Case Studies in Implementation of Cross-Asset Resource Allocation Tools

Bill Robert, Spy Pond Partners
Craig Secrest, High Street Consulting
2018 TRB Transportation Asset Management Conference

spy pond partners, llc

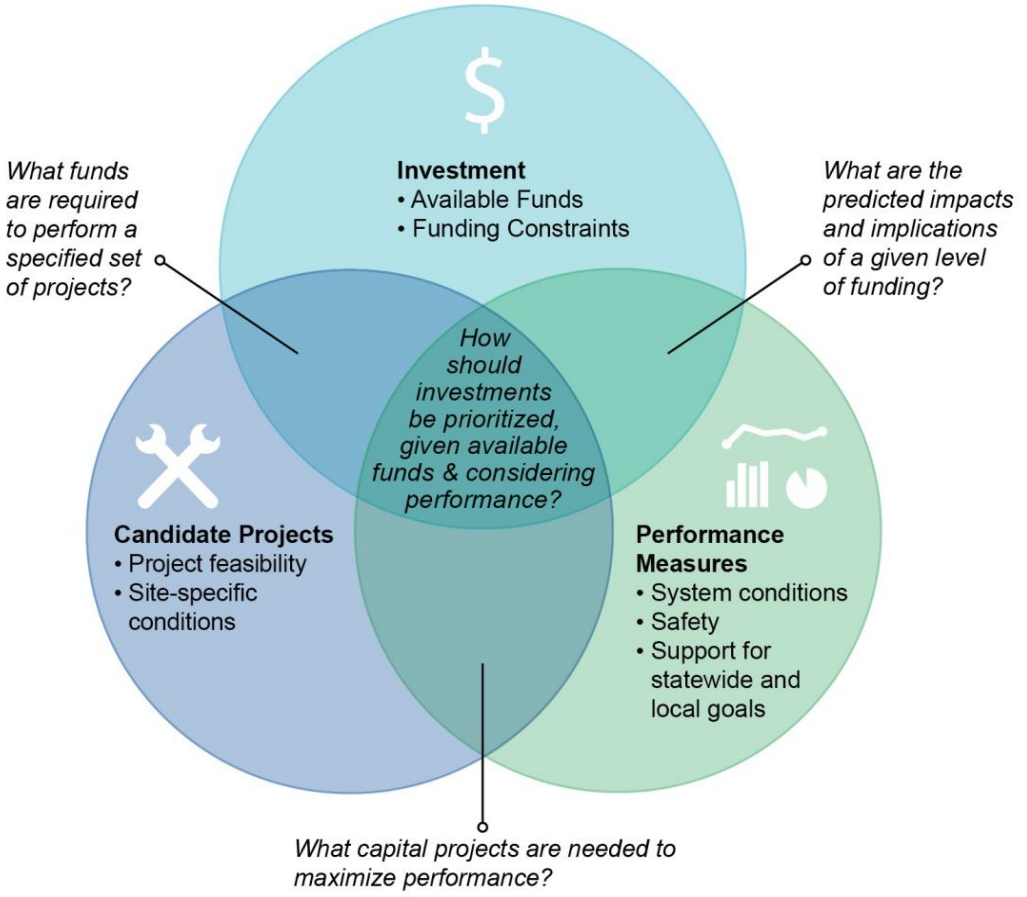
HIGH STREET

Presentation Overview

- Background and Context
  - MODA Overview
  - NCHRP Research
- NCHRP Project 08-103 Case Studies
  - Arizona DOT
  - Delaware Valley Regional Planning Commission (DVRPC)
  - California DOT (Caltrans)
  - Maryland DOT and Maryland State Highway Administration (SHA)
- Lessons Learned

