MassDOT-sponsored Research Project

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Research Problem

How should data be collected, aggregated, and analyzed to forecast transit capital needs and make investment decisions?
Outline

• Current RTA Capital Planning Process
• Literature Review
• Toward Data-Driven Capital Planning
  o Focusing on Targeted Discretionary Program
  o Evaluation Criteria and Scoring Rubrics
  o Tracking Data Over Time
  o Quantitative Optimization
• Potential Process Improvements
• Potential Software Changes
Regional Transit Authorities (RTAs) in Massachusetts

- 15 RTAs in Massachusetts vary greatly in size
- Capital funds from the state are managed and allocated by the MassDOT Rail & Transit Division (RTD)
- Asset Cloud Software is used to aggregate capital asset data

PVTA (Greater Springfield) 21,774,270 trips/year
FRTA (Franklin County, rural) 85,546 trips/year

- **OTP sets the calendar for capital planning process**
  - Nov/Dec

- **RTAs submit capital funding request to RTD**

- **A&F determines the total amount of RTA CAP**
  - Feb/Mar

- **RTD determines how to allocate funds for the next fiscal year**

- **RTD releases a draft project list for review by RTAs**
  - April

- **RTD submits a final project list to OTP for inclusion in CIP**

- **The approved list is formalized for regional TIPs and STIP**

- **STIP must be approved by FTA to release funds**
  - June 30

- **RTAs work to procure assets by the end of the fiscal year**

**Abbreviations**
- OTP – Office of Transportation Planning
- A&F – Executive Office for Administration & Finance
- CIP – Capital Investment Program
- TIP – Transportation Improvement Program
- STIP – State Transportation Improvement Program
MassDOT Strategic Priorities

1. **Reliability**
   Maintain and improve the overall condition and reliability of the transportation system
   - Necessary routine and capital maintenance
   - State of Good Repair projects designed primarily to bring asset condition up to an acceptable level
   - Asset management and system preservation projects

2. **Modernization**
   Modernize the transportation system to make it safer and more accessible and to accommodate growth
   - Compliance with federal mandates or other statutory requirements for safety and/or accessibility improvements
   - Projects that go beyond State of Good Repair and substantially modernize existing assets
   - Projects that provide expanded capacity to accommodate current or anticipated demand on existing transportation systems

3. **Expansion**
   Expand diverse transportation options for communities throughout the Commonwealth
   - Projects that expand highway, transit and rail networks and/or services
   - Projects that expand bicycle and pedestrian networks to provide more transportation options and address health and sustainability objectives
Existing RTA Capital Planning Process

Challenges for MassDOT Rail & Transit Division

• RTA CAP is a scarce resource, so projects must be selected across 15 RTAs

• Comparison of projects is difficult because
  o Different RTAs operate in very different settings
  o Different types of capital investments (e.g., vehicles, technology, facilities, etc.)
  o Different sizes of investments

• Although there are straightforward Useful Life Benchmarks (ULBs) for revenue vehicles, it is difficult to forecast other asset needs
Existing RTA Capital Planning Process

Challenges for RTAs

• Timelines can be challenging, especially in the face of uncertainty
  o Requirement to spend funds by June 30 is challenging given the lead times for procurement
  o Processes and timelines for making project changes midyear are also uncertain

• Not a clear process, timeline, or sequence of requirements for some situations
  o Large, multi-year projects (e.g., facilities or IT upgrades)
  o Funds that become available as the end of the fiscal year approaches

• Lack of clarity for how decisions are made
Literature: Transit Asset Management (TAM)

FTA requires transit agencies to prepare TAM plans
- Inventory of assets (rolling stock, equipment, facilities)
- Condition assessment of assets (age of vehicles, TERM rating for facilities)
- Description of a decision support tool
- A prioritized list of investments

Most agencies track condition relative to State of Good Repair (SGR) based on Useful Life Benchmark (ULB) and TERM rating

TCRP 172 provides a model framework for forecasting likelihood of deterioration based on archived vehicle breakdown and/or TERM rating data.
Literature: Funding Scenarios

• Compare funding scenarios relative to State of Good Repair (SGR) objectives
  o Example: CTtransit compares 3 scenarios:
    1) No Funding  2) Expected Funding  3) SGR for All Assets

• Use project requests to determine a budget allocation to each agency, but allow flexibility in final project selection
  o Example: PennDOT determines a budget allocation to each agency based on a list of requested project, but each agency can choose among their own project what to program within the allocated budget.
Literature: Scoring Rubrics

• It is common to use an application process with a scoring rubric for competitive funds

**New Hampshire**
• Rubric has 5 general weighted categories, evaluated by at least 3 people
• Obligate themselves to award funds based on the ranking or to justify deviations

**Idaho, South Dakota**
• Much more comprehensive scoring rubrics, but no explicit policy to bind final decision to the ranking of scores
Objectives for Data-Driven Capital Planning Process

The underlying principles for the recommended planning and decision-making processes are:

1) A data-driven capital planning process should be transparent and reproducible.

2) The capital planning process should align with MassDOT priorities and serve RTA needs.

