
Submitted to:



PERFORMANCE AUDIT OF THE OHIO DEPARTMENT OF TRANSPORTATION

RFP Reference Number: AOS 2019-002

Maintenance Management

September 30, 2020

Submitted by:

The Kercher Group, Inc.

and supported by



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GLOSSARY

AASHTOAmerican Association of State Highway Transportation Officials

AOS Auditor of State

AP..... Administrative Professional

BMS..... Bridge Management System

CAGR..... Compound Annual Growth Rate

CDL.....Commercial Drivers Licenses

CMCounty Manager

CPACapital Programs Administrator

CS..... Element Condition State

CSF Critical Success Factors

DODivision of Operations

DOTDepartment of Transportation

DQMP Data Quality Management Plan

EIMS..... ODOT Maintenance Management System

ELLIS ODOT designed web-based project management application

FC.....Floor Condition

FHWA..... Federal Highway Administration

FYFiscal Year

GAGeneral Appraisal

GARVEE..... Grant Anticipation Revenue Vehicle

GCR General Condition Rating

GIS.....Geographic Information Mapping

HCAPHighway Capital Improvement

HMA..... Highway Maintenance Administrator

HPMS Highway Performance Monitoring System

HT.....Highway Technician

LTPP Long-Term Pavement Performance

MBIManual for Bridge Inspection

MCR Maintenance Condition Rating Manual

MFT..... Motor Fuel Tax

MO.....Office of Maintenance Operations

NBI National Bridge Inventory

NBISNational Bridge Inspection Standards

NCHRP..... National Cooperative Highway Research Project
NHSNational Highway System
ODOT Ohio Department of Transportation
OPEOffice of Pavement Engineering
OSE.....Office of Structural Engineering
PCR..... Pavement Condition Rating
PCS Protective Coating System
PM Program Management
PMS..... Pavement Management System
RPM Raised Reflective Markers
STIP State Transportation Improvement Program
TA..... Transportation Administrator
TAM Transportation Asset Management
TAMP Transportation Asset Management Plan
TM..... Transportation Manager
TP Transportation Policy Division
TPM..... Transition Probability Matrices
VMT Vehicle Miles Traveled
WGA..... Weighted General Appraisal

MAINTENANCE MANAGEMENT

Executive Summary

The Kercher/PFM consulting team (Kercher) is pleased to provide this performance audit report on the Ohio Department of Transportation's (ODOT) maintenance management program. The report covers Kercher's review of the ODOT central office and field maintenance operations and management program to determine the extent to which the agency applies nationally recognized asset management practices in its development and delivery. Kercher also examined the maintenance program to determine how effectively ODOT's asset management plans and policies influence decisions made by ODOT management and the 12 districts in the following areas:

- Organizational approach, objectives, performance measures, resource allocation, and field oversight
- Collection and analysis of roadway asset condition data
- Processes for the following areas:
 - Setting maintenance targets
 - Allocating resources
 - Linking work performed to performance objectives
 - Cost control
 - Continuous process improvement

Major Findings

Kercher's analysis of the ODOT Maintenance Management program found the following:

- ODOT maintenance personnel actively participated in project interviews and are supportive of improved assessment methodologies for determining maintenance conditions and identifying deficiencies so that the roadway network is kept in good condition.
- Maintenance managers across all districts are consistently inspecting their roads every two weeks to record and take corrective action on any deficiencies found.
- Capital maintenance planning is performed annually and coordinated between ODOT headquarters and districts.

However,

- ODOT lags peer states in leveraging the benefits of a computerized maintenance management system that could improve analysis and reporting of costs associated with routine maintenance activities.
- ODOT cannot compare its costs for conducting maintenance work in-house compared to the cost of hiring contractors to perform maintenance although peer states easily and routinely make such comparisons.
- ODOT lacks maintenance performance measures for some assets although such performance measures existed in the past in ODOT and were also found to be used by the peer states.
- ODOT invested several million dollars into a computerized maintenance management system which it only partially uses and which it now plans to replace.

- Peer states have successfully implemented the same maintenance management system currently used by ODOT.

Major Recommendations

- *Do not abandon the existing maintenance management system (EIMS) but instead note lessons learned from its peer states on how best to configure and leverage its existing maintenance management system tools.*
- *Ensure the maintenance management system captures the costs of maintenance activities and allows analysis of the most economical means for conducting highway maintenance.*
- *Restart, strengthen and enhance the Maintenance Condition Rating (MCR) program.*
- *Undertake a resource allocation study to ensure that the allocation of highway technician resources is properly balanced to achieve both maintenance and construction objectives.*

Introduction

The Kercher/PFM consulting team (Kercher) is pleased to provide this performance audit report on the Ohio Department of Transportation's (ODOT) maintenance management program. This document is one of three (3) such reports (the others covering the pavement and bridge functions of ODOT) produced by the Kercher team under contract to the Ohio Auditor of State (AOS). These reports are components of a comprehensive performance audit of ODOT being performed in compliance with HB 62 of the 133rd General Assembly of Ohio.

The report covers Kercher's review of the ODOT maintenance management program to determine the extent to which the agency applies nationally recognized asset management practices in its development and delivery. Kercher also examined the extent to which ODOT's asset management plans and policies are put into effect and influence decisions made by ODOT management and the 12 districts in the following areas:

- Organizational approach, objectives, performance measures, resource allocation, and field oversight
- Collection and analysis of roadway asset condition data
- Processes for the following areas:
 - Setting maintenance target
 - Allocating resources
 - Linking work performed to performance objectives
 - Cost control
 - Continuous process improvement

Approach

The Kercher team used the following, common approach in performing the respective performance audit reports:

- Performed a baseline analysis of ODOT
- Identified and interviewed a sample of peer states
- Reviewed topic reference resources for best practice guidance/information
- Benchmarked ODOT against peer state practices and best practice guidance
- Identified potential practice improvement opportunities considered applicable to ODOT
- Provided results of the benchmarking exercise
- Recommended practice changes (if any) and identified potential benefits

Kercher produced this report in three (3) stages and a final report as described below:

1. ODOT Baseline Task
2. Peer State / Best Practice Task
3. Draft Final Report
4. Final Report

ODOT provided comments to the baseline and draft final reports. Kercher addressed these comments as appropriate when creating additional report content; report drafts included additional refinements of previously submitted information.

Report Organization

This report is organized around the review areas identified in the request for proposal (RFP) for this project. This design was intended to simplify efforts to find specific areas of interest.

Within each topic area, the report generally is organized around the following headings:

1. Topic Introduction
2. Baseline Task
3. Peer State / Best Practice Review
4. Analysis
5. Recommendations and Anticipated Benefits

This following text provides a general introduction to each of the heading areas. Specific information related to each of these headings is found in each review area.

Topic Introduction

In each review area, Kercher describes the significance of the subject to the overall performance of the ODOT program. This discussion is intended to provide context for comparing the ODOT approach in each practice area to peers and best practice.

Baseline Task

Kercher carried out the baseline phase of the audit by conducting interviews with the ODOT Director of Operations, the Maintenance Operations Unit Director and district management staff who are involved with the maintenance program. This review included considerable effort to understand how the maintenance program is planned and executed and how performance or outcomes are measured and reported a statewide and district level. Details on the performance measures are found in Section A. This information was vetted with ODOT as part of the report review process and served as basis for the peer state/best practice review process described below.

Peer State / Best Practice Review

The Kercher team identified a subset of states for the maintenance review task, based on proximity to Ohio, environmental similarities, and related considerations (size of system, etc.) From this initial candidate list, the following six (6) states were selected:

1. Indiana
2. Kentucky
3. Michigan
4. Minnesota
5. New York
6. North Carolina

Table 1 provides some comparative highway statistics for ODOT and the peer states being used for benchmarking. The “data source” designation identified in Table 1 corresponds with the FHWA website

data naming used. This information is derived from the most current, comparative 50-state data available from the FHWA website at the time of this project (2018).¹

NOTE: In other sections of this report, some of the data in the table below has slightly different values identified. These variances correspond with the data source and the date of the information. All data sources are footnoted or otherwise cited.

Table 1: Comparative Highway Statistics

Data Source / Measure Type	Ohio	Indiana	Kentucky	Michigan	Minnesota	New York	North Carolina
<i>4.4.3.2. Length by ownership</i> National Highway System HM40, Centerline Miles	5,160	3,545	3,268	5,244	5,173	6,055	5,622
<i>4.4.3.4. Lane-miles by functional system,</i> National Highway System, HM43 Lane Miles by Functional System	21,784	13,170	12,424	22,437	16,078	26,804	21,521
<i>4.4.6.1. Estimated length by functional system,</i> State highway agency-owned public roads HM80, Length by Functional System	19,249	11,135	27,671	9,676	11,733	15,079	80,011
<i>4.4.6.2. Estimated lane-miles,</i> State highway agency-owned public roads, HM81, Estimated lane-miles							
MILES	19,249	11,135	27,671	9,676	11,733	15,079	80,011
LANE-MILES	49,636	28,752	62,216	27,444	29,240	38,152	172,887
DVMT ²	196,007	108,423	107,835	148,639	95,448	165,525	246,969
AADT ³ /LANE	3,949	3,771	1,733	5,416	3,264	4,339	1,428

Kercher conducted this outreach via a series of phone and virtual interviews conducted over a period of several weeks. Each interview averaged between 1-2 hours, following a prepared interview guide that was provided to each DOT in advance of the call.

The ODOT Director assisted in encouraging these states to participate in this effort by writing a letter to his counterpart at each DOT. This assistance significantly helped in gathering this information.

In addition to the time spent directly participating in the interview, most state participants required some level of preparation time. In many cases, additional phone calls and/or emails were used to provide

¹ FHWA Highway Statistics 2018, website:
<https://www.fhwa.dot.gov/policyinformation/statistics/2018/index.cfm>

² Daily Vehicle Miles Traveled

³ Annual Average Daily Traffic

supplemental information. Not every DOT was able to answer all questions but even an inability to provide an answer was meaningful within the context of this benchmarking effort.

Participating DOTs were offered a copy of the peer states information gather through this effort. This information is summarized in **Appendix A**.

Kercher also considered relevant guidance information from AASHTO, FHWA, NCHRP or resources related to these areas. The consulting team used its professional judgement in identifying applicable best practice in these review areas.

In each of the review areas in this document, the “Peer State / Best Practice” sections identify practices that the consulting team perceived as being of particular interest and relevance to the benchmarking effort.

Analysis

The Analysis section contains Kercher’s comparative comments and analysis of current ODOT practices to the peer states and other guidance materials examined. This information is intended to provide the support basis for the subsequent project recommendations and benefits.

Recommendations and Benefits

Kercher identified any recommended changes in these sections. In cases where ODOT already is employing best practice, the team’s recommendation indicates that ODOT should continue accordingly. In cases where Kercher perceives that ODOT could benefit from change, the appropriate recommendation is identified along with the anticipated benefit of this change.

A. Performance Approach

Topic Introduction

The Ohio Department of Transportation (ODOT) owns, operates and maintains a variety of transportation infrastructure assets to support its mission. Maintenance management at ODOT involves performing a range of routine and preventive activities designed to ensure serviceability, extend the life, and maximize the performance of these assets.

ODOT estimates that districts self-perform 80-95%⁴⁴ of routine highway maintenance activities using its internal workforce while outsourcing the remaining percentage to local contractors. The scope of work for this project identified the following subset of maintenance activities for review:

1. Drainage maintenance
2. Pavement markings
3. Signs
4. Protective barrier
5. Shoulders
6. Pavement patching and crack sealing
7. Vegetative control
8. Litter collection

⁴⁴ Based on interviews with ODOT district maintenance personnel

Note: Snow and ice operations (winter maintenance) were not included in this scope of work as were other areas such as emergency operations, etc.

The Ohio Department of Transportation (ODOT) makes significant investments to maintain its roadway network facilities. Assuring the long-term operation of these investments is critical to maintaining infrastructure asset value for stakeholders and users.

ODOT Baseline

To identify ODOT's baseline status in each of the maintenance areas identified for review, Kercher performed a combination of document/data review and outreach to ODOT personnel. This outreach included conducting virtual interviews with representatives from ODOT's Division of Operations (DO) as well as multiple outreach efforts to the twelve (12) ODOT districts.

Central Office Interviews

Kercher jointly interviewed central office-based representatives from the DO that are involved in planning and supporting ODOT field operations. The Office of Maintenance Operations (MO) reports to the DO and has primary responsibility for statewide maintenance programs. The MO also provides operational guidance to the districts, which report up through the Assistant Director of Field Operations.

Kercher also conducted interviews with the Assistant Director of Field Operations and the Assistant Director of Transportation Policy/Chief Engineer, among others.

District Interviews

Kercher conducted separate interviews with staff from each of ODOT's districts. Kercher provided advance copies of the interview questions to ODOT personnel. All District Highway Maintenance Administrators (HMA) were interviewed and most districts also included as many as three (3) additional staff members such as County Managers in the sessions. Interviews were scheduled for two (2) hours.

In some cases, districts provided written responses to compliment interview discussions. Otherwise, the consulting team captured ODOT responses in notes. Interviews frequently required additional emails and/or phone calls to clarify comments.

This outreach effort resulted in capturing a significant volume of detailed notes. This information provided the basis for much of the information used in the maintenance activity review discussions that follow.

Internet Survey

Kercher created and used an Internet-based survey to supplement the interview efforts described above. This survey tool targeted the district-based personnel most directly involved in managing ODOT's district maintenance management: Highway Maintenance Administrators (HMA) and County Managers (CM). ODOT was encouraged to allow other district-based maintenance supervisory and support personnel to submit responses as preferred.

Kercher committed to providing respondents anonymity in order to encourage unbiased feedback. While the design of this tool supports distinguishing survey responses by the respondents' position and district, no information is used that would allow a specific district or individual to be identified; instead, this information was used to analyze response consistency and/or variance by respondent position and district.

The Kercher team received 77 responses to the 46-question online survey⁵. All 12 districts provided multiple responses, ranging from a low of three (3) responses to a high of 10.

CMs were the largest response group, providing 60 submissions. HMAs supplied 10 responses while the remaining responses included several position titles (identified in the summary results as “Others”).

Essentially, this survey was a self-assessment of the effectiveness ODOT’s maintenance program from the perspective of field maintenance forces. Details on this survey are found in **Appendix B** while a summary of the key points from this survey are found below.

Survey Scoring Methodology

Each of the survey responses was assigned a numerical value in order to sum and calculate an average score for each question by employee classification.

Question 3 was unique in that it used a “A-F” grading scale. The scores associated with this scale is found in Table 2:

Table 2: Letter Grade Scoring Scale

Grade	Score
A	10
B	7
C	5
D	2
F	0

All subsequent questions used a scoring scale that was based on the extent the respondent agreed or disagreed with a statement. This response options and scale used are shown in Table 3:

Table 3: Agree - Disagree Scoring Scale

Response	Score
Strongly Agree	15
Agree	10
Disagree	-10
Strongly Disagree	-15
Do not know / No opinion	0

Survey Analysis

⁵ Copy of the Internet survey questions is attached as

Question 3 was intended to serve as a general assessment of the success of the maintenance management program at each respondent's location. As indicated, this question used a different scoring scale than the other questions.