Cross-Asset Resource Allocation Overview

- Factors to consider when deciding how to invest across assets and investment areas (e.g., safety, mobility, asset preservation)
  - What's the right investment strategy for a given asset?
  - How do I incorporate broader agency goals and objectives in project-level decisions?
  - How do I prioritize investments across assets and investment areas given funding limitations?
- Typical strategy is to divide asset/investment types into group and allocate within asset/investment type
- More recently agencies have begun to revisit cross-asset resource allocation approaches



Application of MODA to Cross-Asset Investments

- Multi-Objective Decision Analysis (MODA) provides an approach for prioritizing cross-asset/multi-objective decisions
- Basic approach
  - Define a utility or value function incorporating an agency's objectives
  - Calculate the utility/value for individual candidate projects (or groups of projects)
  - Prioritize considering the utility of each candidate and its cost
- Also referred to using Multi-Criteria Decision-Making (MCDM) or other acronyms
- Potential benefits
  - More efficient and effective use of funding
  - Improved system performance
  - Improved transparency and repeatability

Challenges in Applying MODA

- Defining the scope of the analysis
  - Often end up prioritizing projects within a selected set of investment categories for a single decision period
- Developing a set of candidates
  - Where do these come from?
- Defining the utility function
  - Can be hard to quantify goals and objectives – and then obtain needed data
- Weighting objectives
  - Often the Analytical Hierarchy Process (AHP) is used to establish weights through a set of pairwise comparisons
  - Other approaches, such Data Envelopment Analysis (DEA) circumvent need for this additional step

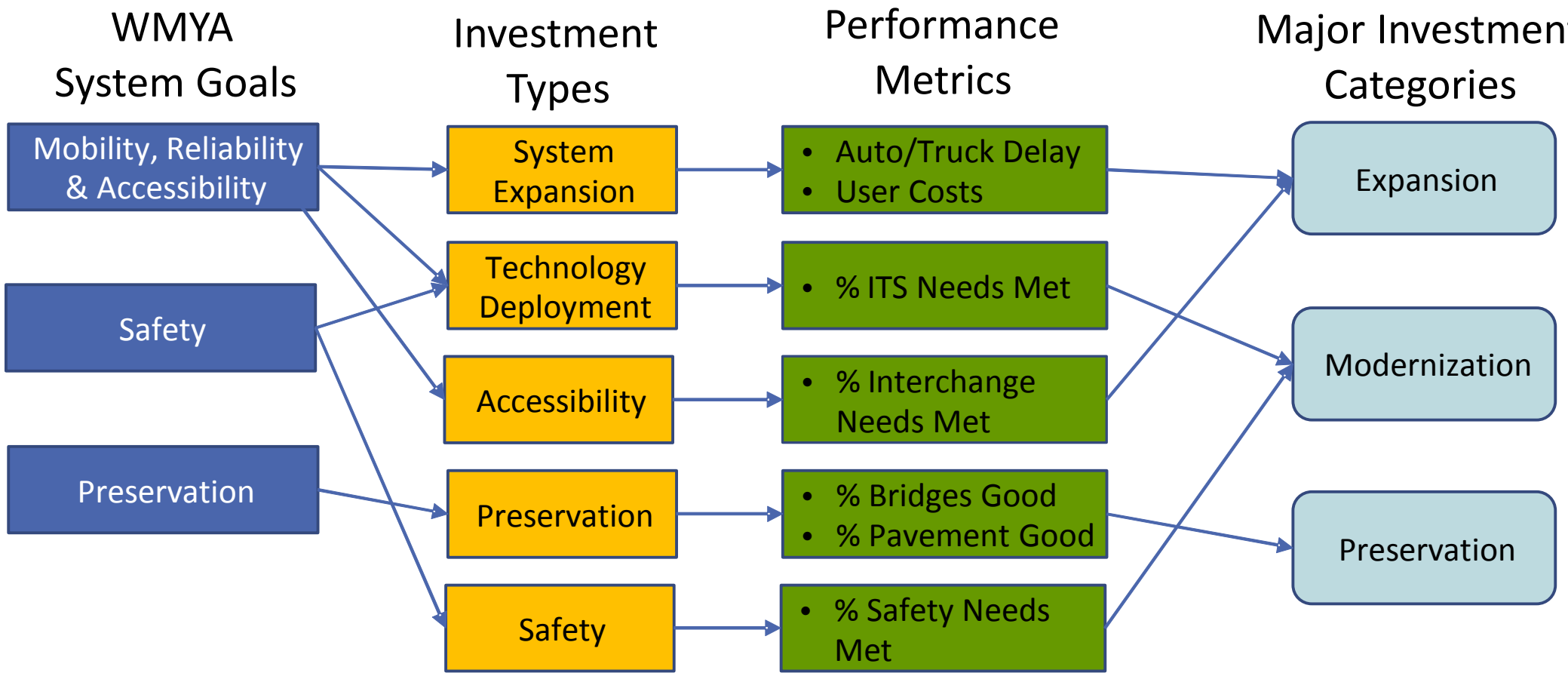
NCHRP Research in Cross-Asset Resource Allocation for Transportation Asset Management

