Cost Effectiveness of Design-Build, Lane Rental, and A + B Contracting Techniques

Kelly C. Strong
Department of Civil, Construction and Environmental Engineering
Iowa State University
454 Town Engineering Building
Ames, IA 50011
kstrong@iastate.edu

James Tometich
Department of Civil, Construction and Environmental Engineering
Iowa State University
425 Town Engineering Building
Ames, IA 50011
tometich@iastate.edu

Nolan Raadt
Department of Civil, Construction and Environmental Engineering
Iowa State University
136 Town Engineering Building
Ames, IA 50011
nolanr@iastate.edu

ABSTRACT

Many state DOT specifications are generally prescriptive, in that they describe how contractors should conduct certain operations using minimum standards of equipment and materials. These prescriptive specifications, known as method specifications, have performed admirably in the past. However, rehabilitation and reconstruction projects, especially in a rapid renewal scenario, demand more creativity and innovation. Prescriptive specifications, used in conjunction with traditional procurement and contracting, do not properly foster this innovation. This study compares relevant performance criteria for three alternative contracting techniques (A + B, lane rental, design-build) and for traditional contracting. The research methodology involved surveying national experts who rated each innovative contracting method for each performance factor on each of the project types. Results indicate that design-build and A+B contracts are the most effective methods when time is the primary driver of cost or when complex design issues require interdisciplinary coordination. Because design-build appears to hold much promise for dramatically accelerating schedules, we utilized in-depth personal interviews of project team members involved in a design-build urban corridor reconstruction project in Minnesota. Interview data suggest the following issues need to be addressed as use of design-build contracting continues to gain acceptance:

- Determination of appropriate level of design completion prior to issuance of the request for proposal
- Co-location of project team members
- Definition of responsibilities for quality control and quality assurance
- Adaptation of traditional state procedures, procurement systems, forms, and project information handling methods to better fit design-build delivery philosophy

Key words: best practices—innovative contracting—performance

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BACKGROUND AND PROBLEM STATEMENT

Many governmental agencies charged with delivering public infrastructure have been experimenting with innovative contracting methods over the last several years. Many of the more common techniques have recently been formally approved for use by the Federal Highway Administration (FWHA 2002). One particular federal program, Special Experiment Projects-14 (SEP-14), has helped to define and clarify many of these new innovative contracting methods accurately to ensure that the processes and practices involved with innovative contracting are implemented effectively. The primary objective of SEP-14 was to review specified innovative contract techniques as they were applied to specific projects, which were monitored closely to measure the effectiveness of innovative contracting compared to the traditional design-bid-build method or other acceptable methods.

The specific innovative contracting methods under investigation in the SEP-14 report are the following:

- A + B with an incentive/disincentive (I/D) option
- Lane rental
- Design-build

A + B contracting is sometimes referred to as cost plus time contracting or biparameter bidding. For the remainder of this report, the term A + B contracting will be used.

Each of the innovative contract types listed above have proved to be acceptable practice by contractors and transportation agencies in highway construction. A + B contracting (both with and without incentive/disincentive) and lane rental contracts have been labeled as acceptable practices by the FHWA since 1995 and are no longer considered experimental. These two contract types were subjected to the FHWA's protocol of approving new innovative contract types (Special Experiment Projects-14) from 1990 to 1995.

The FHWA is continuing to develop guidelines and regulations for design-build contracting as mandated by section 1307(c) of the Transportation Equity Act for the 21st Century (TEA-21), enacted on June 9, 1998. The TEA-21 required the Secretary of Transportation to issue regulations to allow design-build contracting for selected projects. The regulations list the criteria and procedures that will be used by the FHWA in approving the use of design-build contracting by state transportation departments. The regulation does not require the use of design-build contracting, but allows state DOTs to use it as an optional technique in addition to traditional contracting methods. Use of design-build was formalized by the Federal Highway Administration in 2002 with the issuance of the Final Rule (Federal Register 2002).

Now that innovative contracting methods have been practiced for several years in many states and the federal government has recognized and defined many standard practices for innovative contracting, the need has arisen to examine and compare the effectiveness of different innovative contracting methods to each other, instead of independently comparing them to the traditional method of delivery.

Several states have researched innovative contracting methods with the objective of developing a protocol to assist agency personnel in selecting the most effective contract type based on certain project parameters. There have also been reports by various non-governmental organizations and institutions that have researched one or more innovative contracting techniques. The main reports and most comprehensive studies are outlined in the following paragraphs to develop an integrated summary and synthesis of current thinking on the comparative effectiveness of innovative contracting methods.

