WisDOT Data Governance, Phase II

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16. Abstract

The WisDOT Data Governance research project, conducted by the Institute for Physical Infrastructure and Transportation (IPIT) at the University of Wisconsin-Milwaukee (UWM), explored and developed recommendations for an implementation-ready WisDOT Data Governance Framework. This framework focuses on harmonizing data sources, controlling access, documenting ownership, and capturing both technical and descriptive information. Throughout the project, the IPIT team members held regular biweekly meetings with WisDOT team members and conducted external interviews with six state DOTs to gather insights on various aspects of Data Governance. The collected information covered the structure, documentation, rules, implementation workloads, and software/tools used in Data Governance Programs. Based on this research, the team developed drafts for five main documents, including a Data Governance Structure, a board/council charter, detailed roles and responsibilities, a process flow diagram for data intake, and a data intake form. Additionally, internal engagement with the Internal Connected and Automated Vehicle (iCAV) group guided modifications and improvements to these materials, setting the stage for the future implementation of a Data Governance Program within WisDOT.

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EXECUTIVE SUMMARY

Data within Departments of Transportation (DOTs) are growing at an exponential rate, and so are their importance. The Internet of Things (IoT) and the ease of data collection through high frequency sensors is forcing DOTs to deal with unprecedented volumes of data. For example, a single Connected and Autonomous Vehicle (CAV) produces 3-40 gigabits of data per second or 1.4-19 terabytes every hour. Multiply this by the number of expected CAVs and the time they are on the road, and it is easy to see that the volume of this one dataset would overwhelm any IT department. Decisions about transportation assets such as confidentiality, security, access management, and data retention cannot be left to individuals who work with good intentions but lack an enterprise perspective or knowledge base. These decisions must be made with the best interests of the enterprise and state in mind. That is why many states across the country are developing and implementing robust Data Governance Frameworks to serve as a guide for all stakeholders and ensure clarity on the established guidelines and regulations.

Recent evaluations revealed deficiencies that highlight the pressing need for the Wisconsin Department of Transportation (WisDOT) to adopt a more structured department-wide approach to Data Governance. First, WisDOT has a significant gap in data classification practices in accordance with the Wisconsin 191 – Data Classification Standard. WisDOT has struggled to adequately perform and track data classification of all department data assets, despite some progress toward defining and implementing data classification procedures. Second, WisDOT faces difficulties determining the official "system of record" for specific data partly due to the existence of multiple siloed datasets with similar characteristics. Third, WisDOT lacks a centralized repository that documents all business area applications and their associated databases and datasets which, in turn, hinders efficient discovery, tracking, management, and dispersal of critical data assets.

The establishment of a comprehensive WisDOT Data Governance Framework and the implementation of a Data Catalog tool would address these issues by supporting the required structure, classification, and documentation. Enhancing the department's overall data management practices would greatly increase data consistency, accuracy, and regulatory compliance and, in turn, improve data discovery and decision-making.

A WisDOT Data Governance Framework that harmonizes data sources, controls access, documents ownership, and captures technical and descriptive information was developed by the Institute for Physical Infrastructure and Transportation (IPIT) at the University of Wisconsin-Milwaukee (UWM). The project team conducted biweekly meetings with WisDOT team members and interviewed six other state DOTs to collect relevant information and documentation on Data Governance Programs. The UWM team analyzed and summarized their findings to provide insights into Data Governance Structure, documentation, rules, implementation workloads, and software/tools used.

Based on this information, the research team developed drafts for five main documents: 1) Data Governance structure mapping the WisDOT organizational chart; 2) Data Governance Board/Council Charter for elaborating the roles and responsibilities of both upper-level

governance bodies; 3) detailed roles and responsibilities for all levels within the Data Governance structure; 4) a process flow diagram for data intake; and 5) a data intake form capturing essential information for new data, enabling informed decision-making by Data Governance bodies. The research team also engaged with the WisDOT Internal Connected and Automated Vehicle (iCAV) group for feedback on the derived materials to further refine them for a potential Data Governance Program within WisDOT.

The project's primary objective was to establish a comprehensive WisDOT Data Governance Framework that enhances data quality, facilitates data discovery and sharing, improves data accessibility, ensures data confidentiality, and strengthens data security. The developed materials provide a solid foundation for implementing a Data Governance Program that matches the current WisDOT's organizational structure and data stewardship, ensuring that Data Governance is ingrained in the organization's culture and operations. The IPIT team's work has laid the groundwork for a successful implementation of a Data Governance Program at WisDOT that will enable the agency to handle the massive and emerging data generated by connected and automated vehicle technology.

The benefits of operating as a data-driven organization far outweigh the associated costs. Implementation and long-term maintenance of WisDOT Data Governance and data cataloging initiatives on an enterprise-wide scale will require significant effort and dedicated resources. Dedicated resources include: 1) an established Data Governance Consulting Service to provide guidance and framework for the implementation of enterprise Data Governance across WisDOT; and 2) two full-time positions: a Chief Data Officer (CDO) to address key objectives (e.g., rules standardization, issue resolution, compliance monitoring, and on-going support for data stakeholders and a Data Catalog Administrator to help coordinate data collection, documentation, analyses, and leveraging of metadata within the Data Catalog to uncover new relationships that advance WisDOT’s mission. These positions will work alongside existing Data Stewards to develop, oversee, and implement Data Governance policies.

Lastly, it is critical to acknowledge that Data Governance is not a standalone new application or system, but rather an ongoing department-wide program that spans multiple business cultures and division business areas. The key to successfully promoting and implementing Data Governance is effective organizational change management. This can be achieved by employing appropriate data stewardship strategies that involve engagement, training, and support, which will encourage buy-in from employees at all levels. Additionally, aligning Data Catalog software with Data Governance Initiatives at an early stage is important for widespread acceptance of these agency-wide efforts.

1 BACKGROUND

1.1 Problem Statement

Data Governance is an agency wide initiative that needs to be driven by the leaders of every Division to be successful. It is important to note that in order to achieve true Data Governance, the responsibility extends beyond IT related department and lies with the agency as a whole, requiring the active participation of leadership, management teams, Data Stewards, Data Custodian and data users, including both creators and consumers. The previous WisDOT Data Inventory/Catalog research project, completed by the Institute for Physical Infrastructure and Transportation (IPIT) at the University of Wisconsin-Milwaukee (UWM), focused on identifying digital datasets and gathering relevant information about them within WisDOT. The analysis of the project's results clearly indicates the need for WisDOT to establish enterprise-wide Data Governance and data cataloging practices. This includes harmonizing data sources, implementing proper access controls, documenting ownership, and creating both technical and descriptive information to address the who, what, where, when, and why of enterprise data. The current project builds upon these prior efforts, with the overarching goal of establishing and implementing comprehensive enterprise-wide Data Governance.

To further emphasize the problems that arise from the absence of a Data Governance Program and a Data Catalog tool, it is important to highlight key points. Firstly, there is evidence of potential benefits that can be realized through the implementation of a Data Catalog, as discussed in supporting documentation. Secondly, there is a recognized deficiency in data classification practices within WisDOT, as identified in recent evaluations. This deficiency is evident in the agency's failure to appropriately perform and track data classification of all agency data assets. Despite previous unsuccessful attempts to define and implement data classification procedures, the persistent absence of a structured approach continues to pose a significant challenge.

Moreover, WisDOT encounters difficulties in identifying the official "system of record" for multiple datasets with similar features. For instance, one can envision a scenario in which an organization faces the challenge of not having a comprehensive master list documenting all applications and their associated databases for data retrieval or storage purposes. This critical information is dispersed across multiple sources, lacking a centralized and official repository, thereby hindering efficient tracking and management. Without a robust Data Governance Framework, WisDOT lacks the necessary mechanisms to determine the authoritative data source for such critical elements. Establishing a comprehensive Data Governance Program and implementing a Data Catalog tool will address these issues by providing the necessary structure, classification, and documentation to ensure data consistency, accuracy, confidentiality, and regulatory compliance.

By emphasizing these challenges, it becomes evident that the establishment of enterprise-wide Data Governance and data cataloging is imperative for WisDOT to enhance data management practices, streamline processes, and enable effective decision-making based on reliable and well-managed data assets. Thus, this project builds upon past efforts around data cataloging at

WisDOT with the ultimate goal being the establishment and implementation of enterprise-wide Data Governance.

1.2 Objectives

The objectives of this project are to explore and develop recommendations for an implementation ready WisDOT Data Governance Framework that harmonizes data sources, properly controls access, documents ownership, and has a mechanism to capture both technical and descriptive information about the who, what, where, when, and why of enterprise data. Such a Data Governance Framework is mainly established for future data. Ultimately a Governance Committee will be developed that has: a charter with an organizational structure and guiding principles; an understandable process with clear roles and responsibilities; and forms with a list of questions/requirements for making sound decisions on new datasets that are being acquired by the agency.

1.3 Method

To accomplish the project objectives, the research team first revisited the literature review in the previous project regarding the Data Governance practices among state DOTs and examined the previous WisDOT Data Governance Survey to all 50 states DOTs. Then the team conducted further external phone interviews to determine the Data Governance state-of-the-practice within DOTs and requested Data Governance relevant materials from the interviewed DOTs. Building upon the collected materials, the team worked with the internal stakeholders in WisDOT to develop key Data Governance documentation to support the future Data Governance Program.

1.4 Organization of Report

The remainder of this report is organized as follows: Section 2 presents the results from both the previous WisDOT Data Governance Survey to 50 states and the external phone interviews with six selected state DOTs to determine the Data Governance state-of-the-practice within DOTs, identifying state-of-the-practice trends. Section 3 presents the developed Data Governance related documentation. Section 4 presents internal engagement with iCAV in WisDOT. Section 5 concludes this report with a summary and a discussion of the directions for future work.

2 EXTERNAL INTERVIEWS: STATE DOTS

Data Governance at state DOTs is a newly emerging activity; therefore, very little information is available in the published literature regarding Data Governance, data cataloging or data inventory at DOTs. Because this is an emerging field of study, WisDOT surveyed other state DOTs regarding their progress in the overarching area of Data Governance and collected their responses. This section will discuss the results of both the survey and the phone interviews with six selected state DOTs (i.e., Caltrans, FDOT, INDOT, IowaDOT, ODOD, and SCDOT). The selection was based on the survey results that aimed at covering all implementation stages of Data Governance Program among different state DOTs. The results of the survey and interviews were then synthesized to identify state-of-the-practice trends, especially focusing on the following specific aspects among state DOTs (if not covered in the survey results): 1) structure and documentation of Data Governance, 2) rules of the Data Governance, 3) implementation workloads (e.g., FTE, personnel) needed for Data Governance, and 4) Data Governance software, tools, and application.

2.1 WisDOT Data Governance Survey

A survey was sent on April 5th, 2022, to all 50 states and Washington, D.C. by WisDOT to gather information on transportation agencies' Data Governance practices via the AASHTO Research Advisory Committee and the AASHTO Committee on Data Management and Analytics with basically two simple questions that can be seen in the figure below.

Hello RAC members,

The Wisconsin Department of Transportation is seeking information from state DOTs regarding Data Governance. Please forward this survey to your agency's Chief Information Officer or other individual responsible for Information Technology.

When available, please include web links or attachments to any resources that might further explain your state's policies and practices. The results of this survey will be shared to the AASHTO RAC website.

1. Does your state DOT have a data governance program or processes?
    a. If yes, do you have any staff dedicated to data governance?
    b. If yes, what are their roles/titles?
2. Does your state have data cataloging software?
    c. If yes, what data cataloging software are you using?

Please provide contact information if you are willing to participate in a follow-up email or phone call.
Name:
Title:
Phone number:
Email address:

Please send responses to research@dot.wi.gov by April 20th.
Thank you for your time and participation.

Figure 1. Original Email Sent by WisDOT

2.1.1 Brief Summary and Findings

Twenty-seven agencies responded to the survey. Eleven states and Washington DC indicated that they have Data Governance in place; other eleven states mentioned they either have a Data Governance Plan in progress or decided to plan for Data Governance in the near future. Sixteen states have staff whose roles include Data Governance. Ten states have staff dedicated to Data Governance or will have dedicated staff in the future. Seven states currently use data cataloging software. Additionally, four states are in the process of implementing data cataloging software or are looking into software options. Figure 2 below shows the progress of Data Governance Program by states who responded to the survey.

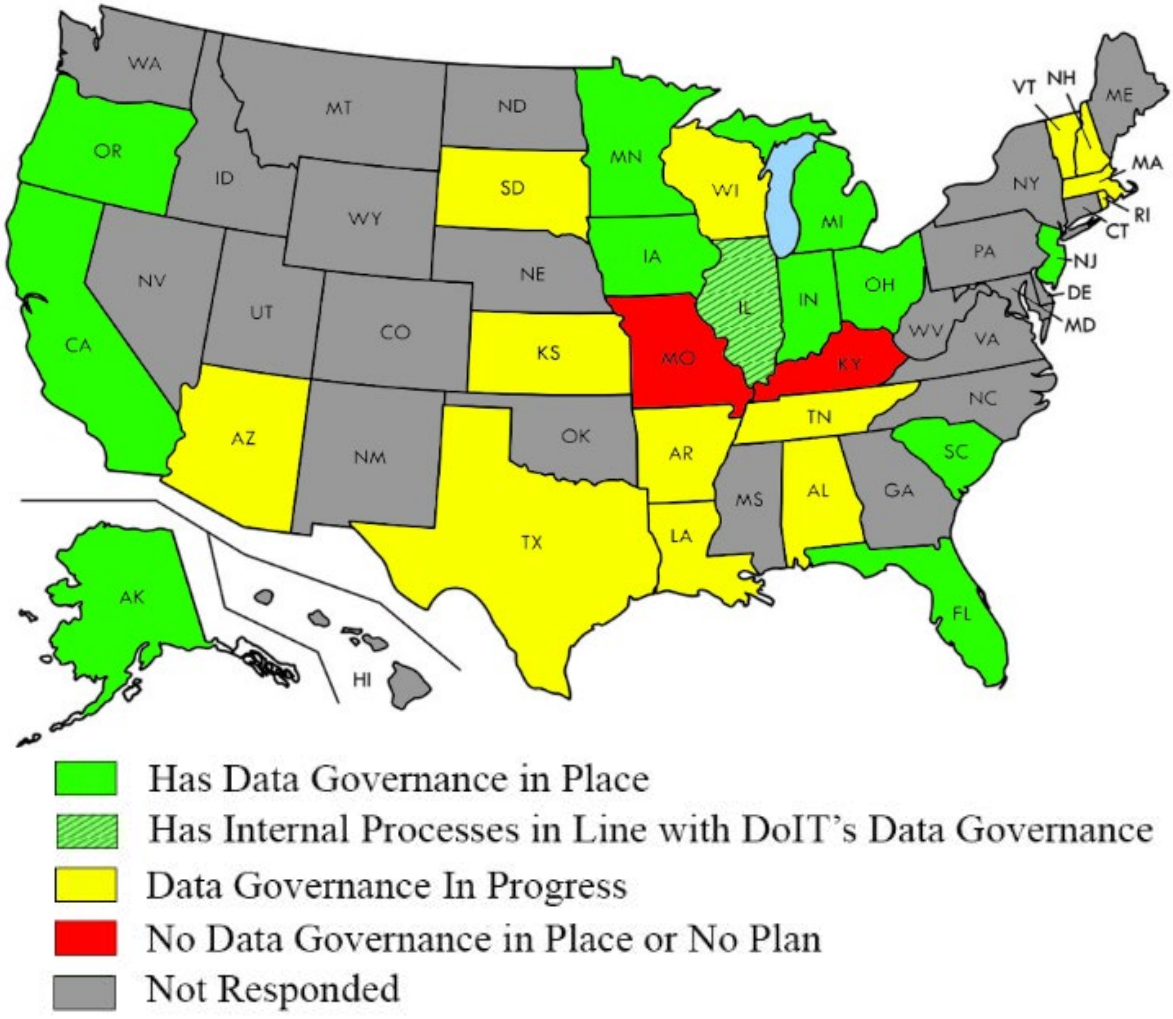


Figure 2. Data Governance Progress by Different States Who Responded to the Survey

Table 1 below summarizes the information regarding the tool/software used by states to support their Data Governance Program.

Table 1. Summary of Information Regarding Tool/Software Usage by Different States Who Responded to the Survey

State	What data cataloging software are you using?
District of Columbia	ESRI tools
Florida	Informatica EDC (FDOT); Data.world EDC (State of Florida)
Indiana	Informatica
Kentucky	SAP Information Steward
Michigan	IBM InfoSphere Information Governance Catalog
Minnesota	The BDC is a custom Java application in the process of being recoded to .NET or replaced.
South Dakota	File Director

2.2 Interviews with Selected State DOTs

Based on survey results and discussion with team members from BITS, six states were selected for further external interviews. The purpose of the external interview is to understand the current practice and opinions from state DOTs regarding their procedures on establishing their own Data Governance Program. Two states, Ohio and Iowa, had already been approached by WisDOT earlier before the start of this project, and the related Data Governance related documentation has been retrieved (including some presentations made to WisDOT). Thus, no additional virtual interviews have been made, and instead, the research team reviewed all the retrieved materials to accomplish the external interviews for these two states. Similarly, Caltrans was contacted by the research team during the project and provided the team with abundant Data Governance documentation so no further virtual interview was scheduled. The table below displays the interview schedules for the rest of the three states of Florida, Indiana, and South Carolina.

Table 2. External Interviews Schedules with State DOTs

DOT	Position	Date	Time
INDOT	Director of Data Governance	10/03/2022	12:00PM - 1:00PM
SCDOT	Data Governance Officer	10/04/2022	9:00AM - 10:00AM
FDOT	Civil Integrated Management Officer	10/05/2022	9:00AM - 10:00AM

In the meantime, the following questions were also generated and used to ask other states that are of primary interest to WisDOT:

- What were your goals/benefits of implementing a Data Governance Framework?
- What if any were your Data Governance guiding principles?
    - For the committee
    - For the data itself
- What is your Data Governance Committee's organizational structure?
- Do you have defined roles & responsibilities?
- Does the committee have a charter?

- Do you have any documented policies, procedures, or standards?
- What were your main lessons learned?
- Do you have a process flow or swim lane diagram for intake and decision making?
- Is there an intake form or questions for new data?
- Can we get copies of any/all of the above?

2.2.1 Caltrans

Caltrans' Enterprise Data Governance Program is referred to as CTDATA, an acronym representing Caltrans Data is Authoritative, Trusted, and Accessible. According to their CTDATA Action Plan, initiated in 2018, the action plan demonstrates a clear roadmap for Caltrans to achieve the final goal(s). It should also be noted that the program is highly tied to geospatial data management. The general goal of the program is to provide reliable, accessible, sharable, quality controlled, and documented data for use by Caltrans and its partners that support analysis and decision making. Specifically, it focuses on aspects to 1) increase the data value; 2) maximize data sharing; 3) enhance data literacy; 4) improve data efficiency; 5) increase data consistency and interoperability; and 6) protect sensitive and confidential data. Correspondingly, the following benefits have been recognized by implementing the Data Governance Program: 1) find the data you need; 2) use the right data sources; 3) trust datasets that you did not create; 4) avoid duplicating data and wasting resources; 5) get reports easily; 6) eliminate repetitive data requests; and 7) prevent misunderstanding or misuse of data.

