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Project Title

Guidelines for Developing and Reviewing Baseline Schedules for Wyoming Transportation Projects

University

University of Wyoming

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Research Needs

Wyoming has a short construction season which forces transportation projects to be completed under tight schedules. Project schedules are affected by several factors such as contractor's competency and resource availability, weather conditions, stipulated contract completion time, and project delivery methods. Contractor's competency refers to the contractor's ability to develop an accurate project schedule with reasonable productivity rates and logical work sequencing. In many cases, contractors develop schedules that are not accurate enough to represent work sequencing, account for reasonable productivity or fail incorporate expected weather events. When inaccurate baseline schedules are approved prior to construction, it creates a lot of challenges to track and monitor project progress. Unlike building construction, heavy civil construction projects are significantly impacted by weather events throughout the project schedule (Ibbs and Kang 2018 and Ballestoros-Perez 2018). Thus, scheduling project activities must consider regional priorities such as extreme weather events and the short construction season in Wyoming. Because of the short construction season in Wyoming, stipulated completion time is likely to be short and project schedules must be crashed or accelerated by contractors to meet contract completion time which adds another level of project scheduling complexity. Finally, the project delivery method can impact the construction schedule. For example, research shows that the use of incentives or disincentives can have a positive impact on the construction schedule while the use of cost-plus time contracts may delay the project completion date (Choi et al. 2012).

In a short construction season in which most activities are critical, it is important to develop accurate construction schedules for infrastructure projects. This will help avoid schedule delays and disruption in transportation services. It is also necessary for Wyoming Department of Transportation (WYDOT) engineers to have the capability to review and detect inaccurate

project schedules before work commencement. This will allow WYDOT engineers to systematically monitor the progress of construction projects and recommend corrective actions when needed.

Research Objectives

There are two main objectives of this research as follows:

1. Evaluate the accuracy of baseline schedules submitted to WYDOT prior to commencement of work in terms of productivity rates, activity sequencing, weather impacts, and scope gaps.
2. Quantify the significance of factors such as project delivery methods, weather impact, and productivity rates affecting project schedules to develop recommendations and guidelines for developing and reviewing baseline schedules.

Research Methods

The research will be conducted in three phases 1) data collection, 2) data analysis, 3) results validation as shown in Figure 1. In phase I, the research team will collect baseline schedules, Daily Work Report (DWR) data, and project delivery method data from WYDOT regional offices. The data collected should represent multiple types of work including new construction, maintenance, and rehabilitation. Additionally, the data collected should represent different types of maintenance and rehabilitation treatment methods used by WYDOT. Depending on contracting methods used by WYDOT, the research team will also collect data regarding the project delivery methods used for letting construction and maintenance work. The research team will also collect DWR data created electronically (i.e., AASHTOWare) or manually (i.e., created using paper-based templates in the field). Depending on the DWR data format, digitization may be required to process and analyze the collected data.

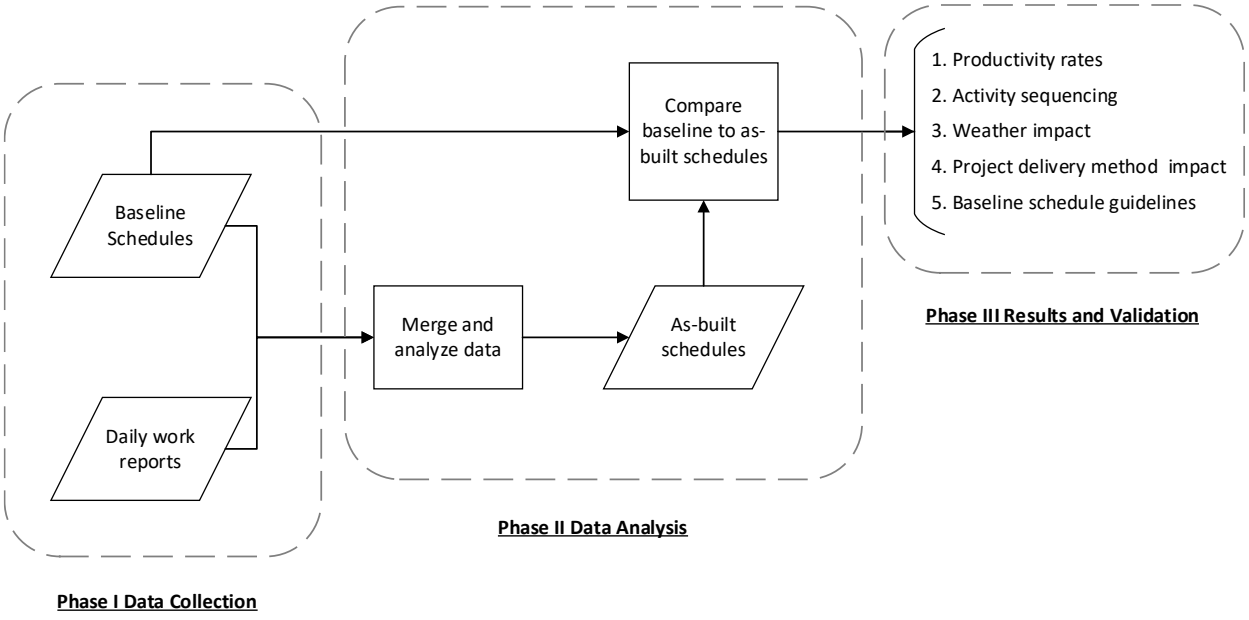

Figure 1. Research methodology and phases

In phase II, the research team will use the DWR data and baseline schedules to reconstruct as-built schedules. As-built schedules show the actual activity duration, productivity rates, activity sequencing, and work stoppage. Using forensic schedule delay analysis, the research team will analyze past projects progress, inaccurate activity sequencing, inaccurate productivity rates, and weather impacts by comparing baseline schedules to as-built schedules. The research team will also use statistical analysis to evaluate the impact of project delivery method on schedule slippage. For example, the project will investigate the use of incentives and their relationship to schedule performance. The null hypothesis to be tested is there is no relationship between schedule's slippage and the project's delivery method. The research team will test this hypothesis for transportation projects in Wyoming.

