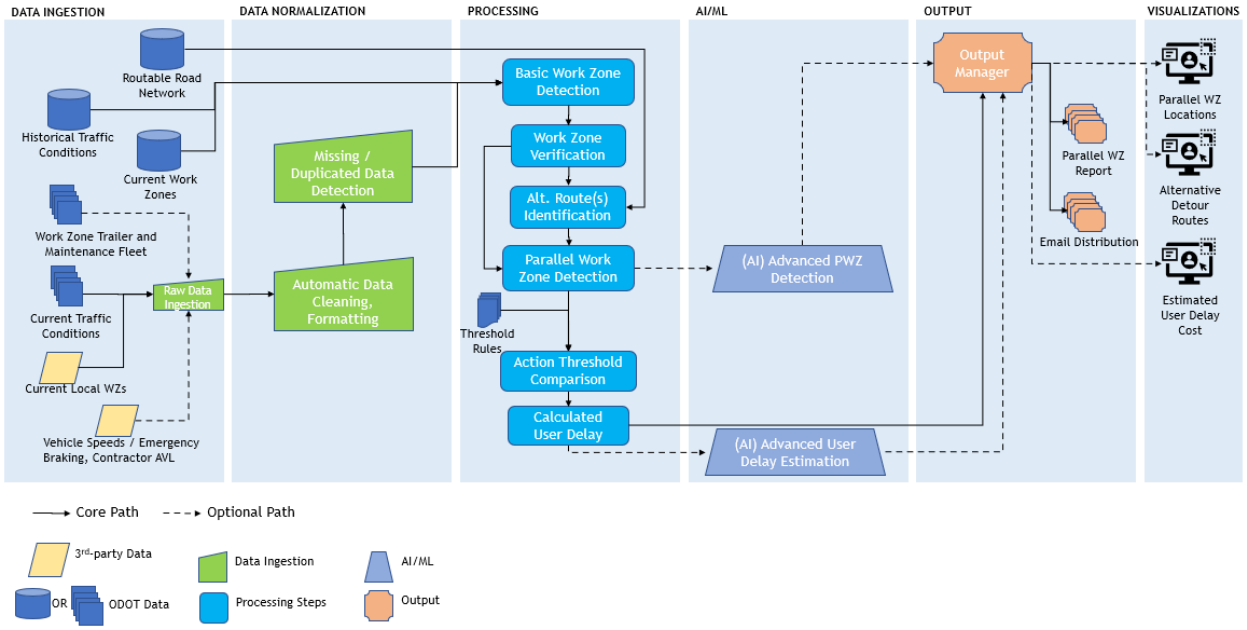
Achieving Efficiencies within ODOT with the Event Streaming Platform



Prepared by:
Mallory Crow, PhD, PE
Paul A. Avery, MSME
John Fuller, GISP

Prepared for:
The Ohio Department of Transportation,
Office of Statewide Planning & Research

Project ID Number: 114247

August 2023

Final Report

AECOM

RESEARCH

U.S. Department of Transportation
Federal Highway Administration

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/OH-2023-12		

4. Title and Subtitle	5. Report Date
Achieving Efficiencies within ODOT with the Event Streaming Platform	**August 2023**
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Mallory Crow, PhD, PE **Paul A Avery, MSME** **John Fuller, GISP**	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
AECOM Technical Services, Inc. **277 West Nationwide Blvd.** **Columbus, Ohio 43215**	
	11. Contract or Grant No.
	36499

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Ohio Department of Transportation **1980 West Broad Street** **Columbus, Ohio 43223**	**Final Report**
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The goal of this research is to achieve efficiencies within ODOT for the Event Streaming Platform (ESP). This research queried potential Use Case data from several of the divisions and two of the districts at ODOT with the goal of identifying current tasks that may benefit from automation, tasks that are redundant or use multiple systems to draw a conclusion, and data gaps. From the data collection, 17 Use Cases for ESP were identified for analysis across ODOT. The additional data points collected may identify other improvements outside of the ESP platform which are data provided to ODOT for an increase in benefits from this research.

The research developed a high-level statement of work (SOW) and a summarized one-page information sheet for each Use Case that may be used when ODOT is ready to pursue the development within the ESP environment. Using a scoring method based on relative cost and reusability, each Use Case is scored to determine an optimal implementation plan, or Roadmap.

17. Keywords	18. Distribution Statement
Event Streaming Platform, ESP, Use Case, Data Efficiencies	**No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161**

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	**Unclassified**	**102**	

Form DOT F 1700.7 (8-72) **Reproduction of completed pages authorized**

Credits and Acknowledgments Page

Prepared in cooperation with the Ohio Department of Transportation
and the U.S. Department of Transportation, Federal Highway Administration

The research team would like to thank the Technical Advisory Committee (TAC): Nick Hegemier, Preeti Choudhary, George Padavick, Kevin Hartman, and Tom Keller. Along with the TAC, this project was successful because of the valuable input from other ODOT personnel: Jamie Hendershot, Jonathan Young, Jen Alford, Jeff Sayer, Thom Slack, Jim Snyder, Renee Szymanski, Traci Luers, Josh Thieman, and all other workshop participants. Finally, the team would like to thank the ODOT Research Staff: Vicky Fout, Jill Martindale, Michelle Lucas, and Jennifer Spriggs, all who helped keep this project on track.

Table of Contents

List of Figures

List of Tables

List of Acronyms

ADT – Average Daily Traffic

AI – Artificial Intelligent

AVL – Automatic Vehicle Location

ESP – Event Streaming Platform

FHWA – Federal Highway Administration

FY – Fiscal Year

ITS – Intelligent Transportation System

LOS – Level of Service

ML – Machine Learning

MOT – Maintenance of Traffic

ODOT – Ohio Department of Transportation

SOW – Statement of Work

TAC – Technical Advisory Committee

TMC – Traffic Management Center

TSMO – Transportation Systems Management and Operations

UC – Use Case

1 Problem Statement

The Ohio Department of Transportation (ODOT) system is rated[1]:

- 5th largest in Nation, with More than 8,000 lane miles of Interstate,
- 2nd most bridges in Nation, with 27,000 bridge structures,
- 6th largest volume in the Nation with 1.38 billion tons of freight move annually in and through Ohio, and
- 4th in the Nation with 5,081 route miles of active rail mileage.

And ODOT is responsible for managing the roadway by improving safety, maintaining current assets, optimizing the current system, and enhancing capacity. ODOT accomplishes managing this system with more than 5,000 employees in more than 100 locations across the state[2] with a budget of $3 Billion in Fiscal Year (FY) 2022[3].

For ODOT to efficiently manage their infrastructure; the collection, procurement, and analysis of data are required. Mobility, asset, weather, safety, work zone, work force diversity, commercial vehicle, financial, purchase orders, and personnel retainment are samples of data that are used at ODOT to manage their services in an equitable manner.

With an operation of this size, the data collected can quickly become unmanageable due to the amount available. Furthermore, ODOT continues to find innovative methods for data analytics to provide valuable insights. One way to manage these data and create meaningful insights is through ODOT's Division of Information Technology's development of an Event Streaming Platform (ESP), which is expected to assimilate disparate data in both streaming and batch formats to automatically extract insights not currently available to ODOT staff.

Additionally, the ESP should help to automate a variety of routine and repetitive tasks, enabling ODOT to realize significant cost savings. ODOT desires to identify and address data gaps, data sharing issues, third-party data requirements, and process inefficiencies to improve the capabilities and usability of the ESP for all ODOT personnel.

1.1 Organization of Report

This report is divided into five Sections.

- Section 1 presents the problem that is to be addressed by this research project.
- Section 2 discusses the goals and objectives and how they will be addressed.
- Section 3 presents the methodology and steps taken within this research.
- Section 4 presents the research findings and conclusions.
- Section 5 includes the implementation details.

[1] ODOT Ranking Data
[2] ODOT Staffing Data
[3] ODOT 2022 Annual Report

2 Research Background

ODOT launched ESP in 2020 with the completion of setup and configuration of non-production ESP. ODOT completed the development of initial pilot use cases using INRIX speed data, incident data, camera data with output to the ODOT Traffic Management Center (TMC) and Transportation Systems Management and Operations (TSMO) data warehouse with the ESP. Currently, ODOT is in the process of development of data publishing and data discovery and setup of the production ESP. The identification of use cases is, and will continue to be, on-going and this research project supports that goal for ESP integration into ODOT.

The goal of this project is to identify efficiencies across ODOT for the ESP. Future application needs and data automation processes must be defined based on current ODOT personnel activity workflows, repetitive tasks, and activities and integration of cross-process and internal organization collaboration. Use cases and statements of work (SOW) must be developed to support ODOT personnel, other ODOT users, and future technology that can be employed using the ESP, as presented in Figure 1.

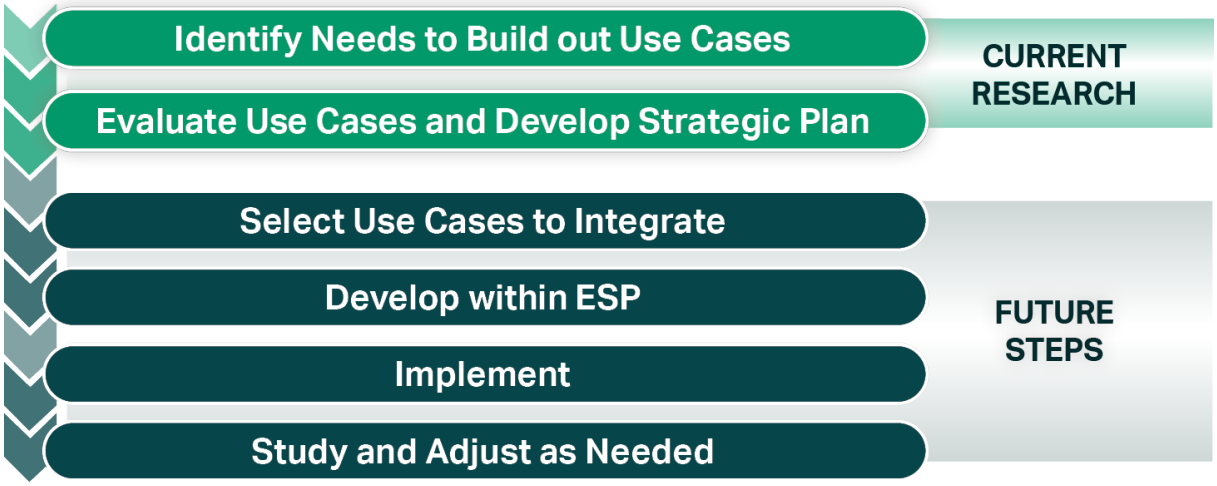
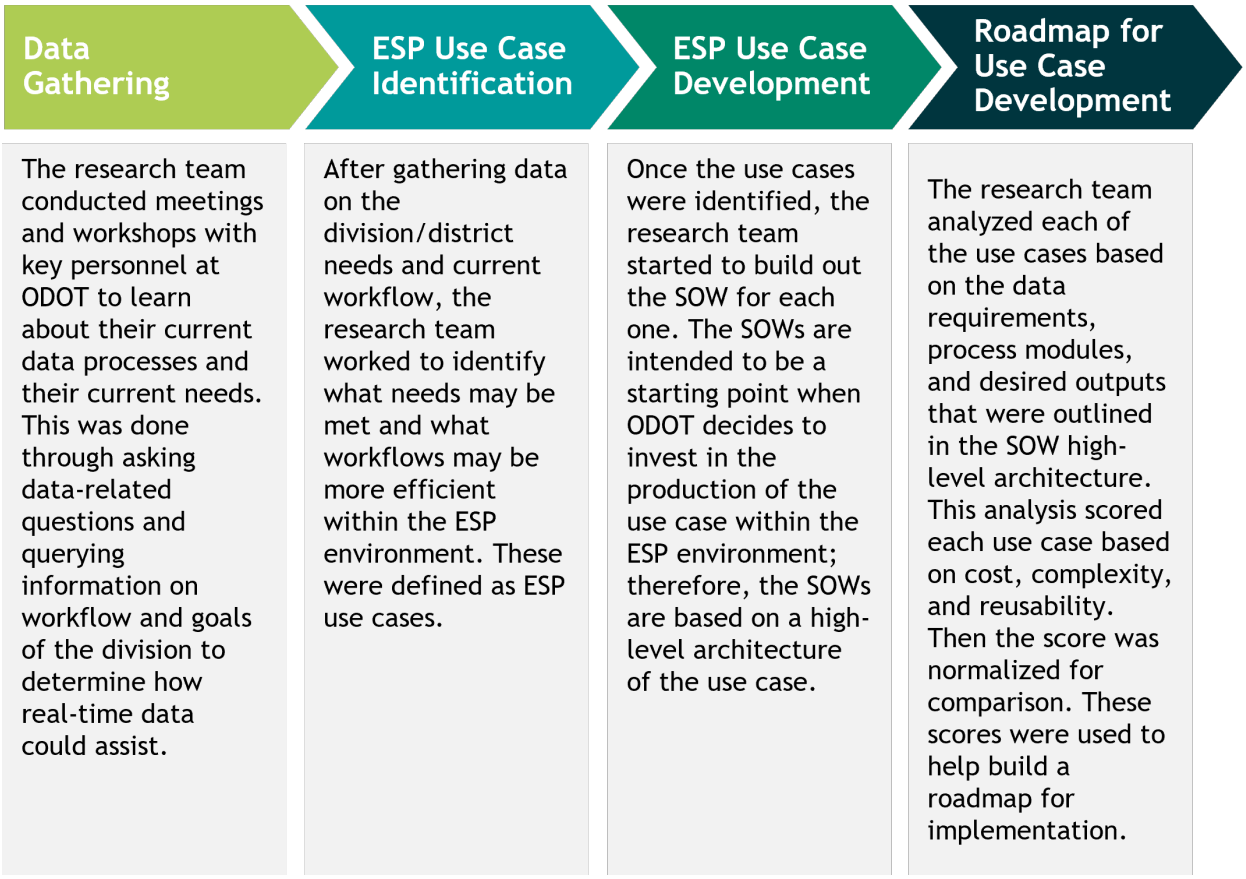


Figure 1: Goals of this Project

As seen in Figure 1, this research project is the starting point for future requirements to fully develop ESP applications.

The project was divided into two phases, which allowed the team to verify that methodology will produce meaningful and useful deliverables for ODOT in Phase One then continued the research further in Phase Two. Phase One collected, developed, and analyzed Use Cases specifically for the Division of Operations. At the completion of the deliverables for Phase One, the research team expanded the process for use case development into other divisions at ODOT Central Office and at two districts, one urban and one rural, to ensure research is considering the diverse demographic within Ohio. The project team also considered the Jusice40 disadvantaged communities when selecting the districts, to increase equity when selecting use cases.

The following is an outline of the tasks completed to meet the project goals:



More details for these tasks are presented in Section 3, Research Approach.

2.1 Benefits from this Research

There are several benefits from this research project:

- Identification of use cases for ESP across several ODOT divisions, departments, and districts.
- Creation of SOW which can be used for future development of the use cases within ESP. These SOW include a high-level architecture.
- Development of Implementation plan via roadmap for efficient deployment of Use Cases. This was accomplished by evaluating and scoring each use case.
- Continued exposure and education to ODOT personnel on ESP which can lead to additional use cases in the future.
- Removal of data silos and facilitation of data conversations across ODOT.
- Identification of additional improvements outside the ESP platform. During this project, workshops with internal ODOT stakeholders enabled discussions on data gaps, processes that could be improved, and other data issues or ideas for streamlining work processes. These discussions led to the use cases for ESP; however, additional data points collected may identify other improvements outside of the ESP platform. These data are presented in Appendix A.

3 Research Approach

The project was divided into two phases which followed the same methodology, with the only difference being the participants the team worked with to identify use cases.

3.1 Data Gathering

The research team worked with the Technical Advisory Committee (TAC) to select the divisions and associated department(s) that should be interviewed as part of data gathering efforts. Since the ESP is meant to support real-time metrics, Phase One focused on stakeholders from the Division of Operations. Phase Two expanded into collecting data from the Finance, Human Resources, Construction Management, and Engineering departments. Figure 2 presents the divisions and departments involved with this research project.

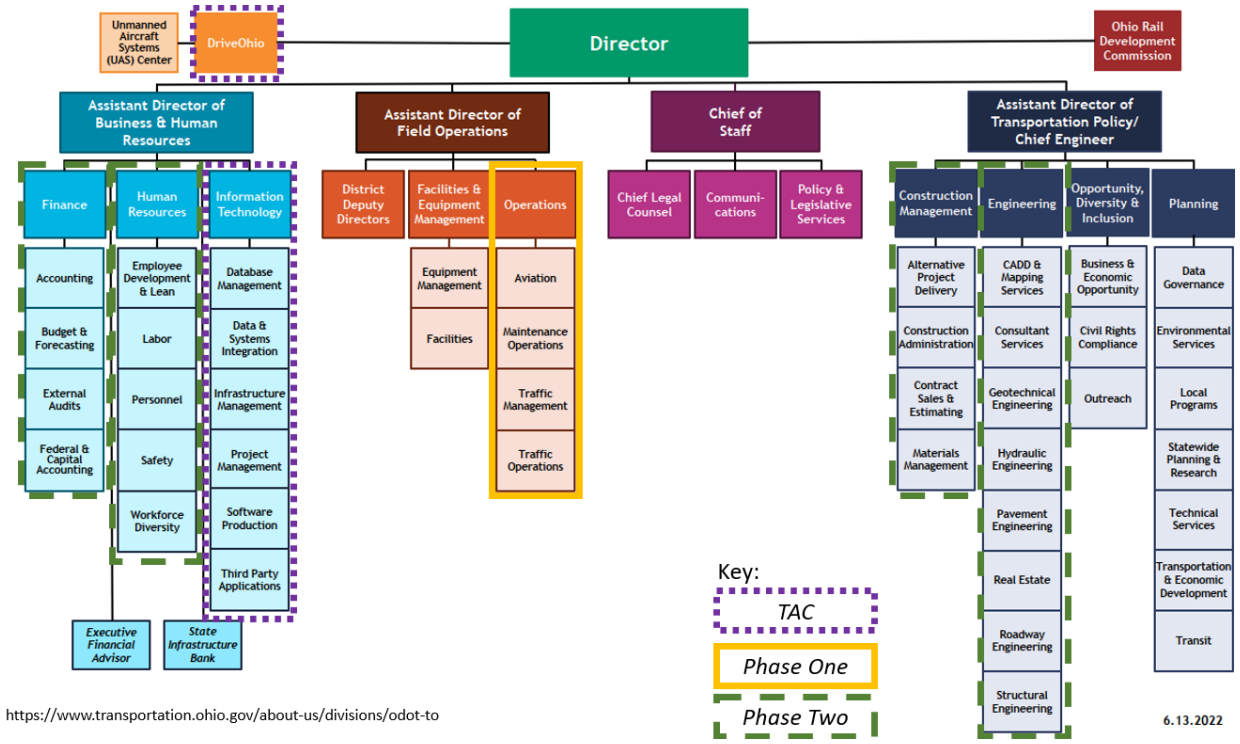


Figure 2: ODOT Organizational Chart[4] and Divisions and Departments Involved in Each Phase

In addition to the divisions and departments, Phase Two included Districts 6 and 10, shown in Figure 3, to seek input on ESP use cases that may benefit them.

[4] ODOT Organizational Chart Data

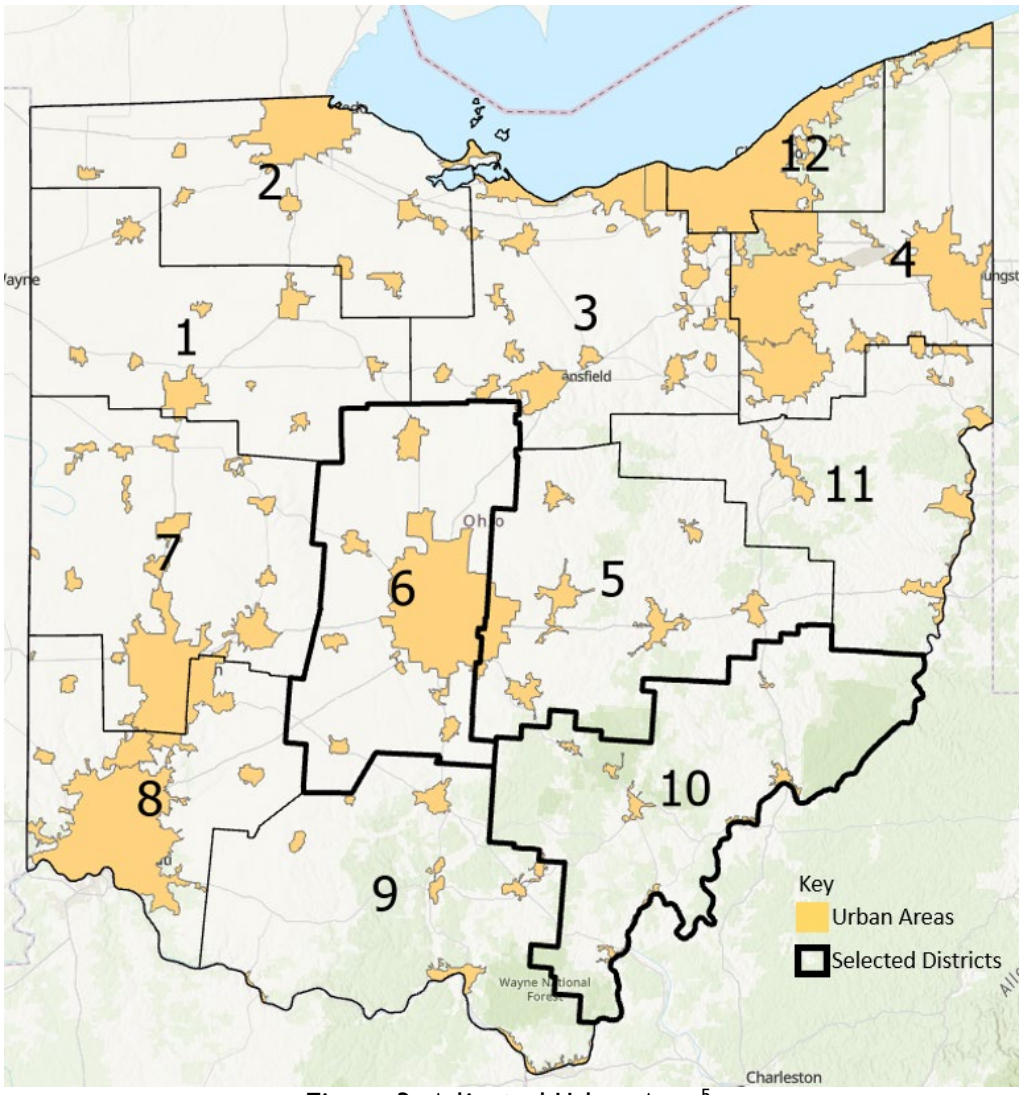


Figure 3: Adjusted Urban Area[5]

It is important to have input from various geographical traveling landscapes. District 6 includes eight counties in central Ohio and contains the greater Columbus region. This district maintains more than 4,900 lane-miles of interstate, federal, and state highways with 1,557 bridges[6]. District 10 includes nine counties in southeast Ohio with 4,000 lane-miles of roadways with 1,200 bridges[7]. As seen in Figure 3, District 6 encompasses a large urban area while District 10 is mostly rural. In addition to urban vs rural representation, the research team wanted to ensure that the use case data collected will benefit disadvantaged communities. Figure 4 presents the Justice40 disadvantaged areas within Ohio.

[5] GIS Data Shown in Figure 3
[6] District 6 Data
[7] District 10 Data

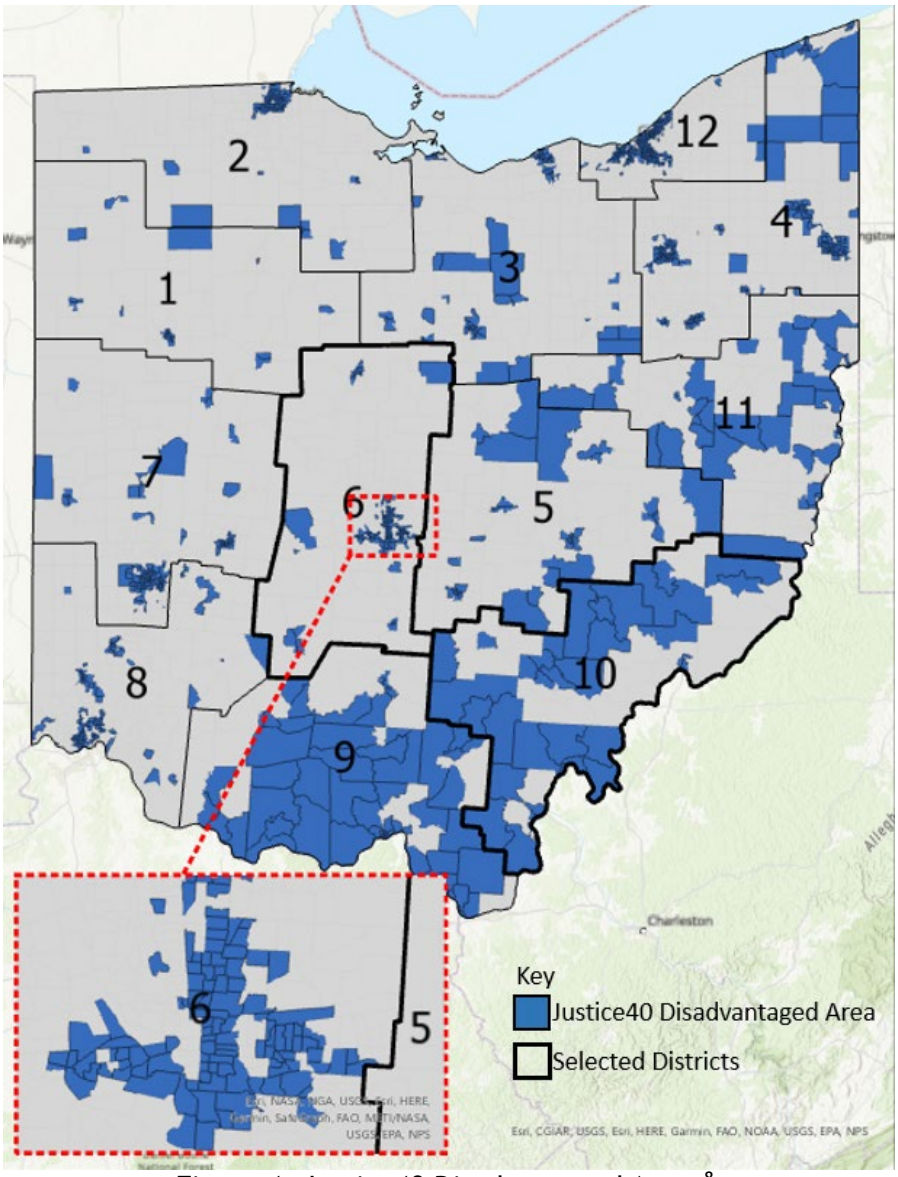


Figure 4: Justice40 Disadvantaged Areas[8]

As seen in Figure 4, Districts 6 and 10 consist of disadvantaged committees. The goal was to identify use cases that would benefit travelers with different, unique mobility challenges and provide an improved level of service (LOS) for broad range of demographics throughout Ohio.

Once the participants were selected for data gathering, the research team conducted workshops and asked specific data and workflow questions to see if ESP could assist with efficiency. Once the data were gathered from the participants, the team moved to the next step of identification of ESP use cases.

[8] Justice40 Disadvantaged Data

3.2 ESP Use Case Identification

The research team, including the TAC, reviewed the workshop notes and built lists of the potential areas for improvement. Then the team worked to identify which improvement may be realized with the ESP. Some of the topics used to identify these use cases are presented in Figure 5.