The figure below deciphers the organizational structure (left) developed by Caltrans for their Data Governance Program and the internal interactions among different levels of units (right).

Each of the upper-level units (colored in blue in the structure) has its own charter with detailed roles and responsibilities defined, primarily focusing on scoping, reviewing, and sponsoring the low-level units (colored in green in the structure) who are responsible for implementing, producing, and performing. The figure below shows both the core data principles of the program and the guiding principles for each upper-level unit.

Regarding the data intake process into the Data Governance Program (both existing and new data), Caltrans developed the following guides:

1. *Data Assessment, Governance Scoping and Initiation Guide*, consisting of a set of templates and guidance resources that are available to support these efforts and promote consistency in how we document and share information about Caltrans data resources. The process can be described as: 1) Select Data Scope; 2) Identify Gaps; 3) Scope Governance Effort; and 4) Implement.
2. *Caltrans Data Documentation Package*, describing and referencing several standard data documentation deliverables, including: 1) Data Catalog, 2) Corporate Data List; 3) Data Element Standards; 4) Data Flows; 5) Dataset Metadata; 6) Business Glossary Terms; 7) Data Dictionary; 8) Business Rules; and 9) Data Quality Management Plan.
3. *Caltrans Data Quality Management Plan*, providing a framework for assessment, documentation and improvement of data quality management practices for Caltrans for any data set or system.

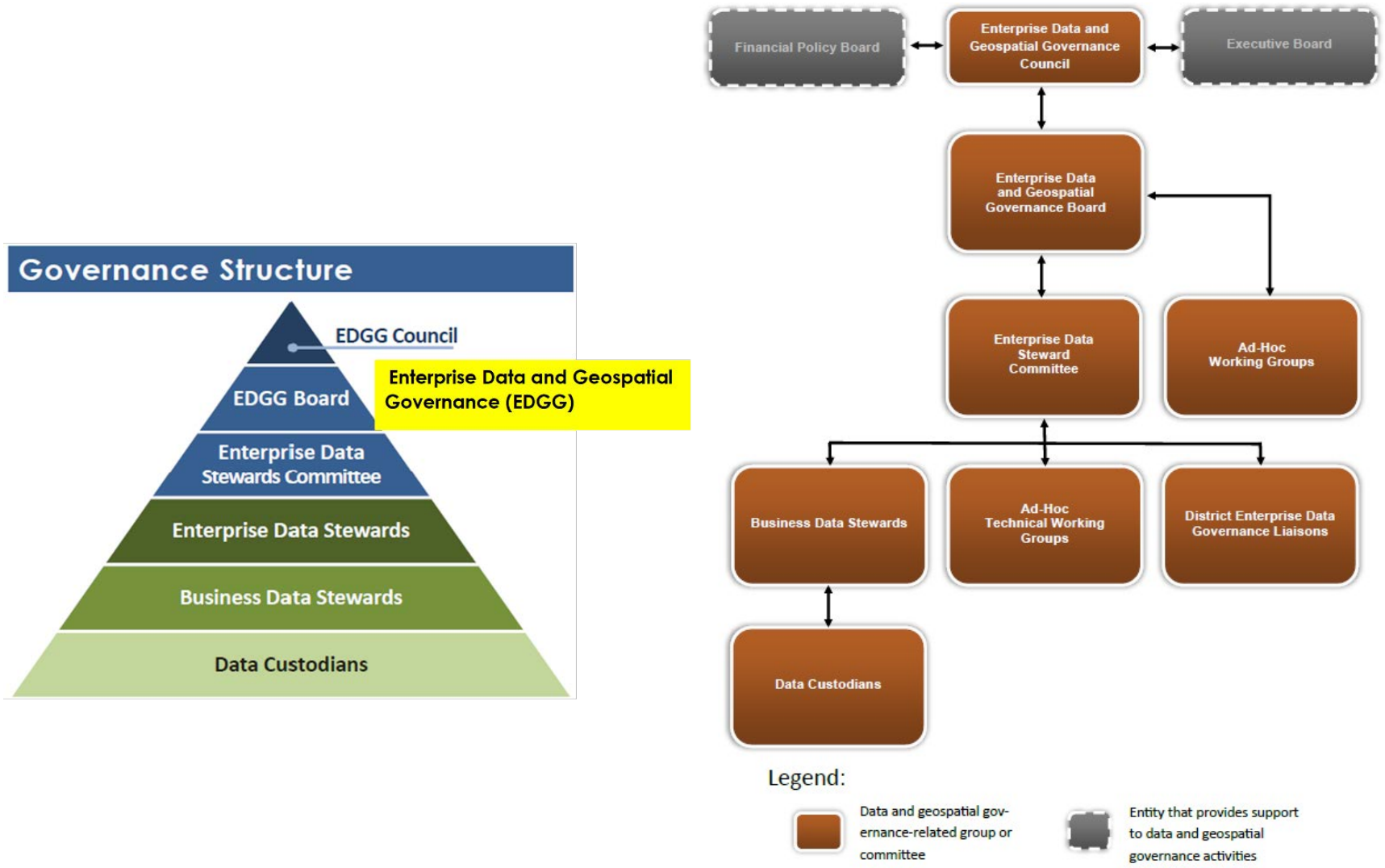
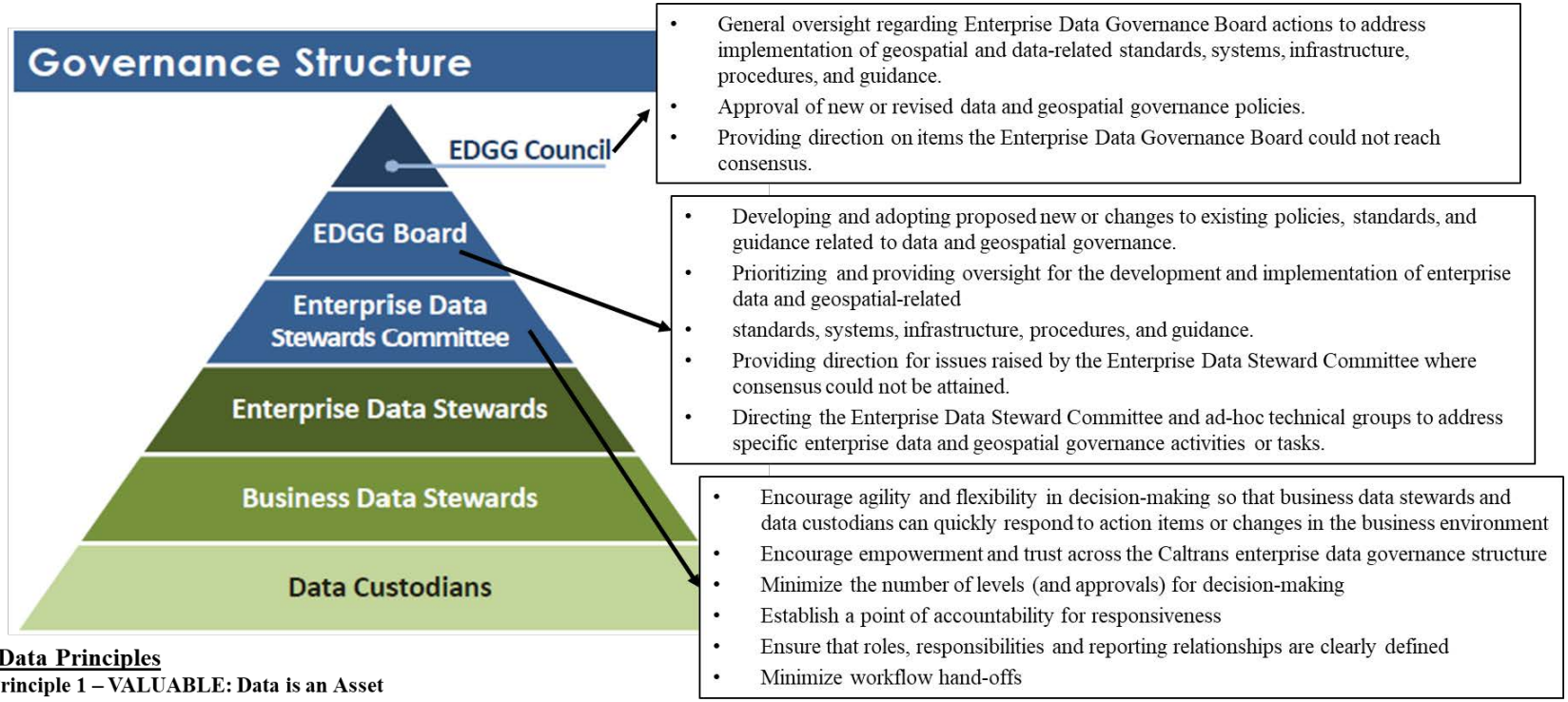


Figure 3. Data Governance Organizational Structure by Caltrans



Core Data Principles

- **Principle 1 – VALUABLE: Data is an Asset**
- **Principle 2 – AVAILABLE: Data is open, accessible, transparent and shared**
- **Principle 3 – RELIABLE: Data quality and extent is fit for a variety of applications**
- **Principle 4 – AUTHORIZED: Data is secure and compliant with regulations**
- **Principle 5 – CLEAR: There is a common vocabulary and data definition**
- **Principle 6 – EFFICIENT: Data is not duplicated**
- **Principle 7 – ACCOUNTABLE: Decisions maximize the benefit of data**

Figure 4. Guiding Principles of Caltrans' Data Governance Program

Based on the detailed documents, Caltrans also developed some briefings to promote the Data Governance concept for more buy-ins.

The question for performance measurement of the Data Governance Program remains unanswered, since no evidence has been found so far from the provided materials, for both the qualitative and quantitative measurements/metrics.

2.2.2 FDOT

In 2015, the Florida Department of Transportation (FDOT) initiated an effort to establish a framework for widespread adoption of Data Governance and Master Data Management. The goal was to implement Data Governance principles defined in Florida Statute 282 and enhance data reliability and sharing across FDOT. This initiative, known as Reliable, Organized and Accurate Data Sharing (ROADS), aimed to enable informed decision-making based on readily available and accurate data.

Complying with Florida Statute 282, Data Governance involves organizing, classifying, securing, and implementing policies, procedures, and standards for effective data utilization. Its purpose is to formalize data management, facilitating strategic planning and decision-making. Recognizing the long-term value of data, meticulous management throughout its life cycle is essential.

Effective data life cycle management ensures a smooth flow of information assets within an organization, from planning and creation to obsolescence. FDOT has been actively streamlining information sharing to achieve ROADS' objectives. Barriers hindering efficient information exchange are being eliminated, enabling faster and better decision-making. Moreover, ROADS supports the development of a comprehensive Enterprise Information Management Structure governed by FDOT Transportation Technology, facilitating effective data asset management and governance throughout the organization.

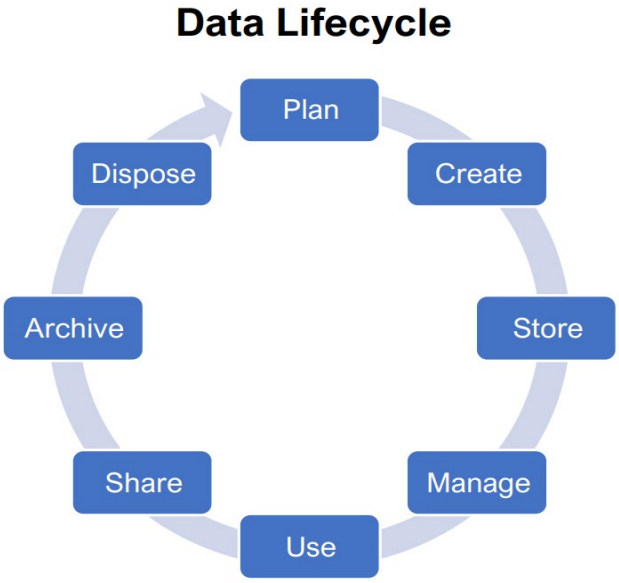


Figure 5. ROADS Data Management Planning: Key considerations for each

Prior to the initiative, an assessment was conducted with five key problems identified: difficulty in determining available data, limited data access, lack of standardized data management, absence of an enterprise-level data view, and the need for a centralized solution. To address these issues, FDOT launched the Reliable, Organized, Accurate Data Sharing (ROADS) initiative. Its goal is to enhance data reliability, simplify data sharing, and ensure readily available and accurate data for informed decision-making. Surveys and interviews were conducted across the central office and 7 districts to assess FDOT's needs, revealing 63 distinct information gaps. With the data management issues identified, FDOT then focused on the key elements to improve data management by acting on people, process, and technology (Figure 6).

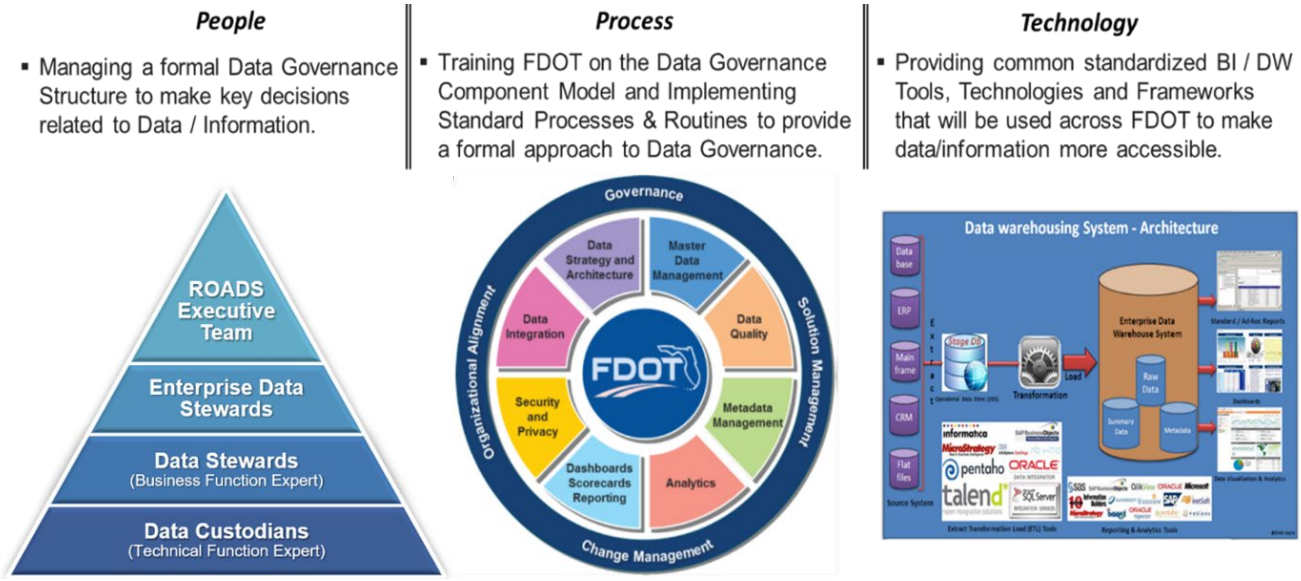


Figure 6. FDOT ROADS Key Elements

It is worth noting that the executive team plays a pivotal role in establishing the overarching rules, processes, and procedures of Data Governance. This highlights a top-down organizational structure, where the leadership sets the framework for Data Governance within the organization.

Moreover, according to the interview, FDOT believes that one of the core functions of the Data Governance Program is to ensure the utilization of data, as data becomes useless if it is not effectively utilized. Such emphasis is centered around catering to the needs of the end users. Additionally, this faith also helps FDOT to enhance the data sharing, as one example is that FDOT is in the process of complying with the state's Cloud-first policy (Fla. Stat. § 282.206 (*Statutes & Constitution :View Statutes : Online Sunshine,* n.d.)) in their Data Governance Program.

Two documents regarding the data management planning or the type of data intake process can be found in their "The Story of ROADS" website (FDOT, n.d.):

1. *FDOT Data Governance Checklist* is a list of key considerations for each phase of the data lifecycle.

2. *FDOT ROADS Data Management Planning Resource* is a quick reference guide for important Data Governance considerations in Transportation Technology projects.

In terms of the performance measurement for the Data Governance Program, although no quantitative measures have been established, several qualitative metrics can be found as:

- *Information is secure, accurate, reliable and at the appropriate level.*
- *Accessing relevant business data becomes quicker and more efficient.*
- *Reduction in the amount of time needed to locate data.*
- *Sharing information across the organization is streamlined to enable better and faster decisions.*
- *Greater capability to link data from different districts, functional areas and systems.*
- *Barriers that prevent the efficient sharing of information are removed.*

2.2.3 INDOT

INDOT has successfully implemented a robust Data Governance Program, utilizing a bottom-up approach that prioritizes the development of rules, standards, and policies. The program's structure involves Data Stewards who play a vital role in defining and reporting to data trustees, who form part of the Data Governance Committee, for approval. Figure 7, based on insights gathered during interviews, illustrates this concept and provides a visual representation of the informal INDOT Data Governance Structure.

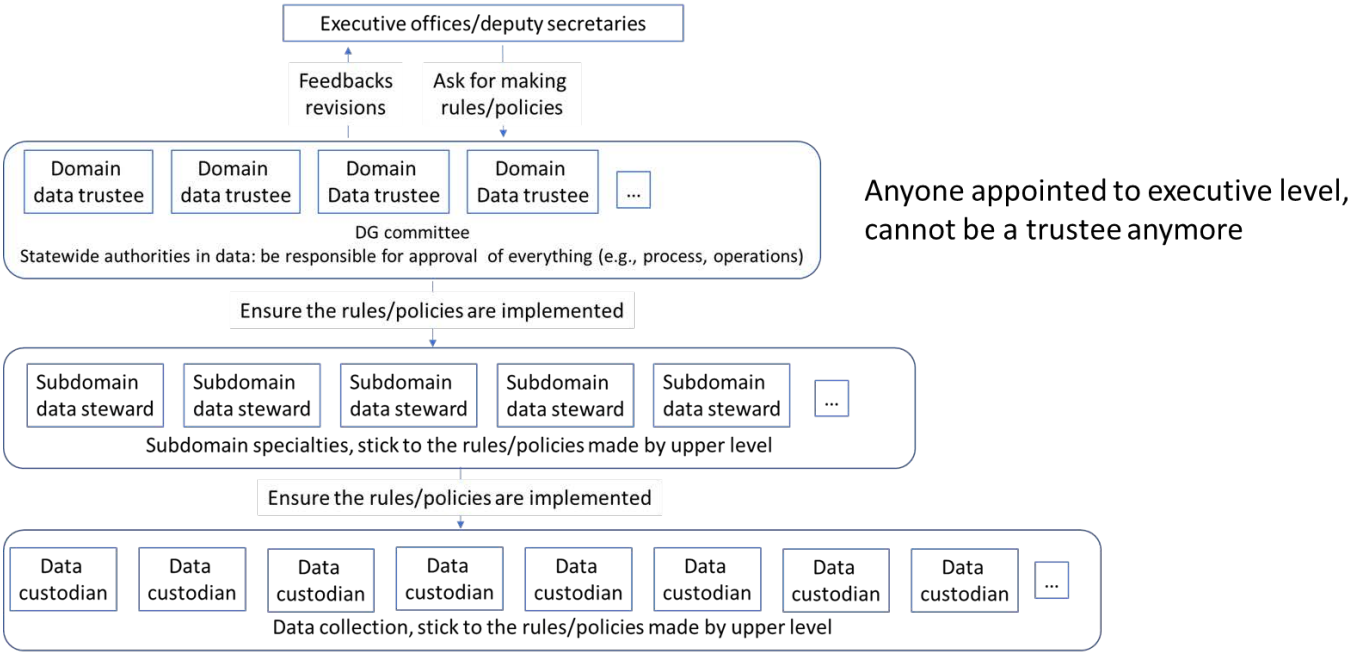


Figure 7. Informal INDOT Data Governance Structure

While specific materials from the interviewee were not obtained, key aspects of INDOT's Data Governance Program can be summarized to provide valuable insights. Central to the program is the core belief that activities and processes should closely align with assets. By establishing this alignment, INDOT ensures effective management and maintenance of its transportation infrastructure assets, ultimately contributing to improved operations and service delivery.

