Data Capability Maturity Model Guidelines

DATA PROGRAM RESEARCH

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List of Abbreviations

CIO chief information officer

CMM capability maturity model

CMU Carnegie Mellon University

DHS Department of Homeland Security

GSA General Services Administration

ITS intelligent transportation system

ITS-JPO Intelligent Transportation Service Joint Program Office

MPO metropolitan planning organization

OMB Office of Management and Budget

SEI Software Engineering Institute

SME subject matter expert

TSMO transportation systems management and operations

USDOT U.S. Department of Transportation

# Introduction

The Intelligent Transportation Systems Joint Program Office (ITS-JPO) Data Access and Exchanges Program seeks to enhance how agencies that collect/generate ITS or transportation data manage, access, and use those data throughout the transportation ecosystem, to support the next generation of ITS technologies. Capability maturity models (CMM) have proven effective at helping agencies avoid failed projects and continuously improve their processes across multiple categories (dimensions).1 The Data Access and Exchanges Program developed a data management CMM designed to determine the level of readiness of an organization to produce, collect, analyze, integrate, disseminate/share, store, maintain, support, and retire data. This CMM can assess the technical and organizational capability maturity of the U.S. Department of Transportation (USDOT) and its modal administrations/offices. This CMM can also assess the capabilities of institutions and organizations external to USDOT, such as State departments of transportation (DOTs), municipal DOTs, metropolitan planning organizations (MPOs), university research centers, transit agencies, and other entities.

The remainder of this document refers to the ITS-JPO data management CMM as the Data CMM. Some parts of this document may use the term data management CMM to refer to more generalized versions of the Data CMM, or other analogous CMMs from the literature. To support use of the Data CMM, this document presents a set of CMM guidelines. These guidelines will help stakeholders and implementors understand the following elements of the Data CMM: dimensions, subdimensions, capability levels, use cases, and readiness checklists. The intended audience for these guidelines consists of agencies (both internal and external to USDOT) interested in improving their ability to manage, access, and use ITS or transportation data.

The Data CMM contains much more content than other transportation CMMs at the time of this writing. Data CMM users can apply judgment regarding which parts of the assessment will be most helpful to the agency. In general, completing more parts of the assessment will lead to more robust understanding of actions that could improve capability maturity. The Data CMM also provides a “Response Rate” output measure that will allow reviewers to know which parts of the assessment are complete.

The Data CMM provides the following capability maturity ratings for each dimension, subdimension, and readiness checklist item:

* Level 1: Low Capability
* Level 2: Medium Capability
* Level 3: High Capability
* Level 4: Maximum Capability

These are self-assessed descriptors/degrees of capability maturity that do not carry any intrinsic meaning or definition.

# The CMM Concept

CMMs are process improvement plans1. The CMM concept emerged in the late 1980s when observers noted that Department of Defense software development programs had frequent cost overruns and late deliveries. The Software Engineering Institute (SEI) at Carnegie Mellon University (CMU) investigated the problem and concluded the problems were managerial, not technical2. The result was the development of a software process maturity framework that described five maturity levels. This CMM originally intended to solve a specific problem and encourage improvements in processes. Since then, many industries have tried to repeat the original successes of the software CMM. The goal of these variants is to achieve continuous improvement in processes and capabilities. At their core, these CMMs document and encourage effective practices and are only successful when those in management apply and self-evaluate. Mark Paulk of CMU suggests that all CMMs “struggle with balancing generality, detail, and usability,” and that all CMM frameworks need to be “abstract and flexible” for use in a wide range of environments. The goal-based structure of the software CMM made it powerful and flexible in the right hands; however, variants that tried to be too niche have been less successful. Paulk says that successful CMMs “need to be the basis for a best-practice framework that act as the basis for reliable and consistent appraisals and effective process improvement programs.”

The transportation industry has developed several CMMs for specialized areas within transportation. Some examples of these specialized areas include transportation systems management and operations (TSMO)3,4, traffic analysis5, connected and automated vehicles6, traffic signal management7, and transportation data management8. The Data CMM differs from other CMMs in the following ways:

* Provides a more rigorous assessment of capability maturity levels compared to other data management CMMs. The primary mechanisms for achieving this increased rigor are through the availability of comprehensive readiness checklists, a dedicated mechanism for documenting barriers to advancement, key transportation use cases for data management, and an efficient software tool for applying the Data CMM.
* Does not directly address capabilities beyond those needed for data management. For example, the Data CMM does not directly assess the agency’s proficiency at leveraging traffic simulation models, measuring the performance of TSMO strategies, or integrating vehicle-to-infrastructure systems. However, if an agency improves its data management capabilities, this could indirectly improve their capabilities in these other areas. For example, a mature data management system could facilitate the development and review of traffic simulation models.

To help readers understand the overall CMM concept, a simple example of a transportation CMM may be helpful. Figure 1 illustrates a high-level view of FHWA’s traffic analysis CMM framework. This illustration shows that the traffic analysis CMM has 8 dimensions, 25 subdimensions, and 4 levels of capability maturity. This framework allows transportation agencies to self-assess their capability maturities within each of the 8 dimensions and 25 subdimensions. Once they have assessed their strengths and weaknesses within these dimensions and subdimensions, they can develop an action plan for improving targeted areas on an annual basis.

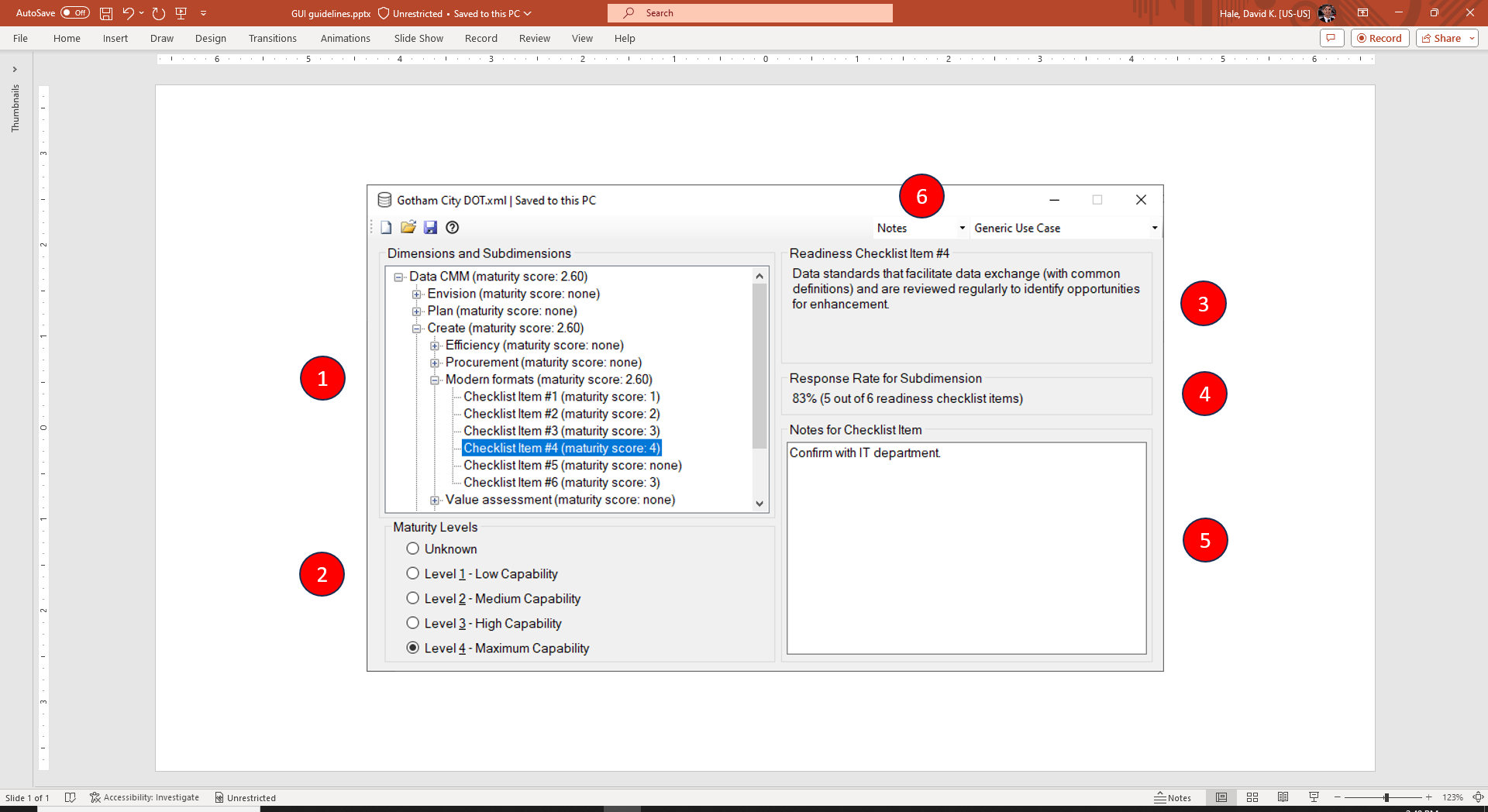
The figure is a conceptual illustration of the traffic analysis capability maturity framework. The upper, middle, and lower sections of the figure are labeled "LEVELS OF CAPABILITY", "DIMENSIONS", and "SUB-DIMENSIONS", respectively. These three labels appear at the left edge of the figure, with each label rotated 90 degrees counterclockise. The figure is anchored by the eight dimensions in the middle layer. These eight dimensions appear as eight rectangles stacked from left to right, with tiny spaces in between. Each rectangle is approximately twice as tall as it is wide. The text labels within each rectangle are rotated 90 degrees counterclockise. From left to right, the eight text labels are Culture, Workforce, Collaboration, Business Process, Supporting Data, Analysis Process and Documentation, Tool Availability and Capability, Performance Estimation and Measures. The leftmost four rectangles are colored dark blue, while the rightmost four rectangles are colored green. A long, horizontal label that spans the top of all four of the leftmost rectangles says "BUSINESS AND RELATIONSHIP-ORIENTED". A long, horizontal label that spans the top of all four of the rightmost rectangles says "TECHNICAL TRAFFIC AND ANALYSIS-ORIENTED". At the top layer of the figure, a partially transparent block arrow (colored gray) points from the top of the eight rectangles to the top edge of the figure. The block arrow is divided into four equal sections from top to bottom. Each of these four sections contains a large, center-justified text label that passes through the middle of the transparent block arrow. From bottom to top, these four text labels are "Level 1. Performed", "Level 2. Initiated and Managed", "Level 3. Established", and "Level 4. Integrated and Optimized", respectively. At the bottom layer of the figure are eight bulleted lists of text, with one list below each of the eight rectangles from the middle layer. The items below the Culture rectangle are "Understanding role and value", "Cost acceptance", and "Management and operation modeling". The items below the Workforce rectangle are "Workforce development" and "Current staffing KSAs". The items below the Collaboration rectangle are "Intra-agency" and "Inter-agency". The items below the Business Process rectangle are "Scoping", "Administration", "Institutionalization", and "Archiving and maintenance". The items below the Supporting Data rectangle are "Data requirement setting", "Data analytics", "Multiple data sources", "Data exchange", and "Data management". The items below the Analysis Process and Documentation rectangle are "Analysis approach", "Advanced and emerging strategies", "VC&V", and "Analysis reporting and documentation". The items below the Tool Availability and Capability rectangle are "Tool selection" and "Tool availability". The items below the Performance Estimation and Measures rectangle are "Measure selection", "Measure estimation", and "Measure use".