The text of Question 3 was as follows:

"I would rate the condition and overall maintenance level of service within my jurisdictional area of responsibility as follows (on a scale of "A" being the highest with "F" being the lowest)"

Survey responses to this question were as follows:

Table 4: Overall Assessment of Maintenance Service

	HMA	CM	Others	Grand Total	Question Text
Count	10	60	7	77	Number of Responses
Q3	8.5	7.2	6.7	7.3	I would rate the condition and overall maintenance level of service within my jurisdictional area of responsibility as follows (on a scale of "A" being the highest with "F" being the lowest):

As indicated, HMAs rated the overall maintenance level in their respective areas at 8.5, which translates into an A-/B+. CMs reported a somewhat lower score of 7.2, which is slightly above a B. Interestingly, respondents that were not HMAs or CMs had an average score of 6.7, which roughly corresponds with a B-.

All subsequent questions used the described Agree/Disagree scale. The five (5) questions with the highest composite average agreement scores are indicated in [Table 5](#):

Table 5: Statements with Highest Level of Agreement

	HMA	CM	Others	Grand Total	Question Text
	10	60	7	77	Number of Responses
Q28	13.5	11.5	13.3	11.9	Work activity details and accomplishments are captured daily at the crew level.
Q4	13.0	11.2	13.3	11.6	Agency goals and objectives are clearly communicated to all levels of administrators, managers, and supervisors
Q5	11.5	11.0	12.5	11.2	District Goals and Priorities for the Maintenance Program are clearly communicated.
Q15	10.5	11.1	11.7	11.1	The overall condition of pavements, bridges, conduits and other roadway assets and features is improving within my jurisdictional area of responsibility.
Q23	14.0	10.7	9.2	11.1	The materials needed to accomplish my work program are readily available.

The five (5) questions with the lowest composite average agreement scores are indicated in [Table 6](#):

Table 6: Statements with the Lowest Level of Agreement

	HMA	CM	Others	Grand Total	Question Text
	10	60	7	77	Number of Responses
Q29	(11.0)	(7.9)	(5.8)	(8.2)	Mobile devices are used to enter work activity details and accomplishments.
Q39	(6.0)	(7.3)	(8.0)	(7.1)	I have seen examples of neighboring state maintenance and operations manuals.

Q20	(2.0)	(1.3)	(5.8)	(1.7)	I have sufficient labor resources to satisfactorily accomplish the objectives of the Maintenance Program within my jurisdictional area of responsibility.
Q35	5.0	0.8	(2.0)	1.2	Wide deviations from planned work are examined to determine causes and impacts.
Q43	3.0	1.3	10.0	2.1	Outstanding performance in meeting schedule, quality, and cost objectives is recognized and rewarded.

Survey Summary

Survey responses mostly support the information gathered during interviews. However, in some cases the survey finds some minor disparity between middle and lower management opinions.

HMAs generally had a slightly higher opinion of whether agency goals and objectives are clearly communicated to all levels of administrators, managers, and supervisors than the CMs did. Additionally, there is a slight difference in agreement on if the current organizational structure at the district and central office levels is conducive to effective and efficient management of operations and maintenance. This degree of variance is expected as most organizations lose a certain amount of detail as information and directives are transferred to lower levels.

HMAs generally had a higher opinion of the condition rating and overall maintenance level of service within their jurisdictional area of responsibility than the CMs. However, when examining specific elements such as pavement markings, sign condition, and litter control the CMs generally rated those conditions higher than the HMAs. Interestingly, maintenance responsibility for those same items are generally not the responsibility of the CM with the exception of litter control.

HMAs had a lower opinion of the previous performance standards and method of collecting condition data. This is consistent with the personal interviews with HMAs, where most expressed frustration and disappointment with the past assessment methodology and were looking forward to the new MCA process.

CMs had a lower opinion of believing the overall process for planning and allocating money, labor, equipment, material, and maintenance contracts is reasonable and appropriate. This is understandable as the CMs are one position removed from the overall process and may not have full acceptance of the outcomes.

Both the HMAs and CMs surveyed believe that there are insufficient labor resources to satisfactorily accomplish the objectives of the Maintenance Program. This was consistent with most district interviews.

CMs generally do not perceive that existing work activity codes provide an appropriate level of detail for planning and capturing work accomplished. This contrasted with HMAs opinion of the work activity codes as being appropriate. However, many HMAs expressed in the interviews that activity codes were routinely being analyzed and being modified.

Overall, the survey results served to validate the information gathered during Kercher’s interviews with the districts and the central office.

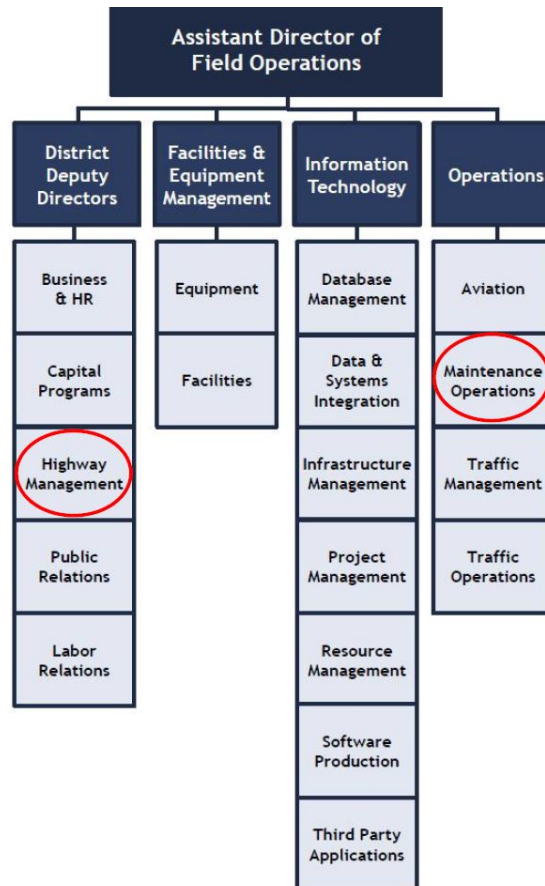
Governance Structure⁶

ODOT Baseline

ODOT maintains its 43,000+ lane miles⁷ of roadway infrastructure using a decentralized organizational approach with (12) districts. The Assistant Director of Field Operations (ADFO) has overall authority for these districts as well as central office divisions with maintenance program responsibilities. The ADFO reports to the ODOT Director.

The ADFO has several direct reports, as indicated in [Figure 1](#). Beyond the 12 District Deputy Directors, the DO, and more specifically the Office of Maintenance Operations, is the ODOT central office group mostly closely involved with supporting ODOT maintenance operations.

Figure 1: Dep Director of Operations Direct Reports⁸



⁶ See 'Combined District Interviews_3_sorted' 'Governance Structure' Questions 1-4

⁷ ODOT Transportation Asset Management Plan (TAMP) website:

<https://www.transportation.ohio.gov/wps/portal/gov/odot/working/publications/asset-management-plan>

⁸ Image extracted from ODOT website:

<http://www.dot.state.oh.us/policy/Pages/ODOTTableofOrganization.aspx>

Division of Operations Maintenance Responsibilities

The DO provides districts with broad parameters for the maintenance program which include guidelines and statewide standards. The MO provides budget management guidance including funding allocations for statewide programs such as equipment purchases, facilities and snow and ice removal to the districts. The MO also oversees the preparation of the 101G contracts, which are utilized to procure all materials for projects (stone, asphalt, fill dirt, concrete, salt).

The MO has established a Maintenance Operations Manual (MOM)⁹ that provides recommendations and guidelines on various maintenance activities, statewide policy and statutes. The MO operates different statewide programs such as salt ordering, salt budgets, GPS/AVL, and pollinator habitats.

The MO schedules and coordinates bi-monthly meetings with all HMAs to discuss macro level policy guidance for maintaining consistency in standards and environmental requirements. The bi-monthly meetings also provide an opportunity for the districts to discuss operational challenges and share maintenance concepts. HMAs meet independently of the MO in alternating months for sessions that are hosted by each of the 12 districts on a rotational basis and which are primarily focused on operational processes.

The MO conducts an annual, comprehensive Transportation Administrator (TA) training class that was originally developed by the district-based Highway Maintenance Administrator (HMA) group. This very popular program has been in existence for 10 years and each district gets about 2-3 training slots per year where TA's are instructed on statewide policies and operational procedures.

Ultimately the districts control the work being done and what materials are used in accordance with ODOT standards and specifications. However, the MO provides guidance and support as needed.

District Maintenance Responsibilities

As stated earlier, ODOT is decentralized with the 12 districts having control of day-to-day operations. HMAs direct district maintenance operations. The districts all have a similar, autonomous governance structure. Districts geographical size ranges from three to nine counties with at least one maintenance garage located in each county.

Some of the larger urban counties have more than one garage and many counties have additional outpost facilities as required to support winter maintenance operations. Outposts are staffed during the winter season and have salt storage and fuel. At least one garage in each county has a County Manager (CM), who reports directly to the HMA.

The HMA along with their CMs develop a work plan and budget for each county garage for maintenance activities that are assigned to crews. Crews are managed by front line managers called Transportation Managers (TM).

TMs schedule and prioritize work assignments with personnel and equipment to form activity crews. Crews are composed of Highway Technicians (HT) and have a lead HT that reports to the TM. A county garage may have anywhere from 16 to 40 personnel assigned specifically to maintenance activities.

HMAs and CMs within the districts have access to the MOM; however, they generally do not reference the manual daily but reportedly reference specific content periodically. The MOM primarily serves as a reference for people new in their positions and is updated by the MO regularly.

⁹ Ohio Maintenance Operations Manual. pdf

Peer State / Best Practice Review

The Kercher team, in consultation with ODOT, selected the following six (6) states for benchmarking maintenance programs with ODOT.

1. Indiana
2. Kentucky
3. Michigan
4. Minnesota
5. North Carolina
6. New York

ODOT commonality with the peer states includes similar commercial Maintenance Management Software (MMS), Maintenance Quality Assurance (MQA) programs, similar climate, and geographical characteristics (including three border states) and a comparatively large highway network.

Highlights of relevant peer state practices include the following:

Indiana

The Indiana DOT (INDOT) is organized into six (6) geographical districts, each of which is led by a Deputy District Commissioner. Within each district is a Highway Maintenance Director that oversees operations and maintenance. This position compares to ODOT's District HMA. This is where all the planning takes place for operations based on guidance that the executive team puts out and where all fleet maintenance occurs.

Roadway maintenance personnel report to the Highway Maintenance Director, whose office creates policies, procedures, and allocations of the different budget types. All procedures are posted online and there is also a performance standard manual. Districts typically are comprised of five (5) sub-districts, which have 3-4 maintenance units.

INDOT's Statewide Maintenance Director leads its headquarters-based Maintenance Operation. A second position, the Statewide Maintenance Engineer, develops performance standards for maintenance activities in addition to policies and procedures. The following departments report to the Statewide Maintenance Engineer.

- Statewide facilities – oversee capital program and day-to-day procedures for maintenance facilities.
- Fleet management – capital purchases of new trucks and cars, guidance, policies and procedures for in house maintenance procedures
- Warehousing operations – deliver to each district, produce signs in-house

Michigan

Michigan DOT (MDOT) has a Central Maintenance Unit (CO) that interacts with field units (Regions). The state is divided geographically into seven (7) Regions, which are further subdivided into Transportation Service Centers (TSC). The primary role of the MDOT central office is to provide support to field offices.

MDOT Regions report to a Chief Operating Officer. Similar to ODOT, MDOT regions have an Associate Engineer of Operations, who is second in command for the Region and oversees the respective regional budget and maintenance activities.

Each Region consists of an alignment group and Operations Associate Engineer, who is the primary point person for overseeing maintenance operations. There also are liaisons that are part of the alignment group that meet once a month to review budget, asset management, training, and other support areas. Most regions have a specialty group that performs specialized maintenance activities on bridges as the county maintenance units often do not have this specialized expertise. Traffic control centers, one statewide and a larger one in Detroit, also provide motorist assistance service patrols.

MDOT routine maintenance operations increasingly are contracted with local counties. Currently, MDOT contracts with 63 of the 83 counties in the state. This work is performed under a global, 5-year contract that is currently being re-negotiated. There is a 1-year period to complete this negotiation. Since all entities are public, this type of contract is more of a partnership agreement.

The counties submit billing for time and materials and work out of their own facilities. The MDOT Central Office has analysts to support this contract.

MDOT indicates that it would like to create maintenance performance goals for counties, but counties have pushed back against measures. Currently, MDOT's recourse for unsatisfactory performance is to to reassume responsibility for performing this function.

MDOT has a Maintenance Coordinator that works out of a Transportation Service Center that covers 3-5 county contracts depending on the concentration of roads. In the other counties, state employees working out of maintenance garages complete the maintenance program.

One county in the state did not want to renew the maintenance contracting agreement with MDOT. As a result, MDOT executed a multi-year performance-based contract with a private contractor. Although this type of contract (lump sum - performance based) has been utilized by a few states for nearly two decades, this is the first contract of its kind in Michigan.

New York State

The New York State DOT's (NYSDOT) maintenance organization structure consists of a Main Office unit and 11 regional Offices, 10 of which have maintenance forces. NYSDOT has 59 residencies, which generally align with county boundaries.

NYSDOT has regional bridge crews, tree crews, and specialized crews in addition to the residency crews. Emergencies are handled hierarchically with mutual support between regions. Within the NYSDOT Main Office, there are two (2) Bureaus with maintenance-related responsibilities. The Maintenance Management Bureau consists of program managers that oversee snow and ice, drainage, bridge and pavement subject matter experts (SME's), equipment and work orders. These groups provide feedback on work plans, best practices on equipment and materials as well as training. The Maintenance Planning Bureau oversees funding, including a budget of \$280 million, as well as IT systems and facilities.

NYSDOT operates as both a "matrix organization" and a "traditional" (centralized) model. Organizational structure, budget, and allocations are relatively centralized in that they are hierarchically driven for coordinated response to emergencies and planning. However, day-to-day work is organized at the local level.

NYSDOT Maintenance Management Bureaus play a maintenance management oversight role. The Regional Directors of Operations report to a Regional Director. In turn, Regional Directors report to the Director of Maintenance at NYSDOT headquarters.

In the past, the process followed by Regions for identifying maintenance needs included performing patrols where a foreman had a particular geographic section of highway to manage along with dedicated crews for performing work. Currently, with fewer personnel available, supervisors inform the work planning process and bring needs to the Resident Engineer to create work orders and assign work. The

Resident Engineer is expected to know what the needs are, as well as the history of work demands are in relation to available resources.

Each winter season, NYSDOT hires around two hundred temporary employees (including retirees), who are hired exclusively for performing snow and ice removal operations. These employees work eight (8) hours a day, five (5) days a week, and are full time from October through April.

North Carolina

The North Carolina DOT (NCDOT) operates the second largest state-owned network in the country with 80,000 centerline miles of roadway statewide. NCDOT's system is disproportionately large to its geographic size because North Carolina is one of only a small number of states where counties do not have responsibility for the maintenance of the secondary road system.

