

Implementation Report

EFFECTIVE PRODUCTION RATE ESTIMATION AND ACTIVITY SEQUENCING LOGICS USING DAILY WORK REPORT DATA

https://www.mdt.mt.gov/research/projects/const/production_rates.shtml

Introduction and Summary

Accurate and reliable project duration estimation is highly dependent upon two major components; a) reasonable production rate estimation of major work items, and b) logical sequencing of those work items.

Establishing an appropriate construction contract time, which is crucial for a highway project since it affects not only a highway agency's schedule performance, but also contractor selection, construction costs, construction quality, safety, and public satisfaction. The Federal Highway Administration (FHWA) recommends that the first step for contract time determination should be to estimate realistic production rates of major work items of a project.

The Phase I of this research project resulted in the development of a historical data-driven model for estimating production rates of controlling work items. The research project resulted in the collection

and analysis of digital daily work reports, bid tabulation data and other project characteristics to a) provide a historical range (mean, median, first and third quartile values) of production rates of controlling work items in different working conditions and regions and b) develop regression equations to estimate production rates when key project characteristics are provided. A Microsoft Excel based Production Rate Estimation Tool (PRET) was developed to help MDT estimators to understand the variation of production rates and estimate reasonable production rates. The tool is expected to provide more reliable and practical production rate estimates compared with the current published values.

The Phase II of this research resulted in construction activity sequence logic diagrams for most common work types in MDT. By analyzing historical daily work report (DWR) data of 730 highway projects stored in AASHTOware Site Manager, the current list of

31 controlling work items was expanded into 48 items. The new list covers more than 90% of the activities in the database. The same data analysis revealed that there are five most common highway project types in MDT which include:

1. Overlay (urban),
2. Overlay (rural),
3. Safety,
4. Seal & cover, and
5. Bridge reconstruction and rehabilitation.

These work types account for more than 60% of highway projects in MDT.

For each work type, representative as-built schedules were developed from the DWR data and a construction activity sequence logic diagram was developed to illustrate frequent controlling work items and their sequential relationship. The analysis results were discussed with MDT schedulers to incorporate their practical experience and knowledge into finalizing the list of controlling work items and

PROJECT NO: 9344

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their sequential relationships. The results of this research project can help MDT quickly identify the most common controlling work items and develop a sequence logic for different types of highway projects. The research findings are expected to significantly improve the accuracy and reliability of MDT's scheduling and project duration estimation efforts. This project will allow MDT to be equipped with powerful visual scheduling resources to enhance the current practices.

The implementation recommendations and MDT responses below cover both Phase I and Phase II of this research.

Implementation Recommendations

Recommendation 1:

This research project resulted in the development of an MS Excel-based Production Rate Estimation Tool (PRET) which is immediately available for use and implementation for production rate estimation of controlling work items as part of contract time determination. Once a user enters input parameters specific to a new project, production rates can be automatically estimated based on regression models embedded in the Excel tool. Statistical measures such as mean, median, first and third quartile values are also available in the tool. It is recommended that MDT use the PRET tool as part of their contract time determination process.

MDT Response:

MDT Agrees. The PRET tool will be linked on our website for use

by MDT staff and consultants once the MDT Excel tools and documentation has been updated.

Recommendation 2:

This research project identified statistically significant factors that may affect the production rates of work items and contract time of a project. The key factors include bid quantity, project type, project size, season of work, districts, and area type (urban/rural). It is recommended that MDT contract time developers carefully consider those factors as part of their contract time determination process.

MDT Response:

MDT agrees. These factors will be included in the contract time determination overview and if training can be provided, will be discussed in the training.

Recommendation 3:

The project team recommends that the MDT contract time determination manual should be updated by creating a new section that describes how to use the PRET and its value. The tool and the user manual may need to be added to the appendix section as formal documentation and easy reference for future users.

MDT Response:

MDT agrees. The contract time determination manual will be updated to reflect the tools and information provided by this research project.

Recommendation 4:

This research project resulted in the development of a three tier system that can evaluate a contractor's performance in terms of its historical production rates of controlling work items. This system may have value as a new pre-qualification criterion of potential contractors for a time-sensitive project. Poor performance contractors can be pre-screened to reduce the possibility of schedule delay or MDT can give careful considerations before awarding those contractors a contract.

MDT Response:

MDT partially agrees. MDT has prequalification lists for highly specialized subcontracting items such as rockfall mitigation, blasting, and steam restoration. MDT does not screen general contractors, and by state law cannot reject a low bid based on contractor performance on past projects.

