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TAM Decision Support Tool State of the Practice Synthesis

A Review of Transit Agency Use of
Decision Support Tools

September 2020

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Abbreviations

Acronym	Term
APTA	American Public Transportation Association
COTS	Commercial Off the Shelf
EAM	Enterprise Asset Management
FTA	Federal Transit Administration
MPO	Metropolitan Planning Organization
SGR	State of Good Repair
TAM	Transit Asset Management
TAPT	Transit Asset Prioritization Tool
TCRP	Transit Cooperative Research Program
TERM-Lite	Transit Economic Requirements Model Lite
TIP	Transit Improvement Program
ULB	Useful Life Benchmark

1 Introduction

The Federal Transit Administration (FTA) published the Transit Asset Management (TAM) rule in 2016 to require public transit providers that receive federal transit assistance to incorporate transit asset management into their business practices. The rule formalizes a set of reporting requirements for transit agencies, as well as the requirement for each agency to generate and implement a TAM plan outlining their asset management practices and procedures.

One key element of the TAM plan is a prioritized list of investments, which outlines a basis for investment decision-making throughout the life of the assets in the TAM plan. Generating this list requires using an asset inventory including asset condition and age, as well as considerations of the fiscal and other constraints an agency faces.

All agencies are required to use a decision support tool (DST) to generate this prioritized list of investments, and to identify their DST in their TAM plan. The DSTs identified in TAM plans represent a wide array of software packages and processes. Guidance given to agencies from the FTA TAM rule specifically noted that a decision support tool is “an analytic process or tool that assists in capital asset investment prioritization and/or estimates capital needs over time (does not necessarily mean software packages)”. While DSTs take multiple forms, each tool allows an agency to take inputs (such as, asset condition, age, and mileage) and combine it with agency priorities (i.e., maintenance of service levels, safety, risk, etc.) to decide on how that asset compares in funding priority to other assets.

Decision-making and prioritization gains complexity with the number of assets included in the prioritization process. While smaller agencies may not have difficulty prioritizing among a dozen buses and their needs for maintenance and replacement, a multi-modal agency’s complexity may require a much more sophisticated decision support framework, sometimes including many software package or process-based tools. The variety of tools described in TAM plans and in literature across the field yields a highly varied, highly specialized set of options.

1.1 Methodology

This report pulls from a variety of data sources to identify the current state of the practice for use of DSTs. The primary source of information used in the report was a group of thirty five TAM plans obtained either through publicly available files or through agency TAM plans submitted to FTA. These plans were reviewed for any relevant DST practices. The review of literature also included a scan of literature on asset management for material on the use of DSTs, including academic, industry based, and FTA publications. Finally, the research team conducted interviews with five agencies of various sizes and geographic locations to gain additional qualitative information and insight into agency use of DSTs (see list of TAM plans, literature, and interviewees in the appendix).

Selection of both documents for review and agencies for interviews was partially based on agency tier, a categorization of agencies used to delineate TAM plan reporting requirements. The TAM rule separates agencies into either Tier I or Tier II groupings, depending on the number of vehicles in revenue service during peak service hours and the presence of rail transit.¹ The report includes thirteen Tier I plans, ten Tier II plans, and twelve Group plans.

¹ FTA. *Am I a Tier I or Tier II Agency?*, <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/regulations-and-guidance/asset-management/57026/tierchecklist1704.pdf>.

1.2 Report Organization

This report explores the types of decision support tools in use, existing literature on the tools, and several TAM plans available publicly and through FTA review. The report provides a synthesis of state of the practice for how various agencies implement these tools, and covers the following topics:

- Section 1 introduces DSTs and the background of this synthesis.
- Section 2 describes the major types of DSTs used by agencies
- Section 3 reviews existing literature on DST practices.
- Section 4 examines the state of the practice of DSTs throughout the field.
- Section 5 describes considerations for implementing DSTs, as well as common challenges and opportunities in the development of tools.
- Section 6 provides general conclusions from the research presented.

2 Types of Decision Support Tools

Decision support tools are used to structure data, organize decision making, and provide a basis for prioritization of assets. The decisions they support include priority for funding, maintenance and asset replacement. Agencies identified DSTs in their TAM plans including not only software packages as tools, but also processes to reach a consensus on decisions through staff evaluation, other planning processes, or use of project proposal forms for review. Agencies often use multiple types of tools, and sometimes multiple tools of the same type. This section briefly describes the types of tools contained in the source material for this report.

2.1 Software Packages

Many agencies use one or more software packages to support their TAM decision-making processes. Software packages can track many types of data on assets spanning across multiple functional areas of a business. Some of these types of data relate to:

- Inventory (e.g., asset description, condition assessments, mileage, etc.).
- Maintenance (e.g., records of past maintenance, upcoming planned maintenance, etc.).
- Finance (e.g., spending on an asset, depreciation)
- Procurement (e.g., estimated cost of replacement, asset lifecycle analysis, tracking procurement process steps)

Software packages vary significantly in size, scope and complexity. There are also many manufacturers offering software packages within each of the following categories:

2.1.1 Commercial Off The Shelf (COTS) Software Packages

COTS tools are standard software packages available for purchase from third party vendors. These systems may be transit asset specific or general tools used for asset management. The tools often include optional modules and/or customized configurations to meet an agency's business needs (such as a maintenance scheduling module, or a financial analysis module). COTS tools can also be enterprise asset management tools.

2.1.2 Enterprise Asset Management (EAM) Tools

EAM tools are a class of software packages designed to provide tracking and decision support throughout the entire lifecycle of an asset. These tools are comprehensive in scope, and operate across multiple agency business functions (procurement, prioritization, operations, maintenance, finance, etc.). EAM tools represent a significant investment by an agency, and larger and more complex agencies are more likely to use them. They are more likely to be custom built, or highly customized, than other tools.

2.1.3 Custom Software Packages

Some agencies develop custom DSTs, tailored to the unique needs of their asset management practices and/or existing IT infrastructure. For instance, legacy systems often have many types of assets that need to be treated differently, and the organizations themselves often have distinct business needs for software solutions. These tools are often complex, resource intensive to create and maintain, but provide specialized functionality to the agency. They may or may not be comprehensive enough in scope to be considered EAMs.

2.1.4 Publicly Available Software Packages

Agencies may also choose to use publicly available tools. These tools may be specific to TAM, or general data analysis and tracking tools used for TAM purposes. These tools are often the simplest and least resource intensive to implement; they offer valuable services but may not scale to meet the needs of larger complex agencies and are often not customized.

Many agencies use spreadsheets to track and/or conduct analysis on their transit assets. Spreadsheet-based tools may be simple or complex, but do not generally provide some of the functionalities of other DSTs. Spreadsheet-based tools frequently pair with other DSTs.

Agencies use relational databases for tracking and analysis of transit asset data, sometimes in combination with other tools. Relational databases may provide a more sophisticated method of tracking/analyzing assets than spreadsheets, with far less investment in personnel training or software customization than many larger software packages.

2.2 Processes as Tools

The FTA TAM rule specifically noted that an agency's DST does not need to be a software package, acknowledging the validity of the existing process based decision-making tools many agencies use. The description of processes used as decision-making tools overlaps somewhat with the related FTA report *TAM Investment Prioritization State of the Practice*.