The NCDOT) has a Central Office-based Director of Highway Operations, who has responsibility for maintenance policy and program management. This position reports to a Deputy Chief Engineer, who reports to the NCDOT Chief Engineer.

Within Highway Operations, program oversight is divided between Maintenance Operations/Fleet Management, Operations Program Management, Roadside Environmental, and Structures Management. The Operations Program Management group mostly is focused on asset and maintenance management systems and reporting. Kercher conducted interviews with this group as well as with NCDOT's Maintenance Operations/Fleet unit.

NCDOT is divided into 14 geographical field divisions, each of which is assigned to a Division Engineer. Division Engineers report to a Deputy Chief Engineer and oversee maintenance and construction operations in a 5 to 13 county region. A Division Maintenance Engineer, similar to the ODOT HMA, directs county maintenance and multiple bridge maintenance offices and reports to the Division Engineer. An Assistant Division Maintenance Engineer provides technical support to the position.

County offices are led by County Maintenance Engineers, who are responsible for planning and directing the maintenance program. Transportation Supervisors direct day to day operations and maintenance crews which are staffed by transportation workers. There is typically one (1) maintenance yard per county.

Bridge maintenance is managed by a Division Bridge engineer who reports to the Division Maintenance Engineer. Bridge Maintenance Supervisors lead crews which work out of multiple locations within a division, performing routine and critical maintenance repairs. Bridge Inspection is managed by the Central Office Structures Management.

Division Traffic Engineers oversee a division-wide organization that includes a traffic services group responsible for signals, signs and pavement markings.

Each Division has a Roadside Environmental Unit that oversees vegetation maintenance including herbicide applications, and seeding, rest areas and litter removal. Each unit has an engineer with technicians with unique certifications for herbicide application and plant bed maintenance. NCDOT has a nationally recognized and extensive wildflower program.

Each NCDOT division has an Equipment Unit with an Equipment Superintendent who oversees maintenance of equipment and fuel management for the division fleet.

North Carolina is more centralized than some peer states with respect to policies and budget appropriations. Consistency in performance across the 14 Division is achieved through the agency's MQA program and reporting of work accomplishments and cost through the Maintenance Management System.

Similar to Ohio, Central Office (Operations Program Management) leadership meets with Division Maintenance Engineers quarterly to create a sense of community and promote operational consistency. In addition, education and training is promoted through the Transportation Supervisors Academy, Engineers Academy, and annual Maintenance Engineers Training Technical Sessions.

Kentucky

The Kentucky Transportation Cabinet's (KYTC) organizational structure for maintenance includes a Central Office and 12 districts, each of which are managed by an Executive Director. The Central Office Division of Maintenance oversees policies, budgeting and asset management prioritization, and has staff field engineers assigned that coordinate with the districts.

The Division of Maintenance reports up through the State Highway Engineer. The Division of Maintenance has five (5) branches that coordinate with districts covering permits, roadside, roadway preservation, pavement management, bridge preservation.

Within in each District, Branch Managers are responsible for both construction and maintenance. In turn, Section engineers report to the Branch Manager. Section Engineers are responsible for both construction and maintenance programs in addition to supervision of section level workers. Field Engineers act as liaisons to coordinate with districts.

KYTC transitioned to universal technicians for construction and maintenance about 2-3 years ago. KYTC has a highway technician training program where technicians can obtain certifications in both areas.

Minnesota

The Minnesota DOT (MnDOT) is a decentralized organization. The State Maintenance Office, as well as the eight (8) field Districts report to the Assistant Commissioner for Operations, who reports to the Deputy Commissioner/Chief Engineer.

The State Maintenance Engineer oversees the State Maintenance Office and has budgetary and policy responsibilities. In addition, the Asset Management Program Office reports to the Assistant Commissioner, Modal Planning and Program Management, who has responsibility for guiding implementation of MnDOT's Asset Management System (AMS). The MnDOT AMS supports the Central Office and District maintenance management and reporting needs.

District Engineers are responsible for overseeing construction and maintenance operations. An Area Maintenance Engineer manages district maintenance operations.

Consistency in maintenance operations is achieved through the coordination of the Maintenance Business Management Team (which consists of maintenance engineers from the districts). MnDOT believes this is a large part of why their decentralized model has worked. This group provides oversight and meets monthly. One district maintenance engineer is selected to lead the group and stays in that role for long term for consistency purposes.

The district maintenance work program is decentralized in MnDOT. MnDOT does not attempt to centrally advise districts as to what their work plan should be. Pavement is the largest possible area for coordination with information coming out of the agency pavement management system, but most work planning is performed at the district level.

Budgets for districts are driven by previous year budgeting. Benchmark formulas date to the early 2000s when they were driven by data. MnDOT has received increases of around \$100M in maintenance funding over the past 15 years which has enabled them to keep up with inflation but not necessarily needs and condition.

MnDOT has consistent statewide goals and performance measures for winter maintenance based on ADT. MnDOT is centralized from the standpoint of building consensus on performance metrics.

Analysis

Table 7 summarizes some comparative organizational design elements from ODOT and the peer states:

Table 7: ODOT and Peer States Organizational Comparison

State	Organizational Structure	District /Regions	Unusual Aspects
Ohio	Decentralized	12	Mostly self-performs maintenance
Indiana	Decentralized	6	Each district is led by a Deputy District Commissioner
Kentucky	Decentralized	12	Maintenance and construction are responsibilities are combined in field
Michigan	Decentralized	7	Contract with counties for most maintenance
Minnesota	Decentralized	8	Strongly decentralized
New York	Matrix / Centralized	11	Unusual combination of organization approaches
North Carolina	Weak Centralized	14	Manages all secondary roads

In practice, the organization of each state DOT reflects its unique history, needs and preferences. Therefore, for each DOT, “best practice” reflects whatever organization works best within its operating environment and is complementary to its incumbent personnel.

Though the overall mission of providing a safe and reliable transportation network is universal, DOT organizations are routinely influenced by changes in their operating environment, leadership, and priorities. As a result, these agencies are quite often subjected to continuing reorganization. The relative success of these changes tends to depend as least as much on the leadership of the individuals in charge in combination with well-orchestrated change management versus any inherent superiority on any organization design.

Highly effective organizations tend to have clear goals, meaningful metrics, reasonable and attainable performance targets, and good communication regardless of the organizational model followed. ODOT has been a leader among peer states with respect to performance management for many years, and as such, has instituted agency metrics to foster uniformity in outcomes across a decentralized organization.

Though the MCR program (discussed later in this report) is currently being retooled and hence reporting temporarily suspended, the agency nonetheless has established a methodology for reporting on the overall results of the maintenance program similar to the peer state group. Further, ODOT, again like other states in the peer group, has instituted an effective communication method for technology transfer through the monthly meetings of District MCA’s and staff from the DO which helps bridge the decentralization gap.

The challenge of a decentralized organization structure is best characterized by a need to ensure that sound policies, metrics, practices, training, communication and other management tools are in place to provide organizational controls that are typically stronger in a centralized organization. In the case of ODOT, the consulting team finds that ODOT’s decentralized organizational matrix is adequately structured to carry out the duties of maintaining the asset infrastructure.

Recommendations and Benefits

No recommendations.

Objectives

Creating Workplans and Budgets

ODOT Baseline¹⁰

Zero-based budgeting is a process that starts at zero and funds are allocated based upon planned activities and identified expenditures. This is opposed to using the prior years' spending as a basis for developing a proposed budget.

ODOT requires each work unit to develop a detailed work plan identifying specific road repair projects, equipment purchases, material needs, land and building improvements, etc., with an estimated cost for each. After other expenses such as wages, fuel, salt, utilities, etc. are factored in, the annual budget allocations are determined by a statewide budget committee for each of the 12 districts and central office.¹¹

The Statewide Budget Committee then provides a budget to the districts. Districts develop a 'capital maintenance workplan' with input from pavement and bridge engineers within the framework of that budget.

This workplan may include activity items such as paving and chip seals, tree and brush work, culvert replacements and in some cases berming (reshaping earthen shoulders). These and other major asset replacement projects are categorized as the 'Zero-based budget' workplan category, while the routine maintenance operating budget (described later) is not included in this workplan. Some prescribed cyclical maintenance activities such as mowing, and underdrain cleaning and culvert replacements may be considered by some districts as 'planned maintenance' but generally are part of the routine maintenance operating budget.

Each year, county management teams comprised of CMs, pavement and bridge engineers coordinate their projected planned workloads for the year. District HMAs evaluate requested budget increases and justifications based on historical data and projected work plan.

Major increases in the draft work plan are assessed and sometimes cut if the budgeted funds are insufficient. Counties submit the workplan and budget (complete with any revisions) to the district office. Districts compile county plans into a spreadsheet for submittal to the DO.

Due to emergency repairs and the dynamic nature of maintenance, workplans often change and resources are reallocated appropriately. Some county garages include lead highway workers in the planning process to increase maintenance staff buy-in and improve communication channels.

The Routine Maintenance Operating Budget (which includes maintenance, salaries, fuel, parts, etc.) is not included in the capital maintenance 'zero-based' budget workplans and instead is based upon historical spending and certain parameters, such as growth over prior fiscal year and cost of living adjustments. Routine maintenance work includes activities such as mowing, tree and brush removal, pothole patching, litter and debris removal, ditching, guardrail repairs and other activity needs. These needs typically are

¹⁰ See 'Combined District Interviews_3_sorted' 'Objectives' Questions 5-14

¹¹ Ohio Maintenance Operations Manual.pdf

identified during the bi-weekly inspection process, all of which is considered responsive instead of planned maintenance.

Districts interactions with the DO regarding budgets mostly are limited to presenting the yearly capital maintenance workplan.

The pattern of districts submitting the work plan on a spreadsheet to DO effectively is the same; however, precise processes and procedure may differ from district to district. The capital maintenance workplans typically are completed in April or May.

Peer States / Best Practice Findings

Indiana

The INDOT budget is based on statewide needs assessments and work demands from year to year. INDOT does review the previous year spending and will account for inflation.

New York State

The budget is very demand driven based on winter and summer conditions, especially when it comes to purchasing plow trucks for winter. Regions (districts) are advised by central office regarding what money NYSDOT is allotted. Planning Engineers in central office review and approve work plans, then regions execute services.

Winter maintenance budgets effectively are unconstrained financially while the summer maintenance program is constrained. Regions have a level of autonomy to manage their budget and decisions on what to fund are overseen by Regional Directors of Operation. The Planning Division then makes sure that expressed needs fit into the budget and there are no objectionable items.

NYSDOT supplements the operating budget with capital program funds to ensure needs are met. However, the budget currently is not based on any type of departmental strategic goals. Management is working to integrate maintenance and capital to work in balance, but no certain plan on that yet.

North Carolina

The NCDOT Central Highway Operations Office leads a committee that oversees development and reporting on multi-year work plans as while also providing the policies and foundational components of how NCDOT's 14 Divisions put together a maintenance plan. The Central Office creates tools for how to track and manage these plans and this information is communicated to the Divisions via webinars, training, videos, and other documentation. The NCDOT Central Office allocates maintenance funds to the Divisions, which sub-allocate these funds to counties and Division-wide units to accomplish annual work programs.

The Chief Engineer's Office is responsible for statewide funding decisions and allocations in accordance with the agency budget approved by the legislature.

NCDOT typically has several maintenance budget line items that are earmarked or dictated by the legislature. NCDOT has dedicated Pavement Preservation and Contract Resurfacing line items in the maintenance budget in addition to line items for Routine Maintenance and a General Maintenance Reserve.

Legislation requires that 80% of the Pavement Preservation funds be outsourced while resurfacing is totally outsourced. Funding can be allocated to Divisions in many ways, from 100% needs based to 100% inventory based on for example, roadway mileage. There is currently a hybrid model in place to account for both needs based and asset inventory.

NCDOT also sub-allocates to cost centers within the division based on inventory (pavement and bridge). The General Maintenance Reserve line item has the greatest flexibility.

As a result of recent catastrophic weather-related events, NCDOT now has a newly designated maintenance line item for funding emergencies and disasters. Approximately \$64M is appropriated annually and unspent funds can carry over at the end of a fiscal year with a ceiling balance of \$125M.

Kentucky

The KYTC budget office assesses the amount given to the overall program and then splits between traffic and maintenance, removing personnel costs before distributing to the districts. Until recently, most of the budget was based on historical engineering judgement. In resetting the maintenance allocation process, 10 years of maintenance spending were evaluated, splitting out two (2) types of costing: 1) amount spent on specific assets and 2) funds spent on mobility. Other factors incorporated into the District allocation formula included vehicle miles travelled and total lane miles.

KYTC's fiscal year starts in October and budgets are essentially "restarted". Funding for winter maintenance is based on whatever it takes. The KYTC Statewide Snow and Ice Engineer currently is developing a system that uses weather radar modeling as a factor for district winter maintenance allocations.

KYTC works diligently to be efficient but winter maintenance has significant, difficult to predict impacts on budgetary needs. Whatever funding is left from winter maintenance goes towards non-winter operations. The impact is that sometime summer maintenance needs are underfunded.

Analysis

As observed in the peer state group, DOT's are moving in the direction of needs-based program development models for maintenance operations, increasingly utilizing data obtained through condition assessments and Maintenance Management software tools (MMS) for analysis to drive decision making. Northern tier states like Ohio and the peer states interviewed must also balance the significant demand for winter maintenance activities against asset maintenance needs.

The *2007 – AASHTO Maintenance Manual* states, "What is evolving now is the way in which these various databases can be accessed or queried for specific items to provide input to mathematical programming models, statistical quality control models, engineering economy models, and other optimization methods."¹² In effect, this description applies to how an MMS is used to support the maintenance function at a state DOT.

A 2005 study commissioned by the Transportation Research Board (TRB) on "Maintenance and Operations of Transportation Facilities" recommends incorporating life-cycle cost analysis into maintenance investment strategies and developing performance-based budgets and programs that are geared toward achieving specific levels of services and outcomes.¹³ At its core, the application of these principles for maintenance involves developing a routine operations work plan that identifies the quantities of work needed to achieve or maintain the assets at desired level of service.

Developing a performance-based maintenance program starts with creating a work plan and budget. This information is entered in an MMS to provide the benchmarking basis for measuring costs, work performed

¹² 2007 – AASHTO Maintenance Manual, section 1.2.1.5 Data Systems to Support Maintenance

¹³ Page 15 of 'Transportation Research Circular E-C092' ISSN 0097-8515 Updated 2005

and performance outcomes. Setting maintenance and operational objectives requires developing a work plan and tracking activity against that plan.

Effective maintenance planning includes the development of work activities, performance standards, an accurate asset inventory and the development of a work program and budget. A successful implementation integrates each of these elements and focuses on a proactive maintenance program with certain routine cycles built in. The resulting work program should describe the quantity of work planned for each maintenance activity and calculate the resources necessary to achieve the desired level of service.

The use of periodic condition surveys such as ODOT's MCR can provide the performance feedback needed to measure progress towards those goals and/or provide a checkpoint for adjusting efforts to meet those goals. A robust MMS configured to align with agency business rules is essential for DOT organizations to sufficiently track costs and accomplishments for making decisions about outsourcing or self-performing work. Peer and best practice states report having this kind of information readily accessible through their respective MMS.

