



CONSTRUCTION INDUSTRY INSTITUTE

PROJECT DELIVERY SYSTEMS: CM AT RISK, DESIGN-BUILD, DESIGN-BID-BUILD

Construction Industry Institute

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**Project Delivery Systems:
CM at Risk, Design-Build, Design-Bid-Build**

**Prepared by
The Construction Industry Institute
Design-Build Research Team**

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Executive Summary

Design-Build: It is the nomenclature for a project delivery system that runs the gamut, from organizations employing it regularly, to those who tolerate it occasionally, to organizations restricted by statute from embracing it, to many who have never confronted it. Comparing its success to two other widely used delivery methods, design-bid-build and construction management (CM) at risk, was the charter of this research team. The results — proven by statistical analysis on over 350 projects — are “rock solid.”

Many ways of doing business in the past have proved unacceptable today, or, at least, proved less efficient than alternate methods not formally considered. This results from changes in owner staff makeup; a focus on the owner’s “core” business, which usually is not building capital projects; a need to downsize in-house capabilities; and owners’ inability to respond to an “I need it now!” concept.

The delivery methods that the research team studied, design-build, design-bid-build, and CM at risk, each have had varying success in the industry. The team studied methods used, and considered project attributes, owner in-house needs and desires, and critical success factors.

The research shows that design-build systems have significantly less design and construction cost growth when compared to design-bid-build; that design-bid-build systems have the greatest design and construction schedule growth; and that quality measurement associated with design-build, often maligned by many, is better than quality performance in design-bid-build.

No one method can meet all owner, project, or individual critical success factors. Any delivery system is dependent on the ever-changing dynamics of our industry. Now, however, there are statistically analyzed results that will improve the owners’ ability for selection. Those results are the subject of this report.

Introduction

Background

Achieving a quality project on time and within a specified budget is the goal of all owners. Although effective selection of the project participants and proficient execution of the project are important, selecting the optimum method of execution (the project delivery selection) is critical. Over the years, many owners have had little or no change in the way they execute capital projects, even though the surrounding business climate and the owners themselves have changed. The construction industry needs a quantitative basis for analyzing cost, schedule, quality, and other key project attributes of various project delivery systems and an understanding of how organization and methods of implementation can deliver an improved result.

CII assigned the Design-Build Research Team with a charter to compare the cost, schedule, and quality of the three best-known project delivery systems; design-build, design-bid-build, and construction management (CM) at risk, and to provide owners with noteworthy performance attributes to consider as criteria for selection of a delivery system.

Definitions

Design-bid-build is a traditional process in the U.S. construction industry where the owner contracts separately with a designer and a contractor. The owner normally contracts with a design company to deliver 100 percent design documents. The owner or owner's agent then solicits fixed price bids from contractors to perform the work. Contracts and scope for design and construction are thus distinctly separate (Fig. 1.1).

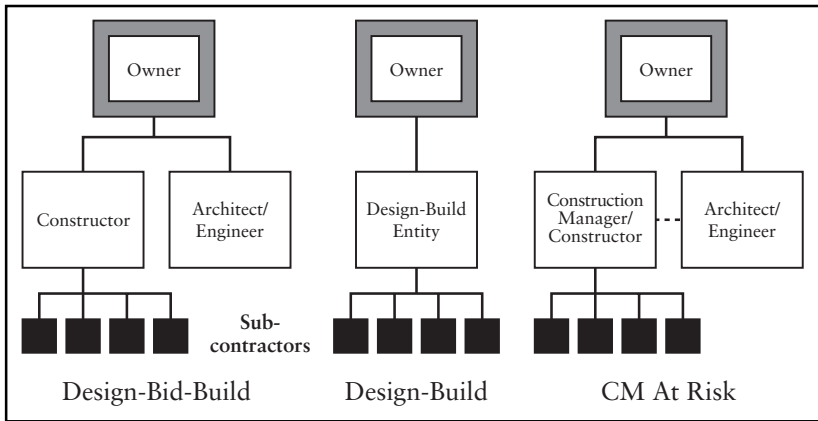


Figure 1.1. Three Project Delivery Systems

Design-build is an agreement between an owner and a single entity to perform both design and construction under a single contract. Portions or all of the design and construction may be performed by the entity or subcontracted to other companies. This system is similar in many respects to that often referred to as an engineer–procure–construct (EPC) contract (Fig.1.1).

Construction management at risk means that the owner contracts separately with a designer and a contractor. The owner contracts with a design company to provide a facility design. The owner selects a contractor to perform construction management services and construction work in accordance with the plans and specifications for a fee. There is an intended integration of effort to provide value-added where the contractor usually has significant input in the design process. The contractor generally guarantees the maximum construction price (Fig. 1.1).

Purpose and Objective of the Study

The purpose of this research was to provide industry with considerations to aid in delivery method selection. This was to be accomplished through the development of a method for collecting key project data for projects under a certain delivery system and to

compare that data to similar data under other delivery methods. To CII's knowledge, extensive quantitative statistical analysis had not been performed to date on the U.S. industry.

Following the collection and analysis of the data, the research team was to provide the industry with considerations to aid in delivery-method selection. Criteria was to be identified to allow owners to build their databases to support future project delivery system selection.

