

# TBM Maturity Model for Federal Agencies

## Focus Area: Data Analytics



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# Introduction

Operations and maintenance (O&M) for existing IT resources consumed approximately 75% of the federal government’s IT budget in 2015, so only a small percentage was aimed at developing new technologies and modernizing existing system and services.<sup>1</sup> (If you’re keeping score at home, that’s quite a big disparity.) This has been the trend across government agencies for some time. **Failing to modernize and innovate brings certain risks:**<sup>2</sup>

- **Outdated IT systems** become increasingly expensive.
- **Budget reductions** or new costs pose serious threats when existing budgets are dedicated solely to maintaining the status quo.
- **Legacy systems** pose security threats as they may be incapable of needed updates.

Innovation, development, and enhancement are not extra activities in which the government should invest if and when it’s convenient. Rather, they are necessary for creating cost effective IT infrastructure that can provide maximum value to federal agencies. In recent years, the federal government leveraged both FITARA and Technology Business Management (TBM) to further improve IT efficiency and effectiveness. This was done in part to address the federal government’s lack of investment in innovation and modernization. However, decisions on where and how to innovate can be difficult and mistakes costly. **A high-level data analytics practice developed through implementation of the TBM taxonomy is a vital tool for making sound decisions about how and when agencies should develop or modernize IT assets and for identifying opportunities for innovation.**

**Figure 1**

TBM Maturity Model - Data Analytics

		Maturity Levels			
		Novice	More Mature	Mature	Leveraged
Focus Areas	<b>Leadership</b>	No Leadership Buy-In	Clear IT Providers	Cost/Decision Transparency	Mission Focused Investment
	<b>Budget &amp; Performance</b>	Unreliable Metrics	Established Standard	Efficiency Gains	Budget Scenarios
	<b>Data Analytics</b>	Ad Hoc & Reactive	Standards Developed	High Data Quality	Robust, Predictive Analytical Models
	<b>Technology</b>	Key Features	Data Tools and Management	Key Development Goals	Integrated & Modern
	<b>TBM Processes</b>	Manual	Aligned	Automated	Efficient

<sup>1</sup> Federal IT Cost Commission Report, **Accelerating the Mission: Recommendations for Optimizing Federal Technology Cost and Value in the Age of FITARA**, 12.

<sup>2</sup> Margie Graves, **IT Modernization**, presented March 9, 2017.

The Data Analytics focus area of the TBM Maturity Model developed by TCG helps agencies develop a TBM data practice to ensure that IT is effectively serving the mission of the agency and enables rigorous decision making around development, modernization, and innovation. The Maturity Model guides agencies through three key areas of their data practice and provides a framework and tools for continuous improvement of: Sourcing, Quality, and Analysis.

## Sourcing

At the beginning of an agency's TBM implementation, the data necessary to create transparency around IT resources is likely spread out among multiple departments, systems, and business units. Agencies should establish a prioritized list of data sources, extract that data through rigorous processes (like the invoicing procedure we discussed in the **Processes focus area**), and allocate data to different layers of the taxonomy (cost pools, IT towers, and business units).

## Quality

As recommended by Federal IT Cost Commission Report,<sup>3</sup> agencies should develop a TBM Data Quality Index to identify missing data sets, gaps in data, breakage between data sets, duplicate records, and other data issues. In addition to these metrics, TCG recommends that agencies use 5 key standards for judging data quality **listed below**.

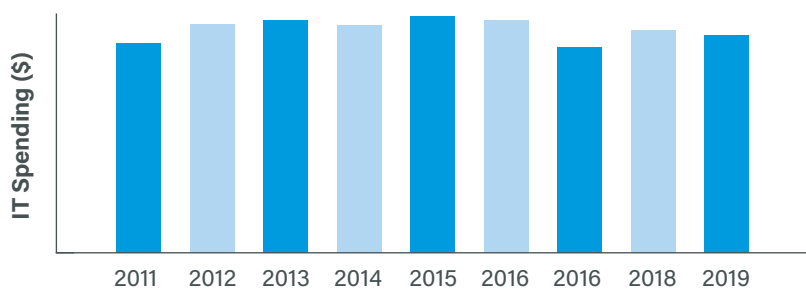
## Analysis

To develop a high quality analytical practice, agencies will need to assess current analytical competencies, identify gaps in the current analytical toolset, and generate KPIs to facilitate improved decision making

### The four stages of maturity in the Data Analytics area are:

#### Ad hoc and Reactive (Novice Level)

Decisions are based on assumptions, and data standards are not established and therefore not enforced. Analysis is limited to canned reports and summary statistics to inform budget decision making. Data sources remain scattered and siloed.