3) Requesting additional data or analyses for project requests or existing assets reflect an increased burden on RTA and/or MassDOT staff. This should be weighed against the benefits.
RTA Capital Funding for FY23

The STIP reports $74.9M of state allocation to transit.
RTA Capital Funding for FY23

Analysis of funding patterns to identify which projects are most likely to be funded and which are subject to the greatest discretion.

- % of Project Funds from Federal Sources
- % of Project Funds from State Sources
- Strategic Priority Area: Reliability, Modernization, Expansion
## RTA Capital Funding for FY23

<table>
<thead>
<tr>
<th>Strategic Priority</th>
<th>State Funds Requested (Projects Requested)</th>
<th>State Funds Selected (Projects Selected)</th>
<th>% Funds Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reliability</td>
<td>$20.8 M (91)</td>
<td>$20.7 M (86)</td>
</tr>
<tr>
<td>2</td>
<td>Modernization</td>
<td>$9.2 M (47)</td>
<td>$7.7 M (42)</td>
</tr>
<tr>
<td>No Priority Listed Capitalized Ops. and Planning</td>
<td>$16.3 M (24)</td>
<td>$16.3 M (23)</td>
<td>100%</td>
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<td>$9.0 M (33)</td>
<td>$7.6 M (29)</td>
</tr>
<tr>
<td>2</td>
<td>Modernization (&lt;$25K)</td>
<td>$0.18 M (14)</td>
<td>$0.16 M (13)</td>
</tr>
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Targeted Discretionary Grant Program

Rather than implementing data requirements or analysis procedures on all project requests, efforts can be focused only on those that are really subject to competition for funds:

e.g., Modernization projects requesting >$25,000 in state funding

A targeted discretionary grant program would

1) Communicate to the RTAs which projects are subject to more scrutiny

2) Limit additional data and reporting requirements only to relevant projects
Evaluation Criteria and Scoring Rubrics

Rubrics can include

- Binary (yes/no) questions for screening projects
- Rating relevance to strategic priorities or other MassDOT initiatives
- Rating the merits of the project and the agency’s ability to manage it

Defining project evaluation criteria and using rubrics to score projects leads to multiple outcomes.

1) Evaluation criteria and rubrics communicate priorities
2) Scoring results increase transparency
3) Scores fuse subjective and objective elements into a quantitative value
Tracking Asset Data Over Time

Revenue Vehicles

• Tracking mileage and age against Useful Life Benchmarks (ULBs) is straightforward.

• TCRP 172 presents a method for tracking condition by Mean Distance Between Failures (MDBF), but this is not commonly used.

Facilities

• Facilities are more varied and complex than vehicles. Typically, condition assessed with Transit Economic Requirements Model (TERM) 5-point scale.

• Archived data of facility conditions over time can be used to estimate the likelihood of deterioration.
Current facility data in Asset Cloud is limited.

- Only 27 of 54 facilities have more than a single observation.
- In 4 instances, the TERM rating increased in a subsequent observation, but there is no record of maintenance or investment linked to the event.
Tracking Asset Data Over Time

Asset condition time series can be used to model deterioration.

**Average Deterioration Rate**

Use available data to calculate the average decrease in TERM rating per asset per year.

For RTA facilities in Asset Cloud:

–0.21 TERM rating/year

**Matrix of Transition Probabilities**

Current data is not sufficient to estimate these probabilities.
Quantitative Approaches

Knapsack Problem
maximize “Value” of selected items
subject to Budget Constraint

Simplest solution is a Greedy Algorithm

- Rank projects from highest to lowest value/cost
- Select projects down the list until the constraint is reached, skipping larger projects if a smaller one can fit

EXAMPLE: Which books should be included to maximize the $ value if the knapsack is limited to 15 kg?
Quantitative Approaches

How can we measure value?

• Accounting of benefits (as in Benefit/Cost ratio), but this can be costly and time-consuming to calculate or estimate
• Score from an evaluation rubric
• Rank-order of projects as provided by RTAs, if project list if submitted in order from highest to lowest priority
• Weighted combination of factors
Quantitative Approaches

Group Fairness Knapsack Problem

“Equitable” Distribution of Funds – want “fair” representation of categories of items (i.e., projects from different RTAs); probably measured by funds, but could be number of projects or benefits

• Requires a baseline fair allocation to be defined
  o Probably not equal $ amount to each RTA
  o Perhaps based on assessment of need, historical program size, or some formula

• Set parameters for constraints to:
  o Restrict Dominance – limit how much more one category can be represented
  o Protect Minority – limit how much less one category can be represented

This approach can also be used to measure “fairness” even if it is not constrained.
Potential Process Improvements

1. Clear and Consistent Procedures and Timelines
   a. Provide timelines for reviews and approvals when changes are made midyear.
   b. Define the process or sequence of requirements for seeking funds for multi-year projects, such as a major facility investment.
   c. Provide a more formal timeline and process for distributing funds that cannot otherwise be spent by the end of the fiscal year (June 30).