An essential component of INDOT's Data Governance Program is the utilization of dashboards. These dashboards serve as valuable tools, supplying critical information to various stakeholders, particularly data trustees who hold responsibility for specific domains. Dashboards provide an overview of key data metrics and indicators, empowering trustees to monitor performance, identify potential issues, and address any gaps that may arise in the data.

Through its Data Governance Program, INDOT has established a structured framework for data management and decision-making. The program enables the organization to define and enforce rules and standards, ensuring consistency, accuracy, and reliability of data across the board. By empowering Data Stewards and involving data trustees, INDOT promotes a culture of accountability and ownership throughout the organization, fostering a data-driven mindset.

2.2.4 Iowa DOT

To facilitate the data integration/data architecture as crucial to furthering the agency's mission and vision, IowaDOT initiated their Enterprise Data Governance Program in 2020, building upon its two previous efforts of Agency's 2018–2020 Strategic Plan and 2016 Enterprise Architecture Plan. Understanding and communicating the benefits of data management and governance enables the IowaDOT to create a rationale for investing in these practices. They believe effective management and governance ensure better quality, increased efficiency, improved resource allocation, policy compliance, and reduced costs. Based on their estimation, potential savings of $350-500 million over 10 years can be achieved by addressing data security, quality, relevance, efficiency, and accessibility challenges. Figure 8 depicts the data management plans and the corresponding strategies.

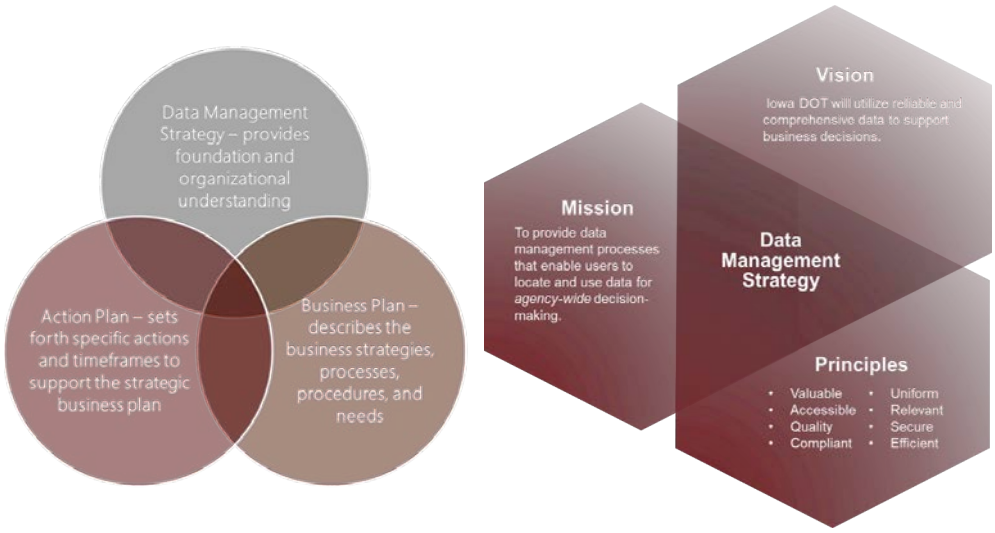


Figure 8. IowaDOT Data Management Plans and Strategies

As a starting point, IowaDOT conducted a data maturity assessment using NCHRP 814 tools to understand gaps in the current data management practice. The assessment evaluated the value of data for pavement and bridge asset management. Additionally, a SWOT analysis was used to assess current practices and identify growth opportunities. The assessment focused on key elements: data strategy, governance, life cycle management, architecture, integration,

collaboration, and quality management. This evaluation informed the development of a robust data management framework. In response to one of the biggest concerns via the assessment as "lack of clear vision/roadmap," a Data Management Roadmap with action items and timeline has been developed, which can be seen in Figure 9. Additionally, several key crucial tasks have been accomplished since the completion of the assessment so far, which are laid out in the following:

- Created a structured communication plan for data management.
- Documented a workflow for data management within the department.
- Developed a Strategic Data Business Plan (SDBP), which includes:
    - Data Management Strategic Plan: Targets executive level managers and other strategic-level staff
    - Data Management Business Plan: Targets Data Domain Trustees and other tactical-level staff
    - Data Management Action Plan: Targets Data Stewards and other operational-level staff
- Created an initial work plan and recommendations to implement the SDBP.

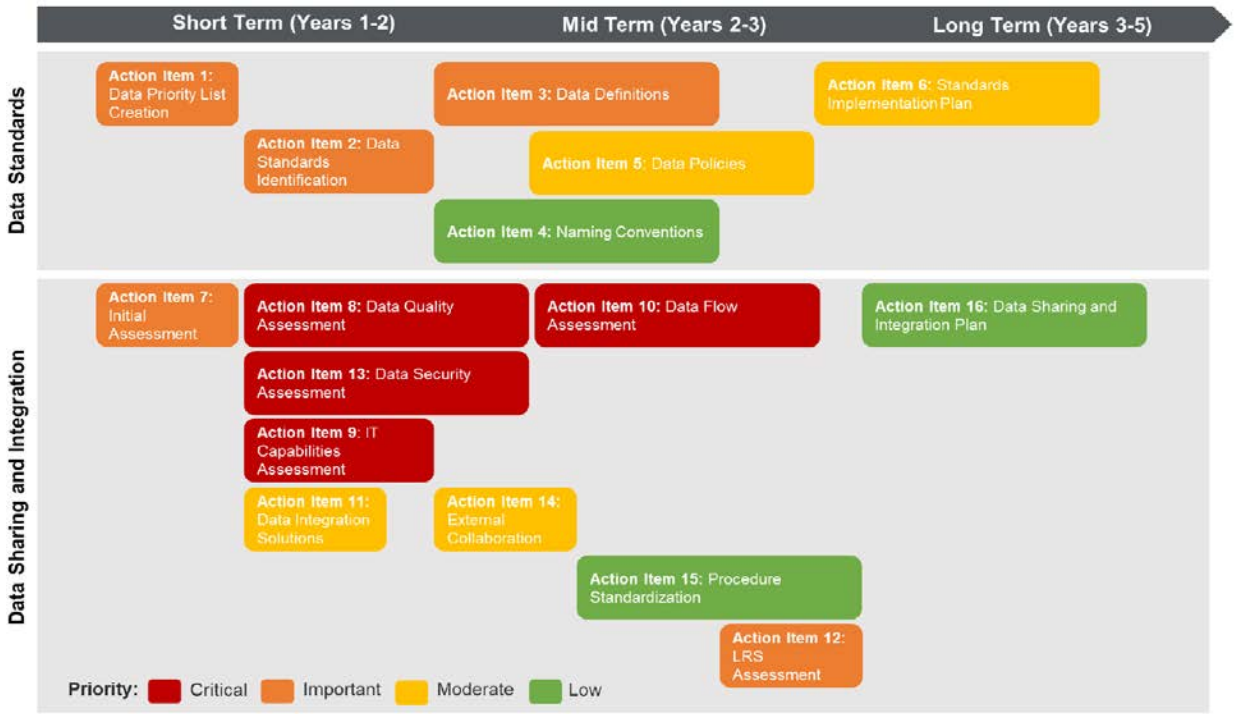


Figure 9. IowaDOT Data Management Roadmap

As continuous efforts, IowaDOT plans to take the next steps to advance their Data Governance Program are as follows:

Firstly, the department will focus on finalizing Data Governance roles. This includes approving the Data Management Committee Charter, which will provide a clear framework for the committee's responsibilities and authority. Additionally, other identified roles will be assessed and reviewed to ensure their alignment with the Data Governance Objectives.

Secondly, IowaDOT aims to communicate the value of data management across the entire agency. By raising awareness about the benefits and importance of effective data management, they can foster a data-driven culture and encourage active participation from all stakeholders.

Lastly, the department will proceed with implementing data management activities outlined in the Data Management Strategic Plan. This will involve securing buy-in from relevant stakeholders to ensure their commitment and support for the proposed initiatives. Additionally, resources and funding will be allocated to execute the recommended data management activities.

Regarding the Data Governance Structure, the governance mode adopted by IowaDOT, depicted in Figure 10, is structured as a three-level (strategic, tactical, and operational) hierarchy. The hierarchy incorporates stakeholder input at every level and approaches Data Governance from multiple perspectives across the agency.

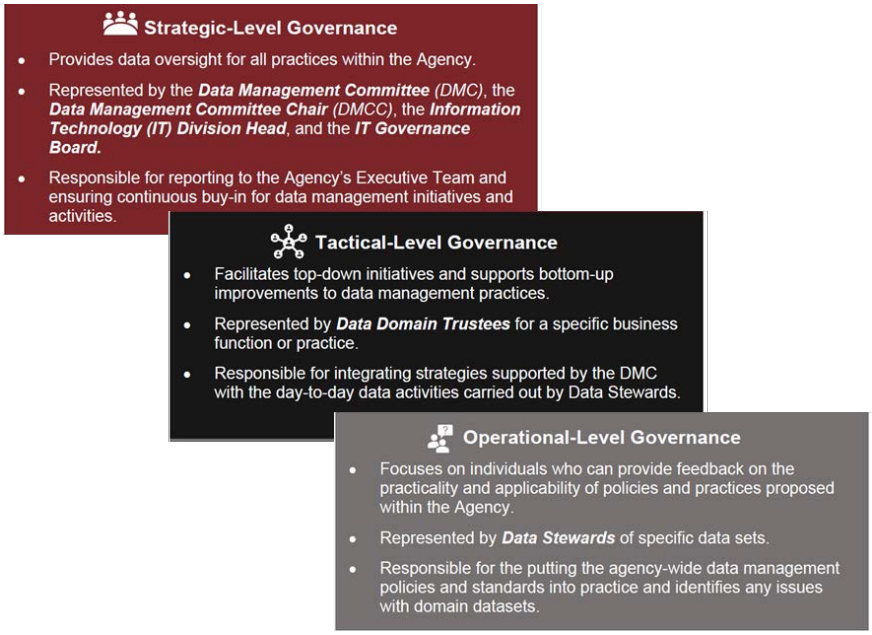


Figure 10. IowaDOT Data Governance Structure

In terms of the performance evaluation, IowaDOT provides their quantitative measures for evaluating the performance of Data Governance Program, which can be illustrated with the following aspects:

- **Overall department-level data maturity**: Using a data management maturity assessment, the committee can determine the department-wide data management maturity periodically.
- **Percent of datasets available via Mater Data Management (MDM) System**: The MDM System is an important component of the agency's data management and integration efforts. Because the overall goal of the department is to have all public data available via the MDM System, the department can determine performance based on the percentage of datasets available within the system.

- **Percent of data with incomplete or missing fields**: Another metric of a sound data practice is consistent data with regards to how attributes are named and reported. The percentage of data with incomplete or missing fields represents the accuracy and completeness of available data.
- **Percent of duplicate or redundant data**: Similarly, the percent of duplicate or unnecessary data is a good measure for assessing the efficiency of the data collection efforts and management systems. The percentage of data or attribute fields out of all the attribute fields managed by the department can be used to assess performance.

2.2.5 ODOT

Ohio DOT (ODOT) is several years into implementing a Data Governance Strategy, which is outlined in (Albee et al., 2020). As part of that strategy, ODOT has developed a three-tiered Governance Framework shown in Figure 11. Data Governance Drivers is the top tier, with governance activities supporting the drivers and data life cycle management making up the day-to-day data management workflows. Within these tiers, the framework consists of four levels of groups with various roles and responsibilities: Strategic, Tactical, Implementation, and Support. As seen along the left side of Figure 11, Data Governance buy-in is at all levels of the agency.

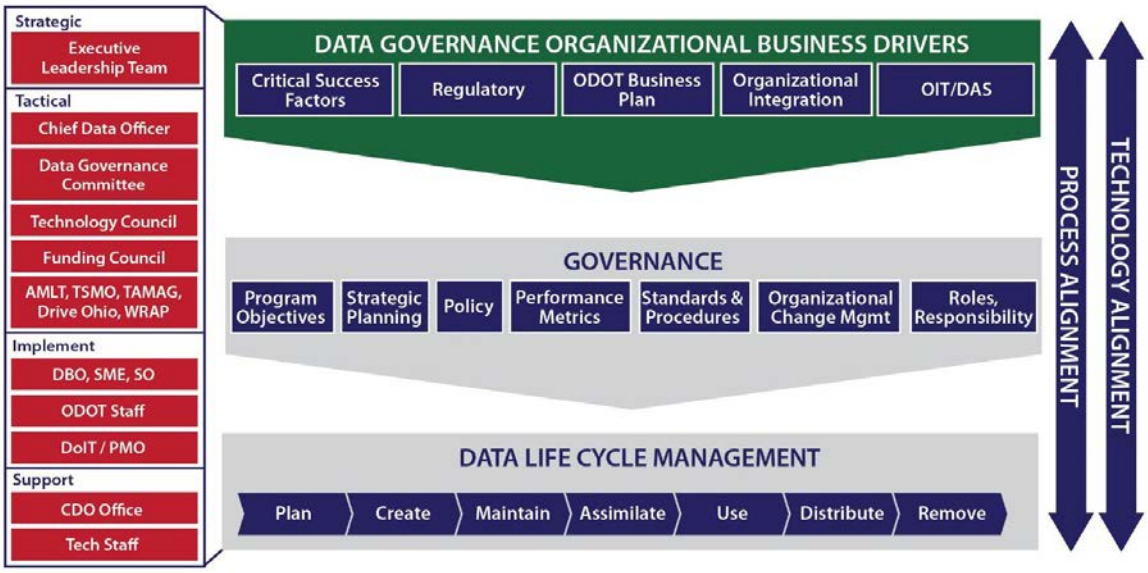


Figure 11. Data Governance Structure of ODOT

ODOT recognizes that effective Data Governance involves not just technology and data, but also people who play a critical role in translating data into enterprise technology. This understanding has allowed the agency to effectively manage the transportation system. While ODOT has primarily focused on aligning its existing data and technology groups within the Data Governance Framework, it acknowledges that software and technology are not the enablers of good Data Governance but rather the result of it. To ensure effective implementation, proper training procedures are essential. ODOT utilizes Prosci's ADKAR model for organizational change management in Data Governance. They have developed marketing materials, such as concise flyers and engaging TV advertisements, broadcast on ODOT TV in county garages and

offices. These materials employ non-technical illustrations, making it easier to comprehend and apply the concept of Data Governance, highlighting the importance of Data Governance.

ODOT values data as an asset and manages it accordingly. Leveraging data enables better decisions, leading to improved quality, cost savings, and enhanced performance. ODOT measures the effectiveness of its Data Governance Program using return of investment (ROI), comparing the benefits with the costs. This includes reduced labor expenses, increased productivity, lower equipment costs, optimized project delivery, and decreased travel time for data collection. Figure below shows an example of Data Governance benefits in terms of ROI.

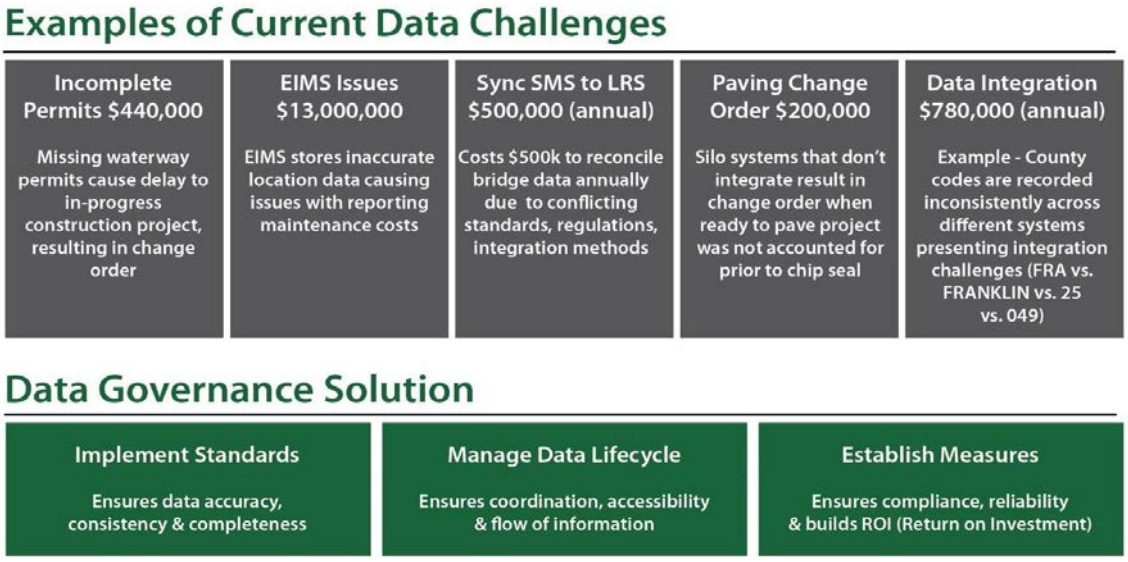


Figure 12. Graphic. Examples of Data Governance Benefits and ROI for ODOT

ODOT further consolidated the findings with the estimation by using an ROI approach in a white paper titled "*ODOT Data Governance: Return on Investment in Transportation Data Governance*," which outlines different types of ROI analyses, including qualitative and quantitative aspects, and establishes a framework for future ROI calculations within the Data Governance Program.

Similar to Caltrans and IowaDOT, ODOT also laid out a clear roadmap and timeline for the Data Governance Program, which can be seen in Figures 13 and 14 at both strategic and task levels.

