

Proposal to the Transportation Construction Management Pooled Fund

Construction Production Rates for Estimating Contract Time

May 12, 2015

Objective

The objective of this research is to develop a guide and tool to effectively estimate contract time for future construction project. This will improve the accuracy and consistency of estimating contract time, leading to shorter construction periods and reduced construction impacts to the traveling public. It will also improve the efficiency of creating estimates, thereby saving the designer's time.

The implementation product of this research study will be a contract time estimating tool that provides state transportation agencies the flexibility of estimating contract time across a broad range of project types. The tool will include a database containing state transportation agency historical project data that will be used to calculate production rates and data that characterize the production rates. The tool will also include parametric models that can be used to estimate contract time based on project quantities for specific project types based on both size and scope. For project types that do not adhere to any specific parametric models, the tool will also include a method to estimate contract time of specific construction activities and combining the activity durations in estimating the overall project duration. The databases within the tool will be constructed in MS Office Excel, and will include:

1. Relevant Historical Project Data that will be used to calculate Production Rates.
2. Production Rates, and/or the ability to calculate Production Rates.
3. Factors to apply to data, based on characterizing information.
4. A user's guide that explains how to use the database to generate Production Rates.
5. A method to use the database to estimate contract time based on significant project characteristics.

In addition to the described tool, the research will develop a research report that will include documentation of the research process, data collection, and the research results.

Background

It is in the best interest of the traveling public for state transportation agency (STA) construction projects to be completed in the least amount of time possible, to minimize lane closures and construction impacts. In addition, the public takes note regarding activity on construction sites and on occasion, STAs receives complaints when it appears that road construction is not being aggressively pursued.

Contractors sometimes fail to aggressively perform construction work when too much time is allowed in the contract to build the project. When contractors have excessive time, they may neglect to fully commit resources to a project or to work as efficiently as possible. STAs need to improve the accuracy and consistency of estimating contract time, which is based on construction production rates. The focus of this research study is to use historical project information to generate a list of production rates for construction activities that will be used by STAs to more accurately estimate the time needed to construct a project.

Currently, time estimating often depends on the experience and knowledge of STA project staff. As many long-term staff members are retiring, less experienced employees are staffing project management positions. Thus the need for a resource for estimating production rates is becoming more important.

Improving time estimates will also support new STA initiatives for program and cash management, and the ability to more accurately budget cash drawdowns. And finally, the availability of historic production rates will help construction project managers to analyze contractor method statements, critical path schedule submittals, and other important components of project management.

Research Plan

The research plan is divided into two phases. Phase I includes Task 1 – Kickoff and Task 2 – Data Collection. Phase II includes Task 3 – Production Rate and Time Estimation, Task 4 – Determine Factors that Affect Production Rates, and Task 5 – Develop Contract Time Estimating Tool. More details about each phase and specific tasks are included below.

PHASE I

Task 1. Kickoff. The objective of Task 1 is to meet with the TCM Study Panel to review and achieve alignment on the proposed work plan and project deliverables. This objective will be met through a webinar with the panel and will occur within the first month after the project's execution. A preliminary work plan will be prepared prior to the webinar and will be the basis for the kickoff meeting. The deliverable from the kick-off meeting will be the final work plan for the project to reflect any suggested changes based on the panel and research team's discussions.

The outcome of Task 1 will be Technical Memo (1), which will describe the final work plan, which will primarily focus on data collection efforts and associated action items.

Task 2. Data Collection. While STAs have a large cache of historical project information, production rate data is not readily accessible. The project will determine the major production-type work items that impact contract time on STA projects, including but not limited to:

1. Paving;
2. Earthwork;
3. Barriers;
4. Culverts;
5. Storm Sewers; and
6. Bridgework/Structural Work.

Production rates are not currently stored for projects, so the research team will need to collect data related to pay quantities, number of days worked, and other project data. The actual data for specific work items to be collected by the research effort will be based on the availability and reliability of the data within the participating state transportation agencies.

The project will also collect project level data to allow analyses that compare quantity of materials installed and overall project duration. The associated project data to be collected include pay quantities, number of days worked, and other project data. At the project level, the research effort will archive overall construction duration, engineer's cost estimate, and construction quantities, which prior research has found to be significantly related to a project's overall construction duration (Taylor et al 2013). In addition, each project will be classified as one of the following types:

1. Limited Access (e.g. interstates and other roadways with limited egress and ingress access);
2. Open Access;
3. New Route;
4. Bridge Rehabilitation; and
5. Bridge Replacement.

Historical project data is stored in a variety of formats across different state transportation agencies, including electronically in *SiteManager*, in PDF format on method statements submitted by contractors, in diaries maintained by construction project managers, and other

sources. The research team will inventory data sources and consult with state transportation agency key personnel to determine which sources or combinations of sources to use as necessary. It is assumed that Colorado, Georgia, and Mississippi will provide data in the form of batch data output from *SiteManager*, unit bid tabulations, or other relevant data sources within their state transportation agency. The collected data will be archived in Excel format. Specific sheets will be categorized by state, construction type, and project type.

The outcome of Task 1 will be Technical Memo [TM] 1, which will describe the data sources, including descriptive statistics (e.g. sample size and average).