2.2.1 Planning Processes

Many agencies identified required, pre-existing planning processes and documents as DSTs. These planning processes were part of existing activities for the transit agency, MPO, or State DOT (such as STIP/TIPs, etc). The planning process (and plans) can include transit specific project or asset prioritizations, and create an overarching framework within which an agency will create their prioritized asset list. Alternatively, the planning processes may overlap with the TAM planning process, and the prioritization of assets. TAM plans reviewed included planning processes like the STIP/TIPs; strategic plans; maintenance, operations and capital planning.

2.2.2 Review and Evaluation Processes for Individual Projects/Assets

DSTs also come in the form of a project evaluation process, often involving a multiple month review of project applications or asset replacement forms and a set of stakeholders completing a project ranking process according to pre-determined criteria. Some agencies required project application forms to include a variety of data on asset condition, age, mileage, and maintenance records when submitted. Agencies assessed this data annually based on their priorities for asset investment and review of experts across departments to reach consensus on a prioritized asset list.

3 Literature Review Synthesis

The research team reviewed existing documentation of DSTs from various sources, including individual agency documents and presentations; research reports (from organizations including American Public Transportation Association (APTA) and the Transit Cooperative Research Program (TCRP)); FTA's TAM program documents and resources; and interview notes from previous FTA research projects. This report pairs with the *TAM Investment Prioritization State of the Practice* report, which goes deeper into the strategies agencies use to prioritize their investments.

Documentation of best practices and agency use of DSTs is sparse. Few resources discuss the impacts of DSTs (such as improved ability to prioritize assets, insights into the state of good repair of assets, etc.), the nuances of their use within agencies, or best practices from the field. However, substantive documentation exists on selection and procurement of DST software packages and free tools.

3.1 DST Procurement

The January 2020 APTA report, [Procuring Software to Support Transit Asset Management](#), thoroughly explores how agencies select and procure DST software packages.² This high-level report covers a range of topics transit agencies should consider when choosing DSTs, including: business requirements and practices; software and systems integration; and procurement and implementation considerations. The APTA report focuses primarily on the implementation of Enterprise Asset Management (EAM) tools, which provide services in multiple business functional areas across the organization.

Agencies seeking to determine which software packages may be the best suited to their context should begin with an examination of their business needs, structure and existing systems. The APTA report linked business functions, FTA TAM rule requirements, and the capabilities of various DST software packages. The report included an exploration of how business practices and TAM DSTs must align, and the difficulties faced by agencies that seek to implement software packages that do not reflect their business practices. One of the key lessons from the report included the difficulty of integrating tools into existing IT architecture – a challenge that may push agencies toward less complex and less comprehensive software packages.

The APTA report is not exhaustive, and serves as a starting point for agencies who are seeking recommended practices on DSTs. To avoid duplication, this FTA report will highlight more specific and nuanced observations and recommendations for the complexities of DST procurement, rather than high-level considerations and practices.

3.2 Implementation of Publicly Available Tools

While the APTA report and related resources provided considerations for implementing EAM tools, multiple other documents provided resources for implementing and using [TERM-Lite](#), [TAPT](#) and other, publicly available or smaller tools that require less agency collaboration and are directly related to asset management.

² APTA Standards Development Program Transit Asset Management Working Group, 2020. *Procuring Software to Support Transit Asset Management*. <https://www.apta.com/wp-content/uploads/APTA-SUDS-TAM-RP-008-20.pdf>

The Transit Economic Requirement Model (TERM) is a tool used to estimate the nation’s transit capital expenditure needs over a 20-year period.³ TERM-Lite is a free, less complex resource offered by FTA for transit agencies. TERM-Lite, based in MS Access, helps agencies “assess the current physical condition and future investment needs of transit assets/operators” ([TERM Lite overview](#)). The TERM Lite documentation explains how to use the TERM-Lite model, and includes information on the model’s assumptions and priorities.⁴ The tool allows users to customize their analysis based on lifecycle assumptions, funding assumptions, and prioritization of different criteria.

[FTA Report 138, the Asset Management Guide Supplement \(2019\)](#), provides detailed information about asset organization (including rolling stock and facilities) and current lifecycle management practices.⁵ It provides agencies with a broader understanding of the contemporary practices involved in asset management.

TCRP Report 172 (2014) gives practitioners tools and guidance to improve asset management.⁶ It includes information on the Transit Asset Prioritization Tool (TAPT), which agencies may use to assist in predicting future asset condition. The Transit Asset Prioritization Tool (TAPT) is a spreadsheet-based tool developed to help agencies prioritize investments in their transit assets. The tool models asset condition and provides a scenario planning functionality to examine different prioritizations and funding possibilities ([TCRP 172](#)).

3.3 Literature on Agency Specific Practices

Documentation of several agencies use or development of DSTs was available in webinars, presentations, and other documents. These documents were available mainly from larger agencies with a more mature TAM implementation, which had been putting TAM practices into place for a longer period and were practicing advanced concepts. While this literature review highlights a number of these examples from larger agencies, it is important to understand that most agencies, regardless of size and maturity, use a form of decision support, and may not be reflected in this literature. Smaller agency practices are not as widely represented in publicly accessible documents and decision support may be an integrated part of other agency planning processes (e.g., TIP/STIP planning, etc.).

3.3.1 Enterprise Asset Management Systems

The Southeastern Pennsylvania Transportation Authority (SEPTA) published a presentation that described their EAM system development in 2011.⁷ Their State of Good Repair (SOGR) database was under development by a contractor at the time of the presentation, and included provisions to allow SEPTA to understand their SGR backlog, project future asset needs, and prioritize spending to enhance the SGR of all assets. Some of their considerations for implementing the EAM system included whether

³ TRB 2013. *Review of the Federal Transit Administration’s Transit Economic Requirements Model*. <http://www.trb.org/Main/Blurbs/168691.aspx>

⁴ FTA 2013. *User Training Transit Economic Requirements Model Overview*. https://www.transit.dot.gov/sites/fta.dot.gov/files/TERM_Lite_Overview.pdf

⁵ FTA 2019. *Asset Management Guide Supplement: Asset Category Overviews & Lifecycle Management – Update (Report 0138)*. https://www.transit.dot.gov/sites/fta.dot.gov/files/TERM_Lite_Overview.pdf

⁶ National Academies of Sciences, Engineering, and Medicine 2014. *Guidance for Developing a Transit Asset Management Plan*. <https://doi.org/10.17226/22306>

⁷ SEPTA 2011. *Development of a System-Wide Asset Management Program*. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/SEPTAs_Practices_and_Plans_-_Jeff_Kneuppel.pdf

it would simply house data from other systems or be fully integrated, what level of granularity would be needed for each dataset and field, and how to include consideration of which projects have safety and/or regulatory impacts if deferred.