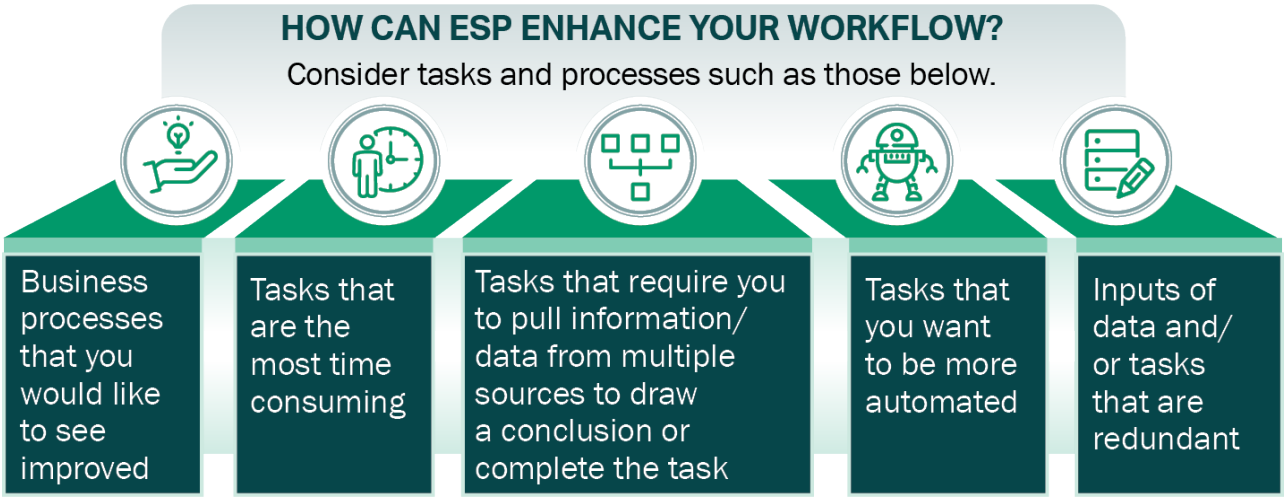


Figure 5: Identifying Use Cases

In addition to the topics presented in Figure 5, the ESP is designed for real-time needs. Using these conditions, the use cases were selected to move forward into development. See Section 4 for details on the selected use cases.

3.3 ESP Use Case Development

Once a use case was identified, the SOW was developed. The SOW included suggested ESP architecture modules, data types and sources, and expected benefits. During the development of the use cases, the team would communicate and verify the SOW data with the proper business owner for the use case. The business owner would be the end user of the ESP outputs; therefore, the team worked to make sure the use case outputs and expected benefits were in line with the business owner's needs. Figure 6 is a sample of the architecture modules with the SOW.

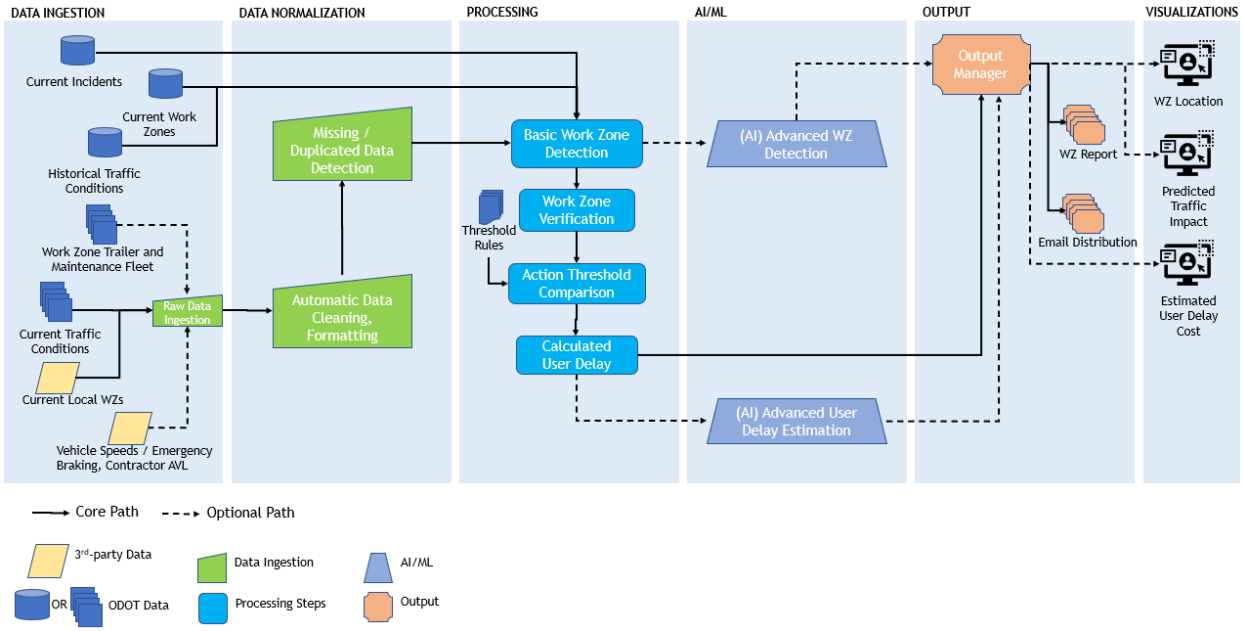
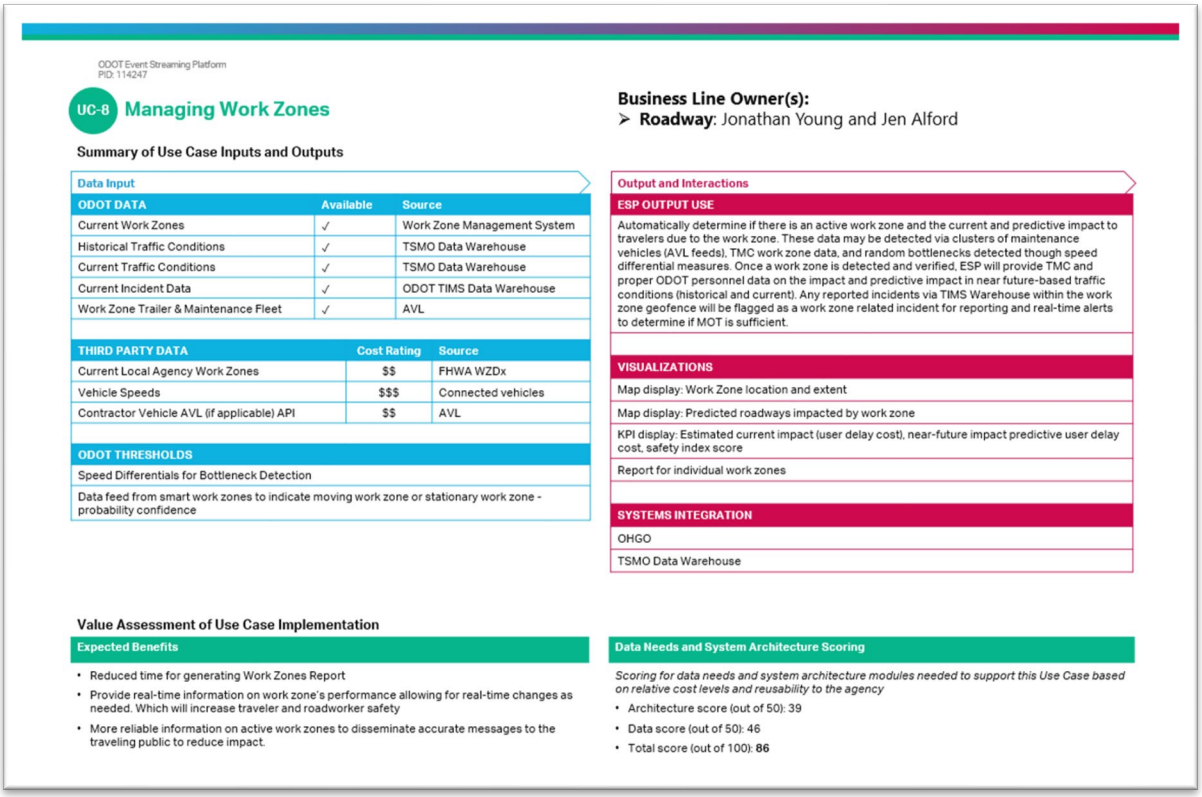


Figure 6: Example of the High-Level Architecture within the SOW

The high-level architecture presents the data inputs, the normalization such as data cleaning, the process modules that would need to be developed, Artificial Intelligent (AI) and Machine Learning (ML) option modules, and the outputs including visualizations. The SOW will provide additional information of each of these elements. In addition, the team developed one-page informational sheets for each use case. A sample is in Figure 7.



ODOT Event Streaming Platform
PID: 114247

UC-8 **Managing Work Zones**

Business Line Owner(s):
➢ **Roadway**: Jonathan Young and Jen Alford

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Work Zones	✓	Work Zone Management System
Historical Traffic Conditions	✓	TSMO Data Warehouse
Current Traffic Conditions	✓	TSMO Data Warehouse
Current Incident Data	✓	ODOT TIMS Data Warehouse
Work Zone Trailer & Maintenance Fleet	✓	AVL

THIRD PARTY DATA	Cost Rating	Source
Current Local Agency Work Zones	$$	FHWA WZDx
Vehicle Speeds	$$$	Connected vehicles
Contractor Vehicle AVL (if applicable) API	$$	AVL

ODOT THRESHOLDS
Speed Differentials for Bottleneck Detection
Data feed from smart work zones to indicate moving work zone or stationary work zone - probability confidence

Output and Interactions

ESP OUTPUT USE

Automatically determine if there is an active work zone and the current and predictive impact to travelers due to the work zone. These data may be detected via clusters of maintenance vehicles (AVL feeds), TMC work zone data, and random bottlenecks detected though speed differential measures. Once a work zone is detected and verified, ESP will provide TMC and proper ODOT personnel data on the impact and predictive impact in near future-based traffic conditions (historical and current). Any reported incidents via TIMS Warehouse within the work zone geofence will be flagged as a work zone related incident for reporting and real-time alerts to determine if MOT is sufficient.

VISUALIZATIONS
Map display: Work Zone location and extent
Map display: Predicted roadways impacted by work zone
KPI display: Estimated current impact (user delay cost), near-future impact predictive user delay cost, safety index score
Report for individual work zones

SYSTEMS INTEGRATION
OHGO
TSMO Data Warehouse

Value Assessment of Use Case Implementation

Expected Benefits

- Reduced time for generating Work Zones Report
- Provide real-time information on work zone's performance allowing for real-time changes as needed. Which will increase traveler and roadworker safety
- More reliable information on active work zones to disseminate accurate messages to the traveling public to reduce impact.

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 39
- Data score (out of 50): 46
- Total score (out of 100): **86**

Figure 7: Sample One-Page Information Sheet for Managing Work Zones Use Case

Once the ESP use case was developed, the team developed a method to score the use case in order to determine a roadmap for deployment.

3.4 Roadmap for Use Case Deployment

ODOT desired to have the individual use cases quantitatively evaluated independently as well as against each other, which would provide ODOT with a roadmap for development, focusing on the most impactful use cases first. This helps direct limited resources to making the greatest impact across ODOT. The method developed generates a score for individual component modules and data sources that were identified during the development of the use cases, and then aggregates those individual component scores per use case based on which modules and data sources are specified in the use case.

Individual module and data source scores are determined by first evaluating an assumed relative cost and reusability using the values in Table 1, which is based on a High-Medium-Low scale. If a module or dataset is used in multiple use cases the reusability would be evaluated as "high", providing a better score. Whereas, if a module or dataset has a low relative cost to develop, because it is already available and collected in-house, for example, the evaluation would be "low", and the score would be better. Table 1 shows the relative scoring assigned to each of the subjective values.

The total score for an individual Module is the sum of the scores for relative cost and reusability. Data sources use these two scores plus the additional value for required vs. optional.

Table 1: Module and Data Source Scoring Assignment

Attribute	Value	Score
Relative Cost	Low	3
	Medium	2
	High	1
	N/A	2
Reusability	Low	1
	Medium	2
	High	3
Required/Optional	Req	2
	Opt	1

Using these individual module and data source scores, the score for each use case could be calculated using the high-level architecture, such as is shown in Figure 6, using Equation 1. Since some use cases may require more data or modules, the overall numeric value will be higher than a use case that has fewer data or modules, the scores were normalized to allow for proper comparison of each use case. The scores were normalized to 50 for module and data sources, as in Equation 2.

$$\sum UC\ Module\ Scores + \sum UC\ Data\ Source\ Scores = Use\ Case\ Total\ Score \qquad \text{Equation 1}$$

$$\left(\frac{\sum UC\ Module\ Scores}{Max\left(\sum UC\ Module\ Scores_{All\ UCs}\right)} \times 50\right) + \left(\frac{\sum UC\ Data\ Source\ Scores}{Max\left(\sum UC\ Data\ Source\ Scores_{All\ UCs}\right)} \times 50\right) = Normalized\ Total\ Score \qquad \text{Equation 2}$$

The normalized total scores allow for the use cases to be sorted for a development roadmap. The team developed three roadmaps, one for each of the two phases, independently, and one with all use cases combined.

4 Research Findings and Conclusions

The research findings and conclusions were distributed across the two phases of the project; however, the results from Phase 1 informed and modified the direction of work for Phase 2. Therefore, the overall deliverables for both phases are the same, which consist of the following items for each use case:

- One-page summary, including suggested ESP architecture modules, data types and sources, and expected benefits, see Appendix B.
- Statement of work containing more detail than the one-page summaries, see in Appendix C to review the high-level architecture that are used to develop the SOW. SOW will be available upon request from the TAC.
- An aggregate score comprised of the identified ESP architecture module and data scores, which were determined using a multifactor matrix.

4.1 Findings

Phase One of this research resulted in the identification of six (6) use cases for ODOT Operations, and Phase Two resulted in an additional 11 use cases across ODOT divisions and departments. Table 2 provides a description of all use cases.

Table 2: Use Cases for ESP

No.	Use Case	Description
		Phase 1
UC-1	Traffic prediction and proactive management	Provide TMC Operators with traffic management recommendations, including location and strategy, to proactively mitigate expected traffic or congestion. TMC Operators implement mitigation via ITS devices (i.e., signals, variable message signs, variable speed limit signs, etc.).
UC-2	Crash prediction and proactive mitigation	Provide TMC Operators with crash avoidance recommendations, including location and strategy, to proactively deploy mitigation in areas with a high probability of crashes occurring. TMC Operators implement mitigation via ITS devices (i.e., signals, variable message signs, variable speed limit signs, etc.) and communication with public safety officials to allow for increased safety presence.
UC-3	Incident detection and response initiation	Automatically detect the occurrence of a crash and initiate crash response strategies. Automatically alert proximal first responders based on incident type and severity. Provide TMC Operators with predicted traffic impacts

No.	Use Case	Description
		and mitigation recommendations, including location and strategy, to proactively mitigate expected crash impacts.
UC-4	Roadway maintenance need detection and dispatch	Automatically detect roadway locations that need maintenance based on vehicle camera and inertial measurement unit data. Automatically schedule and dispatch maintenance crews. Enable robust roadway monitoring and data collection to support the prediction of future maintenance needs.
UC-5	Static asset maintenance need detection and dispatch	Automatically detect static assets that need maintenance based on vehicle camera data. Automatically schedule and dispatch maintenance crews. Enable robust roadway monitoring and data collection to support the prediction of future maintenance needs.
UC-6	Snow/ice treatment determination	Automatically determine expected levels of snow and ice treatment needed by location based on incoming weather and low-friction pavement conditions. Provide estimated treatments needs to snow/ice crews to support preparedness.
	Phase 2	
UC-7	Identifying and Examining Parallel Work Zones	Automatically determine if active work zones and planned detour routes will be impacted by detouring traffic from parallel/nearby work zones. This will include analyzing local agencies' work zones with lane capacity reduction. Predict near-future impacts based on ADT and the corresponding logical detour routes. This will allow end users to determine if additional action should be taken such as dissemination of information for alternative detour routes.
UC-8	Managing Work Zones	Automatically determine if there is an active work zone and the current and predictive impact to travelers due to the work zone. These data may be detected via clusters of maintenance vehicles (AVL feeds), TMC work zone data, and random bottlenecks detected though speed differential measures. Once a work zone is detected and verified, ESP will provide TMC and proper ODOT personnel data on the impact and predictive impact in near future

No.	Use Case	Description
		based on ADT. Any reported incidents via TIMS Warehouse within the work zone geofence will be flagged as a work zone related incident for reporting and real-time alerts to determine if MOT is sufficient.
UC-9	Predicting, Detecting, and Tracking Flooding For Serviceability/Maintenance	Automatically determine if predictive inclement weather (rain and melting snow) could result in flooding along the roadway. Alert maintenance crews of these potential flooding areas. Predict through historical flooding and pavement repair requirements to determine impact of standing water.
UC-10	Monitoring the Non-Contract Procurement Limit ($50K List)	Automatically determine the real-time cumulative procurement total for non-contract. Alert when nearing the threshold for a non-contract vendor procurements, $50,000. Machine Learning for determining the individual store's charge code and save verified detected information into a central database for future charges.
UC-11	Streamline Purchase Order Creation	Develop a single platform. This will align the end-user and the accounting office appropriately to eliminate duplicate work. As users fill out the data, the system will automatically, in real-time, pull proper data from Oaks, and allow for accounting to review/approve data (versus replicating data entry).
UC-12	Identifying and Creating Service Awards	Automatically determine when an employee is nearing a milestone event and create the service award documentation and draft announcement, which can be disseminated at the proper time. These will look forward to upcoming event so awards may be provided at proper dates instead of significantly after the event.
UC-13	Use Census and Workforce Survey Data to Increase Workforce Diversity	Correlate employee survey data with both positive and negative retention results. Automatically pull census data from census.gov using available APIs to evaluate ODOT workforce diversity efforts. Automatically determine metrics for workforce diversity by ODOT District with direct correlation to region's census data.

No.	Use Case	Description
UC-14	Coordinate and Disseminate Heavy Haul Permits Information	Automatically retrieve heavy haul permit information and provide insights into route and timeframe for these heavy hauls. Compare these information with estimated traffic to determine potential impact to other travelers. Additionally, it will compare these heavy haul data with active work zones. When impact to travelers or concerns due to work zones are automatically detected, alerts will be disseminated to the proper parties, including TMC for monitoring and information dissemination as needed. Additionally provide insight to coordinate heavy hauls at appropriate times of day that limit major impact to motoring public.
UC-15	Automating Process of Selecting Detour Needs	Automatically build detour route options based on roadway capacity / function class and ability to handle detouring volume and travel time when incidents or active work zones are currently or predicted to significantly impact travelers. Using a routable roadway network and the placement of an event to the roadway, i.e. incident or active work zone, detour option(s) may be determined, This will account for parallel work zones when determining alternative route. Identify upstream assets that may be utilized to disseminate messages about detour.
UC-16	Correlate Asset Management and Life-cycle Planning (Planning Phase)	Automatically track the age of installed roadway assets and flag those assets that have reached a threshold of their expected life. Flagged assets may be monitored more closely, placed into a replacement planning cycle, or replaced immediately.
UC-17	Automated Roadway Asset Repair Cost Estimation Due to Crashes	Automatically determine a cost estimate range to repair roadway assets that have been damaged due to a crash. This range is centered on a “typical” or average cost based on the asset type, location, and extent of damage. A high and low estimate are also provided as part of the estimate. Generate an asset replacement cost report to submit to insurer

More information on each of these use cases is presented in the SOW and one-page information sheets, which include the data inputs, process modules, outputs, and expected benefits. These may be reviewed in Appendices B and C.

Table 3 presents the normalized score for the use cases (out of 100, with a higher value representing the low cost/high reusability). The resulting roadmaps are in Figure 8 and Figure 9.

Table 3: Use Case Normalized Scores – Phase 1

Use Case	Module Score	Data Score	Total Score
UC-2: Crash prediction and mitigation	50.00	50.00	100.00
UC-1: Traffic prediction and management	40.68	38.46	79.14
UC-5: Static asset maintenance need detection and dispatch	35.59	30.00	65.59
UC-6: Snow/ice treatment determination	35.59	27.69	63.29
UC-3: Incident detection and response initiation	38.14	20.77	58.90
UC-4: Roadway maintenance need detection and dispatch	36.44	21.54	57.98

*Score Value is out of 100, higher value is better

Table 4: Use Case Normalized Scores – Phase 2

Use Case	Module Score	Data Score	Total Score
Operational Use Cases			
UC-15: Automating Process of Selecting Detour Needs	50.00	42.86	92.86
UC-7: Identifying and Examining Parallel Work Zones	42.86	46.43	89.29
UC-8: Managing Work Zones	39.29	46.43	85.71
UC-9: Predicting, Detecting, and Tracking Flooding For Serviceability/Maintenance	33.93	50.00	83.93
UC-14: Coordinate and Disseminate Heavy Haul Permits Information	33.33	40.00	73.33
UC-17: Automated Roadway Asset Repair Cost Estimation Due to Crashes	38.69	30.71	69.40
UC-16: Correlate Asset Management and Life-cycle Planning (Planning Phase)	25.60	33.57	59.17
Non-Operational Use Cases			
UC-13: Use Census and Workforce Survey Data to Increase Workforce Diversity	50.00	50.00	100.00
UC-11: Streamline Purchase Order Creation	42.39	35.00	77.39
UC-12: Identifying and Creating Service Awards	34.78	40.00	74.78
UC-10: Monitoring the Non-Contract Procurement Limit ($50K List)	34.78	32.50	67.28

*Score Value is out of 100, higher value is better

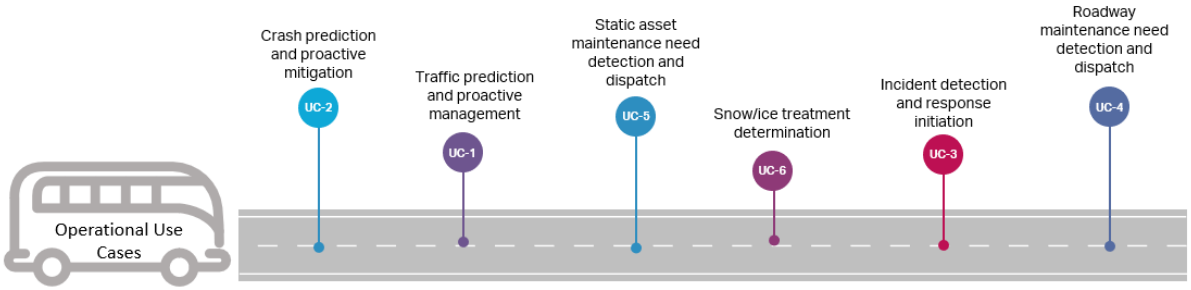


Figure 8: Phase One Roadmap for Deployment

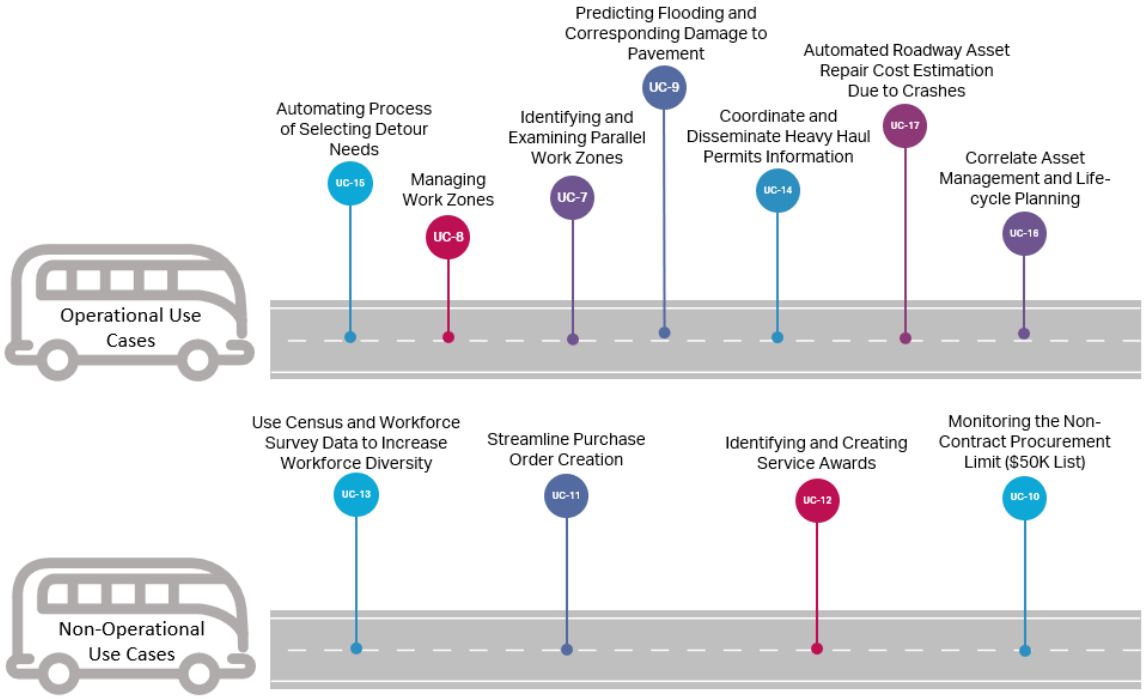


Figure 9: Phase Two Roadmap for Deployment

4.2 Conclusion

The goal of this research is to achieve efficiencies within ODOT for the ESP. This research queried potential use case data from several of the divisions and two of the districts at ODOT, see Figure 2, Figure 3, and Figure 4. From the data collection, 17 use cases for the ESP were identified for analysis across ODOT. The additional data points collected may identify other improvements outside of the ESP platform which are data provided to ODOT for an increase in benefits from this research.

The research developed a high-level SOW and a summarized one-page information sheet for each use case that may be used when ODOT is ready to pursuit the development within the ESP environment. Using a scoring method based on relative cost and reusability, each use case is scored to determine optimal implementation plans, or Roadmaps. See Figure 8 and Figure 9.

The next step from this research is the development of these use cases within the ESP production platform for testing, deployment, calibrations, and evaluation.

5 Recommendations for Implementation

The roadmaps developed within this research are the recommended implementation plan for this research, see Figure 8 and Figure 9. The roadmaps are based on relative cost of data and development of the modules, and outputs. Additionally, the roadmaps considered if data and modules can be used in other use cases. The following sections discuss other aspects of implementation from this research.

5.1 Step Needed to Implement

The steps for implementation will be to utilize the SOWs as a starting point for the development of the use cases. The business owners should work with the development team to discuss current data and systems, needed data and systems/modules, and further detail out the outputs desired. The SOW is a high-level review, so when implementing these use cases, the data within the SOW should be further detailed out in a development plan with the proper team.

Once a development plan is built, the team should develop, test, and calibrate as needed in the ESP test environment. Once all parties are satisfied with the ESP process, it may be moved to the production environment for evaluation.

5.2 Expected Benefits from Implementation

The expected benefits from these use cases are outlined in the SOW and one-page summaries. Table 5 presents the expected benefits for each use case.

Table 5: Use Case Expected Benefits

No.	Use Case	Expected Benefits from Implementation
UC-1	Traffic prediction and proactive management	• Improved situational awareness of real-time traffic conditions • Reduced congestion due to incidents, events, and work zones • Reduced crashes due to the sudden onset of congestion • Reduced end-of-queue crashes from stopped traffic
UC-2	Crash prediction and proactive mitigation	• Reduced crashes where sensors are deployed due to weather conditions • Fewer incidents due to crashes • Lower queue delay times for the traveling public
UC-3	Incident detection and response initiation	• Faster response times to incidents • Faster clearance times of incidents • Lower queue delay times for the traveling public

No.	Use Case	Expected Benefits from Implementation
UC-4	Roadway maintenance need detection and dispatch	• Faster response to critical roadway maintenance • Earlier execution of preventative roadway maintenance • Lower roadway maintenance costs
UC-5	Static asset maintenance need detection and dispatch	• Faster response to critical asset maintenance • Earlier execution of preventative asset maintenance • Asset damage prevention resulting in lower asset maintenance costs
UC-6	Snow/ice treatment determination	• Reduced crashes due to snow/ice conditions • Faster response times to incidents due to pre-positioning of first responders • Faster clearance times of incidents • Smoother traffic flow during snow/ice conditions
UC-7	Identifying and Examining Parallel Work Zones	• Provide real-time information on work zone performance allowing for real-time changes as needed. • More reliable information on active work zones to disseminate accurate messages to the traveling public to reduce impact.
UC-8	Managing Work Zones	• Reduced time for generating Work Zones Report • Provide real-time information on work zone's performance allowing for real-time changes as needed. Which will increase traveler and roadworker safety • More reliable information on active work zones to disseminate accurate messages to the traveling public to reduce impact.
UC-9	Predicting, Detecting, and Tracking Flooding For Serviceability/Maintenance	• Reduced response time to manage flooding / standing water on the roadway, which will increase safety • Better pavement degradation curves for more realistic maintenance requirements and planning
UC-10	Monitoring the Non-Contract Procurement Limit ($50K List)	• Increased awareness of spending limits to comply with Ohio law • Reduce labor in manually sorting data for these metrics

No.	Use Case	Expected Benefits from Implementation
UC-11	Streamline Purchase Order Creation	• Reduce labor required to create a purchase order • Reduce lag time between request of purchase order and approval
UC-12	Identifying and Creating Service Awards	• Reduced effort to develop service awards • Provide service award closer to anniversary/milestone date • Increased employee recognition and satisfaction
UC-13	Use Census and Workforce Survey Data to Increase Workforce Diversity	• Reduce labor for determining work force diversity when compared to the surrounding area's available labor force. • Reduce lag time in developing key performance measures for best decision making
UC-14	Coordinate and Disseminate Heavy Haul Permits Information	• Reduced impact from heavy hauls to traveling public and potential work zone maintenance crews • Increase in information for heavy haul permit holders and ODOT on time and route of these vehicles
UC-15	Automating Process of Selecting Detour Needs	• Increase mobility for the traveling public when unscheduled events occur along the roadway • Better decision-making on selection of proper detour routes based on data-driven methods which will consider the roadway properties and the potential impact of detouring high-volumes of traffic, including commercial vehicle needs • More reliable information on events to disseminate accurate messages to the traveling public to reduce impact
UC-16	Correlate Asset Management and Life-cycle Planning (Planning Phase)	• Ageing assets will more effectively be monitored and replaced as part of ODOT's normal planning cycle • Ageing assets will be replaced prior to a catastrophic failure • Asset replacement can be prioritized according to asset type, % life span, estimated cost to replace, and criticality of asset function

No.	Use Case	Expected Benefits from Implementation
UC-17	Automated Roadway Asset Repair Cost Estimation Due to Crashes	• Faster cost estimation for repair of damaged roadway assets due to crashes • More accurate cost estimation using attributes for asset type, location, crash severity, and historical actual costs • Faster invoicing to insurance provider • Faster repair of roadway asset

5.3 Potential Risks and Obstacles to Implementation

Potential risks in these use case implementations are data input quality and confirming that the modules are robustly built to prevent any incorrect data or alerts, as well as receiving alerts and data in a timely manner. If data outputs are incorrect or not received in enough time for action, end users will not find value in the intended use case within the ESP and it may impact their overall ESP buy-in.

