Artificial Intelligence (AI) Driven Model for Project Duration Estimation

by

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PROBLEM STATEMENT

Getting a construction project done on time is a major performance goal that many DOTs including MDT constantly monitor. However, most DOTs continue to struggle to meet the schedule performance target of their highway projects. For example, in 2017, approximately $144.5 million of road projects in Montana experienced schedule delay (Fraser 2017). Estimating and tracking construction project duration is crucial in the project development process since it not only directly affects the agency’s key performance indicator, but also affects contractor selection, construction costs, construction quality, safety, and public satisfaction. Both unreasonably short or long construction contract times can result in negative consequences such as high bid prices, lack of qualified bidders in bidding, poor work quality, claims and disputes, prolonged inconvenience to the traveling public, lack of innovations, increased administration costs, and safety issues (Jeong et al., 2009, Hildreth 2005, and FHWA 2002).

MDT is in the process of modernizing their contract time determination processes by developing user-friendly tools to facilitate the project duration estimation and contract time determination processes. MDT has successfully developed the Production Rate Estimation Tool (PRET) for controlling activities and visual construction sequence logic diagrams for common types of highway projects. These tools are bottom-up tools that can help support specific work tasks during the scheduling and contract time development processes. As continuation of this modernization effort, there is a need to develop a top-down tool that can estimate a project’s duration when a limited amount of project information is available during the preconstruction stages. This tool can be used throughout the preconstruction phases to quickly determine a reasonable project duration for proper project planning and delivery and it can also be used as a reality check tool along with the bottom-up tools during the procurement stage.

In recent years, artificial intelligence (AI) technologies have improved their technical capabilities for pattern recognition and prediction. Promising AI techniques such as Artificial Neural Networks (ANNs) are capable of processing various types of data and learning complex patterns to make a prediction with reliable accuracy. An AI-based data-driven model can leverage historical project characteristics and performance data to estimate a reliable project duration for a new project. In this research, an AI-based model and its tool will be developed using historical highway project data. The model will identify the most influential factors that affect project duration such as project type, estimated cost, location, material type, starting season, major controlling work items and their quantities. It will use those factors as input variables to estimate the project duration with a certain level of confidence. This project will provide a robust support tool for a quick and reliable estimation of a project’s duration.

BACKGROUND SUMMARY

The FHWA Guide for Construction Contract Time Determination (CTD) (FHWA 2002) provides the following steps for determining contract time: (1) establishing production rates for each controlling work item; (2) adopting production rates to a particular project; (3) understanding potential factors such as business closures and environmental constraints; and (4) determination of contract time with a progress schedule. To comply, DOTs have developed specific tools like spreadsheet-based production rate estimation tools, production rate adjustment tools for weather and site factors, activity sequencing logic diagrams and contract time determination templates to help the scheduler develop a bar chart or a CPM-based schedule.

A web-based survey of 41 DOTs conducted by Taylor et al. (2017) indicated that 68% of DOTs that participated in the survey had a formal procedure for CTD. Fifty three percent of the DOTs have developed agency-specific production rates of controlling work items and 39% of the DOTs use a project-specific sequence logic to estimate contract time. For example, Virginia DOT (Gondy & Hildreth, 2007) categorizes their highway projects into six types and uses production rates and sequence logics for estimating project duration. The Kentucky Transportation Cabinet and Texas DOT have developed a series of tools to support production rate estimation and construction activity sequencing using the critical path method concept.

MDT is in the process of modernizing their contract time determination processes by developing user-friendly tools to facilitate the project duration estimation and contract time determination processes. MDT has successfully developed the Production Rate Estimation Tool (PRET) that can estimate reasonable production rates of controlling activities in MS Excel environment when project information and the quantity of work for each controlling work item are provided (Jeong et al. 2019). Visual construction sequence logic diagrams for common types of highway projects were also developed (Jeong and Alikhani 2020). These tools are bottom-up tools that can help support specific work tasks during the scheduling and contract time development processes. These tools are used during the final design stage when the project information such as work items and their quantities of work are known with high certainty.