Metrolink also detailed their development of an EAM system for TAM in a 2017 presentation⁸, starting with their assessment of current systems and needs. Metrolink showed the various types of data and data systems they need to integrate, and then began designing a system to house all of the data (Figure 1). Metrolink provided a set of lessons learned throughout their process of selecting, procuring and implementing an EAM system, including the need to map all business processes and data needs/flows prior to determining a software package to use. They also noted the importance of data integration and data quality, as well as the need for data owners to have good incentives for and control of their data entries. Metrolink emphasizes that a software package will not ensure that the asset management process is efficient or effective. An APTA sponsored report, “[Defining a Transit Asset Management Framework to Achieve a State of Good Repair](#)” (2013), noted similar points, including that asset management software should be “viewed as a tool, much like any other tool used by staff executing physical maintenance, upgrade or replacement projects”.⁹ While EAM systems are present in many larger agencies and provide a comprehensive DST solution, the report noted that “the management needs of each transit agency should dictate the level of investment” in a DST software package (APTA 2013).

	Condition Assessment Method	GASB 34	NetFacilities	RAMS	AssetWorks	TERM Lite
Asset Type	Equipment				X	X
	Rolling Stock				X	X
	Infrastructure	X		X		X
	Facilities		X			X
	Rating Scale	0 to 100	None	1 to 6	None	1 to 5
	<i>Approach</i>	<i>On-site Assessment</i>	<i>On-site Assessment</i>	<i>On-site Assessment</i>	<i>On-site Assessment</i>	<i>Estimated Condition</i>

Figure 1: Metrolink table describing asset management software packages, data types, and data details. (Source: Metrolink)

As agencies using EAMs move toward more advanced data solutions and analysis, opportunities for improving EAMs and integrating their analysis into agency decision making arise and can be evaluated using comparison of systems. An article in MassTransit Magazine from 2020 describes the process of

⁸ Metrolink 2017. *Notes from the Metrolink Field: Out Approach to Building an Integrated TAM-EAM System*. <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/regulations-and-guidance/asset-management/63616/metrolink-presentation52317.pdf>

⁹ APTA 2013. *Defining a Transit Asset Management Framework to Achieve a State of Good Repair*. <https://www.apta.com/wp-content/uploads/Resources/gap/fedreg/Documents/Defining.a.transit.asset.management.framework.to.achieve.a.state.of.good.repair.pdf>

‘benchmarking’, or the process of creating a baseline for an agency’s EAM, assessing any gaps it may have or needs it does not fulfill – particularly in comparison to other leading systems, and finally developing the system to meet agency goals.¹⁰ Focusing on key performance indicators that are obtainable through the EAM (such as asset condition, service continuity, etc.) is described as a strategy for tracking progress toward meeting agency goals. Other advances, such as those made by New York’s Metropolitan Transit Authority, involve building sophisticated EAM systems capable of providing real-time data to the agency, and requiring a significant investment in staff training.¹¹

3.3.2 TAM Specific Systems

The Capital District Transportation Authority (CDTA) in Albany, New York presented on its use of a DST in a [2018 FTA Transit Asset Management webinar](#).¹² The presentation focused on CDTA’s development of the system. CDTA’s impetus was to be able to create “final scores” from the DST, to rank potential projects on a scale from 1 to 5. CDTA relied on four key areas in their decision-making: data, institutional knowledge, project management, and tool development. The tool creates easily interpreted metrics that are exportable to a spreadsheet, such as age, performance, condition, and level of maintenance. Notably, CDTA’s DST can adjust to weight criteria differently as the needs of the organization change.

Similarly, the Peninsula Corridor Joint Powers Board (owner and operator of Caltrain) identified in its [TAM Plan](#) that it uses a modified version of FTA’s TERM-Lite, which integrates internal business processes to approve TAM related SGR projects.¹³ This custom, yet simple tool assists with Caltrain’s decision-making process to identify any potential risks associated with assets appearing on the backlog. Caltrain “expressed that the agency desires to invest in a prioritization model that would factor in multiple additional criteria and various asset subcomponents in order to provide a truly objective prioritized list matching Caltrain’s SGR needs and priorities”. Additional prioritization criteria could include projected asset condition deterioration, a standardized measure of how critical an asset is to operations, and accounting for recently completed maintenance work orders.

The Massachusetts Bay Transportation Authority (MBTA) uses a project selection framework with eight criteria: system preservation, mobility, cost effectiveness, economic impact, safety, social equity, environmental and health effects, and policy support. Teams of staff across the

Resources for Implementing Publicly Available Tools

- [TCRP Report 172: Guidance for Developing a Transit Asset Management Plan](#)
- [TERM Lite Overview](#)
- [FTA Report 138: Asset Management Guide Supplement](#)

¹⁰ Knowlton 2020. Mass Transit Magazine. *Best Practices- Asset Management: Leveraging Benchmarking to Develop a Digital EAM Strategy in Mass Transit*.

<https://www.masstransitmag.com/rail/maintenance/article/21139148/dxc-technology-best-practices-asset-management-leveraging-benchmarking-to-develop-a-digital-eam-strategy-in-mass-transit>

¹¹ Mass Transit Magazine 2018. *MTA Taps DXC Technology for enterprise asset management solution*.

<https://www.masstransitmag.com/technology/intelligent-transportation-systems/article/21037022/mta-taps-dxc-technology-for-enterprise-asset-management-solution>

¹² FTA 2018. TAM Decision Support Tools. <https://www.youtube.com/watch?v=3F2M0nSvHpc>

¹³ Caltrain 2018. Transit Asset Management Plan.

<https://www.caltrain.com/Assets/planning/pdf/Transit+Asset+Management+Plan.pdf>

organization use these criteria, detailed in the [agency's TAM plan](#), to score each project proposal (in combination with supplementary data including estimated ridership, climate risk, etc.).¹⁴ Both Caltrain and MBTA's approaches represent DSTs integrated into agency policies and processes. Agencies may face challenges adopting and integrating software packages that align well to existing business practices, but can use a mix of software packages and non-software tools to fill gaps in data gathering and prioritization.

San Francisco Municipal Transportation Agency (SFMTA) uses a consensus-based DST [detailed in its TAM plan](#) that provides quantitative analysis of qualitative project evaluation criteria.¹⁵ An executive team establishes these criteria and weights them according to agency priorities. Projects are then scored against these criteria by a capital working group to create a prioritized project list. Tools like this provide a way to quantify and standardize decision-making based on expert input and analysis, while aligning decisions to overarching agency priorities.

¹⁴ MBTA 2018. Transit Asset Management Plan.

https://www.ctps.org/data/calendar/pdfs/2019/MPO_0321_MBTA_TAM_Plan_2018.pdf

¹⁵ San Francisco Municipal Transportation Agency 2018. 2018 Transit Asset Management Plan.

https://www.sfmta.com/sites/default/files/reports-and-documents/2019/09/amg_web_dev_sfmta_2018_transit_asset_management_plan_10.1.2018_approvedcertified_20190913.pdf

4 State of the Practice for Decision Support Tool Use

The state of the practice for DST use included a diverse set of tools, practices and systems across the field, with some major commonalities and many unique cases. Synthesizing a state of the practice for DSTs involved reviewing TAM plan descriptions of use, literature from agencies reporting on their systems, and interviewing a selection of agencies to determine their experiences with tool usage.