- NCHRP Project 08-91 (2015)
  - Initial effort to research cross-asset resource approaches for transportation asset management
  - Resulted in NCHRP Report 806: Guide to Cross-Asset Resource Allocation and the Impact on Transportation System Performance – and a prototype tool
  - Project team: CH2M Hill, High Street Consulting and Burns & McDonnell
- NCHRP Project 08-103 (scheduled for completion in 2018)
  - Objective is to implement the framework and prototype tool from NCHRP Report 806 through a set of case studies
  - Will also result in revised spreadsheet and web tools building on the previous research
  - Performed an initial “beta test” with Utah DOT followed by a set of four case studies
  - Project team: Spy Pond Partners, High Street Consulting and Burns & McDonnell

Arizona DOT Case Study

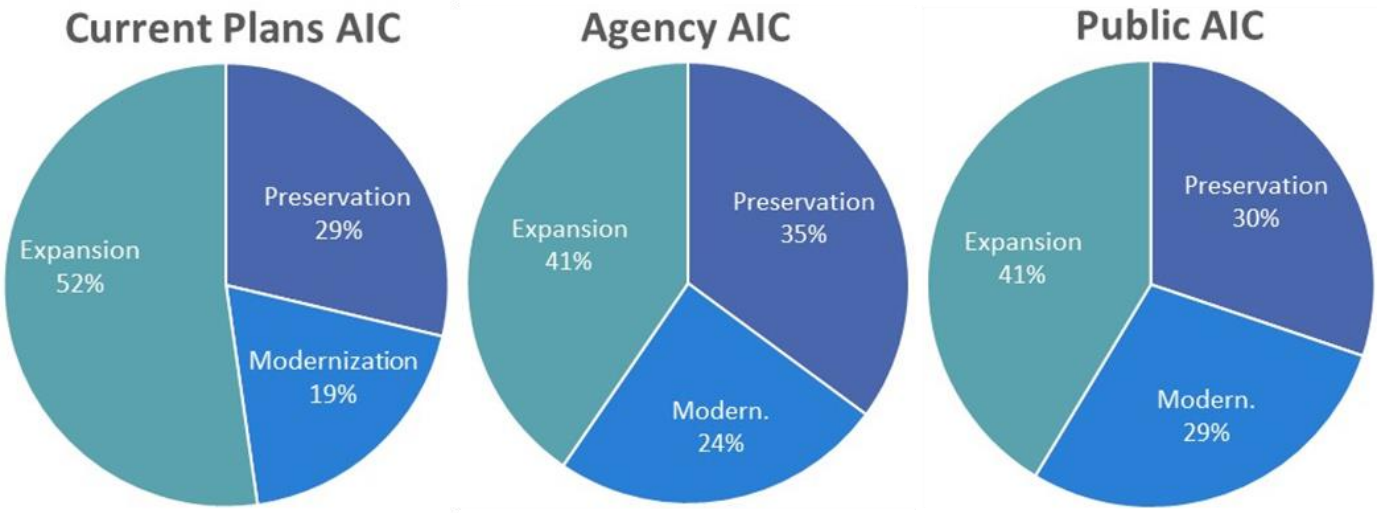
- Used MODA for the long range plan updates
  - What Moves You Arizona (WMYA) 2035/2040
  - High-level approach for determining how to allocate between different investment areas
- Established “Alternative Investment Choices” (AICs) and “Recommended Investment Choices” (RIC) to identify desired allocation of resources between highway preservation, modernization, and expansion
  - WMYA 2035 RIC based largely on qualitative assessments of expected system performance
  - WMYA 2040 RIC more data-driven approach and performance-informed