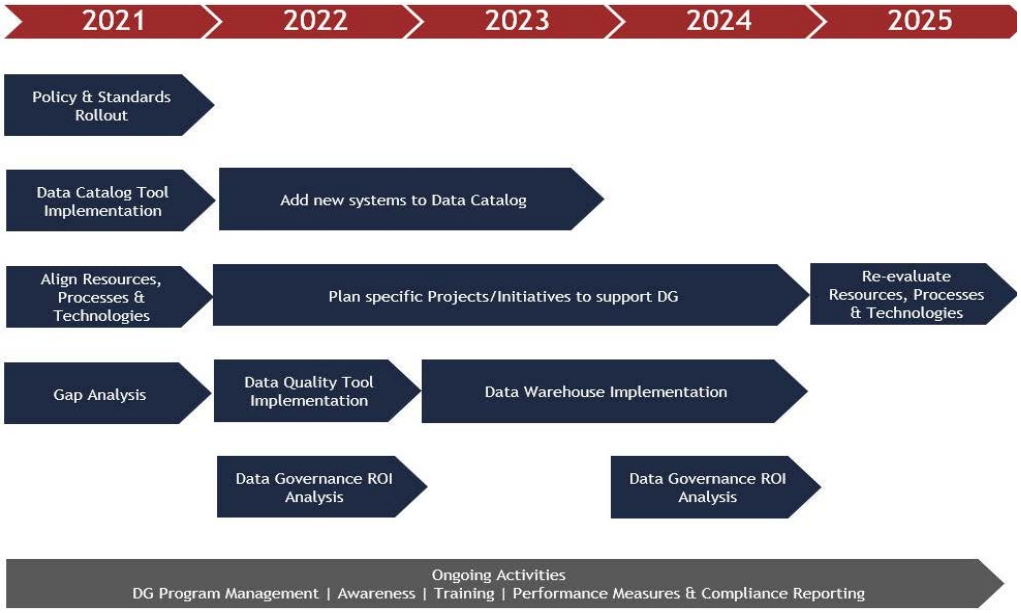


Figure 13. ODOT's Data Governance Strategic Roadmap

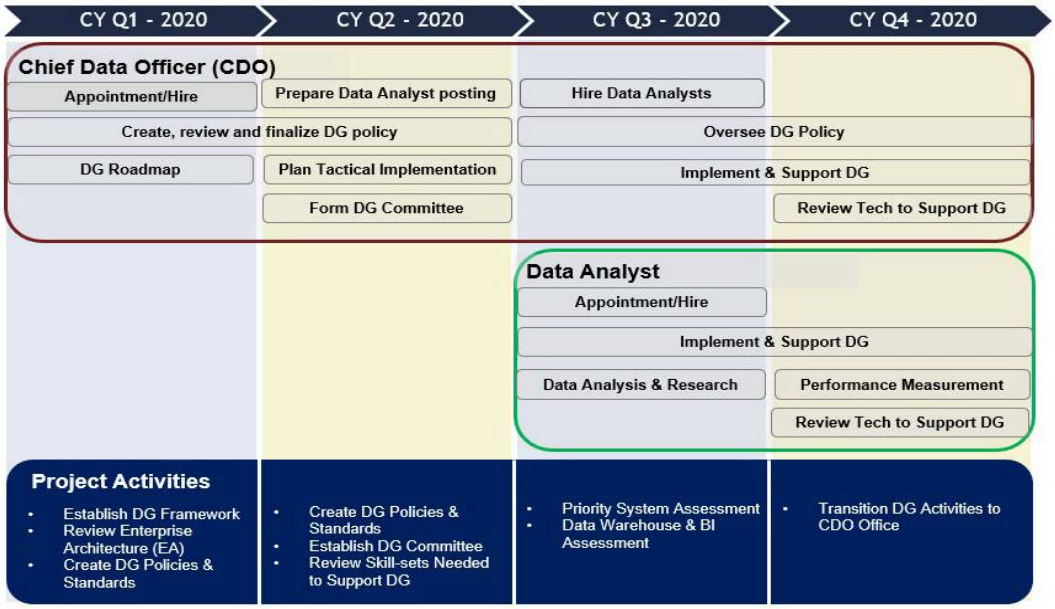


Figure 14. ODOT's Task-Level Data Governance Plan (2020)

2.2.6 SCDOT

SCDOT started their Data Governance Program back in 2020 and just accomplished their data maturity assessment in 2021 by using the Stanford's Data Governance Maturity Model with both quantitative and qualitative analysis to identify the gaps. The major reason for initiating the program is the low confidence in the data owned by the agency due to data quality issues such as inconsistencies. The assessment was conducted at different levels within SCDOT, and the collected data were aggregated and analyzed by division (for the perspectives of engineering, finance and administration, and intermodal planning) and department, with the focus areas as:

- Component (*Core Data Governance competencies*)
    - Awareness
    - Formalization
    - Metadata
    - Stewardship
    - Data Quality
    - Master Data
- Dimension (*Subdivided core competencies to focus on component maturity*)
    - People
    - Policy
    - Capability

For each sub area, they asked a series of questions regarding the data maturity. More information can be found in their internal audit report (SCDOT, 2021). Building upon the results, they are currently working on data discovery and inventory. One key insight from interviews is that the success and establishment of the Data Governance Program heavily rely on the unwavering commitment of top-level administrators within the organization.

2.3 Discussion and Conclusions

In conclusion, Data Governance at state DOTs is a relatively new and emerging field, and there is limited literature available on the topic. To gather information on Data Governance practices among state DOTs, WisDOT conducted a survey and interviews with selected state DOTs. The survey results showed that some states have implemented Data Governance Programs, while others have plans to do so in the near future. The interviews provided insights into the specific aspects of Data Governance, such as the structure and documentation, rules, implementation workloads, and software/tools used.

Caltrans, FDOT, INDOT, IowaDOT, ODOD, and SCDOT were among the state DOTs selected for interviews. Caltrans' Data Governance Program, known as CTDATA, focuses on increasing data value, maximizing data sharing, enhancing data literacy, improving data efficiency, ensuring data consistency and interoperability, and protecting sensitive data. FDOT initiated the Reliable, Organized, and Accurate Data Sharing (ROADS) initiative to enhance data reliability and sharing across the department. INDOT follows a bottom-up approach with Data Stewards reporting to data trustees, while IowaDOT has developed a comprehensive data management framework to address data challenges.

During external interviews, almost all interviewees agreed that the success of Data Governance Initiatives hinged on strong support from top-level executives and senior leadership. It was also confirmed in the review of the retrieved materials from the selected state DOTs. All emphasized the critical role played by executive offices and individuals in championing Data Governance efforts and driving cultural change within the organization. When leaders rank Data Governance as a strategic priority and allocate the necessary resources, it sends a clear message throughout the organization about the importance of data management. By demonstrating their commitment to Data Governance, executives establish a foundation of trust, encourage stakeholder

engagement, and foster a data-driven culture. Such commitment and involvement also ensure that Data Governance becomes an integral part of the organization's operations, ultimately leading to improved data quality, informed decision-making, and enhanced overall data management practices.

Another consistent theme emerged: Data Governance is not limited to being a new application or system solely tied to the IT department. Instead, it is recognized as an organization-wide plan that extends across multiple departments and encompasses different cultures within the organization. It was highlighted that successful Data Governance Initiatives require collaboration and participation from various stakeholders across the organization. By involving representatives from different divisions, programs, and business units, Data Governance can incorporate diverse perspectives, align with organizational goals, and address the unique needs and challenges of each department. This inclusive approach helps bridge cultural differences and promotes a shared understanding of the importance of Data Governance across the entire organization. It also fosters a sense of ownership and accountability, as individuals from different areas of the organization become actively engaged in Data Governance practices, including data stewardship, data quality assurance, and compliance. Moreover, it is also important to address the need for organizational change management as an ongoing and continuing program to effectively implement Data Governance practices. This involves aligning organizational goals and values, creating awareness, and understanding of the importance of Data Governance, and engaging employees at all levels. By incorporating change management principles, such as communication, training, and stakeholder engagement, DOTs can facilitate the adoption of Data Governance principles and practices throughout the organization, ensuring that data is treated as a valuable asset and managed consistently and effectively across different cultural contexts.

In addition, the observation of dedicated Data Governance Officers with diverse backgrounds in various state DOTs implies the existence of different needs and priorities within these organizations. The presence of professionals from finance, engineering, and policy science backgrounds suggests that each state DOT brings its unique perspective and requirements to the Data Governance domain. This diversity underscores the fact that Data Governance Initiatives must be tailored to meet the specific needs and challenges of each state DOT. By leveraging the expertise of individuals with varied backgrounds, state DOTs can ensure a comprehensive approach to Data Governance that addresses the specific nuances of their operations. This approach promotes collaboration, effective decision-making, and the development of Data Governance Strategies that align with the goals and objectives of each state DOT.

The interviews revealed that state DOTs recognize the benefits of Data Governance, such as improved data quality, increased efficiency, better resource allocation, policy compliance, and cost savings. They also emphasized the importance of data utilization and catering to the needs of end users. The organizational structures of the Data Governance Programs varied among the state DOTs, with top-down and three-level hierarchical approaches being observed.

The Data Governance Programs discussed in the interviews had processes and documentation in place for data intake, documentation, and quality management. Several states provided guides, checklists, and resources to support these efforts. However, quantitative performance measures

for evaluating the Data Governance Programs were not explicitly mentioned in the materials reviewed. Some qualitative metrics, such as improved data access, streamlined information sharing, and removal of barriers to efficient data sharing, were highlighted.

Although no explicit messages or information have been received through the external interviews, it is clear that concerns regarding data security and emerging big data issues are escalating.

One notable example of the challenges arising from the massive amounts of data managed by state DOTs is the potential for data breaches or incidents where personal information is exposed. Such occurrences can have far-reaching consequences for businesses and individuals, often resulting in substantial costs and reputational damage. Unfortunately, state DOTs are not exempt from these risks, as evidenced by reported incidents at agencies such as TxDOT (Government Technology, 2020), WSDOT (*Data Incident | WSDOT*, 2022), and IDOT (IDOT, 2022). These incidents serve as a wake-up call for state transportation agencies to prioritize data security and privacy in their handling of big data. The increasing collection and transmission of sensitive personal information raises concerns about data protection. As the volume of data grows exponentially, the risk of unauthorized access, data breaches, and misuse becomes more prevalent. State DOTs must take proactive measures to address these challenges and protect the privacy of individuals. Implementing Data Governance practices plays a crucial role in enhancing data security within the transportation sector. By establishing Data Governance Frameworks, agencies can enforce data protection measures, such as encryption, access controls, and data anonymization, to safeguard sensitive information. These practices help mitigate the risks associated with data breaches and unauthorized access, ensuring compliance with privacy regulations and maintaining public trust.

On the other hand, the emergence of big data, particularly in the context of connected autonomous vehicle (CAV) data, presents significant challenges for state transportation agencies. By 2025, it is projected that the United States will have around 116 million connected cars, each uploading approximately 25 gigabytes of data per hour to the cloud (OmniSci, 2018). This translates to approximately 219 terabytes of data per car annually, resulting in a staggering cumulative total of 25 billion terabytes per year. Handling such a vast amount of data requires robust infrastructure and substantial investments in storage systems, computational resources, and data management technologies. Additionally, the complexity and diversity of data from connected cars pose challenges in integration, standardization, and quality assurance. To address these issues, state transportation agencies must establish Data Governance Frameworks to ensure data consistency, accuracy, and reliability. Implementing Data Governance practices helps establish data standards, define ownership, and establish protocols for data sharing, thereby facilitating better data management. Such implementation could also address the crucial concerns of data security and privacy as the collection and transmission of personal information increases. Data Governance Frameworks enforce protection measures, access controls, and compliance with privacy regulations, mitigating risks associated with data breaches and unauthorized access. Effective Data Governance enables informed decision-making, improved transportation planning, and enhanced operational efficiency, which allows state transportation agencies to

leverage big data analytics to derive valuable insights, identify patterns, and make data-driven decisions. This could lead to optimized traffic management, improved infrastructure planning, and overall efficiency. To overcome the challenges posed by the massive amount of data generated by connected cars, state transportation agencies must invest in infrastructure, establish robust Data Governance Frameworks, and prioritize data security and privacy. By implementing Data Governance practices, agencies can unlock the potential of big data, paving the way for more efficient and sustainable transportation systems in the future.

Overall, the survey and interview results provided valuable insights into the state-of-the-practice trends in Data Governance among state DOTs. The findings contribute to the understanding of Data Governance implementation in the transportation sector and serve as a foundation for further supporting the development of Data Governance relevant initiative materials in the later tasks.

3 DATA GOVERNANCE DOCUMENTATION DEVELOPMENT

3.1 Overview

Through extensive collaboration with other state DOTs, the research team has diligently gathered and consolidated a wealth of information and resources pertaining to the development of a Data Governance Program, with a particular focus on the creation of relevant documentation. As a result, the primary objective of this section is to outline a set of recommended guidelines for Data Governance Documentation based on our comprehensive findings. Drafts for five main documents have been derived, including: 1) Data Governance Structure Mapping the WisDOT organizational chart; 2) Data Governance Board/Council Charter for elaborating the roles and responsibilities of both upper-level governance bodies; 3) detailed roles and responsibilities for all levels of the involved units within the Data Governance Structure; 4) a process flow diagram for data intake to be complied with the Data Governance Program in the future; and 5) a data intake form capturing essential information for new data, enabling informed decision-making by Data Governance bodies.

3.2 Data Governance Structure

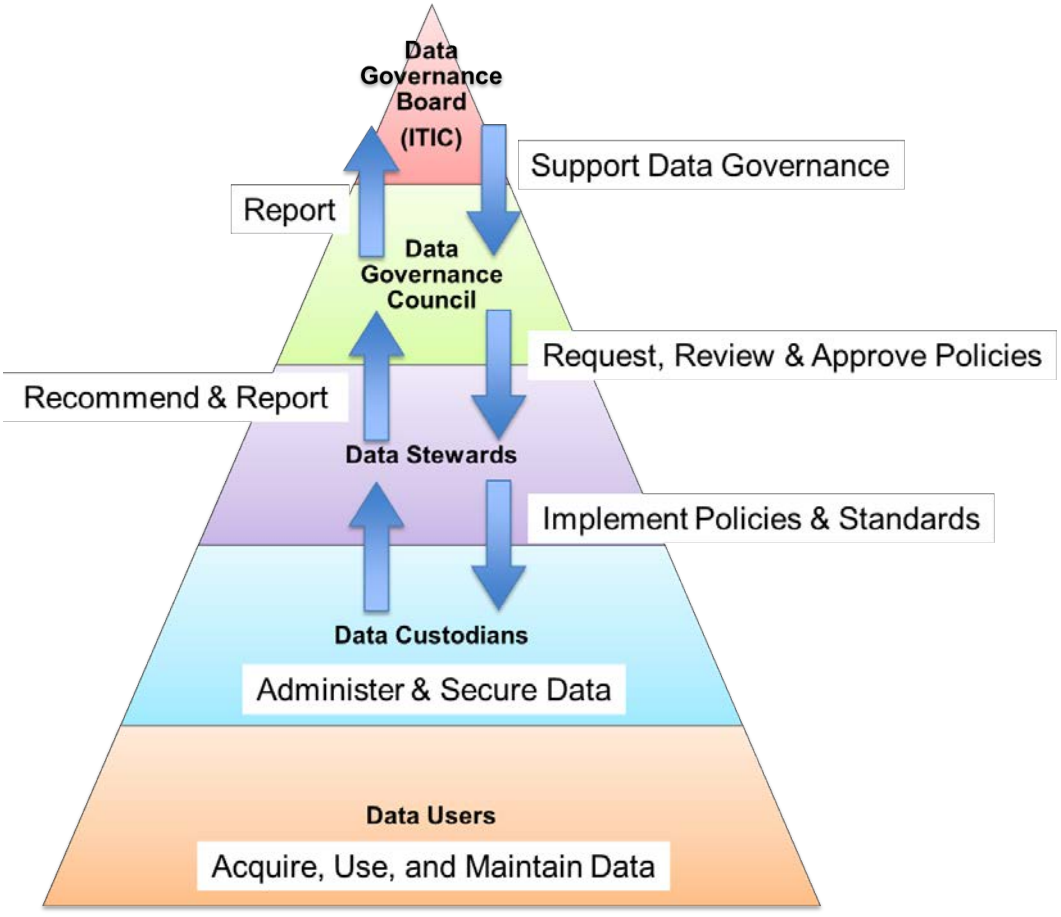


Figure 15. Proposed Data Governance Structure

Figure 15 displays the proposed Data Governance Structure designed for the WisDOT Data Governance Program. This graphical depiction of the Data Governance Framework provides several important functions:

- Clarity and Understanding.
- Hierarchical Structure.
- Role Identification and Definition.
- Process Mapping and Flow.
- Reference and Training Tool.

The Data Governance Structure in the form of a relational pyramid provides a visual representation of the hierarchical relationships, roles, and overarching processes within a Data Governance Program. It promotes clarity, understanding, and alignment among stakeholders, enabling effective communication, collaboration, and execution of Data Governance activities.

3.3 Data Authority

The ultimate authority and responsible party for data at WisDOT empowers individuals to fulfill their roles and responsibilities.

1. The Data Governance Board (DGB) is the highest authority in relation to data assets at WisDOT. The DGB authorizes all Data Governance Council (DGC) members, stewards, custodians, data maintainers, and data users to take action under the authority of the department's Executive Office.
2. Division Directors are the second highest authority in relation to the data assets of their respective divisions.

3.4 Data Governance Board/Council Charter

A charter is a document that is developed in a group setting to clarify team direction while establishing boundaries. It is developed early during the forming of the team. The charter should be developed in a group session to encourage understanding and buy-in. It offers an initial delineation of roles and responsibilities, comprehensively outlines the purpose and objectives of the Data Governance Program, identifies crucial stakeholders, and definitively establishes the authority of the DGB and DGC. This document functions as an authoritative reference for future project planning endeavors. The charters developed for both the Data Governance Council and Board are presented as follows.

3.4.1 Data Governance Board

3.4.1.1 Purpose & Objectives

The WisDOT Data Governance Board (DGB) is the oversight and decision-making body for matters related to Data Governance at WisDOT. The board is made up of division administrator level representation. The purpose of the board is to is to provide department-wide guidance and support in developing and improving Data Governance Programs, and ensuring compliance with data policies, procedures, and standards. The board will also serve as the primary Data

Governance body and decision-making authority on the intake of any new datasets within the. The board provides for consistent action and messaging across WisDOT.

3.4.1.2 Benefits

By fostering a proactive approach to implementing Data Governance at WisDOT, the board (DGB) will realize short and long-term benefits. The main benefits to be gained from the DGB will be to provide improved data quality, lower data management costs, increased access to needed data across the department, lower risks of errors being introduced, and to ensure that clear rules regarding access to data are set, enforced, and adhered to, which will ultimately help improve business decision-making by giving the management better and higher quality data, resulting in enhanced operational efficiency and improved financial performance.

3.4.1.3 Reporting Structure

DGB is sponsored by and presents information and recommendations to the Information Technology Investment Board (ITIC) as needed.

3.4.1.4 Board Members

The DGB is composed of the WisDOT Deputy Secretary, Division Administrators or Deputy Division Administrators, the IT Bureau Director, as well as additional provisional participants. The Division Administrators will be voting members of the Board. Provisional and nonvoting members are welcome to provide input.

Members, Title	**Role**	**Voting**
Deputy Secretary	Board Chair	Voting Member
Division of Budget and Strategic Initiatives (DBSI) Administrator	Board Member	Voting Member
Division of Business Management (DBM) Administrator	Board Member	Voting Member
Division of State Patrol (DSP) Superintendent	Board Member	Voting Member
Division of Transportation System Development (DTSD) Administrator	Board Member	Voting Member
Division of Motor Vehicles (DMV) Administrator	Board Member	Voting Member
Division of Transportation Investment Management (DTIM) Administrator	Board Member	Voting Member
Bureau of Information Technology Services (BITS) Director	Board Member	Voting Member
Strategy, Innovation and Planning Officer	Board Member	Non-Voting Member
Provisional Participants:		Non-Voting Members
TBD		
TBD		
…		

3.4.1.5 Roles and Responsibilities

The individual(s) have accountability for security, privacy, data definitions, data quality, and compliance with data management policies and standards within their functional areas. The DGB reports to the Executive Sponsors (i.e., ITIC) and also works with them to ensure that the

appropriate resources (staff, technical infrastructure) are available to support the data needs. Their role is to represent the interests of the enterprise-wide use of data within their functional areas. Following are the specific responsibilities of the DGG members:

- The DGB is responsible for providing overall direction and governance for the Data Governance Program, including the development of policies and procedures, the allocation of resources, and the implementation of data management processes.
- The DGB is responsible for ensuring that the Data Governance Program is aligned with the organization's business goals and priorities and for making recommendations for improvement as needed.
- The DGB is responsible for ensuring that the organization is in compliance with all relevant data privacy laws and regulations and for responding to data breaches and other data-related incidents.