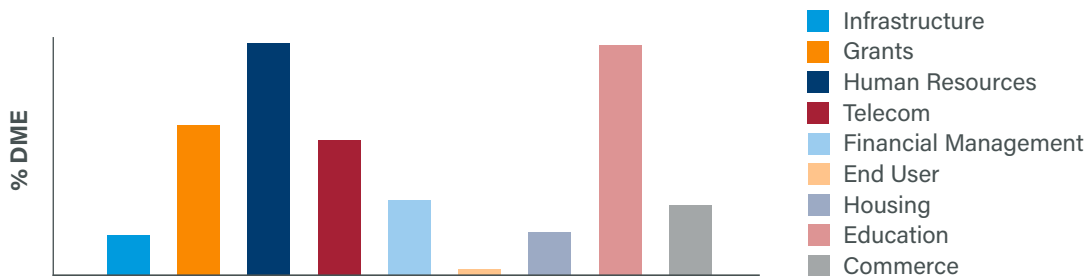
**Note: This chart represents the rudimentary analysis of the novice maturity level. It depicts total IT spending by year, a highly aggregated dataset that makes it difficult to derive specific insights into IT spending.**

<sup>3</sup> **Accelerating the Mission**, 18.

### Standards Developed (More Mature Level)

Process still involves use of non-authoritative data sources. Standards have been developed. Key metrics and acceptable thresholds are established around the data practice to ensure quality and reliability.

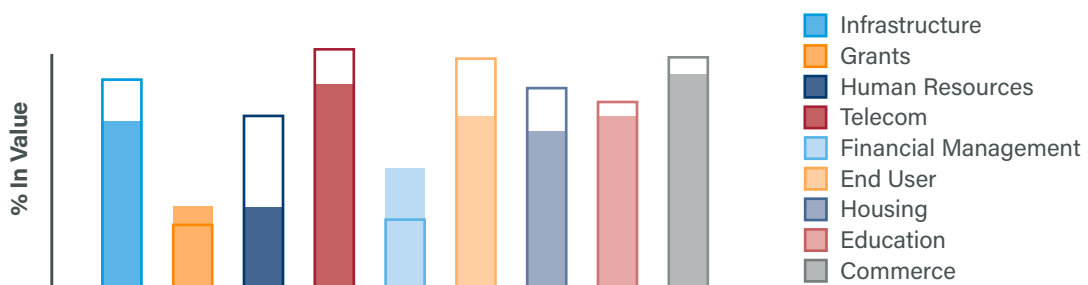
Analysis at this stage goes more in depth primarily by using valuable, high-level CPIC metrics such as development, modernization, and enhancement (DME) spending as a function of total spending. Unlike higher maturity levels, the TBM taxonomy is absent, preventing more granular analysis along IT Towers such as software, hardware, and cloud.



**Note:** The example chart for the More Mature level depicts DME spending as a function of total spending

### High Quality Data (Mature Level)

The majority of data sources are authoritative. Data standards are operationalized through data alerts and reports, and there is clear ownership of remediation actions when issues are identified. As a result, data is consistently accurate and reliable. Agencies at this maturity level have begun to allocate finance and other data sets into the TBM taxonomy.



**Note:** The chart for the Mature Level shows the dollars in value provided by investment against the total cost of the investment, offering a clear picture of ROI by area investment. Negative ROI is represented by white space at the top of the bar for each category. Positive ROI is represented by solid color going past the top of the outline. This is an advanced KPI for innovation, providing insights beyond what is possible through CPIC.

## Robust, Predictive, Analytical Models (Leveraged Level)

All IT financial data adheres to the TBM taxonomy. Data is fully leveraged through the use of advanced analytics (e.g. risk models, forecasting, and other predictive analysis). KPIs for budgeting, performance, and innovation are driven by robust data sets. Analysis at this stage is highly advanced.