Source: FHWA, June 2023

Figure 1. Illustration. High-Level View of FHWA’s Traffic Analysis CMM Framework

# Data CMM Tool Functionality

Figure 2 contains six numbered circles to illustrate items of interest. The first five are the group boxes: Dimensions and Subdimensions, Maturity Levels, Readiness Checklist Items, Response Rate, and Notes/Barriers. Item 6 is a combo box that toggles between documenting miscellaneous notes or barriers to improvement, both of which are optional features. If the user invests time to document the barriers to improvement, this may become valuable when developing action plans to improve capability maturity.



Source: ITS-JPO, January 2024

Figure 2. Illustration. Elements of the Data CMM User Interface Screen

Item 1 (upper left of figure 2) is the Dimensions and Subdimensions group box that contains a tree view of dimensions, subdimensions, and readiness checklist items. The tree view displays capability maturity scores for each dimension, subdimension, and for the overall CMM. Selecting a (sub)dimension will cause the Response Rate group box (item 4) to display the number and percentage of evaluated readiness checklist items within that (sub)dimension. If item number 6 is set to Barriers, selecting a (sub)dimension will cause the Notes/Barriers group box (item 5) to display the barriers to improvement percentages within that (sub)dimension. Selecting a checklist item will display the verbose text description (item 3) and allow the user to enter a score in the Maturity Level group box (item 2), which automatically updates scores in the tree view. The verbose descriptions reflect a maximum level (level 4) of capability maturity. The scores then reflect the extent to which those statements are true. Available “hotkeys” are:

* 1, 2, 3, or 4: Enter a capability maturity level for the selected readiness checklist item.
* F1: Open the About box. (displays tool ownership and version number)
* Ctrl-S: Save the currently entered settings into a file.
* Ctrl-O: Open an existing or previously saved file.
* Ctrl-N: Create a new file.
* F12: Exit the program.

# Data Program CMM Scopes

The ITS-JPO Data Access and Exchanges Program has developed two related CMMs for data management and artificial intelligence (AI)-enabled ITS. Although this document focuses on the Data CMM, it may help to understand its relationship to the AI-ITS CMM that ITS-JPO developed in parallel. The Data CMM seeks to assess an agency’s ability to produce, collect, analyze, integrate, disseminate, share, store, maintain, support, and retire data. By contrast, the AI-ITS CMM seeks to assess an agency’s ability to implement AI-enabled solutions for ITS operational needs. The CMM research teams recognize certain overlaps in the respective scopes, dimensions, and subdimensions. For example, both CMMs have dimensions and subdimensions associated with technical data analysis capabilities, institutional staff development, and organizational culture. At this time of this writing, the respective research teams have not yet created formal linkages between the two CMMs. However, to facilitate possible future linkages, the research teams developed similar framework elements to the extent possible. The Venn diagram in figure 3 illustrates these overlaps at a conceptual level.

Graphical user interface

Description automatically generated with low confidence

Source: ITS-JPO, August 2023

Figure 3. Diagram. Overlapping Area of the Data CMM and AI-enabled ITS CMM

These CMMs both have four levels of capability maturity, although the definitions of these four levels are not identical. The AI-ITS CMM has more dimensions and subdimensions than the Data CMM, but the Data CMM has more readiness checklist items than the AI-ITS CMM. Unlike the AI-ITS CMM, Data CMM users can choose to skip certain readiness checklist items without lowering their capability maturity scores. However, if Data CMM users skip readiness checklist items, the tool will report a lower “response rate”, which may lower confidence in the reported capability maturity scores.

# Use Cases

The Data CMM is applicable to multiple transportation use cases. This information will help the CMM end-user agency develop an action plan for improving its data management capabilities, thus benefiting all projects and datasets that it works with throughout the year. The short list of key use cases represents a set of scenarios for which improved data management is likely to benefit the associated transportation agencies’ missions. These use cases may place fundamentally different priorities on certain dimensions and subdimensions within the CMM. If users face time constraints in completing the full self-assessment, they can choose to only perform the assessment within dimensions or subdimensions that their agency views as high priorities. The current set of internal (to USDOT) and external use cases is as follows:

* Internal
* **Single-Source Data**: Maintain a valuable (narrow scope) data source supporting various internal and external applications (e.g., Work Zone Data Exchange).
* **Research Program**: Support a specific Federal research/grant program (e.g., advanced transportation and congestion management technologies deployment grants, automated driving systems demonstration grants).
* External
* **Regional System Management**: Support data management and analysis for agencies to improve safety, mobility, and other measures of system performance. Example applications of this use case could include streamlining decision support systems, maintaining a transportation monitoring/management system or center, or quantifying and ranking factors that predict or cause safety or mobility problems.
* **Offline Analysis Support**: Support data management for agencies to efficiently conduct offline analysis, modeling, and simulation efforts (i.e., analyses not occurring in realtime as they would for certain monitoring/management systems).
* **University TRC**: Manage university transportation research centers (TRC’s), also known as UTC’s.

The Data CMM tool allows the user to select one of the above use cases. When the user does this, the current version of the tool issues a pop-up message to indicate which dimensions or subdimensions may be high priorities for the selected use case (e.g., the Federal policy dimension may not be a high priority for external agencies). The tool will also save the selected use case into the data file for future reference. For new data files, the tool defaults to “Generic Use Case”, which implies equal prioritization of the available dimensions and subdimensions.