Other responsibilities include:

- Establish and direct the Data Governance Council (DGC) in decision making and enforcement of agency Data Governance policies practices, and guidelines.
- Request and review and approve data standards, rules, policies, and procedures from the DGC.
- Attend and actively participate in meetings.
- Ensure that WisDOT is progressing towards effective Data Governance practices.
- Work collaboratively to meet the purpose and goals of the Board.
- Actively share information between members related to WisDOT Data Governance Initiatives.
- Identify issues and challenges that hinder effective Data Governance practices.
- Evaluate changes to existing policy and new policy.

3.4.1.6 Decision Process

Decisions will be reached by a consensus of members present, where possible. Consensus is defined as reaching a decision that everyone can live with and will support after full consideration of differing viewpoints. Once decided, Data Governance direction, guidance, standards and policies need to be supported by all members, even if consensus was not achieved. If consensus is not achieved, decisions will be escalated to the ITIC. Participants substituting for members carry full proxy in the decision-making process. In the event a board member is absent from a meeting requiring a vote, an advance vote is acceptable, as well a proxy vote on behalf of the member. Voting may occur live and/or electronically, depending on the circumstances.

3.4.1.7 Meetings

Meetings will occur at least quarterly, or more often as necessary on an ad hoc basis to deliberate on urgent Data Governance issues and address topics such as:

- Make changes to the charter.
- Review Data Governance Strategy.

- Review data quality status.
- Review change management/communication plan.
- Review new agency-wide data related initiatives.
- Review and refine the agenda and content for the next meeting.
- Recap action items.
- Review the status of major ongoing initiatives, and monitor steps and decisions made by the DGB.
- Review new demand against the prioritization criteria, the active portfolio, and the ability to meet demand based on resource allocation capacity.
- Identify resource needs and training investments to support Data Governance.

3.4.1.7.1 Annual Meeting

The purpose of the Annual Meeting is to assess the effectiveness of the DGB and update the charter as required to improve performance for the next year.

- Assess the effectiveness of the governance process by comparing the board's effectiveness against their purpose and the relationship to one another.
- Review the board charter, and answer the following questions:
    - Is the board effectively achieving its purpose and expected outcomes?
    - Are the right stakeholders involved in the process?
    - Is the process effectively capturing new opportunities for the enterprise?

3.4.2 Data Governance Council

3.4.2.1 Purpose & Scope

The purpose of the Data Governance Council (DGC) is to provide operational support for the Data Governance Program within the organization.

The DGC is responsible for implementing the policies, procedures, and processes established by the DGB and for ensuring that data are managed in a consistent and effective manner across the organization.

3.4.2.2 Reporting Structure

The DGC will provide regular reports to the DGB and senior management on the status of the Data Governance Program, including progress towards objectives, compliance with policies and regulations, and recommendations for improvement.

3.4.2.3 Council Members

The DGC is composed of Domaine level Data Stewards, Data Owners, and representatives from business units and IT, who have a direct role in the management and use of data.

The DGC is chaired by the Chief Data Officer or a senior executive designated by the DGB.

3.4.2.4 Roles and Responsibilities

The DGC has the authority to approve policies and procedures related to data management within the scope of the Data Governance Program and to allocate resources as needed to support the Data Governance Program. The Data Governance Council is responsible for providing operational support for the Data Governance Program within the organization and for ensuring that data are managed in a consistent and effective manner that supports the organization's business goals. Following are the specific responsibilities of the Council members:

- The DGC is responsible for implementing the Data Governance Framework, including the development and enforcement of data management policies and procedures, the implementation of data validation and quality control processes, and the oversight of data storage and access.
- The DGC is responsible for ensuring that data are managed in a consistent and effective manner across the organization and for making recommendations to the DGB as needed to improve the Data Governance Program.
- The DGC is responsible for ensuring the organization is in compliance with all relevant data privacy laws and regulations and for responding to data breaches and other data-related incidents.
- Reviewing, approving or denying new requests for datasets.
- Attend and actively participate in meetings.
- Ensure that WisDOT is progressing towards effective Data Governance practices.
- Work collaboratively to meet the purpose and goals of the Council.
- Actively share information between members related to WisDOT Data Governance Initiatives.
- Identify issues and challenges that hinder effective Data Governance practices.
- Evaluate changes to existing policy and new policy.
- Assess performance of both Data Steward and Data Custodian groups.

3.4.2.5 Decision Process

Decisions will be reached majorly by consensus of members present, where possible. Consensus is defined as reaching a decision that everyone can live with and will support after a full consideration of differing viewpoints. Once decided, Data Governance direction, guidance, standards and policies need to be supported by all members, even if consensus was not achieved. If consensus is not achieved, decisions will be escalated to the DGB. Participants substituting for members carry full proxy in the decision-making process. In the event a Council member is absent from a meeting requiring a vote, an advance vote is acceptable, as well a proxy vote on behalf of the member. Voting may occur live and/or electronically, depending on the circumstances.

3.4.2.5.1 Review and Evaluation

The DGC will regularly review and evaluate the Data Governance Program to ensure that it is meeting the organization's goals and to make recommendations for improvement as needed.

3.4.2.6 Meetings

The DGC will meet regularly, at least monthly, to review the status of the Data Governance Program, approve policies and procedures, and provide direction as needed.

The DGC may hold additional meetings as needed to address specific issues or to respond to urgent matters.

3.5 Other Roles and Responsibilities

The documentation of roles and responsibilities designed for a Data Governance Program serves as a crucial instrument in ensuring the successful implementation and management of Data Governance Initiatives within the department. This document performs several essential functions specific to the context of a Data Governance Program in a transportation organization:

- Establishing Data Stewardship.
- Defining Data Governance Structure.
- Ensuring Compliance and Data Protection.
- Facilitating Collaboration and Communication.
- Guiding Future Planning and Expansion.

In summary, the documentation of roles and responsibilities for a Data Governance Program plays a vital role in establishing clear accountability, effective communication, and robust data management practices. It provides a structured framework for data stewardship, defines governance structures, ensures compliance and data protection, facilitates collaboration, and guides future program development. The Data Governance Structure and the roles and responsibilities of both DGC and DGB members have been introduced previously; thus this subsection will provide more details for the rest of the involved parties in the Data Governance Program.

3.5.1 Data Steward

The individual(s) with accountability for defining, implementing, and enforcing data standards, rules, policies, and procedures within their functional area to ensure that the appropriate steps are taken to protect the data and that respective standards, rules, policies, and procedures are being properly implemented.

3.5.1.1 Responsibilities:

- Work to achieve the mission, vision and core data principles adopted by the DGB and DGC.
- Support implementation/adoption of Data Governance.
- Serve as the primary authority (subject matter expert) for data within a particular area/scope – understand meaning, derivation, quality requirements, uses, as well as granting/removing access to their data.
- Identify data needs and establish corresponding data standards, rules, policies, and procedures and report to DGC for review and approval.

- Coordinate development and maintenance of documentation (metadata) about databases, data sets, standard reports, and other data assets, including:
    - Descriptions of sources, derivation, and intended uses.
    - Data glossary entries representing key data entities and attributes.
    - Data element definitions (description, type, other data dictionary items).
    - Data flow and lineage diagrams mapping movement of data from original sources to repositories used for analysis, visualization, query, and reporting.
    - Workflow diagrams indicating steps in the data production process.
- Collaborate with other stewards to fulfill WisDOT data needs.
- Ensure confidentiality of data in accordance with Wisconsin Code and Administrative Rules and serve as an authority to withhold data to avoid release of sensitive or confidential data pending a review.
- Perform data quality control activities in cooperation with Data Custodians in a timely fashion:
    - Define data quality metrics and validation rules.
    - Perform data validation and monitoring.
    - Utilize data standards, rules, policies, and procedures.

3.5.2 Data Custodian

The individual(s) with physical custody of the data. They are responsible for implementing Data Governance and best practices for data elements within their functional areas, specifically for technical environment and database infrastructure, such as applications or purchased/collected data. They collaborate with the Data Stewards to implement data transformations, resolve data issues, and collaborate on system changes and security. They also focus on the underlying infrastructure and activities required to keep the data intact and available to users.

3.5.2.1 Responsibilities:

- Work to achieve the mission, vision and core data principles adopted by the DGB and DGC.
- Perform or assist Data Stewards with data loading and transfers.
- Serve as a technical resource for data integration efforts.
- Perform database administrator functions to ensure the safe custody, transport, integrity, and storage of data, including:
    - Capacity planning
    - Hardware and software installation and configuration
    - Database design
    - Data and software migration
    - Performance monitoring
    - Security assurance
    - Technical troubleshooting
    - Data backup and data recovery.
- Establish technical metadata processes to allow for tracking of data movements and updates.

- Conduct data validation and reconciliation processes as specified by the Data Stewards.
- Manage Data User access and modification requests as authorized by appropriate Data Stewards.
- Administer the Data Catalog.

3.5.3 Data User

The individual(s) who creates and/or has access to agency data as part of assigned duties, roles or functions within the agency.

3.5.3.1 Responsibilities:

- Engage with data, data knowledge, and data standards as they encounter them.
- Use data appropriately and within its defined limitations to perform their job and processes, maintain the integrity of data usage.

3.5.4 Other General Data-Related Responsibilities

While Data Stewards have accountability for data, operational responsibilities for production, documentation, and sharing of data will typically be distributed across multiple additional staff. Key data-related responsibilities are listed below:

- Data Quality Management
    - Produce or support preparation of a data quality management plan.
    - Propose and gain agreement on data quality standards.
    - Create rules for quality checks and/or data validation.
    - Develop and/or manage data processes for defect tracking and reporting.
    - Support development of data cleansing processes; review results of those processes to ensure that they are functioning as intended.
- Data Collection/Entry
    - Ensure that data entered or loaded into agency systems adhere to established rules for timeliness and accuracy.
    - Ensure that data entered into agency systems are consistent with field definitions and other standards assigned to the data items by the responsible Data Steward.
    - Keep the Data Steward informed about data quality issues and potential solutions to these issues.
    - Adhere to security protocols for managing and protecting sensitive or confidential data.
- Data Documentation
    - Create and maintain descriptive documentation for systems, databases, data sets, reports, and other data assets.
    - Create and maintain data dictionary information.
    - Create and maintain data flow and lineage diagrams.
    - Create and maintain workflow diagrams.
- Data Governance Support
    - Support Data Stewards on Data Governance activities.

    - Serve as the technical functional expert responsible for supporting and implementing Data Governance and best practices for a particular set of data assets.
- Data Sharing/Reporting
    - Provide technical expertise and assess the technical impact of proposed data initiatives.
    - Create requirements/specifications for data marts, reports, maps and query tools.
    - Create reports, maps and other data visualizations.
- Data Integration and Application Development (typically an IT function)
    - Create views of the data tailored to specific audiences or needs.
    - Write and test Extract-Transform-Load (ETL) scripts.
    - Create or configure applications for data access.
    - Serve as a technical resource to data consumers or other stakeholders seeking to obtain or integrate data.

3.6 Process Flow Diagram

The process flow diagram designed for a Data Governance Program serves as a visual representation of the sequence and interactions of key processes involved in Data Governance activities. This diagram performs several important functions within the Data Governance Program:

- Visualizing Data Governance Processes.
- Identifying Process Steps and Dependencies.
- Clarifying Roles and Responsibilities.
- Identifying Decision Points and Control Gates.
- Supporting Process Analysis and Improvement.
- Communication and Documentation.

The Process Flow Diagram (PFD) designed for a Data Governance Program plays a crucial role in visualizing, analyzing, and communicating the sequence, dependencies, and responsibilities associated with Data Governance processes. It facilitates understanding, collaboration, and process improvement efforts within the Data Governance Program, contributing to the effective management and control of data assets. Figure 16 shows the Proposed Data Intake Process Flow in a format of a swim lane diagram, consisting of four major steps:

1. Data Intake/Initiative
2. Technical Data Catalog
3. Business Data Catalog and Management Plan
4. Implementation, Production and Lifecycle Management

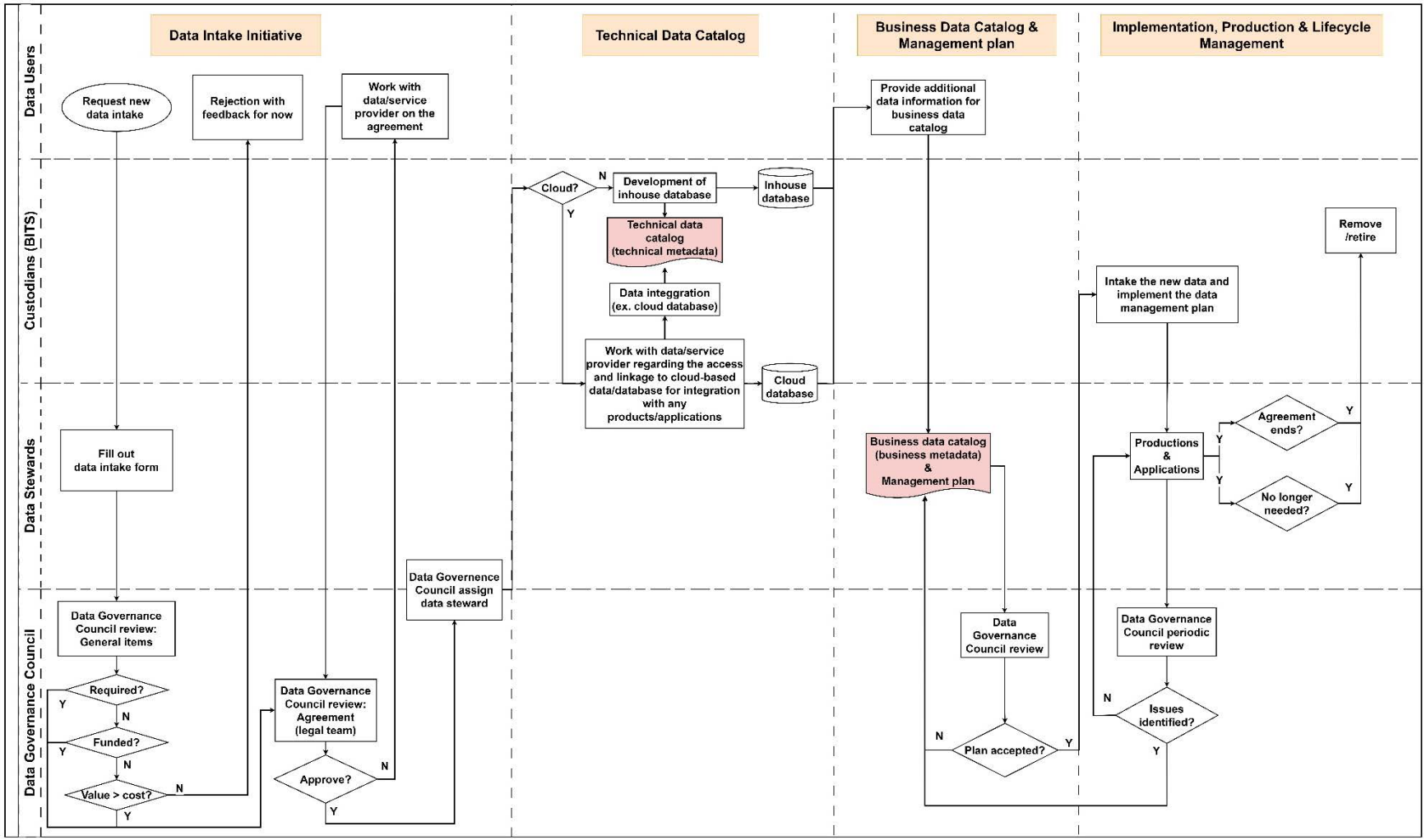


Figure 16. Proposed Data Intake Process Flow Diagram

3.7 Data Intake Form

A data intake form collects necessary information for any new data to guarantee that the right decision will be made by the Data Governance Committees/Councils and related stewardship groups. The form will serve as the first step for taking any data or dataset and will make sure the compliance of the data with the Data Governance Program. This form is designed for data users to submit a request and helps ensure on the following specific perspectives:

- Divisions, bureaus, and units articulate their Data Governance ideas, inquiries, requests, and/or issues in a clear, comprehensive, and concise manner;
- Data Governance Committee has consistent, cohesive, and complete information for intaking, evaluating, and making informed decision about a request; and
- Communication and feedback processes are transparent to everyone involved in the process.

Requests will be triaged by the Data Governance Council for alignment with WisDOT priorities, relevance to the Data Governance charge, impact on the WisDOT as a whole, and the workload capacity for the Data Governance Committees and domain councils. Priority issues will be brought to the relevant committees or councils to incorporate into their work.

The intake form consists of two major sections with the detailed questions listed below:

SECTION I Data Intake/Initiative Decision

1. Proposer's information
    a. Name:
    b. Title:
    c. Division/Bureau, Region/Organization Unit:
    d. Email:
    e. Phone:
2. Name and short description of your data requested for intake:
    a. Name:
    b. Description:
    c. Categorize the data based on the current data domains/business function areas:
3. Business value:
    a. Is this required by federal or other external reporting requirements?
    b. How will the data be used to reduce WisDOT's organizational risk or improve efficiency?
    c. Describe the how this data advances the mission, improves operations, or reduces costs for WisDOT:
    d. Is there a cost to collect, acquire, or use?
4. Data Privacy/Classification: Classify the data based on its sensitivity, such as confidential, private, or public.
    a. What is the classification for your data?
        i. Drop down list of DET based standards:

1. Classified Information
    - Severe or catastrophic adverse impact to WisDOT operations, WisDOT assets, or individuals if data confidentiality, integrity or availability is lost
    - Identified by WisDOT as confidential
    - Subject to regulatory or compliance requirements (e.g., HIPAA, IRS, PCI, PII)
    - Contains personally identifiable information (PII), personal health information (PHI), or state/federal tax information
    - Subject to contractual language requiring a confidential or high classification level (proprietary data) (e.g., CMS/CARES)
2. Restricted Information
    - Serious adverse impact to WisDOT operations, WisDOT assets, or individuals if data confidentiality, integrity or availability is lost
    - Identified by WisDOT as restricted (e.g., WisDOT internal process/procedures documents, security event logs, system configuration information)
3. Sensitive Information
    - Limited adverse impact to WisDOT operations, WisDOT assets, or individuals if data confidentiality, integrity or availability is lost
    - Identified by WisDOT as sensitive (e.g., WisDOT internal policies)
4. Public Information
    - No adverse impact to WisDOT operations, WisDOT assets, or individuals if data confidentiality, integrity or availability is lost
    - Identified by WisDOT as data that can be shared publicly (e.g., WisDOT GIS Open Data)
5. Unsure

b. Is it regulated?

5. Data Source: Name of the source of the data, including the name of the organization, person, or system.
    a. Is there a data sharing agreement required?
    b. Are there terms, conditions and /or acceptable use requirements?