As noted in the literature review, agencies select DSTs based upon a wide variety of factors, including agency TAM maturity, internal structure and process flows (such as how condition data influences maintenance work orders). Use of any one tool does not preclude use of other tools, or indicate why an agency has configured its decision-making process in a certain way. However, many agencies included contextual information about their systems in their TAM plan, including notes on tool selection and implementation. This section will provide a broad overview of how agencies use DSTs in the field, and which types of tools agencies are implementing to guide their decision-making. The review presented here is not comprehensive, and only includes information available publicly or through a small sample of TAM plans (as described in methodology section).

4.1 TAM Plan Reporting of Tool Usage

Agencies are required to identify their DSTs in their TAM plans, and to provide some details on the way these tools support their decision-making. Agencies often included software packages as tools, but also included processes to reach a consensus on decisions through staff evaluation, other planning processes, or use of project proposal forms and review. Many factors influence agency choice of tool type(s), including:

- Agency size and number of assets
- Level of IT complexity and maturity across the agency
- Historical precedent for tool use and existing systems in use (e.g., pre-existing software for financial systems from the same vendor, use of a home-grown tool that is similar to a new COTS product, etc.)
- Business needs (e.g., integrating TAM with preventative maintenance scheduling, etc.)
- Funding available for system procurement/implementation
- TAM culture and maturity

Agency tier is the primary axis for this paper's analysis of tool use, because it is a rough proxy for agency size (see methodology for an explanation of agency tier). Within tiers, however, significant variation in fleet size and complexity can influence agency choice and use of DSTs. Agency TAM plans may allude to other possible factors that influence DST selection- such as overall IT architecture, resources for procurement, and TAM maturity - but there is not enough data available across agencies on the reasons they chose DSTs for analysis.

4.1.1 Tier I

Tier I agencies reported using a wide array of DSTs. These agencies often use COTS or EAM systems, and are more likely to be working toward integration of these systems across the agency. The review team analyzed ten (10) Tier I TAM plans. The following four (4) themes emerge from agency descriptions of their DSTs.

A. Complexity and use of multiple tools

Of all the agencies reviewed, agencies reviewed who used EAM software packages were most often Tier I providers. Tier I agencies are likely to be the most complex in their operations and asset considerations (e.g., assets include multiple types with varied needs for data tracking and replacement considerations, varied maintenance routines, etc.), while having more resources to invest in an asset management system. They may be in a position to gain more from the investment of time and funding into optimizing a DST software package, given the scale of their operations. More efficiently managing the asset lifecycle will yield a higher return on investment when implemented for more assets. While these agencies have invested in a software package that meets many of the business needs surrounding asset management, they may still need to supplement these systems with other software packages or spreadsheets and simpler tools. For example, one Tier I agency that noted using a standard EAM software package also completed its bus replacement scheduling in a spreadsheet, perhaps using data from the asset management system.

Another agency operated two transit systems and reported them both under one TAM Plan (shown in Figure 2 as System 1). They used two separate, unique decision support software packages (both COTS), one for each system. The agency started using each system prior to understanding that they would be prioritizing assets across systems. According to a note in their TAM plan, the operator is seeking ways to make these systems interoperable; however, the tools appear to duplicate functionality and do not provide separate software features. For other agencies who have separate DSTs for different asset types or groups, duplication of functionality and an inability to prioritize across transit assets may complicate the TAM process.

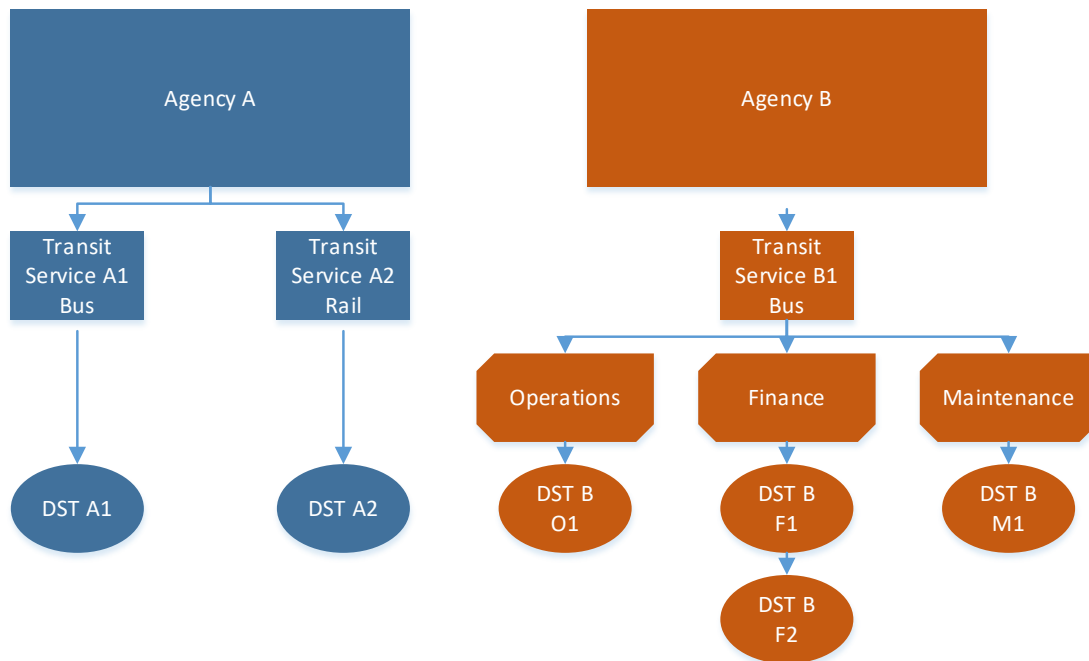


Figure 2: Demonstration of structure of two agencies and their DSTs.

While the agency mentioned above used two DSTs to support two separate transit systems under the same operator, other large agencies needed multiple software systems to support a single transit system (see Figure 2, 'System 2'). For example, one agency's central tools included two large, asset management specific software packages as well as the FTA TERM-Lite tool and mentioned but did not name other manual processes. The large, asset management specific tools it operated are used in

different capacities across asset categories (such as rolling stock, facilities, etc.), making it more challenging to compare asset condition across different categories. The agency included in its TAM plan a table describing each asset category (i.e., rolling stock, facilities), each general business function (i.e. asset inventory, work management, incident management, etc.), and which software package met that business need for each asset category. The complexity represented in the table demonstrates a common issue for large providers: needs for each business function may dictate use of multiple DSTs. The agency's mention but not inclusion of manual processes also implies a level of integration needed to use data coming from each DST.

Each software package used by this agency supported a distinct function, and all data eventually flowed into a standard TAM software package used to combine condition assessments, inventory data and forecasts to complete asset planning and NTD reporting. The agency noted that it uses multiple systems because there is no one product that seems to meet all of its needs. For example, while one of the agency's major asset management software packages provided some limited prioritization capabilities, it does not allow for prioritization throughout the lifecycle of the asset or over longer time horizons. Additionally, the agency adopted TERM-Lite to provide longer-term asset prioritization, using inputs from the other software packages. As the vendors developing DSTs adapt to an increased focus on lifecycle planning, there is an opportunity for standard asset management software packages to align with the needs of agencies for longer-term prioritization.