# Dimensions

Dimensions and subdimensions are perhaps the most fundamental elements of CMMs. They provide the necessary set of categories in which agencies can define their shortcomings and formulate action plans for future improvement. For the Data CMM, these dimensions and subdimensions will determine the level of readiness of an organization to produce, collect, analyze, integrate, disseminate/share, store, maintain, support, and retire data. The Data CMM will also assess a broad range of data-focused resourcing and capability areas such as agency support/funding, talent/workforce, technical infrastructure, sensor capability, security and privacy measures, systems resiliency, documentation, data reuse, data linkage to other datasets, formats and standards, and licensing. Other CMMs in the literature provide multiple choice questions or requirements checklists to help users assess their capability levels. For those subdimensions in which agencies do not achieve the most advanced capability levels, these CMMs do not explicitly or comprehensively document all potential barriers to advancement. This seems to be a fundamental piece of missing information that could help paint a more comprehensive picture of the challenges agencies face, and of the action plans that could lead to higher capability levels. The Data CMM provides the following list of candidate barriers to advancement for each dimension, subdimension, and readiness checklist item:

* **Internal policies.** This barrier to advancement could become relevant if one of the agency’s own policies is discouraging or preventing improved capability in some aspect of data management.
* **External policies.** This could become relevant if an outside agency’s policy is discouraging or preventing improved capability in some area. Examples could include local agencies and TRC’s/UTC’s seeking to conform to State and Federal policies, respectively.
* **Time constraints.** There may be cases where an agency has sufficient budget and motivation to develop a capability, but the perceived amount of time needed to develop that capability becomes a discouraging factor.
* **Budget constraints.** An agency may have sufficient motivation to develop a capability, but the estimated financial cost of developing that capability may appear prohibitive.
* **Technical challenges.** There may be significant technical obstacles to improve capability in a certain area. For example, an agency may wish to adopt certain software or hardware solutions, but these may present compatibility or integration challenges with existing systems.
* **Workforce constraints.** An example of this constraint could be an insufficient number of staff available to sustain improved capability in some aspect of data management.
* **Communication/collaboration challenges.** An example could be an improved data management capability that would require increased interaction between transportation engineers, data scientists, IT specialists, and agency leadership.
* **Bureaucracy and/or administrative delays.** An example could be procurement and adoption of an expensive technology that requires approvals at many levels of the agency.
* **Leadership does not support or prioritize.** Agency leadership may feel that improved capability in some aspect of data management is not a high priority compared to competing priorities.
* **The agency would not benefit from advancing further.** Improved capability in some aspect of data management may be completely irrelevant to the agency’s mission. For example, an agency leveraging data-driven methods to improve performance of the local transportation system may receive no benefit whatsoever from developing advanced data sharing capabilities.

Including such barriers to advancement within the Data CMM helped the framework developers to define a congruent set of dimensions and subdimensions. It will also help the Data CMM user tabulate key information that will inform future action plans. Another intriguing characteristic of the barriers to advancement is the potential applicability to 100 percent of the dimensions, subdimension, and readiness checklist items. For example, if one were to review the full list of readiness checklist items in the Data CMM, one would notice that each of the previously listed candidate barriers to advancement could have a reasonable chance of being applicable to every one of those checklist items for a given agency. Keeping in mind that dimensions do not include the barriers to advancement, the list of dimensions is as follows:

1. **Envision.** This dimension involves assessing the agency’s capacity to define (and readiness to pursue) its own high-level goals and objectives for data management.
2. **Plan.** This involves developing a framework and a technical plan for achieving the high-level goals and objectives.
3. **Create.** This dimension assesses agency capabilities in creation of new data products and resources. Creation capabilities include data collection, preparation, cleaning, and fusing.
4. **Manage.** This dimension assesses the agency’s ability to manage existing data products and resources. This includes storing, maintaining, supporting, and retiring data.
5. **Use.** This assesses the agency’s ability to leverage and benefit from its own data products and resources. This includes analyzing and sharing data.
6. **Policy.** This assesses the agency’s ability to develop, maintain, and adhere to robust data management policies.

This list of dimensions implies the high-level framework illustrated in figure 4. The dimensions also contain subdimensions as described in the next section. CMM users can assess their capability maturity level (score) for each readiness checklist item, where these checklist items will describe the maximum possible level of capability. Users can also document one or more barriers to advancement from the available list of barriers. Users can choose to skip certain checklist items (without lowering their maturity scores) if they view those checklist items as unhelpful to the evaluation. However, if users skip checklist items the tool will report lower response rates, which should reduce reviewers’ confidence in the reported maturity scores.

The barriers-to-advancement feature is an optional feature, so users can bypass this feature if they do not believe it will be helpful. The revised tool design now defaults to “Notes” (see figure 2) to make it clearer that documenting the barriers to advancement is not a requirement. However, if users choose to document the barriers to advancement, the resulting information may prove valuable when developing action plans to advance to the next capability maturity levels.

Graphical user interface, table

Description automatically generated

Source: ITS-JPO, August 2023

Figure 4. Illustration. High-Level View of the Data CMM Framework

# Subdimensions

Subdimensions allow CMM users to assess their capabilities within the dimensions with improved specificity. The subdimensions can also help CMM users identify possible areas of weakness (i.e., agency shortcomings and deficiencies in specific aspects of data management). The list of Data CMM subdimensions (shown within their respective governing dimensions) is as follows:

1. Envision
   1. Culture
   2. Workforce
   3. Collaboration
2. Plan
   1. Framework and model
   2. Cost-effectiveness and value
   3. Architecture and infrastructure
3. Create (includes collecting, preparing, cleaning, and fusing)
   1. Efficiency
   2. Procurement
   3. Modern formats
   4. Value assessment
   5. Methods and metrics
4. Manage (includes storing, maintaining, supporting, and retiring)
   1. Backups
   2. Inventory
   3. Metadata
   4. Organization
   5. Quality monitoring
5. Use (includes analyzing and sharing)
   1. Efficiency
   2. Monitoring
   3. Privacy and security
   4. Methods and metrics
   5. Tools and visualizations
6. Policy
   1. Federal policy
   2. Governance policy

# Readiness Checklists

The Data CMM contains a few hundred readiness checklist items from eight (8) analogous data management CMMs in the literature5,9,10,11,12,13,14,15. The original research team iteratively edited these checklist items along with similar edits to the dimensions and subdimensions. The adjustment process included the following activities:

* Consolidating similar and/or redundant checklist items into a single checklist item.
* Omitting checklist items that appear to be unhelpful to the new Data CMM.
* Adjusting the wording of certain checklist items to improve clarity and/or relevance to a given subdimension.
* Adding new checklist items that are only applicable to a single use case, or only applicable to a subset of the use cases.
* Adding checklist items to subdimensions where CMMs from the literature do not appear to provide adequate coverage of key issues.
* Splitting certain checklist items that conflate too many issues into multiple checklist items, and possibly reassigning the newly created checklist items to the appropriate different subdimension.

The research team began the process of reducing, consolidating, and drafting the readiness checklist items with a first pass to include all checklist items that appeared significantly helpful to the Data CMM. The team then performed additional passes to adjust the number of checklist items within each dimension and subdimension. The second pass attempted to achieve an appropriate distribution of checklist items to avoid overemphasizing or underemphasizing certain dimensions or subdimensions. The team also performed additional passes to adjust the dimensions and subdimensions.

The number of checklist items within each subdimension (and conversely the number of subdimensions within each dimension) should reflect the approximate importance of each dimension and subdimension. In this regard, the number of subdimensions reflects the original team’s view of the relative importance of each dimension.

**In the readiness checklists that follow, it is appropriate to assume that each sentence begins with the phrase “The agency has…”**

## Dimension: Envision

### Subdimension: Culture

1. All management levels having an integrated understanding of objectives and measures of success for data management.
2. A consistent annual budget for data management.
3. A process to solicit and recognize data analytics opportunities that is frequently reviewed for internal consistency, external impact, efficiency, and quality.
4. Reinforcement of the value of advanced analytics from leadership in all activities and ongoing business operations, plus consistent identification of ways to increase adoption in ordinary business tasks.
5. Adoption of advanced analytics throughout the organization measured regularly; action plans are modified and enhanced as needed.
6. Guidebooks, toolkits, and other supporting documents that demonstrate the integration of advanced analytics policies and procedures into ongoing operations.
7. A strong data strategy.
8. Strong leadership buy-in.
9. Strong definition of innovation metrics.
10. Strong innovation awards/recognition.
11. Strong innovation environment and innovation working groups.
12. Strong innovation benchmarking.
13. Data management business cases that require executive sponsorship.
14. An established review process that evaluates and improves data governance.
15. An established organization-wide data governance structure and rollout plan has executive sponsorship.
16. Executive level organization-wide data governance that is operational for the organization’s high-priority subject areas.
17. Data governance that includes representatives from all business units, which are suppliers or consumers of high-priority data subject areas.
18. An established evaluation process for refining data governance to align with changing business priorities and to expand as needed to encompass new functions and domains.
19. Data governance activities and results continuously analyzed against objectives and reported to executive management.
20. Continuous application of metrics, statistical techniques, and other quantitative techniques to determine if data governance efforts are changing organizational behaviors appropriately.
21. Data quality program milestones and metrics that are regularly reviewed by executives, and continuous improvements are implemented.
22. Continual review and refinement of data lifecycle metrics by senior management.
23. A strong action plan to improve data management capabilities.
24. A strong data leadership council.
25. Strong monitoring of data governance metrics.
26. Strong monitoring of security policies.
27. Strong contributions from data stewards who play an active role in managing data.
28. A completely data-driven approach to making major decisions.
29. A strong mandate from the highest levels of the organization to develop a data-driven culture.

