Construction Cost Inflation Model

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Problem Statement

The Wyoming Department of Transportation (WYDOT) utilizes a continuous and comprehensive planning process to determine transportation system project selections. Engineering studies, performance management analysis, asset management systems, and professional judgment of engineers are used to select the transportation system projects that are incorporated into the Statewide Transportation Improvement Program (STIP).

Federal legislation requires state departments of transportation to consider and apply inflation, but do not tell them how to do so. In 2007, WYDOT developed a framework to address inflation. The key issue was, as inflation changed over time, it was not being consistently applied to the life of STIP projects, which was causing projects to move in the STIP due to lack of budget. An inflation committee was established within WYDOT, composed of the State Construction Engineer, State Programming Engineer, Budget Program Analyst, a District Engineer (on a rotating basis), and led by the Contracts and Estimates Office program manager.

Last year, the Contracts and Estimates Engineer presented three construction cost index (CCI) calculation methods his office has historically used, along with the corresponding results when including 2021 data. First was the Spear method that was developed by the previous Contracts and Estimates Engineer. It compares the current year's data to a 10-year data set average, starting in 1997. Second was the Rolling 10 method. This method uses a "rolling" 10-year data set that takes into account the last 10 years, including the present year, to calculate averages for comparison. Third was the Fisher method that compares the current year to the previous year.

There are a few flaws with the CCI methods used. The Spear and Rolling 10 methods struggle with years where the product bundle purchased deviates away from the average. The Fisher method focuses on recency, which may overemphasize years, like 2022, where we have irregularities with inflation. Using a data driven approach that covers both estimated prices and quantities may alleviate the problems with previous methods.

Committee members discovered there are many different calculation methods and indexes out there with wide ranges of results. The committee came to the conclusion that they do not have the expertise nor background to determine which calculation methods and indexes are the most appropriate for WYDOT's business needs. The committee based their inflation recommendations on the Contracts and Estimates Engineer's recent contracts and estimates observations, the Rolling 10 method, and Fisher method for construction cost calculations. Committee members recommended using an inflation rate of 4.5 percent for projects within the STIP and 4 percent inflation for long term asset management purposes. These projected rates fell well short of actual inflation in 2022, which using the methods mentioned above was over 50 percent in 2022. The committee recommended that WYDOT look into a research study to help determine how, and by whom, inflation rates should be calculated.

Background Statement

The STIP is a continually updated snapshot of planned construction, construction engineering, and preliminary engineering costs of the projects and the splits in funding sources (Federal, state, local, and other) for each project. It is a six-year, fiscally constrained program that is approved annually by the Transportation Commission. The current STIP program is fiscally constrained for the years 2023-2028.

Changes in state and Federal funding, construction costs, re-evaluation of priorities, economic conditions, and conditions of roadway assets can and do occur during the year, making the scheduling of projects a complex undertaking and requiring the STIP to be fluid. Changes to the STIP are approved by the Transportation Commission.

The Federal Highway Administration (FHWA) developed the concept of a highway construction cost index (HCCI). An HCCI uses data from construction bids to determine which factors, ranging from asphalt to traffic control, are moving the most and driving the market bids on construction. The most common categories in HCCIs are as follows: Asphalt, Base Stone, Bridge, Concrete, Drainage, Electrical, Grading/Excavation, Traffic Control, and Utilities.

The Contracts and Estimates Engineer has tracked a WYDOT-specific CCI that includes Excavation, Crushed Rock, Mainline Asphalt, Performance Grade Binder, Non-Performance Grade Binder, Tack, Concrete Pavement, Structural Steel, Class Concrete, and Reinforcing Steel. This data has aggregate information on amount used and unit prices. This data is rather useful, but is only updated annually.

The current method for determining inflation is left to the inflation committee, which has no economists on it. The methods used, such as averages and rolling averages, are rather simple and do not adapt quickly when inflation changes. Using an HCCI that is updated on a regular basis would provide both an objective estimation of inflation and incorporate economic data in their inflation calculations.

Literature Review

The literature shows that highway construction cost underestimation is not unique to Wyoming and WYDOT. Wilmot and Cheng developed cost estimation indices for Louisiana to improve estimations. Kyte developed a highway construction project cost estimation tool.

The methods used to estimate costs can vary substantially. Adeli and Wu used neural networks to estimate highway construction costs in Ohio. Chou and O'Connor used statistical modeling to improve cost estimates for the Texas Department of Transportation. Karaca, Gransberg, and Jeong ran through both neural networks and machine learning techniques on the Montana Department of Transportation early estimates.

