



USDOT Region V Regional University Transportation Center Final Report

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A Synthesis of Data Management Practices in the Midwestern DOTs

by

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DISCLAIMER

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Technical Report Summary

NEXTRANS Project No. 166UWY2.2

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Title: A Synthesis of Data Management Practices in the Midwestern DOTs

Introduction

This report presents a snapshot of freight data management practices at state transportation agencies in the Midwest. The scope of practices includes architecture and integration, collaboration, data strategy and governance, quality, and life-cycle management. The scope of freight modes are highway, rail, air, water, and local roads. The methodology is for data management and data value self-assessment.

Findings

The agencies face common barriers that prevent data needs from being met. Among these are lack of access to private databases and lack of in-house expertise. Some current freight modeling and analysis tools require data that is not available the real world.

The tools for assessing data management practices at a state transportation agency require considerable effort to implement. Rather than implement the tools, this research adapted the methodology to create a survey for self-assessment. The assessment findings are limited to a small set of participating states: Illinois, Indiana, Iowa, Kansas, and Michigan.

A radar graph of the capability maturity scores show considerable variation. The self-assessment scores for Data Strategy and Governance and Data Life-cycle Management are low compared to other assessment dimensions. The states do not have formal policies and procedures for managing freight data, and data users have trouble finding data and managing revisions. Most freight datasets are updated once per year which is acceptable since freight plans are prepared less frequently. The Data Architecture and Integration scores are consistent across the agencies. All have linear location referencing standards but not all have tools for transformation between linear and geo-spatial coordinate systems. Spreadsheets are the preferred format although virtually all the datasets have a location reference. The self-assessment score for Data Quality are the highest among the five dimensions that were assessed. This indicates that data quality is of less concern than the other dimensions.

Recommendations

The maturity self-assessment can lead agencies to identify the benefits of data management and the specific actions for moving up the maturity scale. The states agencies should establish a formal structure for freight data governance including policies, business plan, roles, and responsibilities for how data is managed. Proper data catalogs and management plans will increase the value of specialized freight datasets as an agency resource rather than for single purpose use. Agencies can benefit from peer exchange and other resources for advancing data collaboration.

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Introduction

This report presents a snapshot of freight data synthesis and management practices at state transportation agencies (DOTs) in the Midwest. The scope of practices includes data architecture and integration, data collaboration, data strategy and governance. Mode categorizes freight datasets and business processes—highway, rail, air, water, and local roads. The scope of data considered is limited to freight data, defined as all data used to understand freight issues and activities. The State DOTs of the Mid-America Freight Coalition were invited to participate in the project. Wisconsin DOT staff participated in developing the survey instrument. Staff from the DOTs of Illinois, Indiana, Iowa, Kansas, and Missouri participated by responding to the survey. Other states did not participate in the project. The result of the project is a tool for assessing a transportation agency's capability maturity for freight data management.

Statement of the Problem

Freight drives the economic health in the United States, comprising 5-10% of the country's GDP (Gordon Procter & Associates; Cambridge Systematics, Inc.; ATRI; Starliss Corp.; Council of Supply Chain Management Professionals, 2011). Total freight volume has grown faster than the overall economy, increasing congestion and traffic delays on the Interstate Highway System (IHS).

Freight planning is still new to transportation agencies. Prior to the early 1990s, traffic forecasting focused on passenger vehicles rather than on freight (Chase, Anater, & Phelan, 2013). Transportation planners at state DOTs struggle with freight data – as the data user and the data manager. A lack of collaboration between state DOTs and between divisions within DOTs may prevent the agencies from maximizing the use of existing data resources.

Data must drive decision-making to optimize the utility of limited funding for freight projects (Anderson & Harris, 2011). The long-term preservation costs of freight infrastructure demonstrate the importance of using data to prioritize freight projects. Changing freight traffic patterns and growing concerns over security reflect the value of having sound data for both investment and policy-related decisions (Transportation Research Board, 2003).

The lack of freight data is a common obstacle for freight planning efforts (Cambridge Systematics, Inc.; Prime Focus, LLC; Kevin Heanue, 2007). Accurate freight data is important to assess the impact to economic development, and to include freight traffic into transportation demand models. While some commercial datasets are available, agencies face barriers due to limited budgets or staff capacity.

This project allows DOTs to list their own freight data needs and barriers in one centralized location, enabling the agencies to see what practices other DOTs in the MAFC are implementing as freight planning requirements continue to increase in importance.

Project Objectives

The expected outcomes of the project include:

- Identify freight data gaps in state DOTs
- Prioritize areas of improvement to meet DOT agency goals
- Assist state DOTs in deriving the most value from existing data sources
- A tool for assessing capability maturity level of freight data management practices
- A compilation of freight activities and data sources used by state DOTs

Research Approach and Organization of this Report

The Research Team adapted the data value and data management self-assessment questions from NCHRP Report 814 to gather data for analyzing the capability maturity for freight data management. The data collection survey was based on two tools from the National Cooperative Highway Research Program (NCHRP): 1) Data Management Assessment – an evaluation of the maturity of the data’s management structure and 2) Data Value Assessment – an evaluation of the user’s perception of the data’s overall quality and usefulness (Spy Pond Partners, LLC; Iteris, Inc., 2015). These assessments assist agencies in identifying where their existing data is located and who is using it for what purposes. Agencies are also able to determine how effective existing data is for business purposes, who is responsible for managing the data, and how data should be maintained. The survey assessed freight data activities and datasets for planning and engineering-related business activities. The terms are defined in the glossary in Appendix A.

Task 1. In this task, the Research Team conducted a literature review on the state of practice in freight data synthesis and management at state transportation agencies. The relevant literature is summarized in Chapter 2 of this report.

Task 2. This task focused on a data collection strategy. At the proposal stage, the Research Team expected to adapt the Information Engineering Analysis methods of James Martin (Martin, Information Engineering: Introduction, 1989) (Martin, Information Engineering Book II: Planning and Analysis, 1990). However, one finding of the literature review is the availability of potentially useful self-assessment tools developed by the NCHRP. These tools are the result of NCHRP 08-92: Implementing a Transportation Agency Data Self-Assessment. The NCHRP project produced NCHRP Document 214 (Spy Pond Partners, LLC; Iteris, Inc., 2015) and a guidebook for data self-assessment, Report 814 (Spy Pond Partners, LLC; Iteris, Inc., 2015). Both resources have been adapted for this task.

The Research Team tested the NCHRP assessment methodology at the Wisconsin DOT before taking it to all states in the regions. The assessment covers five areas of concern. *Data Strategy and Governance* is concerned with deciding what data to collect and how best to manage and deliver it. *Data Architecture and Integration* is concerned with standardizing spatial referencing across datasets to minimize data duplication and inconsistencies. *Life Cycle Data Management* is concerned with adequately protecting, documenting and delivering data to users. *Data Collaboration* is concerned with achieving efficiencies by coordinating data collection and management within internal and external partners. *Data Value* is concerned with the availability, quality and usability of data to meet business needs (Spy Pond Partners, LLC; Iteris, Inc., 2015).

After testing the survey, participants from the Wisconsin DOT recommended the scope be scaled back. Consequently, the Research Team limited the scope to freight-related dataset used in multimodal freight planning activities. This effectively limited the project scope from any business activities agency-wide to only certain key planning and engineering business activities that use freight data. The scope of survey participants was narrowed to freight data specialists who are familiar with the agency’s freight planning business area and the agency’s data management practices.

Chapter 3 contains more details of how the scope of the NCHRP data management self-assessment tools were adapted for freight data management.

Task 3. In this task, the Research Team developed a customized survey tool based on methodology of NCHRP Report 814. The scope of questions from NCHRP tools were modified so that they could be answered by a freight data specialist. The survey scope of freight data and freight related business activities were prefilled for each state DOT according to the findings of a MAFC Study: *From the Ground*

Up, Aligning State Freight Plans to Enhance State Collaboration and Establish Regional and National Harmonization of Freight Priorities (Perry, Adams, Oberhart, & Zietlow, 2016).

The answer choices for the survey questions were assigned points that reflect the maturity level of the data practice associated with the questions. These questions were derived from the NCHRP 814 Tools. The points scale ranged from 1 to 5, with 5 being the highest maturity level. A full copy of the survey questions and answer choices is included in Appendix B of this report.

Task 4. The survey was distributed to contacts in the planning departments of the 10 state DOTs that participate in the Mid-America Freight Coalition (MAFC), i.e. Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. An invitation to participate in the survey and instructions were sent to the state transportation agencies' planning departments.

The survey was provided through the UW-Madison license for the Qualtrics Survey Software. For those who participated, completing the survey took up to two hours. The survey participants could exit and return to their survey as needed. The survey responses and individual capability ratings are summarized in Chapter 4.

Task 5. In this task, the Research Team applied the capability maturity model to analyze the survey data collected. The Research Team determined a capability maturity score for the five areas of concern described in Task 2. Chapter 5 presents the analysis. The report findings are limited to a small sample of states—Illinois, Indiana, Iowa, Kansas, and Michigan. There is a brief discussion of the maturity levels for the assessment elements in each dimension, followed by recommended actions for moving up the maturity scale. There is a discussion of benefits that can be achieved by increasing capability maturity. The Chapter includes a simple performance comparison across the states on key freight data management practices. It ends with an assessment of barriers to freight data that might impact whether states are able to achieve their freight-related business goals.

Background

Freight Data and Planning

The importance of freight planning continues to rise if the United States is to remain economically competitive in global commerce. The complexity and magnitude of freight systems require coordination between public and private-sector stakeholders, especially given health, pollution, and safety externalities. Better data are needed to monitor and quantify the before and after impacts of freight projects. Without data, freight projects are difficult to justify and project priorities are open to debate. The Florida DOT (FDOT) used travel-time data collected before and after a tunnel project that rerouted trucks away from downtown Miami (O'Rourke, 2016) to show the project successfully diverted trucks without increasing travel times. This is an example of an agency using data to determine the type of project, and then to prove its success.

According to NCFRP Report 9 (Quiroga, et al., 2011), a national freight data architecture that serves both private and public-sector stakeholders is needed to coordinate freight data management. The architecture would standardize freight data requirements, strengthen sharing capabilities, and support strategic public and private partnerships. The benefit would be an understanding of the supply chains and business practices that drive freight transportation choices. This national freight data architecture is defined as:

“...the manner in which data elements are organized and integrated for freight transportation-related applications or business purposes. The data architecture includes the necessary set of tools that describe related functions or roles, components where those roles reside or apply, and data flows that connect roles and components at different domain and aggregation levels” (Quiroga, et al., 2011).

NCFRP Report 22 shows that multiple freight planning activities often rely on the same data source (Holguin-Veras, et al., 2013). The report identified 18 specific freight activities that depend on freight cost data, reflecting the significance of this single data source. In order to address inadequate data, Report 22 recommends standardizing data collection methodology. Current data gaps tend to be filled by estimating or borrowing data, which might not accurately represent conditions.

NCFRP Report 25 discusses the institutional barriers that hinder development of coordinated data management (Cambridge Systematics, Inc.; North River Consulting Group; University of Washington, 2013). Private stakeholders generally expect the public sector to determine the best strategy to improve the transportation system, but valuable private-sector data is often not available for public-sector decision making (Cambridge Systematics, Inc.; North River Consulting Group; University of Washington, 2013). Economic competitiveness and privacy concerns may prevent the private sector from sharing. Other common institutional barriers to sharing freight-related data include dissemination regulations, lack of data personnel, limited funding for data projects, concerns over economic competitiveness between private companies, complexity in the number of institutions involved in data sharing, and complicated interactions of the several stakeholders found in a single project (Cambridge Systematics, Inc.; North River Consulting Group; University of Washington, 2013).

NCFRP Report 35 describes available freight data sources and compares the data element definitions (Walton, 2015). Because agencies have access to several local and regional data that may not be available nationally, there is a perceived need for a central location for data to be stored for collaborative purposes (Walton, 2015). This study resulted in four overarching recommendations:

1. Data collection needs to be comprehensive, coordinated among federal agencies, and complete by including information from all freight infrastructure owners and freight carriers to the extent that proprietary data is protected.
2. Data collection needs to be strengthened to include multimodal origin-destination (O-D) freight data flows, ports of entry performance, import bottlenecks, and the repositioning of empty containers for exports. Additionally, US DOT should evaluate the benefit of purchasing third-party aggregator data to fill critical gaps.
3. Data collection efforts should be tailored to performance measures that are in line with specific outcomes that the US DOT and Congress want to obtain with the increased emphasis on the multimodal national freight system.
4. US DOT should continue to support the development of best practice toolkits for urban and rural freight transportation planning that seek to reduce freight-related congestion, air emissions, parking issues, and impacts on the health and safety of transportation professionals and the public (Walton, 2015).

Freight modeling tools are advanced of the data. The tools cannot be implemented if they require input data that does not exist (Walton, 2015). For example, (Singer, 2016) deemed freight and operations data on trucking to be so inadequate as to be useless for policy analysis.

Common Sources of Data for Freight Transportation Planning

Federal freight data effort started with the Intermodal Surface Transportation Efficiency Act (ISTEA), which tasked the US DOT to create a database for tracking the volume and patterns of goods moved through intermodal transportation along with the investment in intermodal facilities (Perry, Adams, Oberhart, & Zietlow, 2016). The Transportation Equity Act for the 21st Century (TEA-21) and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) continued these requirements for data collection. Following the authorization of SAFETEA-LU in 2005, freight planning became a component of Metropolitan Planning Organization (MPO) transportation planning processes. Although states were not required to plan for freight specifically, funding became more widely available for freight projects.