### Subdimension: Workforce

1. Data administrators who efficiently support all data architecture maintenance needs.
2. Full support from skilled resources with advanced system knowledge of the agency’s integrated data systems.
3. Extensive in-house knowledge of applicable data frameworks.
4. Seamless access to outside expertise, plus inhouse experts qualified to independently verify third-party recommendations.
5. Robust data management workforce development that includes training material, job announcements, interview questions, and desired capability.
6. Comprehensive, cutting-edge in-house data management expertise.
7. Documented roles and responsibilities of different units and staff, including the collaborative processes.
8. Robust data cleaning and data fusion capabilities.
9. Robust analysis capabilities that include data cleaning, data fusion, data mining, business intelligence, AI, and ML.
10. A strong understanding of sensitivity analysis, advanced visualizations, and statistical distributions.
11. A formal job analysis or competency model that was developed for the enterprise itself, is reviewed regularly and refined as the nature of the work changes, and continuously informs the organization’s overarching talent management strategy.
12. A robust process to create specific position descriptions, including the documentation of the unique requirements for the role, but also linked to and aligned with enterprise wide qualifications for advanced analytics positions as determined by a job analysis.
13. Consistent engagement of advanced analytics candidates with the enterprise through a comprehensive employer brand message.
14. A strategy for attracting talent that is regularly reviewed to identify enhancements.
15. A standardized and strategic approach for profiling advanced analytics talent and prioritizing sources that is centralized for the enterprise.
16. Hiring of advanced analytics candidates through an enterprise wide process to enable efficiencies and resource pooling.
17. Governed processes to identify workforce requirements for advanced analytics that continuously inform the overarching enterprise talent management strategy.
18. A dedicated team committed to identifying, tracking and managing advanced analytics talent across the enterprise in support of broad workforce development, risk management (succession planning), and the talent management strategy.
19. A workforce that is structured and designed to operationalize analytics most effectively (use, develop, share, grow) throughout the enterprise and is regularly re evaluated for enhancement.
20. An advanced analytics talent management strategy that is the guiding approach for all human resources programs focused on advanced analytics staff and is reviewed annually to improve as part of advanced analytics workforce development.
21. Career paths for the advanced analytics workforce that are regularly reviewed and enhanced based on emerging learning opportunities.
22. Objective behavioral and competency based performance measures and metrics for advanced analytics positions that are reviewed and refined as the nature of the work changes.
23. Engagement and motivation drivers that are used to inform retention programs, enterprise wide policies, and the overarching enterprise advanced analytics talent management strategy.
24. Advanced analytics learning opportunities that are part of a formal knowledge management program supported by peer development and regularly reviewed for enhancement.
25. Well-defined roles and responsibilities to support the governance of data management and the interaction between governance and the data management function.
26. Agreements in place that provide explicit expectation for the use of shared staff resources with responsibilities for data management.
27. Governance roles, responsibilities, and accountabilities established for data subject area by priority, as stated in the business or data strategy.
28. Data subject area representatives that participate in data governance and associated processes.
29. Classroom, mentoring, e-learning, or on-the-job training in data governance processes required for new governance members and other stakeholders.
30. Defined roles and responsibilities for governance, implementation, and management of data quality practices.
31. A governance group that establishes, maintains, and ensures adherence to data cleansing rules.
32. Stakeholder roles and responsibilities for architectural standards that include compliance accountability, ownership, and training.
33. Strong data policies and documented processes to help staff perform their roles that staff can easily find in a centralized location.
34. Use of a strong process to determine training needs for each role in the organization.
35. Strongly established data roles and responsibilities where the data activities performed are captured and used in performance appraisals/rewards/promotions.
36. Strong mandatory training to support all data roles with data-related duties outlined in position descriptions.
37. A strong majority of job descriptions that include data or analytics skills at every level of the organization.
38. Strong enablement or training programs to help employees at every level develop data skills, including a formal required data literacy program.
39. Strong documentation of data science expertise that would prevent personnel loss from creating any perceivable gap.

### Subdimension: Collaboration

1. Frequent reviews of, learning from, and use of, relevant analyses from multiple outside sources.
2. A feedback mechanism with stakeholders and regulators to affirm existing retention and archiving policies.
3. Documented roles, responsibilities, and collaborative processes to support data management.
4. Data analytics solution implementation review as part of the solution evaluation and engages stakeholders throughout the process.
5. A dedicated advanced analytics communications strategy aligned to broader organizational communications, tailored to specific stakeholder groups, and reviewed regularly for enhancements.
6. Targeted and specific marketing to each customer segment that is used to drive engagement with specific workforce groups to optimize advanced analytics marketing for the enterprise.
7. A strong data community of interest that provides a vision and mission for improving the organization’s data capability through a series of community based programs and events.
8. A strong communications plan for data management that is defined, documented, approved by stakeholders, and scheduled.
9. Planned and conducted data management communications with external stakeholders according to the communications strategy.
10. External data management communications made with the purpose of influencing public policies and industry best practices that impact data.
11. A strong and active interaction and engagement model that ensures stakeholders engagement.
12. An explicitly recognized data management business function that is leveraged across the organization.
13. Statistical results and stakeholder feedback that guide continuous improvement of TCO for data management.
14. Stakeholders that participate in and support data management program funding.
15. Systematic collection of stakeholder reports of data quality issues. Their expectations for improving data quality are included in the data quality strategy, and are measured and monitored.
16. Changes to data stores, data interfaces, and data management process assets planned and approved by stakeholders at the organizational level.
17. Management of changes to shared data sets (or target data sets for a specific business purpose) by data governance structures with relevant stakeholder engagement.
18. A target architecture that is collaboratively developed and jointly approved by business units, IT, and data governance.
19. Contributions to data architecture standards initiatives within the industry.
20. Publication and/or sharing of data management experiences, case studies, best practices, and lessons learned with industry, peers, and stakeholders.
21. A strong community of practice with a strong champion who is an expert in the data field.

## Dimension: Plan

### Subdimension: Framework and model

1. A data model designed to fully implement continuous development practices, including ad hoc data augmentation.
2. New processes designed from the ground up to support emerging technology data.
3. Visual representation of how datasets interrelate in a regularly updated, highly legible, and readily accessible format.
4. All appropriate metadata additions that enhance usability fully accounted for by the data model.
5. A data model that fully accounts for masking of sensitive data in all areas where it may be useful.
6. A formally implemented data management framework and model.
7. A detailed data management framework that reflects the latest national findings.
8. A data management strategy that is fully maintained.
9. A data management strategy implementation that is continuously reviewed to identify opportunities for improvement.
10. Strong principles defined and followed to guide the consistency of practices related to data management.
11. A strong interaction model that ensures the involvement of data governance for projects that use shared data.
12. A data management organization and specified structure that are defined and periodically reviewed to ensure that they meet the needs of the organization.
13. Governance roles, responsibilities, and accountabilities established for data subject area by priority, as stated in the business or data strategy.
14. Use of models to predict compliance with legal and regulatory requirements.
15. Strong data models that are easy to access.

### Subdimension: Cost-effectiveness and value

1. Cost-effective data management.
2. Data from which most stakeholders regularly derive real value.
3. A centralized resource management hub that proactively manages and deploys project resources to gain efficiencies and optimize resource alignment to opportunities.
4. Continuous identification and evaluation of current and potential data sources to improve advanced analytics in support of business needs.
5. Strong data impact.
6. Consistent use of strong metrics, statistical techniques, and/or other quantitative techniques to measure the effectiveness of the data management across all dimensions.
7. A strong business case methodology for data management that aligns with business objectives and data management objectives.
8. A data management business case that reflects analysis of the data management program’s total cost of ownership, and allocates cost elements to organizations, programs, and projects in accordance with the organization’s financial accounting methods.
9. Managing and tracking of cost factors comprising data management TCO across the data management lifecycle.
10. Strong cost and benefit metrics that guide data management priorities.
11. Data management TCO employed to measure, evaluate, and fund changes to data management initiatives and infrastructure.
12. Statistical and other quantitative techniques used to analyze data management cost metrics to assess data management TCO and collection methods.
13. Data management program performance scorecards that include TCO metrics.
14. A data management TCO model that is validated, checked for accuracy, and enhanced through regular reviews and analysis.
15. Statistical results and stakeholder feedback that guide continuous improvement of TCO for data management.
16. Mapping of data management costs to business areas, operational functions, and IT.
17. Data management program funding that aligns with investment decision-making standards that are consistently employed across the organization.
18. Program funding priorities that align with the objectives and priorities of data management.
19. Defined and statistically analyzed measures that determine the effectiveness of program funding with respect to meeting organizational objectives and expected benefits.
20. A defined process for defining benefits and costs for data quality initiatives that is employed to guide data quality strategy implementation.
21. Adherence to established data management measurement and analysis standards.
22. Use of established data management measurement and analysis tailoring guidance.
23. Maintenance of an established organizational data management measurement repository in accordance with usage feedback.
24. Use and maintenance of an established data quality program for the data management measurement repository.
25. Monitoring of data management process performance using statistical and other quantitative techniques.
26. Systematic determination and understanding of the root causes for selected issues to address deficiencies in achieving data management objectives.
27. Management of measures to address data management measurement objectives.
28. Analysis of data management attribute performance and maintenance of data management baseline measures.
29. Validation of data management improvements by stakeholders.
30. Business outcomes clearly defined prior to using data and analytics to make strategic decisions, strong ability to measure success, and a feedback loop to ensure tracking or pivoting to meet desired outcomes.
31. Strong ability to demonstrate the impact of being a data-driven organization on business value across the entire organization.

