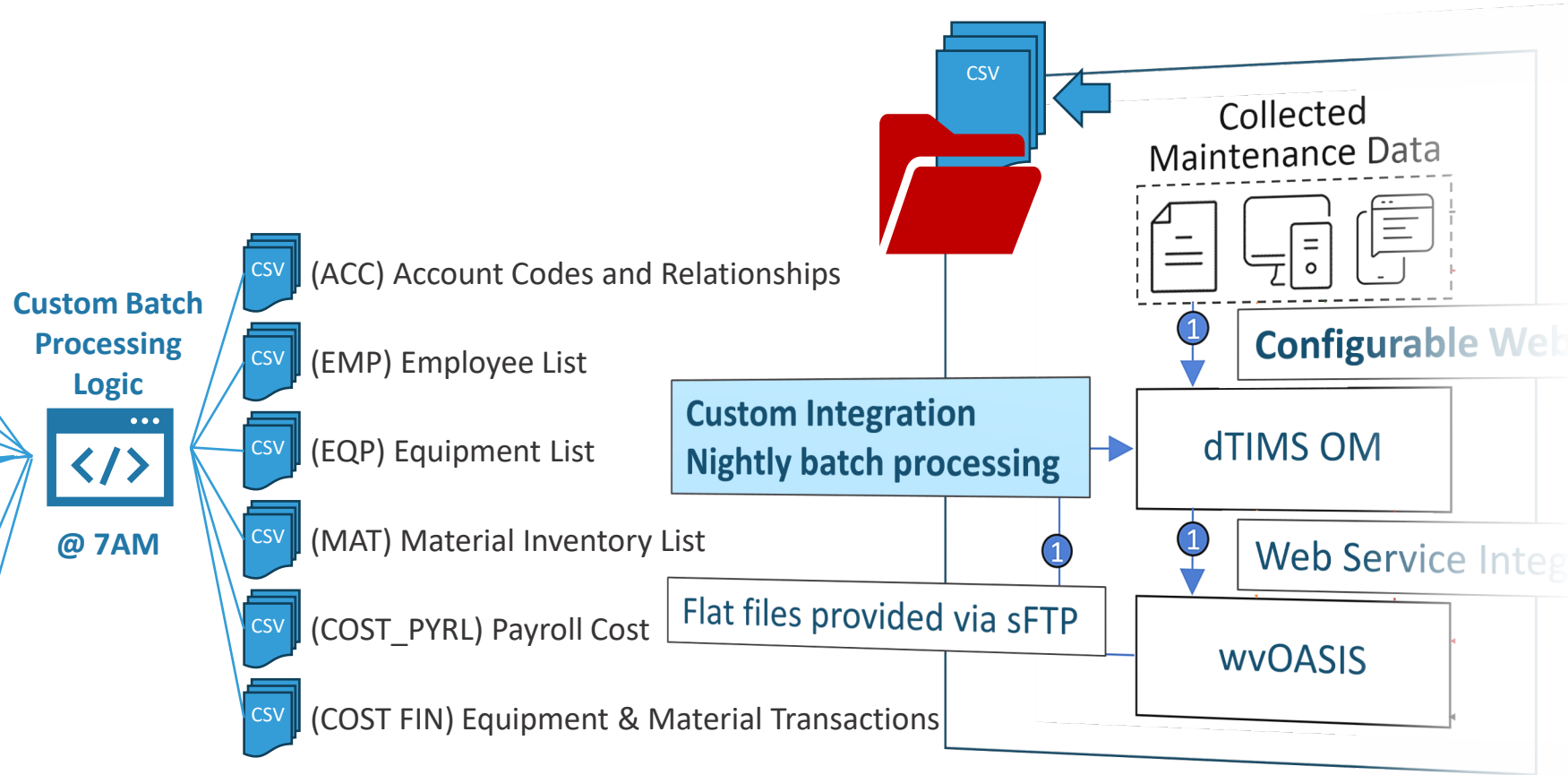




Things to Consider

Cost Interfaces – Things to Consider

Dedicated MMS Implementation Team

- Consider
  - Clear mandate
  - Institutional knowledge of your DOT and maintenance department
  - OCM skills: Cross functional coordination, Presentation, Training
  - Access to experienced ERP and MMS Implementation experts
  - Access to the implementers/developers of the financial system
  - Visibility into other activities around the ERP

Cost Interfaces – Things to Consider

Collaboration Environment

- Consider
  - Establishing a holistic development environment early
  - Test early and iteratively push stable functionalities into Staging / Production environment
  - Practice production migration as early as feasible

IT and Data Governance

- Consider
  - Clearly identify data owner, stewards, and consumers
  - Ensure SOPs are updated to reflect required modification to master data
  - Be sensible around private information, even if it is publicly available

Cost Interfaces – Things to Consider

Requirements Analysis and Design

- Consider
  - Internally collate Use Cases/User stories with data samples from multiple districts / area
  - Invest in the development of real-world test data and test scenarios as early as possible
  - Design for failure

