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TAM Investment Prioritization State of the Practice Synthesis

A Review of Transit Agency Use of Investment Prioritization Processes

September 2020

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Public transit providers that receive federal transit assistance must include an investment prioritization in their TAM Plans. The investment prioritization is a ranking of the programs and projects the agency fund to improve or manage the state of good repair (SGR) of the agency's capital assets within a given budget. This report summarizes the state of the practice of TAM investment prioritization at transit agencies based on a review of relevant reports and publications, agency TAM Plans, and interviews with five transit providers.

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Abbreviations

Acronym	Term
APTA	American Public Transportation Association
CEO	Chief Executive Office
CFR	Code of Federal Regulations
CPC	Capital Program Committee
DOT	Department of Transportation
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
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
TRB	Transportation Research Board
ULB	Useful Life Benchmark

1 Introduction

In the 24th Edition of Status of the Nation's Highways, Bridges, and Transit Conditions and Performance Report, the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) reported that there was an estimated backlog of $98 billion in deferred public transit maintenance and replacement needs, comprised mostly of rail transit assets.[1] Transit agency customers, policymakers, and public agencies increasingly expect more business-like management practices from transit agencies.[2] The magnitude of these capital needs, performance expectations, and increased accountability requires agency managers and accountable executives to become better asset managers.[3]

FTA published the Transit Asset Management (TAM) rule [49 CFR 625] in 2016 requiring public transit providers that receive federal transit assistance to undertake certain TAM activities. One such activity is to develop an agency TAM Plan, which includes an investment prioritization that identifies the agency's programs and projects to improve or manage the state of good repair (SGR) of their capital assets. Table 1 lists the TAM Plan elements required for Tier I and Tier II agencies and shows that both tiers must include a prioritized list of investments in their TAM Plan. The investment prioritization element of the TAM Plan is a ranking of the programs and projects in order of priority and anticipated project year that is consistent with the agency's TAM policies and strategy. The ranked list of programs and projects considers projects that address an identified unacceptable safety risk as well as expected funding level from all sources that will be available during the TAM Plan horizon period.

Tier Applicability	Element Number	Element
Tier I and II Only	1	An inventory of assets
Tier I and II Only	2	A condition assessment of inventoried assets
Tier I and II Only	3	Description of a decision support tool
Tier I and II Only	***4***	***A prioritized list of investments***
Tier I Only	5	TAM and SGR policy
Tier I Only	6	Implementation strategy
Tier I Only	7	List of key annual activities
Tier I Only	8	Identification of resources
Tier I Only	9	Evaluation plan

Table 1. Required TAM Plan elements for Tier I and Tier II agencies. Source: https://www.transit.dot.gov/TAM/TAMPlans

[1] FHWA and FTA 2019. *Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance*. https://www.fhwa.dot.gov/policy/23cpr/pdfs/23cpr.pdf

[2] FTA 2016. *Transit Asset Management Guide: Focusing on the Management of Our Transit Investments.* https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/57411/transitassetmanagementguideftareportno0098.pdf

[3] FTA 2016. *Transit Asset Management Guide: Focusing on the Management of Our Transit Investments.* https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/57411/transitassetmanagementguideftareportno0098.pdf

The research team found that many agencies are looking for ways to improve their investment prioritization processes but are unsure how to do so. The purpose of this synthesis report is to document the state of the practice of investment prioritization to provide transit decision makers with information on existing strategies, models, and tools to support the effective prioritization of investments at their agencies. The report provides a synopsis of effective investment prioritization models and example practices used by transit providers of different sizes and operating characteristics based on an extensive literature review, a review of over 40 TAM Plans, and interviews with five transit agencies. These example practices can assist transit agency staff with developing effective methods for investment prioritization.

1.1 TAM Investment Prioritization and Capital Planning

Investment prioritization is a required element of an agency's TAM Plan that identifies the programs and projects to improve or manage the SGR of their capital assets. In order to accurately prioritize TAM investments, agencies regularly inventory their assets, conduct condition assessments, and establish performance measures for those inventoried assets for which the agency has direct capital responsibility. The prioritized list of investments supports more data-driven maintenance and operating decisions, which help to reduce risk and improve safety.

Capital investment planning is a cyclical process that determines how transit agencies allocate and expend capital funds across the entire agency. Capital plans typically cover a 5-10 year period. Capital planning allows agencies to consider asset lifecycle management and assess potential risk factors across their entire asset portfolio. This process allows agencies to prioritize the projects that will improve safety and address the agency's goals, while also promoting proactive decision making across an agency.

Because the prioritized list of investments is still a relatively new requirement for TAM, it is common for agencies to use their capital planning processes as a starting point and framework in the development of the investment prioritization that is required in TAM Plans. Capital planning and programming uses data on system performance and asset condition to optimize how and when capital funds are expended. These strategies carry over to TAM and investment prioritization with a specific focus on using condition and risk data to keep assets in a SGR. Over time, as agencies' TAM practices mature, they can use the TAM investment prioritization process to identify priority capital investments. This will help ensure the two processes are coordinated, data-driven, and advance TAM goals.