The priority of the survey was on the general building sector, since this grouping has a greater interest in utilizing diverse delivery methods and often confronts design-build as an unacceptable approach by some owners or agencies.

Scope of Study

The projects studied were submitted by a number of companies, including CII member companies, Associated General Contractors (AGC) members, and independent non-affiliated companies. Owner types were both private and public agencies/companies. As data was collected and analyzed, the several building types were categorized into "families" that displayed similar function, system type, complexity, and value.

A target of 300 or more projects was set, with a statistically-supportable minimum of 20 projects in any one family. This was to provide the research team with a sizable and quantifiable basis for confidence in the conclusions provided. Statistical analysis of the data, supported by owner interviews, was to confirm the results.

The research across all three systems studied projects having a variety of contract pricing arrangements, such as guaranteed-maximum-price, cost-plus, lump sum and others. This enabled the research team to separate the delivery systems from the contract types, thereby eliminating contract type as a dominant factor in the results.

Research Methodology

Survey Application

Six “families” were chosen as groupings based on the research team’s knowledge of the building type attributes:

- Light industrial buildings
- Multi-story dwellings
- Simple general buildings
- Complex general buildings
- Process/heavy manufacturing facilities
- Technology projects

The data did not include an owner’s internal project costs. Quality measurements were strictly owner provided and were measured against how well the building and appurtenances had performed.

Data collected included:

- As-planned vs. as-built dates
- Contract and final costs
- Startup and system quality measures
- Project team/environment characteristics
- Building/system characteristics
- Success criteria/lessons-learned

Seven different contract types were considered. They are: lump sum, cost plus, guaranteed maximum price, cost plus fixed fee, cost plus percentage fee, cost plus guaranteed maximum price and incentive fee.

Data sources covered 37 states and a period of time spanning seven years, which was then adjusted for time and location using historical indices such as *R. S. Means*. Square foot size of projects ranged from 50,000 to 2,500,000, and unit cost ranged \$30 to 2,000 dollars per square foot.

Data Analysis

Measures such as the mean, median, variance, and ranges of all metrics calculated from project data were used as initial comparisons. The initial analysis of central tendency quickly confirmed that mean, median, and mode values were very different, thus indicating that need for a battery of tests. Therefore, detailed hypothesis testing was required to make conclusions about the significance of differences between delivery system performance.

Hypothesis testing measured the strength of evidence in the data for or against precise statements about population characteristics. The first hypothesis testing for testing used two sample t-tests based on sample means. Hypothesis testing for sample medians was also chosen. Mood's median test was used because it effectively adjusts for outliers in data, and is particularly appropriate in the preliminary stages of analysis. Working together, two sample t-tests and Mood's median tests allowed the researcher to test significance between a number of critical metrics at a significance level of 95 percent.

In addition, the top performing quartile of all projects was analyzed to study critical explanatory variables impacting project delivery performance. These variables are listed in the project data sheets for each project delivery system.

Summary of Findings

Design and Construction Cost Growth

Most of the projects fell into \$40–200/square foot, which are the normal limits of most general building construction.

The range in results of cost growth based on delivery method was convincing and some times extraordinary. Design-build had the best performance of the three to minimize cost growth, with design-bid-build being the worst. The median cost growth for design-build projects was 2.37 percent, *less than half* the result of design-bid-build projects. Figures 2.1, 2.2, and 2.3 detail the results.

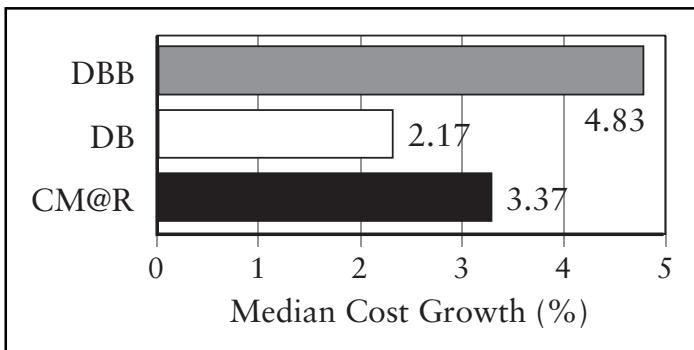


Figure 2.1. Design and Construction Cost Growth

Cost Growth = $[(\text{Final Project Cost} - \text{Contract Award Cost}) / \text{Contract Award Cost}] \times 100$

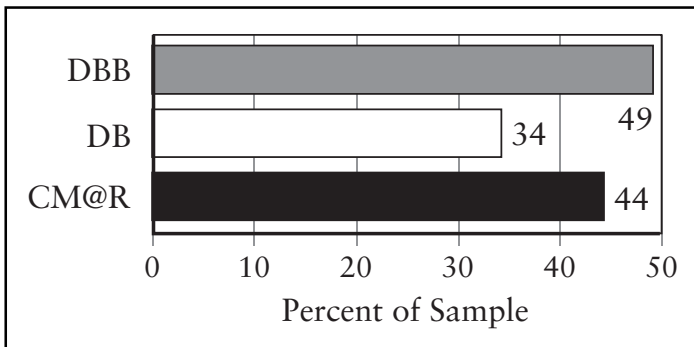


Figure 2.2. Design and Construction Cost Growth

Greater than 5 percent Growth