Comparison of Project Delivery Methods Used in Building Construction Projects

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Abstract

In Pakistan, the traditional project delivery method used for building construction projects is "design-bid-build", especially in public sectors. Most of the projects following traditional project delivery method do not meet the desired project performance in terms of cost, time and quality. The projects performance can be improved by adopting non-traditional project delivery methods. This paper compares the cost and schedule performance of design-bid-build and design-build delivery method, using project data collected from 92 building construction projects of Pakistan. The results of the statistical analysis are presented in two parts. First, the distribution of data set by project delivery method, project type, owner type and contract type used for the projects. Second, results of univariate analysis (descriptive statistics) are presented. Key findings of univariate analysis showed that unit cost of design-bid-build project was 22% more than that of design-build projects. Very less significant differences were found in cost growth between design-bid-build and design-build project delivery methods. Results show that the design-build projects had large construction speed and thus resulted in better schedule performance. It is concluded that the projects performance can be greatly improved by adoption of non-traditional project delivery methods. The present study was restricted to univariate analysis only. It is recommended that future studies may be carried out which include multivariate analysis.

Keywords
Project Delivery Method, design-bid-build, design-build, univariate analysis, Pakistan

1. Introduction

The construction industry attracts a wide variety of clients all of whom have their own objectives and priorities for their particular project. Consequently, when a client is considering the decision to build, a number of important decisions need to be made in order for the project to have a good chance of a successful outcome in terms of cost, schedule and quality. In the building industry, there are several project delivery methods available for owners to deliver construction projects within allocated cost and time. The success of these project delivery methods depend on their performance.

These methods define the contractual links among the key project team members and the flow of information within the hierarchical management structure. Methods vary and their nature is determined by the roles played by the project team members, the relationship between them, the timing of events, as well as the formal general conditions of contract used. An understanding of these can help the owners in the selection of project delivery method best suited for their project.

In Pakistan, the traditional project delivery method used for building construction projects is "design-bid-build", especially in public sectors. Most of the projects following traditional project delivery method do not probably meet the desired project performance in terms of cost, time and quality. The projects performance can be improved by adopting non-traditional project delivery methods (Design-Build, Construction Management at-Risk, etc.). Thus, the objective of the present study is to compare the cost and schedule performance of design-bid-build and design-build delivery method in building projects within Pakistan.

2. Literature Review

Since the late 1960s, research studies have been attempting to assess the performance of the traditional method of project delivery in comparison to non-traditional methods. In recent years, more studies have confirmed that large and complex projects with a higher element of risk achieve better outcomes under non-traditional methods of delivery (Naoum and Langford, 1990). Management contract outperformed as compared with the traditional contract in respect of several factors such as the issue of time, advice from contractor on buildability, and flexibility during construction, allowing the greater variation without affecting project performance (Naoum, 1994). Corrective actions have been taken to adopt the delivery systems (Design-Build, Construction Management at-Risk, Design-Build-Operate, Job Order Contracting) in attempts to allocate risk to the party most capable of minimizing the risk. While these processes have produced some encouraging results (Pocock, 1996), they have not significantly impacted the quality of construction crafts people (Garrity, 1999). Pocock et al. (1996) in their study verified the relationship between project's degree of interaction and performance indicators such as cost growth and schedule growth. Songer and Molenaar (1996) conducted a research to address owner's attitude towards project delivery method and pointed out the rapid growth of design-build project delivery method. Sanvido and Konchar (1998) conducted a study whose goal was to compare the different delivery systems that are widely used in the United States. Construction management at risk, design-build, and design-bid-build were the three main delivery approaches compared. The median scores reported through the results of the research concluded that projects delivered using the design-build approach performed better than those delivered through the construction management at risk or the design-bid-build delivery systems regarding several performance metrics. El Wardani et al. (2004) in their research quantitatively analyzed the correlation between the design-build procurement method and the performance of the design-build with regard to cost, time, and quality metrics. Although limited in numbers, the research consistently pointed out the low performance of project carried out under traditional project delivery method. Probably, no such study has been carried out which compare the cost and schedule performance of design-bid-build and design-build delivery method for building construction projects within Pakistan.