Framework for AIC/RIC Development



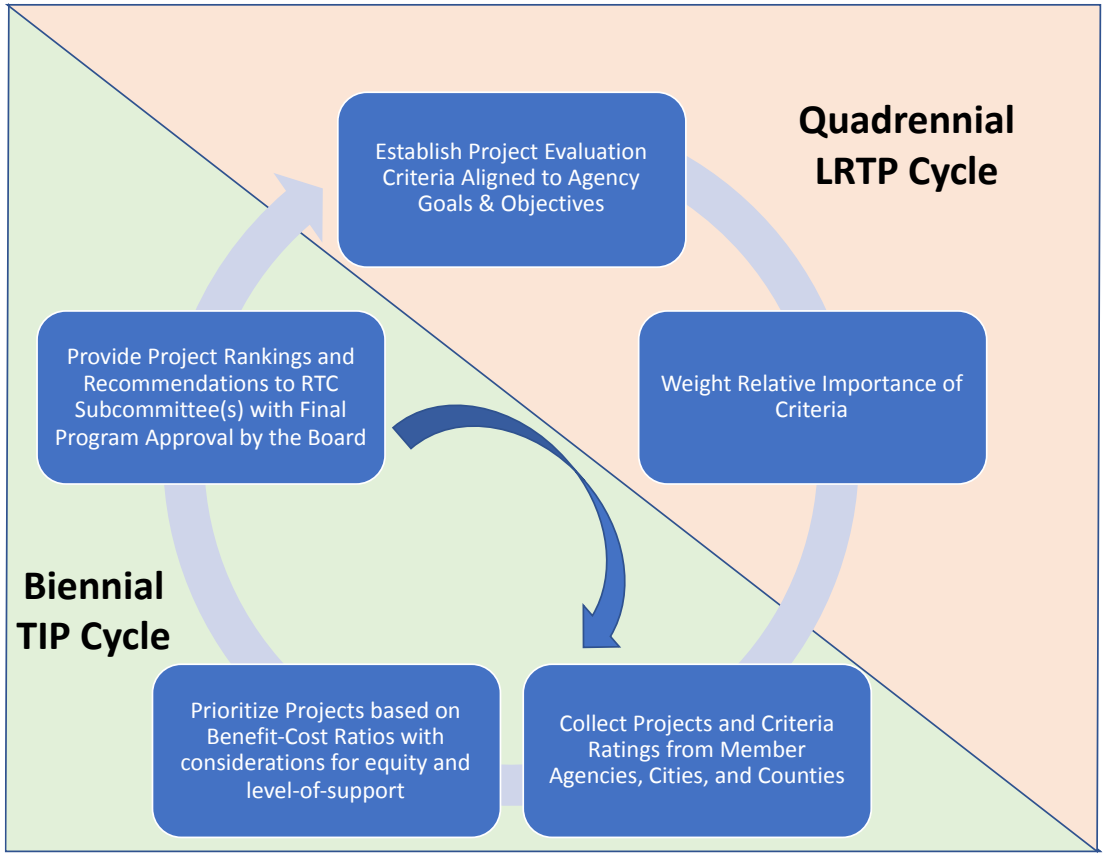
Scenario Analysis

- Established performance curves to define anticipated performance outcomes
- Performed pairwise comparison to determine priority weight on goals
  - Utilized Decision Lens software
- Presented scenario analysis results at workshop attended by stakeholders