In Phase III, the research team will develop a set of guidelines to assist WYDOT engineers review baseline schedules. These guidelines will include 1) realistic productivity rates and activity sequencing for specific type of maintenance and rehabilitation work, 2) historical weather impact on projects across different regions in Wyoming and 3) the impact of project delivery method on project schedules if applicable. These guidelines will be reviewed and validated by WYDOT engineers as well as Wyoming Contractor Association by using surveys and expert interviews.

Expected Outcomes

The expected outcomes of this research are listed as follows:

1. A guide for WYDOT engineers to review baseline schedules in terms of activity sequencing, reasonable productivity rates, and historical weather impacts by region.
2. As built schedules for select projects based on DWR data.
3. The relationship between project delivery methods used by WYDOT and schedule delay.

The research team will develop a guide for WYDOT engineers to help review submitted baseline schedules by contractors. The guidelines will help WYDOT engineers detect unreasonable productivity rates, improper activity sequencing, and failure to account for weather events. This will also help contractors develop accurate baseline schedules that can be monitored effectively. The second outcome of this research is archiving as-built schedules for select projects. This will help WYDOT engineers understand the sequence of construction activities by looking at as-built schedules for historical projects. The last outcome of this research is a relationship between schedule performance and the project delivery method. This will help WYDOT engineers consider schedule performance when selecting project delivery method.

Relevance to Strategic Goals

The project supports US Department of Transportation strategic goal Infrastructure by creating tools to enable timely delivery of infrastructure projects. The infrastructure goal targets transportation infrastructure condition improvement, efficient and safe transportation, accelerating project delivery, and optimizing performance. This project will provide WYDOT engineers with the tools to review baseline schedules for accuracy. This will lead to reducing the number of projects that are behind schedule because of improper planning of the construction phase. By delivering projects in time, WYDOT reduces disruption in transportation services and improves infrastructure condition in a timely manner.

Educational Benefits

One graduate student will work on this project to collect data, digitize DWR data, reconstruct as-built schedules and analyze DWR data and as-built schedules. The results of this project can be incorporated with CM 3100 Scheduling. This class focuses on principles of construction schedules for both vertical and horizontal construction projects. The results of this project can be used as a case study to help students learn more about productivity rates, activity sequencing for horizontal construction projects and factors affecting schedule performance. At a graduate level, the outcomes of this research can be used as a case study to be taught in CE 5710 Civil Engineering Seminar. This will introduce construction management and planning concepts to civil engineering graduate students.

Technology Transfer

The outcomes of this research projects will be published in conference proceedings and journals such as Transportation Research Board, American Society of Civil Engineers (ASCE) Construction research congress, ASCE Journal of Construction Engineering and Management and ASCE Journal of Management in Engineering. Additionally, the research outcomes will be disseminated locally by presenting the outcomes to the Wyoming Contractors Association during their perioding meetings. The research team will also organize seminars or workshops to present the results to WYDOT engineers.

Work Plan

There are five main tasks summarized in Table 1. The first task "Data collection and literature review" which involves collecting baseline schedules and DWR data for multiple projects to represent all regions in Wyoming. In the second task "Questionnaire survey", the project team will develop a survey and distribute it to WYDOT engineers and Wyoming contractors to identify project scheduling challenges and best practices. The research team will obtain necessary approval to distribute the survey through the University of Wyoming Institutional Review Board. In the third task "Developing as-built schedules", the project team will use DWR data to reconstruct as-built schedules for a select set of projects representing all Wyoming regions. In the fourth task "Data analysis", the project team will compare baseline schedules to as-built schedules to identify progress deviation and root causes of schedule inaccuracies. Finally, the project team will present the results to experts within WYDOT and Wyoming contractors for guidelines validation and implementation strategies.

Table 1. Work Plan

Task	Duration	Start Date	End Date
Data collection and literature review	Four months	05/1/2021	09/1/2021
Questionnaire survey	Three months	08/16/2021	11/16/2021
Developing of as-built schedules	Four months	10/16/2021	02/16/2022
Data analysis	Three months	02/16/2022	05/16/2022
Results validation and report writing	Three months	04/1/2022	06/30/2022

Project Cost

Total Project Costs:	$95,787
MPC Funds Requested:	$45,990
Matching Funds:	$49,797
Source of Matching Funds:	University of Wyoming

References

Ballesteros-Pérez, P., Smith, S. T., Lloyd-Papworth, J. G., & Cooke, P. (2018). Incorporating the effect of weather in construction scheduling and management with sine wave curves: Application in the United Kingdom. Construction Management and Economics, 36(12), 666–682. https://doi.org/10.1080/01446193.2018.1478109

Choi, K., Kwak, Y. H., Pyeon, J.-H., & Son, K. (2012). Schedule Effectiveness of Alternative Contracting Strategies for Transportation Infrastructure Improvement Projects. Journal of Construction Engineering and Management, 138(3), 323–330. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000431

Ibbs, W., & Kang, J. M. (2018). Weather-Related Delay Provisions in Public Transportation Construction Contracts. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *10*(3), 04518009. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000259