Recommendation 5:

Controlling work items are the work items that are likely to affect the duration of a project. MDT is recommended to use the expanded list of controlling work items in developing the schedule of a new project, and determining the contract time of a new project. The current list of controlling work items in MDT includes 31 items. By analyzing as-built schedules, the research team identified that the current list doesn't effectively cover all controlling activities that may affect the total duration of a project. It was recognized that some controlling work items were missing, and some of the existing

items in the current list could be aggregated together to one controlling item. The current list has been extended to a new list of 48 items, where each item may include multiple pay items.

MDT Response:

MDT agrees. MDT supports an easily repeatable, data driven methodology for evaluating and prioritizing roadway segments for future mitigation efforts that are cost effective, and that will improve the safety of travelers.

Recommendation 6:

This project developed standard sequence logic diagrams of major controlling work items for five common highway project types in MDT. The research team recommends MDT schedulers use the diagrams as a supporting resource in estimating an accurate, defensible contract time for their future projects. The diagrams can be used as training material for inexperienced schedulers.

MDT Response:

MDT agrees. Visual sequence logic diagrams will be very useful and MDT needs to use them. MDT developed MS Excel sheets for project scheduling in 2008 but they have not been updated yet. These visual sequence diagrams can be added to the Excel sheets as templates. These diagrams will

work as excellent resources for schedulers to simply look at them while developing or reviewing schedules.

Recommendation 7:

The research team recommends the new list of controlling items and the visual sequence logic diagrams should be included in the MDT's contract time determination manual in the appendix as formal documentation and easy reference for future users.

MDT Response:

MDT agrees. MDT's current contract time determination manual has not been updated for a significant amount of time. MDT will review the manual and will revise it by taking this recommendation idea. The revision is likely to be a partial update by adding the new list of controlling items and newly developed logic diagrams.

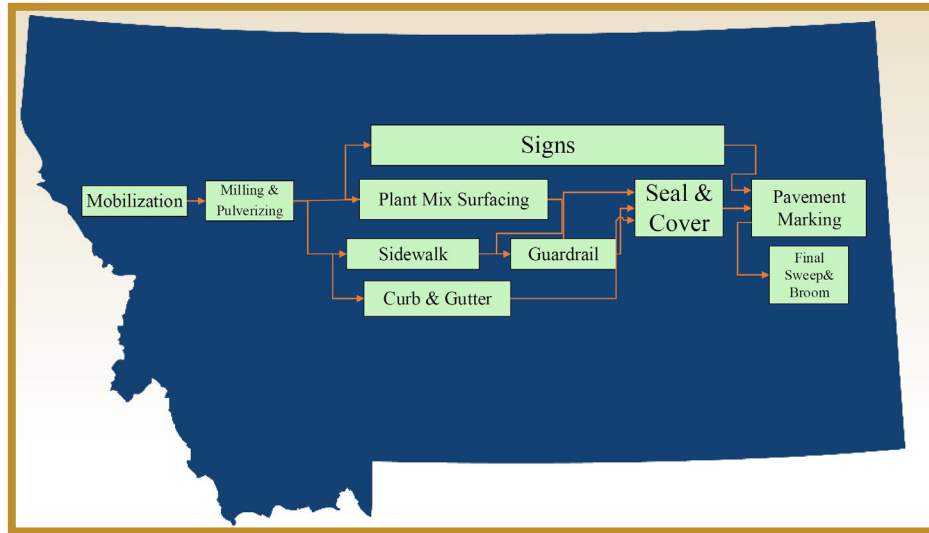
Recommendation 8:

The research team identified the dates that pay items are charged in the Daily Work Reports (AASHTOware SiteManager) may sometimes differ from actual construction dates of the pay items. Some of those dates may include actual payment dates to contractors on the items.

This research project used daily work reports to develop as-built schedules which may include some of those errors. The project team recommends MDT ask contractors to submit an as-built schedule at the completion of a project using MDT's list of controlling work items, not their own work breakdown structure used for the project. The accumulation of accurate as-built schedules will lead to more realistic scheduling and time estimation for future projects.

MDT Response:

MDT partially agrees. If MDT can document and track as-built schedules in a consistent format, that will be beneficial. However, MDT has a required format for contractor's as-built schedule: a Critical Path method (CPM) schedule with Primavera for complex and difficult projects and a bar-chart schedule for common and simple projects. An additional requirement will be challenging since it may require changes in the specifications. Also, asking contractors to develop an as-built schedule based on MDT's controlling work items may not be practical because contractors prefer to use their own work breakdown structure and this additional requirement would require extra work from contractors.



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