Under the Moving Ahead for Progress in the 21st Century Act (MAP-21), states were encouraged to adopt a freight plan as either a standalone document or part of a larger transportation plan to justify project expenses and obtain federal funding for freight-related projects. MAP-21 instructed the US DOT to develop tools for evaluation of freight-related projects. The federal government had already developed several public data sources, such as the National Performance Management Research Data Set (NPMRDS) and the Freight Analysis Framework (FAF) for use at the state level of government. Private companies, such as HERE (a Nokia company), provide data for certain federal datasets by sampling GPS data from smartphones and other devices.

The Fixing America's Surface Transportation Act (FAST Act) renewed MAP-21's commitment and recommended that US DOT reexamine freight flow data collection to reduce gaps and deficiencies in freight transportation demand forecasting. With the authorization of the FAST Act in 2015, all states must complete a freight plan and address reporting requirements for certain freight performance measures. These requirements reflect the importance of freight data practices in preparing freight plans, which are updated every five years.

There is a wealth of data available to guide plan creation and decision making, but states are often limited by resource constraints or by the fact that the benefits of the data have not been recognized. Further, open data sources are dated, such as the Commodity Flow Survey (every 5 years), and Waterborne Commerce Statistics (every 2 years). In the Midwest, freight data use varies widely, but there are some frequently used resources like the FAF and the Surface Transportation Board (STB) Waybill Sample. Table 1 lists the variety of data sources currently used in the Midwest (Perry, Adams, Oberhart, & Zietlow, 2016).

States consult free sources like the FAF and Waterborne Commerce Data as well as paid sources like TRANSEARCH and InfoUSA. In addition, many states use data from other state agencies to help inform their freight plans. States creating plans in-house tend to use freely provided external data and internally generated data from partner agencies such as the Department of Economic Development, State Port Authority, or Department of Agriculture to identify and utilize their data, which is often timely and accurate. Consultant-led plans generally relied on proprietary data such as TRANSEARCH or InfoUSA.

Table 1. Data Sources Used for Freight Planning

State	Data Source	Purpose
Illinois	FAF	Forecast, trucking data, air freight data
	STB Waybill Sample	Railroad data
	TRANSEARCH	Waterborne data, rail data
	USACE Waterborne Commerce Statistics	Waterborne data
Indiana	REMI Forecast	Forecasting economic activity
	FAF 3.4	Economic activity
	INDOT Statewide Travel Demand Model	Economic activity
	TREDIS	Forecasting model from Purdue
	Major Corridor Investment Benefit Analysis System	Cost-benefit analysis
Iowa	Cass Information Systems	Freight index
	EDR Group	Import/export freight flow data
	FAF	Domestic commodity flows and disaggregated data for statewide modeling
	SMC3 Czarlite Rate	Shipment data
	PC*Miler Rail	Mileage data
	Misc	Bill of lading data from contributing companies
	InfoUSA	Used to disaggregate FAF data to the county level
	INRIX Traffic Data	Bottleneck identification and highway improvement prioritization
	Air cargo totals-IA commercial airports	Air commodity flows
	US Census Bureau	County business patterns data
	US Bureau of Economic Analysis	County employment data
	US DOT Commodity Flow Survey	Freight flow information
	US Department of Agriculture	Grain transportation report
	USACE	Lock performance monitoring data, waterborne commerce statistics
	IA DOT	Truck traffic and mileage data
	Railroad Annual Reports	Current conditions and trend information
Kansas	Woods and Poole	Describing the industrial makeup of Kansas economy, including geographic distribution and each industry's contribution to Kansas' output
	Moody's Economy.com	
	US Census	
	US Bureau of Economic Analysis	

State	Data Source	Purpose
	KS Department of Revenue	Describing Kansas' multimodal freight infrastructure, including extent, performance, and operational characteristics Describing commodity type, volume, and value of freight movements relative to Kansas. Assigns freight movements to specific infrastructure
	KDOT GIS files	
	USACE Waterborne Data	
	TRANSEARCH	
	County Agricultural Production Profiles	
	Industry Data	
	National Agricultural Statistics Service	
	STB Waybill Sample	
Michigan	TRANSEARCH	Commodity flows and forecasts
	FAF	Commodity flows and forecasts
	InfoUSA	Employment and economic info
	STB Waybill	Rail flows
	USACE Waterborne Commerce Statistics	Waterborne flows
	Air Cargo	MDOT Aeronautics provides information on air cargo
Minnesota	FAF	Commodity flows and forecasts
	Past Studies	Forecasting
	In-state manufacturing studies	
	Data from freight workshops	
	Data from FAC planning committee	
	Market research	
	Info USA	Business information
Ohio	FAF	Commodity flows
	TRANSEARCH	Commodity flows
	Tompkins Survey	Industry information
	Statewide Highway Traffic Model	Economic impact analysis of investments
Wisconsin	TRANSEARCH	Freight flows (purchase contained 3 years)
	STB Waybill Sample	Rail freight flows
	InfoUSA	Business directory and data
	Multimodal Network Tool	Forecasts

* The STB Waybill Sample cost is \$200 for the dataset plus \$50 for each additional user.

Data costs range widely. INRIX Traffic data, costs \$778,000 annually and is the most expensive source in Table 1, with TRANSEARCH (at about \$100,000 for a one-year dataset) coming in second. The STB Waybill sample's cost varied between states based on the number of users; the data costs \$200 per state, with an additional \$50 charge for each authorized user (Perry, Adams, Oberhart, & Zietlow, 2016).

Some states collect their own data, as is done by Michigan, Minnesota, and Ohio. Minnesota has demonstrated that valuable information can be gathered from existing stakeholders using manufacturer surveys. This data can be generated at a low cost and can reveal "low hanging fruit" that DOTs can act on quickly to demonstrate their commitment to stakeholder engagement (Perry, Adams, Oberhart, & Zietlow, 2016). For example, Minnesota used data collected from industries to change snow plow routes and increase communication.

Current State of Data Management Practice in DOTs

The Virginia Department of Transportation (VDOT) conducted a survey of MPOs and municipalities to identify data needs, barriers, and solutions affecting the state's ability to meet federal performance measurement requirements (Khattak, Wang, Son, & Liu, 2015). The survey includes additional questions pertaining to the user's perceived accessibility to and quality of these data sources. Users indicated how frequently and why they use each data source, as well as data sharing procedures, data collection methodology, and needed improvements to datasets. Finally, questions regarding what potential solution should be used for improving the existing data set allow the user to choose from the following recommendations: increasing awareness of data sources; improving data resources; integrating existing databases; increasing database use; disseminating data by providing access to databases; and establishing organizational structure for governance.

The survey produced several findings. First, MPOs had insufficient data resources compared to the VDOT, but MPOs tend to use different data sources than VDOT. Second, infrastructure and safety were the two datasets in highest demand for fulfilling data needs. Third, access to existing data for external organizations was difficult to gain through the Virginia Information Technologies Agency (VITA). The report recommends that regional planners within VDOT host data sharing workshops with other planning organizations in order to share data and planning resources (Khattak, Wang, Son, & Liu, 2015).

The Texas DOT produced a few reports describing how data can be collected from the private sector. Gathering data from private stakeholders requires a certain level of trust, and TxDOT suggests that states should develop a formalized data sharing program that includes certain protections for private stakeholders, like the ability to provide anonymized data. Another major consideration, is the administrative burden for private firms, who may be discouraged from participating if they must clean their own data (Seedah, et al., 2014).

The Federal Highway Administration (FHWA), in collaboration with TxDOT, conducted a similar survey in order to inventory data usage and needs of DOT, MPO, and municipality officials in Texas (Seedah, et al., 2014). Survey participants answered questions like: "What freight data do you use? What data sources do you currently use? For what purpose(s) do you use the freight data? Have you experienced any issues in obtaining reliable freight data? What freight data variables do you need? What level of detail do you require? How would you use the proposed Statewide Freight Database? (What queries will you run?)"

The responses resulted in the following list of current freight data concerns:

- Assumptions used to disaggregate the data
- Lack of origin-destination data
- Lack of transportation planning involvement in industry decision making

- High costs of acquiring data
- Outdated and aggregated freight data
- Reliability of “free public data”
- Lack of traffic counts on local infrastructure
- There is no level of detail regarding the type of goods moved (i.e., by commodity)
- More data collection is needed for pavement design, construction, turning radii, hazmat cargo, etc.
- Lack of information about seasonal movements
- Unknown routes and unknown vehicle registration data (Dan Seedah et al., 2014)

The survey responses showed that users wanted freight databases with features such as a GIS interface, routing capabilities, and access to available county data, corridor data, and commodity information (Seedah, et al., 2014). Participants indicated a preference for data sources with simple interfaces that are updated frequently for freight transportation planning purposes (Seedah, et al., 2014). The findings led to a recommendation for creating an academic or private entity charged with outreach for freight data sharing (Seedah, et al., 2014).

Methodology

The final report for NCHRP Project 08-36 Task 100 (Secret, Schneweis, & Yarbrough, 2011) proposed a framework and conceptual design of a tool or resources to help transportation agencies assess their data management program. Figure 1, from the report, shows the assessment topics. The framework allows agencies to visualize their entire data inventory and take into consideration which division within the agency owns the data, what divisions use the data, and where the data is physically stored. This framework defines 5 levels, listed in Table 2, for capability maturity for data management.

<p>Strategic Alignment</p> <ul style="list-style-type: none"> • Alignment with strategic goals • Clear and appropriate organizational roles • Alignment with user needs • Identification of data sources, uses, and users • Data utilization and visualization 	<p>Data Quality</p> <ul style="list-style-type: none"> • Accuracy • Consistency • Reliability • Timeliness • Completeness • Currency • Integrity • Confidentiality
<p>Data Program Management Processes</p> <ul style="list-style-type: none"> • Clear definitions • Ability to segregate, aggregate, and analyze • Time and resources for conducting analysis and visualization • Regular audits and validation procedures • Consideration for program trade-offs, costs and life-cycles • Mechanisms for security, privacy, and ethical considerations • Data collaboration • Management continuity 	

Figure 1. Key Assessment Categories and Topic Areas (Secret, Schneweis, & Yarbrough, 2011)

Table 2. Maturity Model for Data Management at a DOT (Secret, Schneeweis, & Yarbrough, 2011)

Maturity Level	Description
Undisciplined	No formal data management approach
Ad hoc	Data management occurs, but is typically in response to a specific problem or project rather than applied organization-wide
Standardization	The organization has implemented some standard data management practices and roles
Proactive	The organization has instituted formal data management policy goals for all business units, has dedicated stewards for all business units, and has begun to both coordinate across the enterprise and measure/predict data program performance
Optimized	Data management is continually improved and used to set, communicate, and enforce business policies and strategic direction

Building on the framework established by NCHRP Project 8-36, Task 100, NCHRP Project 08-92 developed a methodology and set of tools for assessing a transportation agency’s data assets, and then developing a realistic action plan for improvement to both the data assets themselves and ongoing data management processes. This NEXTRANS project adapted the NCHRP project methodologies and tools: 1) Data Management Assessment – an evaluation of the maturity of the data’s management structure and 2) Data Value Assessment – an evaluation of the user’s perception of the data’s overall quality and usefulness (Spy Pond Partners, LLC; Iteris, Inc., 2015).

Figure 1 shows the components of the assessment for the overall capability maturity model along with definitions of the maturity levels. The remainder of this Chapter describes the overall scope of the assessment and the detailed elements in each assessment dimension.

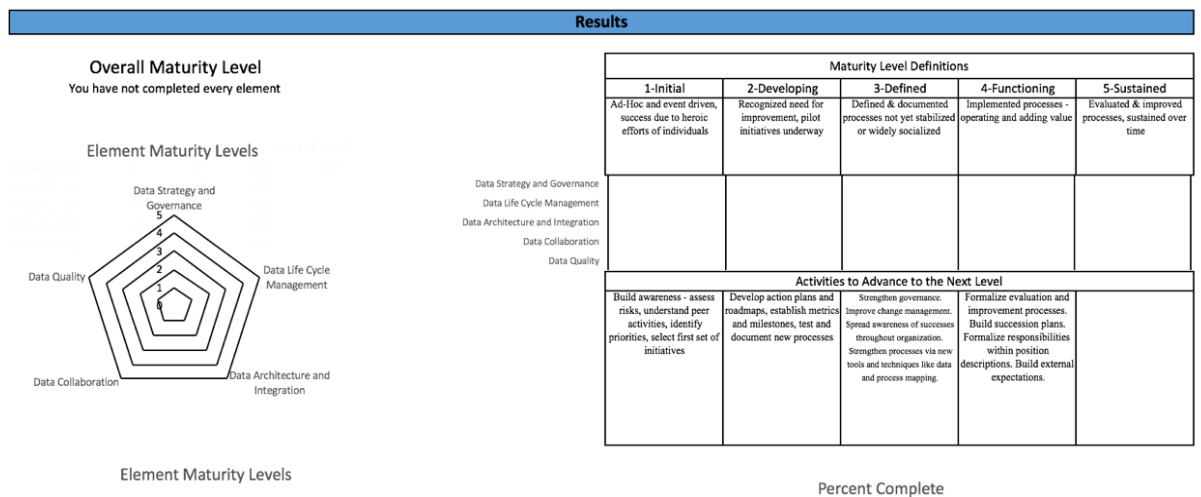


Figure 2. Dimensions of Data Management Assessment (Spy Pond Partners, LLC; Iteris, Inc., 2015)

The Research Team adopted the NCHRP five dimensions of concern for data management assessment (Spy Pond Partners, LLC; Iteris, Inc., 2015) shown in Figure 3. The *Data Strategy and Governance* dimension is about how the agency and individual business units decide what data to collect and how best to manage and deliver it. It includes establishing, enforcing, and sustaining data management strategies, roles, accountability, policies, and processes. The *Data Architecture and Integration* dimension is about practices to standardize and integrate data and includes spatial referencing and minimizing data duplication and inconsistencies. *Life Cycle Data Management* is about the operational aspects of managing data such as documentation and delivery to users. *Data Collaboration* is about coordinating data collection and management within the agency and with external organizations. Data Quality is concerned with the adequacy of available data to meet a defined set of business needs (Spy Pond Partners, LLC; Iteris, Inc., 2015).