A top-down project duration estimation tool is desirable during the preconstruction stages when a limited amount of project information is available and the project design is not finalized. Also, this top-down tool will be handy to check the reasonableness of the project duration and the contract time calculated using the detailed bottom-up methods. Some DOTs such as the Kentucky Transportation Cabinet, Indiana DOT and Ohio DOT have developed a top-down project duration estimation tool based on the fact that there is strong correlation between project duration and key project characteristics such as project type, estimated cost, project location, and bid quantitates (Attal 2010, ODOT 2013, KYTC 2014, Taylor et al. 2017). Regression models were mostly used to establish the statistical relationship between key project parameters and project duration. In a survey, some DOTs reported that the regression method was more accurate and easier to use than their previous contract time estimation methods that used production rates and generic precedence logic (Taylor et al. 2017). Kentucky, Indiana, and Ohio recently developed single variate and multivariate regression models that use cost estimates and selected bid item quantities to estimate contract time. Ohio DOT (2013) developed a regression model for each project type (in total, 19 types) using eight years of project data including project cost, project type, project location, and starting season to estimate project duration. Ohio DOT uses these models to estimate the duration of a project in early preconstruction stages by determining a mean duration with 90% and 95% confidence level. The agency uses such regression tools for preliminary estimation of contract time and use production rate charts and scheduling tools for final setting of contract time (Taylor et al., 2017).

Nevett et al. (2020) collected highway project data from Colorado DOT that included information about construction quantities, cost, and contract time of 15,000 projects. They analyzed 22 variables and developed a multi linear regression model that uses ten influential variables and predicts project duration. Kentucky Transportation Cabinet (KYTC 2014) divided highway projects into small size (lower than $1,000,000) and large size (higher than $1,000,000) and developed unique regression models and an MS Excel tool for ten project types of small size and five project types of large size. The small projects account for more than 90% of the KYTC projects. The regression models require project identification number, construction estimate, the letting date, and the selected design project type as input variables. The model returns an estimated lower, mean, and upper range of completion dates and working days with the 95% confidence level. For large projects, the input variables for the model include the construction estimate and key bid item quantities (KYTC 2014). For example, the regression model for a large New Route Highway project is:

Project Duration = 39.289 + 6.894E-5* Construction Estimate – 0.001* Steel Reinf. (LB) – 0.018* DirtWork_Granular Emb (CU. YD.) – 0.010* Perforated Pipe (LF) – 4.51E-4* Striping (LF)

An MS Excel tool was developed to facilitate the estimation process as shown in Figure 1. Once the input variables are entered, the tool calculates and provides a mean, lower, and upper bound of the estimated project duration.

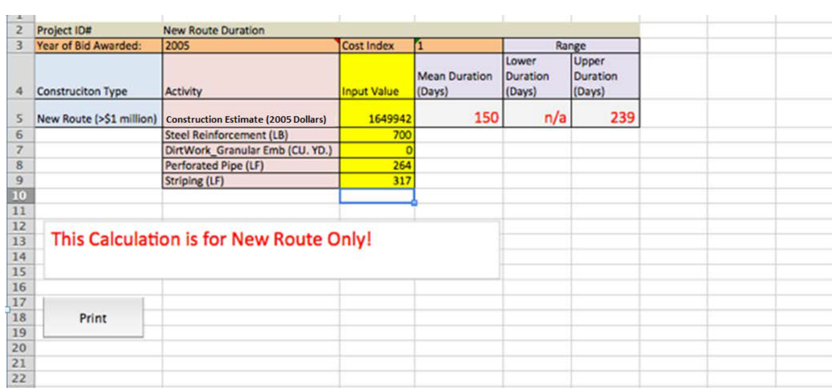

Figure 1: Screenshot of KyTC Excel Tool (KyTC 2014)