B. Integration issues

Another major theme among large agencies using multiple tools is the difficulty of integrating data flows and systems across business functions. One agency notes that it uses multiple separate tools – one to assess asset condition, a second to prioritize assets, and a third system to estimate costs and availability of funding and generate a fiscally constrained prioritized project list. The agency notes that its systems are not integrated, which provides flexibility for the tools to meet the unique needs of each business area, but also complicates the process of prioritizing assets because data integration from multiple systems involves more work and has more potential for error.

A bus-only Tier I system provided a look at the integration of its decision support software packages into the overall agency IT infrastructure. This agency used an EAM software package (among many other systems) for overall transit asset management, including inventory and NTD reporting. The other software packages in use supported business functions including HR, IT, Operations. The agency noted that its EAM system integrates to varying extents with other software systems across the agency. The agency completes ongoing updates and maintenance work on these systems, aiming to improve the integration of data across systems and the functionalities used for decision-making and reporting.

Noteworthy Practice: Diagram of Tools, Business Processes, and Integrations

A smaller Tier I agency provided a diagram showing the interconnection of the various software packages that support its decision-making process. For all business processes (spanning from service planning to operations to asset management) the agency used six interrelated software systems, each with specialized functions. The agency's range of software package use provides a more detailed look into how separate business processes require distinct software packages as compared to a legacy system (legacy systems are the oldest, largest systems), whose complexity may mandate multiple software packages for each business function.

C. Limitations of tools

Although the Tier I agencies reviewed for this paper used the most advanced DST software packages, they also noted the many limitations of these tools. A legacy system illustrated this common issue among agencies in its TAM plan. Tracking decisions within non-EAM asset management software packages is difficult, and the agency frequently used spreadsheets to combine data from multiple other systems for the final decision-making process. The agency exported information for decision-making from its current COTS system to a spreadsheet – however, this process provided no way to track decisions made by the agency, or to easily record those decisions. The agency was looking to implement a new EAM software package to support more comprehensive planning and modeling for decision-making. In addition to the use of this software package and spreadsheets, the agency used a Capital Project Request Form as a tool to support data based decision-making and prioritization of projects.

One larger agency noted that their DST provided good data and helped to ease decision-making, but also eliminated an important “human element” and expert judgement. The importance of first-hand knowledge of fleets, or the integration of knowledge about an agency’s maintenance department efforts or the history of a particular model of bus would be valuable input for any decision-making process.

Another limitation noted is the need for quality input to use DSTs effectively. As one agency noted: “outputs depend on the quality and completeness of the inventory input data,” a lesson generalizable across agencies and DSTs. TERM-Lite helped this agency distribute funding to the most important assets (as based on prioritization criteria), and determine which assets will not receive limited funding, but that this distribution is dependent upon the quality of data inputs.

D. Continuous improvement and maturation of systems/tools

Some agencies discussed the evolution of their TAM decision support practices and tools over time. In one TAM plan from a Tier I agency, the document notes that the agency “has moved from a process that was primarily the product of professional judgement to a more standardized method of evaluating capital projects.” The agency’s DST is a detailed process of data collection, analysis, prioritization and risk assessment.

This agency also mentioned evaluation as an important tool for decision-making – including analysis after project-completion of which projects are completed on schedule, and whether the project succeeds in its original objectives. The agency noted that it will require projects considered for funding to state intended outcomes for the purposes of later evaluation, and use the evaluation outcomes to improve its overall decision-making process. None of the other TAM plans reviewed in this paper identified evaluation as an integral part of the TAM decision-making process or as a tool for improving the prioritization process and making better decisions in the future. As agencies and the industry move toward greater maturity in TAM processes, evaluation of past decision-making will be a valuable best practice for continuous improvement.

One legacy system used a combination of an in-house capital planning and programming tool (which includes data on asset inventory, long-term capital planning, and which is capable of estimating SGR backlog in various funding scenarios) and an individual project/asset replacement review process. Their TAM plan detailed the agency’s project selection framework including criteria influencing prioritization. Teams reviewed and scored each project separately using information from a project request form, and gave a weighted score based on the evaluation criteria. Although this agency had a large number of assets, the decision-making process centered on committee review of project proposals. This process involved subjective judgement and a less formal decision making process. The agency did note that it

will use a new DST developed by its State DOT in the future, but did not give details about this system. Many systems indicated a similar move from somewhat informal, less data-driven processes toward greater formalization and the procurement of specialized DSTs.

The adoption of more specialized DSTs parallels a move toward greater sophistication and specialization of TAM roles within agencies. A legacy

Tier I agency created specific organizational units to support its TAM work. The agency's current decision support team used FTA's TERM-Lite tool to project and prioritize asset needs. One of the newly created units was responsible for establishing EAMs and use of other software packages. While just this one group had responsibility for establishing this system, their work spanned across the organization and included integration of support tools across the agency.

Noteworthy Practice: Tier II Agency Integrating Data and Staff across Agency for TAM

One Tier II agency provided an exceptionally detailed overview of its DST software package. This agency noted that "staff within the maintenance, finance/grants, compliance, operations & safety, and executive departments" used many policies, tools and practices to perform lifecycle asset planning. The agency's inclusion of employees from across the organization mirrored its inclusion of DSTs from across the agency in the TAM plan's identification of DSTs. The agency also detailed use of the integration of data across systems for decision-making. The key DSTs that collected information from these systems and integrated them were a COTS asset management software package and a State DOT Capital Planning Tool software package. The State DOT capital planning tool software package unified inventory and asset performance information across the agency, allowing prioritization and justification for capital needs by the agency and ease of use for the State DOT. This Tier II agency stood out among its peers, and began investing in the development of a TAM plan and process multiple years prior to the TAM Final Rule.

4.1.2 Tier II

Of the 10 Tier II agency TAM plans reviewed, most used a smaller COTS software package (usually specific to TAM), and some used processes and other plans as tools.

A. COTS

Of the Tier II agencies using COTS tools for decision support, most did not provide detail on the functionality of these tools or their use of the tools. Multiple agencies used a standard COTS software package alongside another tool, including the FTA [TAM Plan Template for Small Providers](#) or a lifecycle cost analysis tool (note: the [TAMPlate](#) is another FTA tool replacing the TAM Plan Template for Small Providers). One Tier II provider listed a transit asset management focused discrete software package as its DST, along with their maintenance plan. The software package provided all the data needed for decision-making on maintenance, maintaining SGR, and decision-making generally for the agency. For a smaller agency, a single, simple asset management program may be capable of meeting all needs for data tracking and reporting, and allow for a prioritization of assets.

B. Processes, Plans and In-depth Knowledge of Fleets

Smaller agencies (both those listed here under Tier II and the participants of Group Plans) often used other planning processes and documents as part of their DST framework. For example, one Tier II agency listed its preventive maintenance, vehicle replacement, and transit development plans as its DSTs. These plans provided information including the inventory for all vehicles, their ULB, and a 10-year plan including funding constraints. While it was clear that the data in these plans originally came from some other underlying DST, the plans did not name those DSTs.