1.2 Methodology

The development of this report relied on an extensive literature review to develop an understanding of the state of the practice of investment prioritization at transit agencies nationwide. The research team reviewed and summarized materials on investment prioritization processes from a number of sources to gather information on existing strategies, models, and tools that transit agencies employ to support the effective prioritization of investments. The literature review included the analysis of over 40 transit asset management (TAM) plans from agencies nationwide indicated in Appendix A as well as the review of reports from the Transit Cooperative Research Program (TCRP) and American Public Transportation Association (APTA) highlighted in Appendix C.

The findings from the literature review were analyzed in collaboration with a separate research effort that examined the state of the practice regarding decision support tools, which are used to generate an

agency's prioritized list of investments.[4] The review team for this report conducted five interviews, indicated in Appendix B: two with group TAM Plan sponsors, two with Tier I agencies, and one with a Tier II agency. 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.[5] These interviews helped the research team develop a more comprehensive understanding of investment prioritization processes and to fill existing gaps in the research.

1.3 Report Organization

This report consists of five sections describing the state of investment prioritization processes at transit agencies. The sections cover the following topics:

- Section 1 introduces TAM investment prioritization and its role in capital planning, along with a discussion on the research team's methodology.
- Section 2 describes the research team's scope for the literature review along with some initial findings.
- Section 3 provides a synthesis of the state of investment prioritization at transit agencies across the country.
- Section 4 builds on the state of the practice by describing the main approaches to investment prioritization at transit agencies and details examples of agencies that employ those approaches.
- Section 5 offers a conclusion and details lessons learned through the research and analysis conducted for this report and considers possible improvements agencies can make to their TAM investment prioritization processes over the next several years.

[4] FTA 2020. FTA Report DOT-VNTSC-FTA-20-04, *TAM Decision Support Tool State of the Practice Synthesis: Transit Agency Use of Decision Support Tools in Support of TAM*.
[5] FTA. *Am I a Tier I or Tier II Agency?,* https://www.transit.dot.gov/TAM/gettingstarted/FAQsArchive#Tier.

2 Literature Review Synthesis

2.1 Scope

The literature review focused on the analysis of materials from various sources to inform the research team's understanding of investment prioritization processes. The review of reports from organizations external to FTA provided a baseline understanding on how the investment prioritization process fits into transit asset management. The reviewed literature also offer guidance on investment prioritization strategies and offer approaches and factors that agencies may consider when developing their investment prioritization processes. Section 3 builds on the literature review with an in-depth analysis of the findings from the literature review and discussion of the state of the practice of investment prioritization at transit agencies nationwide.

2.2 Baseline

The review of FTA and TCRP publications provided a baseline understanding of investment prioritization strategies and the role that these strategies and approaches play within transit asset management more broadly. Existing research revealed significant variations in the complexities of investment prioritization processes between agencies. The majority of agencies rely on condition assessments as well as age and mileage information for decision making. Agencies are also beginning to integrate considerations of risk into their investment prioritization processes. The literature suggests that agencies will refine their investment prioritization processes over time as data reliability and collection practices improve. The TAM Plans and interviews with transit agencies built on this baseline understanding and offered a detailed look at how agencies are developing their investment prioritization processes. The TAM Plans and interviews also noted the importance of creating strong channels for communications between departments to promote consistent and reliable data collection and reporting. Appendix A offers a complete list of the agency TAM Plans that were reviewed. Individual approaches toward investment prioritization are not specified by agency in the report as the research team reviewed a number of TAM Plans that are not publicly available.

2.1.1 Baseline Synthesis

This sections synthesizes findings from reports and publications related to investment prioritization that the research reviewed. FTA Report 138, the Asset Management Guide Supplement (2019) includes detailed information about asset category organization and current lifecycle management practices.[6] The report offers a broad understanding of the practices involved in asset management and provided a foundational knowledge on how investment prioritization fits into transit asset management. The report highlights the role that asset data such as condition, age, and mileage plays in prioritizing investments in order to use limited resources to keep assets in SGR. TCRP Report 172: Guidance for Developing a Transit Asset Management Plan offers tools and guidance to decision makers to improve asset management.[7] The report outlines the steps for creating an effective TAM Plan and includes approaches for predicting and prioritizing investment needs through the use of methods such as weighting and selection criteria. The report also introduces the Transit Asset Prioritization Tool (TAPT), which is used by a number of agencies as a decision support tool to track and prioritize the replacement of assets. This report introduced a number of the approaches used by agencies to prioritize investments, which was expanded upon through the agency interviews. TCRP Report 206: Guidance for Calculating the Return on

[6] FTA 2019. *Report 138: The Asset Management Guide Supplement.* https://www.transit.dot.gov/research-innovation/asset-management-guide-supplement-asset-category-overviews-lifecycle-management

[7] TCRP 2014. *Report 172: Guidance for Developing a Transit Asset Management Plan.* http://www.trb.org/Publications/Blurbs/171285.aspx

Investment in Transit State of Good Repair builds on TCRP Report 172 by presenting a methodology for calculating the return on investment for a set of investments to achieve and maintain assets in a state of good repair.[8] The framework outlined in the report may be used to analyze a specific SGR investment or program of investments and supports decision making during the investment prioritization process. This tool is used to calculate the return on investment for specific assets and expands upon the framework in TCRP Report 157, which looks broadly at the steps for keeping assets in SGR. The report also highlights the benefits of investing in SGR and quantifies these benefits for agencies and transit users. This literature introduced a variety of methods that are used to develop an investment prioritization list and provided a tool that agencies may use to support investment prioritization processes.