3. Methodology

The plan of the present study is to empirically compare cost and schedule performance of projects delivered using design-bid-build and design-build delivery methods. Research methodology of the present study is based on a research report of the Construction Industry Institute (CII) (Konchar and Sanvido, 1998). Survey questionnaire of the CII study was modified and adjusted after carrying out a pilot survey. The modified survey instrument was used to collect data on the cost and schedule performance. The collected data was analyzed by using univariate/descriptive statistics comparison of cost and schedule performance metrics between design-bid-build and design-build delivery methods.

3.1 Performance Metrics

3.1.1 Cost Measures
The first metric "unit cost" was defined as the total cost of the project divided by its area. It was calculated by the formula:

$$\text{Unit cost (cost in million/ft}^2) = \text{Actual total cost/area} \qquad (1)$$

The second metric "cost growth" was defined as the difference between final completion cost of the project and the contract cost calculated by:

$$\text{Cost growth (\%)} = [(\text{final project cost-contract cost})/\text{contract cost}]*100 \qquad (2)$$

3.1.2 Schedule Measures
Schedule measures include schedule growth and construction speed. Schedule growth, third metric, was defined as the difference between the total time used to complete the project and the planned time to complete the project calculated by:

$$\text{Schedule growth (\%)} = [(\text{Actual total time-planned time})/\text{planned time}]*100 \qquad (3)$$

Construction speed was defined as the facility gross square foot area divided by the as built construction time. It was calculated by:

$$\text{Construction speed (ft}^2/\text{month}) = \text{Area/total as built construction time} \qquad (4)$$

3.2 Data Collection

Data was collected through the use of modified questionnaire from project owners. Project data was taken from two types of client, public and private. Public owners included organizations like Public Works Department (PWD), Lahore Development Authority (LDA), Capital Development Authority (CDA), Communication and Works Department (C&W) and Pakistan Housing Authority (PHA), etc. Private owners included organizations like Bahria Town, Eden Builders, Emaar Pakistan, Defence Housing Authority (DHA, Islamabad), etc. Total 92 building projects were selected for the present study which, was constructed from January, 2006 to March, 2011.

4. Analysis and Results

Data of 92 projects were entered in spread sheet with project name, type of project, year of completion, contract type and owner type using numerical coding. Data such as project gross covered area, contract cost, completion cost, project anticipated and actual duration were entered without coding. Project data entered in spread sheet was imported in Statistical Package for Social Sciences (SPSS) for analysis.

Projects that did not meet the scope of study in terms of completion time and project nature were eliminated from the analysis.

The results of the statistical analysis of project are presented in two parts. First, the distribution of data set by project delivery method, project type, owner type and contract type used for the projects. Second, results of univariate analysis are presented.

Project Delivery Method
- Design-bid-build   50% of the total number of projects;
- Design-build   50% of the total number of projects.

Project Type
The summary of the selected project type is given in Table 1.

Table 1: Summary of Selected Project Type

Project Type	Project Delivery Method		Total
	Design-Bid-Build	Design-Build	
Residential Buildings	19	16	35
Commercial Buildings	2	6	8
Public Service Buildings	24	19	43
Other	1	5	6
Total	46	46	92

Project Client
Figure 1 shows that 62 percent of the 92 projects surveyed were publicly owned and 38 percent were privately owned
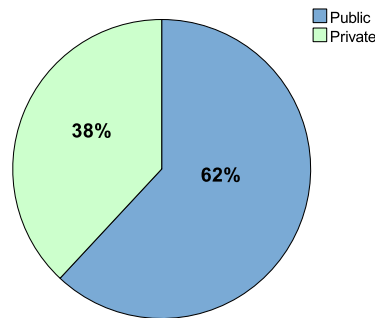

Figure 1: Client Type

Contract Type
Figure 2 represents the distribution of contract type used in the construction project.
- Lump sum   12% of all projects
- Unit price   47.8%
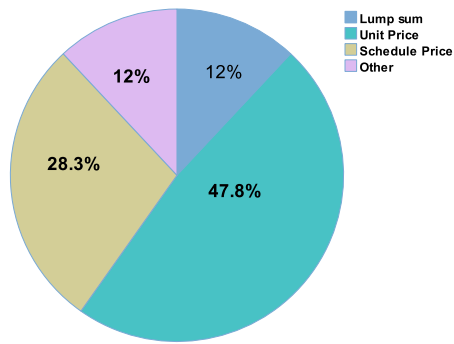- Schedule growth   28.3%
- Other   12%

Figure 2: Contract Type

4.1 Univariate (Descriptive Statistics) Results

The univariate analysis commonly involves reporting measures of central tendency (mean, median,) and involves studying the statistical dispersion (range, interquartile range, and the standard deviation). Using descriptive statistics tests, the mean values for all the cost and schedule performance metrics were compared after removal of the outliers because it is more affected by outliers if present within the data sets. Box plots were plotted to compare project delivery systems graphically.