Although regression models have been commonly used, Artificial Neural Networks (ANNs) have been applied recently because of their capability of recognizing complex non-linear relationships between input and output variables (Attal 2010, Mensah et al., 2016, Mahmood et al. 2017, Pham et al. 2019, Petruseva et al. 2019, Cheng et al. 2019, Karaca et al. 2020). Attal (2010) identified six key project characteristics in highway projects of Virginia DOT and used them as input variables and applied ANNs to predict project duration. They achieved the accuracy of 91% for ANNs in predicting contract time. They compared the accuracy of ANNs with regression analysis results and concluded that the ANNs performed slightly better. The ANN model's accuracy was 91% compared with 89% of the regression model. Mahmood et al. (2017) also used ANNs for predicting contract time and achieved the accuracy of 90% and compared the method with other techniques and concluded that the ANN worked better than other methods. Cheng et al. (2019) used ANN to estimate the completion time of construction projects and achieved 99% of accuracy.

BENEFITS AND BUSINESS CASE

This project is expected to significantly improve the MDT's current practice in project scheduling and contract time determination activities. An AI-driven MS Excel tool that will be developed in this project will be a powerful and defensible data-driven tool for quick and reliable project duration estimation that can be used throughout the preconstruction phases. This top-down tool can also be used as a historical data-driven reality check tool when the contract time of a project must be determined during the final design stage using the bottom-up methods.

One of the major challenges that contract time developers face is the short period of time allowed for contract time estimation. This severe time constraint and the growing amount of pressure for accountability across MDT offices require a quick and effective project scheduling and contract time determination support tool that produces high-quality results in a more reliable and defensible manner. The AI-driven tool that will be developed in this project will serve the purpose.

The following direct benefits are anticipated when the products of the research are implemented:

- Ability to quickly and reliably estimate the duration of a project in early preconstruction phases.
- Enhanced understanding about project characteristics and features that may affect project duration.
- Better project planning and programming with reliable project duration estimates.
- Improved accountability and defensibility of project duration estimates using the historical data-driven tool that will be developed in this project.

OBJECTIVES

The ultimate goal of this project is to develop an AI-based estimation model that takes key highway project characteristics and estimates a reliable project duration with a certain level of confidence. An MS Excel-based tool will also be developed accordingly. The specific objectives of this project are below.

- Obtain and analyze the historical project data.
- Identify the most influential factors that affect the duration of highway projects.
- Develop an AI-based project duration estimation model and validate the results.
- Develop an MS Excel based tool that provides a user-friendly interface for using the AI model.
- Write a final report documenting the key findings from the research.

RESEARCH PLAN

To achieve the goals of this project, the following work tasks are required.

Kick-off meeting

The research will begin with a kick-off meeting between the research team and the MDT technical panel members. This will give a clear understanding of expectations from the MDT as well as tasks to be completed by the research team. One of the most important agenda items for the kick-off meeting will be the types of data needed for the research. All potential variables that may affect the duration of a highway project will be collected. The preliminary list of data attributes may include project ID, project location, project type, project start season, pay item quantities, engineer’s estimate, project duration, actual project cost, and actual project duration. The research team anticipates to collect the last ten years of project data. The research will put coordinated efforts with the panel until all the required data are collected for the research. The research team will create a google drive where all project data can be conveniently uploaded remotely.

Task 1: Critical Review of Current Leading Practices

The research team will review current top-down project duration estimation methods used by some leading DOTs such as the Kentucky Transportation Cabinet, Indiana DOT, Ohio DOT, and Colorado DOT at a minimum. The strengths and weaknesses of those methods in terms of estimation accuracy, technical approach, data requirements, and user interface will be analyzed and documented. This review activity will provide the research team with some insightful ideas for developing a sound methodological process and a practical implementation tool for estimating project duration.

The research team will review the state-of-the art AI techniques such as artificial neural networks to identify the most effective algorithm for project duration estimation. The analysis and review results of the current top-down project duration estimation methods used by some DOTs will be utilized in evaluating the feasibility and suitability of different types of AI techniques for this research. The evaluation results will be documented in the task report.