TCRP Report 157: State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Capital Assets and Evaluating the Implications for Transit introduces a framework for transit agencies to use when evaluating and prioritizing capital asset rehabilitation and replacement investments.[9] The framework uses asset measures such as age and condition to determine both asset-specific impacts such as asset reliability and service quality, along with system impacts including system performance and safety. The framework is used to determine SGR for assets and is accompanied by a set of spreadsheet tools that provided the research team with a sample model and approach to investment prioritization. The report offers a summary of example transit asset management practices and presents an analytical approach that agencies may employ to inform lifecycle management decisions for various assets including bus and rail. Separately, TCRP Report 198: The Relationship Between Transit Asset Condition and Service Quality includes a discussion on the relationship between asset condition and service quality in terms of investment prioritization.[10] The report uses a comprehensive set of quality of service attributes and evaluates the extent to which asset condition impacts each of these attributes. The findings from the report highlight the importance of maintaining transit assets in a state of good repair to maximize quality of service and minimize costs to passengers and transit agencies over time. This strategy relies on an effective investment prioritization strategy and approach to target the assets whose failure would most negatively impact quality of service.

TCRP Synthesis 13: Risk Management for Small and Medium Transit Agencies offers an examination of how small and medium-sized transit agencies may approach risk management services at an affordable cost.[11] The synthesis does not provide a direct discussion of investment prioritization; however, introduces concepts related to data collection and risk control techniques that smaller Tier I and Tier II agencies may use in the development of investment prioritization strategies and approaches.

The review of TAM Plans focused on the description of investment prioritization processes used by transit agencies. These descriptions detail the strategies, models, and tools that agencies use to prioritize investments. The interviews with individual agencies provided additional context to deepen the understanding of specific processes that were described within the TAM Plans. This helped the research team begin identifying best practices and commonalities across agencies, which would inform the state of the practice for investment prioritization.

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[8] TCRP 2019. *Report 206: Guidance for Calculating the Return on Investment in Transit State of Good Repair.* http://www.trb.org/Publications/Blurbs/179880.aspx

[9] TCRP 2012. *Report 157: State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Capital Assets and Evaluating the Implications for Transit.* http://www.trb.org/Publications/Blurbs/167637.aspx

[10] TCRP 2018. *Report 198: The Relationship Between Transit Asset Condition and Service Quality.* https://www.nap.edu/catalog/25085/the-relationship-between-transit-asset-condition-and-service-quality

[11] TCRP 1995. *Synthesis 13: Risk Management for Small and Medium Transit Agencies.* http://www.trb.org/Main/Blurbs/153682.aspx

Additional materials such as related webinars and presentations from previous FTA events helped to fill existing gaps in the research and provided additional detail on noteworthy practices from transit agencies.

3 State of the Practice for Investment Prioritization

This section synthesizes the findings of the literature review to better understand how transit agencies are approaching the investment prioritization process. The findings from the literature review are used to assess trends and commonalities across agencies with a specific focus on the interviews with Tier I and Tier II agencies and the descriptions of investment prioritization processes in agency TAM Plans, which provided a useful gauge of the level of maturity of investment prioritization practices at a wide range of agencies.

The synthesis revealed three common themes across transit agencies.

1. Investment prioritization processes vary significantly from agency to agency.
2. Investment prioritization processes are relatively nascent; however, as data accuracy and reliability improves, processes are maturing to incorporate how investments will impact SGR.
3. Most transit agencies use a type of quantitative project ranking to prioritize investments, often with anecdotal input to fill in data gaps.

3.1 Variation in Investment Prioritization Processes

The sophistication of agencies' investment prioritization processes varies significantly from agency to agency. Agencies with more advanced investment prioritization processes often make use of software and tools to aid staff in decision making. Meanwhile, less-established agencies tend to employ more informal investment prioritization processes using their asset inventories, condition assessments, and observations to make decisions. The range of approaches across agencies indicates that investment prioritization processes are often agency-specific and dependent on agency size, staffing, resources, and level of coordination across departments.

Many Tier I agencies have established, or are in the process of establishing, formal procedures to prioritize investments related to asset management. These procedures involve tools and software to help track assets and support decision making. A common best practice identified across both Tier I and larger Tier II agencies is the use of central databases, typically managed by finance and asset management departments, to track individual assets and maintenance activities. These databases may be supplemented with spreadsheets as needed and allow agencies to begin integrating their asset information systems with ongoing maintenance activities to improve asset lifecycle decision making.