2. Establish Evaluation Criteria or Project Scoring Rubric
   a. Define criteria or priorities for project selection
   b. Create a scoring rubric to quantify the extent to which projects satisfy criteria. The rubric may be used only for discretionary projects. It may be used as an internal tool or shared with RTAs.
Potential Process Improvements

3. Improve Analysis of Asset Condition and Anticipated Needs Over Time
   a. Improve the accuracy and consistency of asset records by integrating with existing platforms or providing Asset Cloud access for all RTAs.
   b. Use consistent methods/tools for calculating depreciation or forecasting deterioration.
   c. Consider data associated with assets over time, such as previous condition ratings or investments.

4. Consider Total Investment Need for State of Good Repair (SGR)
   a. Evaluate a planning scenario without a funding constraint to estimate cost to achieve SGR.
   b. Allow RTAs to communicate the unconstrained SGR analysis to MassDOT.
Potential Process Improvements

5. Use Quantitative Methods to Optimize Objectives

Multiple criteria may be used to prioritize capital projects for funding. Implementation of a data-driven multicriteria optimization tool may account for any of the following.

- Maximize benefits of selected projects (either from estimated benefit/cost analysis or score from evaluation rubric).
- Maximize prioritized requests from RTAs based on rank-order.
- Prioritize “equitable” distribution of funds across RTAs, which may be based on formula or record of past funding.
Potential Software Changes

A. Documentation and Communication (Process Improvements 1 & 2)

i. Centralized storage/access for documentation regarding the capital planning process, highlighting critical timelines and changes from previous years.

ii. Status indication of a request for funds or project change. This would allow RTAs to see where a change request is in the approval process and anticipated dates for decisions or actions.
Potential Software Changes

B. Improved Data Accuracy (Process Improvement 3)

i. Updating the software’s calculations for inflation to determine asset replacement costs.

ii. Require details pertaining to changes in condition numerical score.

iii. Update the software’s cost data for less common vehicle types.

iv. Add depreciation reports that calculate accurate rates of asset depreciation.

v. Utilize Universal Product Code (UPC) Application Programming Interfaces (APIs) to flag manufacturer recommendations for capital equipment replacement.
Potential Software Changes

C. Systems Integrations (Process Improvement 3a)

Integrations with the existing software tools that RTAs use for maintenance management, financial reporting, and depreciation calculation would allow for sharing critical data with MassDOT with minimal staff effort.

D. Scenario Planning and Project Prioritization (Process Improvement 4)

A scenario planning tool would allow RTAs to evaluate the cost of investments needed to achieve SGR without a budget constraint as a way to assess the total level of need.

E. Program Optimization (Process Improvements 2b & 5)

An optimization tool would implement the calculations to recommend a set of projects for funding that maximize objectives. The tool could also incorporate a project scoring rubric.
## Process Improvements

1. **Clear and Consistent Procedures/Timelines**
   - 1.a. Timelines for midyear changes
   - 1.b. Process for multiyear projects
   - 1.c. Formal process for to distribute unspent funds in fiscal year

2. **Evaluation Criteria or Scoring Rubric**
   - 2.a. Define priorities
   - 2.b. Create scoring rubric

3. **Improve Analysis of Asset Condition and Need**
   - 3.a. Improve data accuracy
   - 3.b. Consistent depreciation/forecast
   - 3.c. Consider asset data over time

4. **Consider Funding Need for SGR**
   - 4.a. Funding scenario without budget constraint
   - 4.b. RTAs can communicate total funding need

5. **Quantitative methods to optimize objectives**

## Software Changes

### A. Documentation and Communication
- A.i. Centralized reference for processes and timelines
- A.ii. Status for funds/project changes

### B. Improved Data Accuracy
- B.i. Update inflation for replacement
- B.ii. Details for change in condition
- B.iii. Cost data for less common veh.
- B.iv. Depreciation reports
- B.v. Utilize UPC APIs for manufacturer recommendations

### C. Systems integrations with existing software tools

### D. Scenario planning and project prioritization tools

### E. Program optimization

## Implementation Effort

- **A.i. Centralized reference for processes and timelines**
  - Low – Moderate (Standalone)

- **A.ii. Status for funds/project changes**
  - High (In-App)
  - change in eSTIP

- **B.i. Update inflation for replacement**
  - Low – Moderate

- **B.ii. Details for change in condition**
  - Low – Moderate

- **B.iii. Cost data for less common veh.**
  - Very Low – Moderate

- **B.iv. Depreciation reports**
  - High – Very High

- **B.v. Utilize UPC APIs for manufacturer recommendations**
  - Moderate – Very High

- **C. Systems integrations with existing software tools**
  - Moderate – Very High

- **D. Scenario planning and project prioritization tools**
  - Extremely High

- **E. Program optimization**
  - Moderate – Very High
Conclusions

1) Data and software tools support good capital planning and funding processes, but they are not solutions in and of themselves.

2) Collecting and processing data comes at a cost, so it’s best to focus where the affects decisions.

3) Transparent, consistent, and repeatable processes help everyone involved understand why decisions are made and what to expect.
QUESTIONS

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