Figure 3. Dimensions for Assessing Data Management Maturity Capability

Each assessment dimension is comprised of elements as described in Figure 4. For each element, the maturity levels have been defined to characterize a progression from *Initial* to *Sustained* as defined in Table 3.

Table 3. Capability Maturity Levels for Data Management Assessment

Maturity Level	Rating Score	Description
Initial	1	Ad hoc and event driven, success due to heroic efforts of individuals
Developing	2	Recognized need for improvement, pilot initiatives under way
Defined	3	Defined and documented processes not yet stabilized or widely socialized
Functioning	4	Implemented processes—operating and adding value
Sustained	5	Evaluated and improved processes, sustained over time

The NCHRP tools had to be configured for the project. Configuration consists of recording the business area, developing a list of specific freight activities, and identifying the data needed to perform the freight activities. The Research Team engaged the Planning Bureau staff of the Wisconsin Department of Transportation to test the NCHRP approach for the study. The goal was to determine if the NCHRP assessment methodology and tools could be adapted. The participants from Wisconsin DOT include:

- Donna Brown, Director Bureau of Planning and Economic Development, Wisconsin DOT
- Jennifer Sarnecki, Statewide Planning Chief, Wisconsin DOT
- Dan Thyes, Policy and Program Analyst, Freight Section, Wisconsin DOT
- Andrew Levy, Urban and Regional Planning Supervisor, SE Region, Wisconsin DOT

The Research Team and Wisconsin DOT planning staff populated the data value assessment tool with Wisconsin DOT's business areas, freight activities, and data. While the assessment was successfully completed, DOT employees remarked that the tool did not provide information they did not already know, and that time was very limited to find people to continue assessing additional data sources.

The tool engages users to assess the importance of data sources for freight-related business activities. However, Wisconsin DOT had already selected the data sources to be used for freight analysis. Since Wisconsin DOT already determined which data sources to use for its freight activities, the usefulness of the tool's data source "importance" function has little use for DOT employees.

Another potential problem occurs when assessing a data source if it informs more than one mode. Wisconsin DOT employee, Dan Thyes, mentioned that the value of a data source for a particular business activity varies by mode. For example, a data source that report tonnage may be valuable for network analysis of rail and waterborne freight but for air, value is most important. Given the speed and flexibility of the highway mode, both tonnage and value are needed for multimodal network analysis. As a result, the activity, "Develop a Multimodal Freight Network," was divided by mode (highway, railroad, water, air, and local roads). These newly derived freight activities were used to populate the Data Value Self-Assessment Tool in order to complete the assessment.

Based on the testing, the Research Team decided that instead of adapting the NCHRP tools, the Team would follow the methodology to create a survey that meets the project needs. The goal of the survey is to assess the freight data management capability maturity and lead to recommendations.

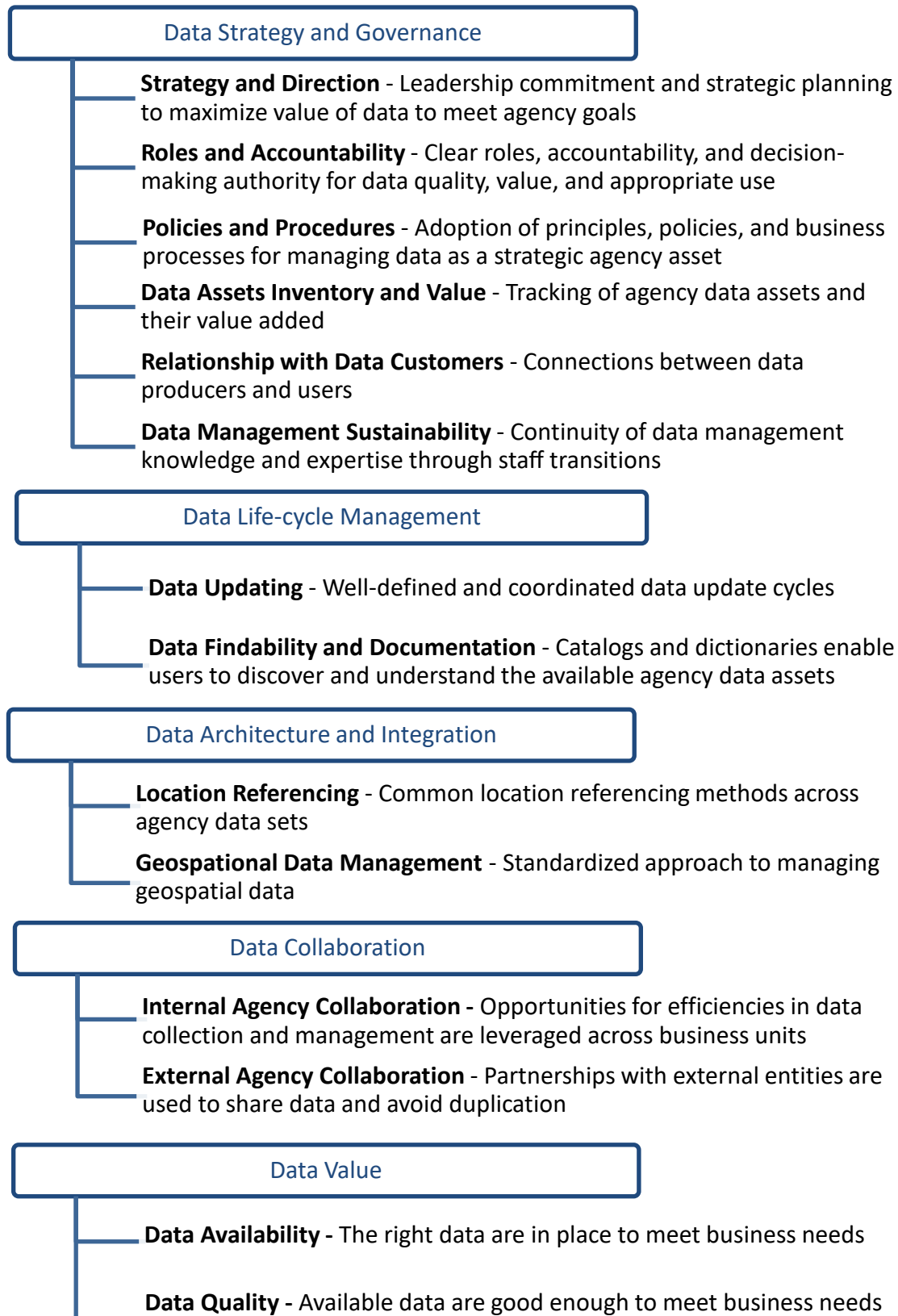


Figure 4. Elements of Data Management Assessment

Capability Assessment Survey Results

The Research Team distributed the capability maturity survey to contacts in the planning departments of the 10 state DOTs that participate in the Mid-America Freight Coalition (MAFC). The MAFC contacts directed the survey to the data custodian in their DOT's planning division. For this research, a *data custodian* is defined as the agency person who manages freight data entities (e.g. total freight tons, manufacturing site locations) in support of planning division freight activities. Not all states participated. The following people are the freight data custodians who participated.

- Kristin Brier – Freight Manager, Multimodal Planning and Programs, Indiana DOT
- Eddie Dawson – Rail/Freight Coordinator, Kansas DOT
- James Durako – Transportation Planning Specialist, Illinois DOT
- Kyle Gonterwitz – GIS Specialist, Planning Division, Kansas DOT
- Jesse Gwilliams – Freight Specialist, Statewide Planning Division, Michigan DOT
- Sam Hiscocks – Freight Coordinator, Iowa DOT

This Chapter summarizes the survey questions that were adopted from the NCHRP Report 814 methodology and the responses received. The questions are organized into the five areas of concern (dimensions) for data management assessment. Many of the survey questions were demanding and some questions were left blank.

The Research Team used the survey responses to compute a capability rating for each dimension. First, numerical capability maturity scores were assigned to the assessment question responses. The higher the score, the higher the capability maturity. All of the assessment criteria are weighted equally. The capability maturity rating is the average rating for all responses in the group of questions. This average rating represents the self-assessment score for each area of concern.

Data Strategy and Governance

Data Strategy and Governance is concerned with how the agency and individual business units decide what data to collect and how best to manage and deliver it. This area of concern includes establishing, enforcing, and sustaining data management strategies, roles, accountability, policies, and processes.

The questions in Table 4 were adapted from the NCHRP methodology (Spy Pond Partners, LLC; Iteris, Inc., 2015). Assessment of an agency's data strategy and governance can be agency-wide or for a single business program or unit. The table indicates the scope of each assessment question.

Each question probes the respondent to identify the appropriate capability levels by offering responses that correspond to the levels. The full set of possible choices for the question responses are shown in the survey in Appendix B. Tables in Appendix C list the responses selected by the survey participants from each DOT.

Table 5 shows the numerical capability maturity scores assigned to the assessment question responses. The capability maturity rating is the average rating for all criteria. The higher the score the higher the capability maturity. The last row in Table 5 shows the average ratings for all criteria. This score represents the Data Strategy and Governance self-assessment rating for each state DOT. According to average scores, Kansas DOT received the highest self-assessment rating.

Table 4. Assessment Questions for Data Strategy and Governance Capability Maturity

Scope	Capability	Assessment Question
Agency-wide	Strategy and Direction	To what extent do your agency’s leadership and strategic planning maximize the value of data to meet agency goals?
Agency-wide	Roles and Accountability	Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?
Agency-wide	Policies and Procedures	Has your DOT adopted policies and processes for managing freight data as a strategic asset?
Agency-wide and Program Level	Data Assets Inventory and Value	Does your DOT have an agency-wide data inventory that includes freight data? Does your business area maintain a data inventory that includes freight data?
Program Level	Data Management Sustainability	Do staff transition processes preserve data management knowledge and expertise within your business area?
Program Level	Relationship to Customers	Do you gather feedback from users of the freight data you manage?

Table 5. Capability Maturity Scores for Data Strategy and Governance

Assessment Question	Michigan	Iowa	Indiana	Illinois	Kansas
To what extent do leadership and strategic planning maximize the value of data to meet agency goals?	3	2	3	1	5
Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?	3	2	2	1	2
Has your DOT adopted policies and processes for managing freight data as a strategic asset?	1	1	1	1	4
Does your DOT have an agency-wide data inventory that includes freight data?	2	3	1	1	4
Does your business area maintain a data inventory that includes freight data?	2	3	2	1	4
Do staff transition processes preserve data management knowledge and expertise within your business area?	3	2	2	1	3
Do you gather feedback from users of the freight data you manage?	2	2	1	1	-
Average Score	2.29	2.14	1.71	1	3.67

Data Life-cycle Management

Life-cycle Data Management is concerned with the operational aspects of managing data to ensure that it is adequately maintained, preserved, protected, documented, and delivered to users.

The scope of data life-cycle management assessment is the freight planning business area with focus on freight data used in planning and engineering. Table 6 lists the survey questions for assessing data life-cycle management. Each question probes the respondent to identify the appropriate capability levels by offering responses that correspond to the levels. Each question has five possible responses, each associated with a level of capability maturity ordered from least to most mature. The full set of possible choices for the responses are shown in the survey in Appendix B. Tables in Appendix C list the responses selected by the survey participants from each DOT.

Table 6. Assessment Questions for Data Life-cycle Management Capability Maturity

Scope	Capability	Assessment Question
Program Level (Freight Planning Business Unit)	Data Findability and Documentation	Does a data catalog enable freight data users to use and understand your data?
Program Level (Freight Planning Business Unit)	Data Updating	If a project generates new freight data, such as new traffic counts, what happens to the data after the project is over?

Table 7 shows the quantitative scores for responses to the data life-cycle management capability questions. Each response was assigned a numerical rating for the capability maturity responses associated with data life-cycle management. The higher the score the higher the capability maturity. The last row in Table 7 shows the average ratings for both criteria. This score represents the Data Life-cycle Management self-assessment rating for each state DOT.

