STATE DOT AND FEDERALLY FUNDED
TRANSIT ASSET MANAGEMENT PRACTICES

Prepared for
NCHRP Project 20-65, Task 48,
Condition of State and Federally Funded Transit Assets

National Cooperative Highway Research Program
Transportation Research Board
of
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INTRODUCTION

This digest present the results of National Cooperative Highway Research Program (NCHRP) Project 20-65, Task 48, Condition of State and Federally Funded Transit Assets. The research was undertaken to provide a transit asset management resource guide for state departments of transportation (DOTs) and other entities that manage federal- and state-funded transit assets. The research was conducted by the Texas A&M Transportation Institute (TTI) under contract to Kittelson & Associates, Inc. The digest was prepared by Associate Transportation Researcher Jonathan Brooks, Associate Research Scientist John Overman, and Assistant Research Scientist Lauren Cochran.

SUMMARY OF RESEARCH

The objective of this research was to develop a resource for state DOTs to use in assessing and managing the condition of federally funded assets. Although state DOTs have a history of implementing highway asset management programs and practices, transit asset management (TAM) practices at state DOTs are less mature, especially for small urban and rural transit provider sub-recipients.

For the purposes of this research, researchers use the following terms and definitions:

- Transit asset management: strategic and systematic procurement, operation, maintenance, rehabilitation, and replacement of federally funded transit assets to manage performance, risk, and costs over the asset's life (adapted from the Federal Transit Administration [FTA] 2012 *Asset Management Guide*).
- Asset hierarchy: a system to classify and rank transit assets (includes four asset classes).
- Asset classes: part of the asset hierarchy (includes vehicles, facilities and stations, guideway elements, and systems).
- Asset types: types of transit assets that can be categorized by asset class.
- Asset data: certain data collected for each asset type; they vary by agency and may be dictated by grant type and reporting requirements.
- Cross-sectional model: a TAM model that identifies conditions of multiple asset types (cut across) at a specified time or across multiple times.
- Longitudinal model: a TAM model that monitors asset condition at regular intervals throughout the asset lifespan.

Figure 1 shows a sample transit asset hierarchy, using the above-defined terminology. For example, a bus is an asset type in the asset class "vehicle." For each asset type, state DOTs collect various asset data. For buses, data may include the vehicle identification number (VIN), in-service date, and mileage.
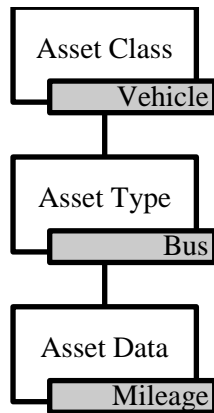
Figure 1. Transit Asset Hierarchy with Vehicle Example.

Researchers conducted the research in two phases. During the first phase, researchers reviewed available literature on transit asset management programs and best practices, and administered an online information collection tool to identify current state DOT TAM practices, including data collection and condition assessment efforts. The following list summarizes current best practices in state DOT TAM:

- A TAM team and/or a TAM champion is the point person for the TAM program. Commitment from executive staff and asset maintainers is essential to program success.
- The 5 Cs provide focus to guide asset acquisition, construction, repair, and preservation. The 5 Cs include clarity, communication, champion, consistency, and comprehensive.
- State DOTs may tailor asset hierarchies. Hierarchies include asset classes, asset types, and asset data.
- TAM is a data-driven process. Some inventories may contain more detailed information than others. Basic inventory information may include asset type, location, and condition.
- Identify TAM software system needs and approaches; note there may not be a single software system for the entire TAM system.
- Investment decisions should be based on quality, comprehensive, and consistent data.
- State DOTs should identify FTA (and other) condition/operating/useful life standards for each asset. Note that asset management systems should account for obsolescence.
- State DOTs can use risk assessments to establish investment priorities. Quantifying based on risks may help identify most critical assets.
- Rehabilitation and replacement policies define what actions should be performed on assets.
- There is a difference between asset prioritization and project prioritization. State DOTs can bundle similar assets together into a project, develop a list of potential projects, and compare the effectiveness of individual projects toward meeting strategic goals. Note that there will be standalone state-of-good-repair projects that are prioritized differently.
- State DOTs may use asset management as a venue to understand vulnerabilities and plan for climate change and extreme weather.
- Agencies should establish performance measures, set targets for measures, and then report on the progress toward meeting the targets.
- Performance management is closely linked to strategic planning and reporting, where strategic planning involves identifying what an agency hopes to achieve. Strategic

planning is based on developing an agency vision or mission, identifying supporting goals and objectives, and developing initiatives and implementation strategies to achieve these objectives.

- The optimal point to rehabilitate or replace an asset is when the life-cycle cost is lowest.
- A geographic information system (GIS)–based map can display asset locations, condition and maintenance history, and photographs.

After the first phase, the project panel reviewed the "state of the state" and considered the status of pending transit asset management rule making by FTA based upon new requirements in the Moving Ahead for Progress in the 21st Century Act (MAP-21).[1] MAP-21 is the two-year federal transportation legislation that authorizes funding for public transportation and highway projects. MAP-21 modifies the previous transportation legislation and establishes the National Transit Asset Management Program.

Per the panel's direction, during the second phase, researchers used the information from the first phase to develop a resource guide for state DOTs to use to monitor transit asset condition in the form of this Research Results Digest (RRD).

The remainder of this digest summarizes the current state of the practice, including a literature review, survey results, case study analysis, and summary of findings, which discusses MAP-21 and TAM, reasons for implementing TAM programs, best practices, and implementation ease.

CURRENT STATE OF THE PRACTICE

To accomplish the research objectives, the research team documented the current state of TAM practices at state DOTs by conducting a desktop literature review, and profiling, selecting, and distributing an online information collection tool to state DOTs.

LITERATURE REVIEW

The primary goal was to determine current transit management practices by reviewing all relevant TAM plans and policies at state DOTs. Researchers reviewed literature including reports, guides, and conference proceedings related to TAM plans and programs, with specific focus on state DOTs using cross-sectional TAM systems. Researchers did not identify any state DOTs currently using a cross-sectional model for asset management of all transit assets. Instead, researchers found states using longitudinal asset management models. Appendix A is the full annotated bibliography resulting from the literature review.

State DOT TAM practices vary widely in implementation history, design, program management, and maturity. Researchers identified the following common practices:

- Most state DOTs cite legislative mandates and greater fiscal responsibility as a catalyst for **program implementation**.
- Agencies included in the literature review rely on the federal and state grant-receiving public transit agencies for **data supply**.

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[1] U.S. Department of Transportation. Moving Ahead for Progress in the 21st Century Act (MAP-21). http://www.dot.gov/map21.

- The three most recurrently used **asset classes** for which data are collected are vehicles, facilities, and equipment.
- **Data collection frequency** is longitudinally managed and is most commonly collected on an annual basis.
- The accuracy of **asset inventory** is a key component of a successful TAM system.
- **Life-cycle cost analysis** is often paired with TAM.
- **Performance measures** are typically part of TAM.

SURVEY OF STATE DOTS

The research team prepared a draft web-based information collection tool to solicit input from all 50 state DOTs, the District of Columbia, and Puerto Rico regarding current transit asset condition-monitoring practices. Researchers designed the survey based on the literature review of current state DOT TAM practices. Researchers included survey questions about three asset classes including vehicles, facilities and stations, and systems. Within each asset class, researchers included survey questions about various asset types and asset data. The project panel reviewed and provided comments on the draft survey.

Researchers used an online survey method to collect information about state DOT practices in collecting and using transit asset data. Twenty-two state DOTs participated in the survey. This section summarizes the survey process and findings, and provides detailed response information. Appendix B contains more detailed response information.

STATE DOT SURVEY PARTICIPANTS

Researchers used email invitations to invite each state DOT to participate. Twenty-two of 50 state DOTs, 44 percent, responded to email invitations and completed the survey. Respondents took an average 23 minutes to complete the survey instrument, which included primarily multiple-choice questions. Figure 2 is a map of responding DOTs. Respondents varied in geographical location and transit program size. The 22 DOTs represent 44 percent of all states, 44 percent of the total U.S. population, 42 percent of the non-urbanized population, 45 percent of the urbanized population, and 39 percent of the non-water land area of the United States.
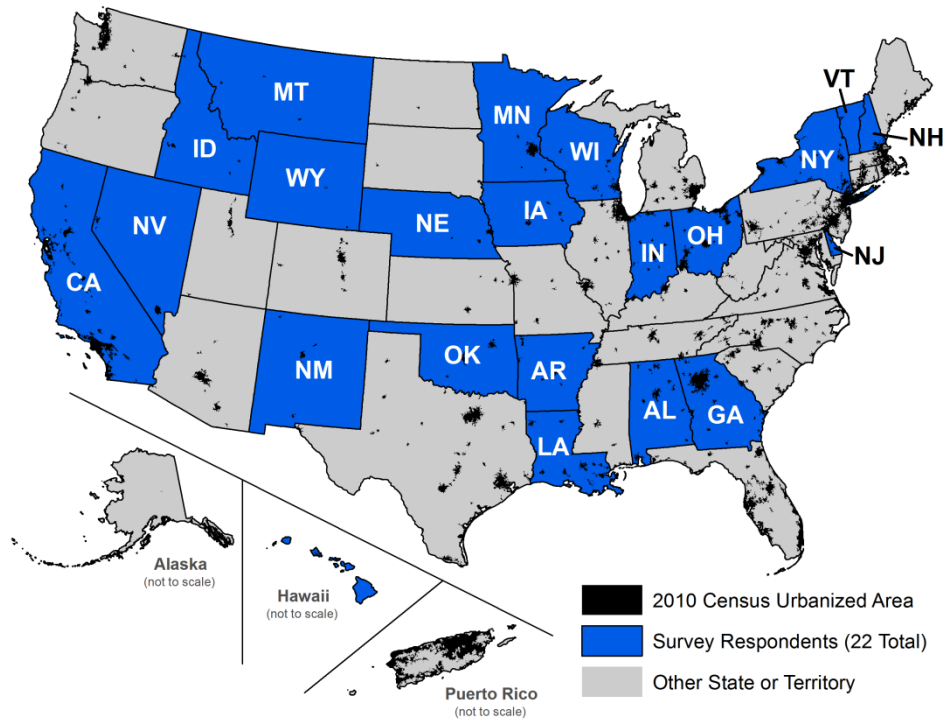
Figure 2. State DOT Survey Response.

SURVEY STRUCTURE AND CONTENT

Researchers used Surveymonkey.com to manage the survey. The survey instrument had four primary sections:

1. Current state DOT practices.
    a. Asset data collection methods.
    b. Description of current practices.
    c. Currency of asset data.
    d. Data collection by type of transit agency.
2. Practices and available data *(details by type of asset; extensive use of survey logic).*
    a. Revenue vehicle fleet.
    b. Non-revenue vehicle fleet.
    c. Passenger facilities.
    d. Administrative facilities.
    e. Vehicle/maintenance repair facilities.
    f. Vehicle storage/garage facilities.
    g. Revenue vehicle equipment.
    h. Communications equipment.
    i. Office equipment/software.
    j. Security/surveillance equipment.
    k. Maintenance shop equipment.
3. Sources of information, guidance, or reports.
4. Comments and observations.

The following are highlights for each section of the survey findings:

- Transit asset data collection by state DOTs varies based on the type of agency from which the state DOT is seeking to collect data: metropolitan transit authorities, Section 5307 urban agencies, Section 5311 rural agencies, or specialized agencies.
- DOTs collect transit asset data via email, online/electronic reporting systems, management/maintenance software systems, and paper forms.
- A majority of DOTs collect data from Section 5307 urban agencies, Section 5311 rural agencies, and specialized agencies. DOTs noted the data among peer agencies had comparable quality and breadth.
- All but one DOT reported collecting asset data for the revenue vehicle fleet. The next most common asset class data collected include maintenance facilities, administrative facilities, and vehicle storage facilities. About half of state DOTs collect asset data for other types of assets classes.
- DOTs most often collect asset data annually; for some assets classes and types, asset data are collected more frequently.
- DOTs commented on the level of effort required to begin data collection for assets not already documented by the state. DOTs indicated that beginning data collection for revenue vehicles would be "very easy" or "easy"; the other 10 types of assets received mixed reviews as far as the perceived challenge to begin data collection.
- DOTs most often acknowledged that they collect some transit asset data but lack a formal process or plan to use the data. One DOT possessed an advanced data collection process with strategic goals linked to the budget process.

The following sub-sections summarize survey findings in detail. Appendix B summarizes findings for every survey question.

DOT Data Collection by Type of Transit Agency
Transit asset data collection by state DOTs varies based on the type of agency from which the state DOT is seeking to collect data: metropolitan transit authorities, Section 5307 urban agencies, Section 5311 rural agencies, or specialized agencies (agencies receiving funds from one or several sources, such as a nonprofit agency). Figure 3 summarizes the percent of responding DOTs that collect transit asset data from each type of agency. DOTs reported collecting data from rural agencies (95 percent), specialized agencies (81 percent), urban agencies (71 percent), and metropolitan agencies (24 percent).

Please consider the following four types of transit agencies. From which does your state DOT collect transit asset data—of any type or amount?
Select all that apply.
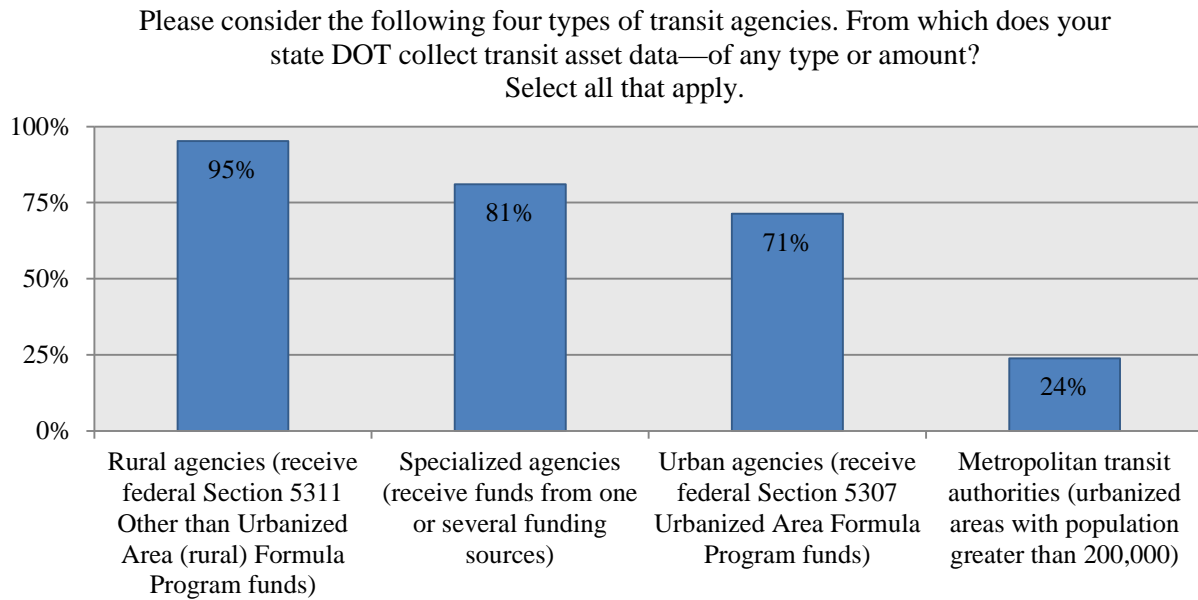
Figure 3. Data Collection by Agency Type.

How DOTs Collect Transit Asset Data

The most common methods DOTs use to collect transit asset data are email exchange (57 percent), followed by online/electronic reporting system (38 percent), management/maintenance software system (29 percent), paper form (24 percent), phone (14 percent), survey (10 percent), and other (24 percent); see Figure 4. DOTs were allowed to select all methods that applied to their agency: 10 DOTs reported using only one method, while the other 12 DOTs used two or more methods.

Which of the following best describes your state DOT's method(s) for collecting data about transit assets? Select all that apply.

Figure 4. Data Collection Methods.

Respondent comments indicated that two DOTs were in the process of acquiring a web-based grants management system to improve their TAM data collection.

Transit Asset Data Currently Available

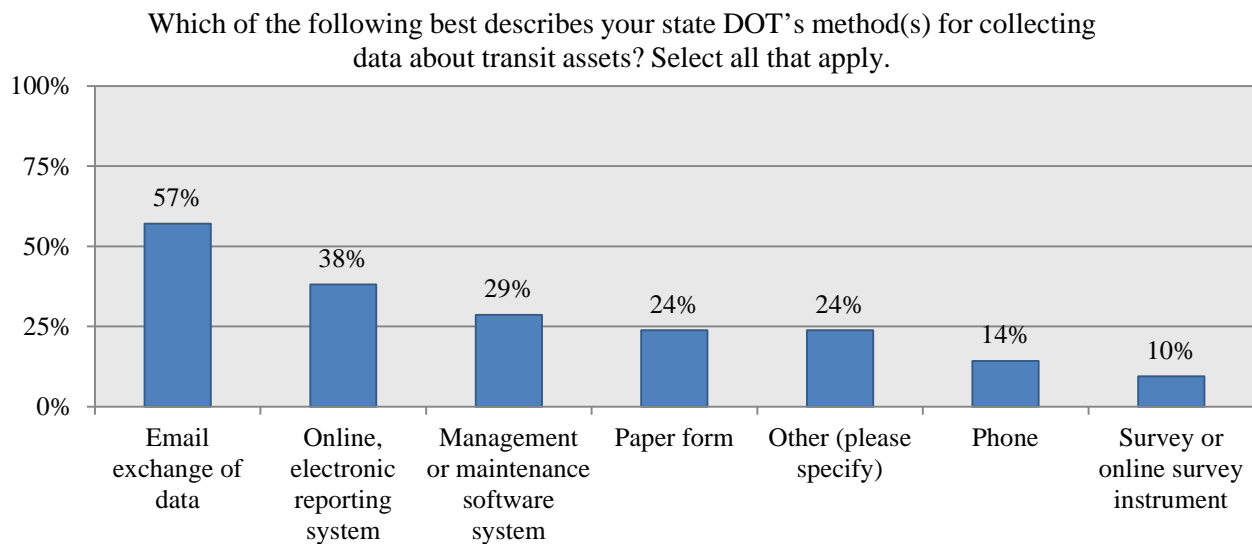More than 70 percent of DOTs collect data from Section 5307 urban agencies, Section 5311 rural agencies, and specialized agencies (see Figure 3). Just over half, 62 percent, of DOTs reported collecting similar data regardless of agency type; the other 38 percent of DOTs vary data collection requirements based on agency type. Researchers also asked DOTs if, in their professional opinion, the quality of data for peer agencies was comparable: 67 percent of DOTs responded that "yes," their data are adequately comparable between peers in their state; 29 percent responded that "no," data may be inadequate for fair comparison; and 5 percent (one DOT) was unsure.