Delaware Valley Regional Planning Commission (DVRPC) Case Study

- DVRPC Role
  - Establishing the region's long-range metropolitan transportation plan
  - Leading bi-annual development of Transportation Improvement Programs (TIPs)
- Utilizing a MODA approach for project evaluation and selection in the TIPs



Establishing Project Evaluation Criteria: Principles

- Alignment with planning goals and objectives
- Differentiating to produce a clear ranking
- Representative of all member counties
- As quantitative as possible
- Measurable using regularly available data
- Relevant for a diverse set of projects
- Comprehensive to cover regional goals
- Simple with concise, non-redundant measures
- Understandable for any audience

Project Scoring and Selection

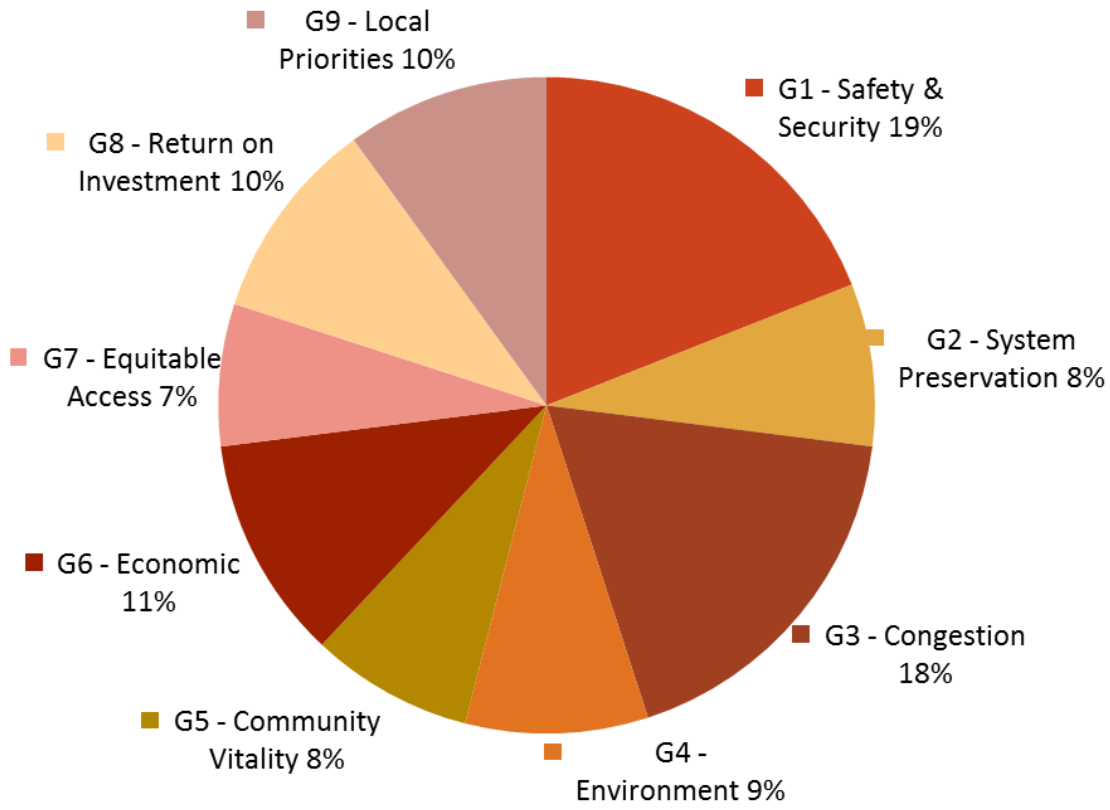
- Used pairwise comparison to select priority weights on evaluation criteria
- Calculate score/cost for each candidate projects
- Regional Technical Committee recommends final project selection considering:
  - Score/Cost value
  - Geographic equity
  - Contribution to fostering a multi-modal system
  - Level of political support
- Process and projects (but not numerical scores) are made available for public comment

