AECOM

DRIVING INNOVATION PRODUCTIVITY AND EFFICIENCY

IMPROVING INFRASTRUCTURE

COST ESTIMATE ACCURACY

Cost intelligence leads **Edward Day** and **Tristan Harvey-Rice** explain how using machine learning and assembly tools can lead to more precise cost estimates faster and using fewer resources than traditional cost modelling approaches.

Large infrastructure projects are notorious for costing more than originally planned, with industry research suggesting overruns can be as high as 45 per cent for rail projects, 34 per cent for bridges and 20 per cent for road projects.

Infrastructure contractors and operators need to establish cost estimates early on in a project to determine project feasibility, secure funding, meet regulations and demonstrate value for money.

Water companies, for example, undergo a price control every five years for the water regulator, Ofwat, whereby they provide projected costs for future works.

While public-funded projects that go over budget can negatively impact on people's perception of the project, making it harder for the project to progress, the macro-economic consequences of project overruns are even more serious. Projects that steer completely off budget can end up being cancelled.

> **"WE'VE DEVELOPED TWO SMART WAYS TO PRODUCE MORE ACCURATE COST ESTIMATES IN EACH SITUATION MORE QUICKLY.**

However, the earlier on in a project's lifecycle, the less is known about the specific details of what actually needs to be built and a site's unique characteristics and how they will affect the final cost.

Typically, contractors and infrastructure organisations will create early stage project estimates manually, using models derived from data based on projects they've previously delivered. They then amend the costs as a project progresses and the actual project scope and associated costs become known.

> LEVERAGING MACHINE LEARNING IN THIS MANNER ALLOWS THOUSANDS OF COST DATAPOINTS TO BE EXTRACTED AND ANALYSED IN A FEW DAYS BY JUST ONE SUITABLY EXPERIENCED DATA SCIENTIST.

However, this modelling approach typically considers just one or two variables or characteristics of each asset/cost, such as the diameter of a piece of pipe and the surface it is being installed into. This is because traditional modelling techniques are largely carried out manually with analysts inspecting data 'by eye' to identify correlations. This leads to models that use only a few cost drivers to create estimates.

Additionally, while some organisations have a lot of historical project data, many don't have the tools, people or time to crunch the data to get the most accurate costs out of it. On the other hand, some organisations don't have enough historical data to generate accurate estimates from in the first place.

CLICK HERE TO SEE MORE ON HOW TO IMPROVE INFRASTRUCTURE COST ESTIMATE ACCURACY

We've developed two smart ways to produce more accurate cost estimates in each situation more quickly and that require fewer resources to perform compared to traditional methods.

TOO MUCH DATA?

MACHINE LEARNING APPROACH

Our machine learning (ML) cost model approach uses algorithms to detect relationships between many different characteristics, or variables, of a project and their cost, as opposed to just one or two as with the more traditional methods. This leads to greater certainty of costs because it allows more sophisticated relationships between the variables to be discovered, removes subjectivity and uses more of the available project scope detail. Organisations with a lot of good quality historical data therefore benefit most from using the ML approach.

We've trialled the approach to derive and train an algorithm that can estimate costs using all available asset characteristics, using AECOM historical data for several hundred pipe laying projects with actual costs. We've analysed the project cost characteristics such as the length, diameter and ground condition of pipes, using the traditional manual modelling approach, followed by our ML approach. While the traditional approach estimate was eight per cent out from the total actual cost, our ML estimate was less than four per cent out, an increase in accuracy of 50 per cent.

CLICK HERE TO SEE MORE ON HOW TO IMPROVE INFRASTRUCTURE COST ESTIMATE ACCURACY

Leveraging ML in this manner allows thousands of cost datapoints to be extracted and analysed in a few days by just one suitably experienced data scientist, achieving results that outperform those that would previously be produced by an entire team of analysts using traditional methods.

NOT ENOUGH DATA?
ASSEMBLIES TOOLS

Being able to track cost changes throughout a project gives a better understanding of the reasons why budgets may be exceeded and therefore where to target efficiencies. It also improves overall learning about specific costs for future estimating and allows greater management over change events and the contractual disputes that can arise from them. However, more traditional cost estimating methods provide very little visibility of why a cost changes from initial estimates to actual costs. In an effort to move away from obscure budget figures that are not based on any asset breakdown or scope build up, we have developed asset assemblies tools, which use high-level design parameters or characteristics to assemble a full bottom up bill-of-quantities estimate at unit or resource level.

Our assemblies tools:

- are helpful for organisations with little of their own information to base estimates on
- use Excel as a platform
- can also be embedded into existing cost estimating systems
- provide generic asset models based on agreed defined specifications taken from assets previously built by an organisation as well as on the organisation's own standard design specifications
- provides a fully detailed estimated asset cost using the bare minimum of information, such as basic asset dimensions, using design assumptions to 'fill in' scope detail that was initially absent
- allows teams to explore procurement strategies with little effort
- can be used to quantify carbon and construction duration.

As a project progresses and actual design and cost information becomes available, asset details and actual costs can be added to the model, updating the bill of quantities produced and providing fully-detailed cost breakdowns that can be compared throughout all project gateways, showing reasons for budget changes and providing an early warning that budgets may be exceeded, giving greater time for challenge or mitigation.

> **"WE'VE BUILT A NUMBER OF ASSEMBLIES FOR HIGH SPEED 2 WHICH FORM PART OF A SUITE OF ESTIMATING TOOLS BEING USED TO VALIDATE THAT THE PROJECT IS ACHIEVING VALUE FOR MONEY.**

We've built a number of assemblies for High Speed 2 which form part of a suite of estimating tools being used to validate that the project is achieving value for money. Separately, we're producing assemblies for the Environment Agency as part of its ongoing internal estimating system development and have been commissioned by Gatwick Airport to produce asset assemblies to benchmark tender returns.

Through development of new techniques such as machine learning and asset assemblies, AECOM is re-defining best practice in estimating and benchmarking, helping organisations improve their investment decision-making and ultimately secure value for money for their customers and shareholders.

Find out more about our cost estimating capabilities here. WL