Figure 5 summarizes data collection by asset type. All but one DOT reported collecting data for revenue vehicle assets. The next most common data available include maintenance facilities (79 percent), administrative facilities (74 percent), and vehicle storage facilities (68 percent). About 50 percent of DOTs collected some, or all, of the other asset types, including various types of equipment, non-revenue fleet, passenger facilities, software, and security/surveillance assets.
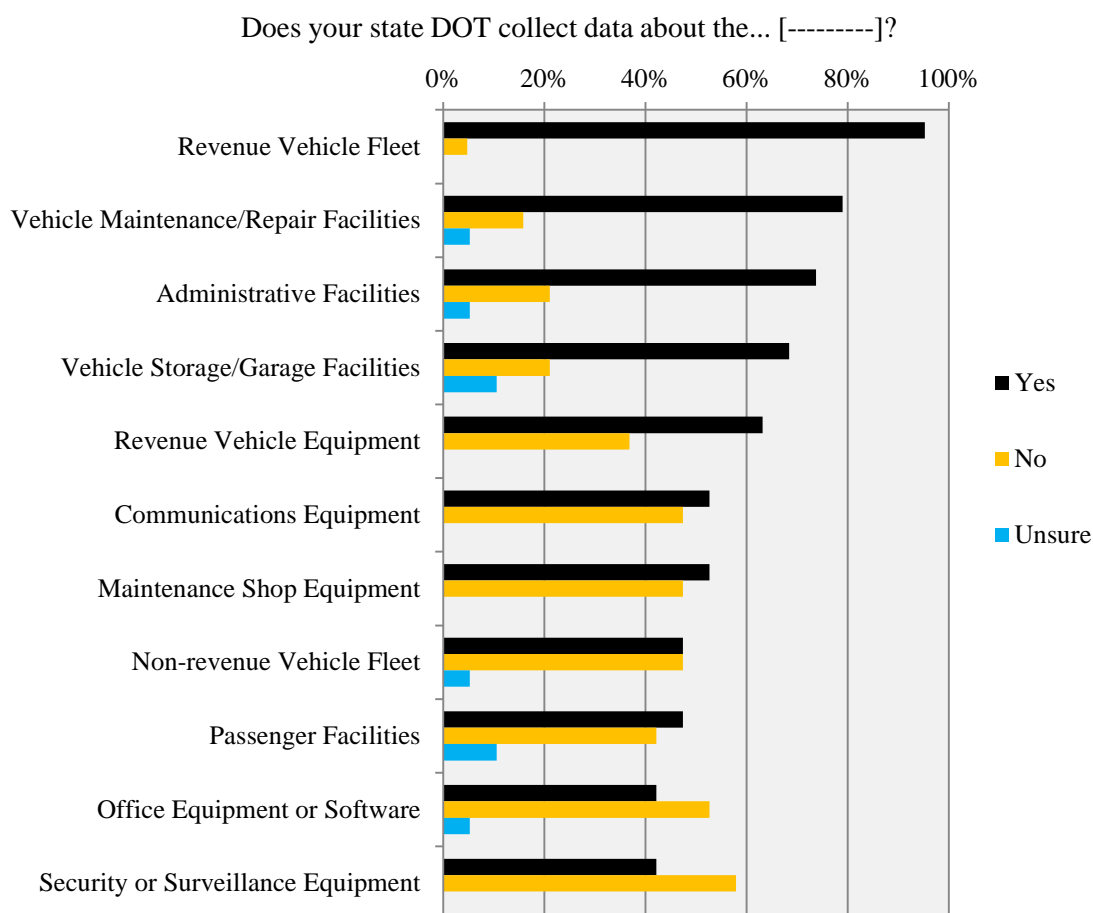

Does your state DOT collect data about the... [---------]?

Figure 5. Data Collection by Asset Type.

Data Collection Frequency

DOTs indicated how frequently (i.e., current) the agency collects data for each asset type. Figure 6 contains the findings for data collection frequency by each of the 11 asset types. Collecting data annually is the most common frequency for every asset type.

How current are your state DOT's data for… [--------]?
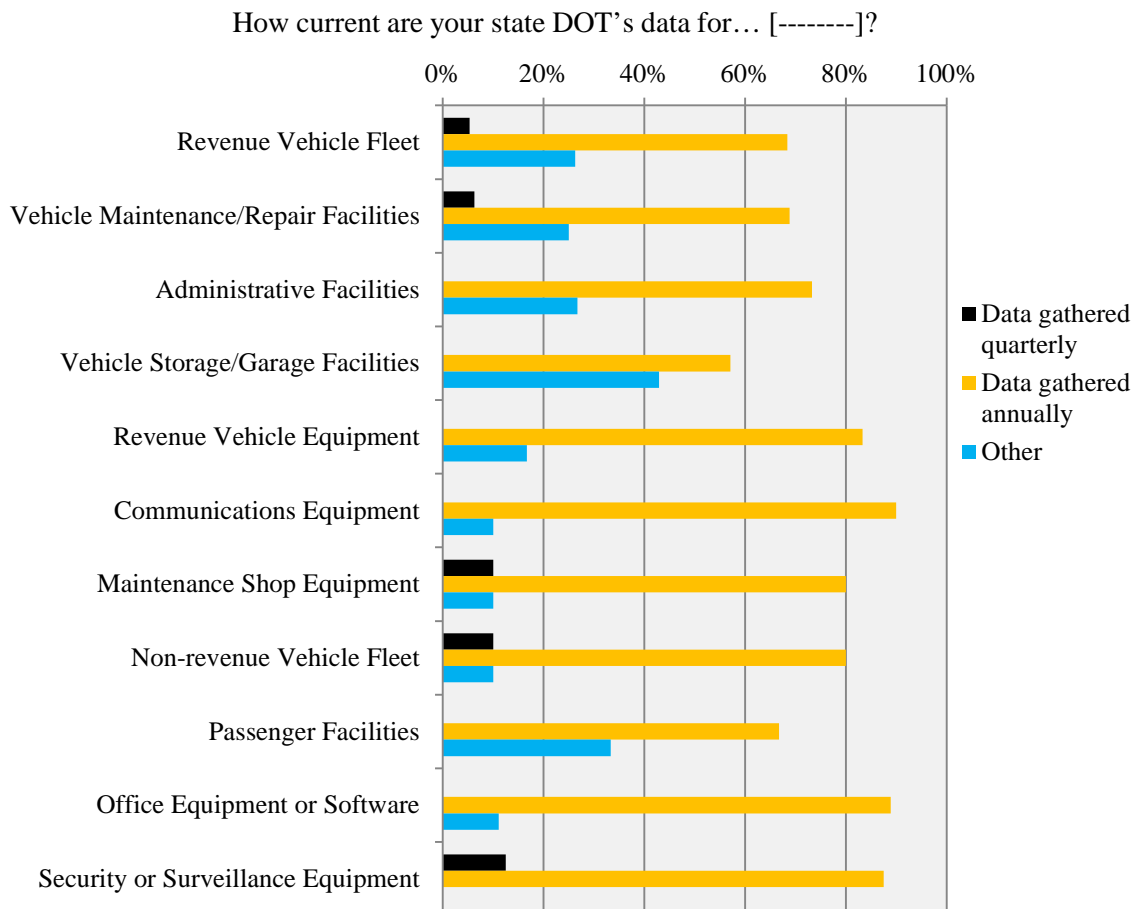
Figure 6. Data Collection Frequency.

Difficulty of Collecting New Types of Transit Asset Data

Researchers used survey logic in the information collection tool to ask state DOTs about the perceived difficulty of beginning data collection for each asset type for which the state does not currently collect data or for which the state is unsure if data are collected regularly. Figure 7 summarizes the findings for data collection difficulty by asset type.

The only asset class for which a majority of DOTs felt beginning data collection would be "very easy" or "easy" is the revenue vehicle fleet with 67 percent. The types of assets perceived by a majority of DOTs as being "difficult" or "very difficult" to begin collection for are maintenance shop equipment (78 percent), revenue vehicle equipment (72 percent), communications equipment (67 percent), security and surveillance equipment (64 percent), and office equipment and/or software (60 percent).

How difficult would it be to start collecting data from all grantees on… [--------]?
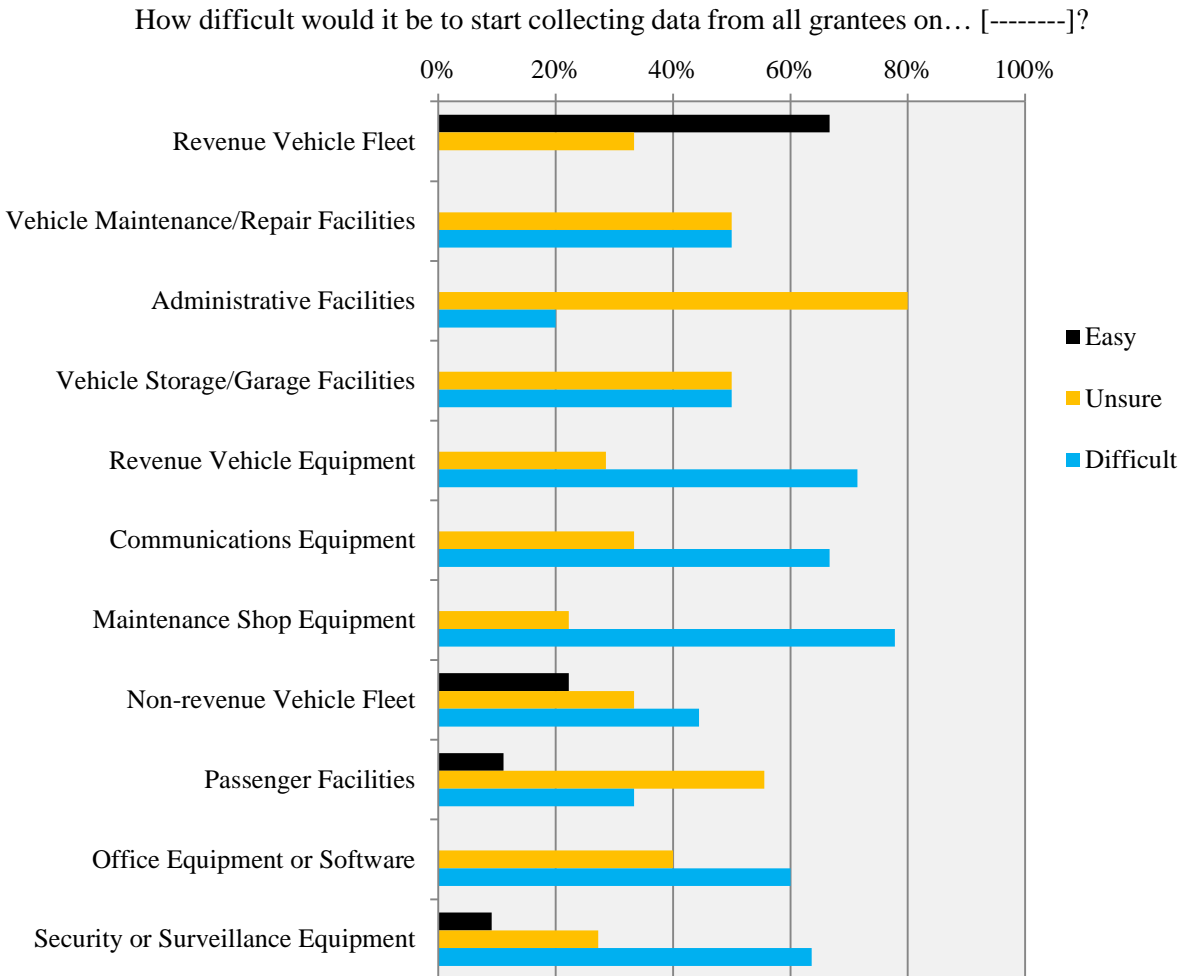
Figure 7. Difficulty to Begin Data Collection.

How DOTs Use Transit Asset Data

Researchers asked DOTs to select which of four statements best describe their data collection process and eventual use of transit asset data (Figure 8). Responses were split between each category, but the largest single group (38 percent) acknowledged their DOT "collects some transit asset data but lacks a formal process or plan to use the data." One DOT possessed a relatively "advanced" data collection process with strategic goals linked to the budget process.

Which of the following statements best describes your state DOT's current practices regarding transit asset management statewide? Select one.

- Our state DOT collects some transit asset data but lacks a formal process or plan to use the data.

- Our state DOT collects some transit asset data and has a basic program or policy regarding using the data for analysis to inform decision making.

- Our state DOT collects detailed transit asset data and regularly uses the data as part of planning and policy making.

- Our state DOT collects detailed transit asset data and has a formal process for statewide asset management planning, with strategic goals and links to the budget process.

Figure 8. Current TAM Practices.

Twenty of the 22 responding state DOTs provided comments about how their agency uses TAM data. The following summarize open-ended comments:
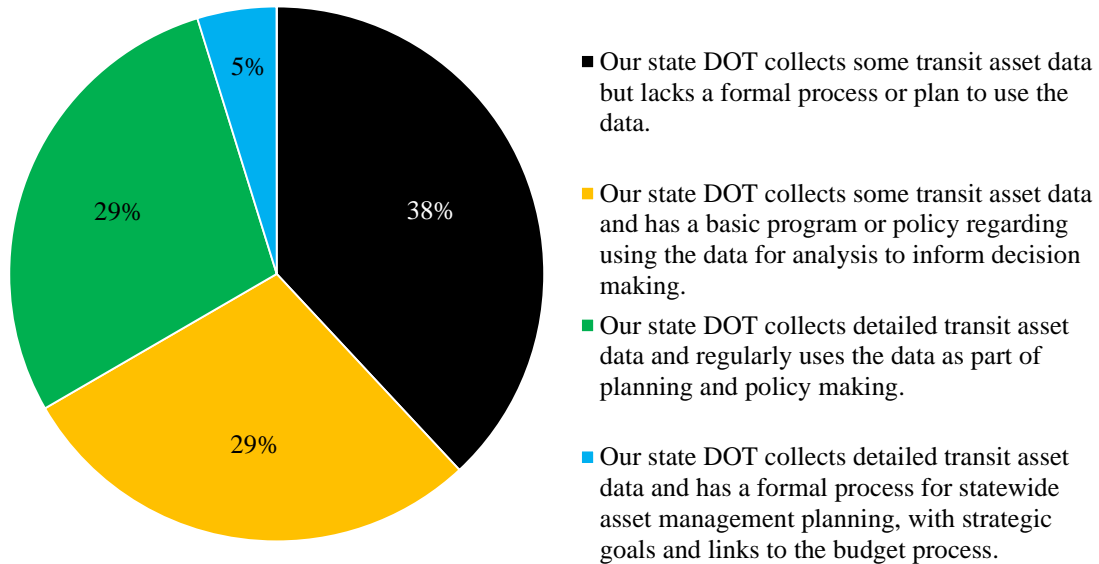
- We collect capital plans from transit providers to assist in planning for capital replacements in future budget years.
- We are evolving to a point at which we will be able to analyze transit asset data to assist with decision making; methods of collecting data include access to department of motor vehicles vehicle records for verification and problem solving.
- We developed statewide tracking software with the help of a contractor; currently, our agencies are entering that information in the system.
- We have maintenance policies for all transit systems and conduct annual spot checks to ensure policy compliance; we ask for their 10-year capital plan annually as part of grant applications.
- We created an Office of Performance Management in 2012 to collect data and organize policy; TAM is one area of interest.
- We receive monthly detailed documentation for any repairs to rolling stock and maintain scheduled replacement information about revenue rolling stock (including spares ratio).
- We use a public transit management system (PTMS) to rank vehicles statewide by age and miles; a vehicle receives a point for each month of service and 1 point for each 3,500 miles. When a vehicle reaches its useful life threshold, as defined by the program, it is programmed for replacement in statewide vehicle rank order.
- We collect the required inventory information from the sub-recipients and develop a replacement schedule for vehicles.

- We maintain a web-based trip statistics and expense-tracking program used by sub-recipients to report ridership data and operating expenses; some of the data collection effort pertains specifically to revenue vehicles.

Role of State DOTs in TAM

One of the final questions of the survey was "In your professional opinion, what role should transit asset management practices play at the state DOT level"? The following summarizes comments from eight respondents who took the time to write comments:

- DOTs have a key role in statewide repair, replacement planning, and budgeting processes (synthesis of six of eight respondents).
- DOTs must track major purchases over a defined threshold on a regular basis (especially for vehicles and facilities), and should know where federal dollars are being spent and if assets are maintained (synthesis of three of eight respondents).
- DOTs should be familiar with and provide general policies to their sub-recipients (synthesis of three of eight respondents).
- DOTs should have an oversight role for TAM and gather important data but not minute details of either (synthesis of three of eight respondents).
- DOTs should use TAM principles to ensure safe delivery of passenger services (synthesis of one of eight respondents).
- DOTs should be responsible for assets in the rural and specialized programs but not assets in use by direct FTA reporting agencies (synthesis of one of eight respondents).

SELECTED STATE DOT PROFILES

Using the online information collection results and literature review, researchers selected for further analysis state DOTs that administer rural, urban, and rail transit, and state DOTs that are direct operators of transit services. Researchers narrowed down the list of state DOTs for comparative analysis based on the following variables:

- Existence of a transit-specific asset management system.
- Geographic location.
- Types of services provided.
- Breadth and depth of asset management system.
- Available literature.

Researchers used case study research to document the asset management and condition assessment models used, and identified aspects of those models that may be replicated by other states. This section begins to explore lessons learned and recommended and best practices by reviewing circumstances and experiences at a selection of state DOTs; particular attention is given to planning and implementation strategies. For example, the Oregon Department of Transportation uses cross-sectional modeling for its vehicles only. Agency profiles include summary information for the following aspects of TAM, as information allowed:

- Implementation history of the state DOT's asset management program.
- Data collection processes used.
- Frequency of data collection.

- Data quality-control practices.
- Measures used to monitor or report asset conditions.

Researchers compiled the information from available resources, provided in this report with a hyperlink to the original document (if available).

ALABAMA DEPARTMENT OF TRANSPORTATION (ALDOT)

ALDOT has 26 agencies receiving support under Section 5311 funds for general public transportation to rural populations.[2] The DOT uses an asset management system for transit vehicles purchased under the FTA Section 5310 and 5311grant-funding programs. ALDOT uses a GIS-based database system to predict vehicle conditions as a function of operational and socioeconomic characteristics. The prediction model pulls data pertaining to active assets from a database built in Microsoft Access. Using 40 data points regarding attributes for each vehicle, the model allows the DOT to estimate the overall fleet quality, identify annual vehicle replacement needs, and predict future funding and budgetary needs. The model assigns a vehicle condition rating based on vehicle age and the following characteristics:

- Engine starting trouble.
- Engine running condition.
- Interior condition (upholstery damage and seats missing).
- Air-conditioning condition.
- Wheelchair lift operation.
- Exterior condition.
- Mileage.