**Note:** This dashboard represents a dynamic interface for analyzing TBM data. The example chart represents a risk model that would use advanced statistical techniques to calculate and weigh risks.

## Sourcing Data

While TBM relies on data from many sources, financial data is the core data set for the methodology.<sup>4</sup> IT financial data can be pulled from the agency's accounting system and allocated to different cost pools such as: hardware, software, labor (internal and external), and telecom. In addition to other sources, TCG sees contractor invoices as an invaluable source of financial data that allows agencies to collect granular information about IT spend at a key source. Collecting data at this level helps agencies avoid having to disentangle non-IT from IT spend. (We discussed the importance of invoicing procedures in the **Processes focus area**.)

In the private sector, data on IT spend is usually not commingled with non-IT data or not to the same degree. In some cases at federal agencies, IT costs are managed through appropriations and recorded in funds for programs and projects that do not distinguish between money spent on IT and money for other areas of a program or department.<sup>5</sup> IT data needs to be decoupled from non-IT spend and then allocated to cost pools and IT Towers.

For financial data, the Federal IT Cost Commission recommended that the GSA's Financial System's Integration Office (FISO) create a common coding scheme for this mapping, using the standard cost

<sup>4</sup>Todd **Tucker, Technology Business Management: The Four Value Conversations CIOs Must Have With Their Businesses**, 85.

<sup>5</sup>**Accelerating the Mission**, 20.

center or activity codes in the Common Government-wide Accounting Classification (CGAC).<sup>6</sup> Though this is a viable solution, **mapping CGAC codes to TBM cost pools or other areas of the taxonomy is not an exact match. Therefore this exercise will provide an imperfect translation of cost data for analysis and decision making.** Moreover, this activity fails to address the issue that the most accurate and granular data will be best classified by the individuals who performed the work reflected in each payment.

Therefore, our recommended approach is to have vendors and other owners of financial and non-financial data provide detailed breakdowns and allocations to cost pools, IT towers, and other areas of the taxonomy because they have familiarity and insight into the nature of IT-spend and management in their areas. Establishing consensus among stakeholders in the agency about how to allocate costs in the taxonomy is an essential step in ensuring that mapping is consistent across the agency.

In addition to financial data, agencies will need to collect data from human resources, operations, mission areas, project management offices, and other key data holders that track the IT assets, labor, consumption, and users in their areas. Because each agency is different you will need to ask who at your agency keeps the authoritative source of data for areas such as, **Project Performance, Estimated Costs, Estimated Schedules, List of Planned Systems and Retirements, Infrastructure costs for shared services, and Commodity IT items such as storage.**

This data should be joined to the financial data collected and organized in the TBM taxonomy. The benefits of linking data in this way are increased cost transparency for TBM stakeholders and improved analytical potential for TBM practice. For example, when project performance is linked to the actual costs represented in the financial data over time the TBM team can identify which IT projects support an overall lower cost of ownership.

Sourcing data can seem like an impossible task. As the **TBM Playbook from GSA** and the Department of Education recommends, “don’t try to boil the ocean.” In other words, agencies should not try to gather “all” the data at once to implement their TBM practice but should continually add sources to improve data quality. This is an iterative process, so to begin, agencies should take the most accessible data and connect that to data in the TBM taxonomy.

#### **Just Start.**

“Your data is not going to be perfect. You’re not going to be able to model everything the way you want, but start. And I can tell you that’s proven to be so true. We just needed to start and things started to fall into place. Are we where we need to be? No, but we are way further down the path than if we had waited for perfection before starting.”<sup>7</sup>

– Steve Adams, Executive Director of IT at Kaiser Permanente.

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<sup>6</sup>**Accelerating the Mission**, 21.



# Data Quality

## Define Standards

For the purposes of the TBM practice, your data must meet minimum thresholds for all of the standards listed below. Through assessment, agencies will be able to determine which aspect will require the most attention to improve their overall data quality. Note: You will only have high quality data when all the standards below are met. For example, agencies tend to stress accuracy, but accuracy alone is not sufficient to ensure data quality.

### **Accuracy**

Data matches expected values and records have no missing data. Determining accuracy requires having established authoritative data sources and approved logic for data transformations.

