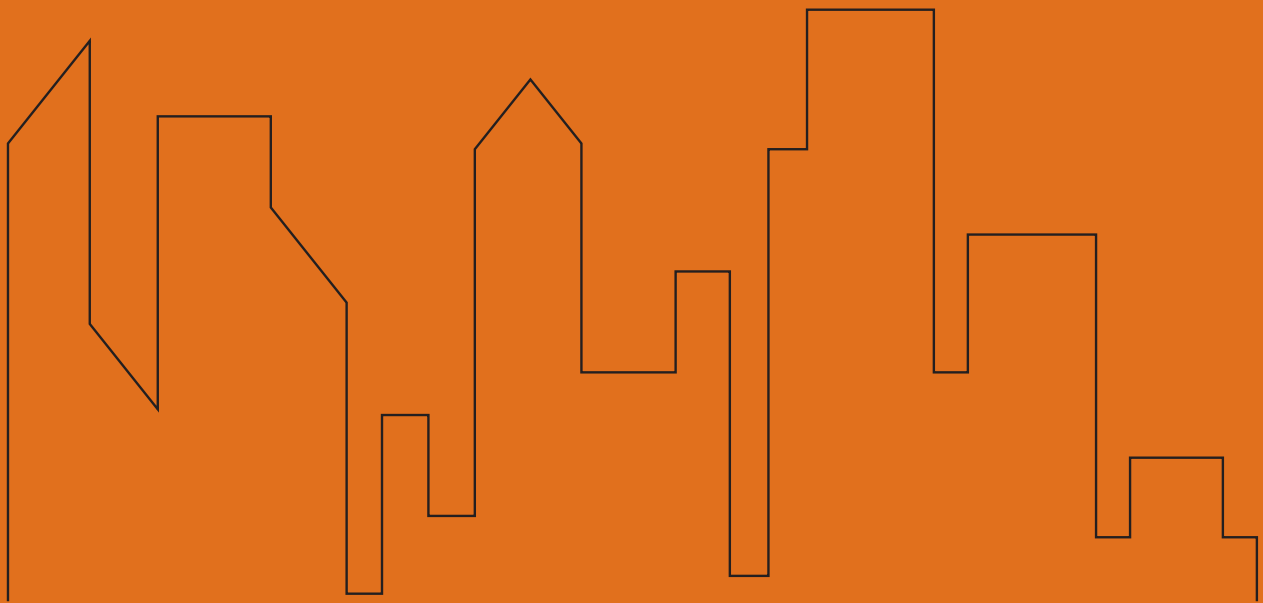


PROJECT DELIVERY SYSTEM SELECTION WORKBOOK



CONSTRUCTION INDUSTRY INSTITUTE

CII Member Companies

3M
Abbott Laboratories
Air Products and Chemicals, Inc.
Alcoa
Anheuser-Busch Companies, Inc.
Aramco Services Company
Atlantic Richfield Company
Bayer Corporation
BP Amoco Corporation
Celanese
Champion International Corporation
Chevron Corporation
CITGO Petroleum Corporation
The Dow Chemical Company
DuPont
Eastman Chemical Company
Exxon Research & Engineering Company
FPL Energy, Inc.
General Motors Corporation
General Services Administration
Intel Corporation
Eli Lilly and Company
LTV Steel Company, Inc.
Mobil Technology Corporation
National Aeronautics & Space Administration
Naval Facilities Engineering Command
Ontario Power Generation
Phillips Petroleum Company
The Procter & Gamble Company
Reliant Energy
Rohm and Haas Company
Shell Oil Company
Solutia Inc.
Tennessee Valley Authority
Texaco Inc.
U.S. Air Force Research Laboratory
U.S. Army Corps of Engineers
U.S. Department of Commerce/NIST
U.S. Department of State
U.S. Steel
Union Carbide Corporation
The University of Texas System
Weyerhaeuser Company
ABB Lummus Global Inc.
BE&K, Inc.
BMW Constructors, Inc.
Bechtel Group, Inc.
Black & Veatch
Burns and Roe Enterprises, Inc.
Butler Manufacturing Company
CDI Engineering Group, Inc.
Chemtex International Inc.
Cherne Contracting Corporation
Chicago Bridge & Iron Company
Cianbro Corporation
Day & Zimmermann International, Inc.
Dick Corporation
Dillingham Construction Holdings Inc.
Eichleay Holdings Inc.
Fisher Controls International, Inc.
Fluor Daniel, Inc.
Foster Wheeler USA Corporation
Fru-Con Construction Corporation
James N. Gray Company
Graycor
H+M Construction Co., Inc.
Hilti Corporation
Honeywell Inc.
International Technology Corporation
Jacobs Engineering Group, Inc.
J. A. Jones, Inc.
Kellogg Brown & Root
Kiewit Construction Group, Inc.
Kværner
Morrison Knudsen Corporation
M. A. Mortenson Company
Murphy Company
The Parsons Corporation
Praxair, Inc.
Raytheon Engineers & Constructors
S&B Engineers and Constructors Ltd.
SAP America, Inc.
Stone & Webster Engineering Corporation
Walbridge Aldinger Company
H. B. Zachry Company