Some large Tier I agencies also use or are in the process of acquiring enterprise asset management (EAM) systems. These systems take a comprehensive and holistic approach to asset management by tracking assets throughout each stage of their lifecycle. Figure 1 shows the full asset lifecycle from planning, design, and acquisition to disposal. These systems also consider maintenance, operation, and financial data to provide asset managers and transit agency leadership with a complete picture of the SGR of transit assets. Transit agencies with more mature investment prioritization processes may also use scenario planning and risk assessments, throughout the data analysis process to target investments at those assets with the highest risk. Both of these processes evaluate the effects of certain policies or decisions in order to target investments toward those assets whose failure presents a higher safety risk.

Figure 1. The stages of an asset's lifecycle.

In general, smaller agencies with fewer assets and less complex systems tend to use investment prioritization processes with fewer stages, as they track condition information for fewer projects and assets. These processes may rely on a bottom-up approach that requires staff tasked with managing assets to provide asset information and projections of capital needs to asset management, finance, and other departments at a transit agency. A transit agency's leadership team will leverage observations and asset information from maintenance staff to develop an effective system to rank and prioritize investments to maintain a SGR for various assets.

3.2 Investment Prioritization Processes are Maturing as Data Accuracy Improves

Most TAM investment prioritization processes are emerging and continue to be refined. Reports and related resources from organizations such as APTA or TCRP provide a necessary baseline understanding of what goes into investment prioritization processes. The literature highlights the importance of using asset-level data such as condition, age, and mileage in decision making and also outlines the importance of considering how agency goals will play into the investment prioritization process. The literature however, does not provide an extensive discussion on the effectiveness of specific investment prioritization approaches used by transit agencies.

Agency TAM Plans help to fill this gap by outlining the approaches and strategies used by agencies to develop their prioritized list of investments and offer a more descriptive outlook to inform the state of the practice. The specific approaches taken by agencies including an examination of how investment prioritization fits within TAM and capital planning more broadly is described in Section 4. Agency interviews built upon the information in the TAM Plans by resolving inconsistencies and helping to fill in knowledge gaps.

The review of TAM Plans revealed that the majority of agencies use a data-driven approach that relies on extensive asset-level data on condition, age, and mileage to develop their prioritized list of investments. Agencies with more effective and established processes tend to be larger agencies that have developed strategies to encourage accurate and reliable data collection. These agencies are able to integrate objective asset-level information such as age or mileage into their decision making processes,

while also making use of local knowledge from asset owners. The combination of these data inputs allows agencies to leverage information that may not appear in traditional data sources leading to a more holistic decision making process.

Meanwhile, many agencies with less mature TAM practices continue to refine their data collection and analysis process due to the limited time since the TAM investment prioritization requirements were enacted. These agencies may also rely on a data-driven approach, but there are often fewer practices in place to encourage communication between departments or audits that ensure data reliability. One State Department of Transportation (DOT) representative noted concerns related to data quality and integrity. The DOT sponsors a Group Plan for agencies across the state and must make decisions based on the available data, even if it is incomplete or inaccurate. Many agencies are beginning to establish agency-wide standards and practices to improve accuracy and consistency in data collection. Over time as these datasets grow more robust and agencies develop practices to encourage more effective data collection and analysis, it is likely that these investment prioritization processes will also improve.

3.3 The Use of Quantitative Project Rankings

The systems that transit agencies use to rank investments vary in complexity, but typically assign a score or weight to maintenance or asset replacement projects based on a number of criteria, such as: age, mileage, and condition. The analysis of this data provides an overview of the condition of assets and an initial understanding of potential investment priorities. Individual departments at an agency may then incorporate anecdotal qualitative information and additional quantitative data from asset managers or other staff to fill in gaps that may not have been adequately covered. This process may also involve considering factors such as improving access for persons with disabilities, improving reliability, and mitigating future safety risks, to ensure that the final ranking will align and be linked with the agency's broader mission statement and strategic goals.

This process to rank projects highlights the importance of establishing strong communication and collaboration between staff managing assets and leadership teams to ensure that there is consistent asset information across all staff and departments. Several agencies finance departments manage their asset inventories and prioritize capital budget requests. Meanwhile, one Tier I agency has its business planning and asset management office collaborate to analyze asset information to develop investment prioritization processes. Strong collaboration allows agencies to leverage their inter-departmental resources to develop a complete and holistic approach to project ranking and the overall investment prioritization process.

The final prioritized list of investments is not fiscally-constrained; however, agency leadership may consider funding availabilities when finalizing their list in order to target investments most effectively. Some agencies may also conduct a risk analysis or calculate benefit-cost ratios alongside their project ranking to infuse their prioritization processes with objectivity and data. The inclusion of these additional tools provides transit agencies with a stronger sense of how funding decisions will affect their asset portfolio and will better enable agencies to keep their assets in SGR.

3.4 Common Challenges across Agencies

As discussed, transit agencies range in maturity and complexity with regard to investment prioritization. Some of the main challenges that agencies encounter are expected growing pains as agencies transition their investment prioritization processes to adopt a more data-driven approach. Some agencies have significant disparities in data accuracy and availability across departments and between asset types, which limits the extent of the analyses they can perform. Agencies must regularly inventory their assets and conduct condition assessments to comply with FTA requirements; however, effective investment

prioritization depends on complete and accurate data that covers an asset's entire lifecycle. As agencies are able to fill missing gaps in their data and develop procedures for collecting and tracking data across asset classes, it will become possible to improve investment prioritization processes.