### **Consistency**

Specified Data points are the same across different reporting mechanisms within the organization. The agency has a single, authoritative source for calculated metrics and descriptive statistics.

### **Freshness**

To ensure data is relevant, it is kept up to date through automated processes. Data records should be time stamped to avoid using out-of-date data when calculating current metrics.

### **Flexibility**

Data can be structured in a variety of ways to fit the different perspectives of stakeholders across the agency. Users can access either raw data or in a specific form such as a pivot table or graphic visualization. In addition, the data platform is designed so that it can handle future schemas and modifications.

### **Accessibility/Security**

Access is restricted to those who have a business justification. Criteria are established for granting access, and there is clear ownership over that process. It is incumbent upon the agency to follow all Federal information security requirements, guidelines, and best practices regarding access to and security of data (for example, FISMA).

## Ensure Data Quality

Ensuring data quality requires mechanisms that bring data quality issues to the surface and make it easy to communicate about these issues among relevant stakeholders. Examples of how this can be done in an operational context are:

- **Establishing automated data quality** mechanisms such as quality reports and notifications that identify outliers and anomalous data (see Table 1)
- **Designating ownership** for reviewing data quality reports and addressing any shortfalls by cleaning data with designated tools, filling gaps in data with generalized allocation rules when necessary, and working with data holders to fix problems with inputs at the source<sup>7</sup>
- **Making data quality** a standing agenda item for relevant meetings
- **Creating a process** for informing contract officer representative (COR) in order to ensure vendors correct or clarify issues with invoice data

In Table 1 we have listed examples of metrics that correspond to each quality standard and mechanisms an agency might use to ensure that these standards are being met. Some metrics like missing data points or duplicate records are common to any data quality check and should show up in standard data reports. Other metrics, such as time spent reorganizing or reformatting data for different stakeholders, are not as easily tracked and may only be possible at the higher maturity levels.

Once agencies begin to collect and analyze data through the lens of the TBM taxonomy, they can begin to identify and test key assumptions around IT management. Testing assumptions is one of the activities that can drive innovation and compel organizations to find new and better ways of utilizing IT. This is one of the higher level value propositions of TBM itself. See Appendix II at the end of this document for more information.

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<sup>7</sup>Tucker, **Four Value Conversations**, 87.