Some smaller agencies did not mention specific DSTs, or did not identify their tools or processes in enough depth to categorize them or provide analysis. In one Tier II plan, an agency discussed data used in the decision-making process, but did not specify how it compiled the data into a comprehensive tool. The agency's TAM plan noted it made decisions using best judgement and experience. While this is not a rigorous, data driven process, small providers often have a much more intimate knowledge of their fleets, and may not need the level of decision support that other agencies use. As one Tier II agency noted in an interview, if an agency only has 15 buses their maintenance staff are likely to be able to prioritize needs across the fleet with little assistance due to their in-depth knowledge of the agency's assets. All agencies must describe a DST in their TAM plan for compliance with the final rule, regardless of the DST form or function.

4.1.3 Group Plan sponsors

Group Plan sponsors provide a unique viewpoint within the TAM world. They are sometimes, but not always, service providers themselves, and assist a varying number of smaller transit agencies with their transit asset management processes. State DOTs are the most frequent sponsor of Group TAM Plans, and vary greatly in their involvement with their Group Plan participants. Some State DOTs noted close collaboration on decision-making, while others seemed to have more limited involvement with their participant's decision-making processes. This variability in engagement influenced the depth of reporting within Group TAM Plans on participant agency DSTs. Although Group Plan participants are all Tier II agencies, their DSTs varied considerably in complexity.

FTA published a [Group TAM Plan Sponsor Workbook](#) in 2018 to assist sponsors in developing plans and working with their participant agencies. The workbook noted that DSTs listed in a group TAM plan may be custom developed, or adopted/adapted from existing tools at one of the participant agencies. Sponsoring agencies must also involve their participant agencies in the use of the sponsoring agencies' DST if it is the primary method of prioritizing assets, or provide oversight for the participant agencies' use of their individual DSTs. The need to cooperatively design, implement and use DSTs across sponsor and participant agencies adds a layer of complexity to the process.

A. Review Process as a tool

Review processes and project review forms are a popular tool for decision-making. Many agencies were found to use a project evaluation committee or similar review process to analyze data on an asset or project, evaluate it with criteria weighted based on the participant agency's needs, and create a prioritized list.

One State DOT Group Plan sponsor's review process included an application review, vehicle asset inventory, and vehicle replacement rating. The DOT used an online database it maintained with information on all vehicles in its program. The review process began with requests for vehicle replacement – indicating that someone at the agency level has already identified a need for vehicle replacement and screened out a portion of assets for consideration. This implies that at least a portion of the decision -making process happens outside the DSTs the DOT has developed, perhaps using direct experience and knowledge of the assets (which may be sufficient to prioritize within small fleets).

Similarly, another sponsor noted that operators submit requests for funding, which a committee then scores and reviews per agency-defined criteria. However, the sponsor did not note whether any participant agencies were using a DST as another source of data on asset condition, or information on

the lifecycle of the assets. Another State DOT Group Plan sponsor noted that its review committee is multi-modal to ensure adequate representation of various areas of expertise when evaluating investment decisions. While these processes are formal, they do not go into enough detail to identify adequately what data is supporting decisions and which (if any) tools the sponsoring agency uses beyond the review process.

B. Datasets as tools

Some agencies defined their datasets as DSTs. These could include financial data on assets, maintenance and inventory records. One sponsoring agency listed these datasets and the software package it uses to store the data as its DST, including standard financial software package and an asset management software package. Using these tools, staff at the agency created a tiered prioritization of assets for replacement based on age, mileage and condition. While this system is sufficient for a basic prioritization, the agency planned to implement a new asset management system to more efficiently track transit assets and prioritize them for investment. The agency noted that it expected this new software package to integrate with its existing systems.

Data integrity is a potential barrier to effective TAM practices, particularly for group plan sponsors who may be integrating data from many participant agencies using multiple different tools. One agency used a consultant to delve into their data and uncover discrepancies (for instance, a new vehicle only in service for one year but listed with 350,000 miles).

Another Group Plan sponsor referenced asset condition assessments, using the TERM rating scale, and using vehicle inventory data. However, the agency did not explain how these sources of information are integrated or how they support decision-making. A common theme among smaller agencies, and Group Plan sponsors, was the presentation of data sources instead of decision-making tools. While each data source does individually support the decision-making process, there is ultimately some way in which each agency combines and prioritizes condition rating, inventory information, and budget information to create a prioritized list. Some sponsoring agencies may not have included this level of detail in the first reporting year for TAM, but others did describe the way these tools informed decision-making.

One State DOT group plan sponsor used a custom, three-factor analysis to determine asset SGR and then prioritize assets for investment. The factors of its analysis included useful life and 'useful mileage', as well as a condition assessment. The output of its analysis was a dataset used as a DST. While the use of mileage as a factor in decision-making is not unique, the agency's formulation of it as 'useful mileage', or the expected miles a vehicle will last through, is an interesting difference among TAM plans and highlights the parallels between age and mileage of an asset.

C. Planning processes and documents as tools

As noted above, many smaller agencies identified planning and policy documents as DSTs, whether they were participants in Group Plans or completing individual plans. Established asset management policies can be essential tools for assisting in the decision support process, particularly if they define a set of decision-making procedures. While planning documents (such as the Transit Improvement Program) may provide support for decision-making within transit asset management, the link between these plans and TAM decisions is not direct. The prioritization methods used in these planning documents are not apparent, and may or may not be the same prioritization methods used for the TAM prioritized list of assets. The process of prioritization likely involves a decision support tool, however, details on these tools are not included when the plan document itself is listed as a DST.

D. Different tools for each participant

Most Group Plan sponsors listed more than one type of DST used by their participant agencies, but did not identify which participant agencies used which tools. Only one Group Plan sponsor noted that the DSTs used by its participant agencies were very different from each other – dependent on the size, nature and business practices of each agency. This plan lists the DSTs, which mainly consist of financial tracking through accounting software packages, inspection of vehicles to determine maintenance/replacement needs, and discussion about agency priorities, service needs, and community needs for assets. While these processes seem largely informal, they appear to be flexible and constructed based on the agency's individual needs, and reflect smaller fleet sizes and the ability to prioritize individual asset needs. As is often the case with smaller agencies, a complex system may be more complicated than necessary, and a spreadsheet can easily track the existing process.

E. Customization of tools

Group Plan participants using COTS tools were less likely to mention customization of these tools or integration of them across other existing systems. However, smaller agencies and Group Plan participant agencies did mention customizations to simple and open source tools, such as TAPT. One State DOT Group Plan sponsor using TAPT modified the tool to include a custom prioritization approach. The sponsor developed a custom scoring mechanism to rank assets based on age, mileage, condition and specific maintenance issues for each make or model. The sponsor then incorporated the scores into the TAPT prioritization process, to ensure that each asset with high priority for replacement under the custom scoring was 'pipelined' into an expedited replacement timeframe within TAPT. This pipelining feature allows an agency to dictate the replacement date range for specific assets, while continuing to use the overall TAPT prioritization methods for all other assets.

This sponsoring agency's high priority assets needed replacement within two years, and so it entered these assets and a custom timeframe for replacement into the tool. Using this system would allow an agency to account for a particularly problematic bus model, known to need replacement due to fleet specific recurring issues but not rated highly according to age, mileage or other factors. This customization effectively incorporates risk into the TAPT tool, adding an additional dimension of analysis. The agency also ran the TAPT model without its customizations, to provide a baseline for comparison.

