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Caltrans Division of Research, Innovation and System Information

Research Notes

Cross-Asset Optimization Model Development Services

Review current Caltrans multi-objective decision analysis (MODA) model and its application for developing the latest State Highway Operation and Protection Program (SHOPP) project portfolio.

Executive

SEPTEMBER 2019

Project Title:
Cross-Asset Optimization Model Development Services

Task Number: 3631

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WHAT IS THE NEED?

Over the past few years, California Department of Transportation (Caltrans) has been striving to optimize strategies and programs for preserving and improving its vast transportation network. As part of its business strategy to enhance transportation asset management (TAM), Caltrans needs to develop cross-asset optimization decision models to support the prioritization and optimal programming of improvement and replacement projects across all highway system assets.

Cross-asset multi-objective optimization can help Caltrans optimize project selections and budget allocations while considering overall portfolio performance targets and risk levels. Analyzing assets at the portfolio level provides the opportunities to find investment and work efficiencies through coordination of program development, management, and project delivery across different asset classes.

Bringing a broader perspective to the portfolio planning process over longer planning horizons would help maximize the value of investment and enable Caltrans to achieve overall performance targets by directing investments where most needed.

However, developing cross-asset optimization models for a large transportation asset portfolio poses several modeling and computational challenges. This project will address these challenges to help Caltrans optimize strategies and programs for preserving and improving its transportation asset portfolio.

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WHAT ARE WE DOING?

This project investigates the application of an innovative cross-asset risk-based multi-objective optimization model to optimize budget allocation and generate long-range network-level project portfolios. The optimization model will be used to support the development of 10-year optimal plans under a range of scenarios and investment strategies, with an initial focus on bridge and pavement assets.

The optimization model and associated tools will support program development decisions through quantitative analysis of investment and strategy trade-offs.

The model will efficiently evaluate all feasible projects for assets improvement/replacement to identify "best value" (or optimal) project portfolios for each year in the planning horizon under any given planning scenario. The model will also evaluate the impact of different funding levels on system performance and risk metrics and determine required funding levels to meet performance and risk targets.

WHAT IS OUR GOAL?

The goal of this project is to enable efficient prioritization and optimal programming of projects across highway system assets. The deliverables of this project include a detailed report that will document the development of the cross-asset optimization model and its application to develop 10-year cross-asset optimized project portfolios for Caltrans bridge and pavement assets under a range of planning scenarios.

The report will describe the development of performance and risk models, optimization objectives and constraints, actions models, results of various planning scenarios, and cross-asset optimization.

WHAT IS THE BENEFIT?

The project extends Caltrans' current MODA methodology with cross-asset multi-objective optimization model that will help Caltrans make optimal programming and investment decisions to meet organizational objectives and performance metrics.

The optimization model leverages advances in data analytics and artificial intelligence to deliver a complete cross-asset capital planning optimization framework, that will help Caltrans better manage assets and deliver optimized long-range programs for its entire transportation asset portfolio.

The project will help Caltrans develop cross-asset optimization decision models to:

- Support the prioritization and optimal programming of improvement and replacement projects across all highway system assets; and
- Identify optimal budget allocation and balanced investment strategies across different highway asset classes to meet organizational objectives and performance metrics.

WHAT IS THE PROGRESS TO DATE?

The project started with a review of Caltrans' current MODA model and processes for developing the SHOPP project portfolio. The work to date also involved gathering of bridge and pavement data.

The next step will include the development of performance, risk, actions models, and planning scenarios for selected bridge and pavement assets. The cross-asset optimization model will be developed and used to optimize budget allocation and balance investment strategies across different asset classes.

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IMAGE

San Francisco–Oakland Bay Bridge, part of California Interstate Highway 80, spanning the San Francisco Bay

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