Each of these use cases are innovative, which means obstacles can be anticipated during implementation. Potential obstacles may be obtaining the proper data and integrating it into all the required systems. When extracting or hooking into various, diverse data sources, there may be challenges in getting all to work cohesively to provide the data outputs as intended in the use case. Cost is typically an obstacle in development and maintenance of the use cases, especially since some of the use cases rely on third-part real-time data, which will have a constant, recurring maintenance cost.

5.4 Strategies to Overcome Potential Risks and Obstacles

The risks outlined in Section 5.3 may be overcome by conducting extensive testing within the non-production ESP environment before launching the final use case functionality within the production ESP environment. The testing should include the proper stakeholders and an evaluation assessment to all stakeholders to review. The assessment needs to evaluate the accuracy of any performance measures and/or alerts.

The obstacles outlined in Section 5.3 may be overcome by the development of an implementation plan which should outline the system requirements and the key contacts for each third-party system or data being used. The cost to develop and maintain should be discussed before ODOT moves forward with the project, with funds for an evaluation within the budget. Also, contingency should be considered to make sure the final use case can be fully developed and evaluated. The evaluation should include a benefit-cost calculation to determine if the use case is of high value to ODOT and the traveling public.

5.5 Potential Users and Other Organizations that may be Affected

The SOWs include the stakeholders for the use cases. See Appendix C to review the high-level architecture that are used to build out the SOW for each use case.

5.6 Suggested Timeframe frame Implementation

The order for deploying the use cases is presented in the roadmaps, seen in Figure 8 and Figure 9. The timeframe for each use case will be dependent on funds and resources available. Each will need time for planning, development, testing, launch in production, and evaluation which should be set based on the complexity of the use case and availability of the data and modules.

5.7 Estimated Costs

The roadmaps of the use cases presented in Figure 8 and Figure 9 considered high-level cost information when determining the optimal implementation strategy. The cost will vary for each use case based on data sources and capital cost to develop. Third-party, real-time datasets will require more maintenance funds compared to currently available in-house data sources. The cost information should be carefully tracked for an accurate benefit-cost analysis to be conducted during the evaluation of the use case.

5.8 Evaluate the On-going Performance and Return-on-Investment of the Implemented Results

Each of the 17 use cases will require a different evaluation methodology since each is designed to conduct a unique function within the ESP. An evaluation plan should be included in the deployment for all use cases. The evaluation plan should include before and after data required and the performance measures that will be calculated. Direct and indirect costs and benefits should be considered and outlined in the evaluation plan.

Appendix A: Workshop Notes

ESP Research Project

Project: Achieving Efficiencies within ODOT with the Event Streaming Platform

ODOT PID # 114247, State # 136342

ESP Key Leadership Workshop *MEETING NOTES*

Date: November 23, 2021

Time: 9:00 AM – 10:30 AM Eastern

Location and/or call-in information: Teams – ODOT Onsite

Attendees:

Organization	Representative
Ohio Research Team	Jill Martindale (Research PM) Nick Hegemier (Drive Ohio) Kevin Hartman (Chief Tech Officer, responsible for data) George Padavick
Ohio DOT	James Bryant (Admin Ops Aviation, airport and maint programs) John MacAdam (Div of Ops, Traffic Mgt, TSMO data warehouse, much data automation into warehouse) Timothy Filla (GIS Analyst in Traffic Mgt, Geospatial) William Welch (Program admin Traffic Mgt, data extracting and loading for Bus Intelligence) Dave Gardner (Admin Tech Svcs - highway, infrastructure, traffic monitoring data) Ian Kidner (Data governance, data standards and coordination, deliver technology to agencies, BI tooling) Andrew Wallace (PM, technical background) Vikki Hankus (Highway performance monitoring) Sandra Mapel (Traffic data, feeding engineers) / Dan Radanovich (Collecting large sums of data) Daniel Radanovich (highway section manager) Stephanie Marik
AECOM	John Fuller, Tim Nyman, Paul Avery

Objective: Understand ESP Current State, Vision and Data Needs

1. OBJECTIVE

- Understand your Division Data Requirements and Workflows
- What would make your Job easier more efficient
- What repeated activities would you like to see automated

- We want to hear from you

2. AGENDA

- Introductions
- Desired Outcomes
- Event Streaming Platform (ESP)
- Division Discussion
- Upcoming Division Meeting Goals
- Division Meeting Personnel

3. MEETING NOTES

- Introductions
    - Vikki Hankis – roadway management, mapping database and roadways and submit FHWA
    - Sandra Mapel – traffic monitoring sections, seasonal factors for design 95% accurate HPMS
    - Dan Radanovich – highway section manager road profiles 3 imager, 3000 lane miles 200 TB of data
    - Ian Kidner admin data governance – implements standards and data quality. Asset management program. Assess and deliver technology for stakeholders. BI Tools
    - James Bryant – aviation admin anything to do with aviation, airport inspection, 145 aircraft maintenance, responsible for aircraft work with FF grant program 5% match on
    - John MacAdam – operations traffic management, TSMO data warehouse, performance warehouse, ETL tools, BI Reports, speed crashes and manual data.
    - Bill Welsh – program admin for analytics and automation. TSMO data warehouse, python scripting, BI
    - Tim Filla – GIS
    - Stephanie
    - Kevin Hartman – IT for data and support and access data. Share and stream data
    - Nick Hegemier – Roll out across ODOT use cases and statements of work. Original CA/AV data.
        - Couple projects collecting and disseminating CAV data. Workforce focused professional
    - Andrew Wallace – PM with Drive Ohio. Process geek

- Goals:
    - Sharing data more easily between ODOT divisions
    - Make data access easier
    - Initially started from Automated Vehicles data collection - expanded to all division data and datasets (weather patterns, etc.)

    - Identify Use Cases for data capture, collection and sharing - Drive out intelligent, data driven decisions
    - Lead to Statements of Work for projects/bids
    - Use Event Streaming Platform to automate manual data processes
- ESP Background (Nick/Kevin):
    - Built in AWS - Pub/Sub model
    - Ways for outside teams to publish data to platform - remove need to involve IT - self services
    - Data discovery modules
    - Future:
        - Dashboard for Traffic Ops group - wide range of data - kicking off 2022
        - Data to predict accident risks - measure vehicle data to predict risk situations - measure data patterns for predictability
        - Possibilities:
            - Vehicle breaking data - compare friction sliding data. Tie to area and crash reports - identify roadways needing improvements. Find issues before crashes (from data)
            - Realtime incoming data - driving safety measures and maintenance
            - Rescue team notifications in real-time - automate alerts to ambulances/fire/rescue
- Projects, Processes and Activities:
    - Andrew Wallace
        - Overview - One dashboard for operations signal maintenance, and operations
        - Weather data, speed data, pull in vehicle data
        - What other data sources could be utilized?
        - Model weather scenarios for ground and air transportation
    - McAdams (and team) - what they currently are doing:
        - Has lots of data - wanted more insights - Built TSMO/TAM data warehouse. Hosting most of ODOTs business data
        - Warehouse centralizing data - processing atop data - pulling data in and running measurement reports – automated
        - Visualization layer of measures - website hosting PowerBI dashboards
        - Moved away from spreadhseets to scripts and automation using front end out of box tools. Removed a lot of manual effort.
        - Future:
            - Machine Learning and AI - answering additional questions
            - Use Imagery data - they collect roadway and pavement imagery data - ready for uses in ML
            - Imagery from traffic cameras, Pathview, pavement pictures.
                - Dan images from Pathview

        - Friction information – friction management program. What they are doing with that data.
        - Sandy traffic data. LRS data to identify location information.
    - Convert Excel to SQL procedures
    - Python scripts to apply business rules (snow ice performance management)
    - Three major data projects (SNIPE) integrate speed and weather data (inrix and rwis)
    - Combine to identify when weather event start traffic effected and recovery
    - TOAST -traffic operations assessment tool for adding new lanes
    - Critical success factor for travel time. Segments of roadway are successful
    - Dashboarding aspect and some tableau dashboards
    - Tim – Dashboard guy internal (public website) – traffic incident recovery times. Data 670 smart lane. Real time data within few minutes trying to use those for traffic management center for TOC operators
    - Provide a warehouse for operators to identify traffic events. WAZE events, incident from highway patrol
    - Speed data,
    - Visualize in real time – varying levels of success using different technologies. Using GeoEvent Technology to map real time data. Dangers slow down feed and real time snow and ice feed. Data coming in to TSMO warehouse
- Ian Kidner – creates a lot of solutions. Kevin - How do we incorporate risk in to plans and resiliency factor. Event how do we keep moving. How do we spend dollars to improve?
- Kevin - Utilize business intelligence to help convince people and processes to incorporate risk-based decision. Develop workplans data management system looks to optimize pavement. Different buckets of money that could be utilized to solve multiple problems. Social justice and economic impact. How transportation impacts. Risk factors preservation dollars need to incorporate other risk factors. Need buy in. Show that we can use data
- Nick - how do we spend money in state. Roads and bridges. Manage reliability of roadways. Roadway conditions such as striping. Workzone. OEM measuring conditions.
- Jim Bryant – road sensors have information shared to them for AWOS and ASOS systems for more rural airports know conditions.
- Tech Services – traffic monitoring for Vikki maintaining base layer of locations and features everyone is using maintaining and updating QA/QC annual perpetuation. Any changes to roadway systems and network.
    - Design plans go through design engineers and solid basemap
    - Traffic side ML off of video cameras – worked with universities by 13 classifications.
    - Highway patrol tire measurements and sensitivities. Weigh-in-motion data. Strictly in excel currently. Move to some targeting enforcement.
    - Which type of vehicle is everywhere within 95% accuracy from camera
    - A lot of duplication related to analytics

        - Duplicate Reports. Try to have share report and tool usage. Possible have templates.
        - Have a SharePoint Site to post reports that they are building. Trying to encourage people to share. Not sure if this is the best way of doing it.
    - Dave Gardner:
        - Friction data - has a management program within tech services.
        - Storing and using data - but opportunities to obtain more and use it in different ways
        - Linear Referencing System data -
    - William Welch/Tim - TSMO warehouse integrating data
        - Excel converted to SQL - scripting and applying business rules
        - Big Data products - automated and dashboarded (Python scripts and PowerBI):
            - Snow and Ice Performance tool - integrates speed data with weather data - combine to identify weather event starting/ending and traffic impact/recovery
            - Traffic Ops Assessment tool - integrates data for making funding decisions on programs. Find ways to reduce congestion without lanes
            - Critical Success Factor for Travel Times - how reliable roadway segments are
        - Dashboarding - Crash data plus recovery times. Safety response performance. Smart lane performance - using data in warehouse from different sources
        - Realtime - sources feeding TSMO warehouse are near real-time.
            - Monitoring traffic via cameras and data feeds. Load to warehouse and visualize.
            - WAZE app integration
            - Dangerous slowdowns
            - Realtime mapping
            - Leveraging Esri GeoEvent technology - mapping data in real-time (dangerous slowdown speeds, snow/ice events)
- Products Produced/Consumed
    - Want to be predictive
    - Incorporating risk into decision processes
    - Resiliency - spending dollars into the right problem areas
        - Process for workplan dev. Pavement Mgt System optimizing targets. How to use the right funding
- Improvements (Ian)
    - Consider other risk factors beyond Pavement condition - for determining impact and drive funding
    - Use data to make better decisions and increase impact
- How to spend money on existing assets (Nick)

    - Future state:
        - Measure roadway rideability and focus on roads in worse condition. Identify these via vehicle data
        - Striping conditions - drivers perceiving workzones and roadways. Measuring conditions from machine view. Focus on most needy sections
- Impacts to Aviation (James Bryant)
    - Importing local weather - rural areas needing near-weather conditions
- Tech Services (Sandra/Vicky)
    - Traffic Monitoring -
    - Maintaining roadway features - Done thru year. QA/QC checking - publishing Annual Perpetuation Report - changes to roadway thru prior year
    - Design plans and data from County Engineers
    - Basemaps of local inventory - maintains this basemap that is used by other - big input
    - Processes/Workflows for enhancement
        - Traffic Monitoring - want machine learning off video cameras - real-time
        - University work on breakdown by classifications of vehicles
        - Excel data being shared across teams - find ways to automate (Sandra)
        - Bring in camera data - identify vehicle classifications in each line via ML of images
        - (Ian) Dupe of efforts within analytics - Must have enough sources to meet all team's needs
            - Might want to consolidate tools and make data shared and available - beware of tool duplication
        - SharePoint sites for sharing data - encouraging people to share data - but looking for best mechanism to do this
            - ESP can share datasets - consolidate
- **ESP Goal:**
    - **Validation of datasets - comparing existing and consolidating/removing duplication**
    - **Publish insights off data - make this shared and consumable Realtime**
    - **Need Analytic Insight Datasets - that can be recognized by platform users**
- (Dan) Collecting lots of pavement data (conditions - cracking - texture of roadways)
    - Historic data is available - data posted long after the event. Lacking near-real-time data.
        - Cars provide simplistic view, but more near-real-time
    - Friction Mgt - Critical data. Some don't want this data prior to crashes. But risk analysis should be done via this data
    - Lacking tools for friction data analytics
    - Wealth of pavement condition data ride quality or 3d imagery. Firm log data. Largely historic takes time to publish some collected in 2020 takes year to

publish. Ride quality data is simplistic view. Might show where things are coming from cars. Large contingency that does want to know that.
    - Unleash crash friction data – friction management program made available for people to see
- Andrew – no safety funding – district must come up with operating budget. Largely funding situation
- Bill - Installs sensors and maintains them at rest areas trying to get away from sensors that don't work.
    - Automated data report for assets. Is there a reporting mechanism for non-reporting? Have operators report areas of repair not in crash reports
- Data Not Available/Needed
    - (Jim) Weather data
    - Sensor data that is off by vehicles - pursuing ways to use ML on imagery
    - Data from dump trucks - use this for road-defect detection
    - Actively pursue ways to feed traffic systems parking counts.
    - Automated data shared to maintenance crews. And data in reverse - Items fixed reporting back for tracking
    - Challenges with data formatting - sharing data across systems challenging due to formatting
        - **Need data normalization - should be a separate SOW**
        - Need shared data in a format that other teams can use (imagery data formatting and ingestion)
        - Consistent formatting and conventions are needed
        - Missing Data (from other platforms) - example - images used to be stable and now rotate. Need timestamping on camera adjustments
            - Unknown data gaps and missing data points. Need consistency from sources. Need alerts on missing data
    - (Sandra) Would like a feed with weather data merged into warehouse. Mark locations as a "weather day" - tag counts as a-typical so they can be excluded from typical data views
        - Identify different weather events - and flag data as within these events
        - Predicted weather/forecasting. Very valuable data for anticipating upcoming needs
        - Potentially: Offer this data to private sector businesses
    - Missing data and when that is how to bridge the gap. They rotate cameras have home position have timestamp of when moved. Workflow. Knowing of data gaps and if we can fill in
- **Use Case - Make sure shared data is done in a usable manner/format**
- **Statement of Work for data normalization** for use in different tools. Ian is really interested in as well. Interaction with Ian and Sandra Bosch cameras for vehicle counts get data off cameras. Script to read and ingest. Have camera naming conventions work with Ian and Sandy
- Data for Sharing

    - (Traffic Ops) Camera imaging
    - Crash Report - automate this with notifications. Near real-time
- Tools/Visualizations
    - Interested in Computer vision - Cameras at rest locations
    - MS2 System - has lots of data. But need a simpler tool for understanding data. Want reporting for non-data, non-tech users
    - Need explanation on the data - so its easily understood by report viewers.
    - Too much presented data can be a challenge
    - Feed with weather data and merge into data warehouse. Ohio weather different tag weather day or abnormal.
        - How you would like to see those weather events come across rain, snow, fog.
        - Accessing different systems and integrating weather systems.
        - Operations for predictive modeling for weather prediction for other people. Stage assets differently. Couple different weather programs in Aviation. OGO app leverage as a commercial use.

4. ACTION ITEM SUMMARY:

- AECOM Finalize Meeting Minutes
- AECOM start working on Use Cases and Statements of Work
- AECOM prepare for next meetings with Research Team
- Division Meetings - identify the other people to interview
    - Need coverage on key divisions for follow-up meetings

ESP Research Project
Project: Achieving Efficiencies within ODOT with the Event Streaming Platform
ODOT PID # 114247, State # 136342

District Workshop *MEETING NOTES*

Districts 10 and 6 attended, and a member from Central Office

District 6 Notes:

When discussing goals for each district the following were mentioned for D6:

- Plan Sets (especially historical) in spatial format (GIS) are a current need.
- Other data needs are permits and overall land use, there is a need to streamline processes and approval. It was mentioned there is a need to work with local agencies for appropriate detour routes.
- Would like to see a risk analysis module that can explore the exposure of employees in the field.
- Spatial log maintenance agreements and have them be accessible to see what is ODOT's responsibility.
- D6 would be to improve the inspection and collection of culverts, underdrains & BMPs.
- Detect wrong-way drivers and drunk drivers (crash prevention).

Along with these goals, they mentioned that there is a need to improve the permitting process. Some of the redundant and time-consuming tasks are the development of traffic studies (are there ways to hone into specific project trip origin-destination, trip generation, and pinch points (bottlenecks)), this is done over and over usually by consultants. Mapping these can allow others to review and see where other improvements may be needed.

Processes that required multiple datasets to be queried are when there are incidents involving ODOT assets, such as bridge hits. This requires many data sources to be pulled and reviewed for insurance (data from EMIS, cost data, inspection, crash reports, etc.). Also, onboarding new staff requires many sources - background checks and drug screening (and long lag time can occur).

Real-time needs are any safety and traffic conditions, especially within a work zone.

District 10 Notes:

When discussing goals for each district the following were mentioned for D10:

- Permit (heavy haul) - no outputs from this process currently. Don’t know when and where (not communicated to construction and other travelers).

- Construction work zones - communicating to the public where impacts/lane closures and detours. Format for "google" to send to the public. A spreadsheet for user cost for detours and still difficult to use - one cannot click on a map using historical data. Determine if one should maintain traffic or detour.
- Work Plan data for reporting - conflict mitigation, overlapping projects.

When asking about business processes that could use improvements the following tasks were mentioned:

- Work Plan Development regarding pavement, cost, and life cycle (pavement conditions, degradation curves, pavement treatment, chip-seal to replacements, current rating conditions, PCR rating). Currently, FME streamlining this process
- Asset Management/Inventory ELIS but still have to do Gasb form manual (project by project)
- EMIS - timekeeping/charging jobs number (EMIS into ELIS, a lot of the same information).
- A system where they can administrate a construction project by collecting as-build, approving material, in one place (currently there is a system for each).

Similar to D6, tort claims require pulling data from many sources, including crash data somethings and the crash tool isn't the most user-friendly. And have to clean up the crash data manually.

Real-time needs include work zone restrictions. Disabled vehicles were mentioned but others felt that there aren't any high-priority mitigating actions, so not sure about the need for these data in real-time. Snow and ice recovery time is another need.

It was mentioned that traffic studies (impact studies) are conducted but never reviewed to see if they were accurate. Could map these findings to track against real-world data and compare.

Current data gaps mentioned were flooding information and impacts on roadways. For systems that work well for D10, TIMS was mentioned, only wish there was better reporting data for upper management.

For tasks that are more susceptible to human error, the programming awards process in ELIS was mentioned, some things get changed and then not updated in ELIS. Also, building the Work Plans between Capital and Operations go back and forth frequently, and never really know what is correct. Tasks with long lag times for D10 are the change order process and the project close-out process.

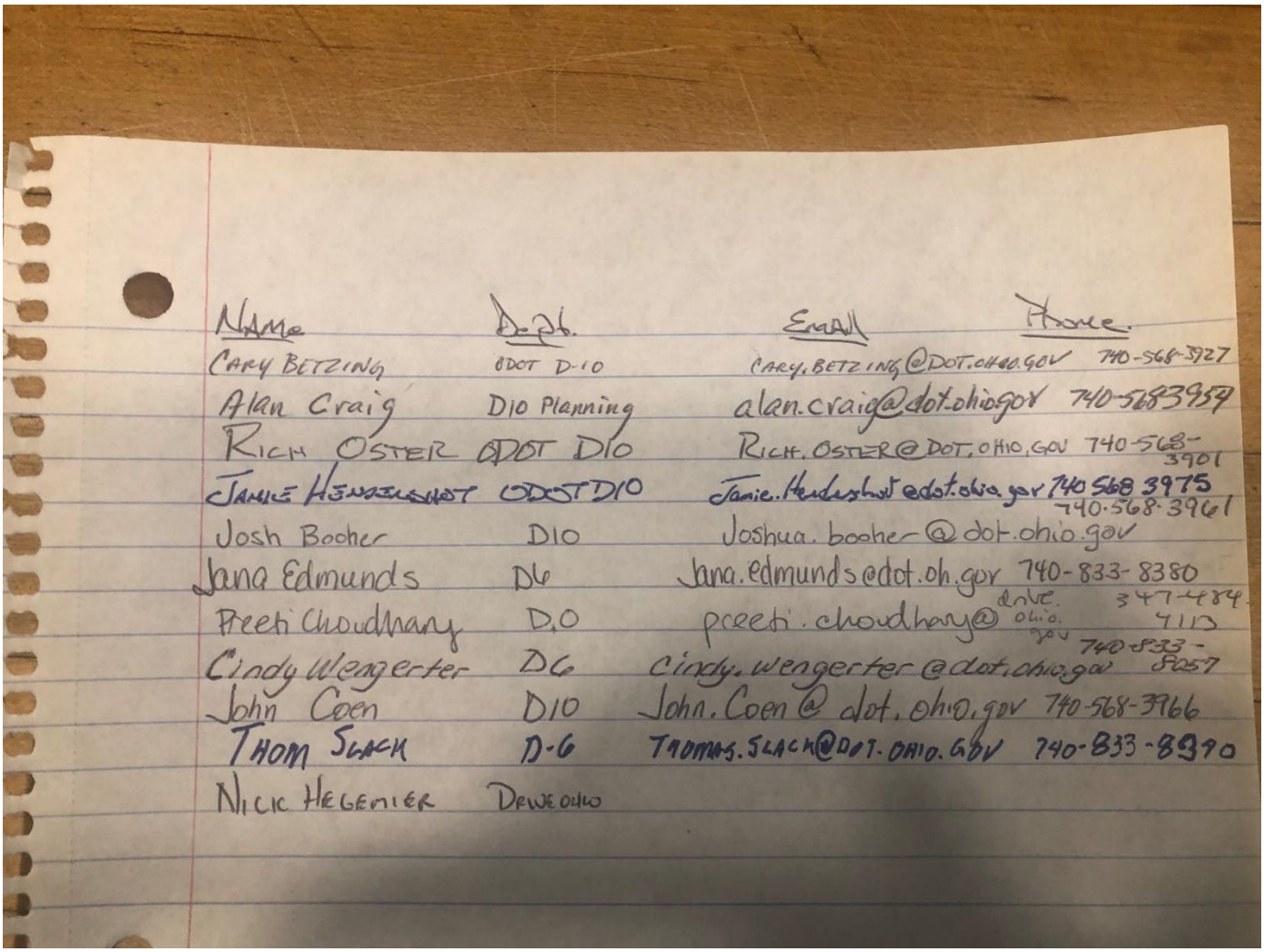
<u>Central Office Notes:</u>

- Would like a better understanding of utilities in an area.

- Right-of-way (ROW) plan request is time-consuming. Currently scanned and not user-friendly, some districts have a system in place but not all the districts have utilized (OROW)

Next Steps

- Permit - private drives and land use data, work with locals for appropriate detour routes
- Risk analysis for boots-on-ground, exposure
- Log Maintenance Agreements - accessible to see what ODOT's responsibility
- Improve inspection and collection of culverts, underdrains, and BMPs
- Detection of wrong-way drivers / drunk drivers (crash prevention)
- Traffic Impact studies (modeling and forecasting to define O/D) - take data from reports that were developed and map it or model. What is the impact of new development
- Bottleneck locations
- Insurance data when collected for an incident (like bridge hits). Data from EMIS, cost data, inspection, crash report, etc.
- Heavy Haul Permit
- Weather recovery alert
- Construction Work Zones – Communication with the public
- Construction Work Zones – User cost detours
- Work Plan data for reporting - conflict mitigation, overlapping projects.
- Asset Management/Inventory ELIS
- Timekeeping EMIS into ELIS
- construction management system
- Tot Claims
- Cost Estimate – inflation estimator
- Cost Estimate – pick spatial roadway and calculate the cost to replace assets
- Life Span of assets
- Inspections of assets
- Change order process
- ROW data



Name	Dept.	Email	Phone
Cary Betzing	ODOT D-10	cary.betzing@dot.ohio.gov	740-568-3927
Alan Craig	D10 Planning	alan.craig@dot.ohio.gov	740-5683959
Rich Oster	ODOT D10	Rich.Oster@dot.ohio.gov	740-568-3901
Jamie Hendershot	ODOT D10	Jamie.Hendershot@dot.ohio.gov	740 568 3975
Josh Booher	D10	Joshua.booher@dot.ohio.gov	740-568-3961
Jana Edmunds	D6	Jana.edmunds@dot.oh.gov	740-833-8380
Preeti Choudhary	D.O	preeti.choudhary@dot.ohio.gov	347-484-4113
Cindy Wengerter	D6	cindy.wengerter@dot.ohio.gov	740-833-8057
John Coen	D10	John.Coen@dot.ohio.gov	740-568-3966
Thom Slack	D-6	Thomas.Slack@dot.ohio.gov	740-833-8390
Nick Hegenier	Dewe Ohio		

Division Workshop - Engineering *MEETING NOTES*

Departments attended: Pavement, Roadway, and Hydraulic. (missing CADD & Mapping Services, Consultant Services, Geotechnical, Real Estate, and Bridge)

Pavement

Overall focus is pavement performance. They tried to automate condition rating, twice, but had accuracy issues, however, they would like for this to be automated. They would like to see the development of performance curves improved [potential].

Reviewing old/historical plans is time consuming, they have to use microfilm (if they exist at all). In the winter they conduct local federal aid inspections which requires physical routing map development. The inspectors need to track where they have been and need to go, so they use the maps to mark-off when work is completed. They do half the state each year.

Field collection, soil data (investigate spreadsheets), and historical data/plans are the main data sources pulled for insights.

The software/datasets they use are traffic data, road inventory lookups. There is in-house software for overlay designs. They use TIMS and ArcMap. The larger limitation is inputting project history files, there is no database of project history. Also, ODOT maintenance data would be helpful, never successful in getting data out of that. Also, there isn't an integration with GPS data maps. Not interested in review salt usage on roadways at this point, but maybe in the future.

The same four people collect the PCR data, so it is consistent but its somewhat objective, biggest error is skipping a section in the review. [image processing for more uniform PCR]

Program for curve is in-house and takes a long time to process data (days of processing and still crashes) only once every three years. [Need a more efficient way].

TIMS is very helpful and works like they want but does take a while for data to get updated.