Comments

The consultant team's interviews with ODOT districts included detailed descriptions for developing a capital maintenance plan as part of the 'zero-based' budget development. However, ODOT did not identify an accompanying business process for developing a routine maintenance¹⁴ operation work plan.

With all data either residing in or potentially accessible by ODOT's Enterprise Information Management System (EIMS) through integration, the recommendations outlined below will allow ODOT to direct efforts toward specific deficiencies in asset features and allows flexibility to reallocate resources where needed. Therefore, it is important to be able to track and monitor work progress and expenditures to assess the effectiveness of the workplan within EIMS.

Recommendations and Benefits

- 1. Develop a performance-based business process within EIMS to assist with routine maintenance work planning while tracking budget expenditures and work accomplishments against that plan***
- 2. Work plans and budget should be developed within EIMS***
- 3. Integrate MCR condition rating information within EIMS to leverage the data for routine operations work planning***

Benefits:

- Provides better accountability for both performance and costs
- Provides a needs-based budget process with all data residing in one place for accessible analysis
- Provides a platform for developing and adjusting a performance-based work plan for routine operations

¹⁴ "Routine Maintenance" refers to the work associated with performing ongoing activities such as mowing, tree and brush removal, pothole patching, litter and debris removal, ditching, guardrail repairs and other activity needs.

Maintenance Management System

ODOT Baseline

ODOT's maintenance management system, known as the EIMS, was implemented in 2014. EIMS currently is not integrated with other frequently used ODOT applications such as GIS, the annual work plan database, and bi-weekly data collection applications and databases.

EIMS was originally envisioned to use mobile devices for capturing daily work accomplishments. However, this has not been accomplished; instead, ODOT is using a separate mobile platform for capturing and tracking roadway defects or work needs and activities identified through bi-weekly route reviews.

All districts capture and input work accomplishments by crew into EIMS on a daily basis. However, ODOT interviews suggest that inconsistencies exist in the use of EIMS for reporting work progress using this data.

Interviews indicate that ODOT currently is in the planning stages of replacing this system as it is perceived as no longer meeting the desired functionality and reporting needs of field maintenance staff. As such, the work planning functionality available in the EIMS software is not being used since the department has indicated an intention to replace this system.

The complexity of the maintenance work plan may change from year to year; however, districts do not routinely track and report on the work progress compared to the plan. Managers reportedly evaluate the accomplished work versus their yearly work plan at the end of the year; some occasionally refer to this plan throughout the year. Districts stated the work plan is developed in spreadsheets rather than inside of EIMS. Accordingly, generating reports for comparison is cumbersome.

Counties are now using a non-EIMS integrated iPad-based application as a field data collector to identify work to be done as part of a bi-weekly field review, understanding this is mostly a reactive model. This application accumulates the target work identified in a list that can be filtered and queried.

Planned work identified through the bi-weekly review process is manually incorporated into EIMS through work orders and day cards. Locations on road sections where work is performed is included on the EIMS day cards to track work accomplished and costs. Work can also be booked to some specific assets which have been inventoried such as bridges and culverts.

MO-supplied goals dictate certain types of asset planning. For instance, underdrains must be inspected and cleaned as necessary every three (3) years, roadside sign sheeting is replaced on 15-year cycles, and pavement markings are re-painted annually. MO guidance includes snow and ice clearance goals. All districts indicated that asset replacement goals are followed.

Capital projects such as 'Ready to Pave' often drive other activities such as full depth pavement repairs and culvert replacements. Some districts report that they inspect culvert conditions and other required work one year in advance of major capital construction projects.

ODOT has collected inventory and condition information for all culverts between 12 inches diameter and those meeting the Ohio definition of a bridge (10 feet or greater along the center of the road). The culvert inspection program involves an engineer, who inspects 20% of all the culverts-categorized inventory each year within the district, videos the condition and assigns a general condition rating. "Poor" category culverts are inspected more frequently. In one district, if a paving operation is scheduled/programmed, then the engineer will coordinate a culvert replacement and repair prior to paving. Data collected with this inventory and condition data is managed in the GIS database.

Peer States / Best Practice Findings

Indiana

INDOT first began using a maintenance management system in the 1970s and implemented an Agile Assets MMS around 2007 which it continues to use. All work planning is accomplished within the MMS and INDOT is currently upgrading to include the work programming and cyclical processes of asset maintenance. *Tableau* software is used to view reports, many of which are automatically generated, enhancing the ability of Central Office and field staff to routinely observe and analyze program results.

INDOT is moving towards using mobile devices in the field for data entry and has integrated field data collectors with their MMS software. Unit supervisors utilize mobile devices and plans are underway to have onboard displays on trucks for maintenance teams to use from mobile hotspots.

INDOT MMS Improvement Initiative

INDOT went through a major upgrade of their AgileAssets software to better meet their specific business process needs. To enhance this process, INDOT reached out to other AgileAssets MMS clients including Louisiana and Oklahoma both of whom had gone through similar MMS software upgrades to leverage new features and functionality software with a great deal of success.

INDOT indicates that these discussions were very helpful in addressing its concerns with the software. The results are that INDOT is better satisfied with the information being captured and reported and has avoided the cost and time

Kentucky

KYTC implemented AgileAssets Maintenance Management software in the early 2000's. KYTC primarily uses the system to input work orders and track material usage and activity costs. Although the system has a planning function, it is not currently applied. KYTC is piloting a mobile solution for the MMS software this summer. The plan is to be able to record a work request in the field during initial observation where it may then be approved through MMS as a work request at the office.

The Kentucky MRP (MQA) data and score card is stored in MMS but not yet integrated into its MRP reports.

Michigan

MDOT uses a commercial maintenance management work system developed by Data Transfer Systems/ VueWorks that has been in place for a year and half. This MMS includes maintenance and work activities and logs employee labor, equipment and materials cost information. Budgeting is not a part of the MMS functionality yet. MDOT currently makes use of their SIGMA financial system for this purpose.

Planning capabilities allow users to create future work orders and estimate crew resources to see how much the work planned would cost. The system has a mapping component which can set limits and it is also tied to and integrated with police reports for asset damage, such as guardrail.

Maintenance supervisors/lead workers have iPhones and iPads to add work orders to the MMS and they can also work in offline mode. There is also a syncing process for uploading data when logged in to integrate information. This technology allows for condition reporting to monitor specific assets/defects in the field. MDOT can also flag items in GPS and add pins to a map. From there, the flagged item/area connects to the garage that maintains that segment of roadway. A service request is then logged, and cost is submitted in Sigma Financial which is a manual process.

Minnesota

MnDOT began implementing AgileAssets software about five (5) years ago as an enterprise asset management system (AMS) and has now rolled it out to all departments. The software implementation and required business process improvements that have supported a successful roll out are overseen by the Asset Management Planning Office (AMPO) in the Central Office, which includes senior staff with many years of field experience. MnDOT has developed an extensive inventory of key assets which are managed within the AMS. MnDOT also placed a great deal of emphasis on documenting existing and desired business processes to ensure that their MMS would readily support their agency asset management strategies and performance objectives. Their software implementation approach and on-going commitment of staff resources to fully leverage the capabilities of the system is considered industry leading.

North Carolina

NCDOT began implementing its enterprise AgileAssets asset management system in 2001. The MMS module went live in 2004, and the agency has worked closely with the vendor over the years on system enhancements tailored to meet agency needs. NCDOT has staff with the capability of making software configuration changes and recently added an on-site AgileAssets consultant to assist the central office with the system on a full-time basis.

IPad's are integrated with NCDOT's MMS and used to manage maps, plans and collect inventory, which has been working very well. In terms of identifying maintenance needs, this begins at the route level and is being captured in the field by Transportation Supervisors. There are occasional issues with offline connectivity and sometimes information may occasionally be collected by paper.

Analysis

Table 8 compares ODOT and the peer states in terms of MMS application and usage. Of note, Michigan is the only state in this group that does not use the Agile Asset system as its MMS.

Table 8: MMS Usage by State

	Maintenance Management System (MMS) Use and Comparison						
	Ohio	Indiana	New York	Michigan	North Carolina	Minnesota	Kentucky
System	Agile Assets	Agile Assets	Agile Assets	VueWorks	Agile Assets	Agile Assets	Agile Assets
Interface with Financial System	Yes	No	Yes	No	Yes	Yes	Yes
Interface BMS	No	Yes	Yes	No	Yes	Yes	No
Interface PMS	No	No	Yes	No	Yes	Yes	Yes
Integrated Service Request System	No	Yes	Yes	Yes	Yes	Yes	Yes
Work Planning Functionality	No	Yes	Transitioning	Yes	Yes	Yes	No
MQA Integration	No	No	No	Yes	Yes	Yes	Yes
Interfaced Inventory, Materials Management	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mobile Unit Crew Data Entry	No	No	No	Yes	In Pilot	Yes	No
Location referencing of work performed via asset location, GPS and/or agency LRS	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tracking Contract Maintenance	No	No	Unknown	Yes	Yes	No	Yes
Interfaced Equipment Management	Yes	Yes	Yes	Yes	Yes	No	Yes
Tracking/reporting for FHWA ER or FEMA events	No	Yes	Unknown	Yes	Yes	Yes	Yes
What-if analysis for various performance targets and levels of funding	No	Yes	No	Yes	No	No	No
Establishment/tracking of annual work program	No	Yes	Transitioning	No	Yes	Yes	Yes

As indicated in [Table 8](#), the peer DOTs that also use the Agile Asset’s MMS software product generally had many more system linkages (interfaces or EAMS platform) between the MMS and other systems than ODOT. Additionally, many of these states were using their MMS to track performance and/or costs in many more areas and in some cases, also were using mobile technologies to support data collection and entry. These differences were notable in terms of the peer DOTs being able to provide ready, specific responses related to the cost of internally produced services versus contractor costs.

Comments

ODOT districts interviewed varied on their base knowledge and their leveraged use of data from EIMS. This variance in skills likely is dependent on training and the configurations rather than the capabilities of the system itself.

EIMS is largely being used as repository for daily work accomplishment information but is not being widely used as a work planning or budgeting tool for tracking performance and decision making. Essentially, ODOT is using an array of other software tools and databases to drive maintenance decision making on a day to day basis instead of functionality that could be configured in their MMS.

Service requests from customers and in-house personnel are not formally tracked in a statewide unified database. Statistics on response time are not readily available to the district or headquarters. The EIMS is a logical place to enter, track responses and serves as an easy transition point to a work order.

Kercher notes that an MMS typically has the largest number of users of any of the transportation asset-focused systems (often numbering 1,000 or more users).¹⁵ In comparison, the number of users of state DOT pavement and bridge management systems typically involve a much smaller user base (often 10 or fewer in a DOT).

An MMS also tends to have the largest range of positions using this application, ranging from front line workers and supervisors, to data entry personnel, to agency management and executives. Field staff generally have preferences for ease of use (user Interface) over the analysis and reporting capabilities of the system; management is typically leveraging the system for data reporting capabilities needed to drive decision making.

Most commercial asset management system providers hold user conferences on regular schedules and encourage peer agencies to engage one another as a user community to better understand available functionality and offer input to product enhancement. In most states including the peer group interviewed, the central maintenance or asset management offices tend to be the sponsors of and experts in the use of their respective MMS's, generally providing on-going training for field users.

Forums such as the AASHTO Committee on Maintenance and maintenance-oriented committees of the Transportation Research Board (TRB) combined with the research efforts supported by these groups have significantly influenced the development and enhancement of maintenance management systems over time. Compared to the peer state group, the ODOT MO appears to be only tangentially involved with the MMS. States that report a successful implementation of their MMS have included heavy involvement of their central maintenance office personnel in its configuration to match maintenance business processes more closely and take ownership of the system.

Like many things, the larger and more diverse the group being supported with a given product or solution, the greater the challenge related to keeping all users satisfied. Similarly, applications that attempt to support a broad number of needs typically have an ongoing need for system configuration enhancements, updates, and integration with new technologies to fully leverage this investment.

As stated previously, INDOT went through a major upgrade of their AgileAssets software to better meet their specific business process needs. This was because at one point, INDOT was ready to consider replacing its Agile Assets MMS. However, INDOT reached out to the Louisiana and Oklahoma DOTs, both of whom are AgileAssets system users who reported having good success with their MMS. The outcome of these conversions was that INDOT determined that the MMS had the capability to provide the desired functionality/capability within additional upgrades, resource investment, and training. Perhaps more importantly, INDOT perceived that the time and cost required to achieve the desired outcomes was far less than attempting to replace the existing MMS. The outcome is that INDOT currently is leveraging its MMS and reports being satisfied with reports and analysis provided by the existing software.

Recommendations and Benefits

4. Upgrade and/or enhance the existing EIMS to include integration other with key agency management systems to streamline business processes

Benefits:

- Improve cost and performance reporting
- Save significant ODOT personnel time and money compared to replacing the MMS

¹⁵ Per 2020 survey of State DOTs conducted on behalf of the Tennessee Department of Transportation.

- Peer state experiences provide a template to repeat success

5. Create a statewide Service Request system to track response times and conclusions in EIMS

Benefits:

- Provide a searchable statewide database that supports greater performance accountability

6. Increase central maintenance office involvement/ownership in EIMS configuration/use

Benefits:

- Provide a primary product owner for purposes of identifying system configuration, uniform training and extension needs
- Improve coordination and support

Performance Measures

ODOT Baseline

Over the years ODOT has implemented performance measures to gauge asset performance levels using different iterations of mechanisms for rating the conditions of assets on the roadway. Historically, ODOT used in-house inspectors to capture the assessment data. However, ODOT transitioned to using contracted consultants to perform the field evaluations a few years ago. ODOT has established several agency level metrics for reporting on organizational performance. These performance measures are referred to as Critical Success Factors (CSF).¹⁶

The Maintenance Condition Rating (MCR) served as one of ODOT CSF's for the maintenance area in addition to a travel time index and snow and ice clearance metric. Unfortunately, ODOT experienced issues with the timeliness of this work and the reliability of the rating scores. As a result, this CSF was suspended and no assessment has been conducted in the last two (2) years.¹⁷

Within the last year, ODOT began a planned transition back to in-house assessments and a new MCR manual is being revised. HMAs have assisted in writing the new manual, which will be submitted to them for final review and comments in the near term.¹⁸

The draft MCR defines four (4) maintenance categories:

1. Barrier
2. Pavement
3. Pavement Marking
4. Traffic Control Devices (signs)

The draft MCR manual provided to the consulting team describes MCR as follows:

¹⁶ See 'Combined District Interviews_3_sorted' 'Performance Measures' Questions 15-19

¹⁷ See '031620 Maintenance Interview – 1300 hc notes- cp _ page 6

¹⁸ See 'Combined District Interviews_3_sorted' Question 17

“MCR is a visual inspection conducted from a moving vehicle, of the four MCR maintenance categories. MCR inspections will be randomly generated and will occur on every county’s state-maintained highways every six months. The MCR Inspection vehicle speed ranges from one mile per hour to a maximum of 20 miles per hour. The MCR team(s) use laptop touch-screen computers with GPS technology to collect the maintenance deficiency data.”¹⁹

The HMAs and CMs interviewed believe the MCR will be more of a performance measure than a planning tool. Some quotes regarding the revised MCR include the following:

“It will give us feedback on how we are doing from a routine maintenance perspective as long as it is done on random sections and we get instant feedback.”²⁰

“(The draft MCR addresses) two (2) flaws with the previous MCR: 1) it should be random and 2) it needs to be timely.”²¹

“The previous methodology had four (4) quadrants in each county and the counties would be notified which quadrant was going to be audited-so counties naturally addressed deficiencies prior to arrival of team.”²²

The MO has not yet decided how the MCR scoring will be determined. One of the problems with previous versions was that the districts and MO perceived that the scoring was deceptively high and with so little range in scores as to render it ineffective as a management tool. The system’s inability to capture perceived deficiencies in assets or groups of assets prevented the districts from identifying where to focus resources for a uniform level of service.