Project Delivery System Selection Workbook

Prepared by the

Construction Industry Institute

Design-Build Research Team

Implementation Resource 133-2

October 1999

© 1999 Construction Industry Institute™.

The University of Texas at Austin.

CII members may reproduce and distribute this work internally in any medium at no cost to internal recipients. CII members are permitted to revise and adapt this work for the internal use provided an informational copy is furnished to CII.

Available to non-members by purchase; however, no copies may be made or distributed and no modifications made without prior written permission from CII. Contact CII at <http://construction-institute.org/catalog.htm> to purchase copies. Volume discounts may be available.

All CII members, current students, and faculty at a college or university are eligible to purchase CII products at member prices. Faculty and students at a college or university may reproduce and distribute this work without modification for educational use.

Printed in the United States of America.

Contents

<i>Chapter</i>	<i>Page</i>
1. Introduction	1
Purpose	1
Definition of a project delivery system	1
What makes up the selection tool?	2
2. Using the Project Delivery System Selector	3
Step 1 – Identify critical project goals	5
Step 2 – Review the system selector matrix	5
Step 3 – Examine key questions for the client	10
Step 4 – Examine critical project delivery success factors	10
Step 5 – Alternatives to use of optimum system	12
Step 6 – Review other considerations for the client	16
3. Conclusions	21
Appendix A – Facility Classification Definitions	23
Appendix B – Glossary of Terms	25
Appendix C – Project Delivery System Selector	31
Bibliography	37

Chapter 1

Introduction

.....

Project delivery systems have evolved over many years. The research community has made several efforts to document quantitative differences between the three principal project delivery systems used in the U.S. today. These systems include construction management at risk, design-build, and design-bid-build. The Construction Industry Institute, through Research Team 133, sponsored the first comprehensive, empirical comparison of construction management at risk, design-build, and design-bid-build in the U.S.

The database of 351 projects developed in this study contained significant data and lessons learned, which were analyzed to develop project delivery lessons for owners. These and the empirical comparison were integrated into a working tool that an owner can use to select a project delivery system. This guideline, based on specific project data, is highly applicable to public and private sector owners in the U.S. general building sector.

Purpose

This publication will guide an owner, planner, or stakeholder of a facility through a project delivery selection process. The user should achieve three results by using this guide. They are to:

1. Better understand the proven performance of each project delivery system and how it can impact their business.
2. Be better able to select the system best suited for their particular facility goals.
3. Recognize project characteristics of highly successful projects and learn ways to create these characteristics on their project, regardless of which project delivery system is used.

Definition of a project delivery system

A project delivery system defines the relationships, roles, and responsibilities of project team members and the sequence of activities required to provide a facility. In many cases, the owner of a facility will select a project delivery system and organize their design and construction team accordingly. However, with the advent of several alternative project

.....

delivery systems, an owner might be uncertain about which project delivery system is best suited for their particular facility goals. This implementation tool for selecting project delivery systems was the logical next step.

What makes up the selection tool?