A primary barrier inhibiting effective data collection is a lack of awareness of the importance of accurate and complete data at all levels of an agency. Operations and maintenance staff who are aware of the use of asset information in making investment decisions may be more likely to comply with proper data collection and input procedures. Raising awareness on the importance of accurate and reliable data and explaining the role data plays in maintaining assets in SGR will translate to better data collection and stronger communication across departments, which is essential for developing effective investment prioritization processes.

A common challenge that transit agencies experience relates to the difficulty of identifying the total cost of ownership of an asset, **including labor and parts.**

Information on the cost of individual assets and of maintenance is critical for making informed investment decisions. Similar to inconsistent data, the lack of this information makes it difficult for agencies to assess their funding needs to maintain assets in SGR. Agencies may also consider incorporating future lifecycle cost requirements into investment prioritization processes to assess the funding that may be needed to keep future assets in SGR. This will allow agencies to identify tradeoffs and prioritize between projects with similar needs in the short and long-term. By tracking information on current and future costs more consistently, agencies will be able to integrate this data into their investment prioritization processes to promote more effective decision making.

4 Approaches to Investment Prioritization

This section describes the main approaches that transit agencies use for investment prioritization and providing examples of those approaches. The approaches are divided into three primary categories: project ranking, risk analysis, and software tools.

Of the three primary categories of approaches, project rankings cover the most commonly used method of investment prioritization, which typically involves the ranking of projects based on a set of criteria. Risk analysis is used by agencies with more mature investment prioritization processes and may be combined with the use of project rankings. This method involves assigning a risk score to projects and incorporating the score into the overall project ranking to ensure that funding is used to address various types of asset risk (service impact, safety, financial loss, etc.). Lastly, software tools, specifically the Transit Economic Requirements Model (TERM)-Lite and the TAPT tool are used by some agencies to support the investment prioritization process.

4.1 Project Ranking

Most agencies use an investment prioritization process that assigns a value to projects based on certain criteria. The agency then ranks projects based on their value to develop a prioritized list. Often, agencies revise their prioritized list multiple times, with progressively higher levels of leadership making each successive revision. Several versions of this approach are described below, including the use of specific criteria for different asset classes and the development of a nominal scale ranking system. Agencies refine their project ranking systems over time once they observe how effective they are. This section also covers an approach used by agencies that ties ranking criteria to the agency's strategic goals.

4.1.1 Different initial ranking criteria for different assets

A Tier I agency established individual departmental decision criteria to guide the investment prioritization process and then uses a separate set of criteria to score them, as shown in Figure 2. Revenue vehicle departments submit projects based on time until the asset reaches its ULB, assigning priority to those that have expended the largest percentage of their ULB. Departments that manage non-revenue equipment submit projects based on age, giving priority to projects that address the oldest assets' needs. Finally, the departments that manage rail infrastructure and facilities submit projects based on department leadership's assessment of immediate needs. The Asset Management Division sorts the project proposals into three categories:

1. **Compliance** – A project whose primary intent is to address specific legal requirements or to mitigate agency liabilities.
2. **Renewal** – A project whose primary intent is to address existing assets and system and reduce maintenance backlog.
3. **Enhancement** – A project whose primary intent is to expand the agency's geographic reach, enhance the value of current service, and/or procure additional assets.

The Asset Management Division assigns the highest priority to compliance projects, followed by renewal and then enhancement. The Budget and Financial Analysis Division then scores projects according to criteria related to the agency's mission statement, like improving accessible service, improving the agency's ability to meet future needs, and increasing the reliability of service. The project scores lead to a prioritized list, which is reviewed against the agency's funding requirements, strategic regional objectives, and annual goals of the board of directors before the agency's board of directors finalizes it.