From the inspection, the vehicles are assigned a condition rating on a five-point scale:

1. Bad: vehicle needs immediate replacement.
2. Poor: vehicle should be replaced.
3. Fair: vehicle is acceptable.
4. Good: vehicle has no outstanding problems.
5. Excellent: vehicle is in new condition.

ALDOT uses the condition rating as the dependent variable to determine vehicle replacement needs. ALDOT uses seven elements as independent variables: age, total miles, miles per year on unpaved roads, wheelchair accessibility, population, percentage of population age 65 and over in the county of operation, and percentage of commuters in the county of operation. Vehicle age, total mileage, and miles traveled per year on unpaved roads were the strongest predictors of vehicle condition. ALDOT lists the quality of the database as key to the analysis and the asset management system. Input and output were simplified to reduce errors and to make the system user friendly.

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[2] M. D. Anderson and N. S. Davenport. *A Rural Transit Asset Management System*. University Transportation Center for Alabama, Tuscaloosa, June 2005, http://utca.eng.ua.edu/files/2011/08/04401fnl.pdf.

ILLINOIS DEPARTMENT OF TRANSPORTATION (IDOT)

IDOT developed a capital asset needs model to estimate 10-year capital needs for transit agencies outside of the Chicago metropolitan area (downstate transit agencies).[3] Transit agencies completed a detailed survey of existing asset inventory (vehicles and major facilities) and known investment needs. In addition, on-site capital cost data collection and inspections of asset physical conditions were conducted at three urban and two rural systems. Historical cost data were collected for the following:

- Facility construction and capital repairs.
- Annual capital expenditures on other needs such as equipment, shelters, and radios.
- Annual operating and maintenance costs.
- Engine/transmission rebuilds.

IDOT used these data to establish life-cycle cost curves for four types of buses and seven types of paratransit vehicles. A minimum-cost replacement strategy was used to minimize total life-cycle costs. The life-cycle costs include:

- Original purchase (investment) cost.
- Lifetime rehabilitation costs (engine and transmission rebuilds and mid-life overhauls).
- Annual operating and maintenance costs.

This analysis of life-cycle costs establishes when the vehicles should be replaced in the IDOT capital needs model. Replacement needs for all facilities were determined based on standard useful lives. The data collection also provided the data required to evaluate the physical condition of downstate transit assets. IDOT has used the capital assets needs model annually since 2003 to estimate statewide capital needs. IDOT also prepares needs assessments for the individual transit systems to use in capital planning.

INDIANA DEPARTMENT OF TRANSPORTATION (INDOT)

The State of Indiana has 38 public transportation systems divided into two categories: fixed-route operators and demand response systems. Those operated by private contractors are not included in the TAM system.[4] INDOT describes the framework and methodology used by the Indiana Public Transportation Equipment and Facilities Management System (IPTMS) in the process of transit management. The report describes the basic framework of the INDOT management system comprised of six primary elements:

- Development of a comprehensive asset inventory.
- Development of a tentative, time-based replacement schedule.
- Evaluation of the condition of assets near the end of their life cycle.
- Updating of the replacement schedule based on the condition of assets.
- Priorities of asset replacement.
- The final decision and procurement process.

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[3] Booz Allen Hamilton. "Downstate Illinois Capital Needs Assessment." PowerPoint, prepared for Illinois Public Transportation Association, October 2003.

[4] M. G. Karlaftis, J. P. Lynch, K. C. Sinha, and J. D. Fricker. "Indiana Public Transportation Management System." *Transportation Research Record* 1604, paper no. 971230, 1997, pp. 92–101, http://trb.metapress.com/content/44n0505611p17077/fulltext.pdf.

The report concludes by noting that four areas are necessary for successful implementation:

- Establishment of a profile to record asset condition and decay.
- Identification of a threshold for performance indicator values.
- Development of a quantitative model to simulate the needs of future transit.
- Establishment of overall guidelines to update and monitor the management system.

MICHIGAN DEPARTMENT OF TRANSPORTATION (MDOT)

MDOT's Public Transportation Asset Management (PTAM) system manages the assets of approximately 100 transit agencies statewide.[5] A statewide vehicle inventory is used for forecasting, and a financial database is used for budgeting and funding. Transit agencies across the state use an online annual application model to apply for capital projects. Modules include vehicle, equipment, facility, and operating assistance inventories. Reporting in all applicable models is required for public transit agencies to receive state and federal funds. While the PTAM system itself is the responsibility of MDOT's Passenger Transportation Division of the Bureau of Urban and Public Transportation, specific entries into the system are the responsibilities of the individual transit agencies.

OREGON DEPARTMENT OF TRANSPORTATION (ODOT)

The ODOT Public Transportation Division (PTD) defines capital assets[6] as:

- Rolling stock (all vehicles used for passenger transport).
- Vehicles that are not used for passenger transportation, such as maintenance and staff vehicles.
- Shop equipment (fixed or mobile vehicle maintenance equipment).
- Office equipment (including office computer servers, personal computers, copiers, and other large office equipment).
- Communications equipment (includes telephone systems and radio systems when the purchase is more than $5,000).
- Passenger shelters and signage.
- Buildings and facilities (such as bus barns, maintenance shops, or transit centers).

ODOT calls attention to the diversity among transit agencies in the state; therefore, a one-size-fits-all approach to asset management plans is not practical. PTD provides assistance to transit agencies to develop a comprehensive transit asset management plan tailored to their scope. The report outlines three mandatory elements ODOT requires of each transit agency's asset management plan:

1. A complete inventory of vehicles, equipment, and facility assets (ODOT has established guidelines for inventory asset).
2. An asset/vehicle replacement schedule and policy (ODOT uses useful life standards).
3. A vehicle maintenance plan.

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[5] MDOT. "Public Transportation Management System." http://www.michigan.gov/documents/buses_16567_7.pdf.
[6] ODOT Public Transit Division. *Management of Grant-Funded Capital Assets.*
http://www.oregon.gov/ODOT/PT/resources/guidance-library/handbook-capital-asset-management.pdf.

The criteria used to evaluate vehicle replacement grant applications are:

- The transit service for which the vehicle will be used.
- Whether the vehicle minimum age standard has been met or exceeded.
- Whether the vehicle minimum mileage standard has been met or exceeded.
- Vehicle condition and excessive maintenance issues/expenditures

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT)

WSDOT's current practices are described in a guide for sub-recipients in the State of Washington.[7] The guide includes background on legislative requirements to implement a plan, guidance on how to develop a plan, and the components that should be included. WSDOT requires that all public transportation agencies in the state submit an asset management plan in order to receive state funding. The plan must inventory all transportation system assets and provide a preservation plan based on life-cycle cost analysis. Assets that are owned and operated by contractors do not have to be included in the plan. Assets are defined as:

- All rolling stock (passenger service vehicles).
- Facilities with a replacement value of $25,000 or greater.
- Other equipment with a replacement value of $100,000 or greater.

The guide lists all assets that should be inventoried under each of these three categories. There is a framework for each plan; elements include:

- A mission statement.
- An inventory of transit assets.
- A preventative maintenance program.
- A cost model that reflects the agency's policies and standards.

SUMMARY OF FINDINGS

This section summarizes study findings under the following subject areas:

- MAP-21 and TAM.
- FTA rule making.
- Types of transit assets.
- Reasons for implementing a TAM plan.
- Best practices for TAM planning and implementation.
- Implementation ease.

MAP-21 AND TAM

MAP-21 mandated all federal funding recipients (including sub-recipients) develop a TAM plan, use an asset management system to develop capital asset inventories and condition assessments,

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[7] Public Transportation and Rail Division, WSDOT. *Guide to Preparing Your Transit Asset Management Plan.* 2005. http://www.wsdot.wa.gov/NR/rdonlyres/2055AB7A-DDD4-4BB0-A22B-BA2A7EF7954F/0/guide_to_preparing_your_TAMP.pdf.

report the condition of their system, and describe any changes in the asset conditions since the last report.

FTA grant recipients, metropolitan planning organizations, and states will be accountable for setting and reporting performance on transit state-of-good-repair performance targets. The goal of this process is to coordinate state-of-good-repair and capital investment planning at the transit agency, regional, and state levels.

FTA RULE MAKING

FTA released an Announcement of Proposed Rulemaking regarding TAM, and the rule making closed for public comment in early January 2014. Per MAP-21, FTA is first required to define a state of good repair (SGR). The SGR definition will impact eligible projects for funding and will "form the cornerstone of the entire National Transit Asset Management System envisioned by MAP-21 (SGR White Paper, 2013)." The SGR definition will also provide the foundation for transit agencies to develop their TAM plans.

FTA accepted comments on four different approaches to the SGR definition and therefore TAM. The four approaches were based on:

1. Asset age.
2. Asset condition.
3. Asset performance.
4. A combined approach (age, condition, and performance).

Once SGR is defined, FTA must also set asset condition-measuring standards and define performance measures based on standards.

TYPES OF TRANSIT ASSETS

Transit assets vary agency to agency, and consequently state DOTs must often identify, collect, and evaluate many types of assets as part of any level of transit asset management at the state level. The research team conducted a survey to ascertain existing asset data held by state DOTs. The previous survey summary discussed findings for types of assets. However, the research team also collected information about state DOT efforts to collect detailed data for each asset. Complete results about actual data held by state DOTs for each of the 11 types of assets researchers inquired about is in Appendix B.

State DOTs may use agency goals and objectives to determine the level of data granularity the state wishes to collect. For example, TAM data for revenue vehicles may include vehicle identification, VIN, make/manufacturer, model year, number of seats, current mileage, FTA vehicle type, purchase year, wheelchair tie-downs, fuel type, condition rating, in-service date, storage location/type, gross vehicle weight rating, and mileage at last major breakdown. Some state DOTs could even track individual subcomponents and parts. TAM data for vehicle maintenance facilities may include owned/leased status, purpose/functions, address, facility name, size/capacity, cost, description, in-service date, expected life-span, Americans with Disabilities Act (ADA) accessibility, date of last renovation, and structure type (i.e., steel, wood, or concrete).

There are many reasons why a state DOT implements a TAM plan. Researchers identified the following reasons via literature and survey findings (the reason is in bold, the italicized quote is from the source of the reason, and parentheses enclose the source itself):

- **Extend useful life of assets:** *"…to maximize the useful life of existing assets and keep facilities in top condition to ensure service quality"* [8]
- **Guide budgeting and funding strategies:** *"Determine a funding strategy, select specific projects within constraints, predict future health under a range of funding levels, and inform policymakers of the effects of potential policy actions and funding levels"* [9] *"Budget responsibly and negotiate political funding"* [10]
- **Secure additional funding:** *"Powerful tool in communicating to elected officials the needs and consequences of investing (or not investing) in infrastructure…TAM process did provide the impetus for the legislature to feel comfortable that existing assets were being handled well"* [11]
- **Infrastructure safety and security:** *"Safety investments and improvements where the public is most at risk"* [12]
- **Strategic decision making:** *"Foster integrated strategic decision making"* [13] *"Planning and constructing the best mobility-focused projects on schedule"* [14] *"Adopt a 'fix it before it is broke' principle"* [15]
- **People:** *"Making GDOT a better place will make GDOT a place that works better"* [16] *"Obtain higher customer service ratings"* [17]
- **Maintenance:** *"Take care of assets in the most efficient way possible"* [18] *"Maintain facilities at a higher level of service and lower the cost to maintain over time"* [19]

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[8] Federal Highway Administration. Asset Management. http://www.fhwa.dot.gov/asset/if08008/amo_06.cfm.

[9] Federal Highway Administration. Asset Management. http://www.fhwa.dot.gov/asset/if08008/amo_06.cfm.

[10] MDOT. "Public Transportation Management System." http://www.michigan.gov/documents/buses_16567_7.pdf.

[11] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007. http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.

[12] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007. http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.

[13] Oregon Department of Transportation. http://www.oregon.gov/ODOT/TD/asset_mgmt/docs/Plans/04-AMSP-10-111711_FINAL.pdf.

[14] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007. http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.

[15] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007. http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.

[16] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007. http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.

[17] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007. http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.

BEST PRACTICES FOR TAM PLANNING AND IMPLEMENTATION

Table 1 is a summary matrix of best practices as identified by the research team via literature, DOT profiles, and the survey. Appendix C contains the detailed table summarizing best practices.

Table 1. TAM Best Practices Summary Matrix.

STRATEGY	DETAILS
EASY	
Assemble a TAM team/designate a champion	A TAM team and/or a TAM champion is the point person for the TAM program. Teams can be grouped by asset class or asset type, and responsibilities include setting goals and objectives, analyzing life-cycle costs, and recommending investment strategies. Commitment from executive staff and asset maintainers is essential to program success. Staffing requirements for TAM activities will vary by state.
Use the 5 Cs	The 5 Cs provide focus to guide asset acquisition, construction, repair, and preservation. The 5 Cs include clarity, communication, champion, consistency, and comprehensive.
Determine asset hierarchy	State DOTs create tailored asset hierarchies. Hierarchies include asset classes, asset types, and asset data. After identifying asset classes and asset types, state DOTs identify which data points to collect for each asset type.
Create an inventory	TAM is a data-driven process. To implement a TAM plan, state DOTs collect asset data for each asset type and compile the information into an inventory. Some inventories may contain more detailed information than others. Basic inventory information may include asset type, location, and condition. State DOTs may use agency goals and objectives when developing an asset inventory and determining data granularity. (Note that the Southeastern Pennsylvania Transit Authority suggests starting with a pilot inventory system where data are collected for one asset type or mode instead of an entire system.)
Determine software needs	Software systems for asset inventory may be basic spreadsheets or very advanced systems, linked to other databases. Define software system needs. Note that there may not be a single software system for the entire TAM system.
Collect quality data via email or other means	Investment decisions should be based on quality, comprehensive, and consistent data. Data should include asset condition. The most common method DOTs use to collect transit asset data is email exchange.
Determine asset type useful life standards	State DOTs should identify FTA (and other) condition/operating/useful life standards for each asset. Note that asset management systems should account for obsolescence.

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[18] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007.
http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.
[19] Cambridge Systematics, Inc., and Michael D. Meyer. *U.S. Domestic Scan Program: Best Practices in Transportation Asset Management.* NCHRP Project 20-68, 2007.
http://onlinepubs.trb.org/onlinepubs/trbnet/acl/ncrhp2068_domestic_scan_tam_final_report.pdf.

STRATEGY	DETAILS
MODERATE	
Conduct a risk assessment for assets	Ineffective risk management could lead to added costs, safety violations, regulatory actions, and bad public relations. State DOTs can use risk assessments to establish investment priorities. A cost of failure risk assessment may include: • What can go wrong? • What is the likelihood that it will go wrong? • What are the consequences (and what is the time domain)? Quantifying based on risks may help identify the most critical assets.
Develop a rehabilitation and replacement policy	Rehabilitation and replacement policies define what actions should be performed on assets. The policy should answer the question "At what point should the asset be rehabilitated or replaced, consistent with transit agency goals and absent budget constraints?"
Develop a project selection tool (analyze options and tradeoffs)	There is a difference between asset prioritization and project prioritization. State DOTs can bundle similar assets together into a project, develop a list of potential projects, and compare the effectiveness of individual projects toward meeting strategic goals. Note that there will be standalone SGR projects that are prioritized differently.
Incorporate climate change adaptation planning	As with risk assessments, state DOTs may use asset management as a venue to understand vulnerabilities and plan for climate change and extreme weather. Climate change adaptation planning may fit within the existing planning context, use existing agency data, leverage agency expertise, and document lessons learned and institutional knowledge.
DIFFICULT	
Establish performance measures/measure outcomes	Agencies should establish performance measures, set targets for measures, and then report on the progress toward meeting the targets. The rule is that measures of outcomes are preferred to measures of outputs. Outcome measures are often more difficult to measure.
Link performance to strategic planning	Performance management is closely linked with strategic planning and reporting, where strategic planning involves identifying what an agency hopes to achieve. Strategic planning is based on developing an agency vision or mission, identifying supporting goals and objectives, and developing initiatives and implementation strategies to achieve these objectives.
Incorporate life-cycle cost analysis	The optimal point to rehabilitate or replace an asset is when the life-cycle cost is lowest. Some agencies moved away from the worst-first investment strategy to life-cycle cost analysis to select projects.
Integrate GIS	A GIS-based map can display asset locations, condition and maintenance history, and photographs.

IMPLEMENTATION EASE

Figure 9 depicts the relative ease of implementation for each best practice identified for state DOT TAM efforts; difficulty or ease are relative concepts and will vary agency to agency and state to state.
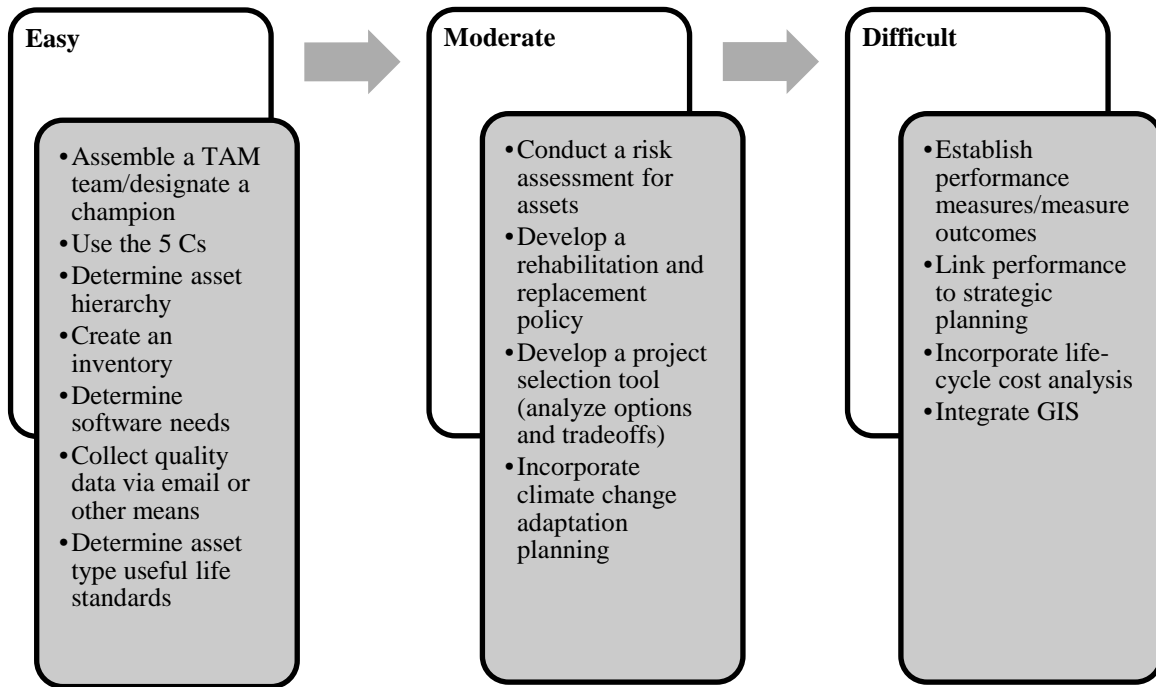
Easy		Moderate		Difficult
• Assemble a TAM team/designate a champion • Use the 5 Cs • Determine asset hierarchy • Create an inventory • Determine software needs • Collect quality data via email or other means • Determine asset type useful life standards	→	• Conduct a risk assessment for assets • Develop a rehabilitation and replacement policy • Develop a project selection tool (analyze options and tradeoffs) • Incorporate climate change adaptation planning	→	• Establish performance measures/measure outcomes • Link performance to strategic planning • Incorporate life-cycle cost analysis • Integrate GIS

Figure 9. TAM Best Practices, Ranked by Implementation Ease.