District staff expressed concern during the interviews that deficiencies noted in previous assessment methods were based on a total count, not taking into consideration the number of road segments sampled. Counties with larger networks were disproportionately penalized as a result.

ODOT has not yet determined a satisfactory metric and recognizes it will need to get consensus from the districts to avoid ratings that are unactionable (e.g., scores of 96% every time).²³ Most districts currently rely on the bi-weekly inspections for work identification. District staff overwhelmingly supported the concept of an MCR program and with it currently suspended, expressed concern with not having an objective indicator of how effectively district work programs are being delivered.

Based on interviews with MO and District staff, work performance guidelines are not established as a guide for accomplishing maintenance activities except in a few instances at the county levels. An effort was made several years ago to do this statewide, but it is not currently a focus of the department.

¹⁹ MCR Manual.pdf

²⁰ See ‘District Interview Guide Ohio-sent to client 031820_Rod’ Question 24

²¹ See ‘Combined District Interviews_3_sorted’ Question 16

²² See ‘Combined District Interviews_3_sorted’ Question 17

²³ See ‘Combined District Interviews_3_sorted’ Question 15

Peer States / Best Practice Findings

Kentucky

The KYTC Maintenance Rating Program (MRP) issues report cards for the districts and the agency provides a detailed manual for the program. More than a dozen maintenance items in the program are evaluated with assessments beginning in May and take around three (3) months to complete. The report is due at the end of August.

Although the program is about 20 years old, there have been peer exchanges and efforts to keep up to date with what other peer states are doing. The performance threshold requirements are pass/fail on random sampling using one-mile segments with a 90-98% confidence level, district or statewide. The samples are based on a facility type and frequency is run by county every 3 years, and by district every year. Scoring has an 80% target statewide. The MRP is not yet used to determine work needs or establish plans.

New York State

NYS DOT is in the process of developing an updated version of MQA. NYS DOT did not previously have maintenance-established performance standards tied to outcome-based budgets from the MQA but plans to do so with their new program.

The MQA measures are based on pass/fail criteria, with a specific set of criteria for maintenance characteristics. NYS DOT's goal is to bring together the MQA and budget to fully determine a needs-based budget for both short- and long-term maintenance planning. There is an inventory of ancillary assets and NYS DOT is reporting work against those assets. NYS DOT's goal is to put the pieces together between conditions, inventory, and budget.

**Figure 2: Sample NCDOT MCAP Scorecard
2014 SCORING PERFORMANCE MEASURES**

		MCA Survey Period: Qtr 1, 2014 To Qtr 4, 2014			Non-MCA Survey Year: 2014				
		System :		Secondary					
		Summary :		Statewide					
ELEMENT		Collection Method	Relative Importance	Element Weight	Target Score	Element Points	Actual Score	Element Points	
RM-1	Unpaved Shoulders	MCA	8	0.093	80	7.44	95	8.84	
RM-2	Ditches (Lateral Ditches)	MCA	6	0.07	80	5.58	91	6.35	
RM-3	Crossline Pipes (Blocked)	MCA	6	0.07	80	5.58	80	5.58	
RM-4	Crossline Pipes (Damaged)	MCA	7	0.081	80	6.51	93	7.57	
RM-5	Curb & Gutter (Blocked)	MCA	5	0.058	80	4.65	97	5.64	
RM-6	Boxes (Blocked or Damaged)	MCA	5	0.058	80	4.65	88	5.17	
R-1	Vegetation (Brush & Tree)	MCA	6	0.07	80	5.58	83	5.79	
R-2	Vegetation (Turf Condition)	MCA	4	0.047	80	3.72	96	4.47	
R-3	Storm Water Devices (NPDES)	ROADSIDE	4	0.047	80	3.72	93	4.33	
T-1	Long Line Pvmnt Markings	MCA	8	0.093	80	7.44	90	8.37	
T-2	Words and Symbols	MCA	5	0.058	80	4.65	91	5.29	
T-4	Ground Mounted Signs	NTSS	8	0.093	85	7.91	96	8.93	
B-4	NBIS Culverts	BRIDGE	7	0.081	75	6.1	69	5.62	
B-5	Non-NBIS Culverts	BRIDGE	7	0.081	70	5.7	85	6.92	
TOTAL:					86	1,000	79.23	88.87	

North Carolina

NCDOT's Maintenance Condition Assessment Program (MCAP) has been in place since 1998 and is incorporated into its MMS. However, the MCAP program recently was placed on hold because of major budgetary shortfalls.

Condition surveys typically are conducted every two (2) years statewide for all 100 counties and NCDOT has historically spent about \$1M per cycle to collect data. Since maintenance operations are planned and executed at the county level, NCDOT extended its network sampling down to the county level by system many years ago. This enabled

them to obtain sufficient condition and performance data needed for planning and budgeting.

NCDOT's asset management focus recently has shifted more to replacement of assets based on lifecycles versus condition. However, NCDOT Central Highway Operations Office staff are working to restructure the program to show how plans are working, that the level of service is going up, and adjust the program to make sure everything is measured in alignment with current business process.

Michigan

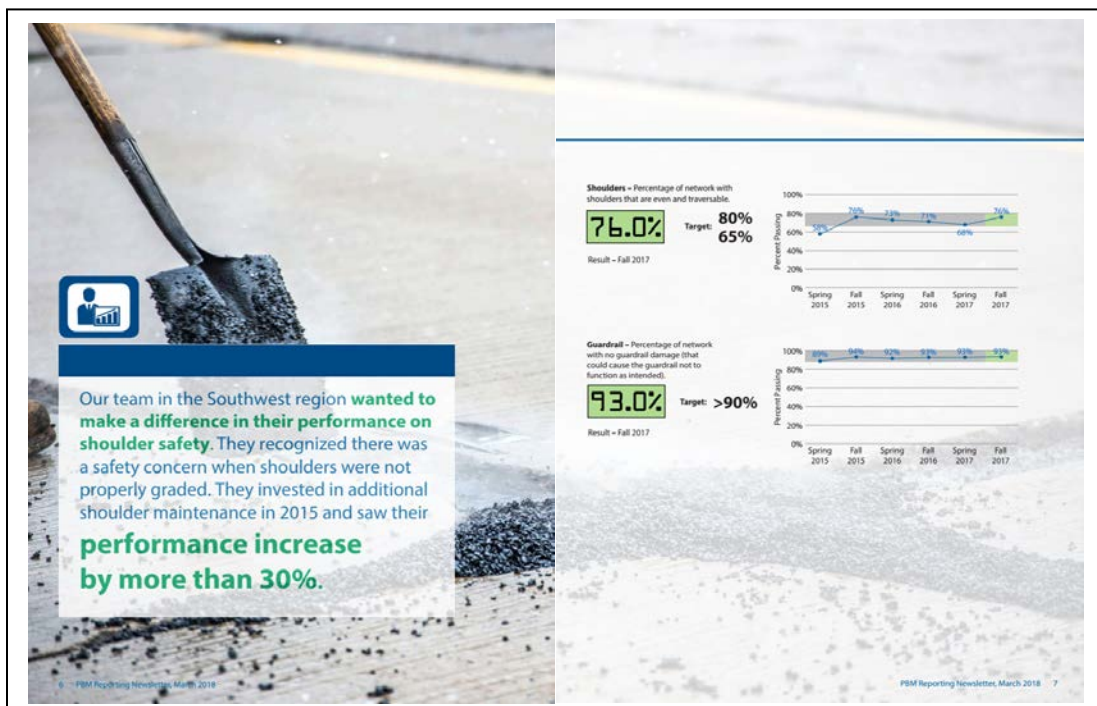
MDOT has a Performance-Based Maintenance (PBM) rating system that is based on rating selected assets using threshold conditions on a percent passing scoring criteria. The system is still relatively new, and the goal is to be more data driven as it continues to evolve.

MDOT PBM Approach

- Two (2) times a year MDOT Engineers review performance measures
- 20 different criteria evaluated under a pass/fail system.

Figure 3 provides an example of a MDOT PBM report.

Figure 3: MDOT PBM Reporting Example



PBM data has been collected for the past four (4) years and is shared with the local counties who are contracted to perform the maintenance. The data has been presented at statewide meetings and used as a 'justification tool' when trying to prioritize maintenance needs.

Analysis

Per NCHRP Project 14-12, *Highway Maintenance Quality Assurance*²⁴, about half of the state DOTs have developed Maintenance Quality Assurance (MQA) programs. These programs typically use the guidance described in *Report 422: Maintenance QA Program Implementation Manual*²⁵ for assessing maintenance conditions, establishing levels of service, and quantifying funding needs. Many states including ODOT that have implemented these programs are only assessing and reporting conditions. Further, only a handful are currently leveraging the additional benefits that MQA data can offer with respect to developing activity-based work plans, needs based budgets, or providing support for trade-off decisions.

A maintenance condition survey is the first, and perhaps the most important, step of a maintenance management system. A quality management system must be based upon accurate data; therefore, it is imperative that the information collected is uniform and consistent. Using this initial field survey information, a maintenance matrix can be developed to show the ties between maintenance activities and the characteristics of various roadway features.

ODOT's system is similar to those of peer states in that it compares the existing threshold conditions of individual maintenance characteristics with the acceptable threshold condition. However, the integrity of the system may come into question should field managers know in advance where assessments are going to occur. ODOT field managers are aware that only a specific quadrant of their area will be assessed each year and would be imprudent not to concentrate efforts on that specific area. Peer states often mitigate this problem by applying random sampling throughout the maintenance area (county / district) instead of focusing on all road segments in a concentrated quadrant of the county. Additionally, the threshold condition criteria should be within an acceptable range for both management and customers. If the threshold is too low, scores will be deceptively high. ODOT districts often stated the MCR didn't match their own eye test.

Peer states assessment methodology included objective 'on the ground' measurable thresholds instead of 'windshield' assessments. The 'on the ground' method of measuring defects is objective and more precise which increases the data collection confidence level.

Table 9 and Table 10 contain a comparison of ODOT's MCR program with a selection of other state DOTs.

Note: The states identified in the tables below differ from the benchmarking states otherwise used in this report. This is because this information has been compiled over time by the consulting team rather than specifically for this project.

²⁴ http://www.nap.edu/openbook.php?record_id=6346

²⁵ http://onlinepubs.trb.org/onlinepubs/nchrp/impacts/NCHRPImpacts_422.pdf

Table 9: Benchmarking Comparison 1

	Ohio	New York	Virginia	Florida	Mississippi	North Carolina
	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION
Length of Segment Rated	0.1 Mi.	0.1 Mi.	0.1 Mi.	0.1 Mi.	0.1 Mi.	0.1 Mi.
Sample Size	Estimated 25% of road inventory at the county level	80% confidence at the county level	20% of inventory	minimum 30 samples for each of urban and rural areas, per maintenance area	95% confidence at the statewide level	95% confidence rate on Interstate and 90% at Division level and Primary/Secondary at each maintenance area (county) level.
Inventory	Pavement and bridge and some ancillary	Pavement, Bridge, some culvert and Retaining Wall	Full Interstate Inventory	Full Inventory	Partial Inventory	pavement and bridge only
Frequency	annual	annual	annual	3 times annually	annual	Rolling quarterly for annual
Inspection Methodology	Windshield assessment with threshold conditions	Pass/Fail	5 point scaled threshold system	Pass/Fail	Measurement of quantity outside of threshold	11 assets - Measurement of quantity outside of threshold

Table 10: Benchmarking Comparison 2

	Ohio	Washington State	Michigan	South Carolina	Utah	Kentucky
	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION	THRESHOLD CONDITION
Length of Segment Rated	0.1 Mi.	0.1 Mi.	0.1 Mi.	1.0 Mi.	varies per linear segment	one-mile segments
Sample Size	Estimated 25% of road inventory at the county level	95% confidence at the statewide level	Random	Random Sampling per system, each county	100% of all assets	Random sampling with a 90% to 98% confidence level
Inventory	Pavement and bridge and some ancillary	Full Inventory	unknown	collected during the assessment	100% Inventory	Pavement, bridge and sign
Frequency	annual	semi-annual	semi-annual	annual	semi-annual	annual
Inspection Methodology	Windshield assessment with threshold conditions	Measurement of quantity outside of threshold	Pass/Fail	Measurement of quantity outside of threshold	Measurement of quantity outside of threshold	Pass/Fail

Recommendations and Benefits

7. Restart, Strengthen and enhance the Maintenance Condition Rating (MCR) program

- *MCR is the only performance measure that has been used by ODOT to report on maintenance conditions. Restarting the program should be a key agency priority*
- *Use random sampling with specified statistical confidence level*
- *Evaluate MCR threshold condition criteria and scale to better match management and customer expectations*
- *Use on-the-ground inspections with threshold measurements instead of windshield inspections*
- *Include timeliness response requirements in performance criteria*
- *Establish a timeliness performance standard for customer service requests*

Benefits:

- Provide more reliable assessments of actual field conditions
- Strengthen the confidence level and maintain the integrity of the MCR program
- Increased accuracy and consistency of inspections

Resource Allocation

Staffing

*ODOT Baseline*²⁶

ODOT reports a total of 2,603 maintenance personnel²⁷ that support the delivery of district operations and maintenance programs for the 43,000+ lane mile (LM) ODOT highway network. Comparing staffing levels on the basis of lane miles (LM) per maintenance employee is a fairly common benchmarking metric. ODOT's current average is 16.7 LM/maintenance employee. Table 11 provides details on district-by-district maintenance staffing levels and ratios.

Table 11: Maintenance Employees by District and Lane Mile

Location	Total Maintenance Personnel	Lane Miles ²⁸	Lane Miles/Employee
District 1	193	3,300	17.1
District 2	213	3,339	15.7
District 3	234	4,174	17.8
District 4	245	4,201	17.1
District 5	189	3,528	18.7
District 6	242	4,246	17.5
District 7	246	4,122	16.8
District 8	222	3,837	17.3
District 9	211	3,686	17.5
District 10	210	3,960	18.9
District 11	193	3,265	16.9
District 12	205	1,803	8.8
Grand Total	2,603	43,461	16.7

As noted by Table 11, ODOT districts 10 and 12 appear to be outliers on either side of the statewide average.

Staffing levels for maintenance are generally established based on requirements for winter snow and ice removal operations. From the project interviews, Districts estimated anywhere between 80% and 95% of all routine summer maintenance work is accomplished with in-house resources. ODOT was unable to provide exact figures.