**Table 1**

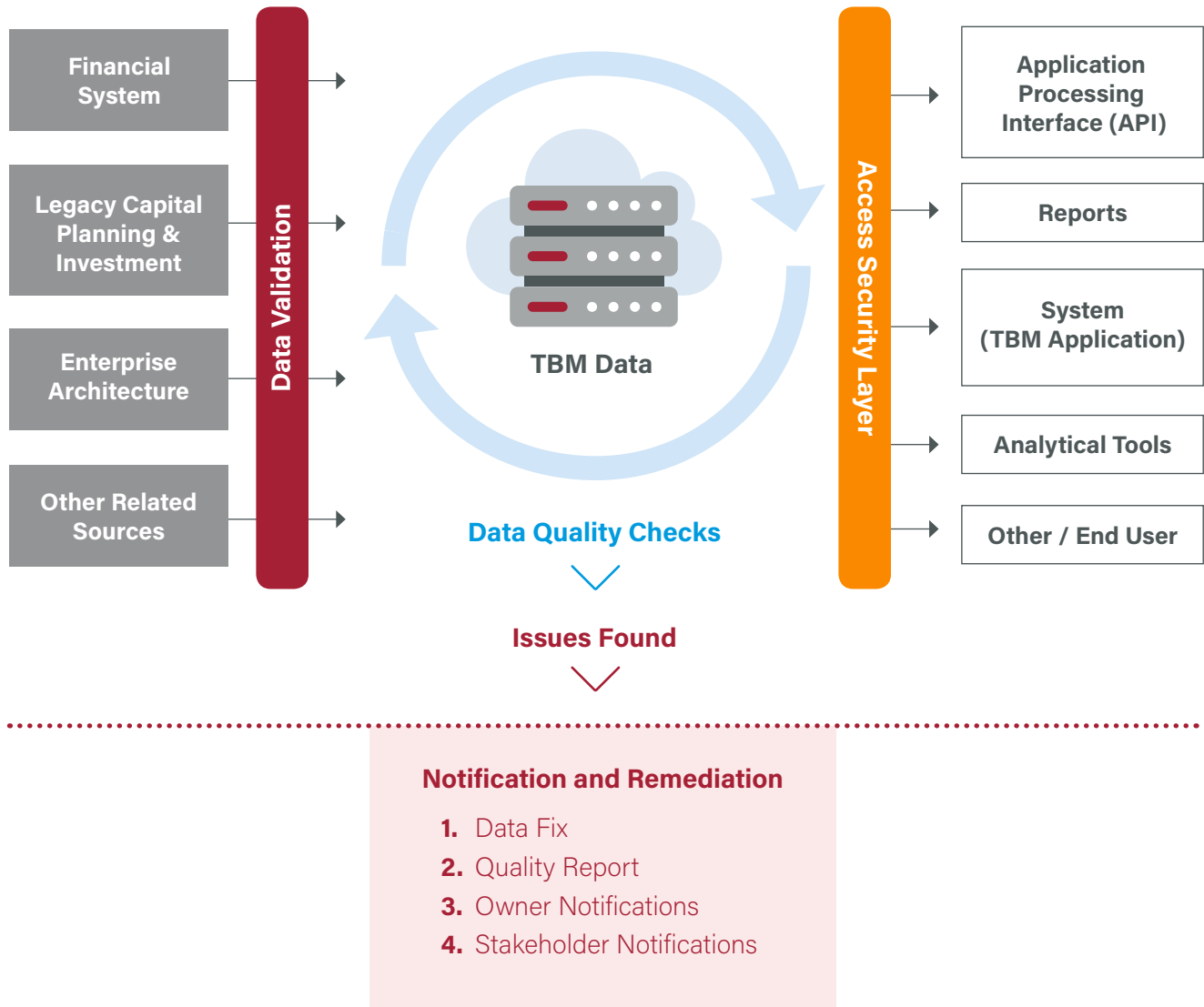
Standards	Metrics	Mechanism
<b>Accuracy</b>	<ul style="list-style-type: none"> <li>▪ How many missing data points have been identified?</li> <li>▪ How many outliers have been identified?</li> <li>▪ Are there any gaps in data sets?</li> <li>▪ How many duplicate records have been identified?</li> </ul>	<p><b>Mechanism:</b> Automated Data Reports</p> <p><b>Purpose:</b> Flag deviations above or below given benchmarks for metrics.</p>
<b>Freshness</b>	<ul style="list-style-type: none"> <li>▪ How many updates were completed after scheduled time?</li> <li>▪ How many invoices were submitted after the due dates?</li> <li>▪ How many times did processes fail to pull/push data?</li> <li>▪ How much time passed between updates?</li> </ul>	<p><b>Mechanism:</b> Email Notifications</p> <p><b>Purpose:</b> Automated notifications alert relevant staff when data transfer is in error or lagging.</p> <p><b>Mechanism:</b> Data Quality Report</p> <p><b>Purpose:</b> Data is updated in real time as much as possible and report states time between updates.</p>
<b>Consistency</b>	<ul style="list-style-type: none"> <li>▪ How do ad hoc calculations result in different outcomes for different stakeholders?</li> <li>▪ How many deviations in externally reported values? (Example: Is finance or business data on application use consistent with data from IT sources?)</li> </ul>	<p><b>Mechanism:</b> Rigorous QA of data products including ad hoc reports.</p> <p><b>Purpose:</b> Detect deviations in standard metrics among different stakeholders and ensure standard calculations are used among stakeholders.</p>