However, this project focuses more on highway construction cost inflation, which is more specific and less researched. Gransberg and Diekmann studied California and South Dakota highway construction cost inflation to see if there is a difference between urban and rural inflation. They found that inflation in urban California was less volatile than rural South Dakota's inflation. We should expect Wyoming's inflation to be volatile as it is the least populous state and second to last in population density. This reaffirms the need for better inflation estimation techniques.

O'Brien, Rubin, and Brown used a survey of contractors to determine the drivers of highway construction bid inflation. Their research found that labor costs account for nearly 40 percent of project costs. They also found that lack of competition, elevated input costs, and project type and size are the most important factors driving bid inflation.

The closest study to what this project is proposing is Qin, Wang, and Wang. They were modeling the best interest rates, inflation rates, and discount rates to use for infrastructure investments in South Dakota. They used BID TABS software to extract information on eight inputs in construction: Unclassified

Excavation, Liquid Asphalt, Asphalt Concrete, Gravel Cushion, PCC Pavement, Class A Concrete, Reinforcing Steel, and Structural Steel.

Objectives

The first objective of the project is to identify the current inflation estimation practices, past estimates, and past actuals to develop a baseline of estimation performance. By establishing a baseline, we can compare how well the proposed model performs against past practices. If the model performs better than past practices, the project should be continued. If the model performs the same or worse, a new model should be pursued.

The second objective of the project is to use the Producer Price Indices (PPI) for the nine common categories in HCCIs to create material-specific inflation for those nine areas. The HCCI approach to cost estimation follows a method set up by the FHWA. PPI data is reliable and reported relatively quickly (within a month or two of collection). PPI data also allows for inflation calculations and estimates on a regular basis, as the data is reported on a monthly basis.

The third objective of the project is to create a model to project inflation rates several years into the future as highway construction projects may last several years. If successful, this will give a better estimation of long-term project costs and fewer projects will be delayed due to cost overruns and funding reallocations.

Project success will be measured simply. The project is successful if the collective cost estimations are closer to actual costs than previous methods used.

Benefits

Closer cost estimations will help WYDOT more accurately predict project costs and mitigates shuffling of projects and how they are funded. This data driven method allows for the models to be updated annually. Data may be housed in multiple locations and dashboards may be built on the Center for Business and Economic Analysis website, wyomingeconomicdata.com.

Better cost estimations will improve WYDOT operations as budgeted costs should more closely follow actual costs. This means fewer cost overruns, fewer delayed projects, and fewer canceled projects. This also helps with public relations, as there will be fewer projects that run over their allotted budget and the method being used is one suggested by the FHWA.

This project also establishes a connection between WYDOT and the CBEA at LCCC. If future economics-related issues pop up at WYDOT, there is now a reliable and known economist to reach out to.

Applicable Questions

Are there any potential barriers to implementation?

One potential barrier is continued funding for the project. If the data is to be collected, housed, and reported on an annual basis, there needs to be an annual budget to pay for the data collection, housing, and reports. The report budget will be small portion of WYDOT's overall budget and shouldn't be much of a barrier.

What is the expected period for implementation?

WYDOT has suggested annual updates for inflation figures. Since WYDOT has an October-September fiscal year, annual updated inflation for the year moving forward may be provided on November 1st, shortly after the fiscal year begins and before the major construction bid season in January and February. The project, if successful, could be repeated with annual reports coming out on November 1st.

Does the project involve action on Federal lands or other conditions that will require National Environmental Policy Act (NEPA) documentation and/or forest service or other permits?

No.

What are the major uncontrollable factors and/or unknowns in the project such as weather, wildlife, material properties, traffic, etc.? For each uncontrollable factor, address whether there could be additional costs or delays.

There should be no uncontrollable factors. The data to be used is publicly available and updated on a monthly basis.

Should the project be segmented into phases with go/no-go decision points based on known unknowns?

The project should be halted if the models prove to be less useful than the previous methods used.

If the project involves evolution of one or more technologies, is a technology road map provided showing how these technologies fit together?

The project doesn't involve evolution of technology.

Will a Buy American Waiver be necessary?

No.

Will any data produced by this project be considered confidential or sensitive?

No. All data to be used is publicly available.

Will the data and/or report from the final project be copyrighted, patented, or trademarked?

No. All data to be used is publicly available. Reports will be made publicly available.

Statement of Work

A) Work Plan/Scope

The initial piece of the project will be gaining a better understanding of construction cost inflation estimates. We should use estimated versus actual costs of projects to gather information on well current forecasting methods are working.

