State of Good Repair: Prioritizing and Evaluating Implications of Investments in Transit Capital Asset Rehabilitation and Replacement

prepared for the
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Outline

• TCRP E-09 project description
• Review of state-of-good-repair (SGR) literature and existing practice
• Relating SGR to performance
• Framework for transit asset rehabilitation and replacement
  • Overview
  • Framework steps
  • Examples
• Tools for evaluating and prioritizing asset rehabilitation and replacement
• Conclusions
TCRP E-09 Project Description

Overview

- TCRP E-09: Prioritizing the Rehabilitation and Replacement of Existing Capital Assets and Evaluating the Implications for Transit

- Objectives
  - *Develop a framework* for public transportation organizations to use to prioritize asset rehabilitation and replacement
  - *Identify methods* for assessing the positive and negative consequences of varying investment levels on key indicators of public transportation service and performance

- Project team
  - Spy Pond Partners, LLC
  - KKO & Associates, LLC
  - Harry Cohen
  - Joseph Barr
TCRP E-09 Project Description

Tasks

- Phase I Tasks
  - Literature Review
  - Define Impacts and Implications of Rehabilitation/Replacement Investments
  - Identify Organizations for Interviews
  - Evaluation Prioritization Methods

- Phase II Tasks
  - Prepare Framework
  - Develop Assessments Methods
  - Prepare Final Report

- Current Status
  - Phase I completed in Summer 2011
  - Preliminary Draft Final Report submitted
  - Now finalizing the report and assessment methods
SGR Review Summary

• Reviewed asset and transit management literature over past 10 years and conducted 11 agency interviews

• Key findings
  • Predominant measures for SGR analysis are cost to perform recommended work and asset age/remaining life
  • Numerous definitions of “SGR” and no consensus on any particular definition
  • Notable analytical approaches
    • FTA TERM Model – 5-point condition scale for assessing SGR, assets assigned a condition based
    • MBTA SGR Database – includes approach for prioritizing limited SGR funds
    • MTC Regional Transit Capital Inventory – uses an approach conceptually similar to that of TERM to predict SGR needs, costs
    • London Underground - uses lost customer hours (LCH) to characterize SGR impacts
  • Asset management approaches used for pavement and bridges are highly applicable to transit, though U.S. asset management guidance is geared towards highways
Relating SGR to Performance

Case Studies

• New York City Transit (NYCT)
  • Steep decline in condition in the 1970’s, followed by remarkable restoration of the system
  • Subway MDBF dropped from 23K miles to 7K - now 156K
  • Significant deferral in rail replacement – over 50% classified as requiring replacement
  • 80% increase in delays – subsequently dropped 59%
  • 17% reduction in ridership – subsequently grew 58%

• Other Examples
  • Chicago Transit Authority (CTA)
    Douglas Branch
  • Toronto Transit Commission (TTC)
  • Details on bus agency experience in the FTA report *Useful Life of Buses and Vans*

Source: Boylan
Relating SGR to Performance

*Categorizing Impacts and Implications*

**Asset Measures**
- Asset Age
- Asset Condition

**Asset-Specific Impacts**
- Asset Availability
- Asset Reliability
- Service Quality
- Routine Maintenance Costs

**System Impacts**
- System Performance
- Customer Perceptions
- Environmental Performance
- Network Capacity
- Safety
- Asset Life Cycle Costs

**Asset State of Repair**

**Rehabilitation/Replacement Actions**

**Agency Standards and Policies**

**Available Funding**

**Other Revenue Sources**
- Farebox Revenue

**Service Demand**

spy pond partners, llc
Relating SGR to Performance

Implications

• There is a strong - but indirect - relationship between asset measures (age, condition) and system impacts shown in the figure

• Better analytic methods are needed to
  • Predict asset-specific and system impacts
  • Relate asset conditions to performance, and convert measures of performance to agency and user costs
  • Provide an economic justification for achieving a given state of repair

• Recommended performance measures
  • Asset measures
    • Age
    • Condition
  • Asset-specific impacts
    • Availability
    • Hours of delay
    • Maintenance costs
    • % of assets enhanced/improved

use to communicate investment impacts and predict life-cycle agency and user costs
Framework for Asset Rehabilitation and Replacement

**Elements of the Framework**

- **Investment**
  - Available Funds
  - Funding Constraints

- **Rehabilitation & Replacement Actions**
  - Optimal Policy
  - Minimum Thresholds

- **Performance Measures**
  - Operating Costs
  - System Performance
  - Reliability
  - Safety

**Questions:**
- What funds are required to perform a specified set of actions?
- How should investments be prioritized, given available funds & considering performance?
- What are the predicted impacts and implications of a given level of funding?
- How will capital asset rehabilitation & replacement impact performance?
Framework for Asset Rehabilitation and Replacement

Process for Evaluating and Prioritizing Rehabilitation/Replacement Projects

1. Collect Data
2. Analyze Asset Conditions and Performance
3. Generate Rehabilitation/Replacement Alternatives
4. Define Investment Scenarios
5. Prioritize Projects
6. Develop Investment Plan
7. Perform Work
Framework for Asset Rehabilitation and Replacement

**Process Steps**

- **Collect Data**
  - Establish the Capital Asset Inventory
  - Define Data Collection and Inspection Protocols
  - Implement an Asset Management System

- **Analyze Asset Conditions and Performance**
  - Define Performance Measures
  - Calculate Current Conditions and Performance
  - Project Conditions and Performance

- **Generate Rehab/Replacement Alternatives**
  - Develop a Rehabilitation/Replacement Policy
  - Determine Candidate Actions
  - Quantify Costs and Impacts of Each Alternative
Framework for Asset Rehabilitation and Replacement