F. Sponsor DSTs

In addition to the participant agencies' DSTs, some Group Plan sponsors also discussed the tools they use to support decision-making involving their Group Plan participants. One State DOT noted a list of items that guided its decisions on asset funding requests, including: 10-year capital plans; five-year operating and capital plans (providing more detail than the 10-year capital plans); transit system grant applications; annual inspections conducted by the DOT; and preventive and corrective maintenance costs. The State DOT used these documents and datasets to help understand the needs of the participant agencies more thoroughly and help prioritize investments across systems. The DOT's use of multiple reports from participant agencies in combination with its own condition assessment work provides a high level of oversight to the participant agencies, while also giving a more informed look at the state of good repair across all of the Tier II systems in the plan.

Only one of the dozen State DOT Group Plans reviewed used a standard grants management software package for its decision support needs, and noted that the software package includes a TAM specific

module. The DOT's plan participants maintained an inventory for all assets within the software package, and the State DOT used this information on age to generate a list of prioritized assets. While the State DOT received age information directly, it estimated mileage for the vehicles. The use of a COTS tool by a State DOT for decision-making concerning its participants requires a high level of cooperation and compliance in reporting from participants, and could duplicate these agencies' existing DSTs and data tracking.

Another State DOT Group Plan sponsor provided detail on all aspects of decision-making for itself and its participant agencies. The sponsor used DSTs for evaluating agency requests, but also included information on participant agencies' DSTs for their internal decision support. The sponsor explains their commitment to "provide and regularly enhance DSTs already in place" among participant agencies. The State DOT provided a customized capital-planning tool that links to its grants management system (a widely available open source tool, [transam](#)). The sponsor agency developed a detailed user guide for its tool. The sponsor noted that some participant agencies have adopted regular use of the tool for internal decision-making and reporting, while others only update the tool once per year to meet the requirements for capital planning and TAM plan development (see box at right). One participant agency noted that it enters some data into the tool monthly, providing a rich set of information for prioritizing investments.

This DOT represents one end of a spectrum of involvement between State DOT Group Plan sponsors and their Tier II agency participants. While some DOT's do not detail extensive involvement with participants, others provided services related to planning, decision-making and even implementation of grants. Participant agencies also demonstrated a wide range of engagement in the Group TAM Plan process. One DOT noted that some of its agencies rely entirely on the DOT generated prioritization list, while others have internally developed prioritization lists using their own DSTs, and engaged in a dialogue when the two lists differ. The DOT also noted that the next step in the TAM maturity of their participant agencies would be agencies' ability to assess which assets are low on the agency's priority list but need to be considered as higher priority through other knowledge of the asset that is not included in the decision-making process, and advocate for changes to the prioritization.

Noteworthy Practice: Custom Decision Support Tool Enables NTD Reporting Efficiencies

This State DOT's custom tool for participant agencies is used not only for decision support, but also allows agencies to easily automate their TAM reporting to NTD. Including this functionality in the DST to automate this major requirement of the TAM process may serve as an incentive for adoption for many participant agencies.

4.2 Incorporating Risk Assessment

The ways in which agencies assess risk can influence and interact with the DSTs they use. Risk is a routine part of assessing the relative priority of assets, particularly if risks to service disruption, safety or other critical issues arise. Agencies often use risk matrices to assess the relative impact and severity of risks, and plan for risk mitigation.¹⁶

One Tier I agency discussed their prioritization process, but not the tool which integrated their data. However, the agency did use a risk register, which is one form of decision support in which an agency assigns a likelihood of a negative event happening and the relative impact it would have on operations.

¹⁶ Note: The TAM final rule does not require use of a risk based approach.

This register combines ratings of likelihood and impact into an overall prioritization of risk, which then allows the agency to work on prevention and mitigation strategies for the most likely and/or most impactful risks.

Another agency using FTA's TERM-Lite tool to prioritize their asset needs noted that it customized TERM-Lite to include a measure of risk. The measure of risk was based on the model of the vehicles, including higher risk scores for those vehicles whose fleet was known to have issues. These risks were incorporated into the weighted criteria used within TERM, but not much detail was given on the mechanics of the customization. This adaptation could be a noteworthy practice, and might be a desirable alteration for other agencies to adopt.

One Tier II agency was using risk matrices since before asset management was a defined business practice. Their risk matrices informed decision-making and investment prioritization. Recently, the agency drafted new risk matrices as part of their safety plan, which ties closely to their TAM plan. By using the matrices, the agency was able to address asset management concerns that also affected safety. Looking forward, the agency plans to align their safety and asset management practices, drawing on commonalities like inspections to guide decision-making.

Apart from the examples included above, most agencies do not integrate risk directly into internal asset management processes, and risk assessment does not appear to play a substantial role in agency decision-making. Those that do include risk do so by altering existing tools to incorporate risk or through incorporating known risks into manual portions of the decision-making process. The TAM Investment Prioritization State of the Practice report provides a more in-depth discussion of risk matrices, and their role in internal processes.

5 Implementation Considerations & Opportunities for Future Development

Agencies have implemented a wide array of DSTs, including both software packages and non-software solutions. Similarities emerged among those agencies using software package as their DSTs, particularly regarding implementation of tools and gaps in current tool functionalities. The following section describes some of these themes, and describes multiple considerations for agencies implementing DST software packages.

5.1 Change Management, TAM Maturity, and the Use of Decision Support Tools

Transit Asset Management is a practice requiring not only technical skills and resources, but also agency capacity and knowledge. The level of 'TAM maturity' at an agency refers to a range of abilities, experiences and effective implementation of TAM practices. Maturity can include the relative ability of an agency to implement and effectively use TAM processes throughout the agency, and it can also refer to the depth of experience the agency or its staff has with TAM principles and practices. Agencies have varying levels of TAM maturity, ranging from those new to TAM practices and those who were already implementing TAM processes prior to the release of the TAM final rule.

Agencies that have been working on TAM implementation for longer generally showed a more advanced integration of DSTs across the agency, with broader reach among departments and often more data coming into DSTs. However, the length of use of DSTs did not correlate with the complexity of those tools – the complexity of tool(s) correlates to the size and complexity of operations.

One reason agencies with higher TAM maturity generally had more integrated systems is the time necessary to revise business practices, formalize new processes, and persuade others to use new systems. One agency spoke about the links between their various departments and the data flows supporting a decision, and said "frequent communication is key." Creating business process changes (such as new data collection routines, implementing new data flows, and aligning staff functions) can be a significant barrier to effective use of DSTs, because of institutional constraints.

5.2 Gaps, Needs, and Barriers/Opportunities

Agencies identified multiple gaps, barriers and opportunities related to their DSTs, varying from tool capability upgrades to more people and process focused changes. Some agencies felt that their tools met current needs, but lacked elements – and multiple agencies were in the midst of new system procurements. One agency was procuring a set of tools for their plan participants, adding a level of complication for operators who might need to track separate service statistics and have very different business processes. As already discussed, data quality and management can present a barrier to successfully implementing DSTs.