4.1.1 Unit Cost
Figure 3 illustrates the result of data analysis that design-build projects had a mean unit cost less than design-bid-build projects.
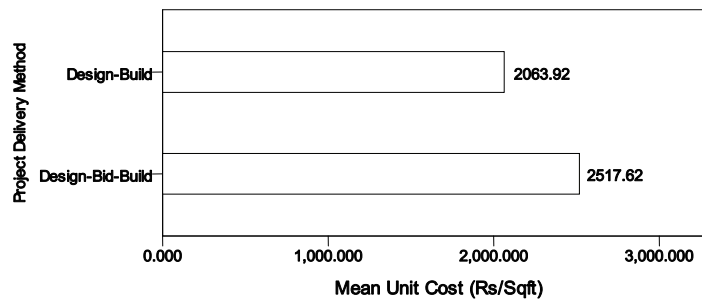
Figure 3: Mean Unit Cost by Project Delivery Method

The project unit cost, by nature, varies immensely from one project to another according to the scope definition of the project. The unit cost variability within the data set can be visually analyzed by box plot.

The center horizontal line in each box plot represents the median value for unit cost. Each box stretches from the lower hinge (defined as the 25th percentile) to the upper hinge (the 75th percentile) and therefore contains the middle half of the sample data in the distribution.

From Figure 4 it can be seen that 25 percent of design-bid-build and design-build projects had unit cost over Rs 3200/ ft² and Rs 2500/ ft², respectively. While, 25 percent of design-bid-build and design-build projects fall at below Rs 1600/ ft² and Rs 1300/ ft² unit cost, respectively. This implies that the unit cost of projects using design-bid-build is greater than the projects using design-build method.
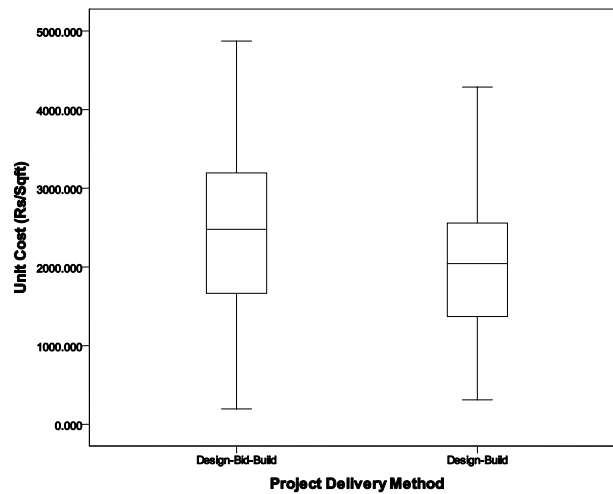
Figure 4: Unit Cost by Project Delivery Method

4.1.2 Cost Growth

Figure 5 shows that 44.56% of the projects using design-build experiencing absolute change in cost (cost reduction or increase), while 47.83% of the projects using design-bid-build experienced cost growth.
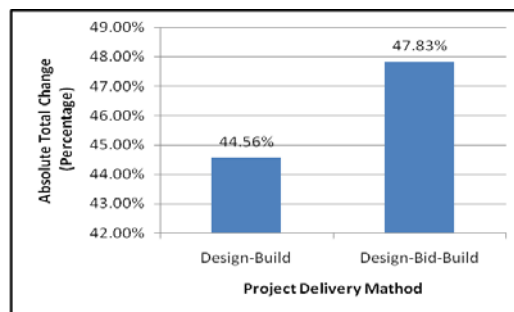