Table 7. Capability Maturity Scores for Data Life-cycle Management

Criteria	Michigan	Iowa	Indiana	Illinois
Does a data catalog enable freight data users to use and understand your data?	2	2	1	1
If a project generates new freight data, what happens to the data after the project is over?	3	5	3	1
Average Score	2.5	3.5	2	1

Data Architecture and Integration

Data Architecture and Integration is concerned with practices to standardize and integrate data and includes standardizing spatial referencing and other key linkages across datasets and minimizing data duplication and inconsistencies.

The state DOTs were asked about their Location Referencing System (LRS) tools and GIS systems, their performances, and their integration to the current state DOT’s technology. The questions are listed in Table 8. Each question probes the respondent to identify the appropriate capability levels by offering responses that correspond to the levels. Each question has five possible responses, each associated with a level of capability maturity ordered from least to most mature. The full set of possible choices for the question responses are shown in the survey in Appendix B. Tables in Appendix C list the responses selected by the survey participants from each DOT.

Table 8. Assessment Questions for Data Architecture and Integration Capability Maturity

Scope	Capability	Assessment Question
Agency-wide	Location Referencing	Does your DOT have a single (unifying) location referencing system (LRS)?
Agency-wide	Geospatial Data Management	Does your DOT have a standardized approach to collection, management, and integration of geospatial data?

In Table 9, the responses to the Data Architecture and Integration assessment questions were assigned a numerical maturity scores. The higher the score, the higher the capability maturity. The last row in Table 9 shows the average ratings for both criteria. This score represents the Data Architecture and Integration self-assessment rating for each state DOT.

Table 9. Capability Maturity Scores for Data Architecture and Integration

Criteria	Michigan	Iowa	Indiana	Illinois	Kansas
Does your DOT have a single (unifying) location referencing system (LRS)?	3	3	4	1	2
Does your DOT have a standardized approach to collection, management, and integration of geospatial data?	3	3	2	1	2
Average Score	3	3	3	1	2

Data Collaboration

Data Collaboration is concerned with achieving efficiencies through processes to coordinate data collection and management within the agency and to partner with external organizations to share data.

Data sharing and collaborations can be internal with other business areas and external with the private sector or other government agencies. The data managers in the freight planning units were asked about collaboration between DOT business units and with external entities. The questions are listed in Table 10. Each question probes the respondent to identify the appropriate capability levels by offering responses that correspond to the levels. Each question has five possible responses, each associated with a level of capability maturity ordered from least to most mature. The full set of possible choices for the

responses are shown in the survey in Appendix B. Tables in Appendix C list the responses selected by the survey participants from each DOT.

In Table 11, the responses to the Data Collaboration assessment questions were assigned a numerical maturity score associated with the line of questions. The higher the score, the higher the capability maturity. The last row in Table 11 shows the average ratings for both criteria. This score represents the Data Collaboration self-assessment rating for each state DOT.

Table 10. Assessment Questions for Data Collaboration Capability Maturity

Scope	Capability	Assessment Question
Program Specific	Internal Agency Collaboration	Do you share and receive data with organizations outside of your DOT?
Program Specific	External Collaboration	Do you collaborate on data collection and management with data experts in other business areas?

Table 11. Capability Maturity Scores for Data Collaboration

Capability Maturity Criteria	Rating Score for DOT in State				
	Michigan	Iowa	Indiana	Illinois	Kansas
Do you share and receive data with organizations outside of your DOT?	4	2	1	1	4
Do you collaborate on data collection and management with data experts in other business areas?	5	3	3	1	3
Average Score	4.5	2.5	2	1	3.5

Data Value Assessment

Data Value Assessment evaluates the availability, quality and usability the agency’s freight datasets for the various business activities and decisions. *Availability* is assessed with respect to specific business activities. *Quality* and *Usability* are assessed for each of the major datasets/sources that are used for performing the selected business activities. The Research Team assessed the quality and usability of available datasets for common freight-related business activities at a state transportation agency.

Table 12 lists the scope of business activities that require exclusive or shared freight-related data. The list was obtained from the CFIRE MAFC-14 Alignment Study (Perry, Adams, Oberhart, & Zietlow, 2016). Most of these activities use data to create new data products, maps, priorities, forecasts, etc., that get used by others and are updated on a periodic basis. The domain column indicates the business area responsible for the business activity data. Most are freight planning and engineering activities.

For data quality assessment, the survey participants were asked how well the various freight-related datasets satisfy the needs for the business activities. The participants were asked to rate the quality of the datasets/source used for the freight-related planning activities. Table 13 shows the quality rating response for the datasets/sources used by each agency to support freight related business activities. Colors indicate the self-assessment rating for the quality of the datasets. Each rating level was assign a numerical score between 1 and 5, with 5 being the highest maturity level. The last row in Table 13 shows the average ratings of all datasets used by each agency. This score represents the Data Quality self-assessment rating for each state DOT.

Table 12. Scope of Agency Business Activities Requiring Freight Data

Business Activities Requiring Freight Data	Domain
Preparing Long-range Statewide Freight Plan	Freight Planning
Preparing State Rail Plan	Freight Planning
Truck and Traffic Forecasting	Freight Planning
Statewide and Urban Travel Demand Modeling	Freight Planning
Designating Statewide Corridors of Significance	Freight Planning
Preparing Maps and Tables (Related to the Multimodal Freight Network)	Freight Planning
For Responding to External Requests for Freight Volumes on Local Corridors	Freight Planning
Administer Grant/Loan Programs for Non-highway Freight Modes	Programming
Scoring and Programming of Highway Projects	Programming
In Pavement and Bridge Management Tools	Asset Management
For Statewide Asset Inventory (e.g. Rest Areas for Truck Parking)	Asset Management
For OSOW Permitting	Motor Carrier Division
For Commercial Vehicle Enforcement and Weigh Station Justification	State Police

Table 13. Adequacy of Freight Datasets for Planning and Engineering Business Activities at State DOTs

Data Source	Michigan	Iowa	Indiana	Illinois
TRANSEARCH INSIGHT	Yellow	White	Green	Red
Freight Analysis Framework (FAF)	Yellow	Yellow	Green	Red
InfoUSA (Industry Employment)	Yellow	Yellow	White	White
Waterborne Commerce Statistics (US Army Corp. of Engineers)	Yellow	Yellow	White	Red
STB Waybill Sample	Yellow	White	White	Red
INRIX Traffic Data	White	Green	White	White
County Agricultural Production Profiles (US Dept. of Agriculture)	White	Green	White	White
US Census Bureau	White	Green	White	White
US Bureau of Econ Analysis	White	Green	White	White
Commodity Flow Survey (US Dept. of Transportation)	White	Yellow	White	White
Railroad Annual Reports	White	Yellow	White	White
Major Corridor Investment Benefit Analysis	White	White	Orange	White
REMI Forecast	White	White	Green	White
State Origin-Destination Studies	Green	White	White	White
Statewide Travel Demand Model	White	White	Green	White
TREDIS Transportation Economic Development Impact System	White	Yellow	Green	White
State Air Cargo Statistics	Orange	Green	White	White
Average Rating	3.67	4.27	4.56	1
Quality Assessment Color Code	Maturity Rating	Description		
Green	5	Perfectly sufficient		
Yellow	3.67	Acceptable but needs improvement		
Orange	2.33	Useful but low-quality limits value		
Red	1	Not enough quality to be useful		
White	-	Not identified		

Some states use more datasets than others, especially states that have in-house capacity to conduct freight analyses. Michigan and Iowa prepare their State Plans with in-house expertise. This may explain why these states use more freight datasets than other states. The same explanation may account for why Michigan and Iowa identified many datasets as acceptable but needing improvement. Experienced analysts are likely to know the assumptions and limitations of common databases.

Common datasets and sources among the states are the Freight Analysis Framework (FAF)¹ from Oak Ridge National Laboratory, the commercial TRANSEARCH INSIGHT², Waterborne Commerce Statistics³ from the US Army Corp of Engineers, Rail Carload Waybill Sample from the Surface Transportation Board⁴, US Census Bureau⁵, Bureau of Economic Analysis from the US Department of Commerce⁶, and various state-level air and rail cargo statistics and travel demand forecasts. Kansas also uses Moody's Economy.com, Woods & Poole economic and demographic database⁷, County Agricultural Production Profiles from the US Department of Agriculture National Agricultural Statistics Service⁸, and Kansas Department of Revenue. The agency did not respond to the survey question on whether the quality of these datasets is adequate for their freight planning activities.

Some datasets/sources got widely different ratings from the state DOTs. For example, Michigan DOT stated that TRANSEARCH's quality is acceptable but needs improvement. Meanwhile, Illinois DOT stated that TRANSEARCH's quality is not enough to be useful. The quality ratings from Illinois cannot be explained. Illinois DOT uses common data from TRANSEARCH, FAF, USACE Waterborne Commerce, and STB Waybill Sample. However, these data sources do not provide the information quality needed to be useful in their freight planning activities.

In addition, the survey participants asked about the compatible software format for each data set.

- What format/platform do you use for each data set (e.g. GIS, spreadsheet)?
- Roughly how many times per year is each data set updated? Please enter a number.

The spreadsheet is most popular data format although virtually all of the datasets have a location data item. Some data comes from specific models such as Transcad but can be converted with readily available tools. The *Data Architecture and Data Integration* dimension of the assessments is concerned with geospatial referencing.

Some of the datasets are propriety and some are in the public domain. Various license agreements control whether the agency staff can make revisions to the database and whether those revisions will propagate to the next release of the database. Most freight datasets are updated once per year. This update frequency is acceptable since freight plans are prepared much less frequently.

Analysis and Recommendations

This Chapter presents the results of the capability maturity assessment. The report findings are limited to a small sample of states. The participating states are Illinois, Indiana, Iowa, Kansas, and Michigan.

The Chapter starts with a radar graph of the capability maturity score for each assessment dimension. There is a brief discussion of the maturity levels for the assessment elements in each dimension, followed by recommended actions for moving up the maturity scale taken from NCHRP Report 814 (Spy Pond Partners, LLC; Iteris, Inc., 2015). There is a discussion of benefits that can be achieved by increasing capability maturity and, finally, a discussion related to freight data management practices. The Chapter

¹ <http://faf.ornl.gov/fafweb/>

² <http://www.ihsglobalinsight.com/ProductsServices/ProductDetail838.htm>

³ <http://www.iwr.usace.army.mil/About/Technical-Centers/WCSC-Waterborne-Commerce-Statistics-Center/>

⁴ https://www.stb.gov/stb/industry/econ_waybill.html

⁵ <https://www.census.gov/>

⁶ <https://www.bea.gov/>

⁷ <https://www.woodsandpoole.com/>

⁸ https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/County_Agricultural_Production/index.php

ends with an assessment of barriers to freight data that might impact whether states are able to achieve their freight-related business goals.

Capability Maturity Radar Graph

Figure 5 shows the self-assessed competency levels for freight data management at each state DOT. The figure is a radar graph that shows values relative to a center ring at level 1. This graph type is useful when the categories (on the radar spikes) are not directly comparable. The raw graph data is in Table 33.

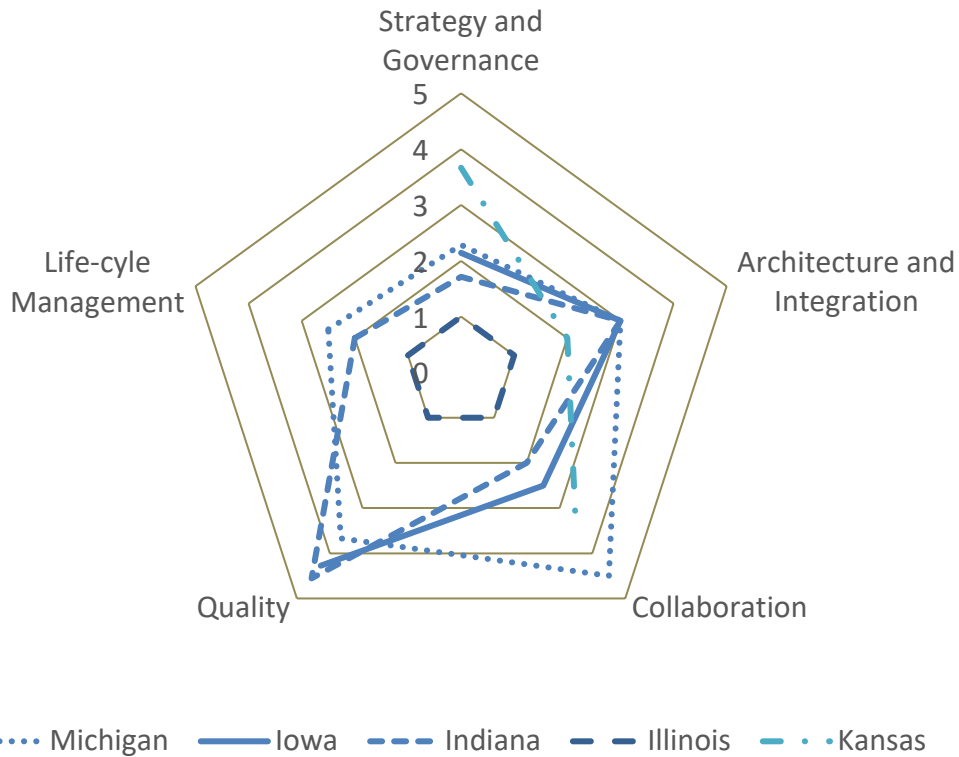


Figure 5. Capability Maturity Radar Graph

Table 14. Capability Maturity Assessment Scores

Assessment Element	Michigan	Iowa	Indiana	Illinois	Kansas
Strategy and Governance	2.29	2.14	1.71	1.00	3.67
Life-cycle Management	2.50	3.50	2.00	1.00	-
Architecture and Integration	3.00	3.00	3.00	1.00	2.00
Collaboration	4.50	2.50	2.00	1.00	3.50
Quality	3.67	4.27	4.56	1.00	-

Data Strategy and Governance

The analysis includes five elements for assessing the maturity of data strategy and governance practices.