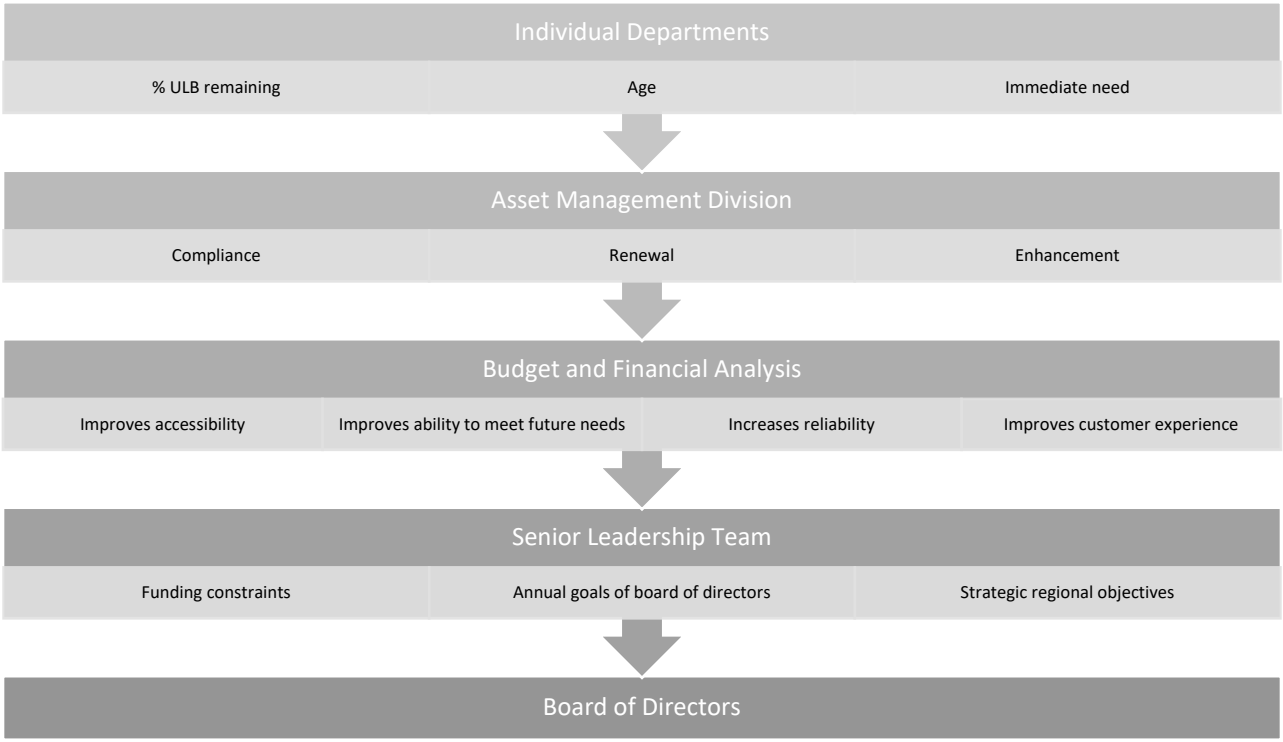

Figure 2. The three different sets of criteria RTD uses to develop its prioritized list of investments. Source: Based on information in the Tier I agency's TAM 2018 Plan.

4.1.2 Nominal scale ranking

A Tier II agency in the Pacific northwest uses a simplified process that ranks proposed projects as high, medium, and low priority. Each year, the agency's departments prepare project requests that include a narrative description that covers how the department's assets are managed and their condition. Departments must also provide a five-year outlook of expected costs of replacements and improvements of their assets. The Capital Program Committee creates a draft Capital Improvement Program using the project proposals and five-year outlooks. The committee reviews all of the proposals it receives and ranks them on a high, medium, and low scale according to age, ULB, asset criticality, and remaining federal fiscal responsibility. Projects and programs that improve the state of good repair of assets, alleviate an unacceptable safety risk, and consider the Americans with Disabilities Act requirements (49 CFR Part 37) concerning maintenance of accessible features and the alteration of transit facilities receive higher priority. The committee proceeds to develop a draft Capital Improvement Program incorporating the narratives provided by the departments.

4.1.3 Ranking criteria based on agency goals

An urban Tier I agency explicitly ties its project ranking criteria to its goals as stated in its strategic plan to ensure that investments advance the agency's stated mission. Figure 3 shows a graphic from the agency's TAM Plan showing the relationship between the agency's strategic goals and its investment scoring criteria. The agency uses a customized version of the TERM-Lite tool to generate an initial list of reinvestment needs based on assets' useful life and known rehabilitation plans. At the same time, the agency solicits a list of additional needs not captured by the automatically-generated from department heads. It also adds and removes projects based on regulatory requirements to refine the prioritized list. The agency proceeds to select projects based on available funding and project phasing efficiencies.

The scoring system scores investments on a scale of 1 (lowest) to 5 (highest) for each of four criteria. The agency then multiplies the average of the safety and security, service delivery, and ridership impacts scores (which it considers representative of the consequence of the asset failing) by the asset condition score (which it considers representative of the probability of the asset failing). The resulting priority score is then multiplied by 5 to generate a score out of 100 points to better capture the variation in priority. In addition to criteria scoring, the agency identifies any individual assets or groups of assets that have a higher priority due to compliance reasons. These assets may have been damaged or identified through investigation or audit as needing replacement; no longer meet code, standard, or regulation; or are technologically obsolete and therefore no longer fit for service. Any asset that needs investment due to compliance receives the highest priority score.

Figure 3. Graphic illustrating the relationship between the agency's strategic goals and investment scoring criteria. Source: WMATA TAM Plan, October 2018.

4.2 Risk Analysis

Risk management is a critical piece of the investment prioritization process. All agencies must consider risk and how investments in maintenance and asset replacement will allow them to meet their current and future needs. Some agencies incorporate risk matrices or risk-scoring elements into their investment prioritization process to further assess risk. These elements allow agencies to focus resources on the assets whose failure present the highest safety risk to the system. The examples described below highlight several agencies that incorporate risk assessments into the development of the prioritized list of investments for their TAM Plan.