This tool for selecting project delivery systems is made up of a six-step guideline. This document provides background on the development of the tool, and discusses the project delivery selection process in detail. In particular, each step contained within the implementation tool and glossary of terms can be found in the notebook. The notebook should be used simultaneously with the tool when selecting a project delivery system.

Chapter 2:

Using the Project Delivery System Selector

A six-step process guides the user through a structured decision making process en route to the selection of a project delivery system. Figure 1 describes this process graphically.

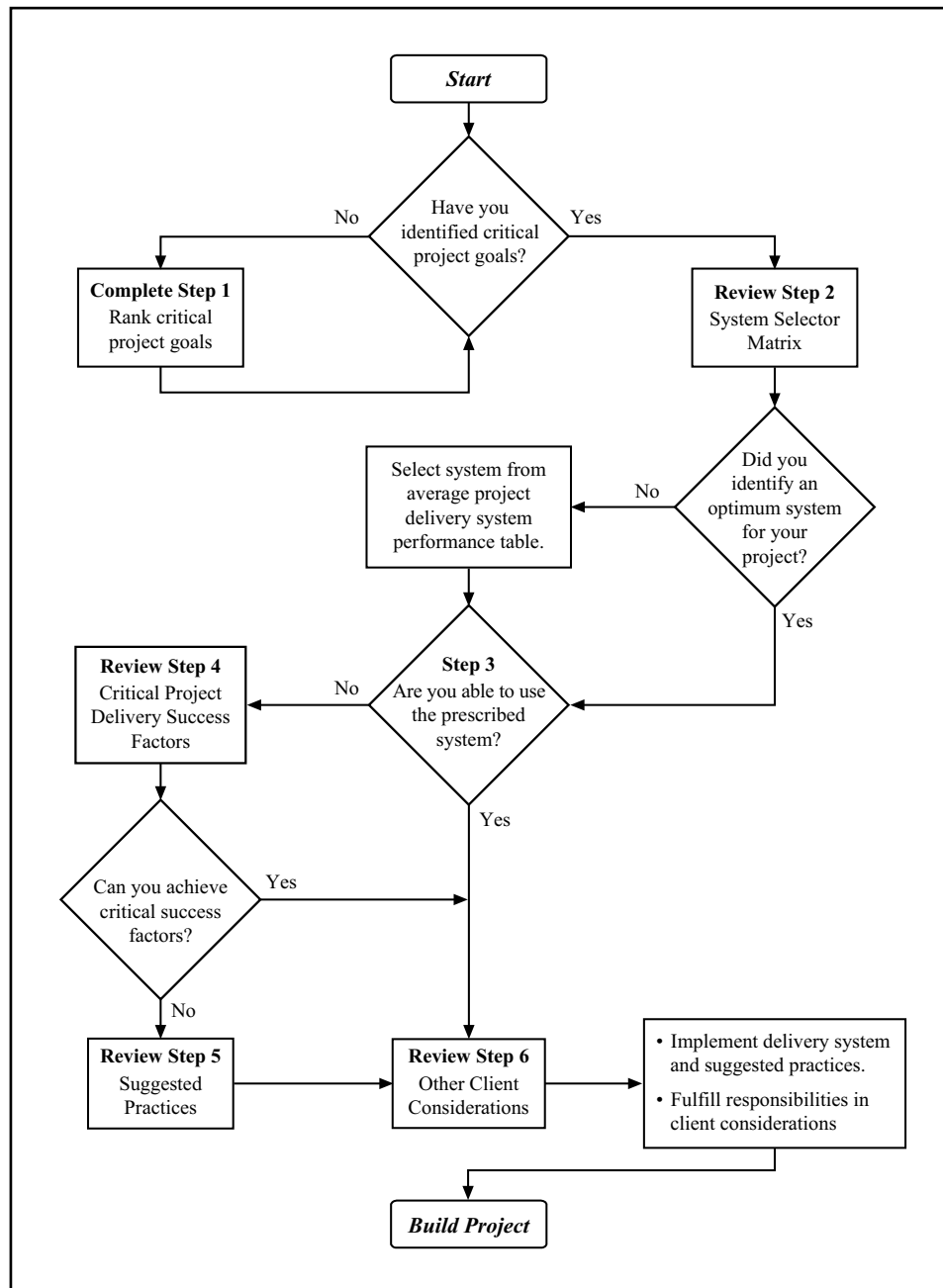


Figure 1. System Selector Flowchart

.....