Roadway

One current goal is based on a FHWA requirement, which require testing pavement marking for reflectivity [for CV/AV application]. Also, they want to increase efficiency of work zones with regards to crashes and conditions, currently working with TMC/operations. Would like to evaluate guardrail/barrier performance measures with crash data [potential process]. Assets missing - such as street lighting details. Pavement management systems indicates where work is needed (what you need to do in what year), not sure how accurate the life-expectance.

plan review on all fronts is time consuming. Currently using ProjectWise/Bluebeam. City gets funding from MDOT, so MDOT must review and there is always case-by-case with standards. 75% of their time on this task. The other 25% is development of Work Zones Report for upper management. Excel-based - data issue esp. with crash data and need better hardware to process. Hooked to Sql data warehouse from ODPS to get the crash data (no control). [better source that doesn't crash when pulling, and automate the report, potential semi real-time

dashboard] This report pulls data from ELLIS, ODPS (crash), and operational data. They use TIMS for asset management just want more and more accurate details (as-build). The plan data require shifting through various manuals.

Traffic studies use synchro, crash (upload issue), HSC, traffic count (sometimes out of date), street lights, bluebeam, and open road. Transmodeler analysis - takes a lot of time to process. Lighting design software used in districts - styles/template built into software; software company updates when they want. bulb ISE files to software company. Citix work environment - processing power - works only with older versions of excel. DAS controls Microsoft.

Data gaps include as-built data, traffic control data, street lighting data, and warranty issues. Errors occur with work zone traffic patterns for MOT when parallel work is occurring [better, real-time data on near by work zones].

Hydraulic

They support the districts' culvert system projects and funding allocation. Would like to track flooding and potential problem areas [can we link to maintenance culvert cleaning data?]. Would like to see more consistent data from districts on culvert inspections.

Plan review is time consuming, requires checking calculations. Consultants typically do the designs work on these projects and will use their software for calculations. Use ProjectWise/Bluebeam to manage documents. Survey data takes a while to receive.

TIMS is main source for data, there are hydraulic maps within TIMS, but don't have all the record plans. Would be nice to have historical imaginary, so you don't have to go to GoogleEarth. Would like better flood data in TIMS (they have a lot of data links already). As-built data are lacking too, sometimes contractors have many options for material, so would be nice to know what was installed.

Quality of culvert data are more susceptible to human error, they use collect app in but it has no skip-field logic. So things get skipped, and don't know its bad till enters the DB.

Next Steps

- Development of performance curves improved - Pavement
- Storing, accessing and review historical plans – Pavement
- Pavement Condition Rating is somewhat subjective, can image processing help? – Pavement
- Work Zone Report – Roadway
- Parallel work zone data for MOT traffic patterns – Roadway
- Barrier/Guard rail assessment – Roadway
- Better as-built data and efficient pavement marking testing for FHWA requirements – Roadway
- Flood tracking (can we link to maintenance cleaning data) - Hydraulic

- Culvert inspection data has no skip-field logic so quality issues – Hydraulic
- Historical imaginary layer in TIMS - Hydraulic

MEETING SIGN-IN SHEET

Project:	ODOT ESP Research 136342 ENG	**Meeting Date:**	8/9/2022 10AM.
Facilitator:	AECOM	**Place/Room:**	DOT CEN GB Room

Name	Title	Department	Phone	E-Mail
Bob Lichaitz	CEO	CFCT	262-252-[illegible]	blichaitz@confluent.io
Bert Hayes	Solutions Engineer	Confluent	512-925-7871	bhayes@confluent.io
Tom Keller	ODOT IT PM	IT	614-466-7996	tom.keller@DOT.ohio.GOV
Jen Alford	ODOT ORE	Roadway	614-565-2804	jennifer.alford@dot.ohio.gov
Jonathan Young	ODOT ORE	Roadway	614-752-9967	jonathan.young@dot.ohio.gov
JEFF SYAR	ODOT	HYDRAULICS	614-[illegible]	JEFFREY.SYAR@DOT.OHIO.GOV
Ganesh Vaithyam	ODOT ESP			Ganesh.vaithyam@dot.ohio.gov
Michael Chiu	Consultant	ODOT IT		Michael.chiu@dot.ohio.gov
Keshav Ramakrishnan	Consultant	ODOT IT		keshav.ramakrishnan@dot.ohio.gov
Sanjay Shah	Business Analyst	ODOT IT		Sanjay.Shah@dot.ohio.gov
Dave Miller	Assistant Admin	ODOT - Pavements	614-995-5991	dave.miller2@dot.ohio.gov
Stephanie Castner	ODOT Eng	ODOT-ENG	614-466-7490	stephanie.castner@dot.ohio.gov

Division Workshop – Human Resources *MEETING NOTES*

Departments attended: Personnel, Labor Relations, Employee Safety and Health, and Workforce Diversity. (Missing: Employee Development and Lean)

Overall Division

The overall division is tasked with:

- Bringing in talent (and resulting services) – force on workforce diversity
- Retention of talent
- Training, safety, and health
- Accountability and negotiation of talent

Some of the reports (staffing levels and governance reports) are time-consuming. Would like to have these in more of a dashboard with real-time stats for upper management.

Class Study with multiple users (working with stakeholders) tends to have a high lag time. And ODOT loaning systems. Transfers from agency to agency take a while to get set up since they rely on other agencies to off-board employees before on-boarding on the ODOT side.

Personnel

Working with an employee on absent leave to receive their appropriations. Currently have had to add working with tax liability since moving to a teleworking environment (i.e. ensure proper taxes). Make sure absent-leave employees get all their proper forms/paperwork (via Oak System and email). Kronos time management systems for tracking. Kronos funnels into Oak System.

Areas that they would like to see improved are the development of service awards and updating the organization chart. Service awards are done quarterly but are a very manual process (80ish awards each quarter. The organization chart will populate in the Oak Peoplesoft system but tends to get errors when updating larger centers and then, must manually get an update. Both via Oaks

There is an HR dashboard with different source reports but they all come from the Oaks system.

There are frequent back and forth (errors) on the personal action reports (EPAR). Districts generate requires proper codes and attachment/forms which leads to wrong or missing data required (this is an Oaks add-on). Districts manually determine what is required and submit it electrically for review and approval but often need to get missing/wrong data before approval. [an opportunity to make more efficient via auto checks?]

The outside vendors' background check lag time was already addressed. EPARs have a high lag time since it takes a while to get all the proper data. Service awards take time, and always

looking back - not forward. The organizational chart is updated bi-weekly - but would like more real-time

Labor Relations

Investigations and tracking relations via Salesforce. Don't have any standard system for investigative office inv services and equal opportunities (two groups, each having their own home-grown system/process)

There are 100s of investigation per year and in need for a way to better track. Also, the creation of annual reports is manually using spreadsheets.

Tracking investigation is all in different "systems" and must all be pulled into one for insights – would like to have one system for this task.

Salesforce working well. Reports come off it and just manual enter the data. Not sure if there is a way to data-dump. Paper/QA then transcript or handwritten. One PDF is then uploaded to Salesforce.

Employee Safety and Health

Just implemented a system called Origami which pulls in three offices into central system: Vehicle Liability, safety, and worker's compensation). Origami is able to provide various departments with reports as required. Report outputs are automated and there is a dashboard available for quick review of data. The software tracks injuries or vehicle issues based on district, employee and/or facility (not by project). Origami goes into DAS and also have a predictive model for injuries based on time of day, day of week, month, gender, hours within a shift, etc. PS1 [form] is only method for capturing near-misses and relies on personnel to decided to report. Use these data for district and state-wide training.

Origami was just launched and is meeting most of their needs (as of now), so no specific request for other business processes to be improved. Mentioned pulling EIMS for vehicle data into Origami and that some work comp is done through the post office still through bureau.

Working with Lean to see if there are any redundancies in data inputs. There is some double-handling with work comp data but not sure that can be changed [further investigations?]. The only time consuming issues is with district's lag time.

Origami pulls from Oaks. Weather details is from PS1 forms, manual input [could it be linked to weather data source for tracking injury types correlated to weather?]

Workforce Diversity

Main focuses are recruitment and retention. They use in-house surveys to collect data, such as an on-boarding survey the new hires fill-in. It is time consuming to compile the data for insights. Has the goal to determine what recruiting/retention efforts work and what does not work. The survey is a combination of open and closed-ended equations (using survey monkey). Also, this group utilizes census data from multiple sources.

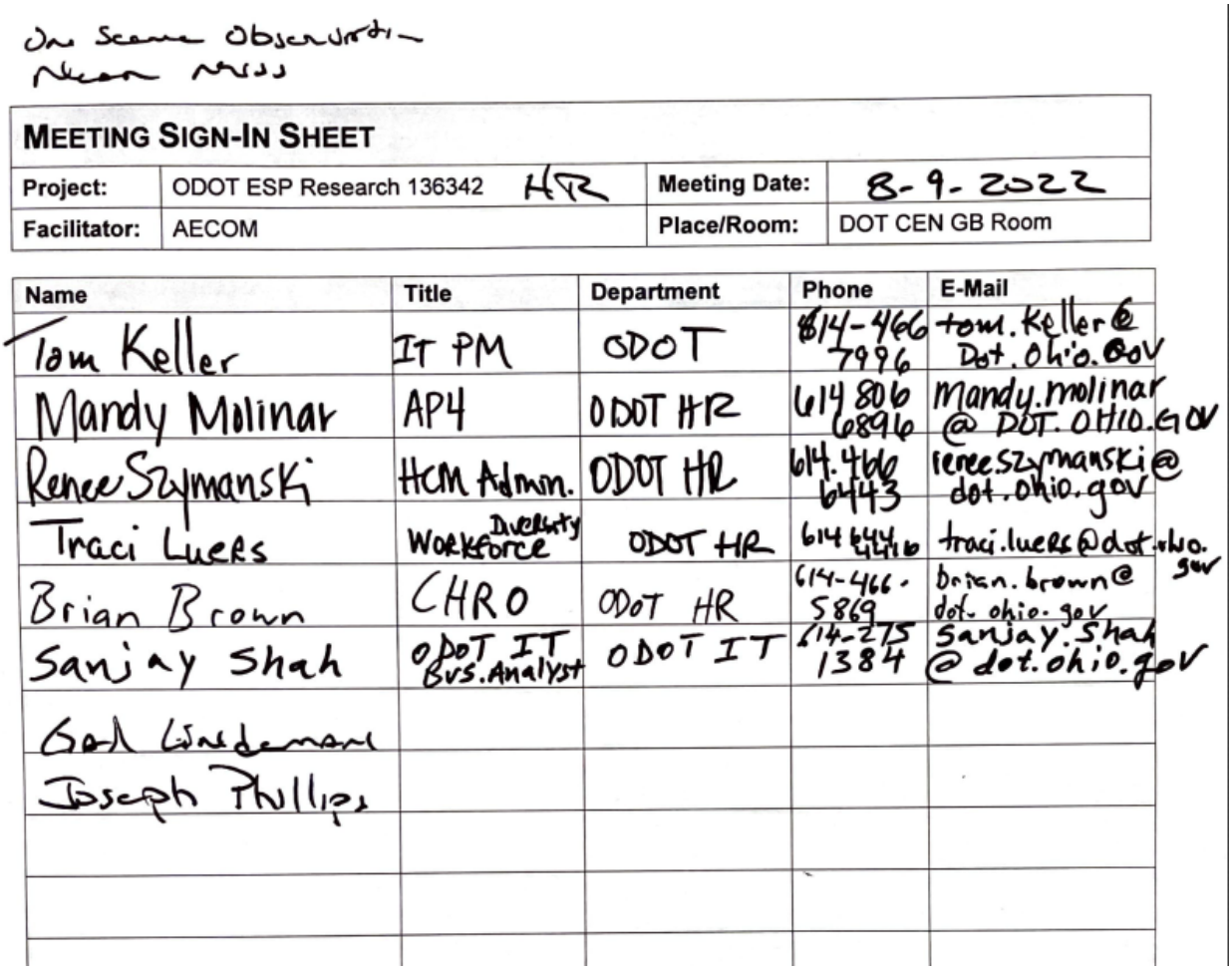
Would like to see the census data and survey data process to be improved. Fast (less manual). Would like to get additional data such as why someone left ODOT with new exit survey which will add to work for manually evaluating the surveys. [any link to why someone left with grievance reports via grievance system]

Census data are pulled from various sources. [can we scrap websites into one GUI/report/dashboard from them?]

Survey data is susceptible to human error.

Next Steps

- Service Awards – looking forward (not back) - personnel
- Org Chat (automate and more real-time/frequent updates) - personnel
- Census Data and survey data for insights – Workforce Diversity
- Standardize investigation data collect and reporting – Labor relations
- Can we leverage Origami data and analyses (predictive) to pull even more insights? Weather data? Near-misses?



MEETING SIGN-IN SHEET

Project:	ODOT ESP Research 136342 HR	**Meeting Date:**	8-9-2022
Facilitator:	AECOM	**Place/Room:**	DOT CEN GB Room

Name	Title	Department	Phone	E-Mail
Tom Keller	IT PM	ODOT	614-466-7996	tom.keller@dot.ohio.gov
Mandy Molinar	AP4	ODOT HR	614 806 6896	Mandy.molinar@DOT.OHIO.GOV
Renee Szymanski	HCM Admin.	ODOT HR	614.466 6443	renee.szymanski@dot.ohio.gov
Traci Luers	Workforce Diversity	ODOT HR	614 644 4416	traci.luers@dot.ohio.gov
Brian Brown	CHRO	ODOT HR	614-466-5869	brian.brown@dot.ohio.gov
Sanjay Shah	ODOT IT Bus. Analyst	ODOT IT	614-275 1384	sanjay.shah@dot.ohio.gov
Gail Wiedeman				
Joseph Phillips				

Division Workshop – Finance *MEETING NOTES*

Departments attended: Accounting, Budget & Forecasting, External Audits, and Federal & Capital Accounting.

Accounting

Accounting has three groups: purchasing, appropriating accounting, and external system. They use Ion Wave software for quotes and it is tailored for their needs. Cost account and inventory use EMIS for equipment, facilities/lane, vehicles, etc. They use FARS for fixed asset reporting system for computers, tools, etc. which is a home-made system out of D11 (potentially may want to replace). Attempted to move this software into IT's realm but didn't work out. This fixed asset system is stable and does everything they need. They use EMIS software for day to day material tracking and are working to upgrade to SAS and new version.

They use SharePoint forms for requisition and quotes but not sure where they go from that point. Purchase Orders (PO) get ingested into Oaks, then Oaks adds data and sends back for the group to manually print to PDF and email to various businesses [can we help send these off automatically]. Contract authorization form for personal service walk through steps is now an editable PDF that is emailed [might be ways to automate this workflow].

The 50K list (database with data about work cost, must be less than 50K/year without a contract). Currently, pull all data into DB via query buttons. Any new vendor is flagged. Shift through PCard charges and assign to vendor for tracking. They check DAS system but the ODOT one is better at assigning charges. Most up-to-date data are valuable for tracking status of yearly cumulative costs.

Calculating overhead rates annual requires multiple data sources: EMIS, Fixed Assets, and propriating account (PA) and spreadsheets. Needs to be adjusted for each district. OH goes into EMIS to apply where needed, such as repair orders.

Budget & Forecasting

They are tasked with forecasting revenue on state/federal side, IRS audit requirements, bonds issued with the treasurer state (each bond process is based on specific requirements). Managing the operation budget such as reviewing payroll and procurement. Capital funds go into transportation maintenance budget via ELLIS and OAKS (first spreadsheets then entered into ELLIS). They generate the annual fiscal report and issue checks/payments.

Would like to see the revenue process automated, building invoices via accounts receivable software, this process is susceptible to human error. AA software houses the budgets for other groups, where they can access to run queries. Would like to automate request for transfer SAC between account codes. Dealing with capital budget could be improved, currently requires ELLIS, spreadsheets, and AA. Also, ORC checks are time consuming and/or redundant.

FHWA releases PDF of tables (notification from FHWA are sent out), then they drop these new table values into combined spreadsheet. [Could the website be scraped when new data is

updated]. There are a few documents/reports created using multiple sources, such as revenue ProAccounting (PA), query to then build report in excel to compare revenue to budget [opportunity to automate].

Some data gaps are the traffic/mile (monthly) data. This is to determine the forecast of consumption in fuel. Governor wants to know in-state vs out-of-state fuel tax. Hard to determine since whole sellers are taxes when sale to retail. [Can we build something that can assist with this?]

External Audits

The work with outside agencies (LPA, transit, design/architecture firms) to oversee funds. They have a new system PreQ which interfaces with office of audit services to get proper documents and communicate with firms. Use BI Query which is an internal tool and database.

The process that they would like to see improved are the ability to capture PM for audits which now uses spreadsheets to create graphs from multiple source spreadsheets. Also, internal invoice form IPS, just a spreadsheet with 1000s of macros with one person maintaining. Note that there are difference spreadsheets/data require based on the type of project being audited.

Tasks that are the most time consuming/redundant is the AE desk review (PreQ is helping). The outward facing for LPA to get information on ODOT budget (CEFA process) is inconsistent with the way it is entered. The CEFA confirmation uses multiple sources, ELLIS, PA, Req, filter data , which is done internally, but cannot do a standard template since it's not required by law; therefore, cannot require LPAs to conform.

Risk assessment on all companies is a data gap. A lot of that is based on how much work they do but it's only at prime-level, not subs. Which doesn't fully represent the risk since the sub could be doing more of the work. Ideally, a more granular risk assessment would be great.

Real-time data needs could be notifications when changes to pre diem and mileage cost rates. Also, when changes are submitted. DSA now reports mileage and per diem rates with links instead of hardcoded to help with easy of updating.

PreQ is working very well for their needs.

Federal & Capital Accounting

They handle accounts payable and travel. They use ELLIS, Oaks, and ProAccounting (PA) to get data - interfaces between these systems are already built in. They also work on Capital accounts which deals with working with FHWA to get reimbursements. The capital data is entered in one place then parsed out to various places. Rollup to Oaks, then keep AA detailed for FHWA.

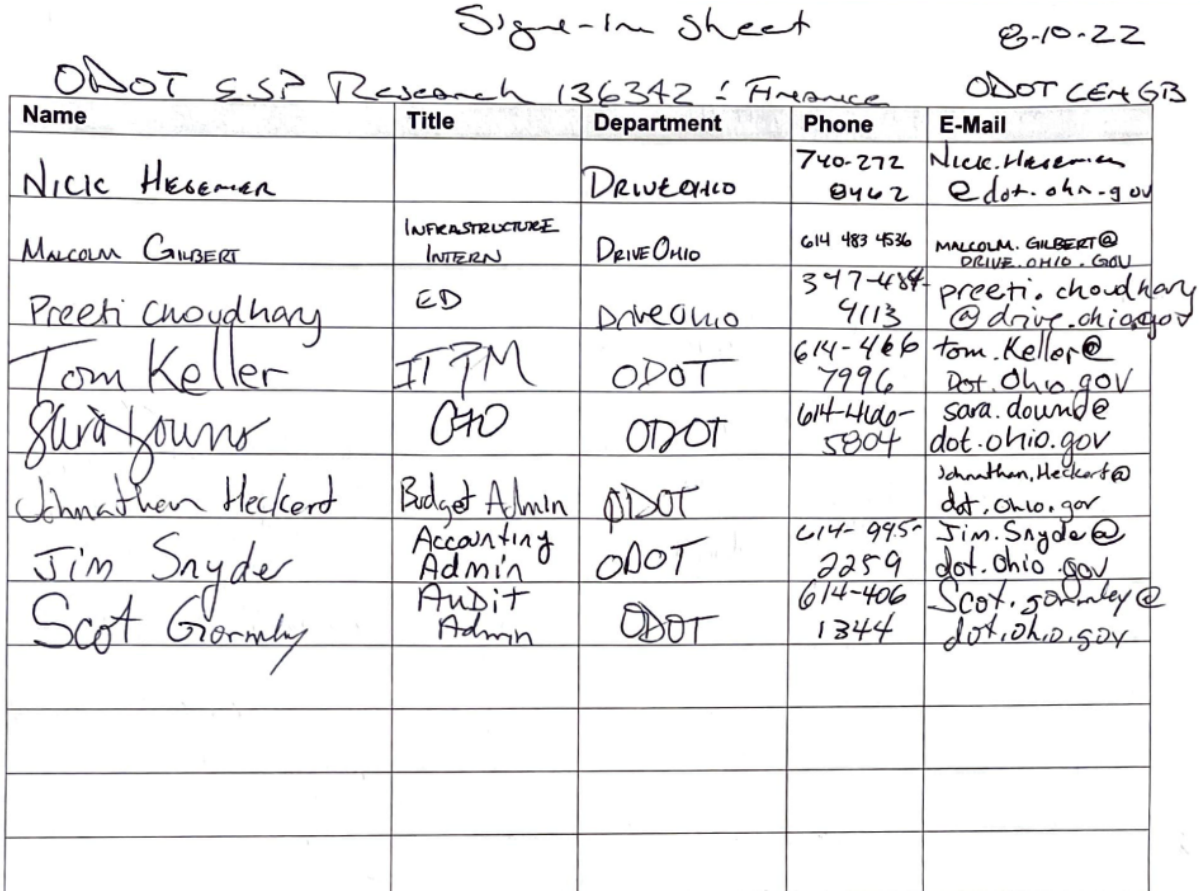
There is a new current billing systems to process labor transactions for FHWA. Working on enhances to it and SPM for FEMA/FHWA. Working on capital project close form to track near/at completion. Form is live but working on next phase (excel spreadsheet and Access DB now - moving with ServiceNow).

Need improves on paper invoice to electronic and need help managing how they come in, assign to people to review and check. Currently, all come into a central mailbox which is easily "messed-up" when more than one person is in it working. [opportunity to help]

They do all data entry, so some cross check for validating fields which leads to a lot of room for errors in vouchers. Compare voucher and invoice [can this be automated?].

Next Steps

- The 50K list – Accounting
- Purchase Orders (PO) get ingested into Oaks, then Oaks' adds data and sends back for the group to manually print to PDF and email to various businesses – Accounting
- Calculating overhead rates annual – Accounting
- FHWA releases PDF of tables (notification from FHWA are sent out), then they drop these new table values into combined spreadsheet – Budgeting and Accounting
- Forecast of consumption in fuel - Budgeting and Accounting
- Risk assessment on all companies is a data gap (only at prime-level, not subs) – External Audits
- Need improves on paper invoice to electronic and need help managing how they come in, assign to people to review and check – Federal & Capital Accounting



Sign-in sheet 8-10-22

ODOT ESP Research 136342 : Finance ODOT CEM GIS

Name	Title	Department	Phone	E-Mail
Nick Hesemer		DriveOhio	740-272 0462	Nick.Hesemer @dot.ohio.gov
Malcolm Gilbert	Infrastructure Intern	DriveOhio	614 483 4536	MALCOLM.GILBERT@DRIVE.OHIO.GOV
Preeti Choudhary	ED	DriveOhio	347-484-4113	preeti.choudhary@drive.ohio.gov
Tom Keller	ITPM	ODOT	614-466 7996	tom.Keller@Dot.Ohio.gov
Sara Journe	OHO	ODOT	614-466-5804	sara.dounde dot.ohio.gov
Johnathon Heckert	Budget Admin	ODOT		Johnathon.Heckert@dot.ohio.gov
Jim Snyder	Accounting Admin	ODOT	614-995-2259	Jim.Snyde@dot.ohio.gov
Scot Gormley	Audit Admin	ODOT	614-466 1344	Scot.Gormley@dot.ohio.gov

Division Workshop – Construction *MEETING NOTES*

Departments attended: Alternative Project Delivery (only the first 30-mins), Contract Sales & Estimating, and Materials Management. (missing Construction Administration)

Overall District

Improvements ideal for TAP list - not all items on it. Data governance with ASSHTO Ware (construction project). Site manager for sampling and testing material.

Alternative Project Delivery

They deal with the 5% of projects with atypical contracting methods. Electric delivery process evaluation, with attempts to streamline. Construction report needs streamlined [potential use case]. Strategic plan for long term and short term goals for technical plans for construction is a current goal.

Construction Administration

[Data provided by other in division] There are staff specialist for different construction process - like asphalt, water issues, earthwork, traffic, etc. Recommended spec updates, review, and publish. Field reviews with recommendations for problems. Checkpoints for work, product, and validation points. Collect attributes of construction for the report - quality report and progress are broken [potential ESP use case?]. These reports need to improve and simplify for field usage. Mobile inspector pushes to software for progress which isn't favorite.

Contract Sales & Estimating

Sits between plans and sales, transactional work. District file to central office. They assign funding and codes and they compare bids to estimates. Working on streamlining execution process, which requires pull data and review via Salesforce, just moved to electric signature which helps. Some back and forth for unique projects. They must look up insurance, policy, work comp details.

There are several locations for data/information that could potentially be optimized, engineering tracks via ELLIS, but also an Access DB to track in office (milestones, dates, etc). Once estimated, moves to construction sales office that uses SharePoint spreadsheet to track. Are data different between systems - major milestones doesn't really change, but others might have different goals/milestones to monitor.

Only redundancy is some dates on forms but try to keep data input district. Automated tasks are being tested now, which is electronic signatures, check, and pre-populated forms in Salesforce. Pulling insurance and worker's comp data requires many sources. They use SAM (federal website) for contractor data.

Some of the software used are: Salesforce per-qual (some manual but mostly automated), AWP preconstruction estimating proposals, bid-express (third-party). Funding codes are manual

spreadsheets, each project has own spreadsheet with enter manual entered. Funding goes to Site Manager. Codes SAC. For Procurement contracts there is an Access DB and SharePoint but moving to Ohiobuys system. They create a report for completest, quarterly report on filing, and status report which are developed manually [automation potential]. Plan files, advising date, letting date, review bids (1 week), check contractor qualifications, awards committee meeting, and execution date are all stored in ProjectWise (PW). Funding and estimate use Access DB that doesn't work with anything else and IT doesn't support it [potential for improvement].

They cannot think of any data gaps but advising controlled route sheets (not updated in TIMS often), this is something they want to request from GIS group [potential]. Only real-time data applications they can think of is being notified if LET date changes on a project via ELLIS. Emergency contracts are few and far between and require a lot of handholding (not anything to automate there).

Plan files from the districts are more susceptible to human error and is time consuming, but not sure of ways to automate, they use PW. They do have to request additional data (back and forth), they only have a checklist to review but no automatic "flagging" if something is missing [potential].

Long lag times with the federal fund approvals via FHWA and while working with local legislation.

Individual systems work well but would be nice to have all in one place [potential use case]. They like the new SharePoint.

Materials Management

They would like a place to store QC plans and better mechanism for supplier to add data. SharePoint site was tested for this but never pushed/buy-in. Currently, supplier to fabricators to contractor to them - then add to their folder - but when revision via email, things don't always get updated then they have to shift to make sure up-to-date files are in there. Currently SSN, proj ID, PID, SFM (structure file number) are attributes [potential for use case].

Sharing and query data could be improved and comparing TAP list and product numbers [potential for use case]. Time consuming tasks include the mix designs, which have specific packets for contractors (spreadsheets), so have to get data from contractor, query, and upload to DB [can this be automated].

They wanted to automate the QA/QC for aggregates but that wasn't pursued because of AASHTO-Ware project. One challenge is getting the districts to input data in a timely manner [see what the process is from districts to determine if there is a fast way]. Could use spatial and direct access to the shop drawings and historical documentations.

