

Comparative Performance Evaluation of Design-Build and Traditional Procurement Systems for Highway Projects in Afghanistan

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Abstract

A project procurement system outlines relationships, responsibilities and roles of the project team members and the sequence and structures of the activities required to deliver a facility. Currently, in Afghanistan design-build and traditional procurement systems are the two main procurement systems used to deliver highway projects. Highway clients, however; have not been fully satisfied with the Afghan industry's abilities to complete their projects on time, within the budget and to an acceptable quality.

Clients' needs and expectations require an assessment of the performance of the design and build, and the traditional project delivery systems for highway projects. This research, therefore; offers an empirical comparison of the design-build and the traditional procurement systems on project duration, cost and quality. Questionnaires surveyed by telephone interviews were used to collect the actual data of executed highway projects. The research involves collection, checking, validation and analysis of the data provided.

The results indicate that the design-build was superior in time performance, while it had slightly poorer performance in cost saving in comparison to the traditional procurement system. On average, both design-build and traditional procurement systems had similar standards of project quality.

Having evaluated the project performance, it was concluded that design-build can significantly reduce the delivery time of highway projects. These findings can potentially assist the highway clients in selection of an appropriate procurement system for highway projects, and greatly improve the understanding of the performance of an individual procurement system.

Keywords: Afghanistan, Design-Build, Highway Projects, Traditional Procurement System

Introduction

According to Beard *et al.* (2001) design-build provides the opportunity for the client to have contract with a single firm. This is one of the main advantages of this method, as the design-build team is responsible for both design and construction of the project. This procurement system, as Friedlander (1998) notes, provide the client with a significant contrast to the traditional procurement system, where designing and constructing are given to separate organisations; thus potentially increasing miscommunication and the difficulty in sharing information.

Although, the design-build (D&B) procurement approach is currently in use for procuring highway projects in Afghanistan, it is relatively a new approach in comparison to

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the more widely used traditional procurement system. Generally, in Afghanistan a large number of highway projects fail to meet their original project deadlines, both in terms of cost and quality and; as a result the clients and contractors have incurred financial losses, while these factors have slowed down the national infrastructure development (MPW, 2005). Clients (public and private) in Afghanistan like other parts of the world are seeking for an alternative procurement to traditional method that can meet their requirements.

The intention of this study is to assess the performance of design and build in comparison with the traditional procurement on duration, cost and quality of highway projects in Afghanistan.

Literature Review

This is not the first research to evaluate the viability of the D&B as an alternative to the traditional procurement system in infrastructure projects, however; this is the first research to evaluate the performance of D&B in comparison to the traditional procurement system on duration, cost and quality of highway projects in Afghanistan. There have no studies been conducted to assess the performance of both procurement systems in Afghanistan.

However; there are researches that have assessed how innovative procurement affects project performance in developed and developing countries. Researchers have also conducted studies to evaluate the performance of D&B versus more traditional procurement system on time, cost and quality of the highway projects.

Warne (2005) studied 21 highway projects to assess the effectiveness of the D&B in comparison to the traditional procurement system. The results indicated that 26% of highway projects which were procured by D&B were completed earlier, generally one to two months ahead of the schedule. Cost performance was also assessed to compare the bid sum compared with the total completion sum. The findings showed that D&B projects perform better than the traditional procurement system, because the cost growth for D&B projects was 4% less than traditional projects. In addition, the quality performance on the basis of client satisfaction was assessed and the findings suggest that the D&B projects perform better or equal to the traditional highway projects.

A research by the University of Colorado (2005) of Special Experimental Projects (SEP) 14 D&B highway projects found an average 14 percent time saving on 61 design-build projects when compared to the traditional projects schedule estimates. Another study by Ellis, Herbsman, and Kumar (1991) for the Florida DOT's (Department of Transportation) reported a 37 percent time saving on the first 11 design-build demonstration projects when compared to the traditional methods.

Sanvido and Konchar, (1999) found a 33 percent project delivery time saving and a 12 percent construction time saving for design-build vs. traditional projects on the 351 design-build, traditional, and construction management at risk projects studied in the building sector. Bennett, Potheary, and Robinson (1996) found a 30 percent project delivery time savings and a 13 percent construction cost savings for D&B vs. traditional projects on the 330 D&B and traditional projects studied in the building sector.

However, according to Molenaar, *et al.* (2005), evidence of initial cost savings due to design-build delivery is not as clear as the scheduling savings, however; there is some evidence of lower initial costs. The University of Colorado (2005) D&B study found an average 2.6 percent cost savings estimated by the project managers on 48 design-build projects analysed. Sanvido and Konchar, (1999) attributed a 6 percent project cost savings to D&B. Bennett, Potheary, and Robinson (1996) found that there is a 13 percent cost savings to D&B in comparison to the traditional projects.