Strategy and Direction: At low levels of maturity, decisions about what data collection and manage are highly decentralized. At high levels of maturity, investments are more deliberate and coordinated.

Roles and Accountability: At low levels of maturity, there is a lack of clarity about who “owns” data and no formal responsibilities for coordinating across business units on data collection and management. At high levels of maturity, roles and responsibilities are more formalized; staff are assigned to data stewardship and management roles, sufficiently trained, and provided with resources.

Policies and Procedures: At low levels of maturity, there are no written and adopted policies and procedures related to data governance and management. At high levels of maturity, policies and procedures are drafted, adopted, and implemented throughout the agency.

Data Management Sustainability: At low levels of maturity, the agency is not aware of risks associated with departures of staff with specialized knowledge and skills related to particular datasets or data management practices. At high levels of maturity, these risks are systematically identified and mitigation actions are in place—including succession plans and mentoring strategies.

Relationship to Customers: At low levels of maturity, data managers do not actively communicate with data users to understand data usage and to get feedback on data quality. At high levels of maturity, data program managers reach out to data users and act on feedback received to make improvements.

As shown in Table 14, the average capability assessment scores for Data Strategy and Governance tend to be lower than for the other assessment dimensions. Agencies can improve data strategy and governance capability to better support business activities by taking one or more of the following recommended actions (Spy Pond Partners, LLC; Iteris, Inc., 2015).

- Data Governance Bodies
- Data Governance and Stewardship Policies
- Data Business Plans
- Data Management Roles & Responsibilities
- Data Communities of Interest
- Succession Planning and Management
- Core Competency Definition

There are many benefits for agencies with mature data strategy and governance capabilities. The benefits compound as more and varying types of data become available. Agencies can better identify where unproductive or lower value investments in freight data that can be discontinued or diverted to higher value data investments. Communication between data providers and data customers reduces the collection of unnecessary or unintended data. Agencies will have the information needed to negotiate the needed terms for agreements on what data is provided, at what frequency, and in what form. Formal roles and accountability will help agency staff by providing data in efficient and effective ways and giving them a consistent and sustainable framework for data management. If implemented well, policies and procedures result in higher quality data, more effective use of data, and clear decision-making processes around data. Agencies can reduce risks of disruption in business activities and plan for the orderly and efficient transition of responsibilities.

Table 34 compares some key aspects of data strategy and governance capabilities. In Kansas, data governance and planning activities are refined to focus on key risks. Comprehensive policies for the data

have been developed based on collaboration across the agency. The freight datasets are maintained and updated frequently. Data inventory is used to identify duplicated datasets to improve efficiency. Michigan and Iowa have some collaboration across business units to improve datasets. The states have developed metrics for data governance, with clearly designated roles of accountability for data quality and value. Data management capabilities and skills are clearly identified in staff position descriptions.

Data Life-cycle Management

The analysis includes two elements for assessing the maturity of data life-cycle management practices.

Data Findability and Documentation: At lower levels of maturity, datasets are discovered primarily by word of mouth. At higher levels of maturity, the agency has and maintains standard information (meta data) about what each data set contains, including the meaning of each data item.

Data Updating: At lower levels of maturity, data updates are made ad hoc and users are not aware of data updating frequencies or methods. In addition, rules for adding and deleting key data entities (e.g., routes, bridges, projects) have not been developed. At higher levels of maturity, business rules govern how each major data set is to be updated. Where applicable, business rules are embedded into applications to prevent data anomalies.

In Table 14, the average capability self-assessment score for Data Life-cycle Management tends to be lower than for the other assessment dimensions. Agencies can improve data life-cycle management using the following recommended actions described in NCHRP Report 814 (Spy Pond Partners, LLC; Iteris, Inc., 2015).

- Data Catalogs and Dictionaries
- Data Management Plans
- Data Curation Profiles
- Standard Operating Procedures

There are benefits for agencies with mature for data life-cycle management capabilities. A catalog of datasets adds value to existing data by promoting re-use and minimizing the chance that duplicate data will be collected. Documenting the source and derivation of data elements also reduces risks associated with data misuse. Rules for updating data can benefit both data managers and users by reducing the cost of data maintenance and improving the quality of data.

Table 15. Data Strategy and Governance Performance

Capability	Michigan	Iowa	Indiana	Illinois	Kansas
Data collection and management	Collaborated under executive leadership	Preparing for the agency-wide data	Collaborated under executive leadership	Performed by individual business unit	Collaborated under executive leadership
Data improvement plan	Systematically reviewed, assessed, and documented	Informally identified and reviewed	Systematically reviewed, assessed, and documented	Upon opportunistic basis	Systematically reviewed and refined to focus on key risks
Data collection and management are aligned to the plan	Yes	No	Yes	No	Yes
The agency has assigned authority for data quality, value, and appropriate use	Data governance body has been established; roles are identified; capability and skilled are included in staff position description.	Individuals have been identified to lead; but no formal responsibility written.	Individuals have been identified to lead; but no formal responsibility written.	No	Individuals have been identified to lead; but no formal responsibility written
Freight data is a strategic asset	No	No	No	No	Comprehensive data management policies are in place. Processes are enforced.
Do you gather feedback from users of the freight data you manage?	Sometimes	Sometimes	Rarely	Rarely	Question not answered

Table 16. Data Inventory Performance

Criteria	Michigan	Iowa	Indiana	Illinois	Kansas
Awareness of freight dataset applications	Yes	Yes	Yes	No	Yes
Freight data is included in the data inventory.	No	Yes	No	No	Yes
Freight data update and maintenance	No	No	No	No	Yes
Transition plan for data custodian staffs	Yes. Key persons are identified	No. The risks are understood, no key person is identified	No. The risks are understood, no key person is identified	No	Yes. Key persons are identified

Data Architecture and Integration

The analysis includes two elements for assessing the maturity of data architecture and integration practices.

Common Location Referencing: At low levels of maturity, different datasets use different methods for location referencing and standards for location referencing have not been established. Some map information or merged datasets are not reliable. At high levels of maturity, location referencing standards are in place for new datasets and existing datasets are transformed as needed to use the standard referencing methods.

Geospatial Data Management: At low levels of maturity, various methods may be used across the agency for collecting and managing spatial data. Hardware, software and services related to GIS are not standardized or coordinated with legacy data management functions. At high levels of maturity, the agency views spatial data management and mapping as integral to the overall data management. GIS data is integrated with other agency business data.

In Table 14, the average capability self-assessment score for the Data Architecture and Integration elements is consistent across the states. The actions listed below are recommended for improving data architecture and integration capability to support business activities that use freight data. These actions are described in NCHRP Report 814 (Spy Pond Partners, LLC; Iteris, Inc., 2015).

- Common Geospatial Referencing
- Data Change Management
- Data Stewardship and Governance Policies
- Data Delivery Platforms

There are many benefits for agencies with mature data architecture and integration capabilities. Standardization of location referencing enables agencies to visualize and integrate data efficiently, thereby increasing the business value of agency data. The agency can keep data current because it can quickly propagate changes to linear references as road changes occur or as errors are corrected. Geo-

spatial data management leads to streamlined data integration processes, thereby eliminating time-consuming, repetitive and error-prone data.

Table 17 summarizes key findings. Indiana DOT appears to lead in capability maturity for spatial data architecture and integration. The LRS is used for all agency datasets that include location. The agency has LRS data standards and requirements. Also, locations can be transformed between coordinate-based location and linear referencing.

Table 17. LRS Data Integration Performance

	Michigan	Iowa	Indiana	Illinois	Kansas
Agency has LRS standards	Establishing standards	Establishing standards	Standards in place	No	Developing
LRS is required for datasets that include location	New datasets	New datasets	All datasets	No	No
Ability to transform between linear and geo-spatial coordinate systems	No	No	Yes	No	No

Data Collaboration

The analysis includes two elements for assessing the maturity of data collaboration practices.

Internal Agency Collaboration: At lower levels of maturity, business units handle data collection and acquisition efforts independently. Each unit views the data they collect as “their own” and does attempt to share data management with business units within the agency. At higher levels of maturity, data partnerships across the agency are encouraged and incentivized and data collection efforts are coordinated across business units.

External Collaboration: At lower levels of maturity, individuals may seek out and acquire datasets from external entities on a one-time basis as needs arise and external requests for agency data are considered on a case-by-case basis. At higher levels of maturity, data sharing is ongoing and data-sharing agreements make the best of both internal and external data resources. The agency provides self-serve access to key datasets for which there are frequent requests.

In Table 14, the average capability self-assessment score for the Data Collaboration elements varies widely across the states. The recommended actions, listed below, can be used to advance data architecture and integration capability. These actions are described in NCHRP Report 814 (Spy Pond Partners, LLC; Iteris, Inc., 2015).

- Multi-Purpose Data Collection
- Data Outsourcing
- Data Business Plans
- Data Governance Bodies
- Data Clearinghouses/Open Data Platforms
- Data-Sharing Agreements
- Data Partnerships

There are many benefits for agencies with mature data collaboration capabilities. First, business units can work together to share costs and support resources to deploy new data collection technologies (e.g., videolog and LiDAR). A collaborative approach to data collection and management reduces duplicative efforts and prevents proliferation of multiple overlapping and inconsistent datasets. Second, external data collaboration capabilities save the agency staff time in fulfilling data requests and give agency staff access to data otherwise unavailable or at a lower cost than if it were collected and managed in-house.

Table 18 summarizes key findings. All of the DOTs share freight data between the planning and other business units within the agency. Michigan DOT and Kansas DOT share freight data with organizations outside the state DOTs. Only Michigan has a staff liaison to manage the external partnerships for data sharing.

Table 18. Data Collaboration Performance

Components of Successful Data Collaborations	Michigan	Iowa	Indiana	Illinois	Kansas
Data update	Regularly	As needed	No	No	Regularly
Partnerships with external entities	Yes	Upon request	No	No	Yes
Collaboration with internal agency units	Yes	Yes	Yes	No	Yes

Data Quality Management

At low levels of maturity, there is a lack of awareness about the quality of the agency’s datasets beyond anecdotal information. At high maturity levels, the agency has standard definitions and metrics for data quality. At low levels of maturity, data quality issues are address as they are found. New data collection efforts do not have standards for data quality assurance. At high maturity levels, data quality techniques include the use of standard quality control and quality assurance processes for new data collection, business rules for data validation, automated data cleansing procedures, procedures for error reporting and correction.

Data quality improvement efforts need to be tailored to specific data types and collection methods. Providing data users with data quality metrics helps them determine whether a dataset meets the needs. Data quality measurement can be costly, so it is important to focus on a few essential measures and take advantage of quality metrics that can be automatically generated (e.g., validation rules).

In Table 14, the average self-assessment score for Data Quality tends to be the highest among the five dimensions that were assessed. Agencies can improve data quality by implementing the quality techniques listed above. These techniques are described in the NCHRP Report 814 (Spy Pond Partners, LLC; Iteris, Inc., 2015).

Freight Goals and Data Barriers

The state DOT agency goals are similar for all states: maintenance, preserving the environment, operational efficiency, and safety. These are consistent with goals of the US DOT and are expected results. The state DOTs were asked about the agency’s freight goals. The freight goals, listed in Table 19,

are organized according to goals that govern the US DOT investment programs. From the perspective of state-level freight planning, economic productivity, efficiency, congestion reduction, safety, security, resiliency, maintenance, and environmental sustainability are common goals for all states.

Table 19. Agency Freight Goals

US DOT Goal	Freight Goal
Economic Development	Improve the contribution of the freight transportation system to economic efficiency, productivity, and competitiveness
Operational Efficiency	Reduce congestion on the freight transportation system Use advanced technology, performance management, innovation, competition, and accountability in operating and maintaining the freight Improve freight mobility while protecting our transportation infrastructure
Safety	Improve the safety, security, and resilience of the freight transportation system
State of Good Repair	Improve the state of good repair of the freight transportation system
Environmental Protection	Reduce adverse environmental and community impacts of the freight transportation system

The survey participants were asked to indicate the barriers they encounter when working with freight data in their business activities. While the freight goals are similar among agencies, the freight data barriers are different. In addition to the well-known barriers of access to private-sector freight data, the participants mentioned other data barriers.

Jesse Gwilliams, of Michigan DOT explains,

“Hard to get complete data on commodity movements, especially by truck. We can get some limited private data, but mostly it is hard to get... and then changes constantly.”

Iowa DOT lacks commodity type by highway, rail, and waterway corridors. On the waterways, they want to know tonnages and values by barge terminal and commodity types by barge terminal. For Iowa DOT, Sam Hiscocks comments,

“We have freight-related data that we update and utilize on a regular basis. However, one barrier that we do have is a lack of knowledge on private data sources that exist and are available to us for purchase.”