Next Steps

- Tap list – Overall Division
- Construction report needs streamlined – Alternative Project Delivery
- Quality report and Mobile inspector progress – Construction Administration
- Combined systems in one place – Contract Sales & Estimating
- Advising controlled route sheets – Contract Sales & Estimating

- Improvements to funding and estimate tool/software (currently Access DB) – Contract Sales & Estimating
- ProjectWise requirement "flagging" to reduce back/forth with district for proper forms/data – Contract Sales & Estimating
- Mix designs improvement, Sharing and query data could be improved – Materials Management
- Comparing TAP list and product numbers – Materials Management

MEETING SIGN-IN SHEET

Project:	ODOT ESP Research 136342 Construction	**Meeting Date:**	8-10-2022
Facilitator:	AECOM	**Place/Room:**	DOT CEN GB Room

Name	Title	Department	Phone	E-Mail
Nick Hegemier		DRIVEOHIO	614-387 4099	Nick.Hegemier @ dot.ohio.gov
Jill Martindale		Research	614-644-8173	
Dan Miller		OMM	614-275-1325	daniel.miller @ dot.ohio.gov
Eric Kahlig		Construction	614 466 2406	eric.kahlig@ dot.ohio.gov
Steve Masters				
Sam Joz				
Nathan Fling				
Tom Keller	IT PM	ODOT	614-466 7996	tom.keller@ Dot.ohio.gov

Table 6: Data Gathered at Workshops – Phase 1

Level	Description
Use Case	Automate DOT asset reporting (type, location, status [reporting/non reporting])
Use Case	Detect and alert upon a sudden slow down on a highway
Use Case	Predict risk of a weather-related crashes within a geographic area
Use Case	Predict risk of crashes within a geographic area
Use Case	Model weather Scenarios for planning and operations for ground and air
Use Case	Improve travel time calculations
Use Case	Leverage PowerBI/Tableau to improve data sharing and analytics from crash data, recovery times, safety response performance, and smart lane performance
Use Case	Identify locations to pre-stage snowplows based on incoming weather conditions
Use Case	Identify road defects using vehicle-based sensor data
Use Case	Identify roadway segments needing maintenance
Use Case	Monitor and track incident response and clearance times
Use Case	Update a base map of traffic conditions using ITS and 3rd-party data
Use Case	Generate a periodic or on-demand report detailing roadway pavement maintenance effectiveness (including KPIs regarding efficacy of funding allocations)
Use Case	Update a base map of DOT assets using near real-time data from vehicles
User Need	Provide access to traffic data in data warehouse for operators to identify traffic events
User Need	Develop Business rules and queries to provide insights from data and share for real time consumption
User Need	Review and Identify best technology or mix of technology for mapping, archiving, and displaying real time data (vehicles, pedestrians, bikes, snow, ice)
User Need	Identify siloed data
User Need	Automate data and report sharing across teams
User Need	Implement data standards and formatting for consistency
User Need	Normalize data if needed for sharing across platforms
User Need	Use Linear Referencing System for all Data to help integrate information location
User Need	Store data from ITS sensors in data warehouse for analysis
User Need	Ingest weather data feed into data warehouse
User Need	Ingest ODOT RWIS data
User Need	Identify missing data from sensors, 3rd-party sources, or other subsystems
User Need	Develop dataset validation process
User Need	Identify opportunities for friction data to support other use cases and purposes within ODOT
User Need	Share (cost, and efficiency) data analysis for near real time data for cameras, data feeds, Waze integration, slowdowns, snow/ice
User Need	Share data for 670 smart lane real time data through Dashboard for traffic management center and TOC operators
User Need	Be more transparent and share safety and other funds to help districts come up with operating budgets

Level	Description
User Need	Develop and advertise site (currently SharePoint) to have people share data, reports, and analytics
User Need	Develop report templates
User Need	Create updated process for workplan development
User Need	Develop tools for friction data analytics
User Need	**Traffic Ops Assessment Tool** to further integrate data sources to support funding decisions
User Need	Automate data sharing to maintenance crews; provide mechanism for maintenance crews to report back on items fixed
User Need	Tag weather data for days (time frame) as (weather day or other event) to exclude from overall metrics
User Need	Incorporate business rules into data queries for data warehouse
User Need	**Snow and Ice Performance Tool** combines data to identify weather event start/end and traffic impact and recovery
User Need	Remove duplicate reports and analytics
User Need	Operators able to report areas of repair not in crash report
User Need	Incorporate risk data into resiliency factors and plans
User Need	Get Vehicle counts by type from cameras
User Need	Implement AI/ML for intelligence on data sources
User Need	Create tool to help determine how to spend money effectively utilizing different buckets of money (social justice, economic impact)
User Need	Automate or script highway patrol measurements and sensitivities, and weigh-in-motion data from excel to provide or assist in targeted enforcement
User Need	Incorporate friction data into crash analysis to provide better risk analysis
User Need	Share certain data with the private sector (revenue model)
User Need	Use dump truck data to identify road defects
User Need	Provide predictions from data and incorporate risk into planning
User Need	Provide analytic insight dataset sharing as subset of data sources for multiple platform users
User Need	Share friction management data to allow others to use and develop business cases to support decision making
User Need	Provide rural areas with weather conditions to make decisions and plan
User Need	Provide weather prediction data
User Need	Promote ESP by having a campaign rollout
User Need	Research, review and analyze computer vision for cameras at rest locations
User Need	Improve process of updating base data and features from design plans
User Need	Identify and consider risk factors other than pavement condition for determining impacts and drive funding
User Need	Improve Automated Vehicle Data collection and analysis
User Need	Track and analyze how State money is spent to better manage reliability of network such as striping, work zone, OEM measurement conditions

Level	Description
User Need	Manage striping conditions using machine learning from vehicle data to monitor work zones and roadway conditions
User Need	Improve Traffic machine learning from video cameras
User Need	Provide integrated pavement condition using 3d imagery, ride quality data, and log data to give better insight into current road conditions
User Need	Identify and pursue traffic systems to provide parking counts
User Need	Provide real time pavement data from vehicle data
User Need	Ingest vehicle-based sensor data

Table 7: Data Gathered at Workshops – Phase 2

Division	Department	Potential Use Case	Description/Notes
Construction	Overall (Construction)	Tap list	Not all items on it
Construction	Alternative Project Delivery	Construction report needs streamlined	Alternative Project Progress report
Construction	Administration	Quality report and Mobile inspector progress	Check points for work, product, and validation points. collection attributes construction for report. Needs simplified for field usage. Mobile inspector pushes to software for progress which isn't ideal
Construction	Contracts Sales & Estimating	Combined systems in one place	There are several locations for data/information that could potentially be optimized, engineering tracks via ELLIS, but also an Access DB to track in office (milestones, dates, etc). Once estimated, moves to construction sales office that uses SharePoint spreadsheet to track.
Construction	Contracts Sales & Estimating	Advising controlled route sheets	Data gaps - advising controlled route sheets (not updated in TIMS often), this is something they want to request from GIS group
Construction	Contracts Sales & Estimating	Improvements to finding and estimate tool/software	Funding and estimate use Access DB that doesn’t work with anything else and IT doesn’t support it
Construction	Contracts Sales & Estimating	ProjectWise requirement "flagging"	to reduce back/forth with district for proper forms/data
Construction	Contracts Sales & Estimating	LET date changes on a project via ELLIS	Real-time notifications for changes to LET dates via ELLIS

Division	Department	Potential Use Case	Description/Notes
Construction	Materials Management	Supplier, Contractor, Fabricator - update files - now just emails	When revision via email, things don't always get updated then they have to shift to make sure up-to-date files are in there. Currently SSN, proj ID, PID, SFM (structure file number) are attributes. Tested SharePoint without success
Construction	Materials Management	Sharing and query data could be improved	Time consuming tasks include the mix designs, which have specific packets for contractors (spreadsheets), so have to get data from contractor, query, and upload to DB
Construction	Materials Management	Comparing TAP list and product numbers	
Engineering	Pavement	Development of performance curves improved	
Engineering	Pavement	Storing, accessing and review historical plans	Reviewing old/historical plans is time consuming, they have to use microfilm (if they exist at all).
Engineering	Pavement	Pavement Condition Rating is somewhat subjective. Sometimes they miss segments while collecting	image processing (UC-4), add alert to tell operator they are missing segments
Engineering	Roadway	Work Zone Report	ESP is launching WZ data, build report faster/real-time to determine if changes are needed
Engineering	Roadway	Parallel work zone data for MOT traffic patterns	
Engineering	Roadway	Barrier/Guard rail assessment	image processing to collect asset data
Engineering	Roadway	Better as-built data and efficient pavement marking testing for FHWA requirements	image processing to collect asset data
Engineering	Hydraulic	Flood tracking (can we link to maintenance cleaning data)	cleaning maintenance conduct, pass performance, weather to predict if flooding might occur
Engineering	Hydraulic	Culvert inspection data has no skip-field logic so quality issues	Might not be ESP unless needed for checks - might be better to fix front end software
Engineering	Hydraulic	Historical imaginary layer in TIMS	
Finance	Accounting	The 50K list	ML to assign charges

Division	Department	Potential Use Case	Description/Notes
Finance	Accounting	Purchase Orders (PO) get ingested into Oaks, then Oaks' adds data and sends back for the group to manually print to PDF and email to various businesses	
Finance	Accounting	Calculating overhead rates	Calculating overhead rates annual requires multiple data sources: EMIS, Fixed Assets, and propriating account (PA) and spreadsheets. Needs to be adjusted for each district. OH goes into EMIS to apply where needed, such as repair orders.
Finance	Budgeting & Accounting	FHWA releases PDF of tables (notification from FHWA are sent out), then they drop these new table values into combined spreadsheet	
Finance	Budgeting & Accounting	Forecast of consumption in fuel	Traffic/mile (monthly) data. This is to determine the forecast of consumption in fuel. Governor wants to know in-state vs out-of-state fuel tax. Hard to determine since whole sellers are taxes when sale to retail.
Finance	External Audits	Risk assessment on all companies is a data gap (only at prime-level, not subs)	
Finance	External Audits	PM audits - replacing Macro sheet replacement	Also, internal invoice form IPS, just a spreadsheet with 1000s of macros with one person maintaining. Note that there are difference spreadsheets/data require based on the type of project being audited.
Finance	Federal & Capital Accounting	Need improves on paper invoice to electronic and need help managing how they come in, assign to people to review and check	
Human Resources	Personnel	Service Awards – looking forward (not back)	
Human Resources	Personnel	Org Chat (automate and more real-time/frequent updates)	

Division	Department	Potential Use Case	Description/Notes
Human Resources	Workforce Diversity	Census Data and survey data for insights	
Human Resources	Labor Relations	Standardize investigation data collect and reporting	
Human Resources	Employee Health and Safety	Can we leverage Origami data and analyses (predictive) to pull even more insights? Weather data? Near-misses?	
D6		Plan sets - historical, spatially	
D6		Permit - private drives and land use data, work with locals for appropriate detour routes	
D6		Risk analysis for boots-on-ground, exposure	
D6		Log Maintenance Agreements - accessible to see what ODOT's responsibility	
D6		Improve inspection and collection of culverts, under drains, and BMPs	
D6		Detection of wrong way drivers / drunk drivers (crash prevention)	
D6		Traffic Impact studies (modeling and forecasting to define O/D) - take data from reports that were developed and map it or model. what is impact for new development	probe data then compare to past studies. Remove incident events, weather events, for a normalized baseline
D6		Bottleneck locations	historical bottleneck - prediction
D6		Insurance data when collection for incident (like bridge hits). Data from EMIS, cost data, inspection, crash report, etc.	
D6		Onboarding new staff	
D6		Safety and traffic conditions - especially in work zones	

Division	Department	Potential Use Case	Description/Notes
D10		Heavy Haul Permit	No outputs, don't know when and where (not communicated to construction and other travels)
D10		Weather recovery alert	
D10		Construction Work Zones	communicating to public where impacts/lane closures and detours. Format for "google" to send to public
D10		Construction Work Zones	Spreadsheet for user cost for detours
D10		Spatial Historical Data	
D10		Work Plan data for reporting - conflict mitigation, overlapping projects.	Is this similar to Engineering need? ID-15 and ID-16
D10		Pavement Work Plan	Work Plan - pavement, cost, life cycle (pavement conditions, degressions curves, pavement treatment, chip-seals to replacements, current rating conditions, PCR rating) FME streamlining this process. Lots of back and forth between Capital and Operations
D10		Asset Management/Inventory ELIS	Asset Management/Inventory ELIS - then have you have to do GASB form manual (project by project)
D10		Timekeeping EMIS into ELIS	timekeeping/charging jobs number (EMIS into ELIS, a lot of same information).
D10		construction management system	Would like one system where they can admin a construction project by collecting as-build, approving material, one place (currently system for each), pay contractor.
D10		Tot Claims	5-10 per week, multiple sources. Tot claims. Other agencies OSHP - we use the crash reports all the time, but constantly need these data. Crash tool isn't great. Manually checking crash data then clean their data.
D10		Cost Estimate	Inflation estimator
D10		Cost Estimate	Pick spatial roadway and calculate cost to replace assets
D10		Life Span of assets	Nothing that flags upcoming life spans

Division	Department	Potential Use Case	Description/Notes
D10		Inspections of assets	see ID-17 and ID-18
D10		Change order process	all over and goes to multiple people
Central Office		ROW data	ROW plan request (finding for people, when they can get on their own). Scanned and not user friendly. D10 and D5 has a system but not all over. OROW system
Central Office		General understanding for utility in area (number of agencies)	

Appendix B: One-Pagers

Project: Achieving Efficiencies within ODOT with the Event Streaming Platform (ESP)

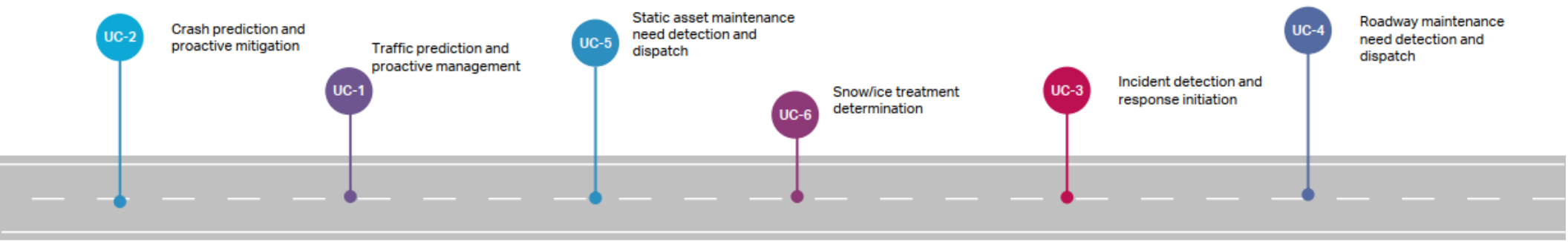
ESP Use Cases

Potential ESP Use Cases identified in coordination with ODOT Operations stakeholders

No.	Use Case	Description
UC-1	Traffic prediction and proactive management	Provide TMC Operators with traffic management recommendations, including location and strategy, to proactively mitigate expected traffic or congestion. TMC Operators implement mitigation via ITS devices (i.e., signals, variable message signs, variable speed limit signs, etc.).
UC-2	Crash prediction and proactive mitigation – *Occurring now as part of Smart Grant Award*	Provide TMC Operators with crash avoidance recommendations, including location and strategy, to proactively deploy mitigation in areas with a high probability of crashes occurring. TMC Operators implement mitigation via ITS devices (i.e., signals, variable message signs, variable speed limit signs, etc.) and communication with public safety officials to allow for increased safety presence.
UC-3	Incident detection and response initiation – *Occurring now as part of Smart Grant Award*	Automatically detect the occurrence of a crash and initiate crash response strategies. Automatically alert proximal first responders based on incident type and severity. Provide TMC Operators with predicted traffic impacts and mitigation recommendations, including location and strategy, to proactively mitigate expected crash impacts.
UC-4	Roadway maintenance need detection and dispatch	Automatically detect roadway locations that need maintenance based on vehicle camera and inertial measurement unit data. Automatically schedule and dispatch maintenance crews. Enable robust roadway monitoring and data collection to support the prediction of future maintenance needs.
UC-5	Static asset maintenance need detection and dispatch	Automatically detect static assets that need maintenance based on vehicle camera data. Automatically schedule and dispatch maintenance crews. Enable robust roadway monitoring and data collection to support the prediction of future maintenance needs.
UC-6	Snow/ice treatment determination	Automatically determine expected levels of snow and ice treatment needed by location based on incoming weather and low-friction pavement conditions. Provide estimated treatments needs to snow/ice crews to support preparedness.

ESP Use Case Roadmap

Recommended sequencing for Use Case development based on high-level value assessment of data and system architecture needs



UC-1 Traffic prediction and proactive management

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Traffic Conditions (speed, volume, congestion)	✓	Buckeye Traffic
Historical Crash Data	✓	TSMO Data Warehouse
Current Incidents	✓	Buckeye Traffic
Current Work Zones	✓	Buckeye Traffic
Historical Traffic Data	✓	TSMO Data Warehouse

THIRD PARTY DATA	Cost Rating	Source
Vehicle Speeds	$$$	Connected vehicles
Emergency Braking Events	$$$	Connected vehicles
Traction Control Events	$$$	Connected vehicles

ODOT THRESHOLDS
Congestion prediction confidence

Output and Interactions

ESP OUTPUT USE

Provide TMC Operators with traffic management recommendations, including location and strategy, to proactively mitigate expected traffic or congestion. TMC Operators implement mitigation via ITS devices (i.e., signals, variable message signs, variable speed limit signs, etc.).

VISUALIZATIONS
Map display: Confidence of predicted congestion
Map display: Speed modification recommendations
Map display: Signal timing modification recommendations

SYSTEMS INTEGRATION
Buckeye Traffic
TSMO Data Warehouse

Value Assessment of Use Case Implementation

Expected Benefits

- Improved situational awareness of real-time traffic conditions
- Reduced congestion due to incidents, events, and work zones
- Reduced crashes due to the sudden onset of congestion
- Reduced end-of-queue crashes from stopped traffic

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 41
- Data score (out of 50): 38
- Total score (out of 100): **79**

UC-2 Crash prediction and proactive mitigation

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Traffic Conditions (speed, volume, congestion, incidents)	✓	Buckeye Traffic
Current Weather Conditions (temperature, relative humidity, dew point)	✓	RWIS Sensors
Current Work Zones	✓	Buckeye Traffic
Historical Traffic Data	✓	TSMO Data Warehouse
Historical Weather Data	✓	TSMO Data Warehouse
Historical Crash Data	✓	TSMO Data Warehouse

THIRD PARTY DATA	Cost Rating	Source
Vehicle Speeds	$$$	Connected vehicles
Emergency Braking Events	$$$	Connected vehicles
Traction Control Events	$$$	Connected vehicles
Other potential CV data (coefficient of friction, queue formation detection)	$$$	Connected vehicles

ODOT THRESHOLDS
Crash probability confidence

Output and Interactions

ESP OUTPUT USE
Provide TMC Operators with crash avoidance recommendations, including location and strategy, to proactively mitigate expected crashes. TMC Operators implement mitigation via ITS devices (i.e., signals, variable message signs, variable speed limit signs, etc.) and communication with public safety officials to allow for increased safety presence.

VISUALIZATIONS
Map display: Confidence of crash probability
Map display: Speed modification recommendations
Map display: Signal timing modification recommendations

SYSTEMS INTEGRATION
Buckeye Traffic
TSMO Data Warehouse

Value Assessment of Use Case Implementation

Expected Benefits

- Reduced crashes where sensors are deployed due to weather conditions
- Fewer incidents due to crashes
- Lower queue delay times for the traveling public

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 50
- Data score (out of 50): 50
- Total score (out of 100): **100**

UC-3 Crash detection and response initiation

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Traffic Conditions (speed, volume, congestion)	✓	Buckeye Traffic

THIRD PARTY DATA	Cost Rating	Source
Vehicle Speeds	$$$	Connected vehicles
Emergency Braking Events	$$$	Connected vehicles
First Responder Availability	TBD	TBD
Crash Detection Alerts	$$$	OEM safety reporting systems, Connected vehicles

ODOT THRESHOLDS
Incident confidence
Speed change threshold

Output and Interactions

ESP OUTPUT USE

Automatically detect the occurrence of a crash and initiate crash response strategies. Automatically alert proximal first responders based on incident type and severity. Provide TMC Operators with predicted traffic impacts and mitigation recommendations, including location and strategy, to proactively mitigate expected crash impacts.

VISUALIZATIONS
Map display: Crash location and severity
Map display: Speed modification recommendations
Map display: Signal timing modification recommendations

SYSTEMS INTEGRATION
Buckeye Traffic
Public safety alert system

Value Assessment of Use Case Implementation

Expected Benefits

- Faster response times to incidents
- Faster clearance times of incidents
- Lower queue delay times for the traveling public

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 38
- Data score (out of 50): 21
- Total score (out of 100): **59**

UC-4 Roadway maintenance need detection and dispatch

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Maintenance Records	✓	Maintenance Management System (EIMS), ODOT TIMS Data Warehouse
Maintenance Crew Availability	✓	Maintenance Management System (EIMS)
Roadway Images	✓	ODOT vehicles
Inertial Measurement Unit Data	✓	ODOT vehicles

THIRD PARTY DATA	Cost Rating	Source
Roadway Imagery Data	$$$	Connected vehicles
Inertial Measurement Unit Data	$$$	Connected vehicles

ODOT THRESHOLDS
Damage thresholds by roadway type
Speed change threshold

Output and Interactions

ESP OUTPUT USE

Automatically detect roadway locations that need maintenance based on vehicle camera and inertial measurement unit data. Automatically schedule and dispatch maintenance crews. Enable robust roadway monitoring and data collection to support the prediction of future maintenance needs.

VISUALIZATIONS

Map display: Roadway trouble spots (e.g., pot holes, lateral cracking, longitudinal cracking) and severity

SYSTEMS INTEGRATION

Maintenance Management System (EIMS)

ODOT SQL

Value Assessment of Use Case Implementation

Expected Benefits

- Faster response to critical roadway maintenance
- Earlier execution of preventative roadway maintenance
- Lower roadway maintenance costs

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 36
- Data score (out of 50): 22
- Total score (out of 100): **58**

UC-5 Static asset maintenance need detection and dispatch

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Maintenance Records	✓	Maintenance Management System (EIMS), ODOT TIMS Data Warehouse
Maintenance Crew Availability	✓	Maintenance Management System (EIMS)
Asset Images	✓	ODOT vehicles
Crash Reports - Property Damage	✓	ODOT TIMS Data Warehouse

THIRD PARTY DATA	Cost Rating	Source
Asset Imagery Data	$$$	Connected vehicles

ODOT THRESHOLDS
Damage thresholds by asset

Output and Interactions

ESP OUTPUT USE

Automatically detect static assets that need maintenance based on vehicle camera data. Automatically schedule and dispatch maintenance crews. Enable robust roadway monitoring and data collection to support the prediction of future maintenance needs.

VISUALIZATIONS

Map display: Asset (e.g., guardrail, sign, cable barrier) damage and severity

SYSTEMS INTEGRATION

Maintenance Management System (EIMS)

ODOT SQL

Value Assessment of Use Case Implementation

Expected Benefits

- Faster response to critical asset maintenance
- Earlier execution of preventative asset maintenance
- Asset damage prevention resulting in lower asset maintenance costs

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 36
- Data score (out of 50): 30
- Total score (out of 100): **66**

UC-6 Snow/ice treatment determination

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Weather Conditions (temperature, relative humidity, dew point)	✓	RWIS Sensors
Roadway ADT	✓	ODOT TIMS Data Warehouse
Historical Snowplow Data	✓	Maintenance Management System (EIMS), ODOT TIMS Data Warehouse

THIRD PARTY DATA	Cost Rating	Source
Traction Control Events	$$$	Connected vehicles
Predicted Snow Accumulation	$	National Weather Service

ODOT THRESHOLDS
Snow accumulation confidence
Snowplow quantities needed by accumulation level

Output and Interactions

ESP OUTPUT USE

Automatically determine expected levels of snow and ice treatment needed by location based on incoming weather and low-friction pavement conditions. Provide estimated treatments needs to snow/ice crews to support preparedness.

VISUALIZATIONS
Map display: Treatment by location
Map display: Traction-control events

SYSTEMS INTEGRATION
Buckeye Traffic
CAD 911

Value Assessment of Use Case Implementation

Expected Benefits

- Reduced crashes due to snow/ice conditions
- Faster response times to incidents due to pre-positioning of first responders
- Faster clearance times of incidents
- Smoother traffic flow during snow/ice conditions

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 36
- Data score (out of 50): 28
- Total score (out of 100): **64**

Project: Achieving Efficiencies within ODOT with the Event Streaming Platform (ESP)

Phase 2 ESP List of Use Cases

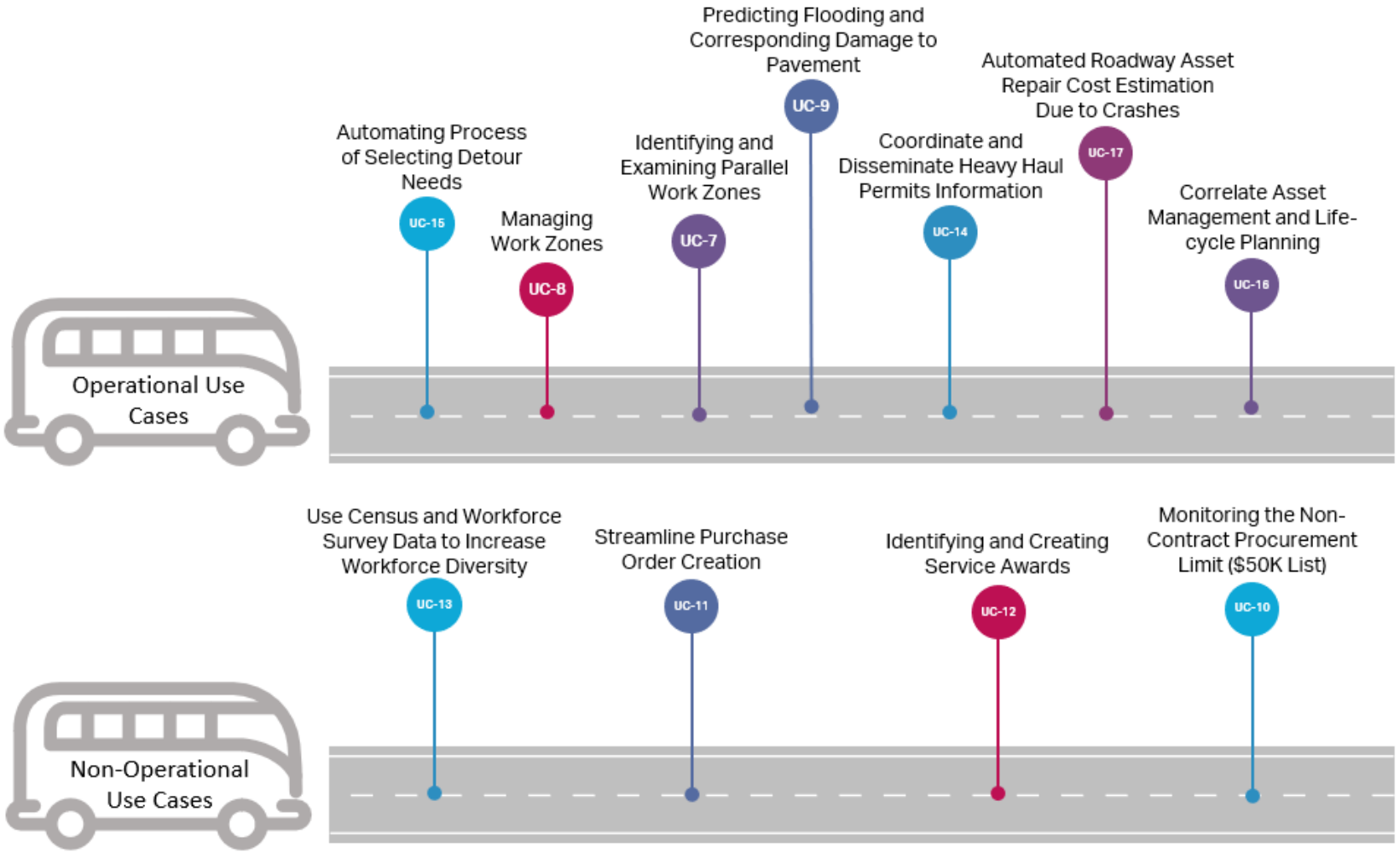
Potential ESP Use Cases identified in coordination with ODOT stakeholders

No.	Use Case	Description
UC-7	Identifying and Examining Parallel Work Zones	Automatically determine if active work zones and planned detour routes will be impacted by detouring traffic from parallel/nearby work zones. This will include analyzing local agencies' work zones with lane capacity reduction. Predict near-future impacts based on ADT and the corresponding logical detour routes. This will allow end users to determine if additional action should be taken such as dissemination of information for alternative detour routes.
UC-8	Managing Work Zones	Automatically determine if there is an active work zone and the current and predictive impact to travelers due to the work zone. These data may be detected via clusters of maintenance vehicles (AVL feeds), TMC work zone data, and random bottlenecks detected though speed differential measures. Once a work zone is detected and verified, ESP will provide TMC and proper ODOT personnel data on the impact and predictive impact in near future based on ADT. Any reported incidents via TIMS Warehouse within the work zone geofence will be flagged as a work zone related incident for reporting and real-time alerts to determine if MOT is sufficient.
UC-9	Predicting, Detecting, and Tracking Flooding For Serviceability/Maintenance	Automatically determine if predictive inclement weather (rain and melting snow) could result in flooding along the roadway. Alert maintenance crews of these potential flooding areas. Predict through historical flooding and pavement repair requirements to determine impact of standing water.
UC-10	Monitoring the Non-Contract Procurement Limit ($50K List) – *Occurring now as part of finance activities*	Automatically determine the real-time cumulative procurement total for non-contract. Alert when nearing the threshold for a non-contract vendor procurements, $50,000. Machine Learning for determining the individual store's charge code and save verified detected information into a central database for future charges.
UC-11	Streamline Purchase Order Creation – *Occurring now as part of finance activities*	Develop a single platform. This will align the end-user and the accounting office appropriately to eliminate duplicate work. As users fill out the data, the system will automatically, in real-time, pull proper data from Oaks, and allow for accounting to review/approve data (versus replicating data entry).
UC-12	Identifying and Creating Service Awards	Automatically determine when an employee is nearing a milestone event and create the service award documentation and draft announcement, which can be disseminated at the proper time. These will look forward to upcoming event so awards may be provided at proper dates instead of significantly after the event.
UC-13	Use Census and Workforce Survey Data to Increase Workforce Diversity	Correlate employee survey data with both positive and negative retention results. Automatically pull census data from census.gov using available APIs to evaluate ODOT workforce diversity efforts. Automatically determine metrics for workforce diversity by ODOT District with direct correlation to region's census data.
UC-14	Coordinate and Disseminate Heavy Haul Permits Information	Automatically retrieve heavy haul permit information and provide insights into route and timeframe for these heavy hauls. Compare these information with estimated traffic to determine potential impact to other travelers. Additionally, it will compare these heavy haul data with active work zones. When impact to travelers or concerns due to work zones are automatically detected, alerts will be disseminated to the proper parties, including TMC for monitoring and information dissemination as needed. Additionally provide insight to coordinate heavy hauls at appropriate times of day that limit major impact to motoring public.
UC-15	Automating Process of Selecting Detour Needs	Automatically build detour route options based on roadway capacity / function class and ability to handle detouring volume and travel time when incidents or active work zones are currently or predicted to significantly impact travelers. Using a routable roadway network and the placement of an event to the roadway, i.e. incident or active work zone, detour option(s) may be determined, This will account for parallel work zones when determining alternative route. Identify upstream assets that may be utilized to disseminate messages about detour.
UC-16	Correlate Asset Management and Life-cycle Planning (Planning Phase)	Automatically track the age of installed roadway assets, and flag those assets that have reached a threshold of their expected life. Flagged assets may be monitored more closely, placed into a replacement planning cycle, or replaced immediately.
UC-17	Automated Roadway Asset Repair Cost Estimation Due to Crashes	Automatically determine a cost estimate range to repair roadway assets that have been damaged due to a crash. This range is centered on a "typical" or average cost based on the asset type, location, and extent of damage. A high and low estimate are also provided as part of the estimate. Generate an asset replacement cost report to submit to insurer

Project: Achieving Efficiencies within ODOT with the Event Streaming Platform (ESP)

Phase 2 ESP Use Case Roadmap

Potential ESP Use Cases identified in coordination with ODOT Operations stakeholders



UC-7 Identifying and Examining Parallel Work Zones

Business Line Owner(s):

- **Roadway**: Jonathan Young and Jen Alford
- **District**: Jamie Hendershot

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Work Zones	✓	Work Zone Management System
Historical Traffic Conditions	✓	TSMO Data Warehouse
Routable Road Network		Work Zone Management System
Work Zone Trailer & Maintenance Fleet	✓	AVL
Current Traffic Conditions	✓	Buckeye Traffic

THIRD PARTY DATA	Cost Rating	Source
Contractor Vehicle AVL (if applicable) API	$$	AVL
Vehicle Speeds / Emergency Braking	$$$	Connected vehicles
Current Local Agency Work Zones	$$	FHWA WZDx

ODOT THRESHOLDS
Work Zone Impacts
Speed Differentials for Bottleneck Detection
Congestion prediction confidence

Output and Interactions

ESP OUTPUT USE
Automatically determine if active work zones and planned detour routes will be impacted by detouring traffic from parallel/nearby work zones. This will include analyzing local agencies' work zones with lane capacity reduction. Predict near-future impacts based on ADT and the corresponding logical detour routes. This will allow end users to determine if additional action should be taken such as dissemination of information for alternative detour routes.