In 2006, the Federal Highway Administration (FHWA) compared project performance of D&B highway projects against similar traditional highway projects. The study results showed that D&B projects reduced the overall duration of their projects by 14 percent, reduced the total cost of the projects by 3 percent, and maintained the same level of quality as compared to traditional project delivery (FHWA 2006).

Research Methodology

Research Techniques and Data Collection Method

The research conducted in this study is primarily quantitative, therefore; the data gathered has been analysed statistically.

Dispersion of stakeholders across the country and different agencies, difficulties to have access to all stakeholders; and geographic distribution of stakeholder were the reasons for not using face-to-face interviews. A structured questionnaire along with a follow-up telephone interview was used to collect the data. The selected method of data collection provided more opportunity to have contact with a large number of respondents. Questionnaires were used to collect information on highway projects that were completed from 2002 to 2011.

Data Analysis Method

Several previous studies (Konchar 1997, Sanvido and Konchar 1999, Molenaar, *et al.* 2005 and FHWA 2006) employed a univariate analysis method and importance index to assess the performance of D&B and traditional procurement systems on duration, cost and quality. Therefore, the univariate analysis method and importance index were chosen for this research. The univariate method compares central tendency measurements, such as means, medians, maximum, minimum and standard deviations. The univariate method is utilized to assess the effects of D&B and traditional procurement systems on time and cost. The importance index is employed to rank the effects of the both procurement systems on quality measurement.

The effect of project duration is calculated based on the differences between planned and actual duration of project phases when the project starts from development to actual completion (FHWA, 2006). The time performance is calculated by the Equation 1:

$$\begin{aligned} \text{Time Performance} \\ = \frac{\text{Final Completion Period} - \text{Original Contract Period}}{\text{Original Contract Period}} \times 100\% \end{aligned} \quad (1)$$

The effect of the project cost (FHWA, 2006) is calculated from contract phase to final delivered project cost. The cost performance is measured by the Equations 2, 3 and 4:

$$\text{Pre - Contract Cost Change} = \frac{\text{Contract Cost} - \text{Budget Cost}}{\text{Budget Cost}} \times 100\% \quad (2)$$

$$\text{Contract Cost Change} = \frac{\text{Final Delivered Cost} - \text{Contract Cost}}{\text{Contract Cost}} \times 100\% \quad (3)$$

$$\text{Total Cost Change} = \frac{\text{Final Delivered Cost} - \text{Budget Cost}}{\text{Budget Cost}} \times 100\% \quad (4)$$

The effects of project quality according to the FHWA (2006) can be assessed with the following three main criteria:

- Conformance with standards & specifications;
- Compliance with provisions of contract warranties (workmanship)
- Overall contracting agency satisfaction.

To identify the average performance of project quality importance index (FHWA, 2006) was used shown in Equation 5:

$$I_P = \frac{\sum_{i=1}^5 a_i \cdot n_i}{N} \quad (5)$$

Where: (a = constant expressing the weight assigned to each responses (ranging from 1 highly unacceptable to 5 very highly acceptable), n= frequency of the responses for each cause and N = total number of responses)

Research Findings and Results

Questionnaire Response

Out of 100 questionnaires distributed, 72 questionnaires were returned. Seven sets of questionnaires were not correctly filled in; hence 65 sets of questionnaires were useable for analysis. Out of 65 surveyed highway projects, 29 projects were design-build and 36 projects were procured through traditional procurement system, thus establishing a good balance between the two procurement systems.

Time-Related Performance Metrics Results

Comparison of the design-build against traditional projects revealed that design-build projects have more time saving than traditional projects.

Table 1. Average Difference of Project Duration of Design-Build and Traditional

Design-Build		Traditional	
Duration Dimensions	Value	Duration Dimensions	Value
Projects	29	Projects	36
Average	13.16%	Average	29.25%
Median	12.63%	Median	21.83%
Minimum Time Saving	-13.87%	Minimum Time Saving	-7.65%
Maximum Time Overrun	70.56%	Maximum Time Overrun	133.20%
Standard Deviation	16.89%	Standard Deviation	27.63%

The results in Table 1 indicate that the average time overrun for design-build projects is 13.16% and it is 29.25% for traditional projects. This result shows that the design-build procurement can reduce the overall duration of a project, in some cases they reduce the contract time significantly. The maximum time saving for design-build projects is 13.87% and had maximum time overrun of 70.56%. Traditional projects had a maximum time saving of 7.65% and led to maximum time overrun of 133.20%. Therefore, on average design-build had ensured effective time saving by 16.09%, in comparison to traditional procurement.