### Subdimension: Architecture and infrastructure

1. A data system architecture that meets analysts' needs.
2. Data management software that is well supported and open source.
3. All of its systems in a cloud-based environment.
4. The ability to easily upgrade or replace all data processes, which are all independent.
5. Implementation of all relevant security software and procedures.
6. Data management software that reflects agency staff’s direct experience with using a wide variety of software.
7. A data repository that supports querying of data in real time, and is reviewed and revised to plan for data needs over a multi-year period.
8. An architectural approach for the target data architecture that is followed across the organization.
9. A target architecture that is collaboratively developed and jointly approved by business units, IT, and data governance.
10. Evaluation and application of both internal and selected external data standards to the development of architectural blueprints and component designs.
11. Alignment of the architecture, technical requirements, and supporting infrastructure capabilities.
12. An architecture that includes the target integration layer, also known as common interface design.
13. Data profiling performed prior to finalizing the design of a data store component that will contain existing data.
14. Statistical analysis of performance and data quality improvements used as input to the architectural design process.
15. Evaluation of prediction models against architectural changes with subsequent adjustments as needed.
16. Architectural standards that are followed across the organization.
17. Inclusion of external requirements applicable to the organization in data architecture standards development.
18. Defined and implemented metrics for monitoring and controlling adoption of, and compliance to, architectural standards.
19. An audit process developed, documented, and performed for evaluating compliance to architectural standards.
20. Audit result metrics and internal deviation patterns that indicate where changes to data architecture standards and enhanced guidance for standards application are needed.
21. Risk-based impact analysis for proposed changes to organizational data architecture standards and guidance prior to acceptance.
22. Research of innovative data technologies and methods for potential adoption, and development of appropriate new standards for those which are deployed.
23. Platform implementation plans that address the scalability, resiliency, and security needed to accommodate changes in anticipated complexity as well as the volume of data and number of users.
24. Platform design and capabilities that ensure that work flow and service level requirements can be met.
25. Capture, storage, and use of platform performance data to verify that the platform meets business performance needs and capacity requirements.
26. A platform that contributes its metadata to the organization’s metadata repository.
27. Analysis of qualitative and quantitative performance metrics for the data management platform using statistical and other quantitative techniques, to support platform change decisions.
28. Platform improvement objectives that are quantitatively expressed and approved by governance.
29. Continuous improvement of the platform based on statistical performance data and causal analysis.
30. Comparison of platform change effects with prediction models and subsequent analysis to improve the prediction models.
31. Strong automation of data governance processes.
32. All the technology it needs, and adoption levels are high.

## Dimension: Create

### Subdimension: Efficiency

1. The ability to develop new data products with ease.
2. The ability to enhance existing data products with ease.
3. Currently available tools that support easy development of additional data products and visualizations.
4. The ability to swiftly develop and use new data products.
5. A well-documented process to regularly review data enrichment opportunities.
6. A well-documented review process that it frequently uses to consider new data products.
7. Documented data collection procedures that are frequently reviewed and updated.
8. Data tables always well formed (one subject per column and one piece of information per row).
9. Data collection supported by automated processes (e.g., ETL), which are continuously improved.
10. Strong data capture capacity.
11. Data sourcing evaluation and selection processes that are defined and employed across the organization.
12. The ability to integrate all data without conversion or modification.
13. All applicable data sets mapped to the same standard wherever possible such that they can be easily joined.
14. Data integration processes that are reviewed and revised as needed to plan for data needs over a multi-year period.
15. Strong data integration capacity.
16. Implemented a mechanism to facilitate transformation by mapping between business terms, attributes, and physical data element names or synonyms.
17. Use of standard data cleansing results report templates at the detail and summary level.
18. Selected highly shared data that are fully integrated, centrally managed, and delivered as needed to integration data stores.

### Subdimension: Procurement

1. Easy and rapid procurement of data management/analysis tools for analysts.
2. Service level agreements that include data quality criteria to hold data providers accountable for cleansed data.
3. Provider service level agreements based on standard templates and processes that are implemented across the organization, tracked, and enforced.
4. Continual review of service level agreements to assure satisfaction of business objectives and requirements.
5. Periodic meetings held with data providers to review planned changes to data content, processes, formats, quality, etc.
6. Partnering relationships developed with selected external providers based upon provider evaluation results and anticipated data needs.

### Subdimension: Modern formats

1. Data collected and stored in modern, well-known, open-source formats.
2. Use of open file formats and common protocols for maximum compatibility with current and future data tools.
3. Data schemas that best meet the analysts’ needs.
4. Data standards that facilitate data exchange (with common definitions) and are reviewed regularly to identify opportunities for enhancement.
5. Use of strong data standards and data standardization policies.
6. Strong practices to ensure new datasets are born or made FAIR (findable, accessible, interoperable, reusable).

### Subdimension: Value assessment

1. Collected data that are highly relevant to current agency needs.
2. Collected data that are highly relevant to future agency needs.
3. Data analytics opportunity selection criteria that are reviewed and refined following project close out, in conjunction with identification, and are shared and replicated across the organization.
4. Data analytics solution evaluation criteria that are congruent across the organization and are refined as priorities change.
5. Frequent reviews of data analytics solutions to document lessons learned and identify additional applicability.
6. Data collection conducted in alignment with the data management strategy in advance of business needs.
7. Continuous consideration of data quality issues in alignment with the goal to ensure that data are suitable for the intended purpose.
8. Data quality assurance by reviewing pre production data to ensure they are fit for purpose and right the first time.
9. Strong data collection processes and procedures.
10. Strong data collection metrics.
11. Data requirements that are defined, validated, and integrated using the organization’s standard requirements definition framework.
12. Assessment of data requirements based on business priorities.
13. Documentation and linkage of the business processes that produce data to the data requirements.
14. Data requirements that comply with and include compliance requirements for both physical and logical data, including security rules as well as technical requirements.
15. Evaluation of requirements to ensure that they are implementable in the target environment.
16. Evaluation of industry best practices pertaining to data requirements against selected criteria to determine if they should be adopted into the development lifecycle.
17. Defined and managed metrics that ensure data requirements as defined satisfy business objectives; corrective actions are taken when performance is not meeting business needs.
18. Continuous process improvement to ensure efficient and consistent prioritization, selection, and verification of data requirements.
19. Sharing of best practices with industry and peers regarding data requirements.
20. Defined measures/metrics and collected information to assess progress in data mapping efforts and adoption of authoritative data sources.
21. Strong application of data governance to new data products.

### Subdimension: Methods and metrics

1. Robust data cleaning and data fusion capabilities.
2. Strong ability to apply artificial intelligence and/or machine learning methods to enhance data cleaning and data fusion.
3. Analyses that explicitly fuse and evaluate multi-source data and emerging data sources via cutting-edge automated methods.
4. Strong data validation, data quality, and auditing capacity.
5. Implemented a mechanism to facilitate transformation by mapping between business terms, attributes, and physical data element names or synonyms.
6. Data quality projects, such as data profiling, data assessments, data cleansing, and risk assessments that align with the business needs identified in the data quality strategy and the cost-benefit analysis.
7. Data profiling methodologies, processes, practices, tools, and results templates that have been defined and standardized.
8. Performance of all techniques identified to meet the data profiling objectives.
9. Maintenance of data change history throughout data cleansing activities.
10. Policies, processes, and procedures to ensure that data cleansing activities are applied at the point of origination in accordance with published rules.
11. Data cleansing rules that are applied consistently across the organization.
12. Management of data cleansing requirements for data providers in accordance with standardized processes.
13. A standard set of practices and rules that staff follow for performing data integration activities.
14. Quality checks that are defined as part of the organizational integration standard and performed as part of data integration processes.
15. Development and deployment of integration interfaces specified in accordance with architectural standards supporting re-use.
16. Interface and integration performance metrics collected and analyzed to identify nonconformance with standards and criteria.
17. Documentation and management of changes to data sources and destinations through the data governance process.
18. Statistical analysis of integration metrics that guides decisions on changes to interfaces and integrations.
19. Performance models for data integration that are continually reviewed and used as input for enhancements.
20. Strong data quality processes during the data preparation phase.
21. A strong process that independently verifies the accuracy of the data.
22. Tools to download, fuse, and analyze data from archives and prepare data for analysis.
23. Full security of all sensitive information/PII from collection to data product.
24. Privacy filters and other safeguards applied at the time of collection.