Standards	Metrics	Mechanism
<b>Flexibility</b>	<ul style="list-style-type: none"> <li>▪ What is the time between an external data call and response?</li> <li>▪ How much time does it take to submit ad hoc reports to external stakeholders?</li> <li>▪ How much time is spent reorganizing, recalculating, or reformatting data to fit business, IT, or finance reporting needs?</li> </ul>	<p><b>Mechanism:</b> Help Desk or Data Center Report.</p> <p><b>Purpose:</b> Show time between data request and response in relation to specified benchmarks or reporting deadlines (external and internal).</p>
<b>Accessibility</b>	<ul style="list-style-type: none"> <li>▪ What is the number of unsecured endpoints (ways of accessing data that don't require user name or password)?</li> <li>▪ What is the number of access requests?</li> <li>▪ What is the number of stakeholder groups without access to required systems or applications?</li> </ul>	<p><b>Mechanism:</b> Usage Reports like Google Analytics</p> <p><b>Purpose:</b> Automated report specifying stats for users and groups: who accessed what, when and for how long. Display what systems various owners and managers have access to.</p>
<b>Security</b>	<ul style="list-style-type: none"> <li>▪ Are appropriate FISMA guidelines followed?</li> <li>▪ Are <b>DHS best practices</b> followed?</li> </ul>	<p><b>Mechanism:</b> Standing meetings with CISO.</p> <p><b>Purpose:</b> Ensure information security guidelines (e.g. FISMA) are met and corrective actions taken to address issues.</p>

Data provided to stakeholders throughout the organization is used to set organizational policy and support critical decisions. Therefore, the processes and operations that integrate data standards and tools must quickly expose issues with data quality, communicate these issues to relevant stakeholders, and trigger corrective actions.

**Figure 2**

Standard TBM Data Process Chart



# Data Analytics

Data analysis is a term that covers a lot of ground and often brings to mind advanced tools such as machine learning, natural language processing, and neural networks. However, at a basic level, data analysis is asking questions of data. As we established in the last sections, this white paper is more about how to lay the foundation for a solid data analytics practice in TBM than what machine learning can do at your agency.

In addition to sourcing data, setting standards, and creating mechanisms to ensure data quality, agencies need to assess their current capabilities in data analysis, acquire the optimal tools for data analysis, and begin analyzing the data they currently have, particularly in terms of the key performance indicators (KPIs) for innovation.

**In this section we'll outline each of these areas:**

- **Assessing Capabilities**
- **Analytical Tools**
- **Analyzing TBM KPIs for Innovation**

## Assessing Capabilities

TBM spending is broken out in multiple ways so that organizations can start connecting analytics from different offices and disciplines—finance, business, IT, etc. In other words, data analysis is the primary tool for creating transparency and a shared perspective among stakeholders around IT management. The data analytics team of any agency must be able to link the data from different areas and other stakeholders and communicate that information clearly and effectively.

**Agencies should assess their data analysis capabilities within these areas:**

- **Basic Data Management:** Agencies should have capabilities with SQL-based and other tools for structuring data, ensuring referential integrity, and implementing best practices for data management.
- **Reporting and Data Visualization:** Knowledge and experience with visualization tools (see Table 2) are valuable to communicate data quickly and efficiently. Designers and analysts should have awareness of business, finance, and IT audiences, as well and be able to create visualizations that are easily digestible for a number of stakeholders at once.
- **Data Modeling and Statistical Analysis:** A vital dimension of a TBM practice is analyzing data to measure performance and create budgets around actual costs, with the potential for **zero-based budgeting**. These capabilities include industry standard risk modeling and budget forecasting as well as advanced techniques such as neural networks, machine learning, and natural language processing.
- **Other capabilities may include specific tools.** For instance, agencies that rely heavily on sharepoint need the capability to move reports and visualizations to that platform to link and integrate technology. (See the **Technology Focus Area** of the maturity model.)

Table 2 lists several tools for data analysis that require different levels of expertise. The list is not exhaustive, and not every agency will need all of these tools. However, they do provide a starting point for thinking about the current capabilities an agency possesses and what assets and expertise may be underutilized.

**Table 2**

Common data tools at agencies that can be leveraged by TBM analysts

Standards	Tool	Description
<b>Visualization</b>	Tableau	Industry standard data manipulation tool that can be used for rapid prototyping and sharing of visualizations.
<b>Visualization</b>	Power BI	Visualization tool from Microsoft similar to Tableau. Numerous extensions and data connection tools included.
<b>Desktop</b>	Excel	Standard data viewing and analysis tool from Microsoft. A common, ubiquitous data format for sharing.
<b>Cloud</b>	Sheets	Google's web-based spreadsheet program that is very similar in form and function to Excel. Federal employees and contractors are likely to have Sheets, Excel, or both available to view and share data and related analyses.
<b>Data Coding</b>	Python	Free, open source programming language with several mature analytical packages that allow users to perform virtually any data operation from addition to Neural Networks.
<b>Data Coding</b>	R	One of the leading data coding languages, R is similar to Python in terms of its limitless capability with data. Capable of machine learning and natural language processing.
<b>TBM Tool</b>	Various	If agencies have elected to use a TBM tool, you should consider the TBM tool a critical source for standard reports and the single source of truth on financial data across the organization.