VISUALIZATIONS
Map display: Parallel Work Zones
Map display: Alternative Detour Route
KPI display: Near-future impact user delay cost

SYSTEMS INTEGRATION
Navigation Phone Apps / Industry
OHGO

Value Assessment of Use Case Implementation

Expected Benefits

- Provide real-time information on work zone performance allowing for real-time changes as needed.
- More reliable information on active work zones to disseminate accurate messages to the traveling public to reduce impact.

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 43
- Data score (out of 50): 46
- Total score (out of 100): **89**

UC-8 Managing Work Zones

Business Line Owner(s):

- **Roadway**: Jonathan Young and Jen Alford

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Work Zones	✓	Work Zone Management System
Historical Traffic Conditions	✓	TSMO Data Warehouse
Current Traffic Conditions	✓	TSMO Data Warehouse
Current Incident Data	✓	ODOT TIMS Data Warehouse
Work Zone Trailer & Maintenance Fleet	✓	AVL

THIRD PARTY DATA	Cost Rating	Source
Current Local Agency Work Zones	$$	FHWA WZDx
Vehicle Speeds	$$$	Connected vehicles
Contractor Vehicle AVL (if applicable) API	$$	AVL

ODOT THRESHOLDS
Speed Differentials for Bottleneck Detection
Data feed from smart work zones to indicate moving work zone or stationary work zone - probability confidence

Output and Interactions

ESP OUTPUT USE
Automatically determine if there is an active work zone and the current and predictive impact to travelers due to the work zone. These data may be detected via clusters of maintenance vehicles (AVL feeds), TMC work zone data, and random bottlenecks detected though speed differential measures. Once a work zone is detected and verified, ESP will provide TMC and proper ODOT personnel data on the impact and predictive impact in near future-based traffic conditions (historical and current). Any reported incidents via TIMS Warehouse within the work zone geofence will be flagged as a work zone related incident for reporting and real-time alerts to determine if MOT is sufficient.

VISUALIZATIONS
Map display: Work Zone location and extent
Map display: Predicted roadways impacted by work zone
KPI display: Estimated current impact (user delay cost), near-future impact predictive user delay cost, safety index score
Report for individual work zones

SYSTEMS INTEGRATION
OHGO
TSMO Data Warehouse

Value Assessment of Use Case Implementation

Expected Benefits

- Reduced time for generating Work Zones Report
- Provide real-time information on work zone's performance allowing for real-time changes as needed. Which will increase traveler and roadworker safety
- More reliable information on active work zones to disseminate accurate messages to the traveling public to reduce impact.

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 39
- Data score (out of 50): 46
- Total score (out of 100): **86**

UC-9 Predicting, Detecting, and Tracking Flooding For Serviceability/Maintenance

Business Line Owner(s):
- **Hydraulic**: Jeff Sayer
- **District**: Jamie Hendershot & Thom Slack

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Weather Conditions	✓	RWIS Sensors (DTN)
Maintenance Records	✓	Maintenance Management System (EIMS), ODOT TIMS Data Warehouse
Maintenance Crew Availability	✓	Maintenance Management System (EIMS)
Pavement Rating		
Historical Flooding Records		Buckeye Traffic

THIRD PARTY DATA	Cost Rating	Source
Traction Control Event / Anomalous Movements	$$$	Connected Vehicle
Predicted Weather Conditions		NWS, NOAA, airports, DTN

ODOT THRESHOLDS
Flooding/standing water threshold
Pavement degradation from standing water

Output and Interactions

ESP OUTPUT USE
Automatically determine if predicted inclement weather (rain and melting snow) may result in flooding along the roadway. Along with detecting if flooding has occurred via connected vehicle data such as anomalous movements. If detection is verified, this will be tracked for historical data. Alert maintenance crews of these potential flooding area and when detected. Pavement maintenance data and historical flooding data may be used to determine impact when flooding occurred and cost-benefit when system predicted, and maintenance crews were able to mitigate.

VISUALIZATIONS
Map display: Location of at-risk flooding locations
Map display: Heatmap of flooding damage based on predictive impact from observed flooding
Map display: Flood Location with Historical Work Orders

SYSTEMS INTEGRATION
Maintenance Management System (EIMS)
ODOT ESRI
Third-party App Integration - Waze/Google/Apple

Value Assessment of Use Case Implementation

Expected Benefits

- Reduced response time to manage flooding / standing water on the roadway, which will increase safety
- Better pavement degradation curves for more realistic maintenance requirements and planning

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 34
- Data score (out of 50): 50
- Total score (out of 100): **84**

UC-10 Monitoring the Non-Contract Procurement Limit ($50K List)

Business Line Owner(s):
- **Accounting**: Jim Snyder

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Charge Code Database	✓	Appropriations Accounting
THIRD PARTY DATA	**Cost Rating**	**Source**
Processed Non-contract payments	$	Oaks Peoplesoft
ODOT THRESHOLDS		
Alert limits/thresholds ($40k, $45k, $50k)		

Output and Interactions

ESP OUTPUT USE
Automatically determine the real-time cumulative procurement total for non-contract. Alert when nearing the threshold for a non-contract vendor procurements, $50,000. Machine Learning for determining the individual store's charge code and save verified detected information into a central database for future charges.
VISUALIZATIONS
KPI: Real-time procurement cost dashboard/report
SYSTEMS INTEGRATION
ODOT SQL – to build a charge code database

Value Assessment of Use Case Implementation

Expected Benefits

- Increased awareness of spending limits to comply with Ohio law
- Reduce labor in manually sorting data for these metrics

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 35
- Data score (out of 50): 33
- Total score (out of 100): **67**

UC-11 Streamline Purchase Order Creation

Business Line Owner(s):
- **Accounting**: Jim Snyder

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Purchase Order Form	✓	SharePoint
Purchase Order Official Request	✓	Appropriations Accounting

THIRD PARTY DATA	Cost Rating	Source
Processed Non-contract payments	$	Oaks Peoplesoft

ODOT THRESHOLDS

Output and Interactions

ESP OUTPUT USE

Develop a single platform. This will align the end-user and the accounting office appropriately to eliminate duplicate work. As users fill out the data, the system will automatically, in real-time, pull proper data from Oaks, and allow for accounting to review/approve data (versus replicating data entry).

VISUALIZATIONS

PO Dashboard

SYSTEMS INTEGRATION

Oaks Peoplesoft

Outlook

Value Assessment of Use Case Implementation

Expected Benefits

- Reduce labor required to create a purchase order
- Reduce lag time between request of purchase order and approval

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 42
- Data score (out of 50): 35
- Total score (out of 100): **77**

UC-12 Identifying and Creating Service Awards

Business Line Owner(s):

- **Human Resources**: Renee Szymanski

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source

THIRD PARTY DATA	Cost Rating	Source
Employee Start Date	✓	Oaks Peoplesoft
Employee Promotion / Awards	✓	Oaks Peoplesoft

ODOT THRESHOLDS

Employees with upcoming Milestone dates within defined time period.

Output and Interactions

ESP OUTPUT USE

Automatically determine when an employee is nearing a milestone event and create the service award documentation and draft announcement, which can be disseminated at the proper time. These will look forward to upcoming event so awards may be provided at proper dates instead of significantly after the event.

VISUALIZATIONS

Service Award Dashboard

SYSTEMS INTEGRATION

Oaks Peoplesoft

Outlook

Value Assessment of Use Case Implementation

Expected Benefits

- Reduced effort to develop service awards
- Provide service award closer to anniversary/milestone date
- Increased employee recognition and satisfaction

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 35
- Data score (out of 50): 40
- Total score (out of 100): **75**

UC-13 Use Census and Workforce Survey Data to Increase Workforce Diversity

Business Line Owner(s):
- **Human Resources**: Traci Luers

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
HR Survey Data	✓	FormStack
Workforce Demographics by District	✓	Cognos

THIRD PARTY DATA	Cost Rating	Source
Census Data	$	Census.gov API
Workforce Retention	$	Oaks Peoplesoft

ODOT THRESHOLDS
Diversity Targets/Goals

Output and Interactions

ESP OUTPUT USE
Correlate employee survey data with both positive and negative retention results. Automatically pull census data from census.gov using available APIs to evaluate ODOT workforce diversity efforts. Automatically determine metrics for workforce diversity by ODOT District.

VISUALIZATIONS
Map display: District Data vs ODOT Workforce
KPI: District Data vs Census Data for District Regions

SYSTEMS INTEGRATION
Oaks Peoplesoft

Value Assessment of Use Case Implementation

Expected Benefits

- Reduce labor for determining work force diversity when compared to the surrounding area's available labor force.
- Reduce lag time in developing key performance measures for best decision making

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 50
- Data score (out of 50): 50
- Total score (out of 100): **100**

UC-14 Coordinate and Disseminate Heavy Haul Permits Information

Business Line Owner(s):
- Josh Thieman
- **District**: Jamie Hendershot

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Work Zones	✓	Work Zone Management System
Historical Traffic Conditions	✓	TSMO Data Warehouse
Current Traffic Conditions	✓	OHGO
Current Incidents	✓	OHGO
Routable Road Network		Work Zone Management System

THIRD PARTY DATA	Cost Rating	Source
Hauling Permit System	$$	ProMiles

ODOT THRESHOLDS
Traffic impact thresholds for alerts
Work Zone impact thresholds for alerts

Output and Interactions

ESP OUTPUT USE

Automatically retrieve heavy haul permit information and provide insights into route and haul details for these heavy hauls in a spatial map and allow users to set alerts with thresholds. Permitters are allotted a five-day window; the output should provide data for upcoming and current permits. Meaningful alerts include load width, height, weight depending on the user. These data may be used to detect conflicts such as work zones (construction and operational). And, comparing these data/detected conflicts with estimated traffic to determine potential impact to other travelers. When impact to travelers or concerns due to conflicts are detected, alerts will be disseminated to the proper parties, including TMC for monitoring and information dissemination as needed. Additionally, provide insight to coordinate heavy hauls at appropriate times of day that limit major impact to motoring public.

VISUALIZATIONS

Map display: Heavy Haul routes with details on vehicle loads/characteristics

SYSTEMS INTEGRATION

- OHGO
- ProMile
- Ohio Hauling Permit System (OHPS)

Value Assessment of Use Case Implementation

Expected Benefits

- Reduced impact from heavy hauls to traveling public and potential work zone maintenance crews.
- Increase in information for heavy haul permit holders and ODOT on time and route of these vehicles.

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 33
- Data score (out of 50): 40
- Total score (out of 100): **73**

UC-15 Automating Process of Selecting Detour Needs

Business Line Owner(s):

- **Roadway**: Jonathan Young and Jen Alford
- **District 6**: Thom Slack

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Current Work Zones	✓	Work Zone Management System
Historical Traffic Conditions	✓	TSMO Data Warehouse
Current Traffic Conditions	✓	OHGO
Routable Road Network		Work Zone Management System
Current Incidents	✓	OHGO

THIRD PARTY DATA	Cost Rating	Source
Current Local Agency Work Zones	$$	FHWA WZDx
Vehicle Speeds	$$$	Connected Vehicle

ODOT THRESHOLDS
Volume and capacity thresholds for each roadway function class
Congestion prediction confidence

Output and Interactions

ESP OUTPUT USE
Automatically build detour route options based on roadway capacity / function class and ability to handle detouring volume and travel time when incidents or active work zones are currently or predicted to significantly impact travelers. Using a routable roadway network and the placement of an event to the roadway, i.e. incident or active work zone, detour option(s) may be determined, This will account for parallel work zones when determining alternative route. Identify upstream assets that may be utilized to disseminate messages about detour.

VISUALIZATIONS
Map display: Alternative detour route
Map display: Active work zone

SYSTEMS INTEGRATION
OHGO
TSMO Data Warehouse
Third-party App Integration - Waze/Google/Apple
Buckeye Traffic
Work Zone Management System

Value Assessment of Use Case Implementation

Expected Benefits

- Increase mobility for the traveling public when unscheduled events occur along the roadway.
- Better decision-making on selection of proper detour routes based on data-driven methods which will consider the roadway properties and the potential impact of detouring high-volumes of traffic, including commercial vehicle needs.
- More reliable information on events to disseminate accurate messages to the traveling public to reduce impact.

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 50
- Data score (out of 50): 43
- Total score (out of 100): **93**

UC-16 Correlate Asset Management and Life-cycle Planning (Planning Phase)

Business Line Owner(s):
- **District**: Jamie Hendershot & Thom Slack

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Asset Inventory with Install Dates	✓	ODOT TIMS Data Warehouse
Maintenance Records	✓	Maintenance Management System (EIMS), ODOT TIMS Data Warehouse
Asset Life Span Data		Asset Expected Life Span DB
Future Roadway Construction Projects	✓	ELLIS
Inflation Data		

THIRD PARTY DATA	Cost Rating	Source
NA		

ODOT THRESHOLDS
Percentage of Expected life span by asset for initial flagging (e.g., 70%)
Percentage of Expected life span by asset for critical flagging (e.g., 90%)
Asset repair history frequency and costs

Output and Interactions

ESP OUTPUT USE
Automatically track the age of installed roadway assets, and flag those assets that have reached a threshold of their expected life. Flagged assets may be monitored more closely, placed into a replacement planning cycle, or replaced immediately while considering upcoming projects that plan to replacing these assets. Automatically review upcoming projects, based on project types the system can flag nearby assets that should be considered for upgrades/replacements during the upcoming project. The flagging will be based on age at time of project and current condition rating (if applicable).

VISUALIZATIONS
Map display: Location, type, and % of life span for assets that exceed threshold
Map display: Future Projects and Potential Impacted Assets
KPI display: Per aging asset - % life span, estimated time to replace, estimated cost to replace
KPI display: Asset status (monitoring, refresh planning, replacement pending, etc)

SYSTEMS INTEGRATION
EIMS

Value Assessment of Use Case Implementation

Expected Benefits

- Ageing assets will more effectively be monitored and replaced as part of ODOT's normal planning cycle
- Ageing assets will be replaced prior to a catastrophic failure
- Asset replacement can be prioritized according to asset type, % life span, estimated cost to replace, and criticality of asset function

Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 26
- Data score (out of 50): 34
- Total score (out of 100): **59**

UC-17 Automated Roadway Asset Repair Cost Estimation Due to Crashes

Business Line Owner(s):
- **District**: Jamie Hendershot & Thom Slack

Summary of Use Case Inputs and Outputs

Data Input

ODOT DATA	Available	Source
Crash Reports	✓	ODOT TIMS Data Warehouse
Current Work Zones		Work Zone Management System
Maintenance Records	✓	Maintenance Management System (EIMS), ODOT TIMS Data Warehouse
Inflation Data		
Asset Inventory (Cost)	✓	ODOT TIMS Data Warehouse

THIRD PARTY DATA	Cost Rating	Source

ODOT THRESHOLDS
New Crash Detected with Property Damage Flag Present

Output and Interactions

ESP OUTPUT USE
Automatically determine a cost estimate range to repair roadway assets that have been damaged due to a crash. This range is centered on a "typical" or average cost based on the asset type, location, and extent of damage. A high and low estimate are also provided as part of the estimate. Generate an asset replacement cost report to submit to insurer and/or contractor if it occurred in work zone. Will automatically review crash report narratives for key words that property damage occurred in case that data field is not filled in.

VISUALIZATIONS
Map display: Location, asset type, and extent of damage for roadway asset
Map display: Cost estimate range with values for Low, Average, and High
Map display: Actual historical repair costs trend line for asset type and location

SYSTEMS INTEGRATION
EIMS
ODOT TIMS Data Warehouse

Value Assessment of Use Case Implementation

Expected Benefits

- Faster cost estimation for repair of damaged roadway assets due to crashes
- More accurate cost estimation using attributes for asset type, location, crash severity, and historical actual costs
- Faster invoicing to insurance provider
- Faster repair of roadway asset

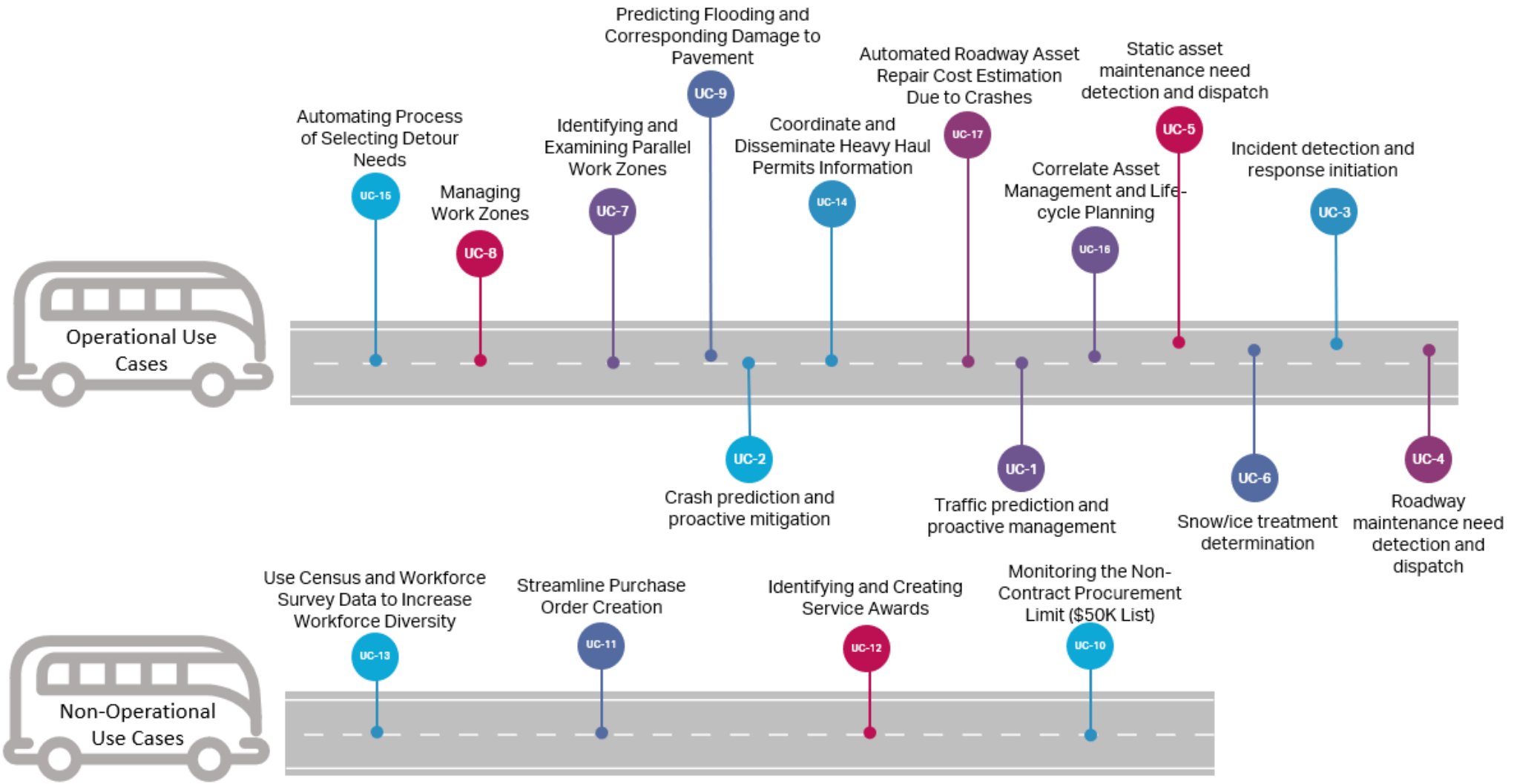
Data Needs and System Architecture Scoring

Scoring for data needs and system architecture modules needed to support this Use Case based on relative cost levels and reusability to the agency

- Architecture score (out of 50): 39
- Data score (out of 50): 31
- Total score (out of 100): **69**

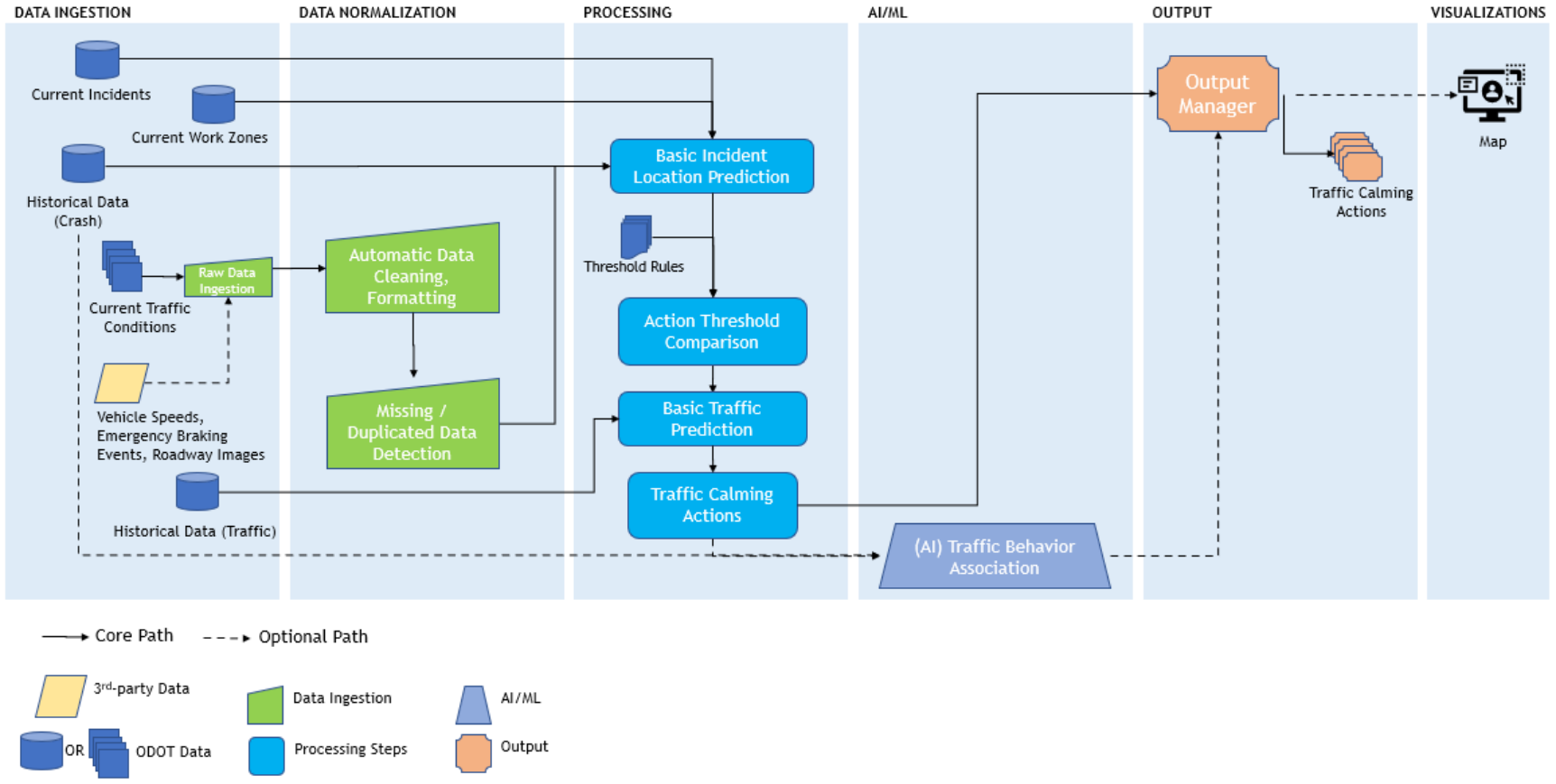
Project: Achieving Efficiencies within ODOT with the Event Streaming Platform (ESP)

Phases 1 and 2 Combined ESP Use Case Roadmap
Potential ESP Use Cases identified in coordination with ODOT Operations stakeholders