Task 2: Data Collection, Preliminary Analysis, and Meeting with MDT Schedulers

In this task, the research team will obtain the historical project data from MDT. As described earlier, the data collection effort will start from the kick-off meeting and will continue during the Task 1 until all the required project data are obtained for this research project.

Recent studies identified key project characteristics as predictors for project duration estimation as shown in Table 1. Controlling work items are activities that are highly likely to be on the critical path of a project. Controlling work items and their quantities were identified as key influential factors by previous researchers. Project location is another contributing factor to project duration. For example, traffic congestion in urban areas may prolong the duration of an urban project. Also, difficulties of carrying materials to mountainous areas may also increase the project duration. The type of project is critical in project duration since each project type has its specific activities and sequences. All items in Table 1 will be considered in this research. However, other project characteristics and attributes available in the MDT historical project databases will be carefully evaluated and analyzed to assess its importance and contribution to project duration.

Table 1: Project attributes used for contract time estimation research

Project Attributes	References
Project location	ODOT (2013), Attal (2010), Hegazy and Ayed (1998)
Project size	KYTC (2014), Jeong et al. (2008)
Estimated cost	KYTC (2014), ODOT (2013), Wilmot and Mei (2005)
Major work item quantities	Mensah et al. (2016), KYTC (2014), ODOT (2013), Williams et al. (2009), Jeong et al. (2008)
Scope of work	Attal (2010)
Contract execution date	ODOT (2013), Attal (2010)
Design method	Hoffman et al. (2007)
Project type	ODOT (2013), Attal (2010), Skitmore & Ng(2003)
Population of the area	Leu & Yang, (1999)
Number of lanes	Mahmood et al. (2017), Williams et al. (2009)
Temperature condition	Ezeldin & Sharara (2006)

The obtained data will be cleaned, processed, normalized if necessary, and organized to be suitable for this research. The research team will first apply explanatory statistical methods to understand the collected data, determine data characteristics and define any visible patterns such as correlation. Statistically significant variables will be identified in this process and these variables will become candidate variables for developing an AI-driven project duration estimation model. A preliminary AI model will be developed using an advanced programing language.

The research team will conduct a virtual meeting with MDT schedulers and representative district engineers to discuss the preliminary findings of the research and obtain their feedback. The meeting will be used to confirm the influential factors identified for project duration estimation. The research team will be able to demonstrate the preliminary AI model to obtain their feedback and identify areas of improvement of the model to assure its practicality. Any additional variables that must be included in the AI-driven project duration estimation model will be determined at this meeting with MDT schedulers and district engineers.

Task 3: AI Model Development

In this task, the findings and results from Tasks 1 and 2 will be utilized to develop fully functioning AI models for project duration estimation. Figure 7 shows a typical architecture of an ANN-driven model. The model receives input variables and passes them to a hidden layer, where the input variables are processed together with a non-linear function to predict the output value. The hidden layer can be either a single layer or multiple hidden layers. Because of the ANN's ability to model a non-linear relationship between input variables and the output variable, an ANN model is expected to increase the accuracy of prediction compared with typical mathematics driven regression models.

