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Project Summary Report 0-4416-S
Project 0-4416: Development of Improved Information for Estimating Construction Time
Authors: James T. O'Connor, Youngki Huh, Yao-chen Kuo, and Wai Kiong Chong
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PROJECT SUMMARY REPORT

Development of Improved Information for Estimating Construction Time: A Summary

What We Did...

The aim of this research was to develop improved information about production rates to further advance the accuracy of construction contract time estimation for Texas Department of Transportation (TxDOT) highway projects.

The four objectives included:

- Collect field-based information concerning crew production rates to improve existing information for estimating highway construction time.
- Identify major factors that drive production rates and apply statistical techniques to formulate relationships between these factors and production rates.
- Establish quantitative prediction models for these factors.
- Develop a user-friendly information system to allow planners to readily access needed production rate information.

The applied methodology involved the following:

- Develop a data collection technique so that field-based information on crew production rates could be collected accurately and efficiently.
- Identify and visit relevant projects located in the state of Texas that constitute a representative sample of highway projects in Texas.
- Apply appropriate methods for analyzing these data, such as linear and nonlinear regression analyses, t tests, and multiple regression modeling.

- Develop a user-friendly information system that TxDOT personnel can efficiently utilize to estimate production rates.

A total of thirty work items that are common to many TxDOT projects but that tend to have highly variable production rates were targeted for study. In collecting field production rate data, the project team visited a total of sixty-three TxDOT highway projects in nine different TxDOT districts and collected a total of 701 work item production rate data points. "As-built" data from four additional projects were also collected and examined in the analyses. Collected information was also used to test the accuracy of the existing Contract Time Determination System (CTDS).

What We Found...

There are four major categories of findings in this research: accuracy and applicability of the CTDS, identification and analysis of production rate drivers, development of production rate models for each work item and associated drivers, and integration of production rate information into a user-friendly system, named HyPRIS.

In general, the CTDS does not contain accurate production rate information. Comparisons between observed, as-built, and CTDS production rate information indicated limited consistency between research-based rates and those provided in the CTDS. A majority of the examined work items have significantly different observed production rates from those contained in the CTDS.

In addition, many production rate units reported by CTDS are inconsistent with the units needed or most convenient for time estimation purposes. For example, the production rate unit for Work Item #420 (Concrete Structures) is 1f/day in CTDS, but this research found that TxDOT design engineers prefer the unit to be ea/crew day, as this enhances efficiency in production rate estimation. Thus, this research concluded that there is a need for a new system to replace CTDS.

For identifying production rate drivers for the thirty selected work items, scatter plots were first used to determine visually whether any possible relationship might exist between candidate production rate drivers and production rates. Coefficients of determination values (commonly known as R-square values) and p-values were used to determine whether it was worthwhile to further analyze a candidate driver. Using an R-square value of 0.28 (suggested by Green 1991) and confidence intervals of 90% for the p-values as criteria, several candidate drivers were further analyzed and many were found to be statistically significant. Linear and nonlinear regression models were used to develop production rates models for significant numerical drivers, while box plots were used to convey the ranges of production rates for significant discrete drivers. A small number of significant drivers were dropped from further analysis as the Project Monitoring Committee found that they were not useful.

This analysis also found that CTDS-reported production rate drivers are generally different from the significant drivers found in analyses of observed rates. Upon finding that many CTDS-reported drivers were not statistically significant, for several work items, new sets of drivers were developed from analysis of observed production rate data.

Linear or nonlinear regression models were developed for every work item and are communicated in the HyPRIS system. Box plots were developed to convey the ranges of production rates for most work items and these are also included in HyPRIS. Where possible, multiple regression models were also developed for work items with several significant drivers and with sufficient data sample sizes.

Finally, this research reports details of the development of the Highway Production Rate Information System (HyPRIS). Visual Basic was used as the programming language for the system. Production rate models are presented as graphs, plots, and/or equations in the system, depending on suitability and usefulness of the format. A user-friendly, hierarchical, Windows-based approach was employed. Since source data sample size and representativeness are significant considerations, for each work item, data point information is also presented in the system. Such information includes the types of projects from which the data points were gathered and the total number of data points for each model. Work item description tables and a glossary table are also included in the system. All information in the system is presented according to TxDOT work item number as prescribed by the TxDOT Specification Handbook. In addition, since this research does not include examinations of many TxDOT work items or of lead and lag relationships between different work items, such information was extracted from CTDS and made available in HyPRIS.

The Researchers Recommend...

The CTDS is outdated and this research offers a superior system as a replacement. However, as the scale of this research was limited to thirty work items, additional common TxDOT project work items are in need of examination for production rate analysis and reporting. In addition, lead and lag relationships between construction activities were not specifically examined in this project, but may be deserving of study. The HyPRIS tool developed can accommodate such future expansion if desired.

HyPRIS is essentially a communication device that conveys previously collected and analyzed data. The ideal scenario would provide for a system (i.e., database) that automates both data collection and analysis and integrates such analysis with production rate reporting. Such a development will not be easy, as field production rate data is extremely cumbersome to accurately collect and analyze. Another possible approach would be to exploit existing accurate as-built production rate data that is currently being recorded at many TxDOT job sites. In this research, regular site visits found that many sites kept extremely good records of their field production data, yet much of this information was not subsequently taken advantage of. Of course, at many sites such related records were too massive and difficult to extract. To better exploit such data, TxDOT may benefit from a data system that can document, extract, and analyze information in an automated fashion.

Most importantly, it is recommended that TxDOT ensure proper implementation and maintenance of HyPRIS. HyPRIS's success depends on three key factors: 1) proper use by all TxDOT engineers involved in estimating construction duration; 2) periodic assessment, review, and updating of HyPRIS-reported production rates; and 3) effective and timely maintenance of HyPRIS to accommodate changes in computing hardware, software, and operating systems. High usage of the system is necessary in order to establish the legacy of the system, and in order to ensure effective feedback from system users. Like so many other similar systems, HyPRIS will become obsolete if it is not updated periodically.

For More Details...

Research Supervisor: James T. O'Connor, C. T. Wells Professor, (512) 471-4645
email: jtoconnor@mail.utexas.edu

TxDOT Project Director: Bob Hundley, P.E., (512) 416-2509
email: bhundley@dot.state.tx.us

For more information, please contact German Claros, Research and Implementation Office, at (512) 465-7403 or gclaros@dot.state.tx.us.

The research is documented in the following reports

0-4416-1 *Development of Improved Information for Estimating Construction Time,* Published February 2005

To obtain copies of a report: CTR Library, Center for Transportation Research, (512) 232-3126, email: ctrlib@uts.cc.utexas.edu

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