Once agencies begin to collect and analyze data through the lens of the TBM taxonomy, they can begin to identify and test key assumptions around IT management. Testing assumptions is one of the activities that can drive innovation and compel organizations to find new and better ways of utilizing IT. This is one of the higher level value propositions of TBM itself. See Appendix II at the end of this document.

## KPIs for Innovation

Even as agencies begin to source, collect, and set standards for data, it is vital that they incorporate key performance indicators into their data analysis practice. TBM emphasizes several sets of KPIs around cost for performance, business aligned portfolio, investment in innovation, and enterprise agility.

TBM provides several KPIs for assessing innovation, including the well-known ratio of O&M to DME spending. Other KPIs include:

- **Investment against Targets by Value Category:** KPI measures investment spending for replacing, maintaining, enhancing, or creating/obtaining new assets and capabilities. Enables agencies to make better judgments about when maintaining an IT system, application, or other asset is getting in the way of establishing something new and more cost effective.
- **Projects on Time and on Budget:** KPI shows total project spending related to scope, budgeting, and schedule. Allows agencies to see which projects are likely to have the biggest impact on the business.
- **Economic Value Added of the IT Investment Portfolio<sup>8</sup>:** KPI translates cost avoidance, productivity, and other benefits to a total dollar value to be compared against the overall cost of the service. This offers a clear comparison of actual cost versus opportunity cost for each IT investment, thereby identifying the best return for investment in an agency.

All of the KPIs for innovation are performance metrics important beyond their connection to innovation. As we noted above, agencies should begin with the data they have available and work to continually improve data quality. Beginning to track these metrics, even with imperfect data, is an important aspect of a data analytics practice.

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<sup>8</sup> Descriptions of these KPIs can be found in both [The Four Value Conversations](#) and [Accelerating the Mission](#) from The Federal IT Cost Commission

## Conclusion

Over the past decade, the principle of data-driven decision making has gone from cutting edge to common place. Managers spend more time than ever looking at data reports to gain insights and inform their management decisions. **Yet, not all data is created equal, and the important task of ensuring data quality is often sacrificed for urgent matters. This priority of the urgent over the important is understandable, but in the context of TBM, failing to ensure data quality is especially detrimental because TBM itself is a data-driven approach to managing costs and consumption of IT resources.** Agencies will not be able to mature their TBM practice and create much needed transparency in IT management without having high-quality data and putting it to work with analytical tools.

High quality data improves processes, enables leadership to make better decisions, and provides accurate budget forecasting and performance evaluation. At a fully leveraged level, quality data makes possible predictive analytics that can positively transform an agency's management of IT resources and help them innovate to increase efficiency.

To mature their agency from their current state to a future, leveraged state as described in the figure above, agencies should use the self-assessment worksheets in the appendices and, as a team, discuss the key issues to develop a shared understanding of what needs to be done to create transparency and a shared perspective around their IT management.

If you have questions about the Maturity Model or would like more information on how to use it, please contact [tbm@tcg.com](mailto:tbm@tcg.com). We look forward to hearing from you!



## Other Resources

Visit [www.tcg.com](http://www.tcg.com) for additional information on implementing TBM at your federal agency.

- *Ready or Not, Here it Comes: Prepare for Technology Business Management*
- *Six Steps to Implementing Technology Business Management at Your Agency.*
- For assistance or questions about implementing TBM at your agency, contact [tbm@tcg.com](mailto:tbm@tcg.com).
- TBM Maturity Model for Federal Agencies and Additional Resources  
<https://www.tcg.com/tbm-resources/>
- [www.tcg.com](http://www.tcg.com) | Keyword: tbm

### About TCG, Inc.

TCG aims to improve the world around us, in big and little ways, every day, for our staff, clients, and community. TCG provides the federal government with positively distinct IT and management advisory services in Agile development, Technology Business Management, federal shared services, budget formulation and execution, and health science analytics that help government programs and America succeed.