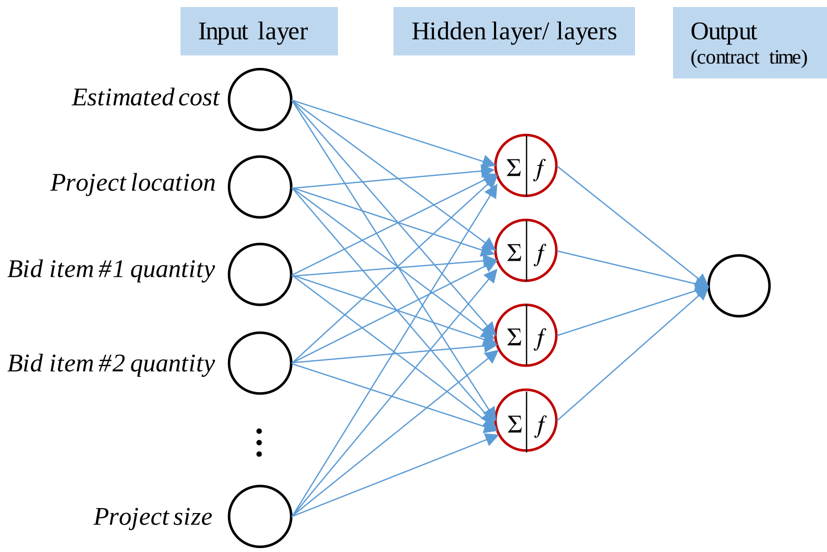

Figure 2: Architecture of an ANN Model

The research team will use advanced techniques such as hyper-parameters tuning, bootstrapping, and adjustment of hidden layers to increase the accuracy and reliability. To ensure the validity of the models, approximately 70 to 80% of the dataset will be used for training a model and the remaining dataset will be used to validate the reliability and accuracy of the model. The research will also develop a multivariate regression model and compare its accuracy with the AI model to select the best model. No task report will be prepared for this task but a virtual meeting with the technical panel will be conducted to show the AI model to obtain the technical panel's feedback before the research team starts to develop a Tool in Task 4.

Task 4: Tool Development

The research team will develop a user-friendly tool based on the AI models developed in Task 3. The research team is envisioning that the tool will be an MS Excel based tool for easy implementation. The research team will use the Visual Basic for Applications (VBA) in MS Excel to automate computational tasks and will use VBA to create a user-friendly interface.

The research team has successfully developed similar types of tools for DOTs including Caltrans, Iowa DOT, Minnesota DOT, and South Dakota DOT. For example. Dr. Jeong developed a stochastic preconstruction service hours estimation tool for Caltrans in 2018 using the agency's historical cost data. A sample screen shot of simulation analysis results that produce the range of estimated values with the corresponding confidence levels is shown in Figure 3. The VBA in MS Excel was used to automate computational tasks such as Monte-Carlo Simulation without relying on commercial MS Excel add-ins. Thus, the tool can work as an independent tool that can run on any computer with MS office package.

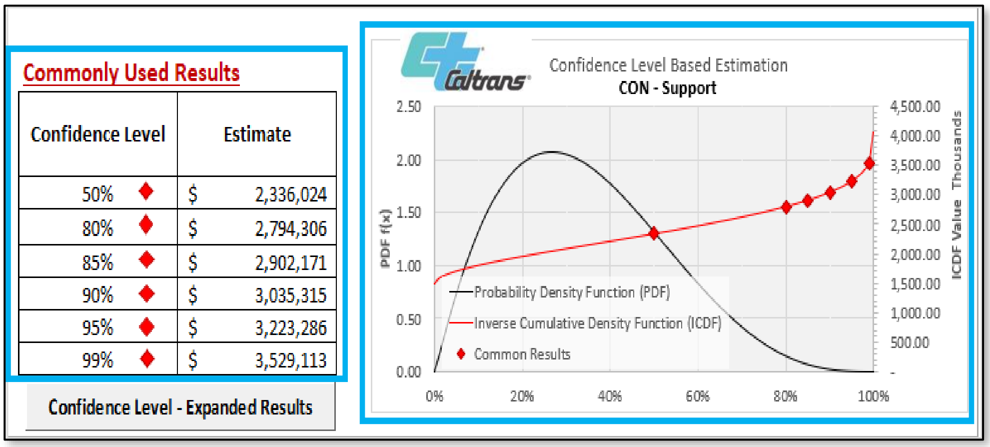

Figure 3: Caltrans Preconstruction Service Hours Estimation Tool

To maximize the value of the tool and the reliability of the embedded computational models, it is important that MDT continuously collects the required data for future calibration of the models. The research team will develop guidance on data collection efforts, data processing and treatment for proper calibration of the models to continuously improve the functionality of the tool.