SECTION II Data Governance

6. Data Owner: Name of the Bureau, Section, Unit or individual(s) responsible for the data.
    a. Data Owner
    b. Data Steward

7. Data Format: Specify the format of the data, such as Excel, CSV, or SQL.
8. Data Volume: Estimate the volume of data to be collected, in terms of records or file size.
    a. Will this be agency or division funded?
9. Data Quality: Indicate the quality of the data, including its accuracy, completeness, and consistency.
    a. How is the data collected? Manual entry, application…
    b. Is there a data dictionary describing each of the data elements in the WisDOT data dictionary catalog?
    c. Is there metadata for the dataset?
    d. Is the dataset updated on a regular basis to meet a stated ongoing business need?
    e. Has a data retention schedule been established and validated by business users?
        i. Specify the retention period for the data, in terms of years or until a specific event occurs.
10. Data Use: Specify the intended use of the data, including business intelligence, data analytics, or decision-making.
    a. Will this need to be in the data warehouse?
    b. Will it be used by GIS applications?
    c. Will this be used with Tableau?
11. Data Access:
    a. Do you have an initial data access plan?
        i. Specify the level of access required for the data, including read-only, edit, or full access.
12. Data Sharing: Indicate if the data will be shared with third parties, and if so, specify the conditions for sharing.
13. Approvals: Indicate any other approvals required besides the Data Governance Committee.
14. Signature: Sign the form to indicate agreement with the terms and conditions for collecting and using the data.

3.8 Summary

This section provides a comprehensive list of essential documents pertaining to Data Governance, developed through the project, to serve as a foundational resource for establishing a Data Governance Program within WisDOT.

4 INTERNAL ENGAGEMENT

This section highlights the project's proactive efforts to engage stakeholders at all levels within WisDOT. The primary objectives of this task encompass three key areas: first, to educate stakeholders on the structure and benefits of Data Governance; second, to identify any unmet requirements and potential challenges that may arise during the implementation of Data Governance; and third, to gather valuable input on the specific Data Governance components that hold the greatest potential for success at WisDOT. In response to a specific request, the research team has primarily collaborated with WisDOT iCAV, a group devoted to CAV technology and deployment, research development, policy advice, and state coordination. Given their expertise and concern regarding the significant volume of CAV data, their involvement in conducting a pilot study has been vital and serves as a major driving force behind this project. The importance of establishing a robust Data Governance Framework cannot be overstated, as failure to do so may result in significant challenges when dealing with such extensive and emerging datasets.

Throughout the project duration, the project manager from WisDOT BITS actively engaged with the iCAV group, regularly presenting the research team's work during iCAV working meetings. The project manager represented the research team and shared all the developed Data Governance Materials discussed in Section 3, including the proposed presentation titled "Data Governance Overview" (available in the Appendix as A3 Data Governance Overview Presentation). These materials were presented to the iCAV group members for their review and feedback, which played a crucial role in refining the derived materials. It is worth noting that the majority of the comments received were focused on the Data Governance Structure, guiding the direction of developing a suitable structure that aligns with WisDOT's current organizational framework and data stewardship.

In conclusion, the project's emphasis on engaging stakeholders and collaborating closely with the iCAV group demonstrates the commitment to implementing effective Data Governance Practices at WisDOT. The significance of establishing proper Data Governance cannot be overstated, given the challenges associated with handling substantial and emerging datasets. The feedback received from the iCAV group members has been instrumental in refining the Data Governance Materials, particularly in developing a structure that aligns with WisDOT's organizational context. By addressing these important aspects and incorporating stakeholder input, the project aims to lay the foundation for a robust Data Governance Framework that will enhance data management practices and enable WisDOT to leverage the full potential of its data resources.

5 CONCLUSIONS AND FUTURE WORK

The WisDOT Data Governance research project completed by the Institute for Physical Infrastructure and Transportation (IPIT) at the University of Wisconsin-Milwaukee (UWM) focused on exploring and developing recommendations and documentations for an implementation-ready WisDOT Data Governance Framework that harmonizes data sources, properly controls access, documents ownership, and has a mechanism to capture both technical and descriptive information. The IPIT team members met with WisDOT team members on a biweekly basis throughout the duration of the project. The project team conducted external interviews with other state DOTs regarding their progress in the overarching area of Data Governance and collected their responses. Six state DOTs have been interviewed, with relevant information and documentation collected, which covers most stages of Data Governance Programs among different state DOTs. Analysis and summary have been made to provide insights on the specific aspects of Data Governance, such as the structure and documentation, rules, implementation workloads, and software/tools used. Additional discussions were also provided on the aspects that have not been covered in the interviews, with the major focuses on both the data security and the big emerging data issues.

Built upon the collected information, the research team then developed drafts for five main documents that have been derived, including: 1) a Data Governance Structure Mapping the WisDOT organizational chart; 2) a Data Governance Board/Council Charter for elaborating the roles and responsibilities of both upper-level governance bodies; 3) detailed roles and responsibilities for all levels of the involved units within the Data Governance Structure; 4) a process flow diagram for data intake to comply with the Data Governance Program in the future; and 5) a data intake form capturing essential information for new data, enabling informed decision-making by Data Governance bodies. Internal engagement has also been made with the iCAV group for modifying or improving the derived materials for a near future Data Governance Program within WisDOT.

Future work

To ensure effective Data Governance implementation and foster a culture of data stewardship within the Wisconsin Department of Transportation (WisDOT), the following recommendations are proposed:

1. Formation of a Data Governance Board and Council: WisDOT should establish a dedicated Data Governance Board and Council to oversee and direct the Data Governance Program. This board will play a crucial role in setting strategic objectives, defining policies, and monitoring the overall progress of Data Governance. The board and council should be comprised of key stakeholders from various departments and units within WisDOT to ensure representation and collaboration.
2. Implementation of Developed Documents: WisDOT should implement the developed documents that serve as a foundation for the Data Governance Program. These include:

- Data Governance Structure: A comprehensive mapping of the Data Governance Structure should be developed, aligning with the organizational chart of WisDOT. This will provide clarity on reporting lines, responsibilities, and accountability within the Data Governance Framework.

- Data Governance Board/Council Charter: A charter outlining the roles, responsibilities, and decision-making authority of the upper-level governance bodies should be established. This document will define the governance board's composition, frequency of meetings, and processes for reviewing and approving Data Governance-related matters.

- Detailed Roles and Responsibilities: Clear roles and responsibilities should be defined for all levels of units involved in the Data Governance Structure. These include Data Stewards, Data Custodians, and other relevant personnel. Defining roles will ensure that everyone understands their obligations and actively participates in Data Governance activities.

- Process Flow Diagram for Data Intake: A process flow diagram should be developed, outlining the steps and requirements for data intake that align with the Data Governance Program. This process flow will ensure that new data are captured and handled in a consistent and standardized manner, supporting data quality and governance practices.

- Data Intake Form: WisDOT should design a data intake form that captures essential information for new data. This form will facilitate informed decision-making by the Data Governance bodies and provide a mechanism to evaluate the suitability and alignment of new data with the overall Data Governance Objectives.

3. Promotion of Data Governance through organizational change management: WisDOT should drive the successful implementation of Data Governance by leveraging organizational change management. By considering the cultural and behavioral aspects of Data Governance, WisDOT can create an environment that encourages buy-in from employees at all levels, to support the adoption and integration of Data Governance Practices throughout the organization. Below are several possible key strategies:

    - Engage Stakeholders and Leadership: It is crucial to gain commitment and involvement from key stakeholders and leaders to drive a culture of Data Governance throughout the organization. This can be done through regular communication, workshops, and collaborative forums where stakeholders can provide input, share insights, and align Data Governance efforts with the organization’s strategic goals.

    - Foster a Culture of Data Stewardship: It is important for employees at all levels to understand their role in data stewardship. This can be achieved by fostering a sense of responsibility and accountability for data within the organization, emphasizing the significance of data quality, security, and compliance. Clear guidelines and expectations should be given for data stewardship, ensuring that employees at all levels understand their roles and responsibilities in managing data effectively.

- Provide Comprehensive Training and Support: Training programs should cover the importance (principles, benefit, etc.) of Data Governance, best practices, and guidelines established within the organization. In addition, it is necessary to leverage the experiences and lessons learned from other successful Data Governance Implementations across various agencies, not limited to transportation agencies. Ongoing support should also be provided through coaching, mentoring, and forums for knowledge sharing to address challenges and promote continuous learning.

4. Adoption of Technology for Data Catalog (an ongoing effort by WisDOT's Bureau of Information Technology Services (BITS)): WisDOT should plan to adopt advanced technology (e.g., Informatica), to automate the Data Catalog. This will enable the management of both technical and business metadata, providing a centralized and comprehensive view of data assets. An automated Data Catalog will streamline data discovery, enhance Data Governance Practices, and support efficient data utilization across WisDOT.

5. Resources Needed:

    - FTE - WisDOT Chief Data Officer (CDO): Oversees the Data Governance Framework at an enterprise level. Works with the Strategy Consultant/Consulting Company to implement Data Governance across all divisions and enforce strategies and policies aligned with critical success factors.

    - FTE - WisDOT Data Catalog Administrator: Coordinates the implementation and administration of the Enterprise Data Catalog tool. Manages data organization, metadata, and user access for streamlined data discovery, enhanced Data Governance, and efficient data utilization.

    - Consultant or contractors: Implement Data Governance, ensuring the establishment of effective rules and practices for data management. Implement the Data Catalog, enabling efficient organization and accessibility of data assets.

By implementing these future work recommendations, WisDOT will be well-equipped to establish a robust Data Governance Program. This program will enable WisDOT to effectively manage data assets, ensure data security and privacy, improve decision-making processes, and foster a data-driven culture within the organization.

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APPENDIX

A1 Survey Results

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
Alabama	Currently we do not have a data governance program or process. We've had some discussions on this topic, see the need, and will be starting this initiative soon.	N/A	N/A	N/A	N/A
Alaska	Yes	No FTEs. We have staff that do this as an added task to their positions.	We have Governance Work Group made up of representatives from each Division. They are a mix of engineers, planners, and IT.	No.	N/A
Arizona	Yes, but we are just developing the program.	Yes, we have a contractor setting up the foundation.		No	N/A
Arkansas	At this time, ARDOT does not have a formalized data governance policy or framework in place. A Data Governance committee has been established to discuss next steps.	N/A	N/A	N/A	N/A
California	Yes. All data governance program materials are internal-facing only.	Yes	Caltrans created a Geospatial Data Officer in late 2017 with responsibilities that included creation and implementation of an enterprise data governance program. A year later a second position was created that reports to the Geospatial	No. We do not have an official enterprise data catalog solution but have considered use of Oracle APEX, Oracle Cloud Infrastructure Data Catalog, Esri Hub and Esri Portal as an interim solution while we pursue an IT project to procure an enterprise data governance technology suite (metadata, data dictionary, data lineage, data quality, data catalog,	N/A

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
			Data Officer that is solely focused on enterprise data governance implementation. We also have defined roles and responsibilities for an Enterprise Data Steward, Business Data Steward, Data Custodian, and District Enterprise Data Governance Liaison. We have named all the Enterprise Data Stewards and District Enterprise Data Governance Liaisons.	business data glossary, and ETL). We have conducted a RFI in 2021 that included a data catalog in its scope for which we received about 12 responses. We conducted demonstrations with about 5 vendors. In addition, our State Chief Data Officer is currently conducting demonstrations of around 8 data catalog solutions. These demonstrations are recorded and may be able to be shared.	
District of Columbia	Yes, DDOT has a Data Governance Committee	There are staff members allocated to the committee, however they are not 100% committed to the committee.	The Data Governance Council is responsible for developing policies and procedures used by the agency for managing data programs used to support the Strategic Plan.	Yes, DDOT has an open data portal located here: https://opendata.dc.gov/pages/edi-overview	Currently using ESRI tools for data cataloging.
Florida	In March 2015, the Florida Department of Transportation (FDOT) launched an initiative to define a clear path for the agency-wide adoption of data governance and master data management. The long-term goal of the initiative, known as Reliable, Organized and Accurate Data Sharing (ROADS), is to improve data reliability and simplify data sharing across FDOT to have readily available and accurate data to make informed	FDOT views all staff as having a role in data governance. However, there are two roles that directly support these activities daily.	**Civil Integrated Management Officer:** this position, in essence, is the Department's Chief Data Officer, but with a focus on operational data. This position also collaborates with external stakeholders, providing and helping them use data that FDOT captures, while also obtaining and leveraging partners' data for FDOT's benefit. **Data Governance Administrator:** this position serves as a key contact for data governance, data quality and various protection issues while working closely with	Yes	Informatica EDC (FDOT) Data.world EDC (State of Florida)

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
	decisions. To learn more, please visit https://arcg.is/1jGWG5.		business and functional area leadership to improve the quality and value of core data assets. This position also works to support adherence to regulatory requirements as well as the agency's technology strategic goals. **Other Participants:** an integral part of FDOT's data governance process includes the assignment of a Data Governance Steering Committee, Enterprise Data Stewards, Data Stewards and Data Custodians to implement and support the Data Governance framework throughout FDOT. These individuals who participate on behalf of a business area, are responsible for developing rules and processes to ensure that data within FDOT is accurate, reliable, and organized for easy access across the enterprise.		
Illinois	No, but we do have some internal processes in line with DoITs data governance	No but we are in the process of establishing a couple of key positions	N/A	No	N/A
Indiana	Yes	Yes	Director of Data Governance, and two additional team members will be added to this department in the near future	Indiana intends to implement Informatica. That project has not yet begun.	Informatica
Iowa	Yes	Yes, one position, currently vacant	Data Quality Analyst	No. Just using Excel for now	N/A

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
Kansas	KDOT does not currently have a formal data governance program. We have engaged with a consultant to help define our digital strategy, which includes data governance.	No	N/A	KDOT does not have any data cataloging software. We have a proprietary tool that creates a data dictionary for certain data sources.	N/A
Kentucky	No	Minimally	Siloed to different areas	Yes	SAP Information Steward
Louisiana	Yes, though the agency-wide data governance program is not fully implemented. Essentially, we have assigned the top-level personnel for a Data Governance Committee, but have yet to define and implement agency-wide data governance processes or defined lower-level personnel within the data governance organization.	No	N/A	Not that I am aware of, at least not at the enterprise level	N/A
Massachusetts	Yes, although it is fairly new. It is a joint initiative through our Information Technology department and our Officer of Performance Management and Innovation (OPMI).	It is not 100% of her job, but part of it. Rachel Bain is MassDOT's Chief Data Officer and head of OPMI. Her email is rbain@dot.state.ma.us.	Chief Data Officer (with support from the Chief Information Officer who is the head of Information Technology)	We do not have software, but we do maintain a Data Catalog. Right now, it is only available to people with GeoDOT logins (accounts for access to our spatial data resources). Link to a screenshot.	N/A
Michigan	Yes	Yes	A Chief Information Steward as well as an Information Stewards Board, made up of	Yes	IBM InfoSphere Information Governance Catalog

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
			15 Information Stewards with representation across our department.		
Minnesota	Yes. From 2009 to 2011, senior managers and representatives from districts and specialty offices throughout the Minnesota Department of Transportation (MnDOT) worked with Cambridge Systematics to develop a data business plan. The 2011 Data Business Plan established MnDOT's vision and mission for guiding data and information programs, defined data governance as "the exercise of authority and control…over the management of data assets," and repurposed data management principles established in the 2006 Minnesota Enterprise Technical Architecture to guide MnDOT data decisions (pp. 7-8, 43, 83). MnDOT adopted an organizational schema for data based on domains and subject areas, then identified subject matter experts to serve as data stewards. The agency	Yes. An Information Governance (IG) unit in our Office of Chief Counsel coordinates information lifecycle management across the agency and helps employees properly handle information assets, from business records to raw data elements in MnDOT applications. IG coordinates with Technology Investment Management (TIM) in the Office of Financial Management and Minnesota Information Technology (MNIT) to coordinate information and technology governance agency wide. Groups like Project Data Management within Engineering Services, Business Integration within the Office of Administration, and the Data & Innovation Unit within Transit and Active Transportation govern	1) Information Governance Supervisor 2) Information Governance and BDC Coordinator 3) BDC Assistant 4) Records Manager 5) Records Center Coordinator	Yes. The BDC stores and publishes descriptive information about MnDOT data assets. BDC metadata assets include business terms, records, and applications.	The BDC is a custom Java application in the process of being recoded to .NET or replaced.

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
	also developed a repository for information about MnDOT data called the Business Data Catalog (BDC).	information and technology within their individual offices.			
Missouri	We do not have a data governance program.	N/A	N/A	We do not have data cataloging software. However, we are in the process of rolling out data labeling in Azure O365 using AIP, Azure Information Protection. We also leverage DLP, Data Loss Prevention, in Exchange Online.	N/A
New Hampshire	Data governance is still rudimentary primarily consisting of a data dictionary and work to centralize and identify the true source of data.	No	N/A	No, stored in Oracle tables	N/A
New Jersey	Yes	No	N/A	No	N/A
Oregon	ODOT has a robust Tech & Data Governance process that was validated recently by Gartner. While our highest level governance body has both tech and data in its scope, we also have a second data governance-focused body (the Data Steering Team) chaired by the Chief Data Steward (on behalf of the Chief Data Officer led Data Solutions Office). The DSO in consultation with the Data Steering Team is establishing the first	Strictly dedicated to data governance NO. However, we have had someone in place developing the framework and roles and processes for data governance as part of their agency-level strategic data focus for many years. That role is now being given an even stronger data governance focus as the need and scope expands.	The original position title was Strategic Data Program Manager. As the focus on data governance grows, the position and title are evolving to Chief Data Steward. Responsibilities for this role will encompass those typically associated with a Data Governance Manager, among other things.	NOT YET. However, we are in the process of developing an interim in-house building data inventory application. Use of this application will help refine requirements for data catalog software as well as provide us with a mechanism for identifying people in governance roles, developing a data taxonomy and other things, while we begin the long procurement process for putting a data catalog in place.	N/A

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
	agency data standards, oversees data policy/guidance/and procedure development, develops the agency data strategy (in consultation with both bodies), is developing training for those in data stewardship roles throughout the organization, etc.				
Rhode Island	We do not have a data governance program. Recent reviews have recommended formal data governance. RIDOT is assessing an approach and looks forward to the results of this survey.	N/A	N/A	No. Currently using Excel	N/A
South Carolina	Yes, the Data Governance Office is currently organized under the IT Project Management Office, but it is an enterprise-wide program, incorporating both business and IT.	Yes, one person.	Data Governance Officer	No. We're in the middle of an initial data inventory effort right now. We're using Microsoft Teams (SharePoint Lists) for data collection, which we export to Excel for a master list.	N/A
South Dakota	SDDOT maintains a Data Retention manual	No dedicated staff	N/A	Yes	File Director
Tennessee	TDOT worked with a consultant to define a data governance policy/process a few years ago. A new director position was created a few months	The new director is currently interviewing to fill roles in the new group.	Statewide Director of Performance Management	No	N/A