The second step of the project will be gathering PPI data for the nine areas used in HCCIs. Data will be collected from the Federal Reserve Economic Data (FRED). We can calculate material-specific inflation using the FRED data. We will also gather wage data on construction labor from the Bureau of Labor and Statistics (BLS). This data can be used to determine wage inflation for projects. This is important as O'Brien, Rubin, and Brown found that labor makes up nearly 40 percent of construction costs. All data

will be collected in Excel and may be converted into a Tableau dashboard per WYDOT's want and approval.

The third step in the project is building an inflation model using the nine HCCI areas' PPIs and labor cost data. The model will be built in two phases. Phase one is collecting inflation estimates for the cost areas. Phase two is using cost area weights, determined by previous actual purchases, to determine total construction inflation for the upcoming year and several years.

The fourth step will be ongoing updating of information used in the model. Updates would be provided on an annual basis. All databases and dashboards would be updated concurrently with the annual report.

Databases will be built and maintained in Excel. Databases will be shared with WYDOT on an annual basis. Dashboards, if WYDOT wants them, will be built in Tableau and presented on the CBEA website.

B) Work Schedule

By July 1, 2023, estimated versus actual cost analyses should be completed. By September 1, 2023, all FRED and BLS data through 2022 should be collected and entered into Excel. By November 1, 2023, the first inflation estimates and models should be completed and compared to previous estimation efforts in a report compiled for WYDOT.

After the first report, WYDOT and the CBEA may work on future agreements on how the work is carried out, completed, and reported on. They may also work on multi-year agreements if the first report is acceptable and up to the standard of WYDOT.

Budget

The first year of the project will cost more because more data collection and analysis work will be done. If the model is successful and the project is continued, each additional year will be less costly than the first year because the project will be primarily upkeep after the first year.

Year 1 Budget

Description	Budgeted Amount	Explanatory Note
Direct Costs		
Principal Investigator	$6,750	$750/month for nine months (February through October). $750 is $75/hour consulting rate at 10 hours per month.
Other Personnel	$0	
Fringe Benefits	$3,150	Medicare, FICA, Health Insurance, Life Insurance, Retiree Insurance, Retirement Benefit
Research Travel	$0	Principal Investigator lives in Cheyenne where WYDOT is headquartered
Report Generation	$1,500	Estimated 20 hours at $75/hour consulting rate

Equipment	$0	Equipment used is provided by CBEA
Other	$0	
Technical Transfer		
Conferences/Report Presentation	$0	
Miscellaneous Travel	$0	Principal Investigator lives in Cheyenne where WYDOT is headquartered
Indirect Costs		
Project Administration	$0	
Indirect Costs	$1,700	15% of Direct Costs
In-Kind Match	$0	
Total Cost	$13,100	

Year 2 and Beyond Budget

Description	Budgeted Amount	Explanatory Note
Direct Costs		
Principal Investigator	$4,500	$375/month for one year. $375 is $75/hour consulting fee at 5 hours per month.
Other Personnel	$0	
Fringe Benefits	$2,300	Medicare, FICA, Health Insurance, Life Insurance, Retiree Insurance, Retirement Benefit
Research Travel	$0	Principal Investigator lives in Cheyenne where WYDOT is headquartered
Report Generation	$1,500	Estimated 20 hours at $75/hour rate – Assuming Annual Report
Equipment	$0	Equipment used is provided by CBEA
Other	$0	
Technical Transfer		
Conferences/Report Presentation	$0	
Miscellaneous Travel	$0	Principal Investigator lives in Cheyenne where WYDOT is headquartered
Indirect Costs		
Project Administration	$0	
Indirect Costs	$1,250	15% of Direct Costs
In-Kind Match	$0	
Total Cost	$9,550	

Implementation

The research, data collection, data storage, modeling, and report building will be carried out by the CBEA at LCCC. The models and inflation estimations may be reported on annually on November 1. The WYDOT Inflation Committee will be responsible for using the results for inflation estimations. This practice would replace the estimation methods used currently by the WYDOT Inflation Committee.

Technology Transfer

The models and inflation estimations should be reported annually to WYDOT by the CBEA. The report will include the methods and models used as well as inflation figures for the upcoming year and several years down the road.

Data Management Plan

The data to be collected will be labor cost increases and PPIs for nine areas: Asphalt, Base Stone, Bridge, Concrete, Drainage, Electrical, Grading/Excavation, Traffic Control, Utilities. Using those ten figures, inflation models will be built and inflation rates will be determined. Both the data from the PPIs and wage data will be provided to WYDOT with the annual report. A guide to data labels will be provided to help future users navigate which labels belong to which variables.

The data will be collected and housed by the CBEA and presented annually with a report for WYDOT. Data will be retained indefinitely by the CBEA. Data will be stored in Microsoft Excel files.

Citations

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