All winter maintenance is performed with in-house forces and staff augmentation will occur using resources possessing Commercial Drivers Licenses (CDL) from other units within the district if needed. Temporary seasonal snowplow operators are used in some cases and districts supplement maintenance staff with college students during summer for non-equipment operation related assignments.

²⁶ See 'Combined District Interviews_3_sorted' page 13 - Resource Allocation

²⁷ From "County Permanent Position Data as of 09.12.2020.xlsx"

²⁸ Lane miles indicated in this table were provide by ODOT via the spreadsheet, "County Permanent Position Data as of 09.12.2020.xls" and differ from the miles indicated in Table 1, which comes from FHWA Table HM81, compiled from 2018 data.

Approximately ten years ago, ODOT initiated the Highway Technician (HT) program to create a more versatile field work force that could meet staffing requirements for both maintenance and construction. Through participation in a structured training program, HT's gain skills and certifications that enable them to be deployed for construction project inspection during summer months in addition to their normal maintenance job responsibilities. The summer season construction workload drives the need for these staff reassignments.

Although total personnel complements are fixed at the district basis, HMAs have the authority to set complements for county and district-wide specialty staffing. At a county level, crew sizes for specific operations are established by the TAs and TMs depending on the job to accomplish. There are no pre-set standards on how many HTs should be on each type of activity. This decision is situationally based on several factors:

- Location
- Flaggers needed
- Traffic volume
- Equipment available
- Crew experience
- Worker safety
- Other considerations

The Internet survey of ODOT maintenance personnel described in this report included several resource-related questions (i.e., the adequacy of current staffing, available equipment and materials). The responses received indicate a strong perception that these resources were mostly adequate. In direct interviews by the project team with ODOT HMA's, this position generally was affirmed but with a significant caveat – that the practice of using HTs to serve as inspectors on construction projects significantly limited ODOT's effective capacity to perform summer maintenance. This was particular problematic at or near urban centers, where ODOT typically experiences labor retention issues (mostly due to workforce competition with other local agencies and private sector employers). The perceived cost disadvantage of using outsourcing for construction inspection to consultants has been the primary driver in these decisions.

Labor retention has not routinely been a challenge for rural areas, where ODOT positions are considered comparatively desirable. However, one ODOT rural district indicated that job growth in the oil and gas industry made it difficult to attract qualified employees.

Peer States / Best Practice Findings

Indiana

INDOT districts are allocated a personnel complement that is established through the Central Office. Districts can make justified requests for changes to allocate additional staffing. Once those positions are allocated, districts have autonomy for determining maintenance and construction assignments. All District Maintenance Directors discuss this allocation process with the central office which was described as "very collaborative and democratic".

INDOT tries to maintain a certain staffing level due to snow and ice requirements. INDOT relies on maintenance employees as well as other job classifications as required to plow snow outside of maintenance such as construction, or Materials and Testing employees. All employees involved with winter maintenance are required to have a CDL.

Michigan

As previously indicated, MDOT contracts extensively with county governments. As such, MDOT's staffing levels are not directly related to the resources used to perform maintenance work.

MDOT states that their total agency in-house headcount is about 4,000 maintenance employees while the contracted county forces use an estimated 1,200 people. However, employee headcount fluctuates based on winter maintenance requirements. Within the past few years, State of Michigan legislation was enacted that allows MDOT technicians perform both construction and maintenance duties (similar to ODOT) though this reportedly does not happen often.

Unlike many peer states, MDOT maintenance complements are driven mainly by summer maintenance as winter maintenance demands are met by using temporary employees. (Temporary employees do not count towards total headcount.)

New York

As indicated previously, NYSDOT hires around two-hundred temporary employees (including retirees) each winter season for performing snow and ice removal operations. These employees work eight (8) hours a day, five (5) days a week, and are full time from October through April.

North Carolina

Division personnel complements are established by the Central Office. Divisions have a set headcount and can reallocate staff with approval. Sharing resources can occur during extreme weather events and that is also the standard for related emergencies. NCDOT's emergency response plan pairs divisions to improve response and coordination.

Analysis

As part of the benchmarking effort, the consulting team requested that the peer states provide information on maintenance staffing levels, reported on the basis of Lane Miles per employee. [Table 12](#) includes the information from ODOT and the states that responded to this request. Also included is corresponding information on some additional states that were collected by the consulting team in a 2016 project for another client.

Table 12: Comparative Staffing Levels

State	Approximate Lane Mile/Maintenance Employee
Ohio	17
North Carolina	28
Kentucky	38
Michigan ²⁹	Not Comparable
Indiana	19
New York	10

²⁹ Michigan contracts with counties to perform most maintenance

State	Approximate Lane Mile/Maintenance Employee
Minnesota	22
Maryland	16
Idaho	25
Massachusetts	35

Comments

As suggested in Table 12, ODOT’s maintenance staffing per lane mile is the third highest of the states identified. However, as discussed in the previous section, this comparison ignores the different maintenance outsourcing levels and approaches used by the states, which makes this comparison somewhat moot.

Since all winter maintenance at ODOT is performed with in-house forces, staff augmentation will occur using resources from other units (Technicians with CDL’s) within the district as needed. ODOT moved to a joint work force combining construction and maintenance a few years ago. ODOT districts generally express some level of concern that the performance of summer maintenance activities is sacrificed to support shifting employees to construction. To the extent that necessary maintenance activities are not being performed to meet ODOT performance standards, this is a concern and warrants examination as to the proper balance of how highway technicians are used.

Recommendations and Benefits

8. Undertake a resource allocation study to ensure that the allocation of highway technician resources is properly balanced to achieve both maintenance and construction objectives

- Study should be in conjunction with a transition to a performance/needs-based maintenance program
- Increased maintenance outsourcing should be also be considered to balance resources

Benefits:

- Consistency in statewide delivery of maintenance and construction programs
- Ensure safety and performance of transportation assets
- Ensure that ODOT can achieve its maintenance performance standards

Maintenance Equipment

ODOT Baseline

ODOT districts report periodic and routine sharing of equipment resources between counties within a district and occasional sharing of resources district to district. Equipment shared between adjoining counties within a district typically includes trucks, backhoes, excavators, crack sealers, and specialty asphalt patching machines. Most districts also have specialty crews that work district wide for activities such as placing asphalt overlays. Equipment such as large excavators are also shared within the district.

Many districts report the need to balance the equipment owned/assigned to each county versus shared among all counties. Districts only periodically share equipment with other districts such as specialized equipment. Operators are generally included when equipment is shared.

Utilization of the equipment is tracked in EIMS, and rental equipment is leveraged to supplement when needed.

Peer States / Best Practice Findings

Michigan

Equipment complements are managed through an equipment management system which considers the cycles that equipment goes through. Most analysis is done at the regional level and pulled into a statewide group. Regions get reimbursed based on the useful life through contracts.

MDOT garages come up with lists of wants and needs which are then given to the associate region engineer followed by review by the alignment team. For counties, MDOT is not involved with determining their equipment as counties must supply the equipment that fills the maintenance performance needs.

North Carolina

Adjustments to division equipment complements are generally made at the division level following central office guidelines. In the near term, decisions are being made more centrally to control costs during the current budget crisis.

Analysis

ODOT's equipment management practices are on par with peer state systems. No deficiencies were noted, and equipment seems to be available where it is needed. The use of rental equipment on an as-needed basis is resourceful and efficient.

Recommendations and Benefits

No recommendation

Outsourcing

ODOT Baseline

ODOT's use of maintenance outsourcing is sporadic and usually limited to major activities involving specialized skills or equipment. Examples include guardrail repair, highway lighting, pavement striping and reflective pavement markers, heavy tree and brush removal and limited outsourcing of routine mowing.

ODOT does not routinely track or analyze the unit cost of maintenance activities though this information is readily available in EIMS from daily data entry through day cards. Contracted maintenance work is not currently managed or tracked within the EIMS application. As such, ODOT does not have an established process for evaluating the effectiveness of in-house performed versus outsourced maintenance activities on a cost or productivity basis.

Some districts would like to have the ability to outsource more work but reported it would be a challenge from a budgeting side, i.e. capital vs operational. Districts report their operational costs (labor) absorb most available maintenance budgets, leaving little available monies to use contracted maintenance.

Several districts were asked the question, "If you had all the funding you needed, would you have the resources (personnel, equipment) to meet the needs of the infrastructure?" All answered "No", indicating a lack of sufficient internal manpower and that even if authorized to hire additional HT's, ODOT would struggle to increase its workforce size due to difficulty in attracting qualified workers. Some districts

indicated that under such a scenario, increased use of outsourcing to local contractors would be required to fill the workload and leverage increased funding.³⁰

Peer States / Best Practice Findings

Indiana

INDOT outsourcing decisions are based on comparing the in-house unit prices from INDOT's MMS to contract unit prices. For example, when long term mowing (up to 6-years renewable) contract pricing was compared to the unit cost (per acre) of in-house mowing, INDOT started outsourcing this activity. INDOT also funded a university research study to assist in analyzing unit pricing comparisons and contract terms to leverage the most economical cost.

Michigan

As indicated previously, Michigan entered a performance-based contract with a private contractor to cover all routine maintenance activities in one of the counties. This is a contracting concept that has been in effect for 20 years in multiple other states but is the first for MDOT. The multi-year lump sum contract includes all maintenance activities and outcomes are determined by performance threshold criteria. The contractor is paid equal monthly installments with penalties subtracted for not meeting performance standards. MDOT stated the contract is early, but so far outcomes have been positive.

Additionally, MDOT outsources routine maintenance operations to 63 of the 83 counties in the state through reimbursable agreement.

North Carolina

NCDOT provided numbers for in-house versus outsourced maintenance expenditures. Based on a 3-year expenditure average for the funding categories below, NCDOT's contracts approximately 70% of its maintenance work and self-performs around 30%:

- General Maintenance Reserve
- Contract Resurfacing
- Pavement Preservation
- Bridge Preservation
- Routine Maintenance

However, by removing resurfacing, pavement preservation and bridge preservation from the mix the breakdown is 60% in-house and 40% outsourced, reflecting traditional routine maintenance activities only. All mowing and guardrail repair are accomplished through contracting. This data was readily available from NCDOT's SAP ERP system, but NCDOT stated that this information can be easily reported directly from its MMS. NCDOT's addition of a contract tag for each maintenance activity code supports this reporting capability and is a noteworthy practice.

Analysis

ODOT was unable to provide the data to compare in-house maintenance spending to contract maintenance spending and does not track or compare these delivery methods on a unit cost basis. This information should be readily available either through an MMS or agency financial system to inform the

³⁰ See 'Combined District Interviews_3_sorted' question 30 - Resource Allocation

decision-making process. Subjective estimates of percent of maintenance work contracted were offered from the districts.

Peer states reported using a function within their MMS that tagged any charge from a contract with a simple check box or alternatively using a set a parallel activity codes for contracted work. This allows peer states easy tracking of contract dollars spent and allowed for a comparative analysis with in-house costs. Although costs is not the only consideration when deciding whether a activity should be outsourced, it is an important component of that decision and serves as an acceptable justification for contracting decisions.

Recommendations and Benefits

9. *Make effective use of outsourcing to level resource requirements*

Benefits:

- Effective use of outsourcing can help balance internal resource availability
- Leverage specialized skills available in the private market
- Utilize resources on an as-need basis by lowering carrying costs of responding to infrequent activities

10. *Track all activity costs to support informed outsourcing decisions*

- Track contractor payments to charge costs directly to appropriate activity
- Use uniform units of measure for unit price comparison
- Track unit price measure to compare outsourcing with in-house costs
- Production rates and unit price targets should be established for both in-house and contract maintenance for each district

Benefits:

- Help determine comparative costs of contractor-performed activities
- Provides a means of benchmarking internal and externally performed activities to support making informed outsourcing decisions
- Helps make “highest and best use” of internal resources
- Supports performance benchmarking

District Oversight

Work Measurement

ODOT Baseline³¹

ODOT relies on its 12 districts to deliver the maintenance program, manage inventory, plan daily work assignments, and maintain the infrastructure at an acceptable level of service. The districts have a significant amount of autonomy and control of labor, equipment, materials, and administration of contracts.

³¹ See 'Combined District Interviews_3_sorted' 'District Oversight' questions 31-49

Critical to the success of these efforts is the ability to accurately capture cost and work accomplished data on various maintenance activities. ODOT's maintenance management system, EIMS, was procured to support this need.

Maintenance Management System

ODOT's EIMS uses activity codes, time entries, materials usage and costs, and location information to track efforts and accomplishments. Critical factors with respect to the usefulness of information captured and reporting of results include data capture accuracy, consistency, and knowledge of how to create the proper reports (or exports) from EIMS.

Districts that are adept at running EIMS can create reports by cost center, budget allocation, encumbrances, and expenditures. EIMS allows these districts to track unit cost through queries. However, even the districts that indicated they were capable of analyzing work accomplishments by specific road segments or asset or maintenance activity seldom perform such analyses. Instead, districts depend on CMs to subjectively provide input on needs and accomplishments even though CMs have access to the same EIMS report queries.

Very few districts describe being concerned with tracking or comparing the unit cost of routine maintenance work.

Many (but not all) districts thought the EIMS was adequate but perceived that the original configuration was not optimal, and that the system required a difficult learning period. However, once the system was set up properly and thorough training was provided, districts experienced fewer problems.

Some TAs and TMs report having experience and being skilled at generating reports from EIMS. However, most counties and/or district offices depend on the local Administrative Professional's (AP) understanding and training of EIMS to obtain that information.³² Anecdotally, APs hired after the current EIMS implementation seem to more easily grasp the system and are able to leverage its capabilities because they were not accustomed to the previous system.

Even districts that reported difficulty accessing the targeted information acknowledged that the needed information likely is in EIMS; districts just do not know what data to query or how to report the targeted data. Districts acknowledge that if their confidence in the data input is good, then the outputs should be useful.

One disappointment voiced by every district is that ODOT field personnel were expected to have handheld devices for crews to capture work that uploaded to EIMS. However, when EIMS was implemented the decision was made to continue with paper-based day cards instead of the mobile application. This was not only a disappointment at the county level but created a system where information transfer was more open to data entry error.

Other Systems

The most popular application in use by the districts and county garages is an iPad application that supports the biweekly inspections of all routes. TMs cover all ODOT maintained routes every two weeks to identify problems in all categories. Some categories including bridge, pavements, signs and geohazards are prepopulated, but they can add other categories under miscellaneous.

³² See 'Combined District Interviews_3_sorted' Question 32

The application is GPS-enabled, and a manager can input equipment and crew size needs as well as provide a photo of the work site. At the district level, it is used in making sure routes are inspected and that deficiencies are being addressed.

Priorities can be assigned (low, medium and high), which assists in work planning and prioritization. At the county level, the main use is for HT-3's planning their weekly work assignments.

Managers can also utilize the ODOT Linear Referencing System (LRS) to mark which sections have previously been inspected. The bi-weekly information collected also goes to a database/website, where statistics can be collected showing the number of deficiencies. Once a repair is made, the deficiency is then removed from the map.

Most all the districts are using this application and it is very popular among its users. One district reported, "The app is a game changer as to what was previously done. It would be helpful if it was linked to EIMS."