GUIDE TO RESOURCE APPENDICES

Three appendices are referenced in the body of the digest and are provided as resources.

APPENDIX A: ANNOTATED BIBLIOGRAPHY

Appendix A contains an annotated bibliography of documents and guidance relevant to TAM. Researchers searched and identified at least 32 relevant sources; each source is listed by author, date, and name and has an accompanying description of how it relates to TAM.

APPENDIX B: SURVEY RESULTS

Appendix B contains the full responses of the web-based survey. As previously stated, researchers used the survey to solicit input from all 50 state DOTs regarding their state- and federally funded transit asset condition-monitoring practices. Researchers designed the survey based on a review of publicly available information about state DOT TAM practices. Twenty-two of 50 state DOTs, or 44 percent, participated in the survey.

APPENDIX C: BEST PRACTICE MATRIX

Appendix C contains a matrix to summarize TAM best practices. Best practices include information from literature and from survey respondents. The matrix cites the source of each best practice idea.

AUTHOR ACKNOWLEDGMENTS

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Appendix A

Annotated Bibliography
for State DOT Transit Asset Management

Anderson, M. A., and Davenport, N. S. (2005). *A Rural Transit Asset Management System.*
Huntsville, AL: University Transportation Center for Alabama.
The project developed a geographic information system (GIS)–based asset management system for 26
rural agencies in Alabama. The system, which can predict the replacement needs of vehicles over a five-
year cycle, combines a traditional database, mathematical and statistical analysis, and SQL programming.
Access and GIS are the applications used to maintain and update the database. Either the linear regression
analysis or the discriminant analysis is conducted to predict future values based on vehicle and
socioeconomic characteristics. In addition, a prediction model is applied to estimate future vehicle
procurement needs and funding allocations.

**Anderson, M. D., Doshier, C. N., Moody, J. D., and Sandlin, A. (n.d.). "Development of a Decision
Support Tool to Better Manage Alabama's Rural Public Transit Vehicle."** *Mid-Continent
Transportation Symposium Proceedings.*
This paper summarizes the method developed by researchers at the University of Alabama in Huntsville
to manage Alabama's rural transit fleet. They first conducted a visual inspection of all state-owned
vehicles, including an examination of the provider's record (vehicle identification numbers, mileage, etc.)
and an assessment of the vehicle's overall condition (appearance, passenger comfort level, maintenance
needs, etc.). Then, a vehicle inventory database was developed based on the data collected to track all
rural public transit vehicles. This database is accessed by all rural agencies in Alabama and serves as an
important decision support tool.

**Berrang, A. S. (2012). "Benefits of Long-Range Capital Planning." Transportation Research Board
9th National Conference. Washington, DC: Transportation Research Board.**
New York Metropolitan Transportation Authority's asset management process includes four steps: (1)
asset inventory and condition assessment update: asset conditions are rated from 1-Modernized to 4-
Deteriorated (the 4s have the priority to get capital investment); (2) long-term priorities and impacts in
five-year increments: identify investment options, costs, and time periods in a five-year capital plan; (3)
integration of a transit asset management (TAM) model: test alternative funding scenarios on future asset
conditions; and (4) regional strategic review.

Robert, W., Gurenich, D., and Hoffman, J. (n.d.). *Asset Management Decision Support System Model
Technical Report.* **Cambridge Systematics, Inc. Washington, DC.**
The research team assisted the New Jersey Department of Transportation (NJDOT) in developing an asset
management decision support model. They reviewed current practices and developed a model, which
aims to use available data to prioritize identified problems and support integrated high-level resource
allocation decisions. The team plans to use actual project data to calibrate the accuracy of this model in
the next step.

**Chang, J., and Collura, J. (1998). "Integrating Public Transportation Facilities and Equipment
Management System into Capital Improvement Planning Process."** *Journal of Transportation
Research Record 01/1998,* **Paper No. 98-1462, pp. 96–102.**
Researchers at Purdue University and the University of Massachusetts at Amherst developed several
models with data from the Federal Transit Administration's National Transit Database (NTD). They
applied quantifiable and objective measures such as age and mileage to estimate the future condition of a

vehicle, and identified opportunities for performance-based incentives among the regional transit authorities and the state transportation agency in Massachusetts.

Christie, C., and Guadagno, K. (2012). *FY2013–2022 Statewide Capital Investment Strategy*. **New Jersey Department of Transportation, New Jersey Turnpike Authority, South Jersey Transportation Authority and N-Transit.**
The core part of asset management is life-cycle management, which reaches or maintains targeted performance levels while minimizing long-term costs. The life-cycle management plan lists available funding resources and then allocates them based on functional classification to preventative maintenance activities, repair and rehabilitation, and replacement.

Davenport, N. S., Anderson, M. D., and Farrington, P. A. (n.d.) "Development and Application of a Vehicle Procurement Model for Rural Fleet Asset Management." *Journal of Transportation Research Record 1927*, **pp. 123–127.**
This paper details the data and procedures used in a prediction model and a multiple linear regression model by the Alabama Department of Transportation for vehicles under the Section 5311 federal grant program. The prediction model focuses on the existing statewide fleet operation based on the collected socioeconomic data and vehicle usage data. The multiple linear regression model predicts the overall vehicle condition in the following five-year period, which serves as a useful decision-making tool for predicting future funding and budget.

Department of Rail and Public Transportation (2009). *The Incorporation of Certain Management Principles into Public Transportation Programs.* **Virginia.**
There are two steps of evaluation: (1) examine the miles of revenue service that will be operated based on proposed budget and then decide if the transit system needs maintenance; and (2) estimate operating revenues of the upcoming year. If the sum of anticipated operating revenues and local subsidy for the upcoming grant year is greater than the same calculation for the current year, the maintenance of the effort requirement will have been met.

Gallucci, G., Goodworth, J., and Allen, J. G. (2012). "Asset Condition Assessment at Chicago's Regional Transportation Authority." **Transportation Research Board 91st Annual Meeting, Washington, DC: Transportation Research Board.**
Regional Transportation Authority produced an inventory of regional capital asset in 2009, including five categories: (1) track and structures; (2) electrical and subway equipment; (3) signals, communications, and fare collection; (4) stations, garages, and facilities; and (5) rolling stock. The asset condition is estimated by the age of the assets and then rated into five categories: 5-excellent condition, 4-good, 3-fair, 2-poor, and 1-beyond useful service life. Assets in the latter categories have priority on getting the system's capital investment.

Karlaftis, M. G., Lynch, J. P., Sinha, K. C., and Fricker, J. D. (1997). "Indiana Public Transportation Management System." *Journal of Transportation Research Report 1604*, **Paper No. 971230, pp. 92–101.**
This paper described the framework and methodology used by the Indiana Public Transportation Equipment and Facilities Management System (IPTMS) in the process of transit management. Four parts are included in this process: (1) the establishment of a profile to record asset condition and decay, (2) the identification of the threshold for performance indicator values, (3) the development of a quantitative model to simulate the needs of future transit, and (4) the establishment of overall guidelines to update and monitor the management system.

Khasnabis, S., Bartus, J., and Ellis, R.D. (n.d.). "Asset Management Strategy to Meet Long-Term Transit Fleet Needs of State Departments of Transportation." *Journal of Transportation Research Record 1887*, **pp. 45–54.**
This paper presented an asset management strategy for state departments of transportation to optimally allocate limited capital grants for purchasing new buses and maintaining existing buses. Two models are introduced in this paper. One aims to maximize the weighted fleet life of buses that are being purchased and rebuilt. Another tries to maximize the entire fleet in a peer group. The output of the former model serves as a direct input of the latter one.

Khasnabis, S., Bartus, J., and Ellis, R. D. (2003). "Asset Management Framework for State Departments of Transportation to Meet Transit Fleet Requirements." *Journal of Transportation Research Record 1835*, **Paper No. 03-2706, pp.74–84.**
Two optimization models were introduced in this paper to assist state departments of transportation to allocate capital funding effectively and equitably. Model 1 is designed to maximize the life of the existing buses, while Model 2 is designed to maximize the remaining life of the entire peer group. In addition, several case studies were conducted to measure the ability of the two models as well.

Ludwig, A. (1997). "Systems Planning for Capital Asset Management—Case Study of New Jersey Public Transportation Facilities and Equipment Management System." *Journal of Transportation Research Report 1604*, **Paper No. 970451, pp. 109–119.**
This paper reviewed and analyzed current implementation of the Public Transportation Facilities and Equipment Management System (PTMS) developed for New Jersey Transit, and then documented the effort made by a team from the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) to improve this capital programming tool.

Massachusetts Department of Transportation Rail and Transit Division (n.d.). *Initiative 6 Improve Capital Planning—Best Practices and Potential MA Improvements, Beyond Boston: A Transit Study for the Commonwealth*. **Boston, MA.**
The document describes the Regional Transit Authority Capital Assistance Program implemented by the Massachusetts Department of Transportation, and elaborates on the interim allocation model and steps and the process of selecting transportation project. In addition, this chapter reviews nine other states' practices in capital investment programming, and summarizes their key themes.

Massachusetts Department of Transportation Rail and Transit Division (n.d.). *MassDOT Community Transit Grant Program (All Sub-recipients)*. **Boston, MA.**
This document is a summary of checklists used by the Community Transit Program (CTP) to ensure that recipients comply with all federal and state requirements related to the receipt of public transportation grants.

McCollom, B., and Berrang, S. (2011). *Transit Asset Condition Reporting: A Synthesis of Transit Practice* **(TCRP Synthesis 92). Washington, DC: Federal Transit Administration.**
Since most large transit agencies are unable to estimate the consequences of no asset management, and are also unable to evaluate alternative funding scenarios, a survey was conducted to research the effort of the 50 largest transit agencies on transit asset management. The researchers found that (1) the main data sources of transit agencies are different; (2) the ways of data storage also vary; (3) the interval of capital needs forecasts is usually one year for most transit agencies; (4) age and inspection results are two major measures to determine asset condition; and (5) it is a widely used way to change capital funding priorities to improve the state of good repair.

Midwest Transportation Consortium (2003). *GIS-Based Integrated Rural and Small Urban Transit Asset Management System.* **Ames, IA: Kurt, C. E., Weaver, P., and Kroeger, D. A.**

This paper developed a vehicle deterioration model to predict the future condition of vehicles owned by the state departments of transportation and local agencies, as well as a life-cycle cost analysis methodology to incorporate cost-condition relationship into the decision-making process. Before then, vehicle information was documented to support the running of models according to selected factors, such as a vehicle's age, mileage, vehicle type, and road type.

National Cooperative Highway Research Program (2006). *Performance Measures and Targets for Transportation Asset* **(NCHRP Report 551). Washington, DC: Transportation Research Board.**
This report details performance measures used for asset management, describes how performance measures can be used to support decision making, and presents a framework for performance measure development.

Oregon Department of Transportation (n.d.). *Management of Grant-Funded Capital Assets.*
According to the size of the agency, this document described requirements for each agency in Oregon about asset management in detail and elaborates components of an asset management plan and standards for vehicle/equipment/facility management (replacement, inventory, safety, etc.).

Tomeh, O., Brady, S., and Skorupski, D. (2001). "National Bus and Facilities Condition Assessment." *Journal of Transportation Research Record 1760***, Paper No.01-2050, pp. 56–68.**
This paper reviewed the current physical condition of vehicles and facilities at a representative sample of transit operators in the United States. The researchers found that the condition estimates were considerably lower than FTA's most recent estimate. An improved statistical model of bus and facility was developed to improve the accuracy of the existing model and the understanding of asset decay.

Transit Cooperative Research Program (2002). *e-Transit: Electronic Business Strategies for Public Transportation Volume 1—Supply Chain: Parts and Inventory Management* **(TCRP Report 84). Washington DC: Transportation Research Board.**
The report addresses the issues of advanced communication technology in the transit industry, reviews current transit industry e-markets, and discusses sellers' role in e-procurement activities and strategies for inventory management. Researchers concluded that actual performance improvements still depended on management personnel, and they made several recommendations for better asset-management decisions.

Transit Cooperative Research Program (2012). *State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Capital Assets and Evaluating the Implications for Transit* **(TCRP Report 157). Washington DC: Transportation Research Board.**
This report describes the results of a Transit Cooperative Research Program (TCRP) project related to achieving a state of good repair for transit assets, focused specifically on approaches for evaluating and prioritizing rehabilitation and replacement investments in existing capital assets. It also presents a framework for transit agencies to use for prioritizing capital asset rehabilitation and replacement decisions.

U.S. Department of Transportation (2007). *Asset Management Overview* **(FHWA-IF-08-008). Washington, DC: Federal Highway Administration, Office of Asset Management.**
The experience of state departments of transportation with TAM in Florida, Maryland, Michigan, and Pennsylvania are described:
Florida
There is no asset management department in Florida. Several departmental agencies—planning, financial, maintenance, and pavement—as well as metropolitan planning organizations participate in the asset management process. A five-year Work Program, which is based on the 10-year Program and Resource Plan and the 20-year Transportation Plan, is responsible for collecting data from each district to develop a list of projects and funding estimates. Florida gives the priority of maintenance to highways The highway

condition is rated with measurements—roadway (pot holes, etc.), roadside (shoulders), vegetation and aesthetics, traffic services (signs and lighting), and drainage (ditches). After highways, pavement and bridges are also on the list of preservation and inspected by the Pavement Management System and Bridge Management System every two years. Following these two is the Florida Strategic Intermodal System, which evaluates the needs for improvement in pavement condition, congestion, safety, intermodal connectivity, and economic development.

Maryland

The Maryland State Highway Administration (SHA) uses five steps to manage its pavements: condition assessment, network-level planning, project selection, projection advertisement, and construction. The SHA pavement division rates the condition of its highway every year from very good to poor and then uses a linear programming model to identify how many lane-miles should be treated and how. Data necessary in this model include pavement type, traffic level, road type, district, last major treatment level, and condition. After modeling, SHA's and each district's specialists develop an inventory of potential projects by applying a tool called the Project Selection Tool (PST). The final projects are decided with the consideration of the district's goals and budget constraints.

Michigan

Michigan's asset management is mandated by law. The Transportation Asset Management Council (TAMC) is mandated to produce an annual budget and suggestions for the State Transportation Commission. The state's transportation management system incorporates three major performance measurements—bridge condition, pavement condition, and customer satisfaction. Bridge condition is evaluated every two years through the bridge inspection process and the national bridge inventory; pavement condition is measured by ride smoothness, cracking, and rutting; and customer satisfaction is addressed through a satisfaction survey of Michigan DOT.

Pennsylvania

the Pennsylvania Department of Transportation (PennDOT) uses its new Pontis-based BMS2 on its Bridge Management System, while replacing its old maintenance system with SAP/Plant Maintenance. In the meantime, PennDOT collaborates with other states in using AASHTO's Asset/Manager NT and PT tools.

U.S. Department of Transportation, Federal Highway Administration, and Federal Transit Administration (2010). *2010 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance*. **Washington, DC.**
This report reviews current practices on the operation and financing mechanism for the nation's highway and transit systems, projects the potential impacts of different capital investment scenarios based on legislation and budget issues, discusses variables that could affect travel growth, and tries to explore a way to achieve the goal of sustainable development.

U.S. Department of Transportation, Federal Transit Administration (n.d.). *State of Good Repair—Bus and Bus Facilities Project Descriptions*. **Washington, DC.**
This document describes projects in the United States that focus on maintaining bus and bus facilities by state. The following information is included: (1) agency, (2) name of the project, (3) grant amount, and (4) brief introduction of the project.

U.S. Department of Transportation, Federal Transit Administration (2007). *Asset Management Overview*. **Washington, DC.**
This document answers questions of "what is transportation asset management" and "why use transportation asset management," and states challenges to implementation and current strategies and practices in implementing asset management.

U.S. Department of Transportation, Federal Transit Administration. (2008). *Transit State of Good Repair Beginning the Dialogue*. **Washington, DC.**

This report summarizes the result of a workshop that was held in October 2008 between representatives from 14 public transportation providers and state departments of transportation. It documents their discussion about transit recapitalization and maintenance issues, asset management practices, innovative financing strategies, and potential research and software needs.

U.S. Department of Transportation, Federal Transit Administration (2010). *National State of Good Repair Assessment.* **Washington, DC.**
This National State of Good Repair is based on the 2009 Rail Modernization Study, but expands the scope of study to all U.S. transit assets, including three modes (rail, bus, and joint assets), both urban and rural operators, and several types of assets (guideways, facilities, systems, stations, vehicles, etc.). The author states that several agencies are developing their capital planning inventories, even though none of the sample agencies actually has one. The author mentions that three main data sources of asset management are the fixed asset ledgers, the prior engineering condition assessments, and the Computerized Maintenance Management System (CMMS). In addition, the author says that agencies generally lack decision support tools and an objective, multi-factor project scoring system.

U.S. Department of Transportation, Federal Transit Administration (2010). *Transit Asset Management Practices: A National and International Review.*
The objective of this report is to build on efforts to date to create a resource of information about existing practices in transit asset management. The report details the published literature in this area and includes additional information on existing practices in 11 organizations prepared through a set of case studies.

Washington State Department of Transportation, Public Transportation and Rail Division (2005). *Guide to Preparing Your Transit Asset Management Plan.* **Washington, DC.**
This guide describes the current practice of transit asset management in the State of Washington. It elaborates on (1) the requirements and origins of legislation on statewide transit assets, (2) the lowest life-cycle cost methodology developed by the expert panel, and (3) the statement, the strategies, and the inventory that should be included in the transit asset management plan.

Yoder, S. L., and Delaurentiis, J. (2003). "The Framework for a Regional Transit Asset Management System." *ITE Journal***, pp. 42–48.**
This paper described the transit management system designed by the Chicago Regional Transportation Authority. The system goals, project planning process, and five major components of business function were analyzed in detail. In the meantime, the software selection framework, as well as pilot project demonstration, are displayed at the end of the paper.

Appendix B

State DOT Transit Asset Management Survey Results

The survey began by asking state DOTs to respond to a set of questions to help researchers and peers understand the general nature of asset management at their agency.