State	1. Does your state DOT have a data governance program or processes?	1a. If yes, do you have any staff dedicated to data governance?	1b. If yes, what are their roles?	2. Does your state have data cataloging software?	2c. If yes, what data cataloging software are you using?
	ago that includes responsibility for data governance. So the plan, or some revision of it, should begin to be implemented this year.				
Texas	TxDOT has recently formed a Data governance Workgroup with representation from our IT Data Management team and data subject matter experts from various divisions and districts at TxDOT. This group is tasked with building our data governance policies and processes, as well as increasing data literacy and access for the agency.	Within the IT Division we have a team of individuals dedicated to the technical aspects of Data Management and Business Intelligence. Additionally, various business divisions also have data analysts who participate in the Data Governance Workgroup.	Some of the relevant roles/titles include Data Management Lead (Designated Data Management officer), Data Architect, and Technical Data Analyst	Not at this time, although our roadmap does include a data cataloguing tool as part of data management architecture	N/A
Vermont	We do not at this time but have some group working together to plan out how it can be established	Nobody is fully dedicated to the project as we are still in the beginning stages of the program	N/A	We do not have data cataloging software. We are investigating how to catalog our datasets. Software seems to be available for our warehouse datasets. We are learning about that now.	N/A

A2 Contact information for Persons that Participated the Survey

Contact Information		
Alaska Jill Melcher Transportation Data Programs Manager 907-465-8592 jill.melcher@alaska.gov	**Kansas** Lori Jones Data Warehouse Supervisor 785-296-4899 lori.jones@ks.gov	**Oregon** Denise Whitney-Dahlke Chief Data Steward 971-719-6274 Denise.d.whitney-dahlke@odot.oregon.gov
Arizona Annabelle Molina Sr. Technology Business Manager Amolina3@azdot.gov	**Kentucky** Jarrod Stanley Research Coordinator jarrod.stanley@ky.gov	**Rhode Island** Steven Kut Data Analyst 401-563-4485 Stephen.kut@dot.ri.gov
Arkansas Charles Brown Chief Information Officer 501-569-2697 charles.brown@ardot.gov	**Louisiana** Brad D. Doucet Director – LA DOTD Enterprise Support Services 225-379-1624 brad.doucet2@la.gov	**South Carolina** Alex Perez-Caballero Data Governance Officer 803-737-1267 caballeroai@scdot.org
Florida John Krause Civil Integrated Management Officer 850-414-4210 john.krause@dot.state.fl.us	**Massachusetts** Liz Williams Director of Data and Policy, Office of Transportation Planning 857-368-8855 liz.williams@dot.state.ma.us	**Tennessee** Joe Kirk Chief Information Officer 615-741-0601 Joe.kirk@tn.gov
Illinois Cheryl Kulavic-Knope Chief of Information Processing, CIO 217-606-1139 cheryl.kulavic-knope@illinois.gov	**Michigan** Janet Harrell Chief Information Steward 517-243-3261 Harrellj1@michigan.gov	**Texas** Suresh Sundararajan Designated Data Management Officer 512-497-4003 Suresh.sundararajan@txdot.gov
Indiana Mark Joseph Director of Data Governance 317-450-6839 mjoseph@indot.in.gov	**Minnesota** Ben Timerson Current Chair, MnDOT Data Domain Stewards 651-366-3855 Benjamin.timerson@state.mn.us	**Vermont** Manny Sainz Chief of Performance (Data Governance Committee Chair) 802-595-9570 Manuel.sainz@vermont.gov
Iowa Peggi Knight Director, Research & Analytics Bureau 515-239-1530 peggi.knight@iowadot.us	**New Jersey** Steven Prichard Manager of Bureau of Information Security and Services 609-963-2491 Steven.prichard@dot.nj.gov	

A3 Data Governance Overview Presentation

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WISCONSIN DEPARTMENT OF TRANSPORTATION

DATA GOVERNANCE OVERVIEW

Prepared for Wisconsin Department of Transportation
Enterprise Data Services Section

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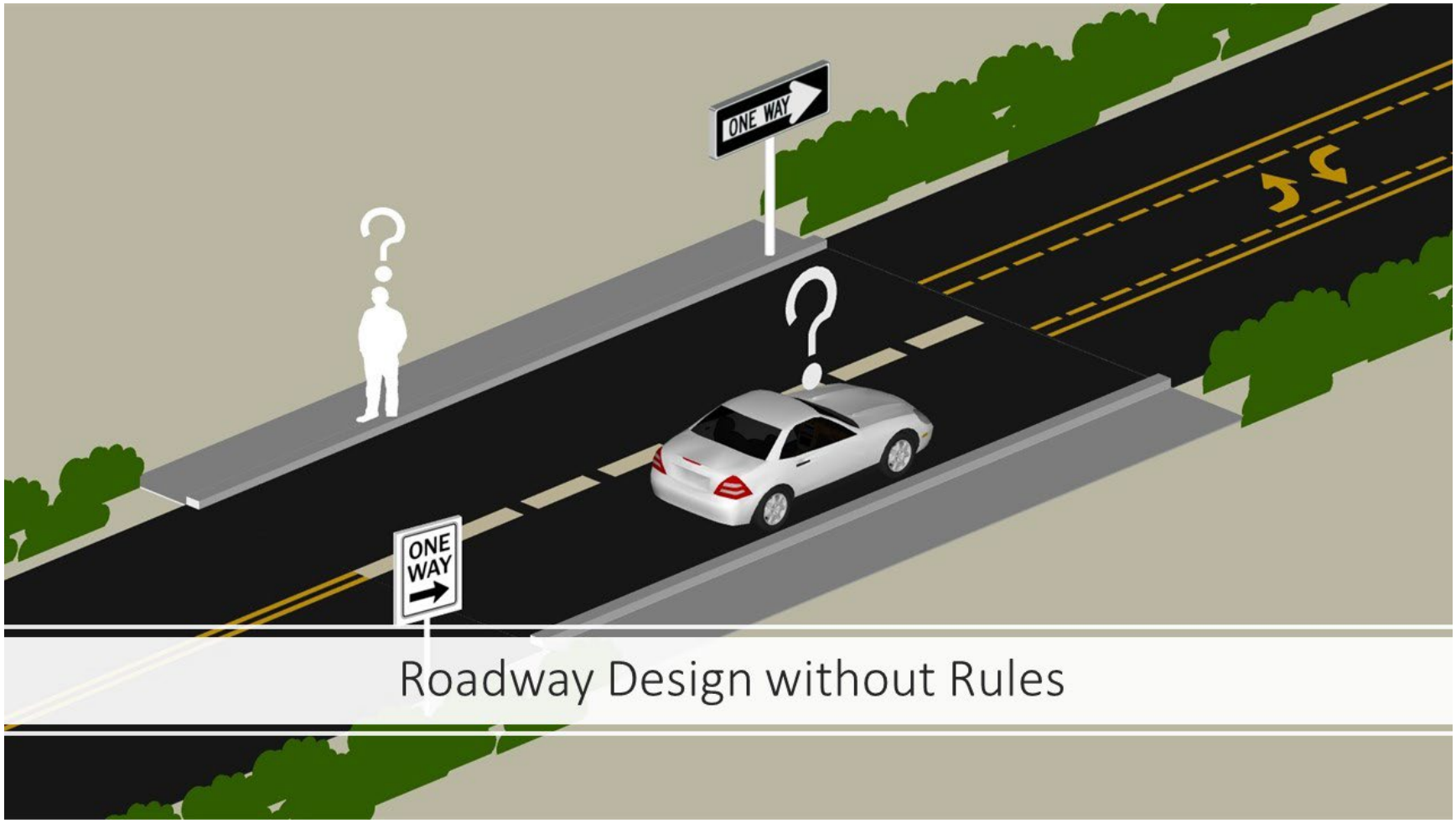
Outline

- What is Data Governance
- Why is Data Governance important and what value does it bring to an organization
- How is Data Governance implemented
- What could put a Data Governance Program at risk


ONE WAY
ONE WAY
Roadway Design without Rules

What Is Data Governance?

Definition

- Data governance (DG) is an overarching structure of agreed upon policy combined with training and auditing to ensure the proper management of information assets.
- DG is policies and procedures that maximize the availability, integration, usability, quality and security of data.
- DG is not the management of data assets, but rather ensuring data is managed.

Data governance outlines the roles, processes, and policies that control data

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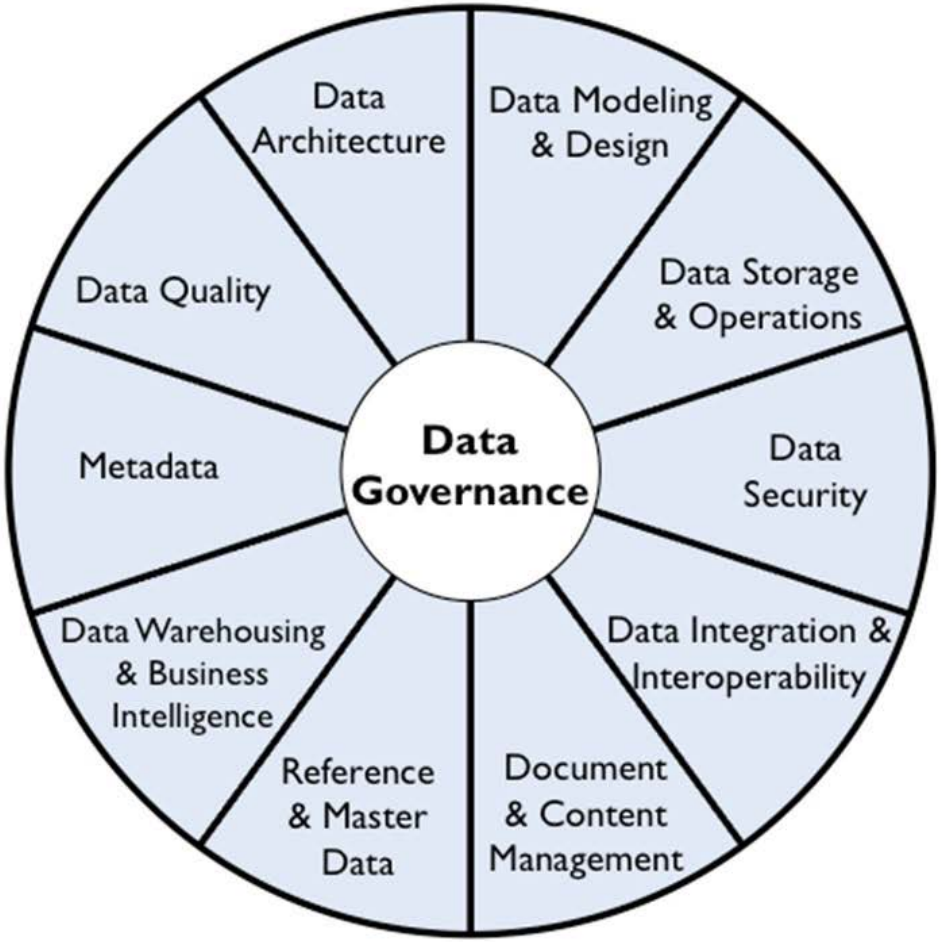
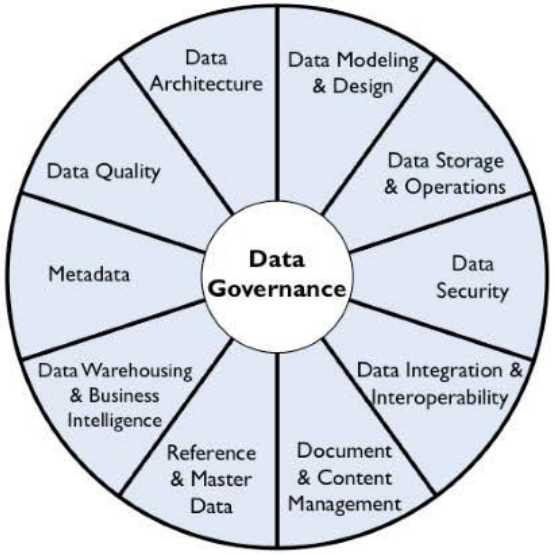


What Is Data Governance?



Policies and Procedures, People to do the work, Technology to help

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- **Data architecture**: The overall structure of data and data-related resources as an integral part of the enterprise architecture
- **Data modeling and design**: Analysis, design, building, testing, and maintenance
- **Data storage and operations**: Structured physical data assets storage deployment and management
- **Data security**: Ensuring privacy, confidentiality, and appropriate access
- **Data integration and interoperability**: Acquisition, extraction, transformation, movement, delivery, replication, federation, virtualization, and operational support
- **Documents and content**: Storing, protecting, indexing, and enabling access to data found in unstructured sources and making this data available for integration and interoperability with structured data
- **Reference and master data**: Managing shared data to reduce redundancy and ensure better data quality through standardized definition and use of data values
- **Data warehousing and business intelligence**: Managing analytical data processing and enabling access to decision support data for reporting and analysis
- **Metadata**: Collecting, categorizing, maintaining, integrating, controlling, managing, and delivering metadata
- **Data quality**: Defining, monitoring, maintaining data integrity, and improving data quality

What Is Data Governance?

People

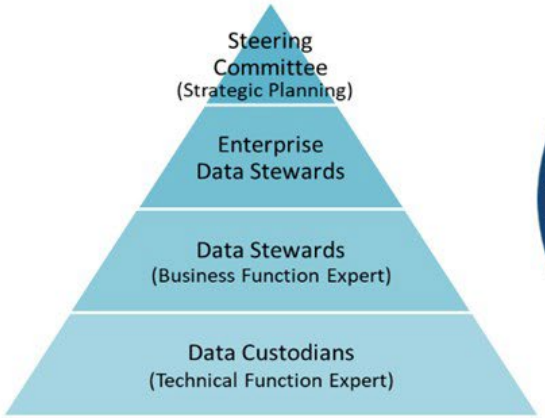
- Managing a formal Data Governance Structure to make key decisions related to Data / Information.

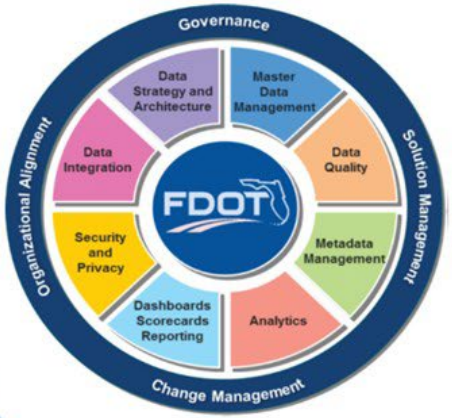
Process

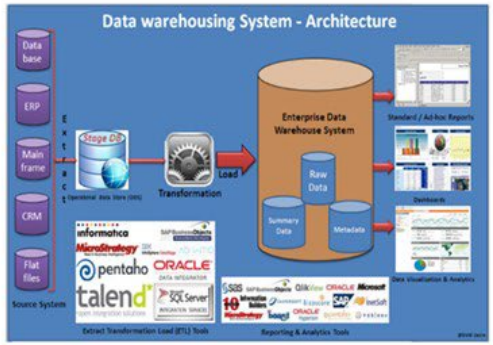
- Training FDOT on the Data Governance Component Model and Implementing Standard Processes & Routines to provide a formal approach to Data Governance.

Technology

- Providing common standardized BI / DW Tools, Technologies and Frameworks that will be used across FDOT to make data/information more accessible.







FDOT's Reliable, Organized, Accurate Data Sharing (ROADS) Project

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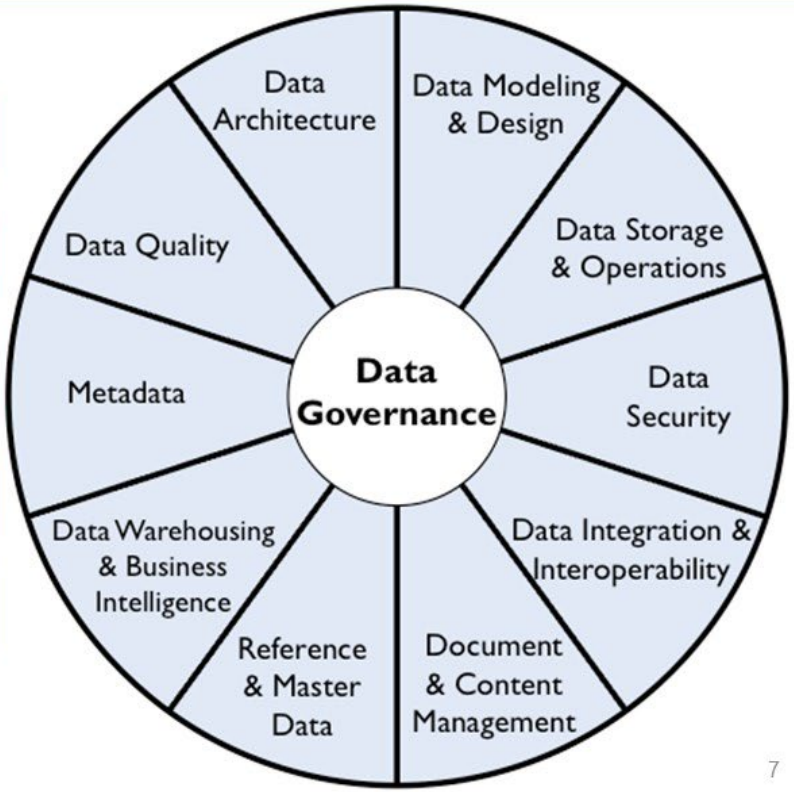
What Is Data Governance? - People

- Executive Sponsor
- Data Governance Admin
- Data Governance Board Council
- Data Stewards
- Consumers



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What Is Data Governance? – People (Cont.)