Maryland DOT Case Study

- Implementing state legislation for prioritizing major expansion projects over $5 million for inclusion in the Consolidated Transportation Plan (CTP)
- Evaluating projects across 9 goals and 23 measures established in the legislation
- Conducted series of workshops to determine evaluation criteria for each measure based on available data and resources
  - Wherever possible utilized quantitative methods
  - Qualitative evaluation criteria used in some cases
- Implemented the resulting scoring approach in Citygate's iOpenDecision

Goals and Weights

- Utilized Delphi method to establish the weights on each of the goals
  - Stakeholders vote on the weights for each goal
  - Discuss difference of opinion
  - Ultimately reach consensus



Maryland DOT State Highway Administration Case Study

- For the NCHRP pilot tested an adapted version of the methodology used for MDOT to prioritize highway asset management projects
- Adapted methodology includes 4 goals and 7 measures
  - Safety (1 measure)
  - System Preservation (1 measure)
  - Mobility (2 measures)
  - Environment and Community (3 measures)
- Tested prioritizing by score/cost and using DEA
- SHA is evaluating pilot results and feasibility of future implementation of a MODA approach for helping prioritize

Cross-Asset Resource Allocation Tool: Data Entry

- After evaluating set of sample projects, data and scores were used in the cross-asset resource allocation tool

Performance Measures for Analysis

Project-Level Performance Measure	*Program Objective*
Goal A Measure 1	Maximize Total Goal A Measure 1
Goal B Measure 1	Maximize Total Goal B Measure 1
Goal C Measure 1	Maximize Total Goal C Measure 1
Goal C Measure 2	Maximize Total Goal C Measure 2
Goal D Measure 1	Maximize Total Goal D Measure 1
Goal D Measure 2	Maximize Total Goal D Measure 2
Goal D Measure 3	Maximize Total Goal D Measure 3

Input performance measures and weights

Performance Measure	Weight
Goal A Measure 1	35.00%
Goal B Measure 1	35.00%
Goal C Measure 1	7.50%
Goal C Measure 2	7.50%
Goal D Measure 1	5.00%
Goal D Measure 2	5.00%
Goal D Measure 3	5.00%

Cross-Asset Resource Allocation Tool: Sample Ranking

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

Project Name	Investment Area	Cost	Overall Score	Overall Score/Cost
Project 10	System Preservation	4635	0.706	1.000
Project 9	System Preservation	6180	0.706	0.750
Project 7	System Preservation	5068.8	0.461	0.596
Project 1	Bridge Replacement	8607	0.590	0.450
Project 6	Widen Roadway	24889	0.554	0.146
Project 4	Widen Roadway	18109	0.218	0.079
Project 2	Bridge Replacement	51333	0.574	0.073
Project 8	System Preservation	21294	0.227	0.070
Project 5	Widen Roadway	121211	0.864	0.047
Project 11	TSM&O	151000	1.000	0.043
Project 3	Mobility and Safety	105407	0.304	0.019