Asset Data Collection Methods
The most common method DOTs use to collect transit asset data is e-mail exchange of data – 57 percent. Figure 5 documents methods DOTs use to collect data. Please note that DOTs were allowed to select all methods that applied to their agency. In fact, 10 of the 22 DOTs reported using only one method while the other 12 DOTs used two or more methods.
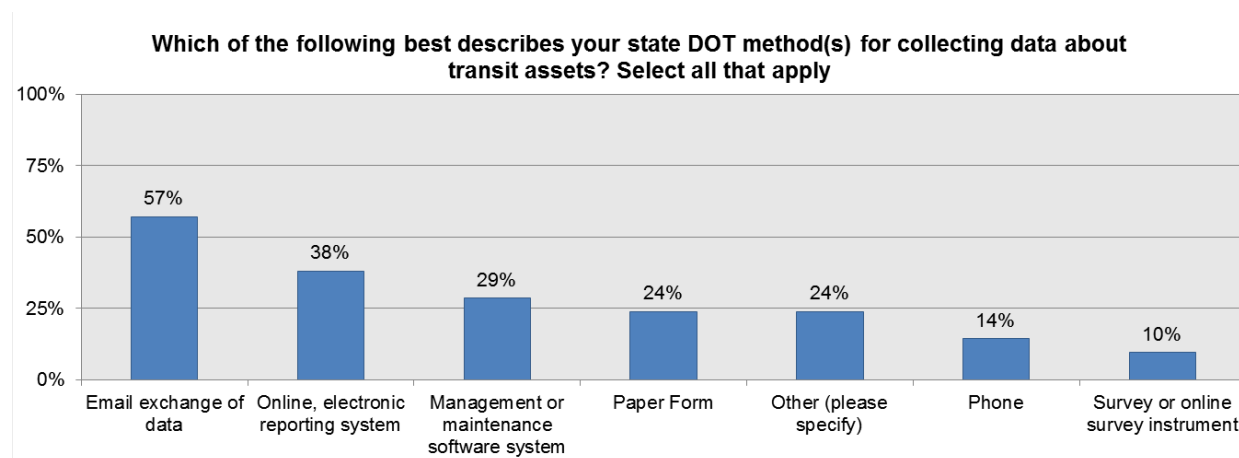
Which of the following best describes your state DOT method(s) for collecting data about transit assets? Select all that apply

Method	Percentage
Email exchange of data	57%
Online, electronic reporting system	38%
Management or maintenance software system	29%
Paper Form	24%
Other (please specify)	24%
Phone	14%
Survey or online survey instrument	10%

Figure 1. Method of Collecting Asset Data

Five agencies marked "other" and shared the following responses in the space for notes:
- Purchasing web-based grants management system (2 responses),
- Excel worksheet (2 responses), and
- Annual audits (1 response).

Description of Current Practice
Researchers asked DOTs to select which of several statements best describes their collection and use of asset data. Responses were split between each category, but the largest single group with 38 percent of the response acknowledged their DOT "collects some transit asset data but lacks a formal process or plan to use the data." However, 5 percent (one DOT in this case) has an advanced data collection process and strategic goals linked to the budget process.

Which of the following statements best describes your state DOT's current practices regarding transit asset management statewide? Select one
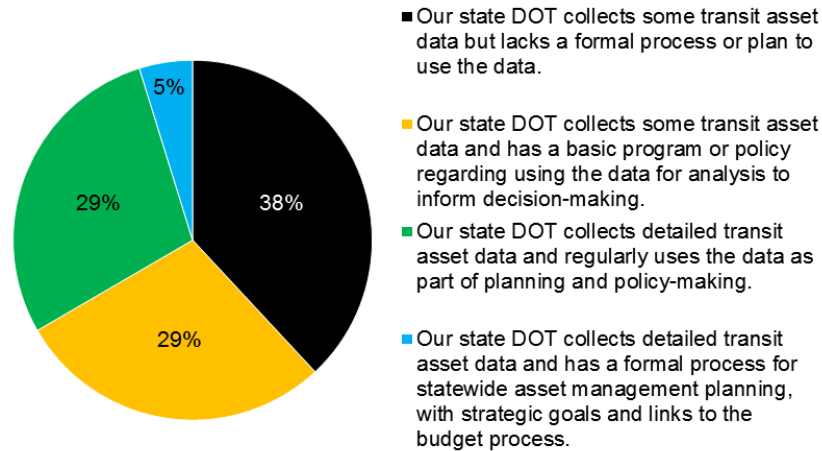

- Our state DOT collects some transit asset data but lacks a formal process or plan to use the data.
- Our state DOT collects some transit asset data and has a basic program or policy regarding using the data for analysis to inform decision-making.
- Our state DOT collects detailed transit asset data and regularly uses the data as part of planning and policy-making.
- Our state DOT collects detailed transit asset data and has a formal process for statewide asset management planning, with strategic goals and links to the budget process.

Figure 2. Summary of How DOTs Use Asset Data

The next question in the survey asked DOTs to "**please briefly describe your state DOT's current practices regarding transit asset management on a statewide basis.**" Twenty of the 22 DOTs provided a response; comments are summarized in the list below:

- We collect capital plans from transit providers to assist in planning for capital replacements and to best address transit asset management.
- We are evolving to a point in which we will be able to analyze transit asset data to assist with decision-making. Methods of collecting data include access to DMV vehicle records for verification and problem-solving.
- Section 5311 agencies report vehicle use data on a monthly basis.
- Section 5310 agencies report vehicle use data on a quarterly basis.
- Vehicle data are entered into an Excel spreadsheet as vehicles are ordered. The data are then transferred into an Access database for storage, queries, and reports.
- We maintain a statewide inventory of all public transit vehicles and capital items with a value of greater than $5k. We use the information primarily to project vehicle capital needs for future budget years.
- The information is utilized to generate an annual POP.
- We maintain a spreadsheet with transit assets and modify the spreadsheet as we distribute capital. We are moving toward a log-in based online reporting system.
- We will be collecting our CY 2013 data for Vehicles (Revenue and Non-Revenue), Facilities, PNR, Equipment Costs of $100,000 for Urban Transit Systems and $1,000 for Transit Systems, and Rail.
- We developed statewide tracking software with the help of a contractor. Presently our agencies are entering that information in the system.
- We have maintenance policies for all transit systems. We spot-check annually to make sure they are following their policies. We also ask for their 10-year capital plan annually as part of their 5311 grant application. They also must complete a fleet inventory annually that gives us SOME current condition measures. For our 5310 programs, we currently monitor (minor inspection) the vehicles annually.
- As of November 2012 we created an Office of Performance Management to organize policies developed and data collected over the years that we have operated.

- We collect some electronic data quarterly and some paper forms annually.
- Annually develop a program of projects for capital purchases detailing rolling stock purchases by county. We capture NTD information that details vehicle incidents in area of fatality, accident reports, and maintenance facility information. We receive monthly detailed documentation for any repairs to rolling stock, and track fuel and mileage data. We maintain scheduled replacement information and track surplus of rolling stock access.
- Rural (FTA 5311) Systems update inventories as changes occur via e-mail. Urban systems are required to submit an annual report detailing their fleet.
- Collect data from recipients through e-mails, phone, and on-site visits. The data is tracked on using an Excel database.
- We currently do not have an updated, comprehensive list of federally funded assets. Very basic information (miles traveled, vehicle revenue service hours, # of passenger boardings) is collected on an annual basis.
- Our DOT uses a Public Transit Management System (PTMS) to rank vehicles statewide by age and miles. Each vehicle is given a point for each month of service and 1 point for each 3,500 miles that it runs. After it reaches its useful life, as defined by this program, it begins receiving positive PTMS points. Vehicles programmed in the STIP are ranked by PTMS points, and those vehicles eligible for replacement are funded in rank order.
- We collect the required inventory information from the sub-recipients. Then, we develop a replacement schedule for vehicles.
- Our Division currently maintains a web-based trip statistics and expense tracking program that sub-recipients are required to use to report ridership data and operating expenses. The ridership side of the program requires sub-recipients to input all data pertaining to vehicles used in providing transportation services in their specific service areas. We export data into an Excel spreadsheet and customize analysis reports as needed, either by our division or by the sub-recipient.
- None, in development.
- We will be glad to provide a generic cover letter and our guidance package on how and what we collect.

Currency of Asset Data

Figure 7 summarizes how current state DOTs' transit asset data is based on whether it is within a month (19 percent), within a year (67 percent), within 3 years (9 percent), or unknown (5 percent or 1 DOT).
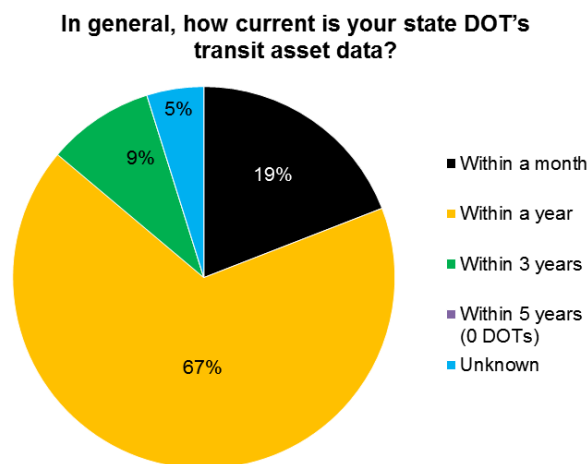

In general, how current is your state DOT's transit asset data?

- Within a month (19%)
- Within a year (67%)
- Within 3 years (9%)
- Within 5 years (0 DOTs)
- Unknown (5%)

Figure 3. Currency of Asset Data at State DOTs

Data Collection by Type of Transit Agency

Most DOTs collect asset data from rural Section 5311 agencies and specialized agencies (95 and 81 percent, respectively, see Figure 8). While only 24 percent of DOTs collect data from metropolitan transit authorities, 71 percent of DOTs collect data from urban agencies receiving Section 5307 funds.
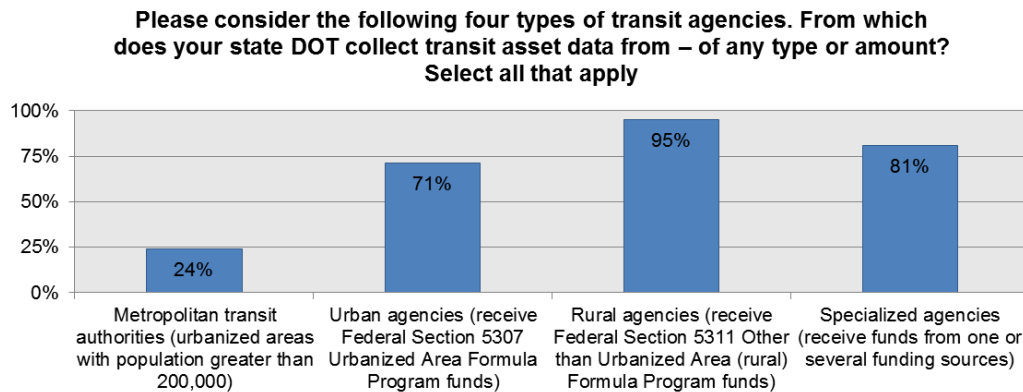
Please consider the following four types of transit agencies. From which does your state DOT collect transit asset data from – of any type or amount? Select all that apply

Figure 4. Asset Data Collection by State DOTs by Type of Transit Agency

Researchers followed up by asking each DOT if they collect similar data from each type of agency or not (see Figure 9). The response varies, but overall 62 percent of DOTs do collect similar data points from all or most agencies.
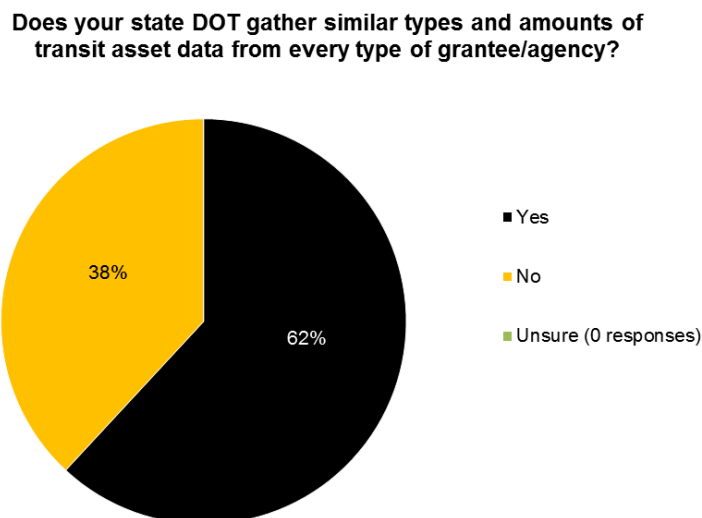
Does your state DOT gather similar types and amounts of transit asset data from every type of grantee/agency?

Figure 5. Similarity of Data Collected between Types of Transit Agencies

Comments related to the similarity of data collection between types of agencies:
- Our DOT only receives ridership and mileage data from urbanized (5307) and specialized (5310) agencies.
- Data is received through regular reporting.
- Tracking of FTA-funded assets for 5311 and 5310 only.
- The urban systems do not report to our DOT. They receive their funding directly from FTA.
- We actually go out and physically inspect (lights, mileage, condition of vehicle, fire extinguisher, etc.) our 5310 vehicles. We depend upon our 5311 recipients to provide us with mileage annually

and maintenance and repair information monthly. We are working to develop asset management plans for the 5311 and 5307 systems as well as a statewide plan for us to base funding decisions.
- We don't gather the same data for 5307s.
- Urban systems report basic information such as make, year, and seating capacity of their vehicles, whereas rural systems also report full VIN numbers.
- We only collect data for the 5310, 5311, 5316, and 5317 agencies.
- Data collection is uniform for all public transit agencies; less information is collected for Section 5310 operators.

Figure 10 documents DOT responses when asked if in their professional opinion the actual quality of the data for agencies was indeed comparable. This is an important question because it is important to have relatively clean, comparable data for assets if developing a statewide asset management plan (for example). A majority, 67 percent, of DOTs felt that "yes" their data is adequately comparable between peer agencies in their state.

Is the data that your state DOT has for each grantee/agency of comparable breadth and quality? (i.e., mark "no" if data availability or reporting quality varies widely between grantees/agencies in your state)

- Yes
- No (please explain)
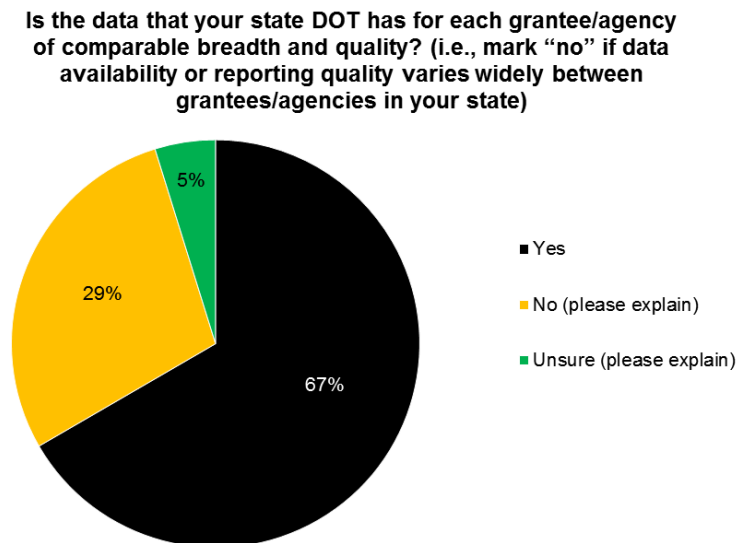- Unsure (please explain)

5%
29%
67%

Figure 6. Breadth and Quality of Data Collected by DOTs about Transit Agencies

Comments related to breadth and quality of data collection between agencies:
- We collect the same information from all the grantees/agencies for our urban and rural systems. As for our 5310 specialized agencies, we only collect vehicle information.
- All assets purchased with FTA funds for our providers are essentially the same (vehicles, camera systems, generators, etc.).
- There may be some variations in the submitted data depending on the size, technical ability, and resources of the county programs.
- We are still working to get everyone on the same page for condition ratings...for example, some people will put that an older vehicle is in poor condition, when in fact it is in fair or good condition when someone else inspects it.
- Each agency provides "some" information, however with less staff to oversee the process and do the QC our quality has slipped. We are still making the same policy decisions and paying out the state 10 percent match to federal programs but it has become harder to manage.

Summary of Practices and Availability of Transit Asset Data

The purpose of this section is to summarize the plethora of data researchers collected from DOTs concerning the types of transit asset data regularly collected, currency of data, and difficulty to start data collection, if necessary. The detailed results for each type of the following types of transit assets are in the following sections of this memorandum:

- Revenue vehicle fleet
- Non-revenue vehicle fleet
- Passenger facilities
- Administrative facilities
- Vehicle/maintenance repair facilities
- Vehicle storage/garage facilities

- Revenue vehicle equipment
- Communications equipment
- Office equipment/software
- Security/surveillance equipment
- Maintenance shop equipment

Figure 11 documents the portion of DOTs presently collecting, at any frequency, transit asset data by type. All but one DOT reported collecting data for the state's revenue vehicle fleet – 95 percent. The next most common data available include information about maintenance facilities (79 percent), administrative facilities (74 percent), and vehicle storage facilities (68 percent). Most state DOTs collect information about revenue vehicles, major capital facilities, and expensive pieces of equipment as some information is required as part of how those assets are procured using local, state, and federal funds.
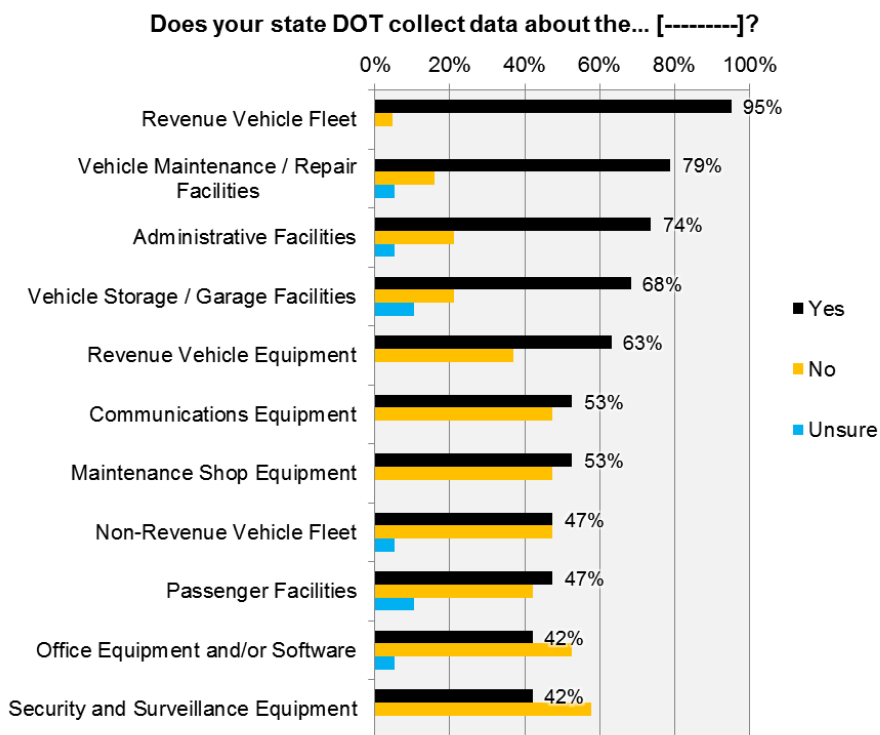
Does your state DOT collect data about the... [---------]?