Stakeholder Turnover

- Consider
  - Phased/Iterative approach with clear goals for each phase
  - Formally capture stakeholder comments in project documentation
  - Practice feature rollout and release often

Cost Interfaces – Things to Consider

COTS Systems Flexibility

- Consider
  - How are unique identifiers handled
  - Ability to customize the data schema to support the integration interfaces
  - Ability to customize the user interface to implement validation logic and calls to web services
  - Ability to incorporate customization into standardized features
  - Does the system expose a modern API

Interface or Integrate

- Consider
  - System capabilities
  - Time criticality
  - Payroll cycles

Cost Interfaces – Things to Consider

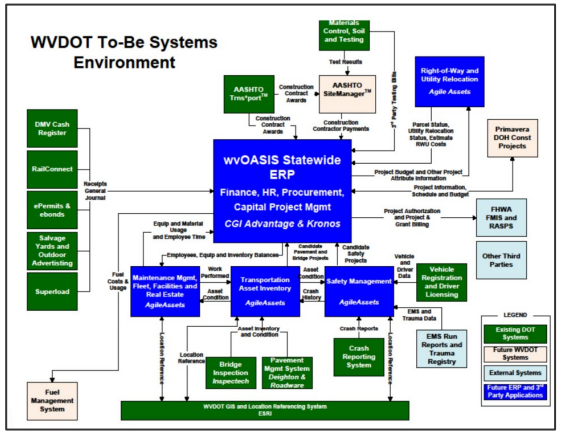
“Out of the box” vs Custom Integration

- Consider
  - Support for updates/lack of updates when the ERP / MMS receive updates in the future
  - Ongoing maintenance/enhancement capability vs cost

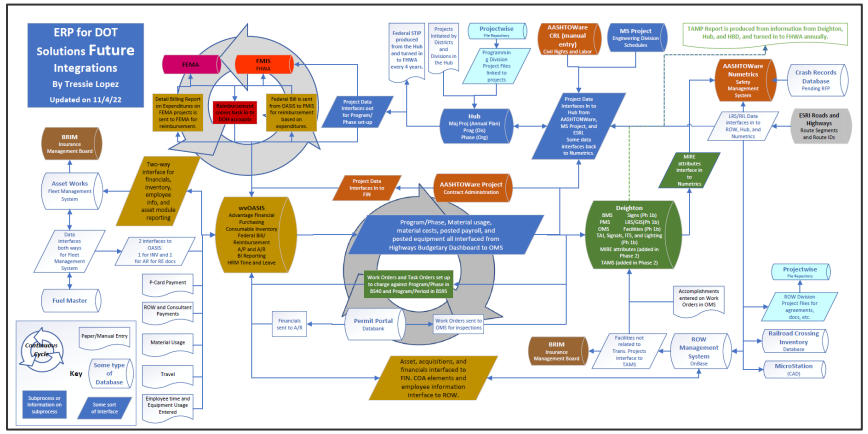
User Experience

- Consider
  - Eliminate “Double Entry” where possible
  - Reduce the need for a user to be in two systems
  - Eliminate round-trips between systems where possible
  - Visualize the integrated data via Map views, Dashboards

Embrace Continuous Improvement



WVDOT ERP Integrations Plan in 2014



WVDOT ERP Integrations Plan in 2022

Do:

- Include future ambitions in plans
- Update, Review, Publish plans regularly
- Plan, test and practice system upgrades
- Design interfaces to be low-coupling

Don't:

- Mix current needs with anticipated needs
- Leave plans in "Perpetual Draft"
- Ignore system upgrades and security patches
- Over-design interfaces to future proof

Thank you!

Contact:

Christopher Chau

chris.chau@deighton.com

Today's presenters

Omidreza Shoghli
Oshoghli@charlotte.edu
University of North Carolina

Charles Pilson
Charles.Pilson@mottmac.com
Mott MacDonald

Steven Griffith
steve_griffith@royjorgensen.com
Roy Jorgensen Associates, Inc.

Matthew Whitley
Mpwhitley@ncdot.gov
NCDOT

Christopher Chau
Chris.Chau@deighton.com
Deighton Associates Ltd.