TCG played a central role in supporting the roll-out of TBM across the Federal government. Our consultants helped create and distribute the policies agencies are now using to improve their management of IT investments, and our insights into IT spend data underpinned government's evolution towards TBM. As early members of the TBM Council, TCG was at the forefront of understanding and interpreting TBM principles for the federal government context.

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## Appendix I: Agency Self Assessment

We have listed questions for self-assessment below, so that agencies can begin to evaluate the maturity level of their TBM practice in the Data Analytics focus area. Questions include both yes and no and short answer. Negative responses indicate areas for improvement, and teams should compare short answers to create consensus and a common understanding of the current maturity level of the agency's TBM practice. Distribute these worksheets to your team to fill out.

### Assess Data Standards

1. Do you have clear, well-defined targets for data standards such as freshness, accuracy, consistency, and accessibility?  
 Yes     No
2. Are stakeholders throughout the agency able to access the data and aggregate it in a way that is useful for them?  
 Yes     No
3. Does the budget decision maker (or their team) perform data checks to ensure the data they are using is accurate?  
 Yes     No
4. How do your quality standards reflect accuracy, consistency, freshness, accessibility, and flexibility?

5. Where are the quality standards articulated? (What policies and SOPs?)
  
6. Do stakeholders know and understand the data quality standards?
  
7. How does your agency assess the freshness of data?
  
8. What are the criteria for granting access to data?
  
9. How common are budget overruns or surpluses and what is the magnitude of difference from budget?

## Ensure Data Quality

10. Is data regularly tested for key risk factors including blank data, outliers, invalid data, and anomalies?

Yes     No

11. Are data quality checks automated?

Yes     No

12. Are stakeholders notified when data quality issues are found?

Yes     No

13. What are the mechanisms for testing and how often is data quality checked through these mechanisms?

14. Who is responsible for reviewing data quality?

15. How often is data quality an agenda item for standing meetings?

16. Do data quality reports clearly identify how weak or strong data is?

17. What is the authoritative data source(s) for generating operational reports (identify each report and respective data source)?

## Assess Capabilities

**18.** Does the TBM team have the skill/bandwidth to accomplish the necessary data management, analysis, visualization, and reporting tasks?

Yes     No

**19.** Are operational analyses, visualizations, and other data tasks automated?

Yes     No

**20.** What are your agency's competency levels for analytical tools such as Microsoft Excel, Tableau, and R/Python?

**21.** What is the common desktop data tool that agency employees use to open data files, e.g. (Excel)?

**22.** How do TBM stakeholders prefer to receive data (please provide mechanism such as API, flat file, etc. and format such as JSON, CSV, XML)?

## Appendix II: Common Assumptions

### Identifying Assumptions

Assumptions are one of the key drivers of institutional inertia. They become ingrained in the culture and routines of an organization and are difficult to change because questioning “the way things have always been done” and suggesting alternatives requires facts and information that are often difficult to collect and communicate. In many ways this is not a negative quality because decisions around innovation and development should be vetted rigorously. High quality data and the tools to analyze it are the means for vetting ideas and decisions around institutional changes to IT management.

Agencies will of course have unique assumptions upon which they operate, and often those assumptions may be backed up by the data. However, even when there is good reason to believe in the validity of certain assumptions, we recommend analyzing the data anyway. Beyond assumptions unique to individual agencies, there are some industry standard ideas that should also be questioned because as the context of the agency differs so do the validity of those assumptions. The assumptions listed below are often valid, but, to know whether they are true in a particular use case, they should be tested.

#### **Cloud computing always saves the government money.**

1. Are the costs of switching to cloud services greater than the potential savings that the services would cost?
2. How much do cloud services cost in relation to an on-premise solution?
3. Have our needs for a cloud service changed? In what ways, and do they still match the service we are using?

#### **Bundling services and products from one company saves money.**

1. How do companies rates adjust compared to their competitors when services and products are purchased a la carte?
2. Is it more cost effective to use Azure (MS cloud) bundled with end user software licences than to use bidding out end user software licenses separate from the cloud?

The assumptions and questions listed here are broad, and the point is not to argue for or against cloud computing, and bundling. Rather, using the data and communicating clearly among stakeholders validates decisions because they are based on facts with which all can agree.