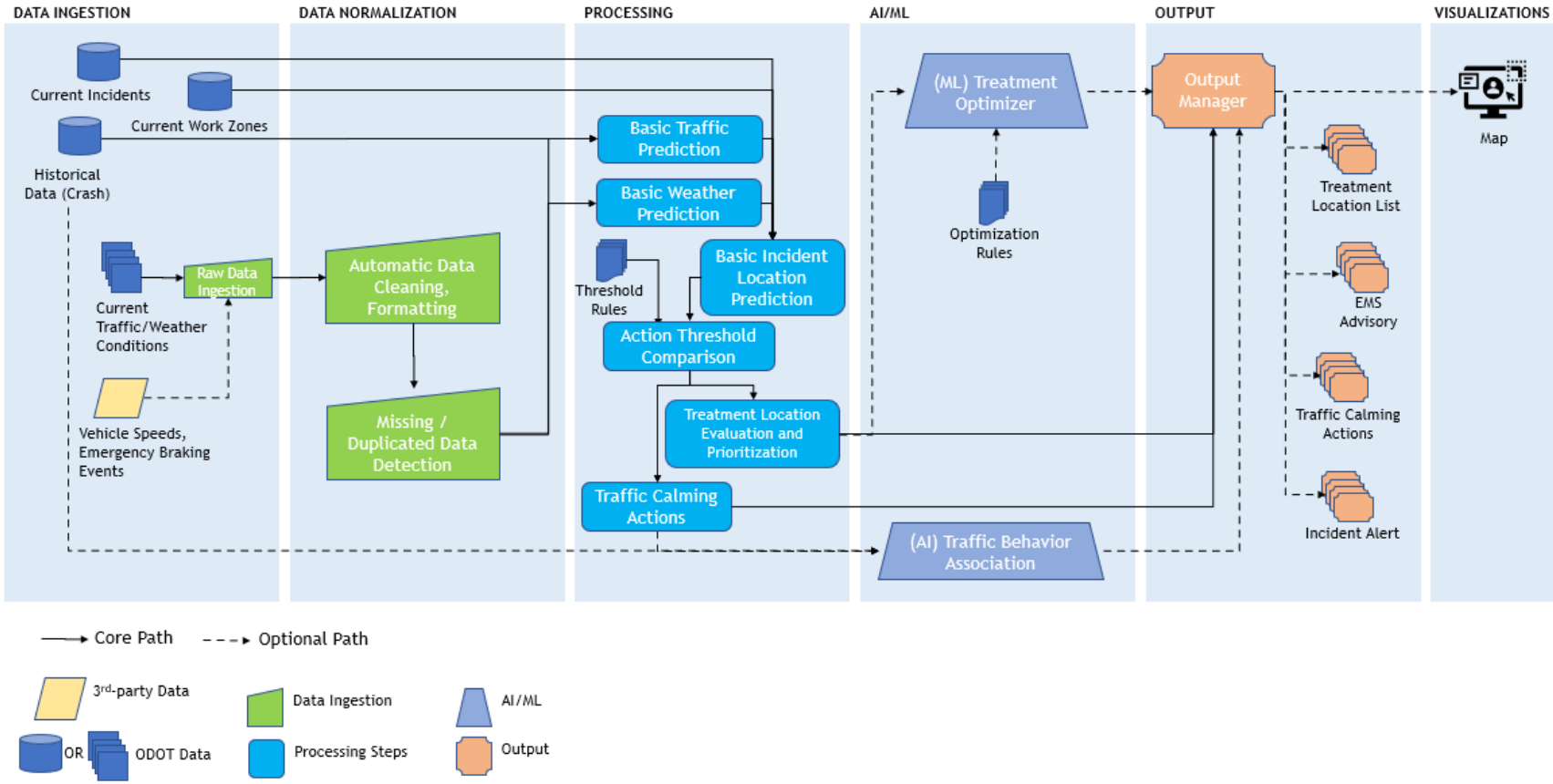


Appendix C: High-Level System Architecture from SOW

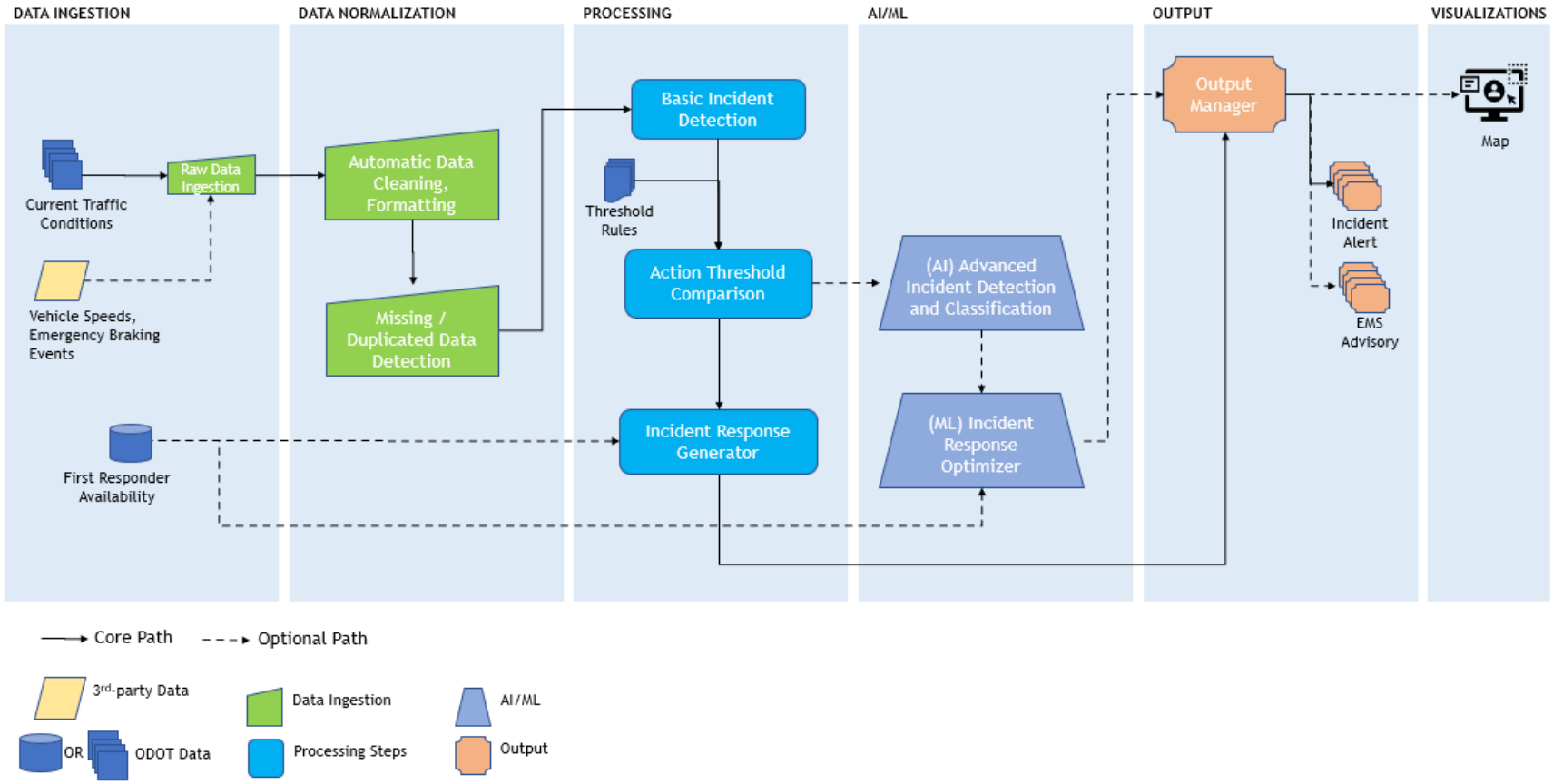
HLA: UC-1 Proactively manage traffic using existing ITS devices based on incidents, events, and work zones



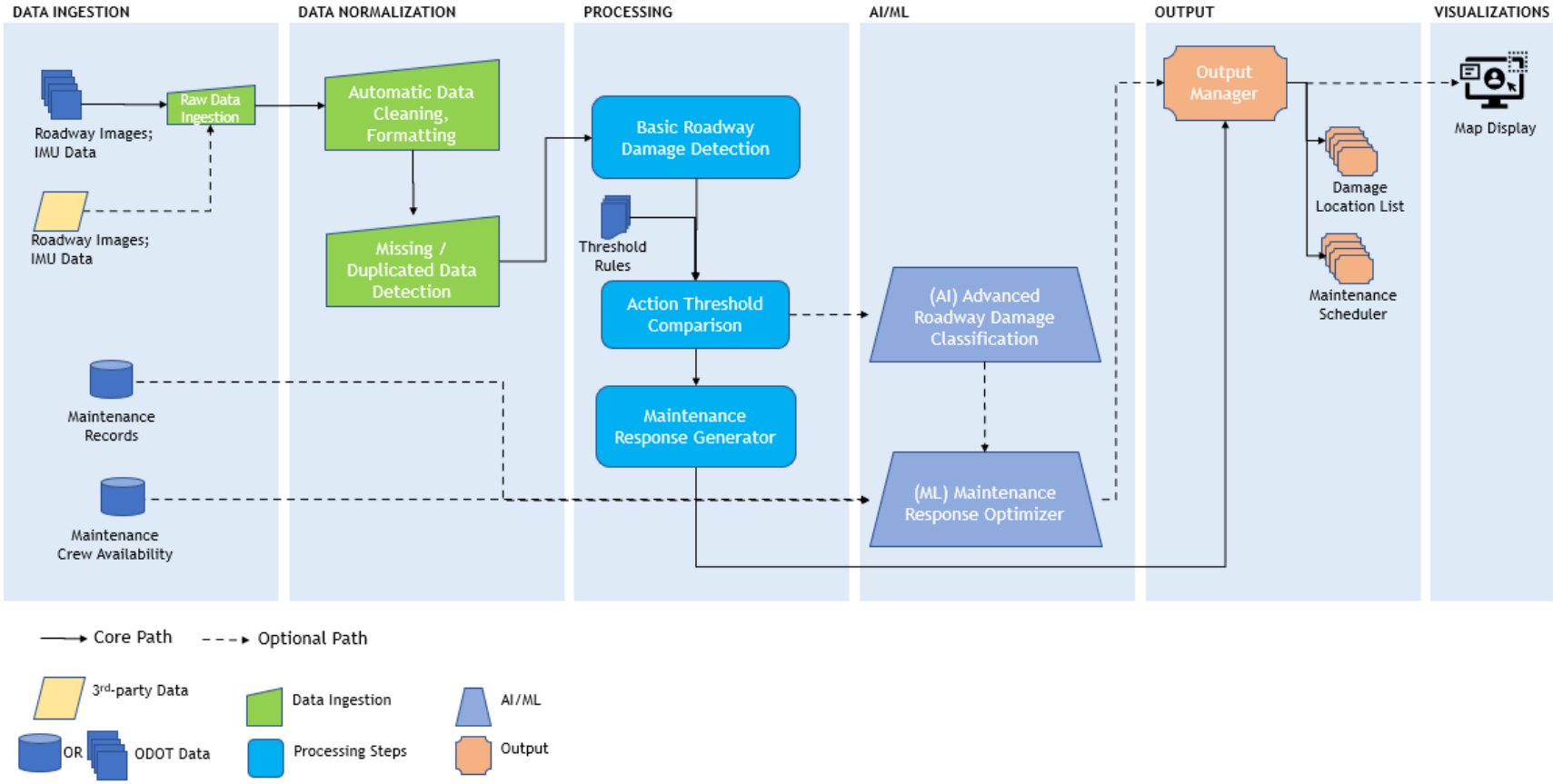
HLA: UC-2 Predict crashes and proactively mitigate



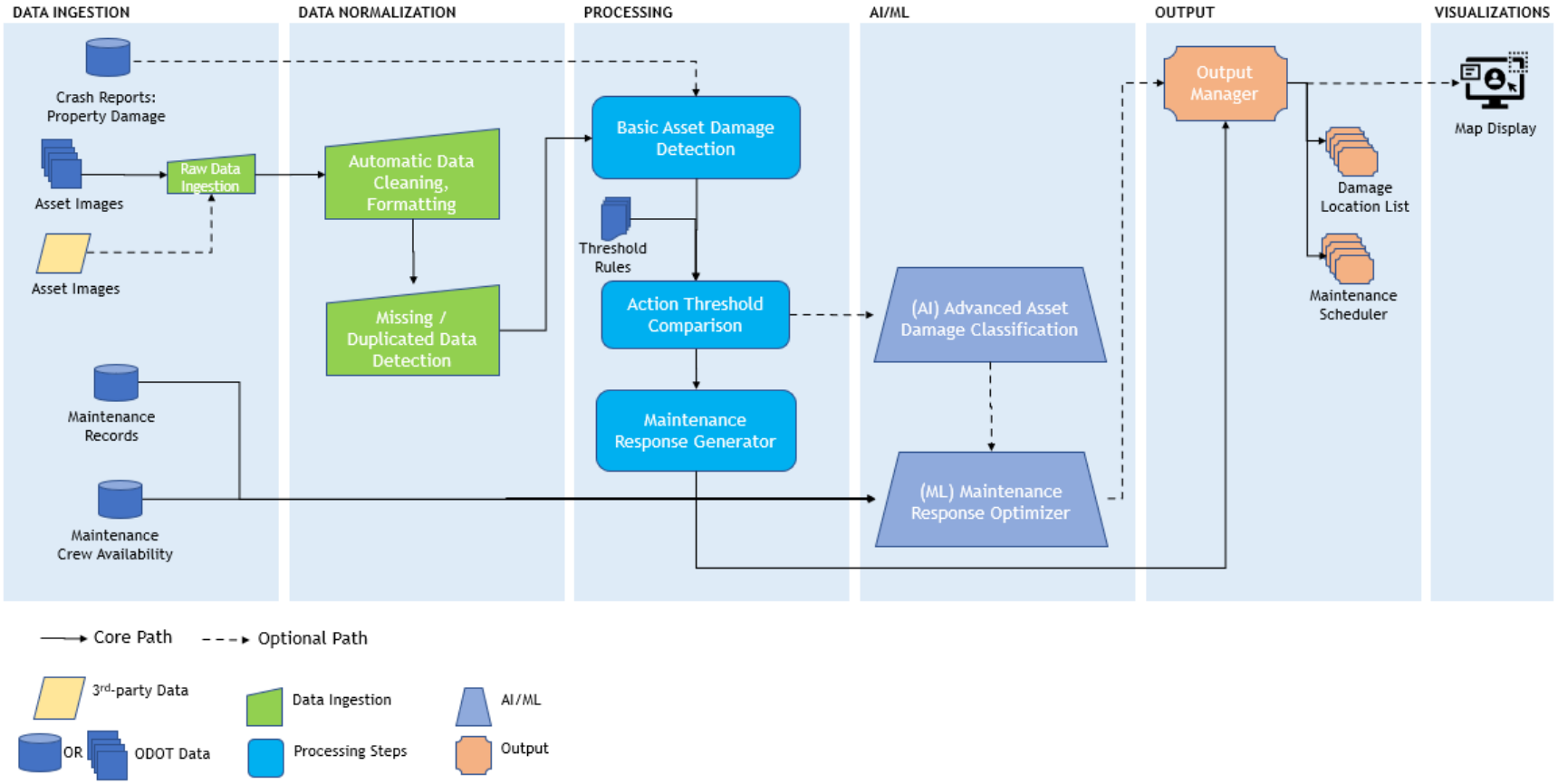
HLA: UC-3 Automatically detect incidents and initiate a response



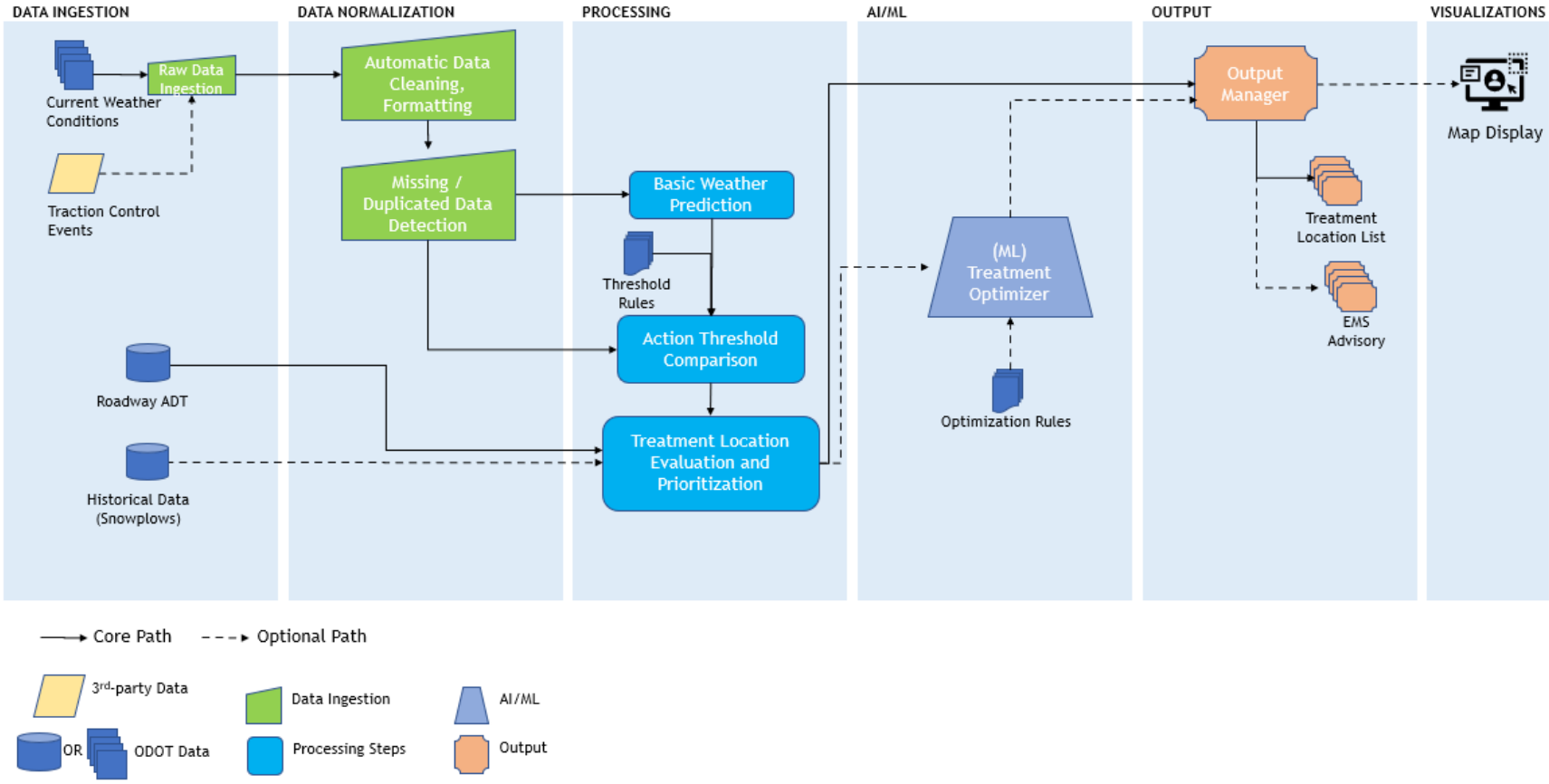
HLA: UC-4 Automatically detect roadways needing maintenance using geo-referenced vehicle-based camera and inertial measurement data, and schedule and dispatch maintenance crews



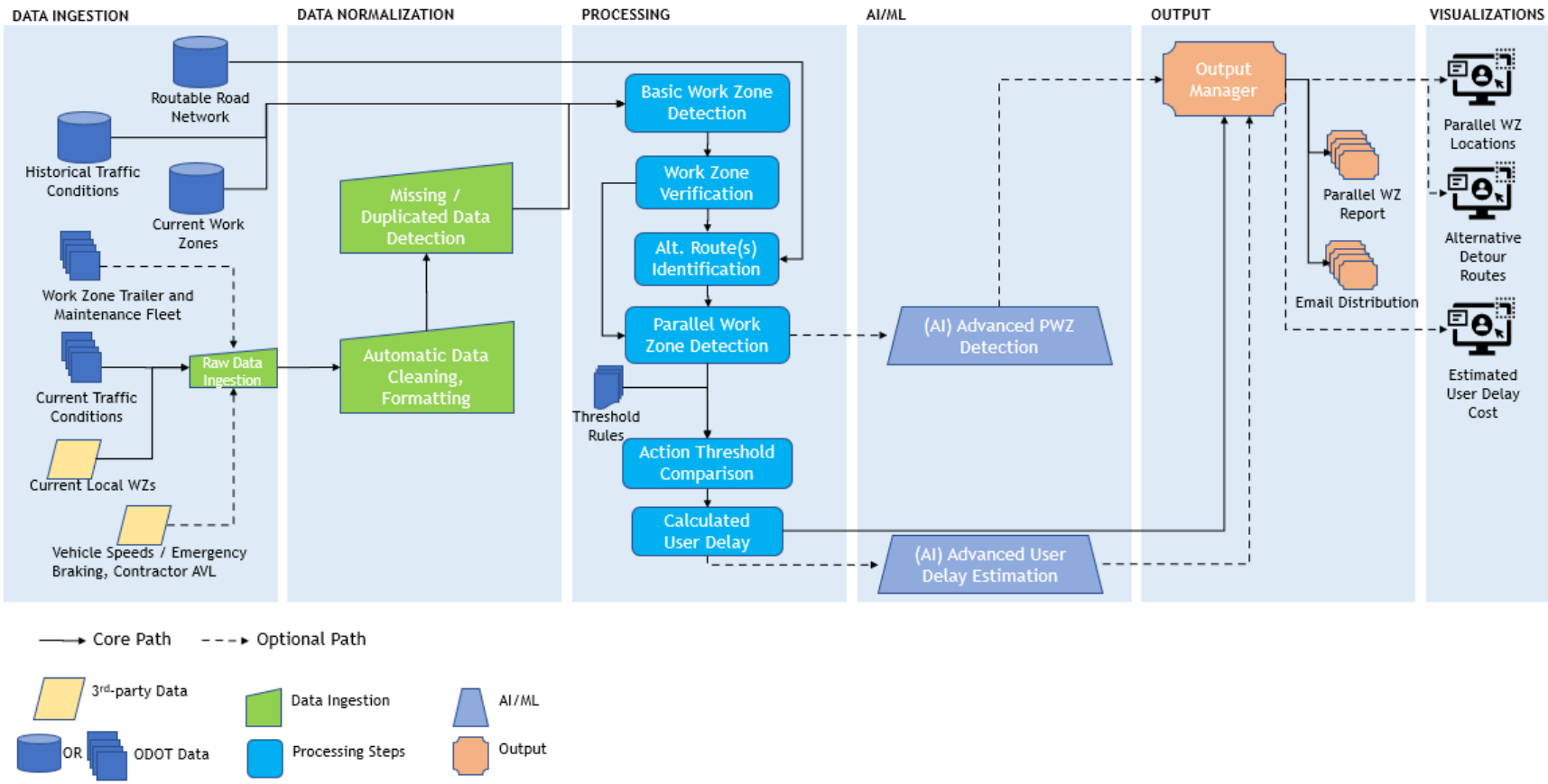
HLA: UC-5 Automatically detect static assets needing repair or replacement using geo-referenced camera data from DOT fleet vehicles, and schedule and dispatch maintenance crews



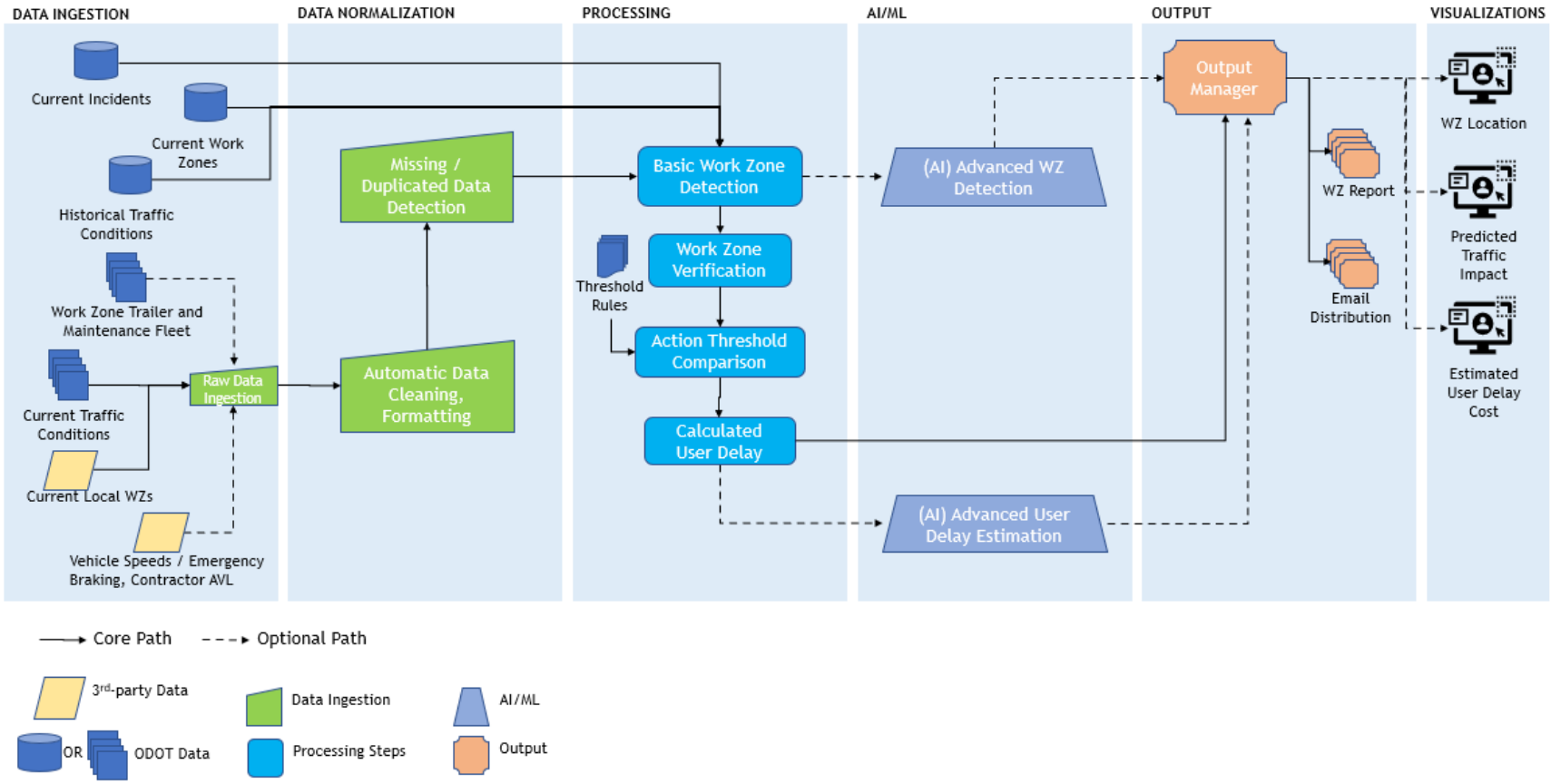
HLA: UC-6 Automatically determine the level of snow and ice treatment, by location (route, milepost, direction, etc.), to assist with staging and operational procedures based on incoming weather and low-friction pavement conditions.