Figure 5: Absolute Change in Cost versus Project Delivery Method

Design-build projects had less cost growth than design-bid-build. In Figure 6, the results indicated that design-build outperformed in terms of sample cost growth as compared to design-bid-build.
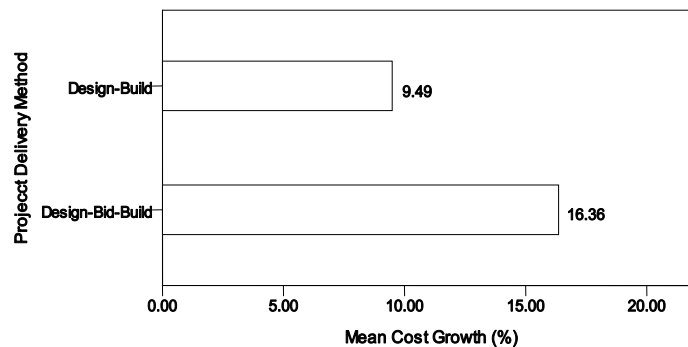

Figure 6: Mean Cost Growth by Project Delivery Method

It is clear from box plot of design build delivery method (Fig.7) that first quartile Q1 is nearly about at zero cost growth, indicating that the projects using design-build significantly experiencing less cost growth than design-bid-build projects. Figure 7 indicates that data set of project delivery method using design-bid-build method was highly skewed.
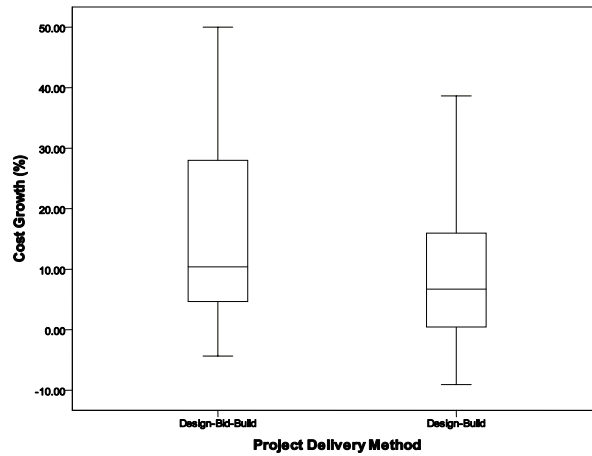
473

Figure 7: Cost Growth by Project Delivery Method

4.1.3 Schedule Growth

Regarding the schedule growth metrics, the analysis showed that the design-bid-build projects had a mean schedule growth almost two times greater than design-build projects as shown in Figure 8.
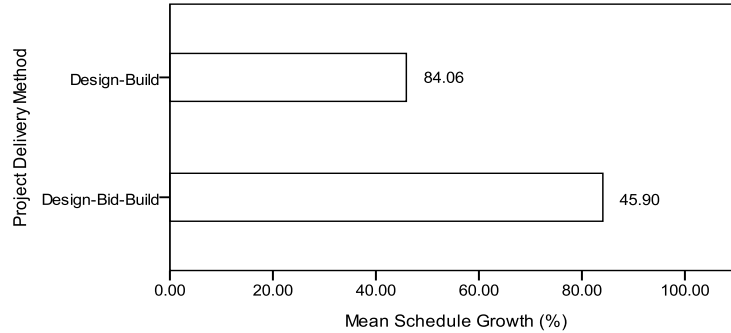

Figure 8: Mean Schedule Growth by Project Delivery Method

Figure 9 shows box plots for schedule growth by project delivery system. The distribution of each sample shows that both project delivery methods had minimum zero percent schedule growth value. But the median value of design-bid-build projects was twice the design-build projects.
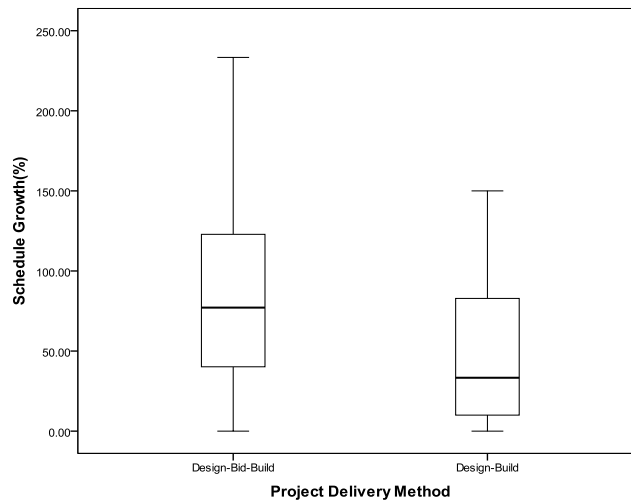