Figure 7. Summary of DOT Asset Data Collection by Type

Figure 12 arranges the types of assets in the same order as in Figure 11; meaning that assets near the top are commonly collected by DOTs, and assets at the bottom are least commonly collected by DOTs. Figure 12 documents how current the data held by DOTs is for each type of asset. While some DOTs gather data quarterly (for some assets) and some gather at other intervals (i.e., monthly), a majority of DOTs gather data about assets on an annual basis.
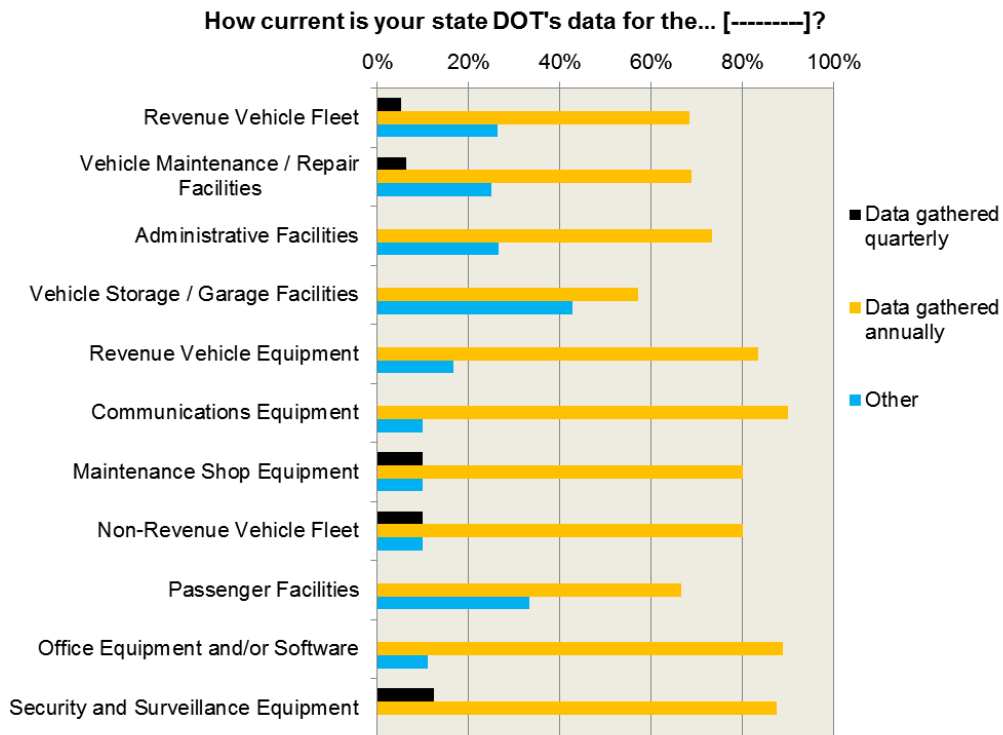
How current is your state DOT's data for the... [---------]?

Figure 8. Summary of DOT Asset Data Currency by Type
(Arranged in same order as in Figure 11)

Researchers sorted DOT survey responses using survey logic: DOTs that marked they do not presently collect data about a type of asset were asked a question about how difficult they thought it may be to begin collecting data about said asset. Figure 13 documents DOT responses about the difficulty of beginning to collect the various types of transit asset data. More than 65% of DOTs responded that collecting revenue vehicle data would be easy. DOT staff opinions about collecting other types of data vary widely from agency to agency.
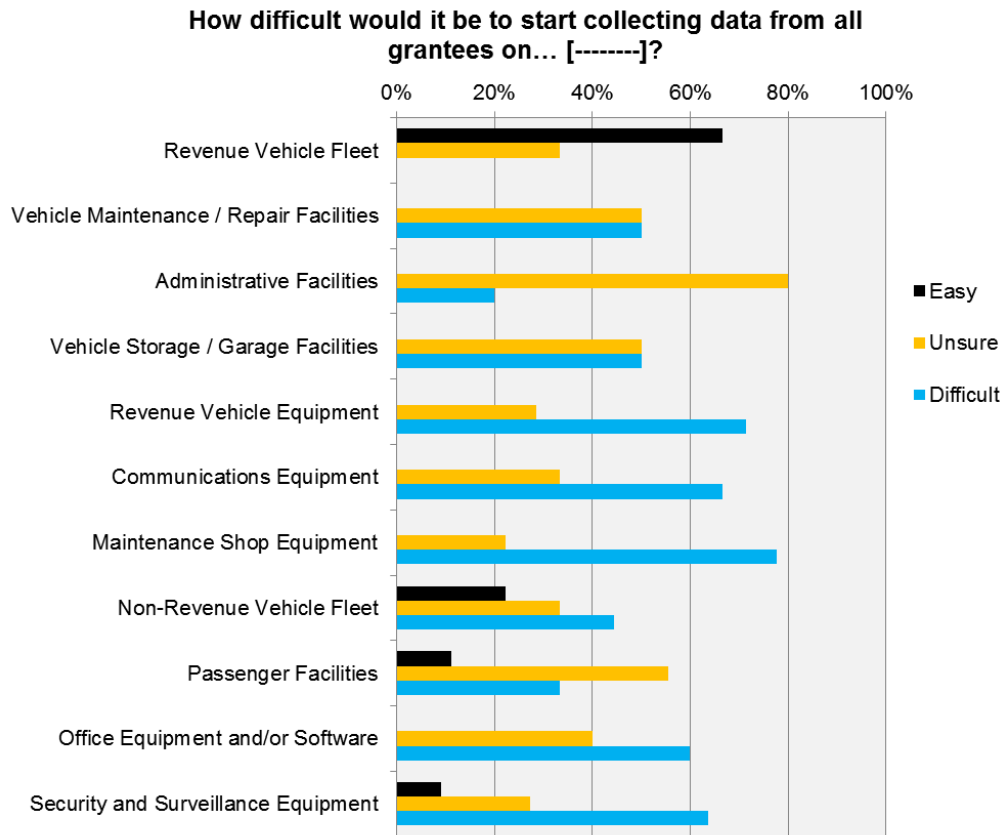
Figure 9. Summary of DOT Opinion about Challenge to Collect More Asset Data by Type
(Arranged in same order as in Figure 11)

Practices and Available Data

This section contains the full response information for each question about DOT asset data collection and challenges for the following types of assets:

- Revenue vehicle fleet
- Non-revenue vehicle fleet
- Passenger facilities
- Administrative facilities
- Vehicle/maintenance repair facilities
- Vehicle storage/garage facilities

- Revenue vehicle equipment
- Communications equipment
- Office equipment/software
- Security/surveillance equipment
- Maintenance shop equipment

Revenue Vehicle Fleet

Table 1

Does your state DOT collect data about the…Revenue Vehicle Fleet?		
Answer Options	**Response Percent**	**Response Count**
Yes	95.2%	20
No	4.8%	1
Unsure	0.0%	0
	answered question	**21**
	skipped question	**1**
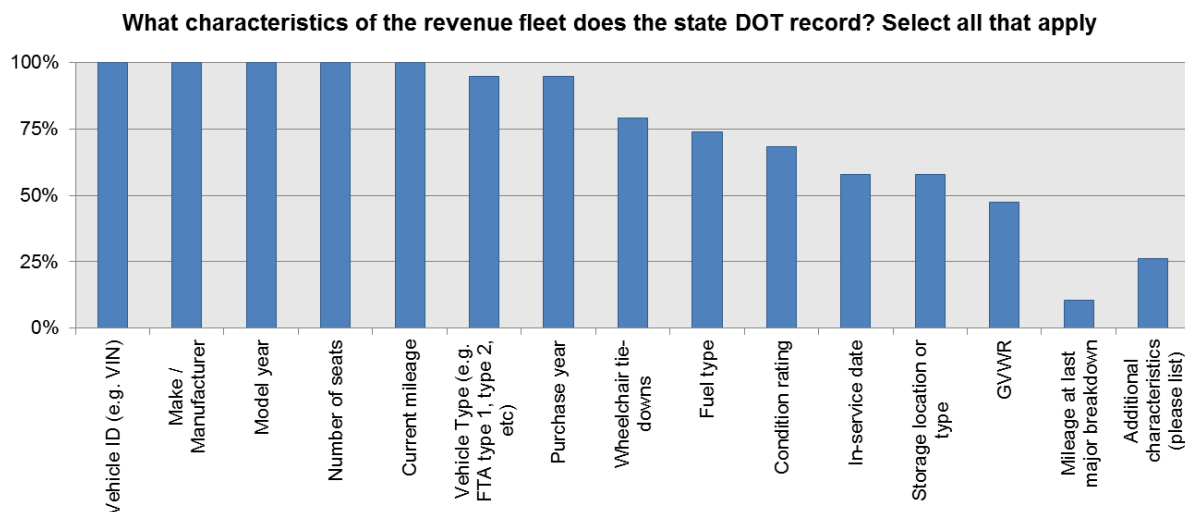
Figure 10 Revenue Fleet Characteristics

Comments related to Figure 14:
- Registration information
- We record the State/FTA grant number that funded the vehicle purchase; we are about to begin collecting in-service date;
- Date of vehicle disposition, ownership of vehicles, and funding source.
  - ADA feature—ramp or lift
  - If the vehicle is owned outright or leased
  - Total purchase price
  - Federal purchase cost
  - License number

- Type and class size
- Fundinggrant and/or contract number
- Year-end odometer readings
- Bike rack; accessibility type and manufacturer; transmission, chassis and AC models and make; date of mileage

Table 2

How current is your state DOT's data for the revenue vehicle fleet?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	5.3%	1
Data gathered annually	68.4%	13
Other	26.3%	5
	answered question	**19**
	skipped question	**3**

Comments relate to Table 2:
- Data gathered BOTH monthly and quarterly
- Gathered monthly
- Every six months
- The majority of the vehicle data are gathered as each vehicle is purchased. Yearly condition and odometer readings are updated.
- Data are gathered monthly.

Table 3

How difficult would it be to start collecting data from all grantees about the revenue vehicle fleet? (such as VIN, make/manufacture, year, fuel type, current mileage, and seats/wheelchair tie-downs)		
Answer Options	**Response Percent**	**Response Count**
Very easy	66.7%	2
Easy	0.0%	0
Unsure	33.3%	1
Difficult	0.0%	0
Very difficult	0.0%	0
	answered question	**3**
	skipped question	**19**

Non-Revenue Vehicle Fleet

Table 4

Does your state DOT collect data about the…Non-Revenue Vehicle Fleet?		
Answer Options	**Response Percent**	**Response Count**
Yes	47.4%	9
No	47.4%	9
Unsure	5.3%	1
	answered question	**19**
	skipped question	**3**

What characteristics of the non-revenue vehicle fleet does the state DOT record? Select all that apply
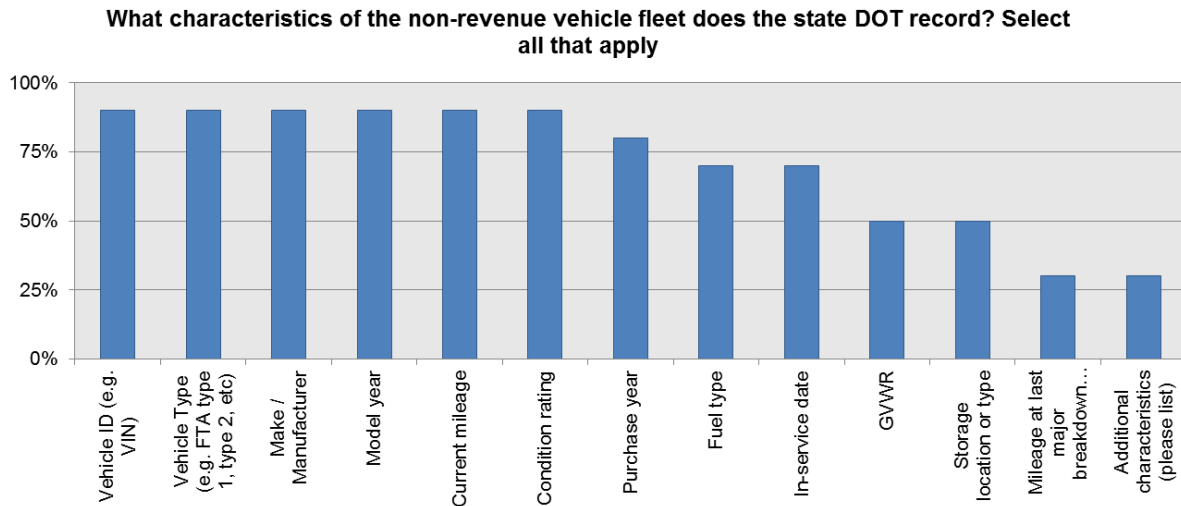

Figure 11. Non-Revenue Vehicle Characteristics

Comments related to Figure 15:
- Registration information
- Date of vehicle disposition, ownership of vehicles, and funding source

Table 5

How current is your state DOT's data for non-revenue vehicle fleet?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	10.0%	1
Data gathered annually	80.0%	8
Other	10.0%	1
answered question		**10**
skipped question		**12**

Table 6

How difficult would it be to start collecting data from all grantees on the non-revenue vehicle fleet? (such as VIN, make/manufacture, year, fuel type, and current mileage)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	22.2%	2
Unsure	33.3%	3
Difficult	11.1%	1
Very difficult	33.3%	3
answered question		**9**
skipped question		**13**

Passenger Facilities

Table 7

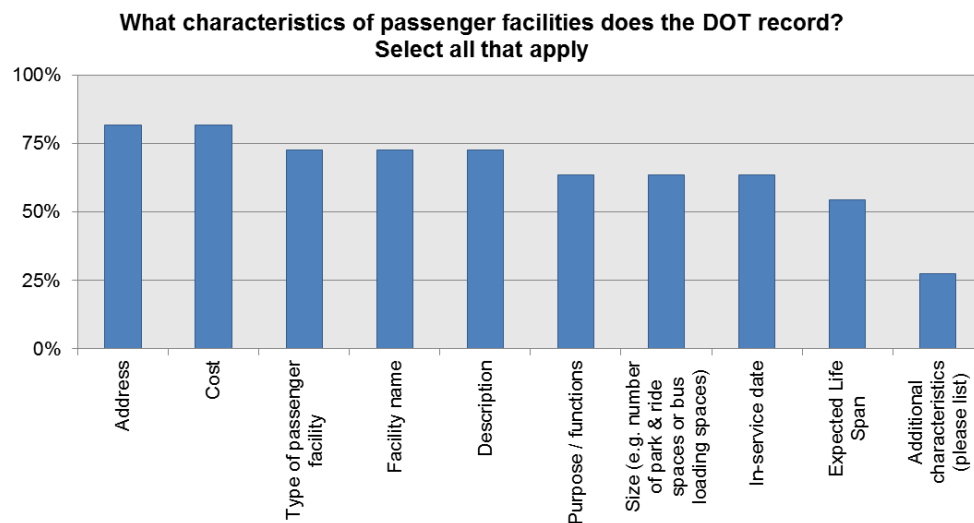| Does your state DOT collect data about…Passenger Facilities? (e.g., bus stops, transit centers, and park and ride lots)		
Answer Options	**Response Percent**	**Response Count**
Yes	47.4%	9
No	42.1%	8
Unsure	10.5%	2
	answered question	**19**
	skipped question	**3**

Figure 12. Passenger Facilities Characteristics

Comments related to Figure 16
- Most of the facility information we currently have is for the main administrative / operations bases; we don't have extensive information on bus shelters, though we will be developing that information in the future.
- ADA accessible, renovation (data and cost), and ownership

Table 8

How current is your state DOT's data for passenger facilities?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	0.0%	0
Data gathered annually	66.7%	8
Other	33.3%	4
	answered question	**12**
	skipped question	**10**

Comments related to Table 8:
- 3 years
- Data is not collected for facilities
- Every Three Years. Starting CY 2013 it will be every year

Table 9

How difficult would it be to start collecting data from all grantees on passenger facilities? (such as name, description, address, size, cost, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	11.1%	1
Unsure	55.6%	5
Difficult	22.2%	2
Very difficult	11.1%	1
	answered question	9
	skipped question	13

Administrative Facilities

Table 10

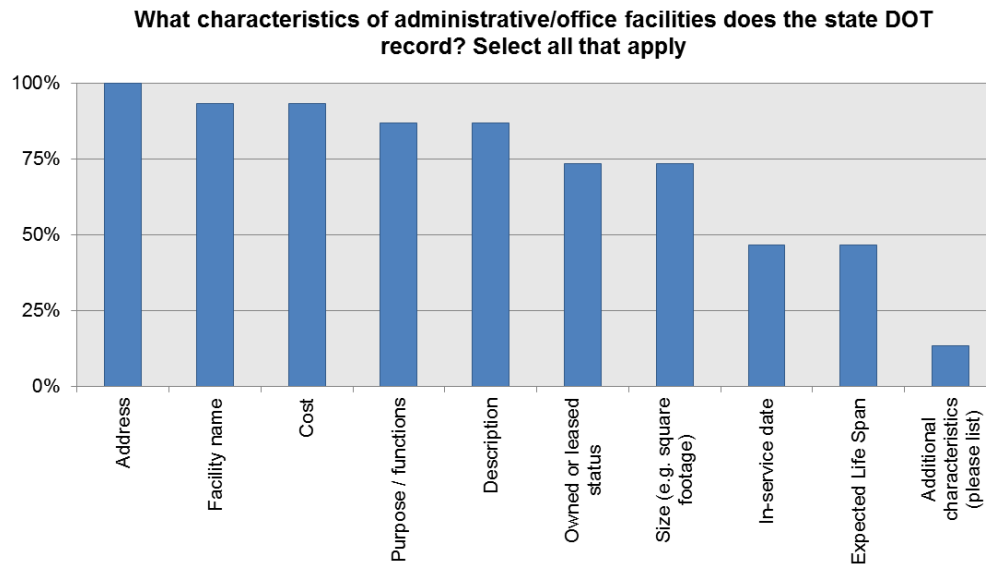| Does your state DOT collect data about…Administrative Facilities?		
Answer Options	**Response Percent**	**Response Count**
Yes	73.7%	14
No	21.1%	4
Unsure	5.3%	1
	answered question	19
	skipped question	3

Figure 13. Administrative Facilities Characteristics

Comments related to Figure 17:
- We generally only have information on facilities that we participated in the funding of, either through state or federal funds
- ADA accessible, renovation (data and cost), and ownership

Table 11

How current is your state DOT's data for administrative facilities?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	0.0%	0
Data gathered annually	73.3%	11
Other	26.7%	4
	answered question	**15**
	skipped question	**7**

Comments related to Table 11:

- 3 years
- Every 3 years; starting CY 2013 will collect annually
- Data on file for facilities constructed or renovated using federal funds
- A few years ago a study was done to gather base data, but has since not been followed up on.