The research team will develop a user's manual with several real examples to demonstrate how to use the tool to estimate the duration of a project. The research team will develop a section that provides guidance on proper interpretation of the analysis results with clear description of the tool's limitations and critical assumptions. In addition, guidance on proper communication among stakeholders on the use of the tool and the analysis results in the context of proper project planning and delivery will be provided to support wide and rapid utilization of the tool.

Task 5: Final report, Project Webinar, Final Presentation and Implementation Meeting

This is the final task of the project. In this task, a draft of the final report that encompasses all task results, findings, and products will be prepared for the technical panel's review. Any comments from the technical panel on the draft will be incorporated into the final report for the technical panel's approval. Other required deliverables such as the project summary report and the performance measures report will be submitted with the approval of the final report. A project webinar along with a final presentation will be provided to the MDT personnel and the technical panel for rapid dissemination of the research findings and to obtain feedback for any final adjustments to the project deliverables. A step-by-step process on "how-to" use the tool will be discussed using some hands-on examples. Also, an implementation meeting will be conducted including the project technical panel and others as appropriate. The purpose of the meeting is to review the research team's implementation recommendations to determine which will be implemented as is, with change, and which will not be implemented. The discussion will include other items, not mentioned in the project final report, to be implemented. The research team will document the discussion results in the form of an implementation report.

INTELLECTUAL PROPERTY

There are no potential intellectual property issues anticipated in this project.

MDT AND TECHNICAL PANEL INVOLVEMENT

The proposed study will require involvement of MDT personnel and resources. The research team will need assistance from MDT personnel who have knowledge in the current practices of project scheduling and contract time determination. The research team may need to interview highly experienced MDT schedulers and district engineers who have years of field experience and understand contributing factors to project duration. The research team needs to obtain historical project data including but not limited to project type, project location, engineer's estimate, list of pay items and their quantities, estimated contract time, actual project duration and cost. In addition, the MDT panel is expected to be available for meetings regarding research tasks and issues identified during the research.

OTHER COLLABORATORS, PARTNERS, AND STAKEHOLDERS

Not Applicable

PRODUCTS

Research products to be developed in this research include:

- Progress reports
- Task reports
- Final report with cover photo (JPG format)
- Project summary report (text and graphics only)
- Implementation meeting and report (text and graphics only)
- Performance measurement report (includes both qualitative and quantitative performance measures, as appropriate)
- Project Poster
- Final Presentation
- Implementation Tool (MS Excel tool)
- User's manual for the tool

All products will be prepared using the latest MDT guidelines and requirements to meet MDT quality standards. Texas A&M University has a full-time technical writing and publications staff. All products will be reviewed and edited by the technical writer to ensure professional quality.

IMPLEMENTATION

The implementation of the research products is expected to modernize the process of project duration estimation and contract time determination at MDT.

- The two major research deliverables will include a) an AI-driven project duration estimation model and b) an MS Excel based Tool. This tool can be used as a quick and effective tool to estimate the duration of a project by project planners, schedulers and contract time developers during the preconstruction phases.
- The current MDT contract time determination manual will be directly affected by the research results. The model and the MS Excel tool that will be developed in this project may be added to the current contract time determination manual.
- An implementation plan will be submitted as part of the final deliverables after an implementation meeting with the project panel.
- Tentative activities necessary for successful implementation – a pilot program.
  a) A webinar or an in-person training session to teach MDT personnel on the value of the research findings and how to use the MS Excel tool (within the first three months after the completion of the project)
  b) Form a task force team for a pilot program at the end of the training session
  c) Select several different types of projects that are in the final design stage (1 month after the task force team is formed)
  d) Use the MS Excel tool that will be developed in this project to estimate the project duration and compare it with the result from current practices (3 months after the previous task)
  e) Conduct a performance evaluation meeting to discuss the comparison results, document the strengths and weaknesses of the tool (value of the tool for MDT), and identify any areas for change and improvement of the tool (1 month after the previous task)
  f) Update the products as required by MDT or by the research team (3 months after the previous task)
- Potential barriers of implementation: Establishment of a strong implementation leadership may be the most important element for successful implementation of a new process. Therefore, it is required to identify or designate top management personnel (so called a champion(s)) and an implementation task force team/committee at the early stage of implementation. The task force team will be the most important vehicle to drive the entire implementation process from planning activities to monitoring the performance of the new process implementation. The champion(s) should be able to help with recruiting a task force, raising resources, increasing awareness, and other important tasks.