PHASE II

Task 3. Production rate and time estimation. Using the data collected from Task 1, the research team will calculate production rates for work items identified during Task 1. In addition, the research will develop regression models that estimate contract based on project data collected in Task 1. This step will require considerable effort to sort through and interpret data. The collected data will be archived in Excel format. Specific sheets will be categorized by state, construction type, and project type and linked to a summary sheet for quick look up. The summary sheet will provide the average production rates for each construction type by state along with average time estimation for each project type. This format should allow state transportation agencies to update the sheets using future project data as needed. The outcome of Task 2 will be TM2, which will describe the analyses that examine the relation between quantities installed and project duration.

Task 4. Determine factors that affect production rates. Production rates are impacted by many factors, so the research team will need to define which are important. Factors to be considered, but not limited to, include:

- the type of project,
- type of contract (design-bid-build or innovative),
- construction season and weather,
- project topography (mountain, rolling, and plain), and
- geographic location (specific state regions, urban, suburban, and rural).

The analysis should include a predictive method such as an adjustment to apply to a rate to account for the impacts of these factors. The outcome of Task 3 will be TM3, which will describe the results of these analyses.

Task 5. Develop Contract Time Estimation Tool. Using historical project durations and quantities of work installed based on data collected from Tasks 1, 2, 3, and 4, the research team will complete the development of an Excel based tool to estimate a contract's time based on the input of estimated quantities. Based on uncertainties in sample sizes, there is the possibility that the tool may not accurately estimate contract time for all project types. In these cases, the tool will include a guide of estimating contract time using a combination of the production rates of key work items from tasks 1, 2, and 3 and project schedule templates. As another deliverable, the project will include a research report that provided more details on the data characteristics and the resulting analyses. The outcome of Task 4 will be the Contract Estimation Guide and Final Report.

Schedule of Tasks

Task	2015					2016							2017												
	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	
PHASE I																									
Task 1 - Kickoff	X																								
Task 2 – Data Collection	X	X	X	X	X	X	X	X	X	X	X	X													
TM 1 – Descriptive Statistics of Collected Data													↑												
PHASE II																									
Task 3 – Production Rate and Time Estimation													X	X	X	X	X	X							
TM 2 – Relation between quantities and duration																			↑						
Task 4 – Analyses of factors effecting production rates																X	X	X	X	X					
TM 4 – Analyses of the variation in unit rates																					↑				
Task 5 – Develop Contract Time Estimation Tool																				X	X	X	X		
Final Report																								↑	

Budget and Justification

The budget is divided into Phase I and Phase II.

PERSONNEL

Salaries for all named personnel are based upon current University of Colorado Boulder academic and staff salary scales. All personnel budget calculations include salary range adjustments and merit increases as applicable for each phase of support in accordance with University policies. 100% effort of 0.5 month summer salary for Phase I and 1.0 month for Phase 2 is requested for the Principal Investigator Paul Goodrum and is calculated at the institutional base salary with an anticipated 3% annual increase throughout the project.

Graduate student support is based on the current University rate with an anticipated annual increase of 3% throughout the project. Salary for Phases I and II at 50% is requested for support of the graduate research assistant.

FRINGE BENEFITS

Fringes are calculated on requested salary per the University's federally negotiated Indirect Cost Rate Agreement, with the Department of Health and Human Services (DHHS). The rate used for the PI is 29%; the rate used for research personnel is 35.8%; the rate used for graduate research assistants is 12.3%; and the rate used for hourly employees is 1.1%.

EQUIPMENT

No funds are requested for major equipment items.

TRAVEL

No funds are requested for travel support

OTHER DIRECT COSTS

Tuition: Graduate student tuition is requested in accordance with University policy. The rate used for GRA tuition remission is the resident rate and includes a 5% annual increase throughout the project.

INDIRECT COSTS

Indirect costs are charged according to the University's federally negotiated rate agreement. The indirect cost rate for on-campus research is 20% of Modified Total Direct Cost (MTDC), predetermined per CDOT agreement.

INFLATION RATES:

The University of Colorado's current budget planning parameters include an annual inflation factor of 3% for salaries of investigators, post-doctoral researchers, graduate research assistant, and hourly students. Tuition is estimated to increase 5% per year and other direct costs, such as travel, can be inflated at 2.2% per year (inflation of other direct costs is optional).

PROPOSED BUDGET DETAILS

Institution: The Regents of the
 University of Colorado
 572 UCB
 Boulder, CO 80309-0572

Title: Construction Production Rates for Estimating Contract Time

Principal Investigator: Paul Goodrum

Duration: 8/1/15 - 7/31/17

	Phase I	Phase II
	<small>8/1/15-7/31/16</small>	<small>8/1/16-7/31/17</small>
A. Salaries and Wages		
PI: Goodrum		
50% time, 0.5 month summer (1), 1 month summer (2)	6,476	13,340
GRA: TBD		
50% time, 12 months	<u>24,672</u>	<u>25,412</u>
Total Salaries and Wages	31,148	38,752
B. Fringe Benefits		
PI: 29%	1,878	3,869
GRA: 12.3%	<u>3,035</u>	<u>3,126</u>
Total Fringe Benefits	4,913	6,994
C. Permanent Equipment		
None requested	<u>0</u>	<u>0</u>
Total Permanent Equipment	0	0
D. Travel		
None requested	<u>0</u>	<u>0</u>
Total Travel	0	0
E. Other Direct Costs		
Tuition Remission	<u>13,680</u>	<u>14,364</u>
Total Other Direct Costs	13,680	14,364
F. Total Direct Costs	49,740	60,111
G. Indirect Costs		
20% of TDC per CDOT Agreement	<u>9,948</u>	<u>12,022</u>
H. Total Costs	59,688	72,133
Total		131,821