Table 12

How difficult would it be to start collecting data from all grantees on administrative facilities? (such as name, description, address, size, cost, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	0.0%	0
Unsure	80.0%	4
Difficult	0.0%	0
Very difficult	20.0%	1
	answered question	**5**
	skipped question	**17**

Vehicle Maintenance/Repair Facilities

Table 13

Does your state DOT collect data about…Vehicle Maintenance/Repair Facilities?		
Answer Options	**Response Percent**	**Response Count**
Yes	78.9%	15
No	15.8%	3
Unsure	5.3%	1
	answered question	**19**
	skipped question	**3**

**What characteristics of vehicle maintenance facilities does the state DOT record?
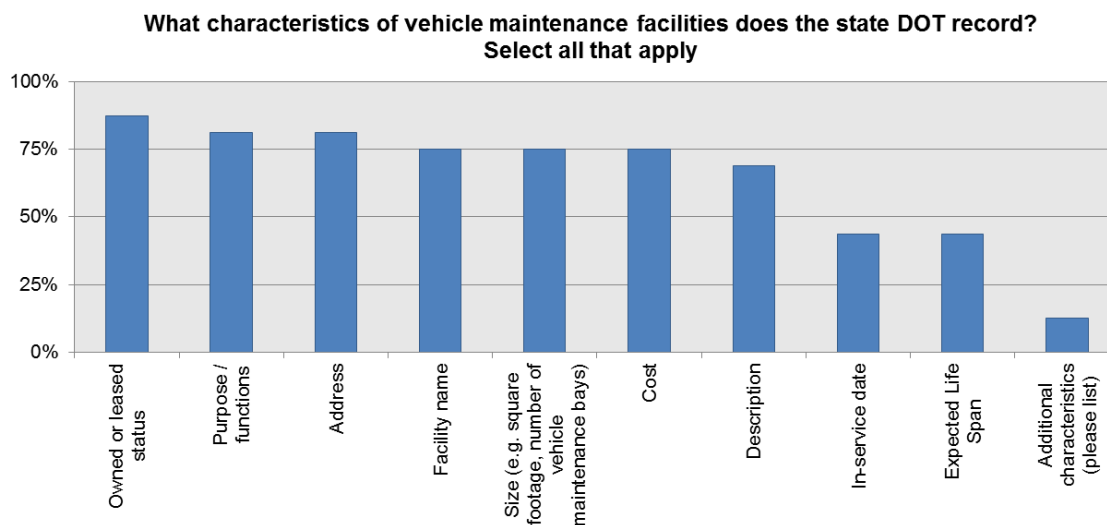Select all that apply**

Figure 14. Vehicle Maintenance Facilities Characteristics

Comments related to Figure 18:

- ADA accessibility, renovation (date and cost), and ownership

Table 14

How current is your state DOT's data for vehicle maintenance facilities?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	6.3%	1
Data gathered annually	68.8%	11
Other	25.0%	4
	answered question	**16**
	skipped question	**6**

Comments related to Table 14:

- 3 years
- Every 3 years; starting CY 2013 will collect annually
- A few years ago a study was done to gather base data; has not been followed up on.
- We only collect data on facilities we have helped fund

Table 15

How difficult would it be to start collecting data from all grantees on vehicle maintenance facilities? (such as name, description, address, size, cost, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	0.0%	0
Unsure	50.0%	2
Difficult	0.0%	0
Very difficult	50.0%	2
	answered question	**4**
	skipped question	**18**

Vehicle Storage/Garage Facilities

Table 16

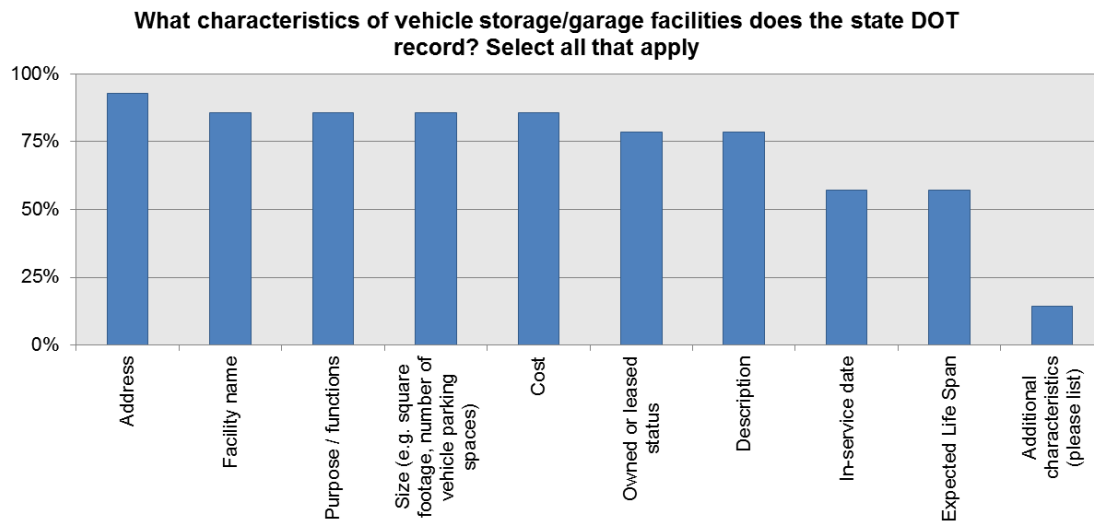| Does your state DOT collect data about…Vehicle Storage/Garage Facilities?		
Answer Options	**Response Percent**	**Response Count**
Yes	68.4%	13
No	21.1%	4
Unsure	10.5%	2
	answered question	**19**
	skipped question	**3**

Figure 15. Vehicle Storage Facilities Characteristics

Comments related to Figure 19:

- ADA accessibility, renovation (date and cost), and ownership

Table 17

How current is your state DOT's data for vehicle storage/garage facilities?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	0.0%	0
Data gathered annually	57.1%	8
Other	42.9%	6
	answered question	**14**
	skipped question	**8**

Comments related to Table 17:

- 3 years
- Every 3 years; starting CY 2013 will collect annually
- Have information for facilities constructed or renovated with federal funds. Info on file from pre-construction through facility occupancy
- A few years ago a study was done to gather base data; has not been followed up on.
- Facilities we have funded

Table 18

How difficult would it be to start collecting data from all grantees on vehicle storage/garage facilities? (such as name, description, address, size, cost, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	0.0%	0
Unsure	50.0%	2
Difficult	50.0%	2
Very difficult	0.0%	0
	answered question	**4**
	skipped question	**18**

Revenue Vehicle Equipment

Table 19

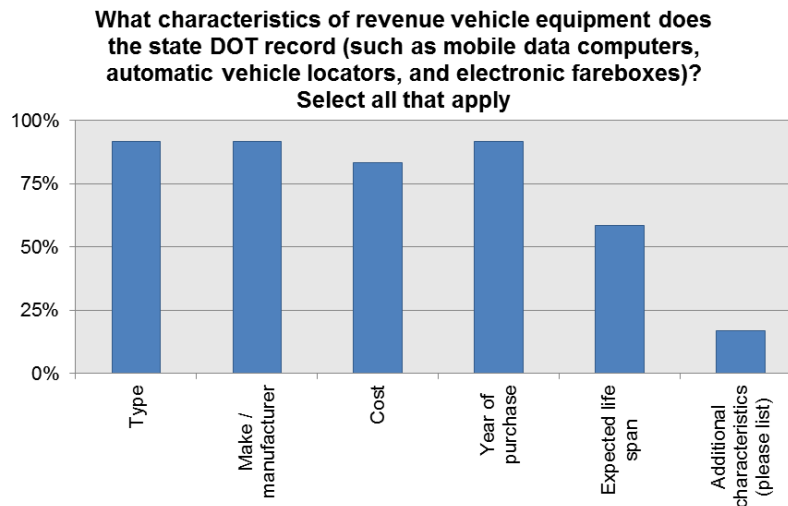| Does your state DOT collect data about…Revenue Vehicle Equipment? (such as mobile data computers, tablets, security cameras, radios, and electronic fareboxes)		
Answer Options	**Response Percent**	**Response Count**
Yes	63.2%	12
No	36.8%	7
Unsure	0.0%	0
	answered question	**19**
	skipped question	**3**

Figure 16. Revenue Vehicle Equipment Characteristics

Comments related to Figure 20:
- State/Federal grant number that funded the purchase
- Serial number. Currently collect equipment data for items costing $100,000 or more for Urban Transit Agencies and $1,000 or more for Rural Transit Systems

Table 20

How current is your state DOT's data for revenue vehicle equipment?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	0.0%	0
Data gathered annually	83.3%	10
Other	16.7%	2
	answered question	**12**
	skipped question	**10**

Comments related to Table 20:
- When purchased

Table 21

How difficult would it be to start collecting data from all grantees on revenue vehicle equipment (e.g., mobile data computers and automatic vehicle locators)? (such as type, cost, purchase year, life span, and etc.)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	0.0%	0
Unsure	28.6%	2
Difficult	28.6%	2
Very difficult	42.9%	3
	answered question	**7**
	skipped question	**15**

Communications Equipment

Table 22

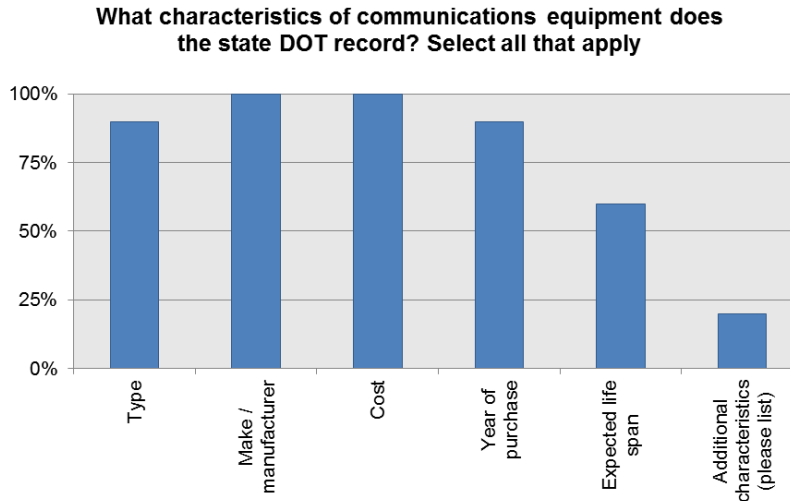| Does your state DOT collect data about…Communications Equipment? (such as dispatch radio equipment or cell phones)		
Answer Options	**Response Percent**	**Response Count**
Yes	52.6%	10
No	47.4%	9
Unsure	0.0%	0
	answered question	**19**
	skipped question	**3**

Figure 17. Communications Equipment Characteristics

Comments related to Figure 21:
- State/Federal grant number that funded the purchase
- Serial number. Currently collect equipment data for items costing $100,000 or more for Urban Transit Agencies and $1,000 or more for Rural Transit Systems

Table 23

How current is your state DOT's data for communications equipment?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	0.0%	0
Data gathered annually	90.0%	9
Other	10.0%	1
	answered question	**10**
	skipped question	**12**

Comments related to Table 23:
- When purchased

Table 24

How difficult would it be to start collecting data from all grantees on communications equipment? (such as type, cost, purchase year, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	0.0%	0
Unsure	33.3%	3
Difficult	33.3%	3
Very difficult	33.3%	3
	answered question	**9**
	skipped question	**13**

Office Equipment/Software

Table 25

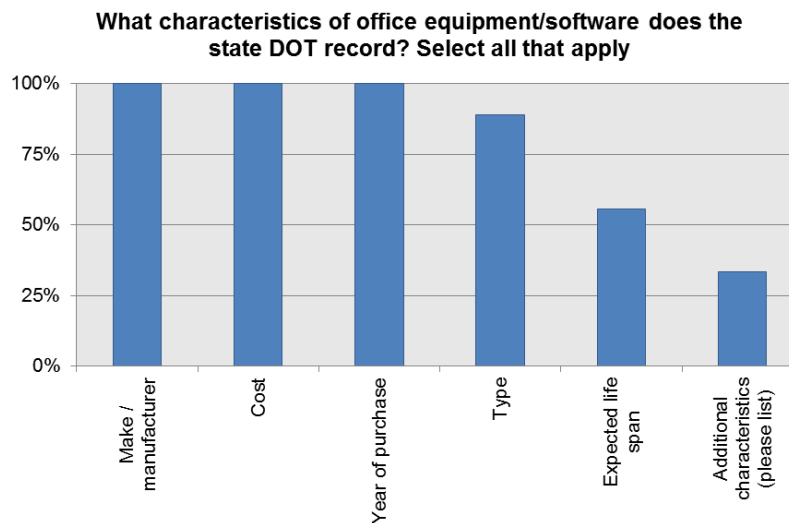| Does your state DOT collect data about…Office Equipment/Software? (such as computers, copiers, and expensive software licenses)		
Answer Options	**Response Percent**	**Response Count**
Yes	42.1%	8
No	52.6%	10
Unsure	5.3%	1
	answered question	**19**
	skipped question	**3**

Figure 18. Office Equipment Characteristics

Comments related to Figure 22:
- Only 5311 agencies
- State/Federal grant number that funded the purchase
- Serial number. Currently collect equipment data for items costing $100,000 or more for Urban Transit Agencies and $1,000 or more for Rural Transit Systems

Table 26

How current is your state DOT's data for office equipment and/or software?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	0.0%	0
Data gathered annually	88.9%	8
Other	11.1%	1
	answered question	**9**
	skipped question	**13**

Comments related to Table 26:
- Only 5311 agencies

Table 27

How difficult would it be to start collecting data from all grantees on office equipment/software? (such as type, cost, purchase year, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	0.0%	0
Unsure	40.0%	4
Difficult	30.0%	3
Very difficult	30.0%	3
	answered question	**10**
	skipped question	**12**

Security/Surveillance Equipment

Table 28

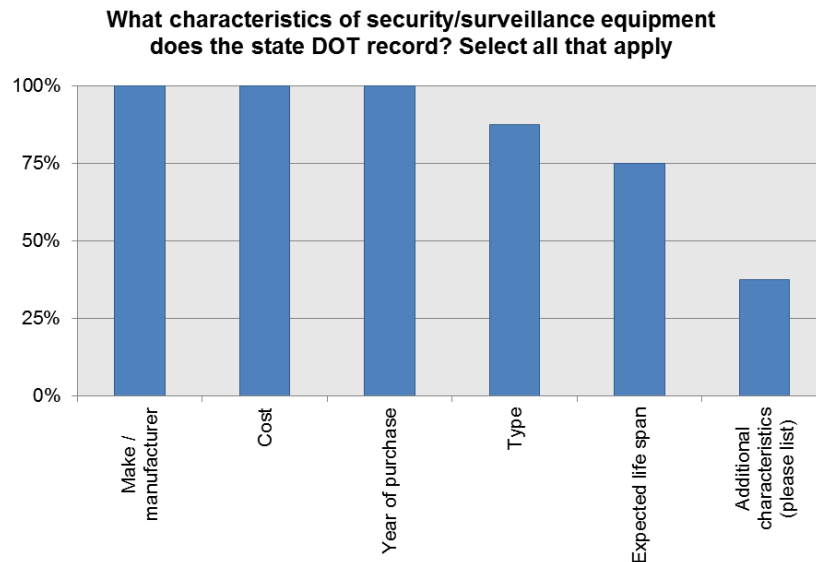| Does your state DOT collect data about…Security/Surveillance Equipment? (such as facility security ID systems and cameras)		
Answer Options	**Response Percent**	**Response Count**
Yes	42.1%	8
No	57.9%	11
Unsure	0.0%	0
	answered question	**19**
	skipped question	**3**

Figure 19. Security Equipment Characteristics

Comments related to Figure 23:
- Only 5311 agencies
- State/Federal grant number that funded the purchase

- Serial number. Currently collect equipment data for items costing $100,000 or more for Urban Transit Agencies and $1,000 or more for Rural Transit Systems

Table 29

How current is your state DOT's data for security and surveillance equipment?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	12.5%	1
Data gathered annually	87.5%	7
Other	0.0%	0
	answered question	**8**
	skipped question	**14**

Table 30

How difficult would it be to start collecting data from all grantees on security and surveillance equipment? (such as type, cost, purchase year, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	9.1%	1
Unsure	27.3%	3
Difficult	36.4%	4
Very difficult	27.3%	3
	answered question	**11**
	skipped question	**11**

Maintenance Shop Equipment

Table 31

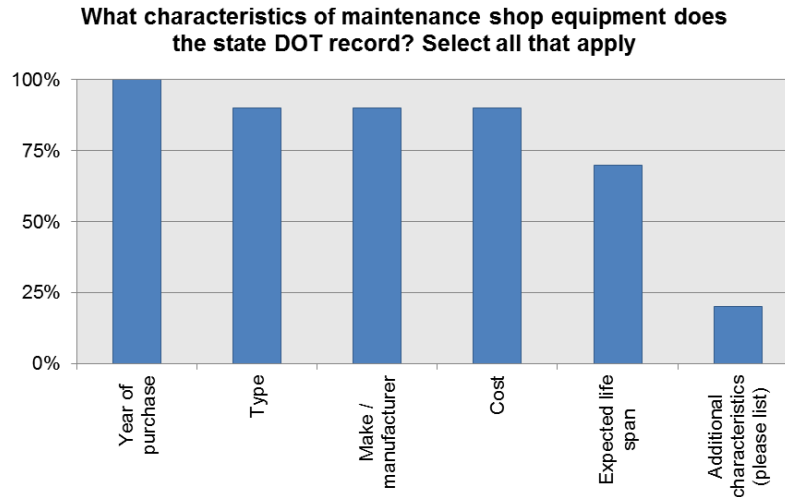| Does your state DOT collect data about…Maintenance Shop Equipment? (such as vehicle lifts, brake rotor stations, and A/C servicing units)		
Answer Options	**Response Percent**	**Response Count**
Yes	52.6%	10
No	47.4%	9
Unsure	0.0%	0
	answered question	**19**
	skipped question	**3**

Figure 20. Maintenance Shop Equipment Characteristics

Comments related to Figure 24:
- See previous comment re: equipment
- Equipment serial number for equipment costing $100,000 or more for Urban Transit Agencies and $1,000 or more for Rural Transit Systems

Table 32

How current is your state DOT's data for maintenance shop equipment?		
Answer Options	**Response Percent**	**Response Count**
Data gathered quarterly	10.0%	1
Data gathered annually	80.0%	8
Other	10.0%	1
answered question		10
skipped question		12

Comments related to Table 32:
- When purchased...depends on equipment

Table 33

How difficult would it be to start collecting data from all grantees on maintenance shop equipment? (such as type, cost, purchase year, and life span)		
Answer Options	**Response Percent**	**Response Count**
Very easy	0.0%	0
Easy	0.0%	0
Unsure	22.2%	2
Difficult	33.3%	3
Very difficult	44.4%	4
answered question		9
skipped question		13

Sources of Information, Guidance, or Reports

Table 34

Are there any additional data, reports, guidelines, documents, etc., that your state DOT would like to share with us? If so, please describe below, provide a web-link/hyperlink, or other information necessary for us to follow-up and obtain the additional information.	
Answer Options	**Response Count**
answered question	**6**
skipped question	**16**

Comments related to Table 34:
- Many of these documents and tools are in development and not ready to be shared at this time.
- Not at this time
- Status of Public Transit Report located at:
  http://www.dot.state.oh.us/Divisions/Planning/Transit/Pages/StatusofPublicTransit.aspx
- https://transit.dotd.la.gov/login.aspx
- We collect 5311 data using a program written for us. Systems record their vehicle maintenance and repair costs per vehicle in that program. Annually, the same program is used for the systems to apply for the next year's grant. There, we collect vehicle information such as current mileage, age, VIN#, expected disposal dates, inspection dates, seating capacity, wheel chair capacity, etc. For the 5310 systems, we annually monitor each vehicle using a paper form that details the condition of the vehicle and its components.
- Please go to http://www.iowadot.gov/transit/policies.html to learn more about our PTMS Policy.