The most prevalent issue agencies noted concerning their DSTs was a lack of integration. Many agencies using multiple software tools use additional manual work to integrate data across platforms (for instance, integrating cost information from a financial system with condition assessments in a maintenance system). While EAM systems can eliminate this duplicative work, they may force business practices to shift significantly, or not accommodate the specific business needs of each agency department. As one agency noted, "the biggest weakness in the TAM process now is communicating data across the agency."

Another common theme across agencies using simpler or open source tools was the need to customize these tools. Some agencies customized weight criteria in the prioritization process, added criteria not present in a tool, or integrated risk into decision-making. One group noted that the inclusion of 'color of money' in future versions of tools would be helpful (the type of grant funding, and applicable period of funding availability). Agencies noted weighing the return on investing the extra time needed to develop customized modules, and at least one agency noted it would hire a consultant to alter their tool to save staff time and more efficiently manage resources. One agency noted that it was developing an additional scenario-planning module for an open source tool. Others noted that having applications available for direct data entry at the time of vehicle inspection (linked to the main system) would help reduce duplicative handling of data, and provide more real-time access to updates.

6 Conclusion

DSTs are highly varied, agency specific and influenced by factors including agency size, business processes, staff capacity, existing systems and integration of IT systems across an agency. Scant literature is available on the state of DST use, but some documentation exists of specific agency use cases, user guides for open source or free tools, and some guidance on how an agency might procure a DST. Despite a lack of published research on the topic, TAM plans provide a window into the choices agencies have made surrounding their DSTs.

6.1 Findings

These key findings describe some of the challenges and themes across agencies:

- Agencies use both **process and software package based solutions**, and sometimes integrate multiple data sources from separate databases. Process based solutions are often preferred by smaller agencies; however, they can also be employed in concert with software packages to lend a ‘human touch’ to the prioritization process.
- Agency **use of DSTs is heavily influenced by agency size and complexity**, with Tier I agencies often using multiple complex DSTs, and smaller agencies opting for process based or spreadsheet tracked decision-making processes.
- **Small providers** often have a much more intimate knowledge of their fleets, and **may not need the level of decision support that other agencies use**.
- **Group Plan sponsors face an additional level of complexity** in their mandate to cooperatively implement and use DSTs with their participant agencies. Group Plan sponsors demonstrated a large variation in the types of tools they and their participants used and in their approaches to standardization vs. the use of many tools across agencies.
- **Data quality** was repeatedly cited as a key challenge in using DSTs, particularly when agencies integrated multiple datasets from within their own agency or across participant agencies.
- While agency tool selection primarily correlates with agency size, **the effectiveness of DST implementation was not correlated with size, but rather agency TAM maturity**. Agencies of any size who have been using and refining DSTs since before the 2016 TAM rule reported that use of their tools was more widespread throughout divisions of their agencies, and met the needs of the TAM process. These agencies also often customized their tools, creating basic alterations (such as adding a particular criteria or weighting scheme) or fundamentally different capabilities (such as adding the ability to use scenario planning within a tool).
- Only one agency reviewed used **evaluation of project outcomes and past prioritizations as a key component of its DST development and implementation**. Learning from past tool use and project outcomes could be a significant source of improvements in DST use.
- Agencies have begun **customizing some of the publicly available free tools** (such as TERM-Lite and TAPT) to incorporate risk and other priorities for the agencies.

Many agencies indicated a move from somewhat informal, less data-driven processes toward greater formalization and the procurement of specialized DSTs. The spectrum of TAM maturity indicates that use of DSTs will continue evolving, increasing in effectiveness and complexity/customization. The adoption of these more specialized DSTs parallels a move toward greater sophistication and specialization of TAM roles within agencies.

6.2 Considerations for Future Research

While some documentation on the use of DSTs is emerging within TAM literature, additional resources could be helpful for agencies seeking to understand the types of DSTs available and how to implement them. One potential research focus could be the efficacy of process-based DSTs as opposed to software package-based DSTs, and whether outcomes vary based on agency size and complexity. An overview of how a transition to a new DST software package should be approached and implemented would also be helpful, as some agencies in this sample were approaching or in the midst of system changes or procurements. The return on investment for transitioning to a new DST software package may also be an area for research – including the questions of what types of agencies gain the most (in time and labor savings or state of good repair) from implementing more customized or complex systems. The effectiveness of EAMs has been written about, but more research on the performance of these systems could help transit agencies make better selections when choosing systems. Additionally, not all agencies described their DSTs in enough detail in their initial TAM plan for analysis – particularly smaller agencies and Group plan sponsors. In the future, analysis of TAM plan descriptions of DSTs may yield more interesting data.

Appendix A

Agency TAM Plans Reviewed

Agency Name	State
City of Montebello	California
Dallas Area Rapid Transit	Texas
District Department of Transportation (DDOT)	District of Columbia
Delaware Transit Corporation	Delaware
Florida DOT	Florida
Green Bay Metro	Wisconsin
Jacksonville Transportation Authority	Florida
Jefferson Transit Authority	Louisiana
Kansas DOT	Kansas
Kentucky DOT	Kentucky
Luzerne County Transportation Authority	Pennsylvania
Maine DOT	Maine
Massachusetts Bay Transportation Authority	Massachusetts
MetroLink	California
Metropolitan Evansville Transit System and Henderson Area Rapid Transit	Indiana
Miami-Dade County Department of Transportation and Public Works	Florida
Mid-Ohio Regional Planning Commission	Ohio
Minnesota DOT	Minnesota
Montana DOT	Montana
Metropolitan Transportation Commission	California
Nashville WeGo Transit	Tennessee
Nevada DOT	Nevada
New Mexico DOT	New Mexico
Orange County Department of Planning	New York
Oregon DOT	Oregon
Ozark Regional Transit	Arkansas
Pasco County Public Transportation	Florida
Pennsylvania DOT	Pennsylvania
Pioneer Valley Transit Authority	Massachusetts
Razorback Transit	Arkansas
Regional Transportation District	Colorado
San Joaquin Regional Transit District	California
Skagit Transit	Washington
Stark Area Regional Transit Authority	Ohio
State Road and Tollway Authority	Georgia
Transportation Authority of River City	Kentucky
Washington Metro Area Transit Authority	District of Columbia

Appendix B

Agencies Interviewed

Agency	State
Delaware Transit Corporation	Delaware
Luzerne County Transit Authority	Pennsylvania
Metra	Illinois
Pennsylvania DOT	Pennsylvania
Tennessee DOT	Tennessee

Appendix C

Documents Reviewed

AASHTO Transportation Asset Management Guide: A Focus on Implementation
APTA's Procuring Software to Support Transit Asset Management
Best Practices- Asset Management: Leveraging Benchmarking to Develop a Digital EAM Strategy in Mass Transit
Defining a Transit Asset Management Framework to Achieve a State of Good Repair
Development of a System-Wide Asset Management Program
FTA Decision Support Tool Webinar
MTA Taps DXC Technology for enterprise asset management solution
Notes from the Metrolink Field: Out Approach to Building an Integrated TAM-EAM System
TAM 101 Course Instructor Guide
TAM Guide and Supplement (2016 Update)
TCRP Report 157: State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Capital Assets and Evaluating the Implications for Transit
TCRP Report 172: Guidance for Developing a Transit Asset Management Plan
TERM Lite Overview