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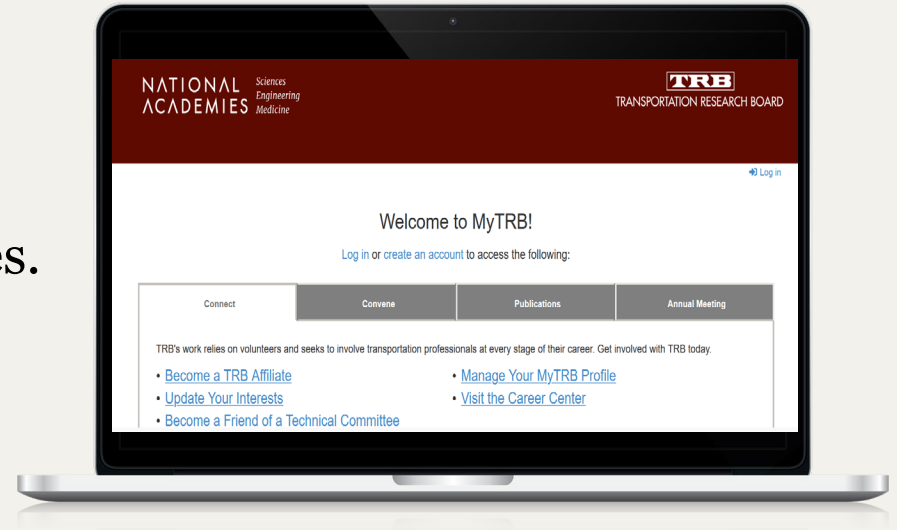

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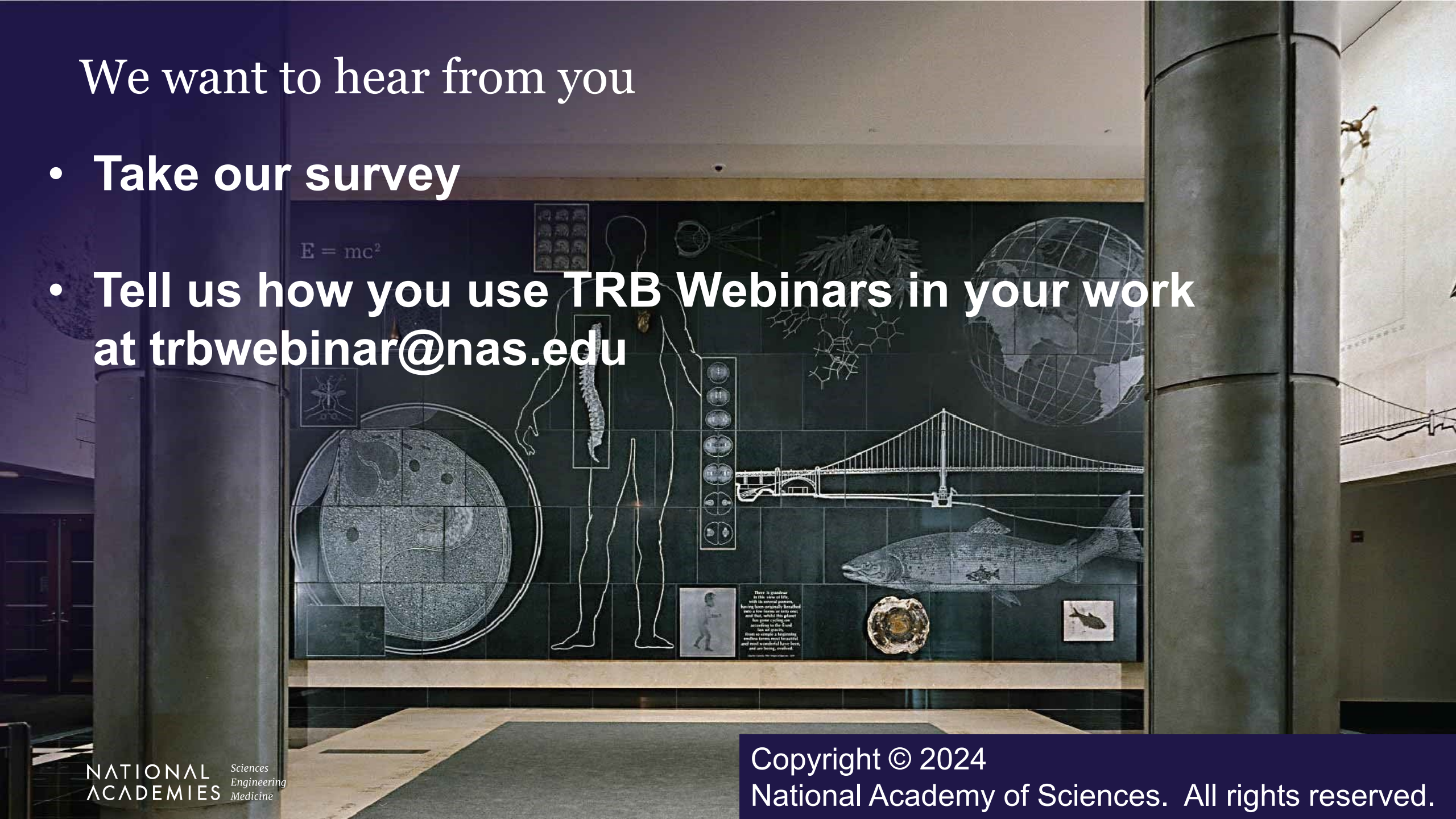

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