## Dimension: Manage

### Subdimension: Backups

1. Backups frequently performed and verified.
2. Backup data stored at multiple offsite locations or by a reputable cloud service provider.
3. The ability to recover data from backup storage very quickly after a disruption.
4. A disaster recovery plan that is frequently reviewed and updated.
5. Strong use of data preservation and retirement criteria including use, impact, value, and uniqueness.
6. Strong use of data retention schedules, data disposition schedules, and end-of-life special considerations.

### Subdimension: Inventory

1. Detailed and frequently updated documentation of data products and processes available in an online, web-based format.
2. Automated processes that regularly update web documentation with information extracted from live data sets.
3. Data governance that monitors the standard organization-wide process used to develop data sourcing requirements.
4. Metrics for the data sourcing management process that are established, maintained, and used.
5. Documentation of critical data elements for which the platform is an authoritative source, trusted source, or system of record.
6. A prescribed data warehouse repository that provides access to historical data for meeting analytics needs supporting business processes.
7. Ability to recreate data context at any specific point in time.
8. A strong inventory of critical data assets that is easy to access.
9. A strong data inventory that is up to date, accurate, reflects all datasets throughout the operating administration, and inventories datasets at levels that are discoverable in the operating administration.
10. Strong data sharing and archival processes and procedures.

### Subdimension: Metadata

1. All data sets enriched with a uniform set of identifying metadata.
2. A metadata catalog maintained for all applicable data.
3. Metadata practices that are regularly reviewed and updated following a documented process.
4. All metadata for all data sets, along with associated documentation, made available wherever appropriate.
5. Metadata feedback from data users openly solicited and regularly reviewed.
6. All data sets augmented with the same well-documented metadata fields wherever possible.
7. All metadata records include labels describing their sensitivity.
8. Strong metadata management.
9. Integration of the business glossary into the organization’s metadata repository with appropriate access permissions.
10. A metadata management strategy that is established, promulgated, and maintained by data governance with input from relevant stakeholders.
11. A metadata repository populated with additional categories and classifications of metadata according to a phased implementation plan, and linked to architecture layers.
12. A data management function that centralizes metadata management efforts and is overseen by data governance.
13. Data governance that approves metadata additions and changes.
14. Measures and metrics used to evaluate the accuracy and adoption of metadata.
15. Validation of metadata, and any changes to metadata, against the existing architecture.
16. Metadata types and data definitions that support consistent import, subscription, and consumption practices.
17. Metadata repository extensions that include exchange data representation standards used by the organization.
18. New metadata management activities that are guided by metadata metrics and historical information about metadata.
19. Evaluation of planned data changes for impact on the metadata repository; and metadata capture, change, and continuous improvement of refinement processes.
20. Easy access to the intended use of critical data assets.
21. Easy access to data lineage and provenance.

### Subdimension: Organization

1. All folders and files follow a documented naming convention.
2. All data sets organized using a single planned folder structure.
3. All data sets conform to a single, documented classification taxonomy.
4. All data stored in a fully functional data lake architecture.
5. All systems referencing the same data connect to a common data source for that data.
6. Reference data that exist in one location as a single source of truth for all users.
7. Master data values stored and managed in one accessible location.
8. Source data that are never deleted or modified.
9. Maintenance of the history and origin of all data files.
10. Source data flagged and scored but never modified or deleted when data quality concerns arise.
11. Strong data archival processes and procedures.
12. An approved business glossary in the development of shared repositories, data transfer standards (e.g., XML), ontologies, semantic models, and similar initiatives involving corporate data.
13. Organization-wide data governance that complies with the business glossary process.
14. Impact assessments conducted, and governance approval obtained, prior to implementing changes to business terms.
15. Metrics captured and used to evaluate the organization’s progress toward a comprehensive business glossary.
16. Compliance monitoring processes that verify correct use of business glossary terms, highlight exceptions, and ensure they are addressed.
17. Statistical and other quantitative techniques that are used to manage the process and develop reporting and projections on business glossary integration for senior management.
18. A business glossary that uses standard industry business terms and definitions as appropriate.
19. A business glossary that is enhanced to contain associated business rules and ontology structures, and is consistent throughout the organization.
20. Documentation, planning, and justification of data set duplication across systems.
21. All data stored as long as possible to support current/future analyses, even if those analyses are not actively in use today.

### Subdimension: Quality monitoring

1. Frequent usability assessment of all data.
2. Active automated and manual monitoring and ranking of data quality.
3. Fully automated data crawling continuously performed, generating timely and detailed alerts on data quality trends.
4. A continuous process with standardized criteria for assessing data quality that is refined and improved regularly.
5. Strong data quality standards and auditing.
6. Strong data validation, data quality, and auditing capacity.
7. Strong data quality metrics that are easy to access.
8. Strong data quality and issue tracking processes and procedures.
9. A data quality strategy that is followed across the organization and is accompanied by corresponding policies, processes, and guidelines.
10. Defined roles and responsibilities for governance, implementation, and management of data quality practices.
11. A defined process for defining benefits and costs for data quality initiatives that is employed to guide data quality strategy implementation.
12. Data quality projects, such as data profiling, data assessments, data cleansing, and risk assessments that align with the business needs identified in the data quality strategy and the cost-benefit analysis.
13. Data quality metrics employed to analyze proposed changes to the data quality strategy.
14. Systematic collection of stakeholder reports of data quality issues. Their expectations for improving data quality are included in the data quality strategy, and are measured and monitored.
15. Data quality program milestones and metrics that are regularly reviewed by executives, and continuous improvements are implemented.
16. Sharing of best practices and successful approaches to improving data quality with industry peers.
17. Data profiling methodologies, processes, practices, tools, and results templates that have been defined and standardized.
18. Performance of all techniques identified to meet the data profiling objectives.
19. Performance of data profiling processes that is measured and used to manage activities across the organization.
20. Real-time or near-real-time automated data profiling reports that are created for all critical data feeds and repositories.
21. Use of statistical and other quantitative techniques to analyze historical data for input to business process and data quality improvements.
22. A strong process to identify and correct data deficiencies that has a strong history of helping to correct the data.
23. Continuous assessment of the extent to which datasets adhere to FAIR (findable, accessible, interoperable, reusable) principles.

## Dimension: Use

### Subdimension: Efficiency

1. Easy and rapid procurement of data management/analysis tools for analysts.
2. Full ability to access, use, and analyze data.
3. Data available to whoever may have a potential use for the data, with the exception of sensitive data.
4. Open data easily reachable via APIs and/or hosted analytics platforms.
5. Fluid and convenient authorization structures that do not hinder authorized use of the data.
6. Use of metrics to expand approved shared data reuse and eliminate process redundancy.
7. All authorized users able to access data directly where stored and analyze at their own cost.
8. All relevant data products shared with authorized users whose usage is monitored and who may bear some of the costs.
9. The ability to easily grant new users access when warranted.
10. The ability to perform all analysis without copying or moving data.
11. All analysis results written to the same location as the data.
12. Efficient sharing of data governance artifacts in a common repository.
13. Ownership of third-party data (in most cases) and the ability to fully use that data with few restrictions.

### Subdimension: Monitoring

1. BI products and processes regularly reviewed so that the most successful ones can be shared and emulated.
2. Detailed documentation sufficient for both users and reviewers. Reviewers ensure analyses meet requirements.
3. Analysis tool selection that reflects agency staff’s direct experience using a wide variety of analysis tools.
4. An advanced analytics projects portfolio including a robust pipeline of opportunities, no overlap in projects, and efficiencies to ensure economies of scale, all of which are regularly reviewed and refined as needed.
5. Continuous project review occurring throughout the process, with ongoing monitoring of success metrics to enable improvement.
6. Advanced analytics project validation that is part of the formal advanced analytics project lifecycle.
7. Continuous review of the data analytics project validation process, updating of processes, and incorporation of results back into the project lifecycle.
8. Continuous review of data analytics tools including processes for decommissioning tools.
9. All relevant data products shared with authorized users whose usage is monitored and who may bear some of the costs.
10. Frequent reviews of data access to ensure that data are as accessible as possible while securing critical information.
11. Analytic reports that are dynamic, access is granted to specified distribution groups, information is customized to meet the audience, and there is a continuous review focused on improving efficiency and effectiveness in the process.
12. Strong monitoring of dataset use, access methods, and impact.
13. Strong peer review of datasets and metadata.