4.2.1 Asset risk analysis

Another Tier I agency incorporated a multi-criteria risk scoring element into its investment prioritization processes. This process relies on the assessment of asset condition, risk, and safety. The agency assigns a risk score to asset components that are observed to be below their minimum condition standard based on asset condition assessments. The risk scores are then calculated on a one to five scale that is based on observed asset condition along with potential consequences to transit services in terms of reliability, safety, and attractiveness should the asset fail. The risk scores inform the agency's prioritization processes as those assets with the highest risk scores receive the highest priority for rehabilitation or replacement. In some cases, projects are identified based on other factors such as operational efficiency or technological modernization; however, even in these cases, the agency relies

on the risk score to prioritize investments. By assessing and ranking risk, the agency is able to use resources effectively to keep assets in a state of good repair.

4.2.2 Strategic risk analysis

Another large Tier I agency developed a multistep prioritization process that uses strategic risk matrices to promote close alignment with the agency's strategic goals. This agency's Strategic Risk group manages the agency's investment prioritization process. The group requires that investment requests, called "resource requests," be made by each department through the use of a standard form. Each resource request must frame the desired investment in terms of a problem it would solve, and tie that solution to the overall strategic mission of the agency. This process helps the agency stay focused on advancing its mission through each of its investments.

According to this process, staff analyze each department's resource requests using the agency's strategic risk matrix, prioritizing investments that would address the most severe and frequent risks. The use of a risk matrix standardizes the investment prioritization process across departments.

The risk prioritization process engages staff from across the agency, including department heads, assistant general managers, and executive leadership. A committee appointed by the assistant general managers, consisting of staff from across the agency, including human resources, operations, and representatives from around the district make recommendations to the executive leadership, who make the final list of which resources will be funded.

4.3 Software Tools

Several agencies use software tools to support their investment prioritization processes. The two tools most commonly mentioned as part of this review were the Transit Economic Requirements Model (TERM)-Lite and the Transit Asset Prioritization Tool (TAPT). Both tools are available to the public for free.

FTA developed TERM-Lite and makes it available free on its website. It is an analysis tool designed to help transit agencies assess:

- State of good repair backlog (total dollar value and by asset type);
- Level of annual investment to attain SGR or other investment objective;
- Impact of variations in funding on future asset conditions and reinvestment needs; and
- Investment priorities – by mode and asset type.

The TERM-Lite tool uses the inventory of an agency's capital assets to assess potential investments for their ability to advance an agency's goals. Some of these goals include improving asset condition, service reliability, and safety, as well as reducing operations and maintenance costs. One smaller Tier I, bus-only agency uses TERM-Lite to conduct a high-level prioritization of investment needs at the asset level. This agency analyzes investment options according to a tier system. It segments investment needs into tiers to focus attention on the highest-scoring projects. The tiers offer a visualization of the priority order of asset replacement needs. The scoring reflects the estimated physical condition of the assets with reinvestment needs and the extent to which reinvestment in the assets will improve system reliability, improve safety/security, and reduce operations and maintenance costs. The highest tier of investments addresses assets that are in poor condition and/or offer the highest potential investment returns.

A Metropolitan Planning Organization (MPO) that sponsors a Group Plan for a number of transit providers uses the TERM-Lite tool to support its investment prioritization process. The agency uses a series of evaluation criteria to develop a scoring and project ranking; however, relies on a TERM-Lite

analysis to inform future needs as a part of its investment prioritization process. The analysis determines the backlog of state of good repair needs for the next 4, 10, and 20 years. This analysis assesses the gap between the total forecasted needs and the total amount of money that is programmed in the state's transportation improvement program. Showing the needs and projected funds in this way helps leadership to better understand the long-term needs and plan projects and the replacement of assets accordingly.

TAPT accompanies the Transportation Research Board (TRB)'s *TCRP Report 172: Guidance for Developing a Transit Asset Management Plan.* It is also available free on the report's download page. TAPT is a spreadsheet programmed with several models to help agencies accomplish the following three tasks:

- Predict future conditions and performance for assets;
- Weigh asset lifecycle costs and risks of impacts of asset failure to assess asset criticality; and
- Prioritize investments based on asset information and parameters set by the agency

Agencies input the asset information, budgets, and specifications including useful life, discount rate, cost per passenger per hour of delay, etc. The tool then produces a prioritized list of assets based on the given asset information and specifications.[12]

A state DOT's Tier I Plan and Tier II Group Plan use TAPT to generate an initial list of priority projects for funding. The agency compiles the asset inventories of its transit providers and the capital investments identified in its capital plan into a central database. Using the agency's budget scenario and discount rate, TAPT produces a prioritized list of investments across Connecticut DOT's subrecipients. The agency then revises the list based on additional factors such as the geographic distribution of investments and additional funding sources available.

[12] TRB 2014. *TCRP Report 172: Guidance for Developing a Transit Asset Management Plan*. http://www.tcrponline.org/PDFDocuments/tcrp_rpt_172.pdf

5 Conclusion

Many agencies are looking for ways enhance their investment prioritization processes. This report synthesizes the findings from TCRP and APTA reports, TAM presentations, TAM Plans, and transit agency interviews to provide decision makers with information on existing strategies, models, and tools to enhance their investment prioritization processes. The research team concluded that the limited available literature on agency investment prioritization processes is likely due to the relative recentness of the TAM requirements and implementation of formal investment prioritization processes. Many agencies rely on a quantitative ranking system to prioritize projects, though the maturity and complexity of that system varies widely between agencies. Additional findings through the research process are described in detail below, as are additional considerations that agencies may adopt to advance their investment prioritization processes. The below findings are based on a combination of review of relevant reports and publications, agency TAM Plans, and interviews for this report.