SCHEDULE

This research is expected to start on February 1, 2021. Major milestones and tasks are included in the proposed schedule in Table 2.

Table 2: Project Time Schedule

Work Task	Dates	2021											2022						
		2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
Kick-off meeting		■		◆			◆			◆			◆			◆			
1 Critical Review of Currrent Leading Practices		■	■	■															
Task 1 Report	4/30/2021			↑															
2 Data collection, Preliminary Analysis, & Meeting with MDT			■	■	■	■	■	■											
Task 2 Report	8/15/2021							↑											
Meeting with MDT	8/31/2021							■											
3 AI Model Development								■	■	■	■	■							
Meeting with MDT	12/15/2021											■							
4 Tool Development											■	■	■	■	■				
Task 4 Report	3/15/2022														↑				
5 Final Report, Final Presentation and Implemenation Meeting																■	■	■	■
5a Draft final report	4/30/2022															↑			
5b Project summary report (PSR)	6/15/2022																	↑	
5c Performance measures report	6/15/2022																	↑	
5d Final report	6/30/2022																	↑	
5e Project Webinar, Final presentation and Implementation Meeting	7/10/2022																		↑
5e Implementation Report	7/15/2022																		↑

◆ Quarterly Progress Reports
↑ Deliverable Due Dates

BUDGET

The total requested funding amount for this project is $130,000. A graduate research assistant's tuition amount for the project will be $17,897 which will be provided by Texas A&M University as cost-share. Thus, the total project value is $147,897. Table 3 on the next page shows the itemized budget.

Table 3: Detailed Project Budget (Removed for web-posting)

Table 4: Travel Budget

All meetings and presentations will be conducted virtually.

Table 5: Task, Meeting, and Deliverable Budget

Task, Meeting, and Deliverable Cost Breakout				
Item	**Labor**	**Travel**	**Supplies**	**Total**
Kick-off meeting	$2,783			$2,783
Task 1	$14,515	$0		$14,515
Task 2	$17,680	$0		$17,680
Task 3	$28,629	$0		$28,629
Task 4	$33,919	$0		$33,919
Task 5				
Deliverable: Final Report	$11,852			$11,852
Deliverable: MS Excel Tool and User Manual	$15,262			$15,262
Deliverable: Project summary report	$974			$974
Deliverable: Implementation report	$1,299			$1,299
Deliverable: Final presentation	$2,273	$0		$2,273
Deliverable: Final poster	$812			$812
Total:	*$130,000*	*$0*	*$0*	$130,000

Table 6: State Fiscal Year (7/1 -6/30) Breakdown

Item	State Fiscal Year		Total Cost
	2021	2022	
Salaries	$15,791	$53,350	$69,141
Benefits	$3,796	$12,871	$16,667
In-State Travel	$		$0
Out of State Travel	$		$0
Expendable Supplies	$	$0	$0
Total Direct Costs	$19,587	$66,221	$85,808
Indirect Cost – 51.5%	$10,088	$34,104	$44,192
Total Project Cost	***$29,675***	***$100,325***	***$130,000***

STAFFING

A highly qualified team has been assembled for this research project. The Principal investigator for this project is Dr. David Jeong. Dr. Jeong is a professor in Construction Science at Texas A&M University. Prior to entering academia, he worked for six years as a cost engineer and project engineer for heavy civil infrastructure projects. He has been the PI and co-PI of more than 40 research projects that have been funded by NCHRP, SHRP-2, FHWA, Iowa, Montana, Minnesota, and Oklahoma DOTs, Federal Transit Administration, the Construction Industry Institute, and others.