Although extensive literature and agency reporting is available for review, for brevity we have highlighted a few of the most important, comprehensive, and/or innovative reports in the following

literature review. The discussion below reflects a mix of comprehensive studies examining a variety of contracting methods as well as some studies that focused on a single contracting method, looked at performance criteria, or used project criteria as a basis for selection. This represents a reliable cross-section of the types of reports extant in the literature.

The South Dakota DOT hired Trauner Consulting Services, Inc., to assist them in defining criteria and guidelines that South Dakota could use to determine the most effective innovative contracting methods (South Dakota DOT 1996). Trauner researched such innovative contract types as I/D, A + B, and lane rental for their study. The South Dakota guidelines based the selection primarily upon project criteria with some consideration of performance characteristics such as cost, time, and road user cost.

The Ohio DOT has internally written a manual (Ohio DOT 2003) to assist in developing construction contracts through a selection criteria process. The innovative contracting methods matrix included in the Ohio manual lists approximately 15 project types and assigns a yes/no assessment on the suitability of various contracting methods for each project type. They examine I/D, lump sum incentive, work day, liquidated savings, design-build, A + B, and warranty contract types in their report. Each contracting method is analyzed in a specific report section, which includes “Definition,” “Objectives,” and “Project Selection Criteria” to help define which practice best suits certain project parameters. There is little discussion of performance criteria other than what can be inferred from project characteristics.

The Utah Technology Transfer Center also generated a best practices guide for innovative contracts (Bolling and Holland 2003). The contract types that were examined in their report include design-build, A + B, lane rental, warranty, and job order contracting. This report is similar in style and content to the Ohio DOT manual, but offers perhaps more definitive discussions of the performance implications of different contracting types. The Utah center examined the impact of different contracting methods on five performance parameters: administration, risk, time, cost, and complexity. In addition, the Bolling and Holland report listed project parameters that would lend themselves to the different contracting methods.

A University of Minnesota report by Cadenhead and Hippchen (2004) examined the design-build contracting method as it is used in the highway construction industry. This report gave examples of past and current design-build projects, and attempted to describe project parameters where the value of design-build delivery could best be captured. The report also described the performance benefits that can result from using design-build contracts for highway construction projects.

A study by Shr et al. (2000) examined A + B contracting as it had been practiced since 1990 and determined that some loss of value or suboptimum contracting was possible if state departments of transportation did not place an upper and lower limit on the time parameter of the bid. Shr, Ran, and Sung followed up this study in 2004, adding that the factors of I/D costs should be added to road user costs methods and then optimized against the A + B (cost plus time) parameters in each of the bids received in order to choose the lowest cost option. This optimization process shifts much of risk to the contractor while maximizing the agency’s resources. However, the optimization modeling can be cumbersome.

The primary intent of the lane rental contracting method is to bring the cost of inconvenience to the public into the contract award equation. Under the lane rental contracting method, contractors are forced to consider and include both construction costs and the costs to the public in their bid. The effect of lane rental is similar to liquidated damages in non-transportation construction. Lane rental is particularly valuable when alternative routing and detours are unavailable, and when the time savings can be readily calculated in dollar terms. (Herbsman and Glagola 1998).

Many of the studies referenced above used either project characteristics or performance criteria, but few used both. Also, most of the studies were single-agency studies. The research project described below

attempts to create a balanced comparison of contracting methods by utilizing both performance and project characteristics and using both quantitative national survey data and a qualitative case study.

RESEARCH OBJECTIVES

The purpose of this research project is to compare the effectiveness of four different contracting methods: traditional system of design-bid-build, A+B contracting, lane rental, and design-build. The objective of the research is to provide transportation managers and educators with insight and recommendations for use in transportation policy. The research project is comprised of two principal components: a national survey of DOT construction engineers and a case study of a successful design-build project. The purpose of the national survey is to provide insight into the project and performance factors related to the different contracting approaches as well as outline the suitability of each of these methods to different types of transportation projects.

The second component of the research effort is a case study of the reconstruction of Trunk Highway 52 through Rochester, Minnesota (ROC-52). The Minnesota Department of Transportation (Mn/DOT) has utilized a design-build approach for ROC-52, and the purpose of the case study is to investigate the project and prepare a set of recommendations to improve the administration of future design-build projects. Design-build was chosen for more in-depth case study analysis because it is the newest and perhaps least understood of the innovative contracting methods considered under SEP-14.