Figure 9: Schedule Growth by Project Delivery Method

4.1.4 Construction Speed

Results indicate that construction speed of design-build projects was significantly faster than design-bid-build projects. Projects executed by design-build appeared to have better schedule performance with faster construction speed as shown in Figure 10. Also, Figure 11 illustrates that box plot of design-build projects was more positively skewed.
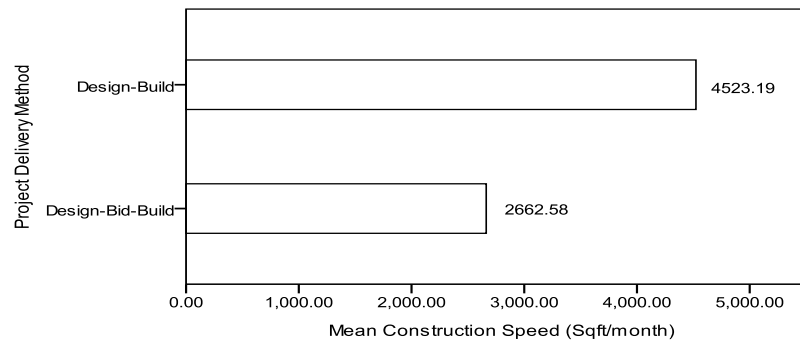

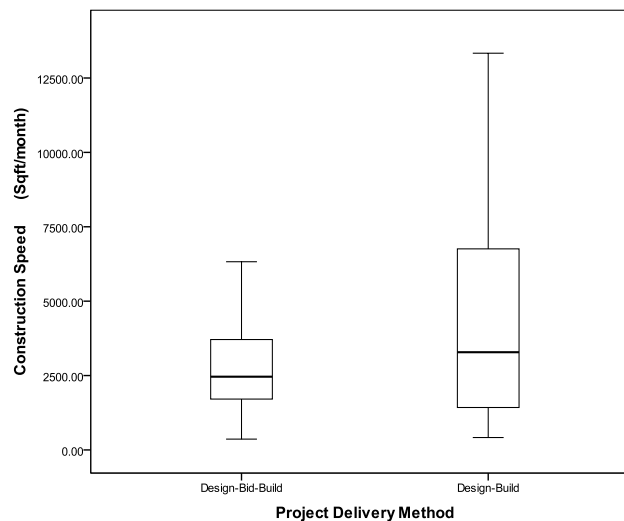**Figure 10: Mean Construction Speed by Project Delivery Method**

Figure 11: Construction Speed by Project Delivery Method

A direct comparison of mean value of cost and time metric by project delivery is shown in Table 2. A baseline unit value was assigned to lower project delivery method. This base line value is either small or large which indicate the better performance than the other value. Absolute percentage difference was taken for cost and schedule growth, while relative percentage was taken to compare the results of unit cost and construction speed.

Table 2: Cost and Time Metric Comparison by Project Delivery Method

Project Delivery Method	Values	Unit Cost	Cost Growth	Schedule Growth	Construction Speed
Design-Bid-Build	Mean Value	2517.62	16.36	84.06	2662.58
	%age change from base line value	22% higher than D-B	6.87% more than D-B	38.15% more than D-B	(Base line)
Design-Build	Mean Value	2063.92	9.49	45.90	4523.19
	%age change from base line value	(Base line)	(Base line)	(Base line)	69.87% faster than D-B-B

5. Conclusions

This study was aimed to compare the cost and schedule performance of design-bid-build and design-build delivery method for building construction projects within Pakistan. Key findings of univariate analysis show that unit cost of design-bid-build project was 22% more than that of design-build projects. Very less significant differences were observed from the results of cost growth between design-bid-build and design-build project delivery method. The results indicate that the design-build projects had large construction speed, and resulted in better schedule performance. The present study is restricted to univariate analysis; it is recommended that future study be carried out with respect to multivariate analysis.

6. References

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