Feedback on work performance and how it is reported back to those performing the work typically occurs when HMAs hold a monthly staff meeting with their CMs. While not every district reported this exact method, each indicated using some method to provide feedback and share information with their county maintenance staff. District HMAs expect all CMs to take this information back to their garages since scheduling is the CM's responsibility and provide the HMAs with the results.

Peer States / Best Practice Findings

Indiana

Work planning involves a two (2) week scheduling process except for emergency response activities. By reviewing these schedules, crew leaders create system work orders.

Productivity is tracked depending on the project area and activity code. INDOT uses its MMS to compare district productivity across the state and monitor how project production rates are performed with smaller crews.

INDOT's MMS supports aggregating work units into equivalent units of work (such as linear feet for guardrail), even when multiple pay items are involved. This allows an equal comparison state-wide. INDOT's Operations Manual details the specific unit of measure for each work activity.

New York State

NYSDOT provides weekly work accomplished summaries of high-level work activity so every residency can see what is accomplished. This report comes directly from the NYSDOT Central Maintenance Bureau. NYSDOT currently is working on geospatial maps with maintenance data and providing it in a more useful form to include historical data. However, that information is not expected to be available for several months.

NYSDOT can produce work accomplished reports and exception reports to flag data entry errors.

North Carolina

NCDOT compares work accomplishments against what is planned, and reports are run throughout the year. In addition, Division Engineers are reporting accomplishments to the Chief Engineer's Office every couple of months, and have the ability to generate reports at any time to look for discrepancies from their MMS.

Annually NCDOT provides a required presentation to the Joint Legislative Transportation Oversight Committee of maintenance activities the Agency is planning to do for the year. Legislatively required programs that are multi-year also include annual interim reporting schedules to make sure the multi-year plan is being followed.

Targets for statewide baseline unit costs of core maintenance activities were created based upon legislative requirements. At one time these costs were reported quarterly but are now done annually to compare actuals to target levels. This is all done at statewide level.

Divisions often use unit costs for planning purposes, which can help in assessing resource allocations. This is done by aggregating work activities into asset level to see how much has been expended. NCDOT can filter anything in the database and noted that the MMS system is good for database management. It can also input ad-hoc work to a location.

NCDOT's updates and tracks work accomplishment consistency. Activity codes are used for all maintenance activities. However, tracking productivity of work accomplishments and production rates has become less of an executive focus in recent years.

NCDOT performed studies aimed at optimizing crew sizes in the 1980's with updates in the late 1990's. These studies also identified target production rates and staffing requirements for most maintenance activities. This information is included as guidance in the NCDOT Maintenance Manual. However, these studies and standards have not been modified since that time.

Of note, NCDOT has modified its list of maintenance activity codes to differentiate between in-house performed and contracted maintenance work for reporting and comparison purposes.

Kentucky

KYTC tracks work performed using activity codes. An MMS report is generated every year to help identify activity code errors. In most districts, field crews report work accomplishments to a timekeeper who enters time sheets into MMS. Each district has a coordinator that notifies the Central Office about training needs and system related concerns. There is also an approval process for work orders where work orders open for two weeks or more are reviewed by a central office System Administrator.

KYTC presets the units of measure for maintenance activities in the MMS and crews report work accomplished based on those units. The majority of maintenance activity codes report accomplishments on the basis of man-hours. This shows general trending and identifies activities with the highest cost but does not provide insight into productivity.

Kentucky uses capital maintenance funds differently than many states, by splitting out asset management related work and including a preservation program. Some federal funds are used for interstate and bridge projects, but mostly the capital maintenance is a statewide system. Guardrail is often included in the six (6) year plan for upgrades or replacement.

Analysis

Full integration of the necessary tools to manage a maintenance program include the need to plan, budget and track work activity at multiple levels of management. ODOT currently maintains components of information about the condition of assets, maintenance budgets and work progress in several different and disconnected systems. There is no single, easily accessible one-stop source of information to inform maintenance decision making. Further, there is little formal monitoring of the routine maintenance program from a cost and productivity standpoint at a statewide level aside from winter maintenance. Either a single repository of maintenance-related data or alternatively integration of the existing disparate systems is needed to seamlessly plan, execute and report on each phase of operations. This type of information should be accessible to districts and all levels of management and comparative analysis reporting should be performed at a statewide level. All of the peer states interviewed are utilizing their MMS software to a much greater extent than ODOT to inform maintenance decision making and track performance. Productivity of both contracted and in-house forces are tracked and analyzed in MMS by several states along with continual tracking of expenditures compared to planned work.

The 2007 AASHTO Maintenance Manual encourages the use of an integrated management system to evaluate tradeoff decisions between different actions at different times in an asset's life cycle. ³³ By integrating these components, choices are made based on comparisons of cost and the consequences of meeting performance targets.

Recommendations and Benefits

- 11. Use performance-based work planning, tracking and budgeting functionality available through ODOT's MMS software to support informed decision making for routine operations***
- 12. Track unit cost for both in-house and outsourced activities***
- 13. Track contractor payments to charge costs directly to the appropriate maintenance activity***
- 14. Perform analysis of EIMS maintenance data input by districts to provide comparative and exception reporting on a statewide basis***

Benefits:

- Identifies comparative costs of contractor-performed activities
- Provides a means of benchmarking internal and externally performed activities to support making informed resourcing decisions
- Provides a 'target' efficiency statistic by benchmarking unit cost for each district
- Helps make "highest and best use" of internal resources
- Supports performance benchmarking

Work Order Entry

ODOT Baseline³⁴

Work order entry for maintenance follows a manual process. ODOT AP's currently enter paper-based day cards submitted by crews that are generally checked by the TMSs'. Common mistakes in data entry that have been identified are being addressed by the TCORE Steering Committee (discussed below).

Service requests are handled by the county offices. There is not a formal database or tracking system in place to track when a service request was logged and when it was resolved. Of note, EIMS is configured to track bridge inspections.

Data Quality Control

The TCORE Steering Committee is the enterprise governing body accountable for all program activity codes, accomplishments, business rules, and quality control of data. TCORE's focus is on transition plans, as well as the post implementation activities needed to ensure a successful deployment of the replacement system application(s) for EIMS. The TCORE Steering Committee provides direct oversight and organizational direction on day-to-day activities of the current EIMS Steering Committee.

The TCORE Steering Committee was formed at the end of December of 2019 after ODOT decided it needed to include all areas of ODOT, not just operations, in data entry standardization. Once TCORE has worked

³³ 2007 – AASHTO Maintenance Manual

³⁴ See 'Combined District Interviews_3_sorted' 'District Oversight' questions 31-49

through and documented all program activity codes, accomplishments and business rules of how business is performed, the focus will shift to best practices and efficiencies. At that time, alternative activity codes and business rules as required will be identified to align with those that are agency wide.³⁵

TCORE has included managers from across the state to look at productivity of work and the committee realizes the importance of charting productivity and attributing work performed to specific assets or road segments. In the previous MCR system, OPI measurement was aimed at production but the accuracy was not good. One HMA interviewed believed the quality of work suffered when production was the focus.

TCORE has been looking at cost by activity and has done some comparison at the county and district level, but this is a limited effort. Some of the TCORE studies noted those districts that appeared to be doing well with respect to low or competitive unit costs were often coding wrong or the conditions were unique and different from the routine.

None of the districts interviewed reported having targets identified for unit costs. While some districts have done limited comparisons with unit cost to other districts in the past, this is not a common metric being used. One district reported that guardrail and mowing are areas where unit costs can be compared.

One district reported being interested in using unit cost metrics to assist in making an in-house versus outsourcing decision. Unfortunately, some districts report a lack of confidence in the accuracy of the work accomplished data, which is critical in the unit cost calculation.

Peer States / Best Practice Findings

Indiana

INDOT staff interviewed outlined a reporting process similar to that used by ODOT for identifying maintenance needs based on observed deficiencies. In their process, supervisors drive roadways weekly and record findings via a deficiency application. This process has been in place since 2003 and it has created greater accountability over time. Now, all collected information goes into MMS and is integrated through the EXPLORE app to show location and to select needs where supervisors take a picture of the deficiency and the system then generates a work request.

Crew leaders also are responsible for capturing each employees' actual work hours on the job site. Once a work order is complete, the labor cost is captured into *PeopleSoft*, INDOT's timekeeping and accounting system.

Michigan

Work orders are processed at the county level where crew supervisors can create them in the field or on a computer. They then create the activity with the appropriate activity code, crew, and equipment. Crew leaders might do it all, but ultimately garage supervisors or maintenance coordinators will generally approve and close out the work. There are quarterly evaluations to eliminate/identify work order anomalies via an index on how well responses are carried out. If damage is present, there are key parameters to see if a work order is included. MDOT noted that when it comes to planned work vs actual work, there's noticeably increasing utilization in the system.

Analysis

Peer states such as Indiana DOT utilize a defect identification process where the data is stored directly to their MMS. This allows the data to be more easily transitioned to a work order for repairs to be

³⁵ See Email – Mike Moreland, Re -TCORE dated 4/8/20

scheduled and completed. It is logical to keep as much usable data as possible under a single point of access to assist in identifying, planning, and scheduling work.

ODOT's use of mobile devices to identify defects on a bi-weekly basis is a noteworthy practice and one of the more progressive asset management tools in use by the department. To fully leverage this information, it is recommended that the department integrate the platform with EIMS to track, prioritize, manage and report on the defect data more easily.

Recommendations and Benefits

15. Integrate bi-weekly assessment data collected through mobile devices with EIMS

16. Track all service requests in EIMS

Benefits:

- Integration of mobile data collection platforms with EIMS would eliminate manual processes and support more efficient planning, execution and reporting of maintenance activities
- Supports leveraging the EIMS system to provide enhanced management reporting
- Supports overall agency performance management and reporting

Inventories

ODOT Baseline³⁶

Some ODOT asset inventories such as bridges or culverts are incorporated into EIMS, making it easier to track the expenditures on those specific assets. Otherwise, work accomplishments are tagged to the route and road section along with associated costs by activity. Decisions on asset inventories are principally based upon agency preferences and the objectives of their asset management programs as the cost associated with collecting and updating asset inventory data can be extremely high.

Peer States / Best Practice Findings

Indiana

INDOT has collected significant inventory information. Most inventory and condition data collected is perceived as accurate. Asset inventory data is stored in their ESRI Roads and Highways application and pushed into MMS through an interface so that the maintenance team can access information on needs and book work accomplished to an asset or roadway segment.

Kentucky

KYTC has a sign inventory included within its MMS that uses machine learning to identify photo log images that can pull inventory from the image.³⁷ Imaging may pick up height, but not necessarily condition. KYTC also has a barcode system in place for signs that updates to MMS inventory and records date installed, type of sign, etc.

The collection of culvert inventory data is in progress, but not statewide yet.

³⁶ See 'Combined District Interviews_3_sorted' 'District Oversight' questions 31-49

³⁷ The Kentucky Transportation Center at the University of Kentucky (<http://ktc.uky.edu/>) is providing this capability.

New York State

Historically, NYSDOT only collected bridge, pavement, and culvert inventory but now the agency has a complete inventory of major assets which is stored in a geospatial warehouse. Inventory is recorded with a unique ID number where work is managed against the designated inventory.

Asset inventory is housed in a different system than the AgileAssets MMS. Currently NYSDOT is in the process of putting this data in the geospatial database and is still in the testing phase. Integration and access to inventory data in MMS will be accomplished through an interface in the future.

North Carolina

Inventory data is housed in ARC GIS with the long-term goal of moving it into the AgileAssets AMS platform. This has been somewhat challenging based on incorporating a large number of pictures. However, this data can be readily accessed through MMS. With its large network, NCDOT notes that it is very expensive to collect inventory data through consultants; therefore, NCDOT field Divisions provide support for this activity. NCDOT has also historically relied on its maintenance condition assessment program (MQA) for assessing and reporting on maintenance needs and condition by asset type as a surrogate for collecting an extensive inventory. They leverage this MQA data to perform maintenance planning and budgeting by asset type based upon statistical sampling of asset conditions and a projection of cost based on historical spending to achieve a target level of service.

Analysis

Most ODOT bridge and culvert inventory data are available in the EIMS management system. However, ancillary asset inventory and condition data is stored in an ESRI database and not accessible through the EIMS. As a result, data on maintenance history, i.e. worked performed on these specific assets, is not being captured and is therefore not available to support life cycle planning and analysis

Note: ODOT is currently researching and evaluating options for managing asset inventory and condition data.

Most peer states either directly store asset inventory data in MMS or that data is available to the MMS through an interface. This allows maintenance teams to easily access that information and update inventory counts and conditions, and track expenditures by asset type.

Recommendations and Benefits

17. Either make EIMS the system of record for asset Inventory and condition data or make this data readily accessible via interface with the database which in which it is maintained

18. Track all transportation asset maintenance activities and accomplishments by roadway segment or specific asset in EIMS

Benefits:

- Improves tracking and reporting of work costs and accomplishments by asset type to support life cycle planning and analysis
- Supports leveraging the EIMS system to provide enhanced management reporting on performance and maintenance needs
- Make better use of inventory data in EIMS to develop work plan projections

B. Collection and Analysis of Condition Data

Drainage Maintenance

*ODOT Baseline*³⁸

ODOT has a very detailed culvert inventory that is supported by asset condition data collection and analysis. The availability of this information allowed ODOT to include culverts in the 2019 TAMP as a key asset using the terminology of “conduit”.

Culverts and drainage systems are a high priority for the routine operations and capital maintenance programs and a significant effort is required to coordinate culvert and other drainage system work. Culvert materials include concrete, plastic, and metal pipe. In lieu of replacement, ODOT has made use of slip-lining or other rehabilitative techniques when practical to extend culvert useful life, avoiding deep excavations and road closures.

Although drainage standards are included in the MCR, districts typically will have even more stringent standards. For instance, District 1 has two (2) staff members that inspect 20% of the system each year and assign a condition rating for culverts. Effectively, every District 1 culvert is inspected every five (5) years. Further, districts also look at the whole drainage system in addition to just the pipe itself and will create work orders as needed for ditch cleaning, erosion control, , cleaning pipe etc. If the inspection is rated a GA 4 or below in the condition assessment, then work is scheduled to replace it. Other culverts rated as poor will be inspected more frequently.

By policy, all culvert replacements require an environmental review for each location. Any major drainage maintenance activity also requires environmental review. Replacements require videos as documentation of need from an environmental perspective.

District drainage crews are overseen by an engineer that is responsible for 24 inch and larger drainage structures. Districts use a statewide database for updating culvert inventory and condition data.

Peer States / Best Practice Findings

Indiana

INDOT has a major focus is on small culvert maintenance, evaluating structures under 36 inches in diameter every year. There are two (2) employees per district evaluating small culverts and assessing them for flow, material, and structural condition. These employees apply culvert ratings via a GIS application. Based on their information, the Asset Engineer and Technical Service team develop a replacement plan. For minor repairs, INDOT uses a software application to place a work request. All culverts rated in a condition of four (4) or below are actively monitored.

INDOT is conducting a considerable amount of manual drain cleaning and they are moving towards cleaning a quarter of drains and inlets each year starting in July 2020. The ultimate target is 100% but that goal is not considered to be practical on a statewide basis at this time. As a result, INDOT is starting with major metro areas with a drain cleaning goal of 100%.

