MONTANA
Department of Transportation
Research

Technical Brief

About This Research

Objectives

- Identify the most influential factors that impact highway project duration
- Create an AI model to estimate project times
- Develop a tool that operationalizes the model

Benefits

- Quick and efficient project duration estimation method
- Effective tool for tracking project progression

USING ARTIFICIAL INTELLIGENCE TO ESTIMATE CONSTRUCTION PROJECT DURATION

AI-PDET, a new AI-based tool, estimates construction project duration, reducing the complexities involved in predicting construction time.

Research Need

The duration of a transportation construction project can impact bids and final cost, inconvenience the traveling public, and even influence work quality. Conversely, multiple aspects of a project, including cost, type and quantity of work performed, and project location may impact its duration.

Accurately estimating overall project duration in planning or preconstruction stages when information is limited can be challenging. A previous research project developed a tool to estimate the production rates of certain project work tasks. In the current study, the Montana Department of Transportation (MDT) was interested in a method that would estimate a project's overall duration.

Artificial intelligence (AI) techniques are capable of processing data to recognize patterns among multiple variables, even among nonlinear relationships, and predict outcomes. Analyzing historical construction project data with AI technology could produce a quick, reliable and defensible method for accurately estimating a project's overall timeline.

Research Process

A review of other state department of transportation (DOT) practices for estimating transportation project duration helped identify current methods and key project characteristics that impact the length of a project. MDT staff provided data from

About This Project

Project title: Artificial Intelligence (AI) Based Tool to Estimate Contract Time

Project number: 9929-819

Technical Panel

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"The tool developed in this project will be very useful for estimating project timelines in early planning stages and potentially throughout a project to track progression"

—Brett Harris, Project Champion

more than 1,000 state highway projects conducted from 2008 to 2019. Data included project location and type, work items and quantities, costs, and actual project durations. Using this data, researchers created a transportation project database to identify trends and support the development and testing of an AI model and project duration estimation tool.

A preliminary analysis revealed the most common project types, work items, and other variables, and identified correlations between project duration and other factors. Variables with the most significant correlations or influence on project duration provided the basis for the development of the model and served as independent variable inputs.

The analysis weighted and processed the inputs drawn from projects in the database to develop the model's algorithm and produce an estimate of project duration. To optimize the algorithm, the machine learning cycle continued adjusting the weights until the output estimations converged with the actual project durations contained in the database. Researchers then identified the most influential variables to maximize the model's computational capacity.

A regression model applied to the same dataset was used to describe the statistical relationships between the variables. These results served as a comparison to the performance of the AI algorithm.

Research Results

The AI model estimated construction project timelines with sufficient accuracy to produce a spreadsheet tool that MDT can use to determine the most probable project duration based on known parameters. The AI model slightly outperformed the regression model used by many state DOTs, but results were very similar.

From 60 input variables, the model identified the top 26 project factors most highly correlated to project duration. Estimated construction cost showed the most significant correlation followed by traffic control work items, including the number of devices needed during construction. Other significant work items that influenced project duration included the use of drainage pipes less than 24 inches in diameter, crushed aggregate base course, and seeding. Contrary to a previous assumption, project location did not significantly influence project duration.

The Artificial Intelligence (AI) Based Project Duration Estimation Tool (AI-PDET) developed in this project allows an MDT user to enter planned calculated construction cost and work item variables to produce an estimated time a project will take to complete. The initial screen includes clear instructions for using the tool, which also produces a project duration estimate from the statistical regression model. This option helps illustrate that while the tool does not provide complete certainty, it produces results consistent with proven methods.

Researchers also provided detailed guidance for updating and enhancing the model's performance, including adding data from more construction projects, running the provided code, and updating the spreadsheet tool.

Research Implementation

The AI-PDET provides a method for analyzing large quantities of data to estimate project duration. A pilot project is planned that will track the tool's performance against actual project times. MDT project designers can use the tool immediately to check initial estimates, and project managers can update time estimates as projects progress and more information becomes available.

MDT Project Champion

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Learn More About This Project

Final report is available in ROSA P.