Kristin Brier of Indiana DOT explains,

“We don’t have an existing infrastructure to measure most dimensions of freight movement in Indiana, so establishing a baseline is difficult.”

These data barriers emphasize the lack of knowledge about privately held commodity flow data. However, if commodity flow data were available, some states do not have the in-house capacity to carry out an analysis to interpret the data.

For Indiana, Kristin Brier writes,

“The data we have is from our oversize/overweight permitting program, and from national datasets such as the FAF. We do not have state-measured data on commodities and flows, common truck routes, or locations of heavy industrial or distribution areas. We do not have any data on the 50+ private ports in Indiana. While we have location information and some level of data about activities at our large transportation facilities (public ports, cargo airports, and intermodal facilities), regional and local facility information is sparse.”

The freight goals indicate what data and information are important. Table 20 lists the goals from the perspective of the agency planning department. The table indicates the states that have expressed the goals and barriers. The table is useful for states to consider how barriers to freight data could affect the agency’s ability to accomplish its freight-related business goals.

Table 20. Data Barriers Which Might Interrupt the Accomplishment of Freight Goals

FREIGHT GOAL	DATA BARRIER					
	No funding for freight data	No knowledge on private database	No access to private database	No capacity for data management	No capacity for data analysis	Lack of commodity data
Improve the contribution of the freight transportation system to economic efficiency, productivity	MI	IA	IA	KS	KS	MI, IA
Freight mobility - Reduce congestion on the freight transportation system	IN, MI	IA	IN, IA	IN	IN	MI, IA
Improve the safety, security, and resilience of the freight transportation system	MI	IA	IA			MI, IA
Improve the state of good repair of the freight transportation system	MI, IN	IA	IA, IN	IN	IN	MI, IA
Reduce adverse environmental and community impacts of the freight transportation system	MI	IA	IA			MI, IA

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APPENDIX A – Glossary

Business Area: An organizational unit within the DOT, e.g., Planning.

Business Function: A process or operation that is performed routinely to carry out a part of the mission of an organization, e.g., Permitting.

Business Procedure: Describes the steps needed to perform a business function.

CRUD: Stands for create, read, update and delete. These are the way users may interact with data. We will use CRUD to describe the characteristics of current and future freight data needs.

Data Custodian: the agency person who manages data entities in support of planning activities.

Data entity: The type of data being used for decision-making (Example: Traffic and facility data are both used for “Programming of State Highway Projects.”)

Dataset: Where the data comes from, including an indication whether it is internally generated by the DOT, or an external source outside the agency. (Example: Traffic and facility data both come from Metamanger at Wisconsin DOT.)

Freight Activity: A task with a beginning and an end that a business area is responsible for performing e.g., Process permit review requests. (Example: “Programming of State Highway Projects” is a freight activity.)

Freight Data: Data for making decisions regarding the planning, design, construction, operation, and maintenance of transportation infrastructure, e.g., truck routes, ESAL charts, truck traffic, variable speed limits, intermodal connectors, OSOW routes, etc.

Freight Data Source: Recognized name of a dataset, database, or data vendor, e.g., Truck counts, Transearch, or HPMS.

Freight Data Types: Data can be classified according to type:

- Freight Asset: Bridges, pavement,
- Freight Facilities: Airport inventory, intermodal facilities inventory, etc.
- Freight Mobility: Commodity flow, travel time, bottlenecks, etc.
- Freight Safety: Truck VMT, Fatalities/Injuries involving Freight.
- Freight Maintenance and Operations: Snow Plow Routes, OSOW,
- Freight Financial, Program or Project Data

Appendix B – CFIRE Freight Data Management Assessment Tool Survey

I. Introduction

Thank you for participating in our study, A Synthesis of Freight Data Practice in Midwest State DOTs. This survey was adapted from the National Cooperative Highway Research Program's *Report 814, Data to Support Transportation Agency Business Needs: A Self-Assessment Guide*. This survey has three parts. You may revise your answers at any point until you submit the completed survey. Please contact CFIRE Project Assistant Sophia Rogers for support via xxx@wisc.edu.

1.1 Please enter your name and position.

- Name (1) _____
- Job title (2) _____

1.2 At which Department of Transportation do you work?

- Illinois (115)
- Indiana (116)
- Iowa (117)
- Kansas (118)
- Kentucky (119)
- Michigan (120)
- Minnesota (121)
- Missouri (122)
- Ohio (123)
- Wisconsin (124)

1.3 What are your agency's overall goals?

- Goal 1 (1) _____
- Goal 2 (2) _____
- Goal 3 (3) _____
- Goal 4 (4) _____
- Goal 5 (5) _____
- Goal 6 (6) _____

1.4 What are your agency's goals specifically related to freight?

- Goal 1 (1) _____
- Goal 2 (2) _____
- Goal 3 (3) _____
- Goal 4 (4) _____
- Goal 5 (5) _____
- Goal 6 (6) _____

I.5 Do you work in the Iowa DOT Office of Systems Planning? *(Displays the reported data based on answer to Question 1.2 - At which Department of Transportation do you work? – Iowa is selected)*

- Yes (1)
- No, I work elsewhere: (2) _____

I.5 In which business area do you work within INDOT Engineering and Asset Management?

I.5 Do you work in the IDOT Bureau of Planning?

I.5 In which business area do you work within the Kansas DOT?

I.5 In which business area do you work within the Kentucky DOT Division of Planning?

- Data Management (1)
- Strategic Planning (2)
- Transportation Systems (3)
- Traffic & Equipment Management (4)
- Customer Service (5)
- Modal Programs (6)
- Other (7) _____

I.5 In which business area do you work within the Michigan DOT Bureau of Transportation Planning?

- Statewide Planning Division (1)
- Transportation Asset Management Council Support Division (2)
- Intermodal Policy Division (3)
- Data Inventory & Integration Division (4)
- Other (5) _____

I.5 In which business area do you work within MnDOT Planning & Programming?

- Office of Transportation System Management (1)
- Programming and Performance Management (2)
- Planning and Data Analysis (3)
- Capital Planning (4)
- Performance, Risk, and Investment Analysis (5)
- Program Financing and Reporting (6)
- Capital Programming (7)
- Investment Planning (8)
- Performance Measures & Risk (9)
- Policy Planning (10)
- District Planning (11)
- Other (12) _____

I.5 Do you work in a more specific business area within MoDOT Transportation Planning?

I.5 Do you work in a more specific business area within the WisDOT Bureau of Planning & Economic Development?

1.5 In which business area do you work within the ODOT Division of Planning?

- Asset Inventory & Systems Integration (1)
- Environmental Services (2)
- Local Programs (3)
- Program Management (4)
- Statewide Planning & Research (5)
- Technical Services (6)
- Transit (7)
- Other (8) _____

1.6 Which barriers do you encounter working with freight data in your business area? Select all that apply.

- We don't have in-house capacity to manage freight data effectively. (1)
- We don't have a dedicated source of funding for freight data. (2)
- We don't have access to privately held data. (3)

1.7 Do other barriers exist? Please list and explain. _____

1.8 Which freight data is your business area lacking and in what level of detail? _____

Questions on Data Architecture and Integration

1.9 Does your DOT have a single location referencing system (LRS)?

- My DOT does not have a single, common LRS. Data sets including location elements cannot be spatially integrated with other agency data sets. (1)
- My DOT is working towards establishing a single, common LRS. Representation of location information is in the process of being standardized. (2)
- My DOT has developed a single, common LRS. Quality standards for the LRS have been established with input from a variety of business units. We have defined a process for propagating changes in the LRS to various agency data sets. New data sets that include location elements are collected using the LRS. (3)
- My DOT's LRS is used for all agency data sets that include location. The LRS meets established quality standards. Methods are in place and functioning to propagate changes in location referencing resulting from road network changes to business data sets. Methods are in place and functioning to translate between coordinate-based location referencing (e.g. latitude/longitude) and linear referencing (e.g. route-milepoint). (4)
- My DOT has a standard architecture for linking agency GIS and LRS data to business data systems. Methods for propagating changes in location referencing resulting from road network changes are automated. Data owners/managers work closely with GIS staff and proactively work to improve their data sets' consistency with agency-wide standards. (5)

1.10 Comments (if needed): _____

1.11 Does your DOT have a standardized approach to collection, management, and integration of geospatial data?

- I don't know how other business areas collect and manage geospatial data. My DOT does not provide enterprise-wide planning and support for management and integration of geospatial data. (1)
- My DOT has designated responsibilities for enterprise-wide planning and support for managing geospatial data. The agency manages a collection of spatial data sets and makes them available for internal use. (2)
- My DOT has written policies and standards that define how geospatial data are to be collected, stored, managed, shared and integrated with non-spatial data attributes. The agency includes consideration of spatial data in their information technology strategic plan (or equivalent) that identifies investment needs and priorities for hardware, software and data. We have identified data entities that should have standard location referencing. (3)
- My DOT has a well-understood and functioning process for collecting, adding and updating geospatial data sets. We have a standard approach to assigning spatial location to key data entities (e.g. construction projects, assets.). Training and support is provided to ensure adherence to adopted policies and standards for geospatial data collection and management, and to build skills in spatial data analysis. (4)
- Spatial data collection, management and visualization requirements are fully integrated within my DOT's information technology and data management planning and operational functions. We periodically reevaluate and update our approach to geospatial data management to reflect changes in technology, data availability and cost, and user requirements. (5)

1.12 Comments (if needed): _____

Questions on Data Collaboration

1.13 Do you share and receive data with organizations outside of your DOT?

- I obtain and use publicly available data but I don't actively partner with outside organizations to share data. (1)
- I obtain and use publicly available data from external entities, and I have acquired single “point-in-time” data sets from external sources. External data requests are handled on a piecemeal basis. (2)
- I'm exploring partnerships with organizations to share data on an ongoing basis. (3)
- I have sustained partnerships with external entities involving regular update cycles. (4)
- I work with a staff liaison to seek new opportunities for data partnerships with external entities. This staff liaison manages external partnerships. (5)

1.14 Comments (if needed): _____

1.15 Do you collaborate on data collection and management with data experts in other business areas?

- Most data collection efforts in my DOT are independent. There have been little or no efforts to coordinate across business units. I don't know the extent to which data are duplicated. (1)
- My DOT has done an assessment of the extent to which there is duplication across data sets within my agency. Opportunities for coordinating data collection and management across business units (e.g. safety and asset management) are periodically discussed, but limited progress has been made. (2)
- My DOT has implemented data collection efforts involving coordination from more than one business unit (e.g. use of video imagery from pavement data collection to extract data on other assets). We have defined metrics to track improvements in data collection and storage efficiency. (3)
- Business data owners are encouraged and incentivized to share their data with a broader audience within my DOT (where appropriate). We are encouraged and incentivized to plan new data collection initiatives in partnerships with other business units where information needs of multiple units can be simultaneously addressed. The agency monitors progress of efforts to reduce data duplication. (4)
- My DOT periodically reviews its data collection programs to identify opportunities to leverage new technologies and externally available data sets. My DOT regularly seeks opportunities to minimize or reduce redundancy in data collection, storage and processing. (5)

1.16 Comments (if needed): _____

Questions on Data Strategy and Governance

1.17 To what extent do your leadership and strategic planning maximize the value of data to meet agency goals?

- I'm not aware of any systematic plan for data improvements. Data collection and management is performed by individual business units with little or no agency-wide direction or coordination. We make changes on a reactive or opportunistic basis. (1)
- Efforts to implement agency-wide data governance or assess agency-wide data needs are being discussed or planned. Data improvement needs are identified and communicated to management in an informal manner. (2)
- Executive leadership has communicated their expectation that business units and information technology functions should collaborate on identifying and implementing data improvements that are of agency-wide benefit. Data business plans or equivalent planning tools have been prepared to identify short and longer term data collection and management strategies that align with business objectives. Data improvement needs have been systematically reviewed, assessed and documented. (3)
- Leadership regularly demonstrates support for data improvements that will lead to improved

agency to effectiveness. Leadership works to facilitate collaboration across business units on data improvements and maintain strong partnerships between IT and business-unit managers. Data business plans or equivalent planning tools are regularly updated. A regular process of data needs assessment is in place and is used to drive budgeting decisions. (4)

- Data governance and planning activities are continually refined to focus on key risks and opportunities and to eliminate activities without demonstrated payoff. Data governance and planning activities would have a high probability of continuing through changes in executive leadership. (5)

1.18 Comments (if needed): _____

1.19 Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?