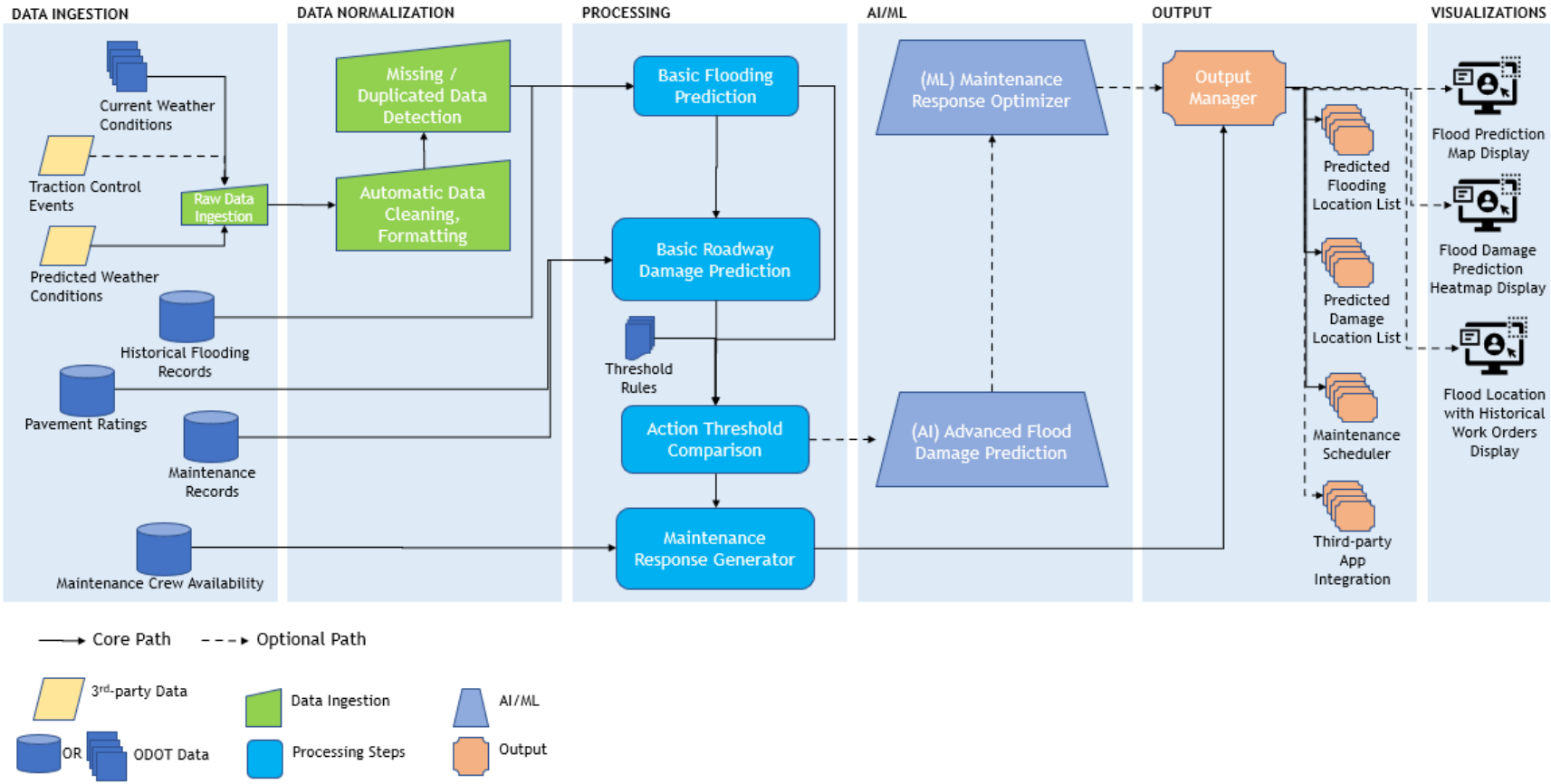
HLA: UC-7 Identifying and Examining Parallel Work Zones



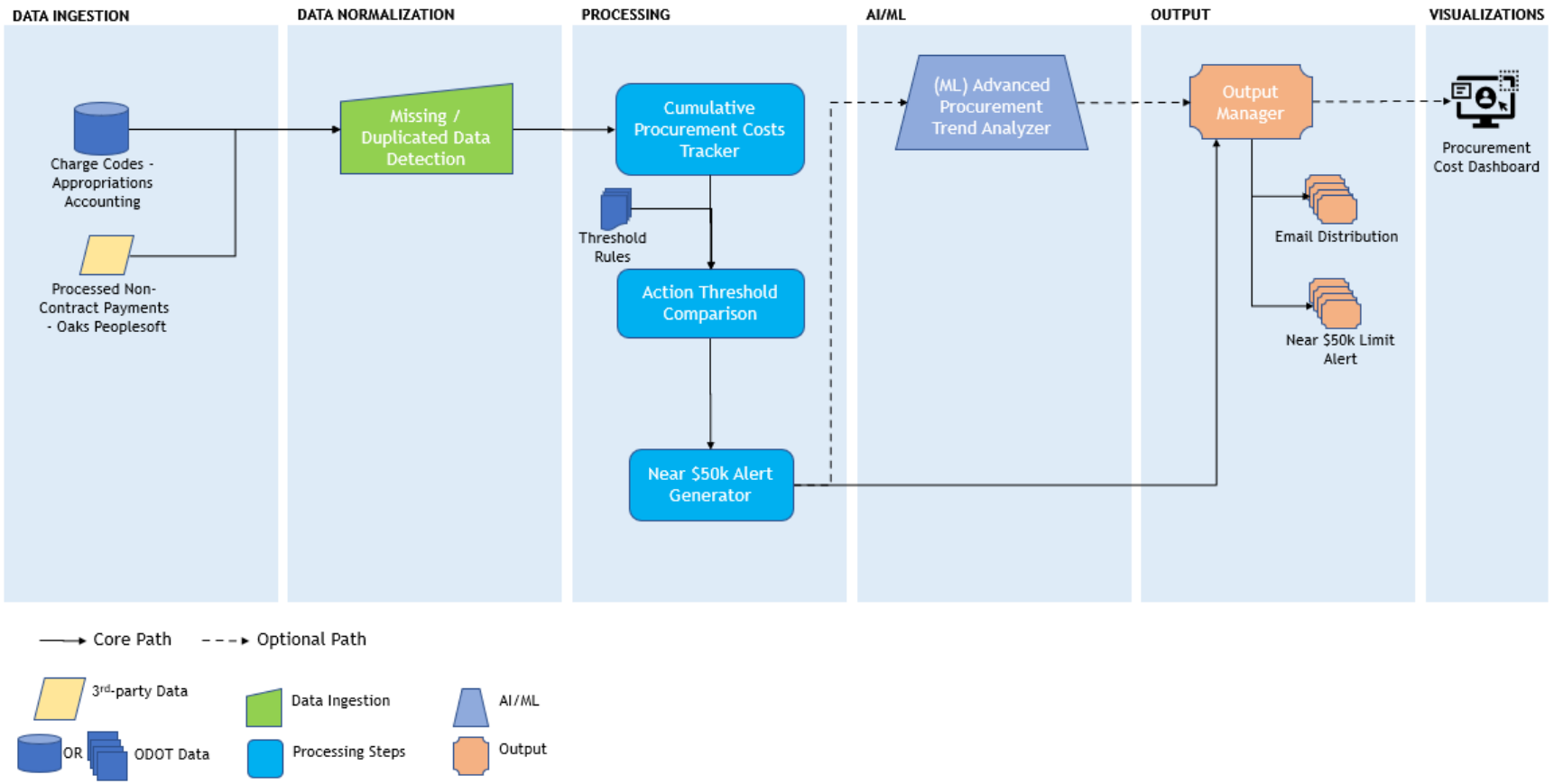
HLA: UC-8 Managing Work Zones



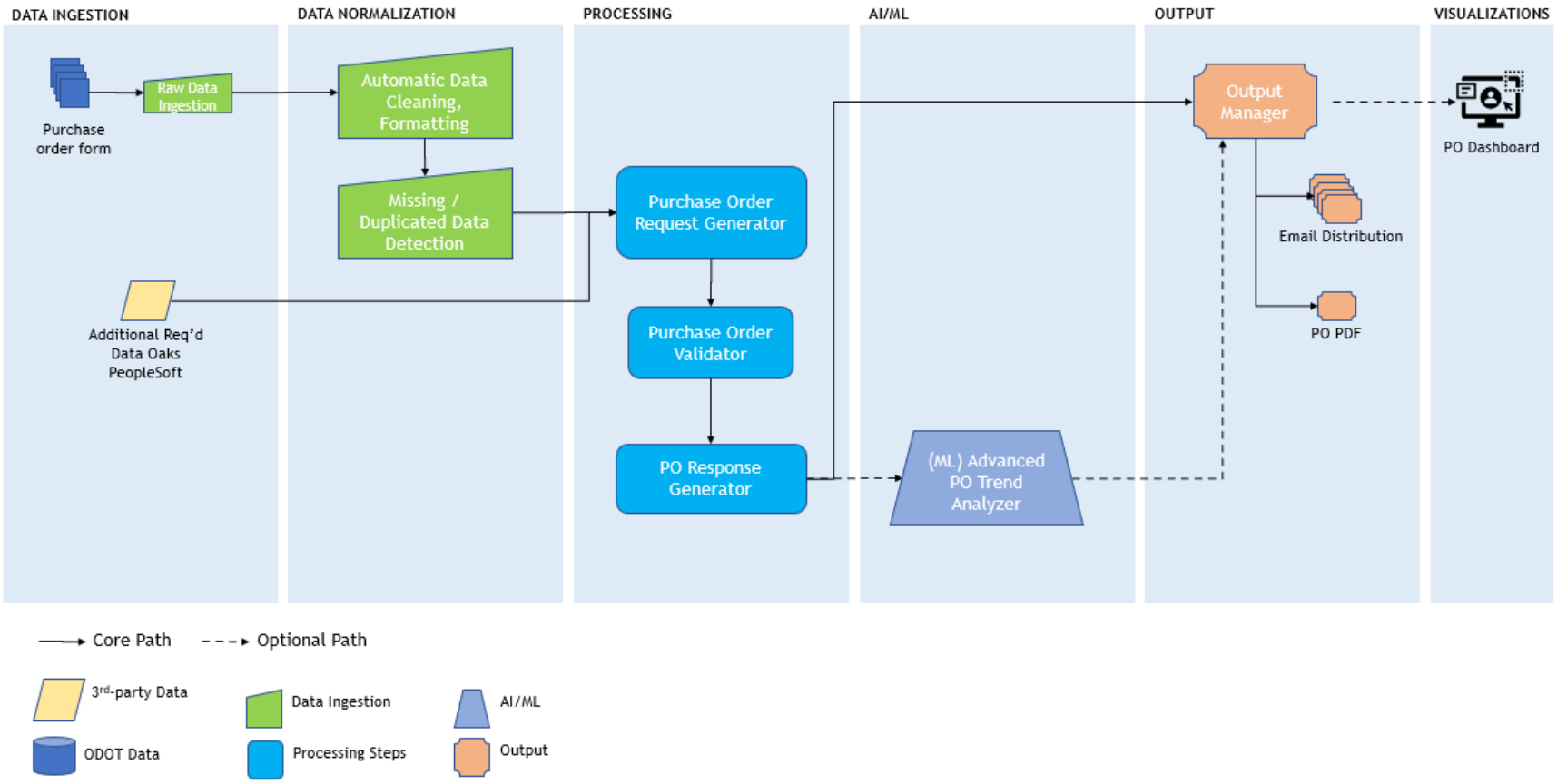
HLA: UC-9 Predicting, Detecting, and Tracking Flooding For Serviceability/Maintenance



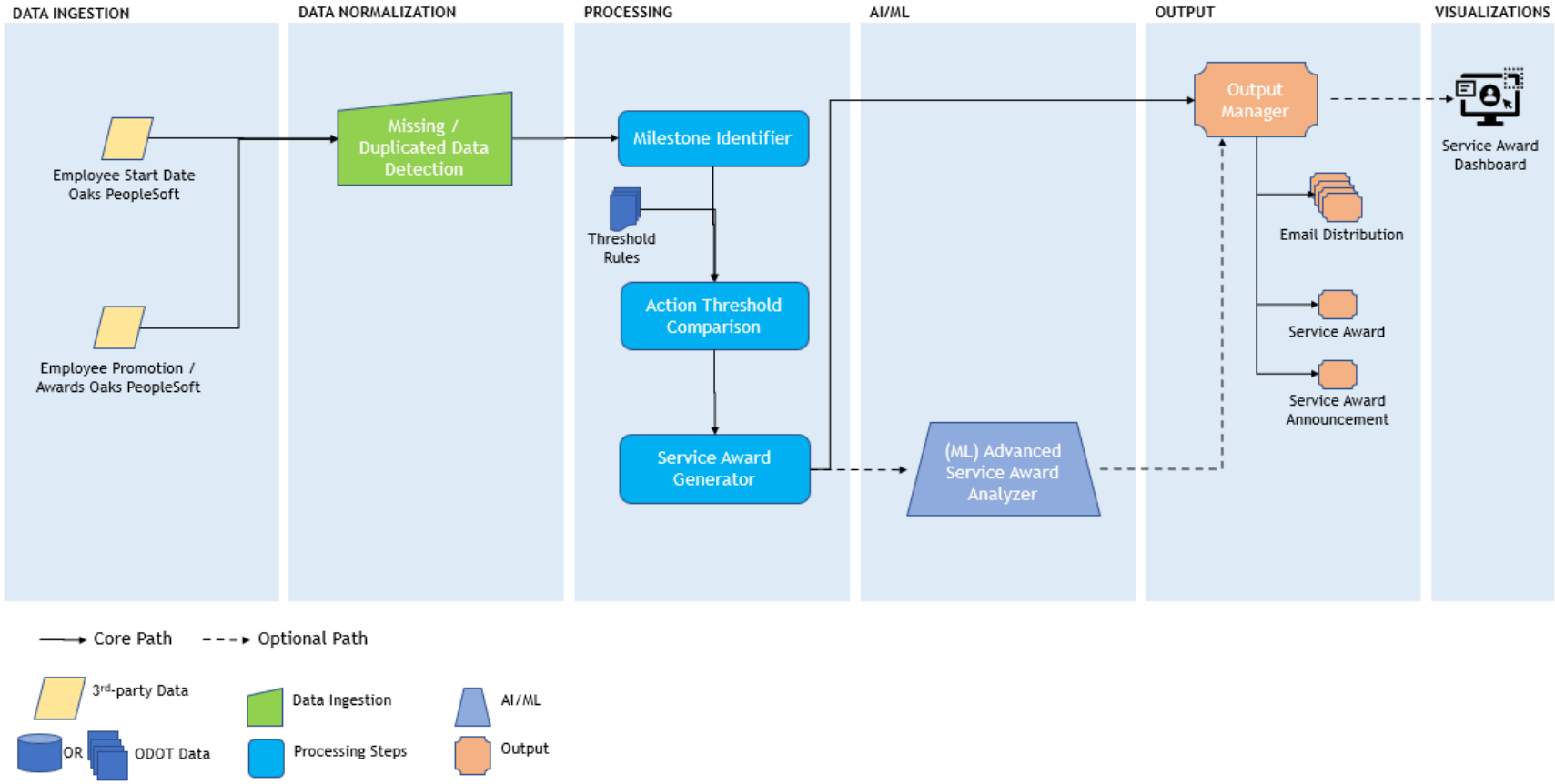
HLA: UC-10 Monitoring the Non-Contract Procurement Limit ($50K List)



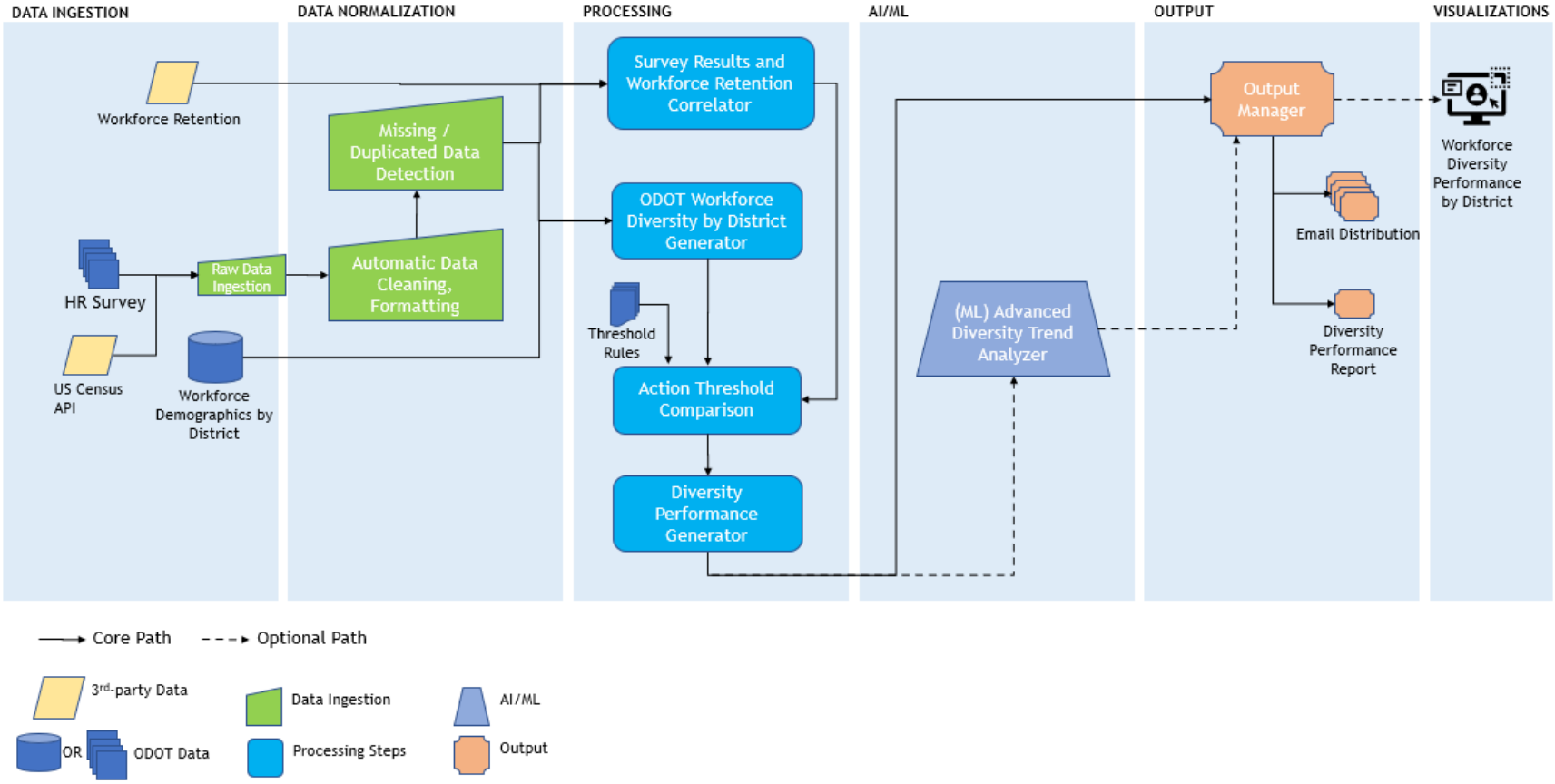
HLA: UC-11 Streamline Purchase Order Creation



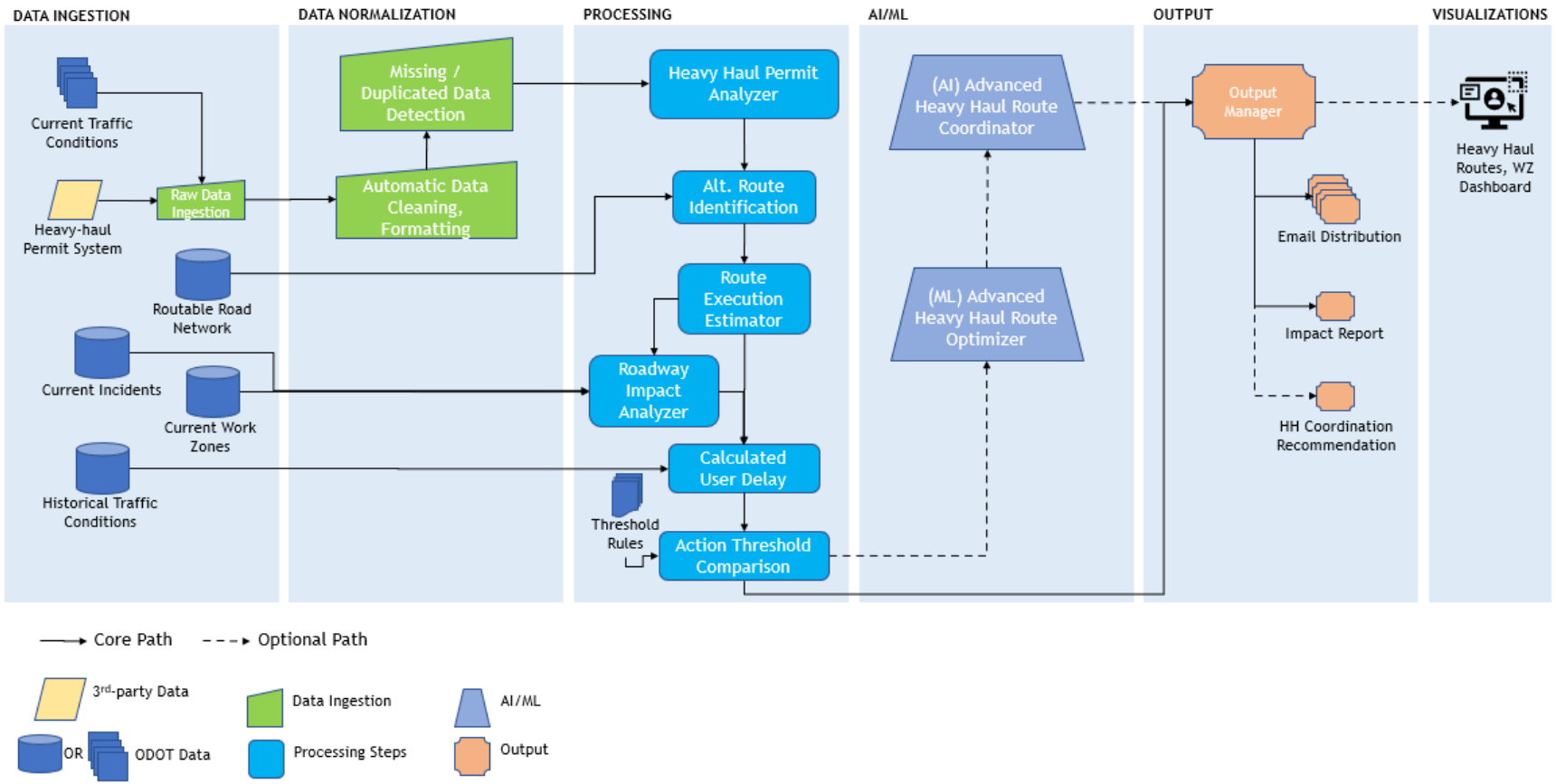
HLA: UC-12 Identifying and Creating Service Awards



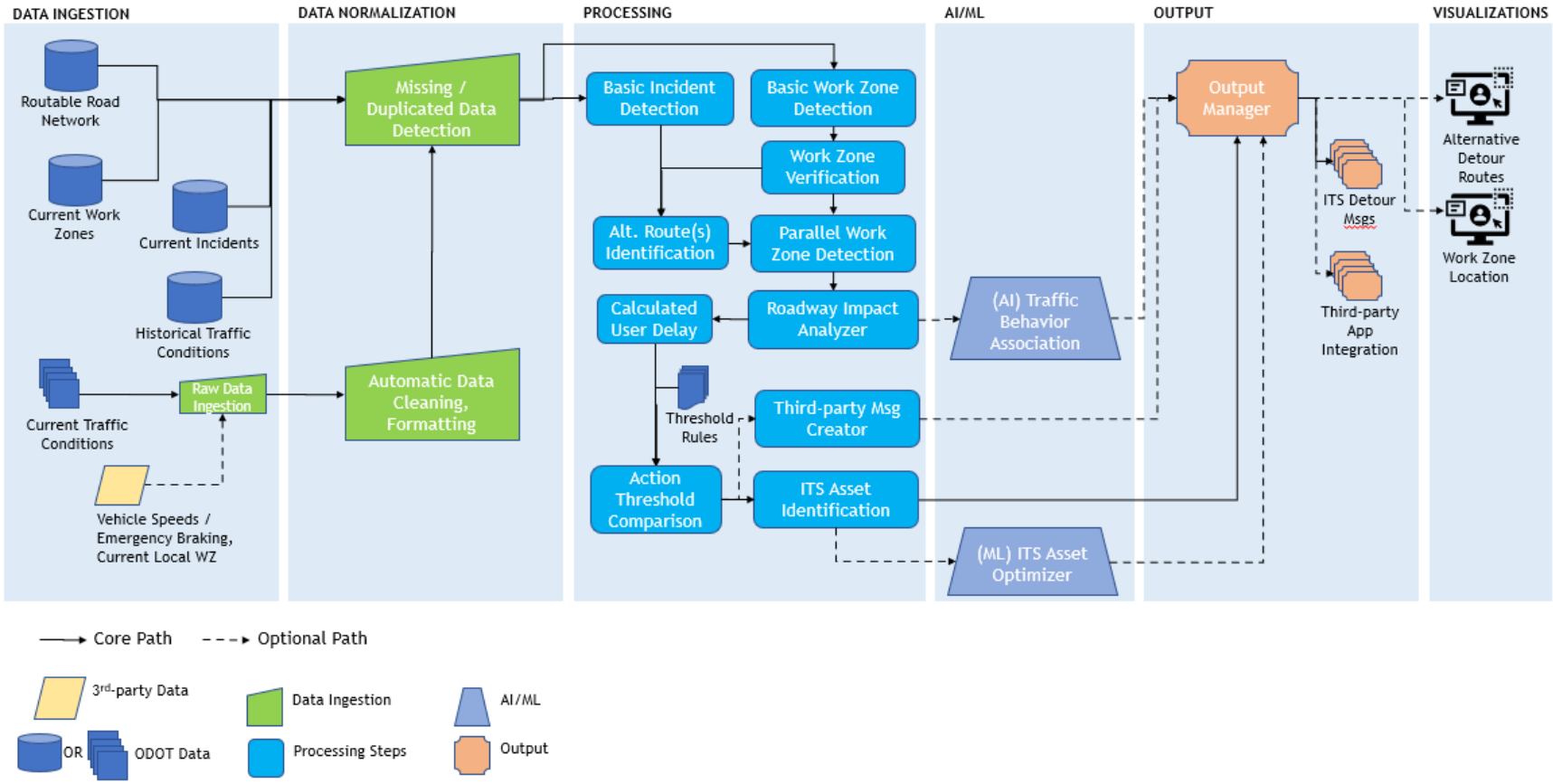
HLA: UC-13 Use Census and Workforce Survey Data to Increase Workforce Diversity



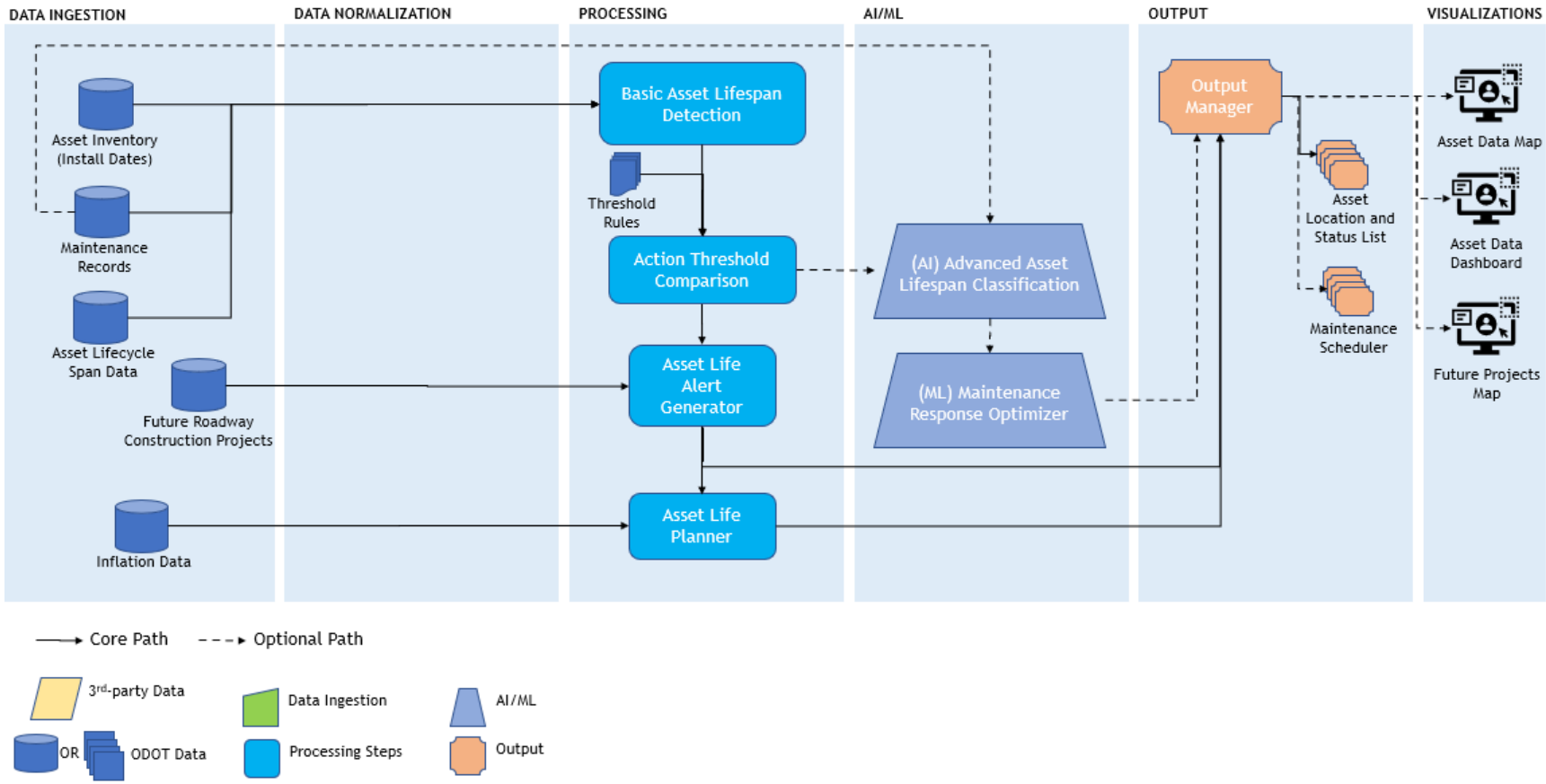
HLA: UC-14 Coordinate and Disseminate Heavy Haul Permits Information



HLA: UC-15 Automating Process of Selecting Detour Needs



HLA: UC-16 Correlate Asset Management and Life-cycle Planning (Planning Phase)



HLA: UC-17 Automated Roadway Asset Repair Cost Estimation Due to Crashes