The finding clearly reveals that design-build is superior in contract time saving than traditional procurement system. The results also confirmed the model by Molenaar (2005) where the design-build projects can reduce the contract time, as illustrated in Figure 1

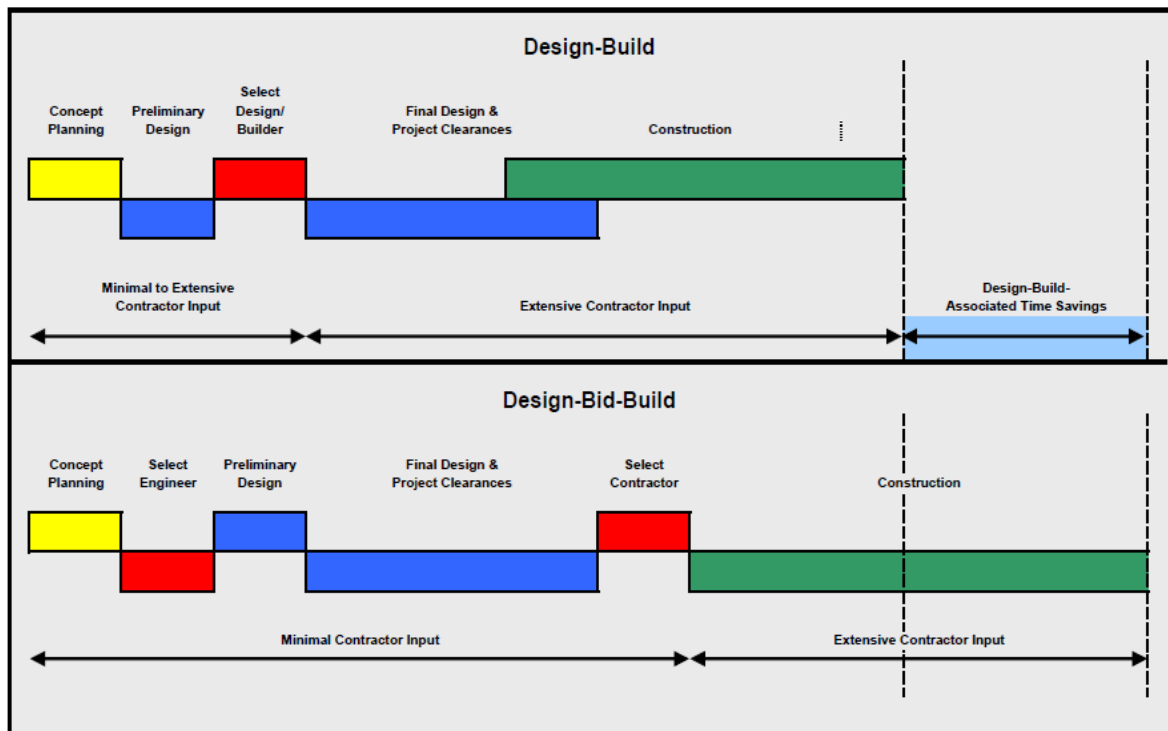


Figure 1: Sequence of Procurement System Activities (adopted from Melonnar et al, 2005)

Cost-Related Performance Metrics Results

On average traditional procurement system had better cost saving performance than their design-build projects counterpart. Traditional projects at pre-contract phase had a cost saving of 2.91% compared with budget, while design-build projects showed a saving against budget of 1.05%. On the basis of average rate of cost saving, as shown in Table 3 traditional projects were contracted lower than the estimated budget, in comparison to design-build projects, however; the magnitude of saving is small so bearing in mind the sample size may not be of great significance.

However, as Table 2 shows, there is much less cost certainty with traditionally procured projects with a wide range extending from a 37.95% cost saving to a 37.22% cost growth. In contrast, project estimations in Table 3 show that design-build projects cost changes were more reliably predictable extending from 7.38% cost saving to a 1.73% cost overrun.

On average traditional projects had a higher cost saving rate compared to their design-build projects counterpart. Although the results in Table 2 & 3 suggest that whilst both design-build and traditionally procured projects experienced cost growth, traditionally procured projects had fewer cost overruns in comparison to the design-build projects. As shown in Table 3 traditional projects experienced 1.51% cost growth, while design-build projects had 2.63% cost overrun.