SURVEY RESEARCH METHODOLGY

The research methodology in this study used multiple methods of analysis, incorporating qualitative and quantitative techniques. The first step in the methodology was to identify relevant performance criteria. Mn/DOT has identified relevant performance factors to be used in determining project success. We chose a subset of those performance factors related to construction procurement and contracting value. The eight relevant performance factors include the following:

- Administrative costs are defined as the different types of internal costs Mn/DOT incurred in tracking processes: contract administration, inspections, reviews, right-of-way acquisition, and environmental assessment and monitoring.
- Construction costs include first costs, costs of change orders, cost of engineering and design, and environmental remediation. Questions regarding the construction costs:
    - Time refers to the overall length of time spent in project planning, funding/appropriations, design, construction, and extensions.
    - Management complexity refers to the relative difficulty of coordinating issues encountered over the course of the project, specifically management-related aspects of the project such as planning and establishment of scope, logistical challenges, utility relocation and coordination, adjustments to unforeseen problems that arose during execution of the project, etc.
    - Third party impact includes disruptions to businesses, schools, churches, residential neighborhoods, and other establishments or destinations along the route.
    - Road user costs refer to the costs incurred by the motoring public resulting from the project. Examples include accidents, driver time, and additional vehicle mileage due to detours.
    - Quality refers to the level of workmanship and the end products' performance versus what is expected by the owner, as well as the amount of post-construction callbacks and required maintenance of the facility.
    - Innovation includes the degree to which contractors are able to use new or less conventional concepts, methods, or materials on the project, and their flexibility to make design changes and pursue alternative ideas or techniques aimed at reducing cost and scheduled time.

Because contract effectiveness is moderated by project type, we incorporated several project types into this analysis. The project types were intended to cover a range of conditions, such as design complexity, road user costs, third party disruptions, etc. The nine project types chosen for analysis include the following:

- Major corridor realignment/expansion
- Multi-lane highway rehabilitation through a city, with detours
- Multi-lane highway rehabilitation through a city, under traffic
- Rural bridge replacement
- Metropolitan bridge replacement
- Two-lane highway resurfacing
- Mill and overlay
- Unbonded concrete overlay
- Preservation project with culvert replacement during two-lane highway resurfacing

The DOT construction engineers from each of the 50 states were sent blank templates for each project type and asked to rank the four different procurement methods from 1 (best) to 4 (worst) on each performance factor. Nineteen usable responses were received. The 38% response rate was deemed acceptable for reliability of the data. The individual rankings were reverse scored (1=4, 2=3, 3=2, 4=1) so that high effectiveness scores would correspond to effective contracting methods. The mean effectiveness scores for each contract type were analyzed using a pairwise t-test for comparison of means. The mean effective scores of the four contract methods for each project type are reported in the following section. Those mean scores that did not achieve statistically significant differences are noted.

KEY FINDINGS FROM THE SURVEY

For major corridor realignment/expansion projects, the performance effectiveness scores are as follows:

- A+B……..22.55
- Lane rental……16.92
- Design-build…….21.08
- Traditional……19.45

The mean differences in performance evaluation scores between A+B and design-build and between design-build and traditional were not significant at the 0.10 level.

For multi-lane highway rehabilitation projects through cities with detours, the performance effectiveness scores are as follows:

- A+B……24.68
- Lane rental……17.18
- Design-build……..19.28
- Traditional……..18.57

The mean differences in performance evaluation scores between lane rental and design-build, between lane rental and traditional, and between design-build and traditional were not significant at the 0.10 level.

For multi-lane highway rehabilitation projects through cities under traffic, the performance effectiveness scores are as follows:

- A+B……24.03
- Lane rental……17.18
- Design-build……..19.26
- Traditional……..18.57

The mean differences in performance evaluation scores between lane rental and design build, between lane rental and traditional, and between design-build and traditional were not significant at the 0.10 level.

For rural bridge replacement projects, the performance effectiveness scores are as follows:

- A+B……..23.40
- Lane rental……..16.13
- Design-build……20.55
- Traditional……...….19.86

The mean differences in performance evaluation scores between design-build and traditional were not significant at the 0.10 level.

For two-lane highway resurfacing projects, the performance effectiveness scores are as follows:

- A+B……..23.50
- Lane rental……..19.13
- Design-build……17.46
- Traditional……19.51

The mean differences in performance evaluation scores between lane rental and design-build, between lane rental and traditional, and between design-build and traditional were not significant at the 0.10 level.

For metropolitan bridge replacement projects, the performance effectiveness scores are as follows:

- A+B……..….24.52
- Lane rental……..17.25
- Design-build……....20.19
- Traditional……18.00

The mean differences in performance evaluation scores between design-build and traditional were not significant at the 0.10 level.

For mill and overlay projects, the performance effectiveness scores are as follows:

- A+B……..…24.60
- Lane rental……..20.12
- Design-build……15.50
- Traditional……19.72

The mean differences in performance evaluation scores between lane rental and traditional were not significant at the 0.10 level.

For unbonded concrete overlay projects, the performance effectiveness scores are as follows:

- A+B……..24.92
- Lane rental……..19.26
- Design-build……16.64
- Traditional……18.64

The mean differences in performance evaluation scores between lane rental and traditional and between design-build and traditional were not significant at the 0.10 level.