- I'm not aware of any established accountability for the quality, value, and appropriate use of data. (1)
- One or more individuals have been identified to lead agency-wide data governance activities. A point person has been designated for each major data set or application but the responsibilities of their role haven't been spelled out. (2)
- An agency-wide data governance body has been established with representation from information technology and business functions and has defined its charter. Objectives and performance metrics for data governance and stewardship have been defined and documented. Role(s) have been designated to identify points of accountability for data quality, value and appropriate use. Decision making authority has been defined for collection/acquisition of new data, discontinuation of current data collection, and significant changes to the content of existing data. Capabilities and skills for data management are included in staff position descriptions, recruiting, and staff development efforts. (3)
- An agency-wide data governance body is active and achieving results recognized as valuable. My DOT is successfully identifying and resolving situations where individual business unit interests are in conflict with agency-wide interests related to data collection and management. Staff with responsibility for data stewardship and management have sufficient time and training to carry out these responsibilities. Staff with responsibility for data stewardship and management play an active role in defining data improvements and periodically produce reports of progress to their managers. (4)
- A charter for agency-wide data governance body is reviewed periodically and updated based on experience. Stewardship roles are periodically reviewed and refined to reflect new or changing data requirements and implementation of new data systems. Staff with responsibility for data stewardship and management are coordinating with their peers in the DOT and with external data partners to deliver best value for resources invested. Data management-related metrics are routinely considered in employee performance reviews. (5)

1.20 Comments (if needed): _____

1.21 Has your DOT adopted policies and processes for managing freight data as a strategic asset?

- I haven't heard of any formal policies and procedures regarding strategic freight-data management. (1)
- Leadership has defined basic freight-data management principles. (2)
- Leadership has established the scope of freight-data management. Data classifications have been defined based on agency-wide importance or need for cross-business unit integration. A limited set of data management policies have been adopted for priority data categories. We have a documented procedure and decision-making process for requesting and evaluating new data collection or acquisition requests. (3)
- Leadership has adopted a comprehensive set of data management policies based on collaboration across my DOT including IT, business units, and records management. Processes are in place to monitor and enforce compliance with policies. We follow written procedures for requesting and evaluating new data collection or acquisition requests. (4)
- Policies are regularly reviewed and updated based on factors such as awareness/reach within my DOT, effectiveness, and cost burden. (5)

1.22 Comments (if needed): _____

1.23 Does your DOT have an agency-wide data inventory that includes freight data?

- My DOT has no agency-wide data inventory that includes freight data. There is limited awareness of how freight data sets are used and what value they provide. (1)
- There is general awareness of how freight data sets are used and what value is being provided, but there is no agency-wide data inventory that includes freight data. (2)
- Freight data sets have been recorded in an agency-wide data inventory. Primary users, uses, and costs are also tracked. (3)
- An agency-wide inventory of data sets that includes freight data is maintained and updated as new data sets come on line. Data inventory information is used to identify duplicative data sets that can be eliminated or consolidated. Managers use information about data storage and management costs to evaluate opportunities for improved efficiencies. (4)
- Not only do we have and utilize an agency-wide data inventory that includes freight data but we also have an excellent understanding of the value provided by freight data sets with respect to efficiency and effectiveness. We are constantly improving our freight data collection and management methods. (5)

1.24 Comments (if needed): _____

1.25 How about your business area? Does your business area maintain a data inventory that includes freight data?

- My business area has no data inventory that includes freight data. There is limited awareness of how freight data sets are used and what value they provide. (1)
- There is general awareness of how freight data sets are used and what value is being provided, but there is no inventory that includes freight data. (2)
- Freight data sets have been recorded in a data inventory. Primary users, uses, and costs are also tracked. (3)
- An inventory of data sets that includes freight data is maintained and updated as new data sets come on line. Data inventory information is used to identify duplicative data sets that can be eliminated or consolidated. Managers use information about data storage and management costs to evaluate opportunities for improved efficiencies. (4)
- Not only do we have and utilize a data inventory that includes freight data but we also have an excellent understanding of the value provided by freight data sets with respect to efficiency and effectiveness. We are constantly improving our freight data collection and management methods. (5)

1.26 Comments (if needed): _____

1.27 Do staff transition processes preserve data management knowledge and expertise within your business area?

- There is little understanding of the risks and needs associated with the retirement of key individuals with specialized data knowledge. (1)
- There is some understanding of the risks and needs associated with the requirement of key individuals with specialized data knowledge. However, these risks have not been systematically identified. (2)
- Individuals with specialized data knowledge have been systematically identified. We have some strategies to mitigate these risks. (3)
- There is a standard process in place to ensure continuity in data management practices through staff transitions. Staffing requirements for data management activities are understood and planned-for. (4)
- People with specialized knowledge about freight data have been identified and there are success plans and mentoring strategies in place to pass on specialized knowledge to others. There is a functioning process in place to bring on new skills and capabilities as needed to address changing technologies and data-management methods. (5)

1.28 Comments (if needed): _____

Section 2. Data Inventory

2.1 Iowa DOT's Office of Systems Planning reported the following freight-related data sets for CFIRE's MAFC-14 Alignment Study. Which data sets do you work with? Please add or remove data sets as needed. *(Displays the reported data based on answer to Question 1.2 - At which Department of Transportation do you work?)*

- Data set 1 (1) _____
- Data set 2 (2) _____
- Data set 3 (3) _____
- Data set 4 (4) _____
- Data set 5 (5) _____

2.2 Which platform is used for each data set (e.g. GIS)?

(Carries forward entered text from Question 2.1 - The Iowa DOT reported the following freight-related data sets for CFIRE's MAFC-14 Alignment Study. Which data sets do you work with? Please add or remove data sets as needed.)

- Data set 1 (1) _____
- Data set 2 (2) _____
- Data set 3 (3) _____
- Data set 4 (4) _____
- Data set 5 (5) _____

2.3 Roughly how many times a year is each data set updated? Please enter a number.

(Carries forward entered text from Question 2.1 - The Iowa DOT reported the following freight-related data sets for CFIRE's MAFC-14 Alignment Study. Which data sets do you work with? Please add or remove data sets as needed.)

- Data set 1 (1) _____
- Data set 2 (2) _____
- Data set 3 (3) _____
- Data set 4 (4) _____
- Data set 5 (5) _____

2.4 Is this data set a subset of another data set? Which one?

(Carries forward entered text from Question 2.1 - The Iowa DOT reported the following freight-related data sets for CFIRE's MAFC-14 Alignment Study. Which data sets do you work with? Please add or remove data sets as needed.)

- Data set 1 (1) _____
- Data set 2 (2) _____
- Data set 3 (3) _____
- Data set 4 (4) _____
- Data set 5 (5) _____

2.5 Do you have access to adding data to this data set? Do you have access to deleting data? (Carries forward entered text from Question 2.1 - The Iowa DOT reported the following freight-related data sets for CFIRE's MAFC-14 Alignment Study. Which data sets do you work with? Please add or remove data sets as needed.)

	I can add but not delete data. (1)	I can delete but not add data. (2)	I can both add and delete data. (3)
Data set 1 (x1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 2 (x2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 3 (x3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 4 (x4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 5 (x5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.6 Describe the quality of each data set. (Carries forward entered text from Question 2.1 - The Iowa DOT reported the following freight-related data sets for CFIRE's MAFC-14 Alignment Study. Which data sets do you work with? Please add or remove data sets as needed.)

	Translating the data takes substantial effort. (1)	Translating the data takes moderate effort. (2)	Reporting capabilities could improve. (3)	Reporting capabilities are perfectly sufficient. (4)	I don't know - not enough information. (5)
Data set 1 (x1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 2 (x2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 3 (x3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 4 (x4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 5 (x5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.7 Describe the usability of each data set.

(Carries forward entered text from Question 2.1 - The Iowa DOT reported the following freight-related data sets for CFIRE's MAFC-14 Alignment Study. Which data sets do you work with? Please add or remove data sets as needed.)

	Translating the data takes substantial effort. (1)	Translating the data takes moderate effort. (2)	Reporting capabilities could improve. (3)	Reporting capabilities are perfectly sufficient. (4)	I don't know - not enough information. (5)
Data set 1 (x1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 2 (x2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 3 (x3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 4 (x4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data set 5 (x5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.8 Are you aware of any data set that your DOT is using elsewhere and your business area might benefit from exploring? Which set? _____

2.9 Which freight-related data entities do you work with? Please overwrite the examples provided with more specific data entities (e.g. highway total tons) and delete unused fields. (Displays generic data entities)

- Data entity 1 (1) _____
- Data entity 2 (2) _____
- Data entity 3 (3) _____
- Data entity 4 (4) _____
- Data entity 5 (5) _____
- Data entity 6 (6) _____
- Data entity 7 (7) _____
- Data entity 8 (8) _____
- Data entity 9 (9) _____
- Data entity 10 (10) _____

2.10 Which data entities does each data set contain? Select all that apply. (Carries forward entered text from Question 2.9)

	Data set 1 (1)	Data set 2 (2)	Data set 3 (3)	Data set 4 (4)	Data set 5 (5)
Data entity 1 (x1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data entity 2 (x2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data entity 3 (x3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data entity 4 (x4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data entity 5 (x5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Section 3. Freight Activities

This section requires you to gather information about freight activities related to your data sets. You might need to ask colleagues for their input.

3.1 Do you gather feedback from users of the freight data you manage?

- I rarely talk to data users and have little understanding of their needs. (1)
- I sometimes reach out to data users but not on a regular basis. (2)
- I've participated in formal meetings with current or potential new users for our data to understand their needs. This information has been taken into account in developing plans for improvements. (3)
- I routinely solicit input from my data users formally and informally. (4)
- Not only do I routinely gather feedback but I also follow written processes for what, when, and how data will be provided. We periodically re-evaluate these processes. (5)

3.2 Comments (if needed): _____

3.3 Does a data catalog enable freight data users to use and understand your data?

- Users rely on “word of mouth” to discover what data are available. There are variations across data sets in terms of the level and type of available documentation. (1)
- Efforts are underway to improve data findability and documentation through adoption of common metadata standards, development of data set catalogs, or creation of web pages with links to commonly requested data sets. (2)
- Standards and policies have been defined to ensure that there is a data dictionary available for each data set. Templates for describing data collection, updating and reporting processes have been developed and are starting to be utilized. (3)
- Business users can access a listing of available data sets to discover data of potential value to meet their needs. Consistent documentation is available describing data collection, updating, and reporting cycles for most of my DOT's core data sets. Data dictionary information is available and up-to-date. Quality assurance processes are in place to ensure that data dictionary information is complete and useful. Processes are in place to keep the data set listing (or catalog) up to date when data sets are added or discontinued. (4)
- Business users can search an agency-wide catalog for availability of data on a particular subject or entity type. The catalog is periodically improved based on feedback from users and research into best practices. (5)

3.4 Comments (if needed): _____

3.5 If a project generates new freight data, such as new traffic counts, what happens to the data after the project is over?

- I don't typically hear about new data being generated in my DOT. If people are generating new data relevant to my data set, I'm not aware of it. (1)
- I have seen reports with new data relevant to my data sets but I either don't trust the data or don't have capacity to integrate it into the shared data set. (2)
- I sometimes integrate new data into the shared data sets but there is no formal process. (3)
- There is a process in place for submitting new data to data custodians but it's not used very often. (4)
- There is a process in place for submitting new data to data custodians and we are constantly improving the data set by adding new data. (5)

3.6 Comments (if needed): _____

3.7 Which distinct freight activities utilize your freight data? Please overwrite the examples provided and delete unused fields.

- Freight activity 1 (1) _____
- Freight activity 2 (2) _____
- Freight activity 3 (3) _____
- Freight activity 4 (4) _____
- Freight activity 5 (5) _____
- Freight activity 6 (6) _____
- Freight activity 7 (7) _____
- Freight activity 8 (8) _____
- Freight activity 9 (9) _____
- Freight activity 10 (10) _____

3.8 Is this an ongoing activity? If not, when will it be completed? *(Carries forward entered text from Question 3.7 – Which distinct freight activities utilize your freight data?)*

	This is an ongoing freight activity. (1)	We will complete this freight activity in the next six months. (2)	We will complete this freight activity in the next six months to a year. (3)	We will complete this freight activity in over a year. (4)
Freight activity 1 (x1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 2 (x2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 3 (x3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 4 (x4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 5 (x5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.9 Are adequate data available to your DOT to support these freight activities? *(Carries forward entered text from Question 3.7 – Which distinct freight activities utilize your freight data?)*

	Little or no data is available to support this activity. (1)	Limited data is available but large gaps remain. (2)	Basic data is available but some gaps remain. (3)	Adequate data is available to meet needs and no gaps remain. (4)
Freight activity 1 (x1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 2 (x2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 3 (x3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 4 (x4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Freight activity 5 (x5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

You've reached the end of this survey. If you are satisfied with your answers, please continue to submit. You will not be able to edit your answers after submitting

Appendix C – Responses to Capability Maturity Assessment Questions

Table 21. Data Strategy and Governance Responses from Michigan DOT

Assessment Question	Capability Maturity
To what extent do your leadership and strategic planning maximize the value of data to meet agency goals?	Executive leadership has communicated their expectation that business units and information technology functions should collaborate on identifying and implementing data improvements that are of agency-wide benefit. Data business plans or equivalent planning tools have been prepared to identify short and longer-term data collection and management strategies that align with business objectives. Data improvement needs have been systematically reviewed, assessed and documented.
Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?	An agency-wide data governance body has been established with representation from information technology and business functions and has defined its charter. Objectives and performance metrics for data governance and stewardship have been defined and documented. Role(s) have been designated to identify points of accountability for data quality, value and appropriate use. Decision making authority has been defined for collection/acquisition of new data, discontinuation of current data collection, and significant changes to the content of existing data. Capabilities and skills for data management are included in staff position descriptions, recruiting, and staff development efforts.
Has your DOT adopted policies and processes for managing freight data as a strategic asset?	I haven't heard of any formal policies and procedures regarding strategic freight-data management.
Does your DOT have an agency-wide data inventory that includes freight data?	There is general awareness of how freight datasets are used and what value is being provided, but there is no agency-wide data inventory that includes freight data.
How about your business area? Does your business area maintain a data inventory that includes freight data?	There is general awareness of how freight datasets are used and what value is being provided, but there is no inventory that includes freight data.
Do staff transition processes preserve data management knowledge and expertise within your business area?	Individuals with specialized data knowledge have been systematically identified. We have some strategies to mitigate these risks.
Do you gather feedback from users of the freight data you manage	I sometimes reach out to data users but not on a regular basis.