Cross-Asset Resource Allocation Tool: Sample Budget Allocation

Overall Budget	Current Allocation
$345,156	$315,401

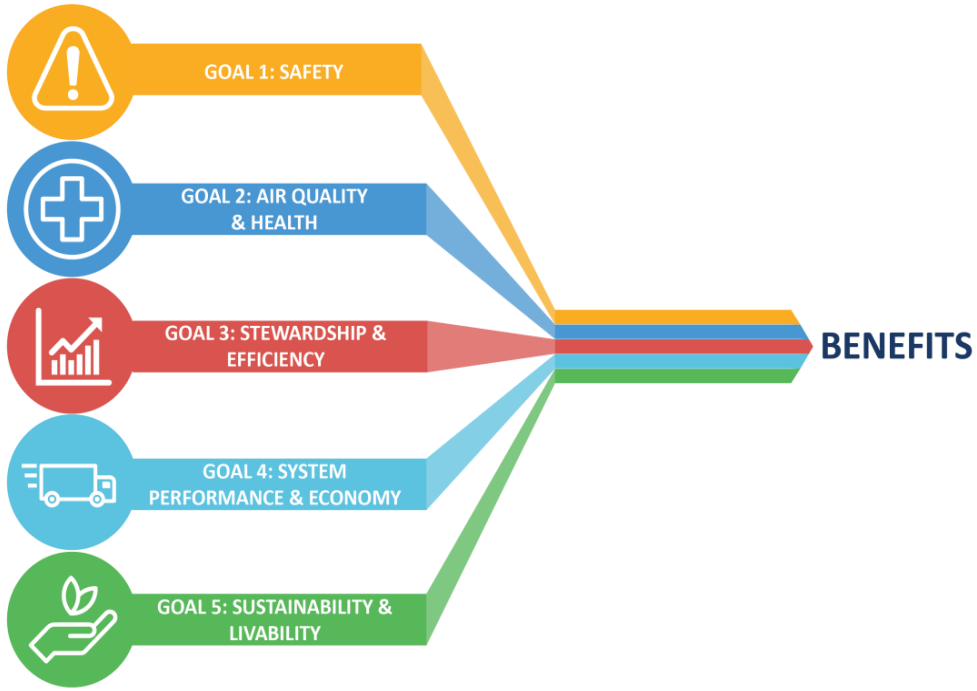
Program Score
74.63%

Investment Area	Minimum Allocation	Maximum Allocation	Current Allocation	Current % Allocation
TSM&O	0	$151,000	$0	0.00%
Widen Roadway	0	$164,209	$164,209	52.06%
System Preservation	0	$37,178	$37,178	11.79%
Bridge Replacement	0	$59,940	$8,607	2.73%
Mobility and Safety	0	$105,407	$105,407	33.42%

Project Name	Investment Area	Cost	Funding Status
Project 11	TSM&O	$151,000	No Build
Project 5	Widen Roadway	$121,211	Build
Project 10	System Preservation	$4,635	Build
Project 9	System Preservation	$6,180	Build
Project 1	Bridge Replacement	$8,607	Build
Project 2	Bridge Replacement	$51,333	No Build
Project 6	Widen Roadway	$24,889	Build
Project 7	System Preservation	$5,069	Build
Project 3	Mobility and Safety	$105,407	Build
Project 8	System Preservation	$21,294	Build
Project 4	Widen Roadway	$18,109	Build

Caltrans

- Utilizing MODA to prioritize projects in the California State Highway Operation and Protection Program (SHOPP)
- Evaluating projects across 5 goals and 12 measures
- Exploring Data Envelopment Analysis (DEA) as an option for prioritizing goal scores
  - Results highly correlated with score/cost ratio ranking
- Next presentation further details this case



Lessons Learned

- Importance of structuring the problem
  - Scoring criteria should be easy to understand
  - Avoid creating overlapping or ambiguous measures
  - Establishing criteria for good/fair/poor conditions or high/low scores as applicable
- Data issues
  - Often hard to get quality data needed to support the process
  - Where data are not available tendency is to fall back on subjective scoring approaches
- Many different options for implementing MODA
  - Variations of goals/objectives and measures
  - Approaches for weighting objectives: AHP vs. Delphi vs. DEA
  - Systems to support the process, including COTS system and NCHRP tools

Thank You!

Contact information

For more info, please contact us at
wrobert@spypondpartners.com

spy pond partners, llc