### Subdimension: Privacy and security

1. Analytical processes that filter/obfuscate records according to access and needs.
2. All relevant data stakeholder groups handled with their own customized privacy protocols.
3. Authorization processes that are up to date and fully prevent all unauthorized use.
4. Frequent reviews of data access to ensure that data are as accessible as possible while securing critical information.
5. Publication of strong data access policies.
6. Strong governance policies in place that enable the sharing of data across functions/departments.
7. Strong ability to perform de-identification and anonymization of data.
8. Robust levels of protection (constraints and restrictions on data use and sharing).

### Subdimension: Methods and metrics

1. Streaming data analyses that provide excellent value.
2. Active use of relevant big data analytical techniques.
3. Users able to easily filter data based on data quality rankings at a high level of granularity.
4. Robust analysis capabilities that include data cleaning, data fusion, data mining, business intelligence, AI, and ML.
5. Analyses that explicitly fuse and evaluate multi-source data and emerging data sources via cutting-edge automated methods.
6. Performance measure selection that reflects integrated process to support decision-making at different levels of the agency.
7. Robust use of sensitivity analysis and statistical distributions.
8. Analytic techniques available to support the broad spectrum of analytics needs.
9. Additional techniques continuously considered to support the organization’s advanced analytics capability over a multi-year time frame.
10. Data analysis methods that include prescriptive analytics, use ML to develop and train predictive analytic models, and are consistently reviewed for additional capability.
11. Analytics services available to support prescriptive analytics.
12. User interaction tools that are able to support all staff with minimal training required.
13. Strong service-level agreements (SLAs) and data exchange/interface standards and oversight.
14. Strong data sharing processes and procedures.

### Subdimension: Tools and visualizations

1. Many data analysis dashboards and supporting tools.
2. Frequent referencing of a variety of relevant and useful data visualizations.
3. The ability to use any number of tools to analyze the data and with few restrictions.
4. All current needs satisfactorily met by a suite of BI products.
5. The ability for data users to develop new BI products and visualizations with minimal administrative red tape or oversight.
6. Access to a wide variety of analysis tools (from a wide variety of developers and vendors), which can be used situationally.
7. Robust use of advanced visualizations.
8. Visualization techniques that are comprehensive (technologically and visually) and provides guidance on their use.
9. Continuous consideration of additional visualization techniques to support the organization’s advanced analytics capability over a multi-year time frame.
10. Customized reports that are dynamically created (using the integrated tools) for each advanced analytics artifact, and visualization processes and tool sets are continuously reviewed and refined.
11. Stakeholders able to choose their own BI tools without undue technical or administrative limitations.

## Dimension: Policy

### Subdimension: Federal policy

1. A designated CIO that reports directly to the Agency head, and has all authority required by FITARA, including oversight of IT planning and purchases.
2. Compliance with transparency and risk management requirements for IT investments, including accurately identifying major IT investments by actual risk, utilizing incremental development, and treating IT investments as major capital projects.
3. Reviews of its IT portfolio with PortfolioStat to achieve savings, reduce waste and duplication, and increase efficiency and effectiveness.
4. Consolidated data centers.
5. Implementation and maintenance of security measures commensurate with risk and magnitude relating to agency data.
6. Use of UpToDate infosec policies as outlined in FISMA and related guidance (Executive Order 14028, Improving the Nation's Cybersecurity, annual memoranda from OMB [most recently M-23-03] and CISA, latest guidance from NIST).
7. Reporting of infosec policy and procedure effectiveness to Director of OMB, the Secretary of Homeland Security, the Comptroller General, and to Congressional Committees.
8. Reporting of major breaches in information security to the US Computer Emergency Readiness Team (US-CERT), to Congress, and, as appropriate, to law enforcement agencies and relevant Offices of Inspector General and General Counsel.
9. Financial data that adheres to the DATA Act Information Model Schema (DAIMS).
10. Full reporting of financial data to the US Treasury Dept.
11. A designated Chief Data Officer.
12. Publication of public government data assets in a standardized machine-readable format.
13. Development and maintenance of a comprehensive data inventory.
14. A process to provide and update an inventory of the agency’s data assets in line with the Director of OMB’s requirements including asset metadata as described in PUBLIC LAW 115–435—132 STAT. 5529 (2019) and on DATA.gov.
15. A designated evaluation officer and a statistics expert to 1) develop and implement an "agency evidence-building plan", 2) establish agency rules, 3) assess evidence-based policy evaluations, 4) assess capacity to support further evidence-based rulemaking.
16. Publication of an annual plan online of data intended for collection, use, or acquisition for the coming year.
17. Publication of an annual plan including data and methods to be used to facilitate evidence-based policymaking.
18. Treatment of digital records that is at least as favorable as its treatment of physical records.
19. Options to digitally conduct transactions, signatures, documentation, and other actions.
20. Accurate assessment of information collection burdens by including the burden from beginning to end, engaging with internal and external stakeholders, considering psychological costs, and considering the collection burden of State, Territorial, Tribal and Local Agencies in addition to those of the Federal government.
21. A goal of minimizing paperwork and data collection burdens by simplifying collection and submission requirements, reducing learning costs to the public of unfamiliar programs, and reducing barriers that disproportionately affect vulnerable populations.
22. Use of OIRA's plain-language Paperwork Reduction Act (PRA) tool on Digital.gov for PRA requirements and procedures.
23. Use of leading design practices to facilitate paperwork including pre-populating forms, transitioning from opt-in to opt-out, automatic-enrollment, cross-enrollment, A/B testing, and other best practices.
24. A designated CIO with appropriate responsibilities.
25. Adherence to the capital planning and investment control (CPIC) process for IT planning and budgets, including OMB Circular A-11. section 55, which is updated annually.
26. Prevention of use of confidential information for non-authorized purposes.
27. Maintenance of strict controls over confidential information collected for statistical purposes.
28. Resolution of all FOIA requests in an appropriate, timely manner.
29. Proactive posting of frequently requested records where possible.
30. Publication of guidelines to ensure the quality of any data disseminated to the public.
31. Adherence to their own published policies concerning data quality.
32. A published policy to correct data upon request and publication of records for such actions.
33. All owned or operated Internet of Things (IoT) devices compliant with NIST standards outlined in NIST’s IoT guidance for Federal agencies, in NISTIR 8228 and in their SP-800-213 Series.
34. Relevant personnel with developed awareness of IoT device risks and challenges, and who monitor new guidance on their mitigation.
35. Adjusted organizational policies and processes to address cybersecurity and privacy risk mitigation throughout the IoT device lifecycle.
36. Implemented and updated mitigation practices for the organization’s IoT devices.
37. Full adherence to federal privacy and security standards.
38. A process to allow individuals to access and amend their data.
39. Publication of notices and updates of each system of records covered by the Privacy Act in the Federal Register.
40. Compliance of all geospatial data with standards established by the Federal Geographic Data Committee (FGDC).
41. Sharing of all geospatial data with a Federal geospatial data clearinghouse.
42. Provision of biannual reports to OMB and GSA on the implementation of Section 508, using reporting guidance from Section508.gov.
43. Compliance with, or exceeding of, the most recent Section 508 requirements on Section508.gov or the CIO Council's Executive Guide to IT Accessibility.
44. The ability to ensure that new and redesigned websites are fully functional on mobile devices.
45. The ability to ensure that new and redesigned websites are accessible to individuals with disabilities.
46. The ability to ensure that new and redesigned websites are consistent in appearance, contain a search function, and designed around data-driven user needs.
47. Use of web-based forms, apps, or digital services to ensure user needs are addressed.