Ex. Ohio DOT: High Level Responsibility by Governance Area

Level	Role	Governance Area						
		Program Objectives	Strategic Planning	Policy	Performance Metrics	Standards & Procedures	Organizational Change Management (OCM)	Roles & Responsibilities
Strategic	Executive Leadership	Mission Vision	Critical Success Factors (CSF) Leadership	Approve Endorse	Endorse Embrace Input	Support Empower	Sponsor Support	Empower Leadership
Tactical	Chief Data Officer Data Governance (DG) Committee Technology Council Funding Council Initiative	Plan Develop Implement Monitor	Plan Develop Implement Monitor	Plan Develop Implement Monitor	Plan Develop Implement Monitor	Plan Develop Implement Monitor	Align across DOT Continuous Improvement	Define Support Monitor
Implement	Data Business Owners (DBO), Subject Matter Expert (SME) DOT Staff Imformation Techonology / Project Management Office (PMO)	Business Functions Manage Programs Subject Matter Expert	Execute Plan Provide Feedback Adhere to Strategy	Enforce Adhere Communicate	Collect Monitor Report	Enforce	Communicate Direction Orientation Onboarding Training	Data Business Ownership Adhere to Policy Education
Support	Chief Data Officer Tech Staff	Accountability Meta Data	Execute Plan Provide Feedback	Research/Input Implement Enforce	Collect Monitor Report	Formalize Enforce	Plan Develop Deliver	Program Management Partnerships Consult/support Provide IT Resources

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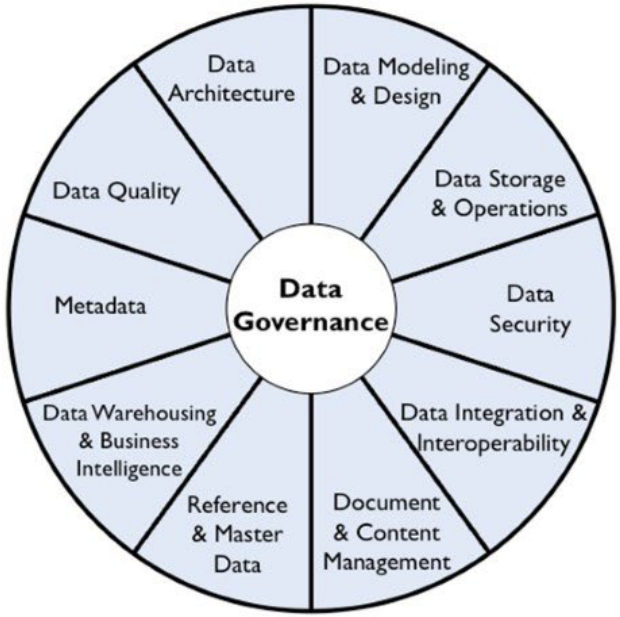
What Is Data Governance? - Policies and Procedures



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Policies and Procedures

Existing Policies and Procedures at DOT

These are not specifically around Data Governance

Division of Enterprise Technology (DET)

for example: Classifications

WisDOT

Good example: Geospatial Metadata standard

Geospatial business data follows the standard

Integrate, Update, Borrow or Create

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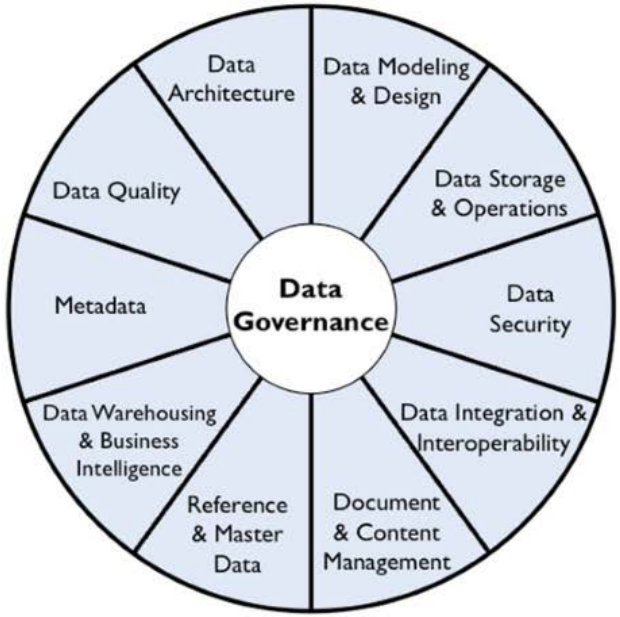
What Is Data Governance? -Technology



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DATA GOVERNANCE TOOLS	FEATURES & FUNCTIONS	PLATFORM
OvalEdge	Data Governance, Data Catalog, Automated Data Lineage, Data Discovery, Self-Service Analytics	Windows, Unix, Cloud, On-Premise, Web, and SaaS.
Integrate.io	Data Integration, ETL, ELT, etc.	Windows & Mac.
Alation	Data Catalog, Data Governance, Data Lineage, Search & Discovery, Self-Service Analytics, Cloud Data Migration & Management, Business & Data Glossary, Data Quality Management.	Cloud, On-Premise, Web, and SaaS.
Dataddo	One management center to monitor all the incoming data, fast deployment, fully scalable, etc.	Web-based
Atlan	Data Governance, Automated Lineage, Auto-Classification of PII, Column Level Access Control, Cloud Integrations.	Web, Cloud, and SaaS.
Collibra	Collaboration Features, Data Help Desk, Automation of Data Governance & Management.	Windows, Mac, iOS, Cloud, Web, and SaaS.
IBM	Data Governance, Data Cataloging, Obtaining Information for Big Data Projects.	Windows, Cloud, Web, and SaaS.
Talend	Data Governance, Cloud Integration, Data Integration, API, & Application Integration.	Windows, Mac, Cloud, Web, and SaaS.
Informatica	Manage GDPR Data Risks, Detect & Protect Sensitive Customer Data, Verify Contact Data.	--
Alteryx	Discover, Prepare, & Analyze the Data. Deploy & Share Analytics. Collaboration Features.	Windows, Mac, Cloud, Web, and SaaS.

Other: Microsoft Azure Purview, Collibra Governance, SAS Data Management, erwin Data Intelligence (DI) for Data Governance, Informatica Axon, SAP Data Hub, Alation, Varonis Data Governance Suite, IBM Data Governance ……

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Why Is DG Important?

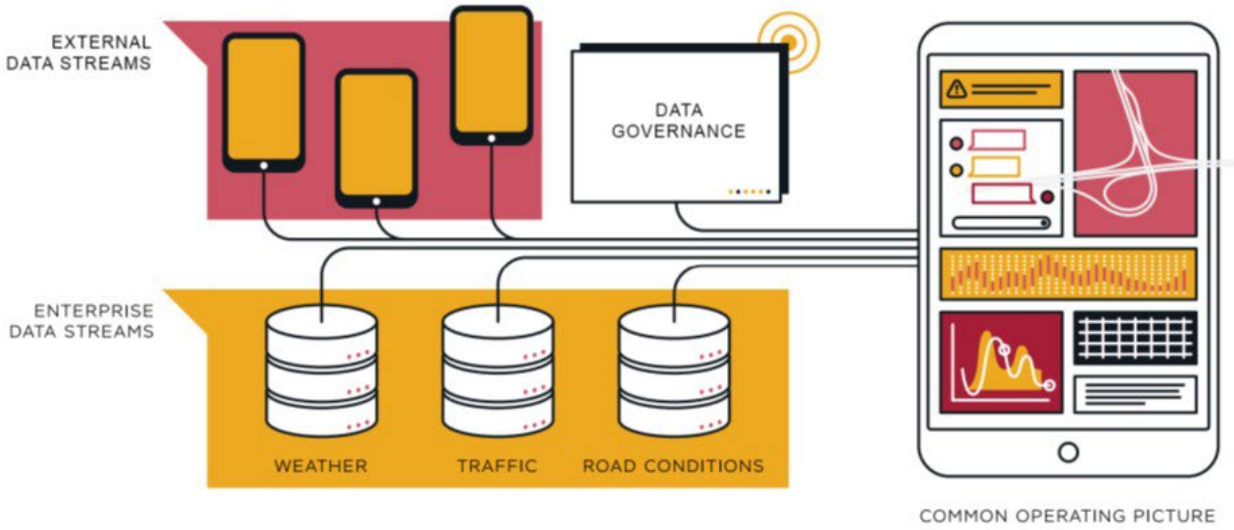
Because a good DG can and will:

1. Manage entire data lifecycle to ensure/improve data quality and consistency

2. Make requirements known to simplify regulatory compliance
3. Build standard processes to increase internal data sharing/reuse
4. Ensure transparency of processes to enhance trust/confidence in data
5. Train management and staff to adopt common approaches to data issues
6. Facilitate data-related collaboration to enable better enterprise-wide decision-making

Why WisDOT Needs Data Governance?

- WisDOT is a data-driven organization



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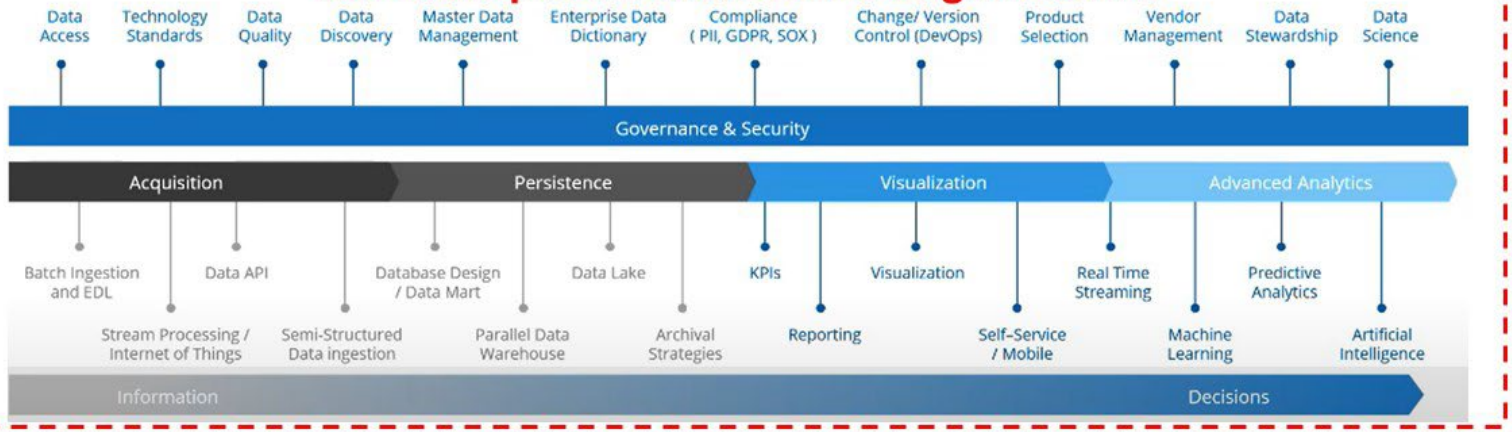
Become Data Driven

1. Data Resistant	2. Data Aware	3. Data Guided	4. Data Savvy	5. Data Driven
•Data does not play a role in business operations •Data is used only on an "as needed" basis	•Organization is data-curious •Data is used to support business areas	•Organization begins to use data in some processes •Often the data quality and trustworthiness limits the value of business solutions	•Organization begins is using data in most processes •Corporate buy-in on data governance, ensuring data quality •Business strategy does not yet rely on data assets	•Organization becomes data first •Data drives strategy •The business considers the data estate a critical assets

An Example of Data Driven Organization



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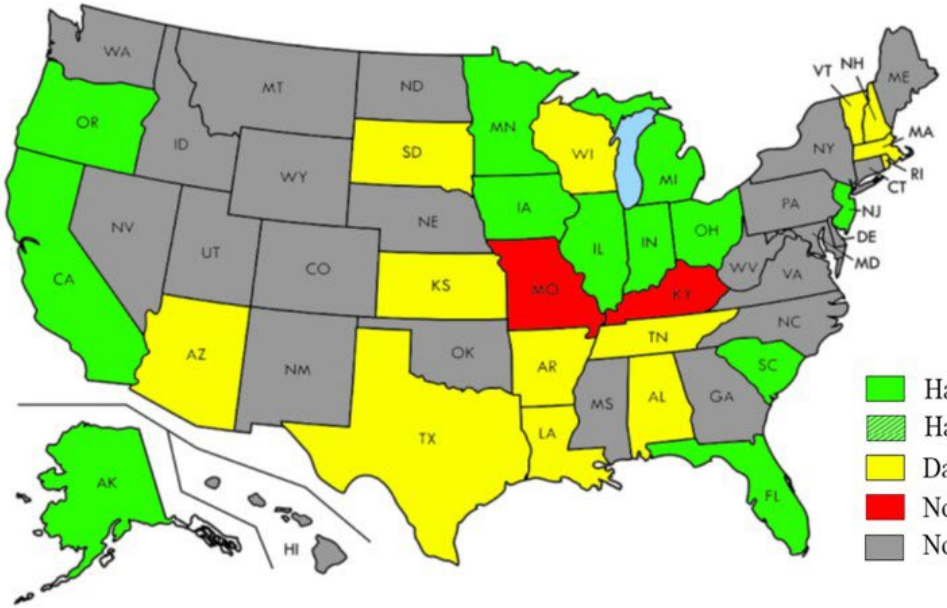
Why WisDOT Needs Data Governance?



Current State of Data Governance among DOTs

- Has Data Governance in Place
- Has Internal Processes in Line with DoIT's Data Governance
- Data Governance In Progress
- No Data Governance in Place or No Plan
- Not Responded

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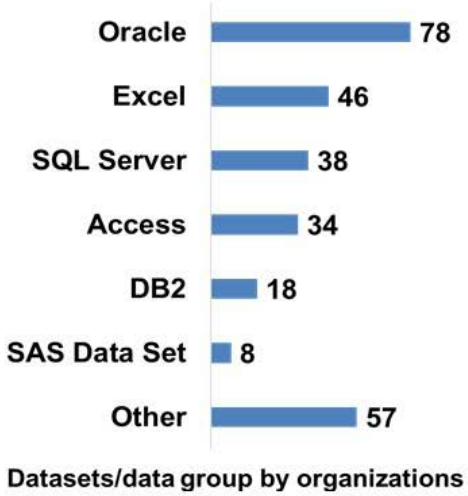
Why WisDOT Needs Data Governance?

- To avoid data silos in different departments and business units (lack of consistent data storage)



Location of Data	No.
WisDOT server/Division of Enterprise Technology (DET) server	**117**
Network drive	**49**
Cloud service	**48**
Business partner's server	**32**
Desktop/laptop	**14**
Other	**39**
DSP server	13
BOX	10
DSP application	2
External hosted	2
Jackalope hosted by vendor High Desert Traffic	1
Internal Network Storage	1
Private Server, backed up by WisDOT	1
DET mainframe	1
SharePoint	1
with shop tech	1
Box, PeopleSoft, some in FIIPS, some in PMP	1
Local install to laptop	1
field counting devices	1
*Not provide specific location information	3
Unsure	**7**

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Why WisDOT Needs Data Governance?

- To help ensure compliance with data privacy laws and other regulations (lack of the way data is classified)

Summary of Data Classifications by Organization

Organization	Public Information	Sensitive Information	Restricted Information	Classified Information	Unsure	Total
Division 1	2	0	0	0	0	2
Division 2	5	4	2	7	0	18
Division 3	1	2	2	6	4	15
Division 4	2	8	4	10	0	24
Division 5	13	22	10	0	2	47
Division 6	61	34	8	9	9	121
Business Partner 1	0	2	0	0	0	2
Business Partner 2	0	0	1	0	0	1
Total	84	72	27	32	15	230

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Why WisDOT Needs Data Governance?

- To agree on common data definitions for a shared understanding of data (lack of standardization in metadata)

AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI
MOSTHARM2	SEQEVT1A	SEQEVT1B	SEQEVT1C	SEQEVT1D	SEQEVT2A	SEQEVT2B	SEQEVT2C	SEQEVT2D	ATNMBR
	BRIDGE								UNK
	BRIDGE								NONE
	BRRAIL								RAILROAD
	MVIT	CURB							0
	JKNIF								1
	BRIDGE								NONE
	CONC B								LEO FRIGO
	OTH NC								B05134
MVIT	BRRAIL	MVIT			MVIT				B5158
	MVIT	ROR R	OT PST						U1P3
MVIT	MVIT				MVIT				100
MVIT	MVIT	MVIT			MVIT	MVIT			I90
	BRIDGE								400
	BRIDGE								181344L
	MVIT	BRIDGE							UNKNOWN
	STRUCK								OAKWOOD RD
MVIT	MVIT				MVIT				ABR7
	MVIT								116TH
MVIT	MVIT				MVIT				BB

Crash Data

BK	BL	BM
STRUCTURE_NUMB	RECORD_TYPE_005A	ROUTE_PREFIX_005I
P13076800000000	'City or Municipal Highway Agency'	'025 - Dane County'
P13076800000000	'City or Municipal Highway Agency'	'025 - Dane County'
P13076800000000	'City or Municipal Highway Agency'	'025 - Dane County'
B13032500000000	'State Highway Agency'	'025 - Dane County'
B13027600000000	'State Highway Agency'	'025 - Dane County'
B13027000000000	'State Highway Agency'	'025 - Dane County'
B05015800160000	'State Highway Agency'	'009 - Brown County
B05013400130000	'State Highway Agency'	'009 - Brown County
B05015800130000	'State Highway Agency'	'009 - Brown County
B05013400020000	'State Highway Agency'	'009 - Brown County
B32020200030000	'State Highway Agency'	'063 - La Crosse Cou
B32021800000000	'State Highway Agency'	'063 - La Crosse Cou
B32008500000000	'City or Municipal Highway Agency'	'063 - La Crosse Cou
B05007200000000	'State Highway Agency'	'009 - Brown County
B05007200000000	'State Highway Agency'	'009 - Brown County
B40080400000000	'State Highway Agency'	'079 - Milwaukee Co
B40073200000000	'State Highway Agency'	'079 - Milwaukee Co
B40086900000000	'State Highway Agency'	'079 - Milwaukee Co
B40081000000000	'State Highway Agency'	'079 - Milwaukee Co

Highway Structure Information Data

Why WisDOT Needs Data Governance?

- To facilitate collaboration

Why WisDOT Needs Data Governance?

- To enable quick recognition of positive impacts

  ✓ For example, the Ohio DOT was able to migrate a great deal of Excel data into an approachable, capability-driven format stored on a SQL server. Staff members began to immediately notice the deficiencies of their data quality, which spurred an overall increase in the data quality.

How To Implement DG - Not a One Size Fits All

Procedures:

1. Establish Purpose, Goal, and Stakeholders
2. Define Success (Metrics, etc.)
3. Assessment
4. Establish Data Governance Board (Assign Ownership)
5. Develop Processes (Access Lifecycle, Change Management, Protection, Tooling)
6. Develop Documentation (Lineage, Catalog, Dictionary, Auditing)
7. Data Quality (Consensus, Control, and Monitoring)
8. Training and Advocacy
9. Iterate Cycle

Ideal State:

1. Regular Data Governance Board Cadence
2. Well Defined and Accepted Data Ownership
3. Process / Documentation / Data Quality is Mostly Operationalized
4. Organizational Data Transparency (Data Ethics)
5. Regular Training and Communication Around (Data Culture / Literacy)

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Data Governance Program Risks

No Buy In	Poorly Defined Roles / Poor Resource Planning	Inability To Measure Success
No Data Culture Training and Communication	Not Finding Right Implementation Balance (One Size Does Not Fit All)	Not Respecting Department Workflow Velocity (Silos)

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Steps for WisDOT Data Governance

Identify best practices at other DOTs

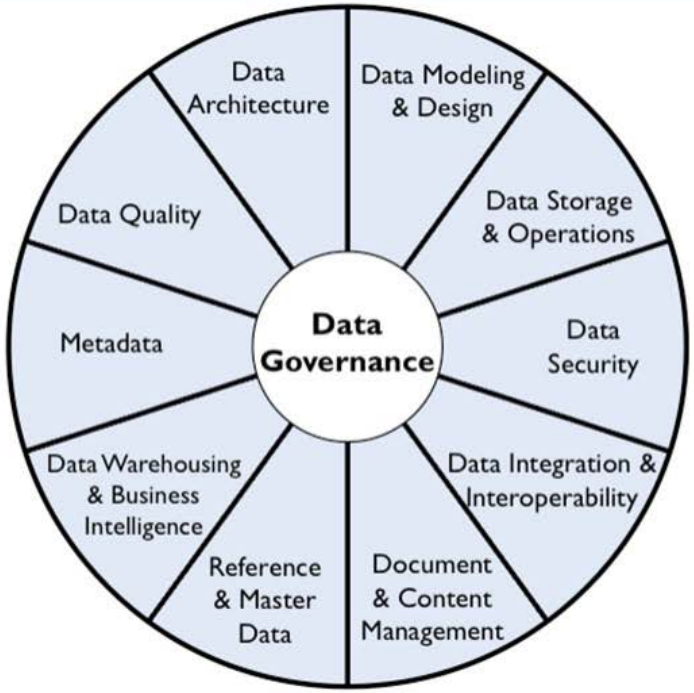
Socialize the concept of Data Governance

Identify key stakeholders at WisDOT

Draft Data Governance structure

Draft Policies and Procedures

Questions and how to plug in



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