North Carolina

NCDOT uses prescribed culvert maintenance standards that are based on a life cycle approach. However, NCDOT also uses threshold criteria for assessing conditions for most asset elements through its MQA

³⁸ See 'Combined District Interviews_3_sorted' 'Collection and Analysis of Condition Data' Question 50

program. For many maintenance elements, there is a response time of 7 days to repair or mitigate upon observation or notification.

A 50-year replacement cycle is assumed for most pipe culverts but NCDOT will also replace them as condition warrants, such as when there is a significant failure or a pending hazardous issue.

NCDOT follows the NBI definition for bridges. Pipes and culverts greater than 48-inch diameter are inventoried and periodically inspected.

Kentucky

KYTC includes culverts and ditching criteria in its MRP program. Assets are evaluated as passing if they have less than 25% blockage.

Analysis

ODOT's culvert maintenance program is considered a maintenance best practice. ODOT has a very detailed culvert inventory that is supported by asset condition data collection and analysis.

Recommendations and Benefits

No recommendation

Pavement Markings

ODOT Baseline

ODOT retraces pavement markings annually with fast dry, water-based paint. While some striping is performed in-house, most of this work is contracted. The ODOT Maintenance Office revised its standard for pavement marking to include the use of wet reflective beads to be included for better retro-reflectivity.

Raised Reflective Markers (RPMs) are used on all state routes and are replaced every three (3) years and/or as needed in areas where damage occurred. There is a visual inspection of all routes each year to look for failing pavement markers and markings. RPMs also are assessed during the bi-weekly inspections to determine missing lenses and castings.

Kercher was unable to identify a performance standard for the maintenance of striping and RPMs other than the ODOT MCR.

Peer States / Best Practice Findings

New York State

NYSDOT retraces pavement markings annually using a water-based paint.

Kentucky

KYTC retraces pavement markings annually using reflectivity as the performance standard.

Analysis

ODOT utilizes a prescribed cyclical replacement standard for pavement markings and RPM's that is in line with peer states and AASHTO guidelines.

Recommendations and Benefits

No recommendations

Signs

ODOT Baseline

ODOT includes signs in its MCR condition assessments. These assets are evaluated in terms of being missing, damaged and having visibility obstructed.³⁹

ODOT previously conducted retro-reflectivity inspections but determined that sign reflectivity performance was generally acceptable up to 15 years. As a result, all sheeting is replaced on a 15-year cycle and is handled by the district Traffic Department.

District traffic engineers are responsible for determining sign replacement frequency. The districts have traffic groups that periodically inspect signs. ODOT reportedly has begun a sign inventory process.

Peer States / Best Practice Findings

Michigan

MDOT follows a 15-year sign replacement program. Damaged signs are to be repaired or replaced as soon as possible.

New York State

NYS DOT does not follow a specific cycle for sheeting replacement; instead, sign sheeting is replaced based on informal condition inspection and needs. The performance standard for critical signs such as yield and stop signs is to provide an immediate response and repair when damaged or not properly functioning.

Kentucky

KYTC's threshold replacement criteria for height and angle is determined by a visual assessment. Signs are not assessed for nighttime visibility.

Analysis

Since conditions vary from location to location, the uniform 15-year replacement schedule of all signs may not result in optimum service levels. For instance, signs facing southward may deteriorate more rapidly from ultra-violet light exposure. Weather variations statewide can also play a role in deterioration of sign facing. Since ODOT collects MCR data on signs, it may be advantageous to include nighttime visibility in this assessment.

Recommendations and Benefits

19. Supplement 15-year sign replacement schedule with assessment condition data

20. Include a nighttime visibility criterion with MCR assessment

Benefits:

- Provide a critical visibility performance criterion
- Provides data for validating or revising sign replacement cycles based on actual performance
- Provides a needs-based performance criterion

³⁹ MCR Manual.pdf

Protective Barriers

ODOT Baseline

Protective barriers include guardrail, concrete median barrier, and cable rail. ODOT has proposed MCR standards for protective barriers but barriers are a dynamic and ever-changing asset.

Public law enforcement agencies responding to accidents provide notification to the districts of damage to protective barriers. . Otherwise, biweekly inspections are the source of this information.

The Kercher team found no ODOT performance standard for responding to functional damage to barriers. However, some districts reported an unofficial 72-hour repair response time target. In interviews, some districts reported self-performing repairs with in-house crews while others utilize contractors.

Contract-performed barrier repairs were informally referred to as “ding and dent” contracts. Where a contract was in place, the contractor usually had 24 hours to complete repairs for locations deemed as emergency. Other functional, but damaged locations required a 72-hour contract response period.

As much as 80 percent of guardrail damage was estimated to be reimbursed through third party insurance claims. As previously indicated, accidents are usually reported by local law enforcement. ODOT county garage staff investigate and document the damage with photos and location information.

After the repairs are made, the ODOT county office provides the actual cost of repairs versus an initial estimate and submits this to the district finance staff. In turn, the district forwards this invoice to ODOT headquarters for processing to insurance companies. Sometimes there is a variance in the damages that law enforcement officers estimated, which can cause a challenge in collecting the third-party reimbursement. This reimbursement is returned to the district where the damage and repair took place.

Peer States / Best Practice Findings

Indiana

The repair policy for INDOT is that a repair must be completed within 15 days of observation or notification. This is part of the customer service process and involves a team that assesses the damage. INDOT uses contractors to perform this work due to perceived expertise concerns.

Michigan

MDOT requires barriers to be repaired as soon as possible due to concerns of possible secondary hits. MDOT uses some private contractors for these repairs and in such cases, the performance standard is to have repairs completed within 14 days. The typical repair schedule for self-performed, non-hazardous locations repair locations is 30 days.

North Carolina

NCDOT has a guardrail repair performance standard requiring repairs to be completed within 14 days notification or observation.

Analysis

Most peer agencies included a performance standard and/or timeliness requirement for barrier and guardrail repair. Ensuring expedient repairs to damaged concrete or rail barrier is critical to public safety. Subsequent hits to a damage barrier section represent an immediate hazard and can be a legal liability.

⁴⁰FHWA recommends in its W-Beam Guardrail Repair guidance document that; “It is important that each

⁴⁰ FHWA ‘A Guide for Highway and Street Maintenance Personnel’ W-Beam Guardrail Repair

agency develop guidance for when to make repairs.” The FHWA document also has provided definitions for functional damage and guidance to repairs to functionally damaged rail.

Recommendations and Benefits

21. Establish a performance standard and/or timeliness requirement for barrier repair

Benefits:

- Provide more holistic asset management
- Improve safety and reduce risk

Shoulders

ODOT Baseline

ODOT has a performance threshold identified in its MCR that unpaved low shoulders should have not more than a two (2) inch drop off and high shoulders should be leveled. ODOT uses the previously described biweekly inspections to identify these deficiencies, which are then scheduled for repair in the work plan.

ODOT wing plows (used on many of its snowplow trucks) for snow and ice removal often damage the unpaved shoulder. Accordingly, spring is considered the best time to focus on reshaping shoulders. Some districts try to cover 80% of network annually. ODOT roadway shoulders typically are constructed with an aggregate gradation mix that allows for good compaction.

Peer States / Best Practice Findings

Indiana

INDOT identifies shoulder maintenance needs based on a strict assessment using MQA criteria. However, INDOT indicates that it is moving towards adding a cyclical (time-based) approach as well.

Michigan

The performance threshold criteria for scheduling repairs to shoulders is the presence of drop-offs equal to or greater than two (2) inches. There are no prescribed standards or cycle repair for shoulders.

Analysis

ODOT has an existing performance measure for shoulder maintenance that is consistent with its peers and generally accepted practice.

Recommendations and Benefits

No recommendation

Pavement Patching and Crack Sealing

ODOT Baseline

ODOT’s Pavement Management System (PMS) provides districts with recommendations on pavement treatments. The PMS project recommendations (work plan) are based on analysis of data collected in annual pavement condition surveys. PMS recommendations are used as a guide for planning the annual capital program. ODOT districts have a performance target of matching 75% of the pavement related projects in their annual work plans by location and treatment to PMS recommendations.

District and county staff work collaboratively to plan and schedule crack sealing and patching work in accordance with annual work plans and six (6) year pavement program recommendations. Districts plan crack sealing in advance of smooth seals and microsurfacing projects or possibly include crack sealing in

asphalt overlay projects. Districts try to seal both longitudinal and transverse cracks within 3-5 years after resurfacing has been done.

Potholes are more prevalent in and near the urban areas of the state where there is more traffic and in areas of greater winter activity. The MCR evaluates with threshold criteria, pavement deterioration including potholes, rutting, pavement shoving and obstructions such as blowups and manholes.

Peer States / Best Practice Findings

Indiana

INDOT Crack sealing on a 3-year cycle. Pothole priority is based upon severity for repair and GIS mapping is used to track needs. Unit supervisors and district leaders use the GIS coordinates to identify work locations.

Michigan

MDOT has a performance goal of addressing pothole repairs requests within 24 hours of notification.

New York State

NYS DOT has a performance goal of addressing pothole repairs within 24-72 hours of notification or observation.

North Carolina

NCDOT has a 48-hours response time standard for addressing pothole repairs once notified.

NCDOT follows a planned program for using dedicated pavement preservations funds to perform crack filling and sealing.

Analysis

ODOT's MCR performance threshold for pavement and crack sealing is consistent with peer states and AASHTO guidelines.

Recommendations and Benefits

No recommendation

Vegetative Control

ODOT Baseline

The ODOT Maintenance Office provides a clear directive on mowing standards and for following pollinator guidelines. Districts are to maintain a 30-foot clear zone and mow as many cycles as necessary on four (4) lane highways.

Districts mow all accessible right of way on two (2) lane routes. There is a more extensive 'cleanup' cycle to mow back once per year, usually in late fall or early winter. Typically, about three (3) routine cycles and one (1) clean up cycle are needed to mow to an acceptable standard.

All districts reported they had begun using growth inhibitors to control growth and reduce mowing cycles. Districts report spraying four (4) lane roadways out to 30-feet from the shoulder. Districts also are using herbicides to control noxious weeds.

Woody growth is controlled using both long-arm mowers and pole saws during the winter months to perform heavy tree and brush vegetation management. District 7 reports using brush cutter attachments on hydraulic excavators to clean around bridges during winter.

While there is no clear measurable performance standard for vegetation height, districts communicated a process for determining the number of mowing cycles needed to produce an acceptable vegetative control performance.

Peer States / Best Practice Findings

Indiana

Last year Indiana made a decision to contract all mowing statewide. INDOT has a statewide standard template that is 15 feet from edge of pavement except for medians depending on the width. Trimming is conducted around all culverts, guard rails, and objects to include a 5-foot diameter clearance.

INDOT Mowing Cycle Standards are as follows:

- Major Metro - 5 mowing cycles per year
- Rural interstate – 3 cycles,
- Everything else - 2 cycles per year

Annually contracted herbicide spraying includes a 30-foot swath for weed control with spot treatment annually targeting invasive species. Contract support requirements include provisions that support tracking for where herbicides are applied and where invasive species are surviving.

Michigan

MDOT's prescribed mowing standard is two (2) cycles per year. Suburban areas may require custom mowing cycles. County contracts allow a reduction to one (1) cycle if conditions support. Most MDOT-contracted counties use subcontractors for this work.

Kentucky

KYTC statewide mowing standards identify three (3) cycles/year but no supporting criteria are identified in KYTC's MRP manual. Mowing in most districts currently is contracted but rising contracting costs have caused districts to trend towards bringing this work in-house. KYTC notes that vendor consolidation and the resulting loss of competition likely is reflected in the higher unit prices.

KYTC's MRP also includes a tree overhang standard for ensuring a minimum clearance.

Analysis

Performance standards for mowing have moved to a more prescribed standard in recent years with peer and best practice states. ODOT has a detailed mowing standard for routine and cleanup mowing with cycle dependent on conditions. ODOT is increasing its use of herbicides to regulate growth and reduce mowing cycles.

Recommendations and Benefits

No recommendation

Litter Collection

ODOT Baseline

ODOT conducts two (2) distinctive litter collection activities: 1) removal of heavy debris that poses an immediate hazard to motorists, and 2) collection and disposal of light litter that is aesthetically displeasing.

ODOT interviews indicated that no condition standard exists for light litter control and identified no examples of routinely scheduled full litter cycles to canvas specified high visibility routes. As such, there is no standard measure for the effectiveness of effort or for the quality control. Lacking objective,

quantifiable measures, ODOT relies on subjective assessments. In practice, litter collection normally occurs at least for large items prior to a mowing cycle.

ODOT utilizes state and local inmate labor to supplement litter pick up activities and pays the state Department of Corrections through a broad statewide agreement. This agreement specifies the routes for litter pick up and ODOT retrieves the bags from the right of way.

In some counties, ODOT has been successful supplementing other routes with inmates from local sheriff departments. Also, ODOT has an *Adopt a Highway* program for volunteer groups. While most rural areas get occasional complaints on litter, urban districts/urban areas typically receive more negative comments.

ODOT in-house crews routinely patrol interstates and pick up heavy debris such as tire treads and big litter objects that pose a hazard to traffic.

Peer States / Best Practice Findings

Indiana

As of 2019, INDOT contracts for litter collection in all districts. Metro areas have a higher standard for litter removal on roadways, including two (2) cycles/month in Gary and Indianapolis. For other metro areas, the cycle is once per month but can be adjusted for winter months if not needed or because of inclement weather.

Litter collection on rural interstates is programmed for five (5) cycles annually with one (1) cycle prior to winter and one (1) directly afterward. The other three (3) cycles align with the mowing cycles.

New York State

Litter is picked up before each mowing cycle but there is no prescribed performance standard. For reference, all bridges are washed on a two (2) year cycle following the winter season.

North Carolina

NCDOT performs litter removal through a combination of state forces, volunteers, and contracts. Litter cycles are common but the agency also follows-up on spot problem areas. Litter removal is aligned with routine mowing cycles. NCDOT uses inspectors from each Division's Roadside Environmental unit to inspect mowing and litter contractors and ensure cycles are completed.

Kentucky

There is a general appearance score criteria in the MRP. Litter cleanup is included in the mowing contracts.

Analysis

Litter standards vary among peer and best practice states since the evaluation of litter control can become subjective and difficult to measure. Agencies often detail a prescribed standard that includes and minimum number of cycles to coincide with mowing cycles plus additional spot litter pickup in problematic areas. As a minimum, agencies have some semblance of a quality assurance process to ensure litter removal cycles were accomplished and to the quality of the effort.

Performance measures with threshold criteria typically include a volumetric measure of litter, either with a count of the number of pieces or estimation of volume over a specified area.

Recommendations and Benefits

22. Establish a prescribed QA process or a performance measure standard for litter as a guide for district maintenance planning

Benefits:

- Provides performance expectations
- Supports positive customer experience
- Contributes to statewide consistency
- Verifies effectiveness of litter maintenance cycles
- Verifies quality of litter removal performance by contractors or in-house forces

APPENDIXES

Appendix A: Peer State Maintenance Management Interview Summaries

Appendix B: ODOT Maintenance Forces Internet Survey Question Details