5.1 Findings

5.1.1 Agency collaboration and communication

Effective investment prioritization processes rely on extensive communication within transit agencies. Agencies must coordinate on data collection, funding needs, and decision making procedures regardless of agency size or complexity of prioritization processes. Strong communication within an agency helps to prevent a potential disconnect between asset owners, agency leadership, and additional stakeholders that support the investment prioritization process. A continued focus on collaboration and communication between agency departments will promote more effective asset management as the practices that guide investment prioritization approaches continue to mature. This focus will lead to continued improvements throughout the data collection and analysis process allowing agencies to develop and refine their investment prioritization processes to allocate resources effectively.

5.1.2 Data availability and reliability

Extensive and accurate asset level data is required to develop prioritized lists of investments. The state of the practice revealed that many agencies utilize a data-driven approach that relies heavily on asset information to shape investment prioritization processes. Agencies rely on a mix of purely objective data such as age and mileage, condition assessments that may have more variation regarding how the information is collected, and on-the-ground knowledge to inform investment prioritization. The various data sources and differences in data collection practices may create challenges for transit agencies who collect data from multiple asset owners as well as for agencies developing a Group Plan who must rely on multiple transit agencies to report data.

In order to mitigate these imperfections in the data collection process, successful agencies promote strong practices for communication across departments and between asset owners to fill existing gaps and resolve any inconsistencies in the data. By making efforts to collect data accurately and consistently, agencies can be confident in their decision making process and promote transparency and objectivity in the development of their final prioritized list of investments.

5.1.3 Range of approaches

The findings from this report revealed that there is no one-size-fits-all approach to the investment prioritization process. A number of common themes emerged with regard to how agencies approach the investment prioritization process with many adopting risk assessments, including project rankings, or incorporating tools such as TERM-Lite into their prioritization processes. Despite some of these similarities, the state of the practice confirmed that individual agency characteristics such as size, operating environment, and available funding, tend to shape how agencies develop and finalize their list

of prioritized investments. The findings from this report will support agencies as they refine and improve their investment prioritization process.

5.2 Considerations for Future Research

This report's literature review and interviews reveal several steps agencies can take in the future to advance their investment prioritization processes. Additional research could help identify ways to help agencies take these steps.

5.2.1 Tracking performance of investment prioritization processes

Most agencies have recently developed and implemented a data-driven TAM investment prioritization process. Over time, transit agencies will be able to track the performance of their investment prioritization processes by assessing whether the processes lead to investment decisions that advance the agencies' strategic goals. Agencies can make adjustments and enhancements to prioritization processes if they find that the processes are leading to investment decisions that do not align as well as they should with the agency's goals. Monitoring the effect that investment prioritization processes have on decision making will allow agencies to continually improve their processes over time.

5.2.2 More data for finer-grained decision making

Many agencies today make investment decisions for groups of assets based in part on manufacturer-provided information such as recommended maintenance interval. Transit agencies will be able to make investment decisions based on individual asset need as they become better able to process and analyze large amounts of asset data. They will be able to gather data on each asset's maintenance history, condition, mileage, and other information to optimize maintenance intervals and the expected service life for individual assets. This will allow agencies to maintain assets in SGR and conserve funding by performing maintenance or asset replacements when necessary. More sophisticated asset management software and skilled data analysis staff will continue enhancing the investment prioritization process and make individual asset analysis and decision making possible.

5.2.3 Leverage the accomplishments of other agencies

Agencies are continuing to improve their investment prioritization processes by developing new tools or prioritization processes or adapting existing ones. This presents the opportunity for other agencies to leverage these improved tools and processes for their own purposes, saving time and funding. Agencies with fewer resources for TAM can significantly enhance their TAM programs by obtaining tools from other agencies and tailoring them to their circumstances as needed. An agency that builds on tools from others in the same geographic region or subject to the same regulatory conditions could benefit even more because the tools will already be customized for its particular environmental and regulatory conditions, for example. While FTA facilitates cross-agency knowledge exchange through its annual TAM Roundtable and webinar series, the research team found only limited examples of agencies building on each other's investment prioritization processes and tools.

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

Appendix C

Documents Reviewed

APTA's Procuring Software to Support Transit Asset Management
TAM Guide and Supplement (2019 Update)
TCRP Synthesis 112: Maintaining Transit Effectiveness Under Major Financial Constraints
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
TCRP Report 174: Improving Safety Culture in Public Transportation
TCRP Report 198: The Relationship Between Transit Asset Condition and Service Quality
TCRP Report 206: Guidance for Calculating the Return on Investment in Transit State of Good Repair
TCRP Synthesis 13: Risk Management for Small and Medium Transit Agencies