Table 2. Average of Cost Performance of Design-Build Projects

Cost Dimensions	Award Cost Changes ((Award-Budget) /Budget)	Contract Cost Changes ((Final-Award) /Award)	Total Cost Changes ((Final-Budget) /Budget)
Projects	29	29	29
Average	-1.05%	2.63%	1.17%
Median	-0.51%	0.15%	-0.20%
Minimum Cost Saving	-7.38%	0.00%	-6.60%
Maximum Cost Overrun	1.73%	19.85%	16.11%
Standard Deviation	2.26%	4.90%	4.53%

Table 3. Average of Cost Performance of Traditional Projects

Cost Dimensions	Award Cost Changes ((Award-Budget) /Budget)	Contract Cost Changes ((Final-Award) /Award)	Total Cost Changes ((Final-Budget) /Budget)
Projects	36	36	36
Average	-2.91%	1.51%	-1.22%
Median	-5.00%	0.00%	-5.00%
Minimum Cost Saving	-37.95%	-22.20%	-29.52%
Maximum Cost Overrun	37.22%	41.84%	71.86%
Standard Deviation	15.57%	11.28%	20.96%

The results in Table 2 illustrate that none of the design-build projects were completed at the contract amount at construction stage as all of these projects experienced cost growth. In contrast, there are some traditional projects that were delivered either within specified contract sum or lower than contract amount.

As Table 3 shows, the estimated influence of traditional projects on cost performance were wide-ranging, extending from a 22.2% cost saving to a 41.84% cost overrun. This statistics resulted in higher standard deviations of 11.28% for traditional projects. In contrast, the range of cost changes as presented in Table 2 for design-build is lower than the traditional projects, where the cost changes range from zero percent saving to a 19.85% increase.

Therefore, on average traditional procurement had better cost saving by 1.12%, in comparison to design-build procurement.

To compare total project cost changes, it was found that only design-build projects experienced cost overrun, while traditional projects saved the total cost. On average the results in Table 2 & 3 indicate that design-build projects experienced cost overrun of 1.17% of estimated budget to final amount of the projects, whereas traditional projects saved the total cost by 1.22%. On the basis of average total cost changes traditional procurement performed somehow better than design-build procurement system.

Quality-Related Performance Metrics Results

When comparing the quality performance of the combined group of design-build projects versus traditional projects, the project survey revealed that highway contracting organisations were not fully satisfied with the level of quality delivered by either procurement systems. The findings suggest that most of highway projects were not delivered with specified level of quality which was indicated in the contracts. On average as shown in Table 4, the project survey respondents reported that 77 % of the design-build and 76% of traditional projects have met their intended quality purpose.

Table 4 illustrates that there was no significant difference noted in quality performance between two procurement systems, because on average the overall satisfaction of client was fairly similar for both procurement systems, which is 3.86 for design-build and 3.83 for traditional projects on a five-point scale (*in which 1 is highly unacceptable and 5 is highly acceptable*). However, compliance with warranty provisions (workmanship) and Conformance with standards/specifications are rated slightly higher for design-build projects than for traditional projects.

Table 4. Average Differences of Quality Performance for Design-Build and Traditional Procurement

Quality Performance	Quality Variables	Ranking					Average
		1	2	3	4	5	
Satisfaction with general quality of the project	Design-Build -Frequency (29 responses)						
	Conformance with standards/specifications	0	1	12	12	4	3.66
	Compliance with warranty provisions (workmanship)	0	4	12	10	3	3.41
	Overall client satisfaction	0	0	10	13	6	3.86
	Traditional -Frequency (36 responses)						
	Conformance with standards/specifications	0	2	16	16	2	3.5
	Compliance with warranty provisions (workmanship)	0	6	18	9	3	3.25
	Overall client satisfaction	0	0	12	18	6	3.83

The average difference between design-build versus traditional projects is 0.12% which is fairly insignificant. This result is not consistent with Gregersen (1998) findings that the quality of design-build projects suffered in comparison to traditional projects, while the cost and duration are more favourable for design-build procurement than traditional procurement system.

Summary and Conclusion

The results show that the design-build procurement can reduce the overall duration of a project, in some cases design-build reduce the contract time significantly. These results suggest that overall design-build versus traditional procurement can be a significant factor in expediting and controlling project delivery time. On average design-build had superior advantages on time saving of 16% in comparison to traditional procurement system

The cost changes for both procurement systems were measured in three project development phases from budget – contract – final completion. Having compared the cost changes between design-build and traditional projects, it was found that cost changes varies a lot, and both procurement systems had mixed impacts on cost changes. On average traditional procurement system had a better cost saving by 1% than their design-build procurement counterpart. However, the difference was not significant. There does, however, seem to be better cost certainty with Design and Built schemes.

The highway organisation satisfaction with the outcome of procurement system is the key issue to measure the quality performance. The findings showed that there was no significant difference in quality performance between two procurement systems, because on average the overall satisfaction of client was fairly similar for both procurement systems.

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