Dr. Jeong has experience and knowledge in project scheduling, cost estimating, risk management, project delivery process and project management which are a required set of expertise for successful completion of the proposed project. He is passionate about project scheduling and contract time determination issues and he deeply understands the significance of a project's contract time in the DOT's business processes and its impact on the contractor's performance and behavior.

Dr. Jeong has conducted several research projects on the active use of construction data to support data-driven decisions. Most of his previous and current research projects are highly related to project scheduling, production rate estimation, project estimating, cost engineering, highway project management, infrastructure asset management and data analytics for project management. Several of his past funded research projects that are directly related to this work are listed below:

- Principal Investigator, "*Effective Production Rate Estimation and Activity Sequencing Logics Using Daily Work Report Data (Phase – II)*" Montana Department of Transportation, 2019-2020.
- Principal Investigator, "*Systematic Approach for Determining Construction Contract Time – A guidebook*" National Cooperative Highway Research Program 08-114, National Academies of Science, 2018-2020.
- Principal Investigator, "*Effective Production Rate Estimation and Activity Sequencing Logics Using Daily Work Report Data (Phase – I)*" Montana Department of Transportation, 2017-2018.
- Co-Principal Investigator, "*Preconstruction Services Estimating Guidebook*," 2013-2015, NCHRP Project 15-51.
- Principal Investigator, "*Data and Information Integration Framework for Highway Project Decision Makings*", Oklahoma Transportation Center, 2012-2013.
- Principal Investigator, "*Procedures and Models for Estimating Preconstruction Engineering Costs of Highway Projects*", Oklahoma Transportation Center, 2010-2012.
- Principal Investigator, "*Development of Improved System for Contract Time Determination (Phase I, II, and III),* Oklahoma Department of Transportation and Oklahoma Transportation Center, 2006, 2007, 2008-2010.

Dr. Jeong has published more than 60 technical journal and conference papers in this field and he has received notable research awards including 2016 ASCE *Journal of Construction Engineering and Management's* Best Scholarly Paper Award, 2015 CII Distinguished Professor Award, 2010 CII Researcher of the Year Award, and 2008 Institute of Industrial Engineers (IIE) Transactions Award –

Best Application Paper. His several national awards are the clear indicator of his dedication, high quality of work and satisfactory deliverables to the research sponsors.

A PhD level graduate student will get involved in this project. The student was involved in the MDT project -"*Effective Production Rate Estimation and Activity Sequencing Logics Using Daily Work Report Data (Phase – II)*" Thus, a synergistic benefit is expected for this proposed project. A professional editor will be hired throughout the project to review and edit all written products to ensure professional quality. Table 7 provides the detailed breakdown of staff hours allocated for each work task.

Table 7: Project Staffing

Name of Principal, Professional, Employee, or Support Classification	Role in Study	Task							Percent of Time vs. Total Project Hours (total hrs./person /total project hrs.)	Percent of Time - Annual Basis (total hours/ person/ 2080 hr.)
		Kick off	1	2	3	4	5	Total		
Dr David Jeong	Principal Investigator	10	34	46	65	75	66	296	15%	14%
Graduate Student 1	Literature review, data analysis and modeling	20	165	185	370	420	406	1566	81%	75%
Editor	Report editing, and review	0	10	10	0	15	25	60	3%	3%
TOTAL		30	209	241	435	510	497	1922	100.0%	N/A

Dr. Jeong will be available to meet the time requirements of this project. Dr. Jeong's time commitments during the term of this project include:

- Teaching: 20%
- Academic service activities: 10%
- NCHRP 15-71 project: 12%
- Construction Industry Institute RT283 project: 8%
- This proposed project: 15%

The level of effort proposed for principal and professional members of the research team will not be changed without written consent of MDT.

FACILITIES

The scope of work outlined in the Research Plan has very little equipment or facility needs associated with any of the tasks. For this research, the level of support services within the institution will be more important than physical equipment and facilities, although Texas A&M University has exceptional facilities for high quality research.

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