For preservation projects with culvert replacement during two-lane highway resurfacing, the performance effectiveness scores are as follows:

- A+B……23.97
- Lane rental……18.26
- Design-build……..17.18
- Traditional……..20.57

The mean differences in performance evaluation scores between lane rental and design build and between lane rental and traditional were not significant at the 0.10 level.

DISCUSSION OF SURVEY RESULTS

A+B contracts received the highest effectiveness score for each of the project types, and the differences in mean effectiveness scores were statistically significant in all comparisons of A+B to other contract types, except for major corridor realignment and expansion, where design-build mean effectiveness score was not statistically significantly different from A+B. This suggests that for all project types considered in this study, A+B contracts will create the greatest value when all relevant performance factors are considered. Of course, procurement protocols that do not allow for multi-attribute value consideration (e.g., low-bid awards) will not capture the optimum effectiveness that innovative contract methods have to offer.

The other three contract methods varied in effectiveness based on project parameters. For major corridor realignment and expansion, where third party disruptions and road user costs can be significant and designs can be complex, design-build scored very high compared to lane rental and traditional contracting. However, on projects with very little design input, such as overlays, design-build scored very low. The benefits of design-build are difficult to capture when the substantial time reductions from overlapping design and construction do not translate into lower road user costs or reduced disruptions to third parties.

We were somewhat surprised to find that design-build and lane rental did not score higher for multi-lane highway rehabilitation through cities, either under traffic or with detours. The complexity of sequencing and management of traffic, along with high traffic volumes typically found on these projects, would suggest value added from decreased project time and greater innovative capabilities. These findings might be explained by the use of equal-weighting performance criteria. Subsequent research should utilize a weighted performance criteria factor to give higher weight to the rankings attached to the most important performance criteria for each project type.

CASE STUDY RESEARCH METHODOLOGY

Investigation of the effectiveness of design-build on the ROC-52 project required the research team to conduct interviews of appropriate project personnel. The insight obtained from these interview sessions forms the basis of this case study. Information gained from the interview process was expected to be mostly qualitative in nature.

Prior to the interviews, a set of project-related criteria were identified as a means of comprehensively evaluating a project's performance. The questions presented in the interview were geared to address these different criteria as applicable to ROC-52. Specifically, we were interested in learning how the use of design-build delivery may have impacted the project. Ultimately, conclusions can be made about the effectiveness of design-build and recommendations can be made that will enhance the performance of future design-build projects.

There were nine core project criteria addressed in the interview sessions: administrative costs, construction costs, time, management complexity, disruption to third parties, road user costs, quality of project, funding flexibility, and innovation. Two general questions were also asked during the interviews to assess perceptions about different types of delivery systems and determine ways that the administration of ROC-52 could have been improved. Interviewees were not necessarily expected to be able to comment on all of these factors, but those who were selected for interviews were able to speak to most of them.

Each interviewee was chosen because he or she had considerable knowledge of the project and would be able to provide insight and suggestions. Interviewees for this case study were chosen after receiving input from Mn/DOT team leaders. Twenty-seven interviews were conducted during January and February of 2005.

CASE STUDY FINDINGS

A detailed discussion of findings from the case study exceeds the scope and space limitations of this paper. In general, findings suggest the following:

- Innovative contracting goes hand-in-hand with innovative financing because of the increased demand on agency cash-flows.
- Project staffing and district staffing must be coordinated because of high-intensity, (relatively) short-term demands on district operations.
- Quality control and quality assurance protocols and responsibilities must be clearly delineated prior to the start of construction.
- Co-location of designer-builder and agency district project engineers promotes exceptional teamwork and communication.
- First costs were thought to be slightly higher, but the percentage increase through change orders was far below typical contracts.
- Time reduction was exceptional (11 years at initial planning, 7 years at first design, 5 years at RFP, slightly less than 3 years actual).
- Road user, third party stakeholders, and the community in general were extremely pleased with the execution of the project.
- Placing public relations and community communication responsibilities with the design-builder was very effective.
- Some DOT personnel have difficulty with the reduced scope of design detailing (buildable vs. biddable documents).

- Input from the design-builder through the alternative technical concept review process led to greater innovation, resulting in both time and cost savings.
- Mn/DOT clearly accepted the risk of unknown conditions and environmental remediation, reducing lengthy negotiations on change orders or contract interpretations.
- Agency decision making and approvals should be delegated to the project level whenever possible.
- Speed of construction put strain on agency resources and processes, creating the need for new methods, new documents, etc.
- Speed of construction places a premium on information management and coordination for complex issues such as utility relocations, right-of-way acquisitions, etc.

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