Comments and Observations

Table 35

In your professional opinion, what role should transit asset management practices play at the state DOT level?	
Answer Options	**Response Count**
answered question	**14**
skipped question	**8**

Comments related to Table 35:
- State DOT's should be responsible for assets in the rural and specialized program but not assets in use by direct FTA reporters (5307 recipients). Currently we do a great deal of double accounting in this area because we were the grantee in many cases under the 5309 discretionary program. Because of a SNAFU in MAP21, state DOTs will be applying for capital funds on behalf of direct recipients in the 5339 program, thus continuing this double accounting scenario.
- It should play a key role in planning and budgeting
- Vital role
- This should be key to repair and replacement plans
- Tracking of useful life of FTA-funded vehicles and facilities through the state.
- Major purchases over a certain threshold. Definitely must track vehicles, facilities, and large purchases.

- An everyday role, the state should know where the federal dollars are being spent and if the assets are being maintained.
- It has actually become my task to develop asset management plan guidance for the systems as well as looking to develop a statewide plan that we at the DOT level can use to help us determine funding. We are hoping to complete this during 2014.
- DOTs should be familiar with and provide general policies to their subs.
- Safety of passenger transport is a paramount concern of service delivery. We are required to provide oversight of rolling stock assets while they are in service. We offer guidelines on best practices, and provide annual inspection of rolling stock inventory to ensure they are equipped with necessary safety equipment and are in good working condition. Sub-recipients provide monthly vehicle reports and send in invoices relating to vehicle maintenance and repairs. We track unusual repairs needed and lift failures. We are constantly modifying our practices to ensure rolling stocks assets are managed effectively.
- To provide for knowledge of a basic approximate readiness level.
- More of an oversight role. Gather particular important data, but not minute details.
- We really should be in the middle and should utilize this information to set up budgets and replacement schedules. Our job should be the gatekeeper between the FTA and the local providers to assist in getting the information and that is about it.
- They should be a mandated focus, with oversight being required by the state.

Table 36

If you would like to add any notes, comments, or clarifications regarding the questions or your answers, please do so in the space below.	
Answer Options	**Response Count**
answered question	**4**
skipped question	**18**

Comments related to Table 36:
- None at this time
- We are currently setting up a web-based online Grants Management Systems to track all our Transit programs (5311, 5310, 5307, etc) and asset management, which include vehicles, facilities and equipment for CY 2013. This data will be tracked annually for FTA reporting and in-office reporting.
- Please do not hesitate to contact me, if you need more information.

Appendix C

Transit Asset Management Best Practice Matrix

Strategy	Details	Agency	Source
Assemble a TAM team/ designate a champion	Hillsborough County Florida assembled two teams to manage the asset management program. The public works department divided the assets into Roadway and Roadside. One team established the scope of services for each category.	*Hillsborough County, FL*	Economics in Asset Management, The Florida Experience (1)
	The Maryland Department of Transportation established a multimodal, department-wide, asset management committee to develop guidelines, principles, and initiatives for asset management.	*Maryland DOT*	FHWA Asset Management Overview (2)
	Michigan DOT established an Interagency committee to guide asset management implementation. The Transportation Asset Management Council (TAMC) was later established to set goals and objectives, analyze life cycle costs, and recommend investment strategies.	*Michigan DOT*	FHWA Asset Management Overview (2)
	Every strategic objective in the PENNDOT asset management plan has an owner or a leader who is responsible for that specific objective. Leaders may be directly involved in implementing asset management in their division or in part of a specific management system. For a large agency such as PENNDOT, a department-wide champion for Asset Management may be advisable to provide vision and day-to-day encouragement for timely implementation of Asset Management.	*PENNDOT*	FHWA Asset Management Overview (2)
	NCHRP 20-68 notes that the success of the asset management process was directly linked to the actions of an asset management champion or champions within the organization. Sometimes the champion was the head of the agency; in others it was a key staff member who strongly believed that asset management was important. The champions for asset management should be: - A communicator; - Respected; - A believer in process; - Willing to take chances; - Able to give credit to others; and - Continually teaching others.	*NCHRP 20-68*	US Domestic Scan Program: Best Practices in Asset Management (3)
5 Cs	CONN DOT uses the 5 Cs: Clarity, Communication, Champion, Consistency, and Comprehensive as a strategy for TAM implementation. The 5 Cs provide a focus for CONN DOT's development of a sustainable TAM program to guide the state's investment in the acquisition, construction, repair, and preservation of the state's transportation assets.	*CONN DOT*	Applying Transportation Asset Management in Connecticut (4)

Strategy	Details	Agency	Source
Determine asset hierarchy	TTI's survey of State DOTs revealed that of the State DOTs that collect data about the revenue vehicle fleet, 100 percent indicated that the following data points are collected: - Vehicle ID (VIN) - Make/manufacturer - Model year - Number of seats - Current mileage Of the State DOT respondents that collect data about the revenue vehicle fleet, 75 percent or more indicated that the following data points are collected: - Vehicle type - Purchase year - Wheelchair tie down Of the State DOT respondents that collect data about the revenue vehicle fleet, 50 percent or more indicated that the following data points are collected: - Fuel type - Condition rating - In-service date - Storage location or type	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect data about the non-revenue vehicle fleet, more than 75 percent indicated that the following data points are collected: - Vehicle ID (VIN) - Vehicle type - Make/manufacturer - Model year - Current mileage - Condition rating - Purchase year Of the State DOT respondents that collect data about the non-revenue vehicle fleet, more than 50 percent indicated that the following data points are collected: - Fuel type - In-service date - GVWR - Storage location or type	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect data about passenger facilities, 75 percent or more indicated that the following data points are collected: - Address - Cost Of the State DOT respondents that collect data about the passenger facilities, more than 50 percent indicated that the following data points are collected: - Type of facility - Facility name - Description - Size - In-service date - Expected useful life	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)

Strategy	Details	Agency	Source
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect information about administrative facilities indicated that the following data points are collected: - Address Of the State DOT respondents that collect information about administrative facilities, 75 percent or more indicated that the following data points are collected: - Facility name - Cost - Purpose/function - Description - Owned or leased status - Size	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect information about vehicle maintenance facilities, 75 percent or more indicated that the following data points are collected: - Owned or leased status - Purpose/function - Address - Facility name - Size - Cost - Description	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect information about storage/garage facilities, 75 percent or more indicated that the following data points are collected: - Address - Facility name - Purpose/function - Size - Cost - Owned or leased status - Description - In-service date - Expected useful life span	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect information about the revenue vehicle fleet, 75 percent or more indicated that the following data points are collected: - Type - Make/manufacturer - Cost - Purchase year - Expected life span	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)

Strategy	Details	Agency	Source
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect information about office equipment, 100 percent indicated that the following data points are collected: - Make/manufacturer - Cost - Purchase year Of the State DOT respondents that collect information about office equipment, 75 percent or more indicated that the following data points are collected: - Type Of the State DOT respondents that collect information about office equipment, 50 percent or more indicated that the following data points are collected: - Expected life span	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect information about security and surveillance equipment, 100 percent indicated that the following data points are collected: - Make/manufacturer - Cost - Purchase year Of the State DOT respondents that collect information about security and surveillance equipment, 75 percent or more indicated that the following data points are collected: - Type - Expected life span	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	TTI's survey of State DOTs revealed that of the State DOT respondents that collect information about maintenance shop equipment, 100 percent indicated that the following data points are collected: - Purchase year Of the State DOT respondents that collect information about maintenance shop equipment, 75 percent or more indicated that the following data points are collected: - Type - Make/manufacturer - Cost Of the State DOT respondents that collect information about maintenance shop equipment, 50 percent or more indicated that the following data points are collected: - Expected life span	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
Create an inventory (Classify assets into categories)	TCRP Report 157 notes that gathering inventory and inspection data is a prerequisite for implementing an asset management plan.	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)

Strategy	Details	Agency	Source
	Oregon DOT sustains and establishes a complete and reliable asset inventory.	*Oregon DOT*	Application of Cross-Asset Optimization in Transportation Asset Management: A Survey of State Practice and Related Research (7)
	Caltrain established a State of Good Repair (SGR) database, which tracks the asset's status, maintenance record, and any relevant test results.	*Caltrain*	Application of Cross-Asset Optimization in Transportation Asset Management: A Survey of State Practice and Related Research (7)
	NCHRP 20-68 states that agencies should start TAM by conducting an organizational self-assessment. The AASHTO *Asset Management Self-Assessment Guide* was pointed to as a very useful tool for undertaking this assessment.	*NCHRP 20-68*	US Domestic Scan Program: Best Practices in Asset Management (3)
	A TTI survey respondent reported that vehicle data is entered into an Excel spreadsheet as vehicles are ordered. The data is then transferred into an Access database for storage, queries, and reports.	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
Collect quality data via email	NCHRP 20-68 states that quality data and cost-effective data collection strategies served as the basis for the cases investigated. In several cases, agencies viewed data as an asset and the data collection process as an important decision support function.	*NCHRP 20-68*	US Domestic Scan Program: Best Practices in Asset Management (3)
	TTI's survey revealed that 67 percent of respondents collect transit asset data annually. 62 percent of DOTs collect similar data for all agencies. Data points are listed in order from the most frequently collected to the least. - Revenue vehicle fleet - Vehicle maintenance/repair facilities - Administrative facilities - Vehicle storage/garage facilities - Revenue vehicle equipment - Communications equipment - Maintenance shop equipment - Non-revenue vehicle fleet - Passenger facilities - Office equipment - Security and surveillance equipment	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)

Strategy	Details	Agency	Source
	TCRP Report 157 states that investment decisions should be based on quality, comprehensive data. Data should extend beyond the basics (purchase date) and include condition.	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)
	TCRP Synthesis 92 states that agencies use electronic databases to store assets. Common data sources are financial records (fixed asset ledgers), asset inspections, and maintenance management systems.	*TCRP Synthesis 92*	Transit Asset Condition Reporting (8)
	TTI's survey revealed that the most common method DOTs use to collect transit asset data is email exchange of data – 57 percent.	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
	Respondents to TTI's survey of State DOTs identified data that equipment data would be the most difficult to collect. Researchers list equipment data points below most to least difficult to collect. - Maintenance shop equipment - Revenue vehicle equipment - Security and surveillance equipment - Communications equipment - Other equipment and/or software	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)
Determine useful life standards	FL DOT identifies the DOT (and other) condition/operating/useful life standards for each asset.	*FL DOT*	US Domestic Scan Program: Best Practices in Asset Management (3)
Conduct a risk assessment for assets	Kaplan and Garrick suggest conducting a "Cost of Failure" risk assessment (Catastrophic or performance). Questions in the analysis may include: · What can go wrong? · What is the likelihood that it will go wrong? · What are the consequences (and what is the time domain)? L(Risk Event) = L(Cause) * L(Defect)* L(Exposure) * L(Effect) *Where L stands for likelihood.*	*Kaplan and Garrick 1981; Haimes 2009*	Best Practices in Selecting Performance Measures and Standards for Effective Asset Management (9)
	In a GDOT study, all agencies used the concept of risk to establish investment priorities.	Multiple	GDOT Study (10)
Develop project selection tool (analyze options and tradeoffs)	Maryland DOT developed a list of potential projects and compared the effectiveness of individual projects toward meeting strategic goals.	*Maryland DOT*	FHWA Asset Management Overview (2)
	NCHRP 20-68 states that some agencies moved away from the "worst first" investment strategy to life-cycle cost to select projects.	*NCHRP 20-68*	US Domestic Scan Program: Best Practices in Asset Management (3)

Strategy	Details	Agency	Source
	Georgia DOT developed metrics to evaluate progress toward strategic objectives. GA DOT also linked performance metrics with resource allocation decision making and developed data and analytical capabilities for evaluating tradeoffs.	*Georgia DOT*	Best Practices in Selecting Performance Measures and Standards for Effective Asset Management (9)
	Oregon DOT integrated reporting and analysis tools that make use of the integrated data system.	*Oregon DOT*	Application of Cross-Asset Optimization in Transportation Asset Management: A Survey of State Practice and Related Research (7)
	NJ DOT created an asset management decision support model that calculates the utility for a user-specified project to support high-level resource allocation decisions.	*NJ DOT*	New Jersey Asset Management Plan: Asset Management Decision Support System Model (11)
	TCRP 157 states that objectives considered by transit agencies when selecting rehabilitation and replacement projects may include: - Reducing transit agency costs - Reducing asset breakdowns/failures - Improving safety - Increasing mobility - Reducing travel time - Improving the quality of service - Reducing emissions - Addressing environmental justice and equity concerns - Improving the environment - Increasing economic development potential - Increasing transit mode share	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)
	A TTI survey respondent reported that, "Our DOT uses a Public Transit Management System (PTMS) to rank vehicles statewide by age and miles. Each vehicle is given a point for each month of service and 1 point for each 3,500 miles that it runs. After it reaches its useful life, as defined by this program, it begins receiving positive PTMS points. Vehicles programmed in the STIP are ranked by PTMS points, and those vehicles eligible for replacement are funded in rank order."	*TTI 2013 NCHRP Task 48 Survey*	Transit Asset Management at State DOTs (5)

Strategy	Details	Agency	Source
Establish performance measures/ measure outcomes	TCRP 157 notes that measuring and reporting performance is an important aspect. Agencies should establish performance measures, set targets for measures, and then report on the progress toward meeting the targets.	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)
	GA DOT states that performance management links metrics to resource allocation decision making in order to enable agencies achieve their strategic objectives. Performance management is necessary for effective asset management.	*GA DOT*	Best Practices in Selecting Performance Measures and Standards for Effective Asset Management (9)
	NCHRP 20-68 states that the most successful asset management processes had performance measures that guided investment decisions throughout the organization. Measures are important indicators for system monitoring. A performance-based asset management approach had become the normal way of doing business in many of the sites visited. Most agencies based decisions on target thresholds on historical data and on some expectation of what could be achieved.	*NCHRP 20-68*	US Domestic Scan Program: Best Practices in Asset Management (3)
	Policy-Driven – Resource allocation decisions are based on a well-defined set of policy goals and objectives. These objectives reflect desired system condition, level of service,and safety provided to customers, and typically are tied to economic, community, and environmental goals as well. *Performance-Based* – Policy objectives are translated into system performance measures that are used for both day-to-day and strategic management.	*FHWA*	Transportation Asset Management (13)
	GA DOT benchmarks against similar and more mature state agencies and then develops metrics for evaluating progress towards strategic goals.	*GA DOT*	Best Practices in Selecting Performance Measures and Standards for Effective Asset Management (9)
	TCRP 157 states that when considering whether to replace an asset, the agency should ask three questions: 1. How does the asset help the transit agency achieve its performance goals? 2. How does performance vary as the asset ages and/or deteriorates? 3. What the impact on performance would be if the asset failed or was removed from service	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)

Strategy	Details	Agency	Source
	TCRP Report 157 states that performance measures should be defined for all physical assets.	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)
	TCRP 157 states that "the rule" is that measures of *outcomes* are preferred to measures of *outputs*. Outcome measures are often more difficult to measure.	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)
Link performance to strategic planning	GA DOT views performance management as closely linked with strategic planning and reporting where strategic planning involves identifying what an agency hopes to achieve. Strategic planning is based on developing an agency vision or mission, identifying supporting goals and objectives, and developing initiatives and implementation strategies to achieve these objectives in agreed upon time frames.	*GA DOT*	Best Practices in Selecting Performance Measures and Standards for Effective Asset Management (9)
	The FHWA states that performance measures should: Flow out of agency mission and objectives. 1. Provide a balanced picture of an agency's business and utilize input, output, outcome, and productivity or efficiency measures. 2. Have a few, well-defined measures tied to a handful of clear goals to be achieved within specific time frames. 3. Be periodically evaluated in an iterative process. 4. Use reliable, available, and easily collected data. 5. Performance measurement reporting and communication should be clear and easy to understand. 6. Incorporate benchmarking. 7. Customer satisfaction, environmental quality, and sustainability are increasingly important outcome measures. 8. Performance targets should be set in relation to achieving strategic goals. 9. Scenario analysis is a useful analytic tool when setting targets. 10. Performance frameworks are structured processes that provide guidance for selecting performance measures, e.g., the Balanced Scorecard Framework.	*FHWA*	Transportation Asset Management (13)

Strategy	Details	Agency	Source
	Oregon DOT states that the agency's strategic planning, implementation plan, and communication plan are now one, integrated document used to guide asset management.	*Oregon DOT*	Transportation Asset Management Plans including Best Practices: Synthesis (14)
Incorporate Life-Cycle Cost Analysis	TCRP 157 states that the optimal point to perform an intervention exists where the life-cycle cost is lowest. This point depends on the asset type, type of intervention (rehabilitation/replacement), and range of other variables.	*TCRP 157*	State of Good Repair: Prioritizing the Rehabilitation and Replacement of Existing Assets and Evaluating the Implications for Transit (6)
Integrate GIS	Hillsborough County, Florida, used a GIS-based map technique called dynamic segmentation. Personnel can display where the roadway assets are located (for TAM this could include: HOV segments, bus stop signs, passenger facilities), ascertain their condition and maintenance history, view photographs, and update data.	*Hillsborough County, FL*	Economics in Asset Management, The Florida Experience (1)