Process Steps

• Define Investment Scenarios
  • Develop Funding and Prioritization Assumptions
  • Define Scenarios
  • Simulate Future Decisions, Conditions and Performance

• Prioritize Projects
  • Specify the Utility Function
  • Refine Project Scope and Budgets
  • Apply the Utility Function

• Develop the Investment Plan
  • Define Funding Level and Constraints
  • Select Projects
  • Prepare the Plan

• Perform Work
# Framework for Asset Rehabilitation and Replacement

**Recommended Minimum Set of Measures for SGR Analysis**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Use For</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of assets in good/fair/poor condition</td>
<td>All assets, including facilities</td>
<td>Useful for reporting and analysis. The threshold for poor condition should coincide with the recommended threshold for rehabilitation/replacement</td>
</tr>
<tr>
<td>Asset availability</td>
<td>All assets excluding those for which availability can be related to delay</td>
<td>Useful for reporting, particularly in cases where it is difficult to relate asset service to delay</td>
</tr>
<tr>
<td>Agency cost</td>
<td>All assets</td>
<td>Useful for analysis. Should include transit agency life cycle maintenance costs, and other costs that vary with asset condition</td>
</tr>
<tr>
<td>User cost</td>
<td>All assets with direct impact on system performance</td>
<td>Useful for analysis. Should include delay costs and other user costs.</td>
</tr>
<tr>
<td>Hours of delay</td>
<td>Vehicles, guideway</td>
<td>Useful for analysis and reporting. Hours can be converted to costs for analysis.</td>
</tr>
<tr>
<td>Percent of assets enhanced/improved</td>
<td>All assets</td>
<td>Useful for analysis and reporting. Use to measure extent of improvements to existing asset, such as percent of buses with low emissions or improved technology</td>
</tr>
</tbody>
</table>
Framework Examples

Performance Reporting – MBTA Performance Scorecard

- One-page scorecard for reporting asset conditions
- Summary measures for each mode, with additional details by mode
  - Ridership
  - Vehicle/System Maintenance
  - On-time Performance
  - Schedule Performance
  - Elevator/Escalator Accessibility
  - Safety
  - Budget
- Updated on the MBTA web site on a monthly basis

Source: MBTA
Framework Examples
Analysis Approaches – MBTA and MTC

• MBTA
  • Established SGR Database for analysis of SGR needs
  • SGR database is notable in its ability to prioritize SGR work given a constrained budget
  • MBTA uses the SGR Database for scenario analysis
  • Project prioritization is handled as a separate process using published weights for key investment objectives

• MTC
  • Uses the Regional Transit Capital Inventory (RTCI) to support analysis of asset replacement needs for Bay Area transportation agencies
  • Refer to the MTC presentation for more details
  • Like MBTA, handles project prioritization as a separate process, also using published weights for key objectives

Source: MBTA
Framework Examples

*Investment Plan – King County Metro*

- Established the Transit Asset Management Program (TAMP) for managing its fixed assets to address investment needs for facilities and infrastructure
- Assets that are within six years of requiring replacement or rehabilitation are inspected on a yearly basis
- The TAMP team develops an annual work plan based on inspection results, budget and other factors
- Summary information provided in the Transit Facilities Condition Report

*Source: King County Metro*
Tools for Evaluating Asset Rehabilitation and Replacement

Overview

• Tools were developed to support the asset rehab/replacement framework
• Support converting key measures of asset performance into agency and user costs
• Three tools developed to analyze asset-specific rehabilitation and replacement needs
  • Vehicle Modeling Tool
  • Age-Based Modeling Tool
  • Condition-Based Modeling Tool
• Prioritization Tool uses data from the other tools to rank projects and simulate allocation of a budget
• See TRB Annual Meeting presentation, upcoming webinar for more details
Tools for Evaluating Asset Rehabilitation and Replacement

Relationship Between the Tools

- Fleet Description
- Base Year Data
- Cost Data

Vehicles

Vehicle Model

- Asset Inventory
- Age/Condition Data
- Cost Data

Non-Vehicle Assets

Age-Based Model

Condition-Based Model

- Asset Rehab/Replacement Alternatives
- Prioritization Data

Prioritization Model

- Budget Data

- Project Rankings
- Initial Budget Allocation
Tools for Evaluating Asset Rehabilitation and Replacement

**Vehicle Tool - Inputs**

Select vehicle type: bus, light rail, heavy rail

Enter inventory description – vehicles and accumulated mileage

Enter base year statistics – based on NTD data

Enter vehicle replacement cost and other parameters
Tools for Evaluating Asset Rehabilitation and Replacement

**Vehicle Tool - Results**

- **Cost-minimizing replacement mileage considering:**
  - Replacement cost
  - Rehabilitation and maintenance
  - Energy (fuel) costs
  - Delay costs from road calls/failures

- **Average annual agency and user costs**

- **Prioritization data – including Prioritization Index (PI) by year and coefficients for a PI curve used in the Prioritization Tool**

Note: PI is calculated by dividing the net benefit of replacement relative to a one-year deferral divided by replacement cost – used to determine economically optimal actions
Conclusions

• Results of the research are intended to help transit agencies
  • Better prioritize asset rehabilitation and replacement
  • Better communicate investment impacts and implications

• The TCRP E-09 project report will detail the materials presented here
  • Review of SGR materials
  • Approach for relating SGR and performance
  • Asset rehabilitation/replacement framework
  • Supporting tools

• Funding has been approved for the next phase of the TCRP E-09 project – this phase is likely to focus on
  • Testing the framework through a set of agency pilots
  • Revisions to the framework and tools
  • Developing guidance for applying the framework