### Subdimension: Governance policy

1. A documented data management plan that it follows and frequently updates.
2. A disaster recovery plan that is frequently reviewed and updated.
3. Application of open data policies wherever possible.
4. Formal documentation and processes for data management and data-driven analysis.
5. Formal processes for archiving, sharing, updating, and maintaining data.
6. Robust and integrated data management and data governance policies and requirements.
7. An enterprise-wide data governance model that is continuously adjusted based on strategy, regulatory requirements, and performance metrics.
8. A data requirements lifecycle that is reviewed regularly and refined as needed to plan for data requirements over a multi-year timeframe.
9. Strong data standardization policy.
10. Strong issue identification and management capacity.
11. Strong data management and stewardship processes and procedures.
12. Strong data security and privacy policy and oversight.
13. Strong data management standards, policies, and processes that are communicated across the organization and adjusted based on feedback.
14. Agreements in place that provide explicit expectation for the use of shared staff resources with responsibilities for data management.
15. Strong procedures to identify and apply needed changes to enhance or redesign the data management function.
16. Defined and implemented governance of the funding process.
17. Governance roles, responsibilities, and accountabilities established for data subject area by priority, as stated in the business or data strategy.
18. Data governance policies that follow defined policies, processes, and standards.
19. An established review process that evaluates and improves data governance.
20. An established organization-wide data governance structure and rollout plan has executive sponsorship.
21. Executive level organization-wide data governance that is operational for the organization’s high-priority subject areas.
22. Data governance that includes representatives from all business units, which are suppliers or consumers of high-priority data subject areas.
23. An established evaluation process for refining data governance to align with changing business priorities and to expand as needed to encompass new functions and domains.
24. Data governance activities and results continuously analyzed against objectives and reported to executive management.
25. Continuous application of metrics, statistical techniques, and other quantitative techniques to determine if data governance efforts are changing organizational behaviors appropriately.
26. Adjustments to data governance activities and structure based on analysis results.
27. Evaluation of external governance structures and industry case studies for best practices and lessons learned, providing ideas for improvements.
28. Data governance processes that are continually refined and improved.
29. A data management function that centralizes metadata management efforts and is overseen by data governance.
30. Data governance that approves metadata additions and changes.
31. A data quality strategy that is followed across the organization and is accompanied by corresponding policies, processes, and guidelines.
32. Data quality metrics employed to analyze proposed changes to the data quality strategy.
33. Adjustment of policies, processes, and guidelines, which are defined to support the data quality strategy, based on performance metrics analysis results.
34. An established and maintained strategy used for risk management.
35. Identification, analysis, and documentation of risks by following the organization’s standard process.
36. Evaluation and categorization of each identified risk using defined risk categories and parameters, to determine its relative priority.
37. A process to develop risk mitigation plans in accordance with the risk management strategy.
38. Continual monitoring of the status of each risk plus implementation of the risk mitigation plan as appropriate.
39. Use of statistical and other quantitative techniques to analyze and determine the quantitative risk to meeting the goals.
40. Policies, processes, and procedures to ensure that data cleansing activities are applied at the point of origination in accordance with published rules.
41. Change management processes addressing the entire data lifecycle that are established and maintained.
42. Management of changes to shared data sets (or target data sets for a specific business purpose) by data governance structures with relevant stakeholder engagement.
43. Data governance that monitors the standard organization-wide process used to develop data sourcing requirements.
44. Data governance that ensures architectural standards are aligned with business needs and aligned with the organization’s senior architecture governance body.
45. Documentation and management of changes to data sources and destinations through the data governance process.
46. Policy that is defined and approved by data governance and implemented at the organizational level requiring logging of data changes, and retention of the logs.
47. An audit program that ensures compliance with organizational data logging, archive, and retention policies.
48. Use of metrics results and stakeholder feedback to improve data retention and archiving policies.
49. Strong monitoring of security policies.
50. Strong policies to ensure all data activities are aligned to the Departmental Data Strategy and the Federal Data Strategy.

# Federal Policy

Federal data policies are primarily applicable to the USDOT use cases but may partially apply to the university TRC/UTC use case. The real-world effect of these policies and legislation on the other external use cases is minimal. The Federal policy subdimension contains readiness checklist items associated with the policies in this section. However, if the Data CMM user selects one the external use cases for which the policies do not apply, the user can skip the Federal policy subdimension during their evaluation. The original research team used the Federal policy requirements in this section to inform their development of readiness checklist items for the Federal policy subdimension. For agencies that adhere to Federal policy, the resulting checklist items can help to assess the effects of these policies on the agency’s ability to manage transportation data.

## Federal Requirements

The following Federal requirements may be relevant to the Data CMM:

* [Federal Information Technology Acquisition Reform Act](https://www.cio.gov/policies-and-priorities/FITARA/) overhauled Federal IT investments to reduce programs’ financial risk and inefficiency and to improve investment impact.16
* [Federal Information Security Modernization Act](https://www.cio.gov/policies-and-priorities/FISMA/) (passed 2002, updated 2014) requires each Federal agency to develop information security standards and assigns responsibility for upholding those standards to the Office of Management and Budget (OMB), the inspectors general, the Department of Homeland Security (DHS), and the agencies themselves.17
* [Digital Accountability and Transparency Act](https://fiscal.treasury.gov/data-transparency/history-overview.html) directed the U.S. Treasury to establish common data standards for financial data provided by all government agencies and to make the data consistent, reliable, searchable, and usable.18
* [OPEN Government Data Act](https://www.cio.gov/handbook/it-laws/ogda/) requires organizations to publish public data in a free, open, standardized, and machine-readable format. It also created a repository of tools, best practices, and schema standards.19
* [Evidence-Based Policy Making Act](https://www.cio.gov/handbook/it-laws/evidence-based-policy-making-act/?clickEvt) establishes processes for the Federal Government to modernize data management and requires agencies to submit annual reports detailing their efforts toward that goal.20
* [Government Paperwork Elimination Act](https://www.cio.gov/handbook/it-laws/gpea/?clickEvt) requires that agencies offer the option to submit/receive information electronically, maintain electronic records, and accept digital signatures.21
* [Paperwork Reduction Act](https://www.cio.gov/handbook/it-laws/pra/?clickEvt) governs the collection of information from the public to maximize benefits and minimize the burden, as well as assigns responsibility for Paperwork Reduction Act policy to the [Office of Personnel Management](https://www.opm.gov/about-us/open-government/digital-government-strategy/fitara/paperwork-reduction-act-guide.pdf) and to agency chief information officers (CIOs).22
* [Geospatial Data Act](https://www.fgdc.gov/gda/gda-fact-sheet-may-2019.pdf) provides guidance on the use of geospatial data; establishes requirements for geospatial data stewardship, budgeting, and reporting; and codifies the role of Federal entities.23
* [Clinger Cohen Act of 1996](https://www.cio.gov/handbook/it-laws/clinger-cohen-act/?clickEvt) establishes the position and responsibilities of agency CIOs and requires OMB to develop a budget process for analyzing and evaluating IT projects.24
* [Confidential Information Protection and Statistical Efficiency Act](https://www.cio.gov/handbook/it-laws/cipsea/?clickEvt) imposes safeguards on information obtained by the Government for statistical purposes with an assurance of confidentiality, and promotes sharing the data among the U.S. Census Bureau, U.S. Bureau of Economic Analysis, and U.S. Bureau of Labor Statistics.25
* [Freedom of Information Act](https://www.foia.gov/about.html) requires disclosure of certain information or documents held by the U.S. Government.26
* [Information Quality Act](https://obamawhitehouse.archives.gov/omb/inforeg_agency_info_quality_links/) promotes the quality of information disseminated by Federal Agencies.27
* [Internet of Things Cybersecurity Improvement Act](https://www.cio.gov/handbook/it-laws/iot/?clickEvt) establishes minimum security standards for Internet of Things devices owned and operated by the Federal Government, and grants agency CIOs enforcement authority.28
* [IT Modernization Centers of Excellence Program Act](https://www.cio.gov/handbook/it-laws/modernization-centers-of-excellence-program-act/?clickEvt) codifies the [General Services Administration’s](https://coe.gsa.gov/) (GSA) IT Centers of Excellence, and requires interagency cooperation on IT efforts such as cloud computing, customer support, data, and infrastructure.29
* [Privacy Act](https://www.justice.gov/opcl/privacy-act-1974) governs collection, maintenance, use, and dissemination of personally identifiable information by agencies.30
* [Rehabilitation Act (Section 508](https://www.gsa.gov/policy-regulations/policy/information-technology-policy/it-accessibility-section-508)) requires organizations to present information in a format accessible to people with disabilities.31
* [21st Century Integrated Digital Experience Act](https://www.transportation.gov/digitalstrategy/21-century-idea) sets accessibility, mobility, and other standards for Federal websites.32

## BIL/IIJA Data Provisions

The [Bipartisan Infrastructure Law](https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf) funds new data programs, imposes new data requirements, and reauthorizes existing programs.33

## Other Federal Requirements

Aside from Federal laws, there are several sources of binding Federal IT and data requirements. These include executive orders, OMB circulars or memoranda, DHS binding directives, and agency rules.34

## Relevant Non-Federal or Non-U.S. Legislation

The following non-Federal or Non-U.S. legislation may be relevant to the Data CMM:

* [California Consumer Privacy Act](https://oag.ca.gov/privacy/ccpa#:~:text=The%20California%20Consumer%20Privacy%20Act,how%20to%20implement%20the%20law.) is the is the most significant State-level data regulation. It establishes several data privacy rights for California consumers, including the right to know, delete, opt-out, correct, limit, and the right to non-discrimination relating to data.35
* [General Data Protection Regulation](https://gdpr.eu/) is the European Union’s primary law governing personal data protection, processing, and movement—perhaps most famous for the “right to be forgotten.”36

## Agency Rules

Many departmental and agency policies exist to implement broader Federal requirements, including USDOT’s privacy, open government, and open data policies.37 Departmental guidance is available at <https://www.transportation.gov>, along with links to agency websites and specific program guidance.38

## Key Organizations

The following key organizations may be relevant to the Data CMM:

* OMB
* GSA
* DHS
* United States CIO Council
* Government Accountability Office
* National Institute of Standards and Technology
* Office of the Inspector General
* National Archives and Records Administration

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