

**Report Title and Number**

*Performance Analysis and Forecasting for WSDOT Highway Projects WARD 675.1*

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# Performance Analysis and Forecasting for WSDOT Highway Projects

## Developing standard overall performance measures for highway projects

WSDOT evaluates contractors' work during construction through progress measurement; in other words, directly comparing the completed work to the planned work. As part of this evaluation, units of work are measured and paid for as the work progresses.

Our proposed performance evaluation goes beyond simple progress measures by relating the amount of progress to the time it took to achieve the work. This gives us a feel for the overall progress and scheduled completion of the contract work as it relates to total payment and overall time. Construction managers are responsible for completing projects on time and on budget. Contractors may experience overruns due to uncontrollable situations such as weather conditions, equipment breakdown, and cost escalation during construction. By monitoring and realizing in a timely manner that a contractor is experiencing such overruns, our construction managers may be able to mitigate the impacts by modifying cash flow, quality control and time impacts.

To do an evaluation, we require a benchmark, or a standard of measurement, against which the overall performance is compared. Due to overruns, projects of similar sizes and conditions experience different time and cost estimates during the actual construction. The problem for us becomes how to account for these differences when monitoring or predicting the time and cost of new projects of similar sizes. This research used historical project data to develop statistically valid boundaries that can be used as a reasonable benchmark for construction management.



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### Examining historical data to develop new prediction tools

WSDOT has built thousands of projects throughout Washington State. For this research, historical project data between 1990 to early 2006 was analyzed and tools were developed to support the evaluation of contractor’s performance and in the prediction of the time and costs of projects.

Data used in developing the tools included:

- cost data, such as contract value and progress estimates (payments),
- time data including project duration and number of working days for each progress estimate
- quantity data for hot mix asphalt, grading, and surfacing, for example.

Benchmark average and minimum performance profiles (curves) were developed for all projects as one group and for categories of small, medium, and large pavement projects.

Based on the historical projects’ time, cost, and quantity data, prediction models were developed. The models use between one to five parameters to predict the time and cost of new projects. The models are intended as an indicator to be used as a supplement to the existing WSDOT prediction tools. This is data that can readily be incorporated as a general indicator of the progress of projects statewide.

The following tables describe how a project was determined to be small, medium or large. Projects were categorized independently by miles, days, value or HMA (hot mix asphalt).

Small Projects	No. of Projects	Min Value	Max Value	Mean	Standard Deviation	Variance
Miles	326	0.01	6.27999973	2.380509	1.737348	3.018379
Days	331	3	64	39.81873	13.75843	189.2943
Value	348	\$105,018.58	\$2,321,238.82	\$1,073,383	\$600,158	\$3.602E+11
HMA	342	0.00	16,753.74	4,978.590	4,986.134	24,861,530

Medium Projects	No. of Projects	Min Value	Max Value	Mean	Standard Deviation	Variance
Miles	145	6.4	18.9500008	10.37874	3.238595	10.48849
Days	143	65	146.5	89.01748	20.44104	417.8360
Value	128	\$2,357,167.46	\$6,495,159.59	\$3,612,667	\$1,031,118	\$1.063E+12
HMA	129	16,927.26	48,767.96	28,764.12	8,153,351	6,647,7130

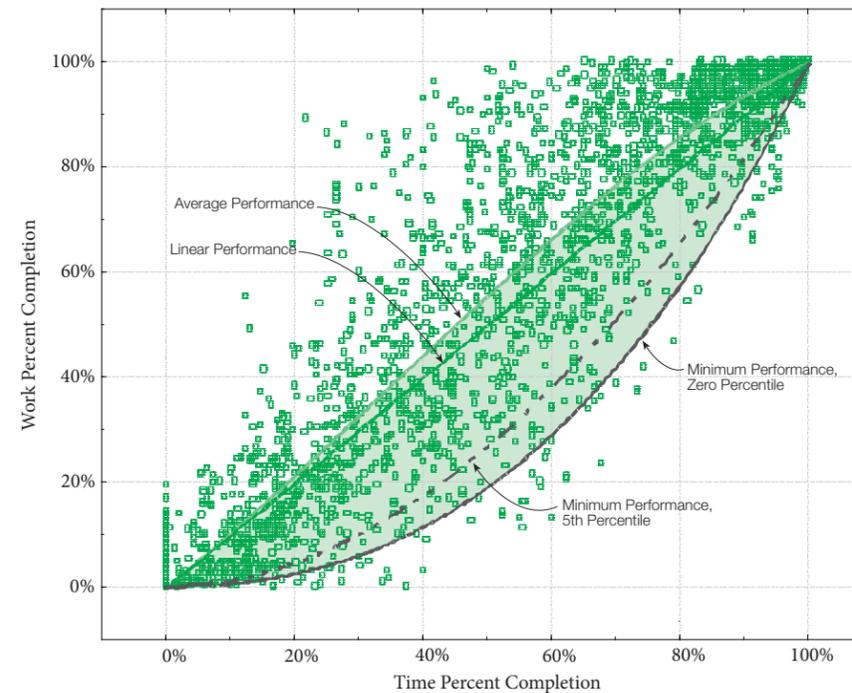
Large Projects	No. of Projects	Min Value	Max Value	Mean	Standard Deviation	Variance
Miles	26	20.113	52,1700011	28.10381	7.845677	61.55465
Days	23	154	615.5	212.0217	96.55574	9323.011
Value	19	\$6,638,740.47	\$18,715,549.56	\$9,484,181	\$3,368,837	\$1.135E+13
HMA	26	51,338.70	99,426.20	69,997.30	16,447.71	270,527,300

### Using performance models to better manage projects

This research gives us the ability to use past data to evaluate future project performance and to predict the time and cost of projects. A project that plots below the line labeled “minimum performance” on the graph indicates that the progress of the project is not consistently performing with what history has determined to be a successful project. By using performance models that indicate when the actual performance approaches the minimum performance, we can react and therefore better manage the project by helping the contractor get back on track. If the actual performance crosses the minimum performance, we would consider imposing a performance penalty. Per agency practice doing so should be a last resort because it may exacerbate the situation.



*Provided your project’s progress tracks within the bounds in the graph, this tool tells you that historically and statistically the cash flow/work progress over time indicates a healthy project and has a likelihood of being successful.*



### Summary of Implementation

WSDOT builds hundreds of transportation projects every year. We rely on time and cost predictions for these projects to make monitoring, planning and budgeting decisions. WSDOT maintains a wealth of data from past and present construction projects, which provides us with, among other things, feedback for future project cost and time estimating.

It is important to create and use as many administration oversight tools as possible. As a result of this research, we now have benchmark performance profiles as a tool for evaluating project progress and estimating cost and time. The products of the research are the graphs which define a performance envelope pertaining to different project criteria. This enables construction administration managers to flag projects that fall outside of expected performances thereby warranting special attention. It also provides executive management a quick, high-level view of whether the projects are progressing consistent with what has been determined to be successful.