Table 22. Data Strategy and Governance Responses from Iowa DOT

Assessment Question	Capability Maturity
To what extent do your leadership and strategic planning maximize the value of data to meet agency goals?	Efforts to implement agency-wide data governance or assess agency-wide data needs are being discussed or planned. Data improvement needs are identified and communicated to management in an informal manner.
Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?	One or more individuals have been identified to lead agency-wide data governance activities. A point person has been designated for each major dataset or application but the responsibilities of their role haven't been spelled out.
Has your DOT adopted policies and processes for managing freight data as a strategic asset?	I haven't heard of any formal policies and procedures regarding strategic freight-data management.
Does your DOT have an agency-wide data inventory that includes freight data?	Freight datasets have been recorded in an agency-wide data inventory. Primary users, uses, and costs are also tracked.
How about your business area? Does your business area maintain a data inventory that includes freight data?	Freight datasets have been recorded in a data inventory. Primary users, uses, and costs are also tracked.
Do staff transition processes preserve data management knowledge and expertise within your business area?	There is some understanding of the risks and needs associated with the requirement of key individuals with specialized data knowledge. However, these risks have not been systematically identified.
Do you gather feedback from users of the freight data you manage	I sometimes reach out to data users but not on a regular basis.

Table 23. Data Strategy and Governance Responses from Indiana DOT

Assessment Question	Capability Maturity
To what extent do your leadership and strategic planning maximize the value of data to meet agency goals?	Executive leadership has communicated their expectation that business units and information technology functions should collaborate on identifying and implementing data improvements that are of agency-wide benefit. Data business plans or equivalent planning tools have been prepared to identify short and longer-term data collection and management strategies that align with business objectives. Data improvement needs have been systematically reviewed, assessed and documented.

Assessment Question	Capability Maturity
Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?	One or more individuals have been identified to lead agency-wide data governance activities. A point person has been designated for each major dataset or application but the responsibilities of their role haven't been spelled out.
Has your DOT adopted policies and processes for managing freight data as a strategic asset?	I haven't heard of any formal policies and procedures regarding strategic freight-data management.
Does your DOT have an agency-wide data inventory that includes freight data?	My DOT has no agency-wide data inventory that includes freight data. There is limited awareness of how freight datasets are used and what value they provide.
How about your business area? Does your business area maintain a data inventory that includes freight data?	There is general awareness of how freight datasets are used and what value is being provided, but there is no inventory that includes freight data.
Do staff transition processes preserve data management knowledge and expertise within your business area?	There is some understanding of the risks and needs associated with the requirement of key individuals with specialized data knowledge. However, these risks have not been systematically identified.
Do you gather feedback from users of the freight data you manage	I rarely talk to data users and have little understanding of their needs.

Table 24. Data Strategy and Governance Responses from Illinois DOT

Assessment Question	Capability Maturity
To what extent do your leadership and strategic planning maximize the value of data to meet agency goals?	I'm not aware of any systematic plan for data improvements. Data collection and management is performed by individual business units with little or no agency-wide direction or coordination. We make changes on a reactive or opportunistic basis.
Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?	I'm not aware of any established accountability for the quality, value, and appropriate use of data.
Has your DOT adopted policies and processes for managing freight data as a strategic asset?	I haven't heard of any formal policies and procedures regarding strategic freight-data management.

Assessment Question	Capability Maturity
Does your DOT have an agency-wide data inventory that includes freight data?	My DOT has no agency-wide data inventory that includes freight data. There is limited awareness of how freight datasets are used and what value they provide.
How about your business area? Does your business area maintain a data inventory that includes freight data?	My business area has no data inventory that includes freight data. There is limited awareness of how freight datasets are used and what value they provide.
Do staff transition processes preserve data management knowledge and expertise within your business area?	There is little understanding of the risks and needs associated with the retirement of key individuals with specialized data knowledge.
Do you gather feedback from users of the freight data you manage?	I rarely talk to data users and have little understanding of their needs.

Table 25. Data Strategy and Governance Responses from Kansas DOT

Assessment Question	Capability Maturity
To what extent do your leadership and strategic planning maximize the value of data to meet agency goals?	Data governance and planning activities are continually refined to focus on key risks and opportunities and to eliminate activities without demonstrated payoff. Data governance and planning activities would have a high probability of continuing through changes in executive leadership.
Has your DOT defined clear roles, accountability, and decision-making authority for data quality, value, and appropriate use?	One or more individuals have been identified to lead agency-wide data governance activities. A point person has been designated for each major dataset or application but the responsibilities of their role haven't been spelled out.
Has your DOT adopted policies and processes for managing freight data as a strategic asset?	Leadership has adopted a comprehensive set of data management policies based on collaboration across my DOT including IT, business units, and records management. Processes are in place to monitor and enforce compliance with policies. We follow written procedures for requesting and evaluating new data collection or acquisition requests.
Does your DOT have an agency-wide data inventory that includes freight data?	An agency-wide inventory of datasets that includes freight data is maintained and updated as new datasets come on line. Data inventory information is used to identify duplicative datasets that can be eliminated or consolidated. Managers use information about data storage and management costs to evaluate opportunities for improved efficiencies.
How about your business area? Does your business area	An inventory of datasets that includes freight data is maintained and updated as new datasets come on line. Data inventory information is used to identify duplicative datasets that can be eliminated or

Assessment Question	Capability Maturity
maintain a data inventory that includes freight data?	consolidated. Managers use information about data storage and management costs to evaluate opportunities for improved efficiencies.
Do staff transition processes preserve data management knowledge and expertise within your business area?	Individuals with specialized data knowledge have been systematically identified. We have some strategies to mitigate these risks.
Do you gather feedback from users of the freight data you manage?	<i>Question was not answered.</i>

Table 26. Data Life-cycle Management Responses from Michigan DOT

Assessment Question	Capability Maturity
Does a data catalog enable freight data users to use and understand your data?	Efforts are underway to improve data findability and documentation through adoption of common metadata standards, development of data set catalogs, or creation of web pages with links to commonly requested datasets.
If a project generates new freight data, such as new traffic counts, what happens to the data after the project is over?	I sometimes integrate new data into the shared datasets but there is no formal process.

Table 27. Data Life-cycle Management Responses from Iowa DOT

Assessment Question	Capability Maturity
Does a data catalog enable freight data users to use and understand your data?	Efforts are underway to improve data findability and documentation through adoption of common metadata standards, development of data set catalogs, or creation of web pages with links to commonly requested datasets.
If a project generates new freight data, such as new traffic counts, what happens to the data after the project is over?	There is a process in place for submitting new data to data custodians and we are constantly improving the dataset by adding new data.

Table 28. Data Life-cycle Management Responses from Indiana DOT

Assessment Question	Capability Maturity
Does a data catalog enable freight data users to use and understand your data?	Users rely on “word of mouth” to discover what data are available. There are variations across datasets in terms of the level and type of available documentation.

If a project generates new freight data, such as new traffic counts, what happens to the data after the project is over?	I sometimes integrate new data into the shared datasets but there is no formal process.
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Table 29. Data Life-cycle Management Responses from Illinois DOT

Assessment Question	Capability Maturity
Does a data catalog enable freight data users to use and understand your data?	Users rely on “word of mouth” to discover what data are available. There are variations across datasets in terms of the level and type of available documentation.
If a project generates new freight data, such as new traffic counts, what happens to the data after the project is over?	I don't typically hear about new data being generated in my DOT. If people are generating new data relevant to my dataset, I'm not aware of it.

Table 30. Data Architecture and Integration Responses from Michigan DOT

Assessment Question	Capability Maturity
Does your DOT have a single (unifying) location referencing system (LRS)?	My DOT has developed a single, common LRS. Quality standards for the LRS have been established with input from a variety of business units. We have defined a process for propagating changes in the LRS to various agency datasets. New datasets that include location elements are collected using the LRS.
Does your DOT have a standardized approach to collection, management, and integration of geospatial data?	My DOT has written policies and standards that define how geospatial data are to be collected, stored, managed, shared and integrated with non-spatial data attributes. The agency includes consideration of spatial data in their information technology strategic plan (or equivalent) that identifies investment needs and priorities for hardware, software and data. We have identified data entities that should have standard location referencing.

Table 31. Data Architecture and Integration Responses from Iowa DOT

Assessment Question	Capability Maturity
Does your DOT have a single (unifying) location referencing system (LRS)?	My DOT has developed a single, common LRS. Quality standards for the LRS have been established with input from a variety of business units. We have defined a process for propagating changes in the LRS to various agency datasets. New datasets that include location elements are collected using the LRS.
Does your DOT have a standardized approach to collection, management, and integration of geospatial data?	My DOT has written policies and standards that define how geospatial data are to be collected, stored, managed, shared and integrated with non-spatial data attributes. The agency includes consideration of spatial data in their information technology strategic plan (or equivalent) that identifies investment needs and

	priorities for hardware, software and data. We have identified data entities that should have standard location referencing.
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Table 32. Data Architecture and Integration Responses from Indiana DOT

Assessment Question	Capability Maturity
Does your DOT have a single (unifying) location referencing system (LRS)?	My DOT's LRS is used for all agency datasets that include location. The LRS meets established quality standards. Methods are in place and functioning to propagate changes in location referencing resulting from road network changes to business datasets. Methods are in place and functioning to translate between coordinate-based location referencing (e.g. latitude/longitude) and linear referencing (e.g. route-milepoint).
Does your DOT have a standardized approach to collection, management, and integration of geospatial data?	My DOT has designated responsibilities for enterprise-wide planning and support for managing geospatial data. The agency manages a collection of spatial datasets and makes them available for internal use.

Table 33. Data Architecture and Integration Responses from Illinois DOT

Assessment Question	Capability Maturity
Does your DOT have a single (unifying) location referencing system (LRS)?	My DOT does not have a single, common LRS. Datasets including location elements cannot be spatially integrated with other agency datasets.
Does your DOT have a standardized approach to collection, management, and integration of geospatial data?	I don't know how other business areas collect and manage geospatial data. My DOT does not provide enterprise-wide planning and support for management and integration of geospatial data.

Table 34. Data Architecture and Integration Responses from Kansas DOT

Assessment Question	Capability Maturity
Does your DOT have a single (unifying) location referencing system (LRS)?	My DOT is working towards establishing a single, common LRS. Representation of location information is in the process of being standardized.
Does your DOT have a standardized approach to collection, management, and integration of geospatial data?	My DOT has designated responsibilities for enterprise-wide planning and support for managing geospatial data. The agency manages a collection of spatial datasets and makes them available for internal use.

Table 35. Data Collaboration Responses from Michigan DOT

Assessment Question	Capability Maturity
Do you share and receive data with organizations outside of your DOT?	I have sustained partnerships with external entities involving regular update cycles.
Do you collaborate on data collection and management with data experts in other business areas?	My DOT periodically reviews its data collection programs to identify opportunities to leverage new technologies and external datasets. My DOT regularly seeks opportunities to minimize or reduce redundancy in data collection, storage, and processing.

Table 36. Data Collaboration Responses from Iowa DOT

Assessment Question	Capability Maturity
Do you share and receive data with organizations outside of your DOT?	I obtain and use publicly available data from external entities, and I have acquired single “point-in-time” datasets from external sources. External data requests are handled on a piecemeal basis.
Do you collaborate on data collection and management with data experts in other business areas?	My DOT has implemented data collection efforts involving coordination from more than one business unit (e.g. use of video imagery from pavement data collection to extract data on other assets). We have defined metrics to track improvements in data collection and storage efficiency.

Table 37. Data Collaboration Responses from Indiana DOT

Assessment Question	Capability Maturity
Do you share and receive data with organizations outside of your DOT?	I obtain and use publicly available data but I don't actively collaborate with outside organizations to share data.
Do you collaborate on data collection and management with data experts in other business areas?	My DOT has implemented data collection efforts involving coordination from more than one business unit (e.g. use of video imagery from pavement data collection to extract data on other assets). We have defined metrics to track improvements in data collection and storage efficiency.

Table 38. Data Collaboration Responses from Illinois DOT

Assessment Question	Capability Maturity
Do you share and receive data with organizations outside of your DOT?	I obtain and use publicly available data but I don't actively collaborate with outside organizations to share data.

Do you collaborate on data collection and management with data experts in other business areas?	Most data collection efforts in my DOT are independent. There are little or no efforts to coordinate across business units. I don't know the extent to which data are duplicated.
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Table 39. Data Collaboration Responses from Kansas DOT

Assessment Question	Capability Maturity
Do you share and receive data with organizations outside of your DOT?	I have sustained partnerships with external entities involving regular update cycles.
Do you collaborate on data collection and management with data experts in other business areas?	My DOT has implemented data collection efforts involving coordination from more than one business unit (e.g. use of video imagery from pavement data collection to extract data on other assets). We have defined metrics to track improvements in data collection and storage efficiency.