The steps outlined in the flowchart refer to the steps in the following sections. These steps are:

- 1. Identify the critical project goals from the perspective of the facility owner.**
This exercise directs the owners' attention to critical cost, schedule, and quality performance areas. Based on the level of agreement with certain statements about each of these areas, an owner can better focus on the critical aspects of a particular job.
- 2. Review the System Selector Matrix.** This directs the owner to select the project delivery system, identified by research, to provide the best results based on particular facility needs.
- 3. Examine the key questions for the client.** This asks the owner to consider two fundamental questions. First, are you authorized to use the optimum project delivery system and second, if not, based on the constraints of your organization, what system(s) can you use?
- 4. Examine the top five critical success factors found on projects using each project delivery system.** If the optimum system selected in Step 2 is different from the system required to be used by the owner in Step 3, the owner can identify the differences between the systems and supplement the required system used with some attributes of the optimum system.
- 5. Consider alternatives to use of optimum system.** In an effort to help the owner achieve each critical project success factor, regardless of the system ultimately used, Step 5 offers a number of suggested practices for accommodating the many specific constraints and challenges faced by a variety of public and private sector owners.
- 6. Review other client considerations to determine other items clients consider when selecting a project delivery system.** Customize Step 6 into an historical log by recording your own individual lessons and experiences from specific projects. Historical references from past projects in your organization can greatly improve the education of others faced with similar challenges and will increase your chances of learning from similar lessons.

Step 1 – Identify critical project goals

Identify your project and its type. Use the facility classification definitions in Appendix A to identify your project type. Review Figure 2, Critical Project Goals, on the next page. Read the statements about each of the nine performance metrics. Circle the number that best shows the “Level of Importance” of the statements in each section. Level of importance ranges from More Important (5) to Less Important (1). In the “Score” column, add the two scores from each section. In the “Rank” column, rank each of the nine sections in ascending order. Scores reflect the relative importance of each performance metric. If two or more metrics have the same score, rank them according to what you feel is most critical to the specific project. The metric(s) with the highest score should be given the most consideration when reviewing the System Selector Matrix in Step 2.

Step 2 – Review the system selector matrix

Use the system selector matrix to select your optimum project delivery system.

Figure 3, System Selector Matrix, illustrates the relationship between facility type, delivery system, and each cost, schedule, and quality performance metric. The matrix identifies specific areas where one project delivery system outperforms another.

Use the System Selector Matrix to select the project delivery system proven to provide the best results based on your particular facility needs. Using your critical metric(s) identified in Step 1 and your facility type, identify the cell most critical to you and select the theoretically optimum delivery system. A solid circle in this matrix indicates that a significant difference does exist between the project delivery systems. Text then describes that difference. For instance, in the light industrial class, both design-build and construction management at risk significantly out-perform design-bid-build in terms of construction speed.

Figure 2. Critical Project Goals

Name of project: _____ Type of facility: _____	Level of Importance					Score (Sum)	Rank (1-8)
	More Important			Less Important			
Unit Cost							
Final square foot cost is critical on this project.	5	4	3	2	1		
The square foot cost is critical to owner's profitability.	5	4	3	2	1		
Construction speed							
The duration of construction time is critical to you.	5	4	3	2	1		
The schedule demands a short construction period.	5	4	3	2	1		
Delivery speed							
Your facility produces products that must get to market rapidly.	5	4	3	2	1		
The duration of design and construction time is critical to you.	5	4	3	2	1		
Cost Growth							
Funding is limited to the contract costs and a small contingency.	5	4	3	2	1		
The certainty of completion on budget is critical.	5	4	3	2	1		
Schedule Growth							
The certainty of completion on schedule is critical.	5	4	3	2	1		
Your business obligations require occupying the facility on time.	5	4	3	2	1		
Turnover quality							
The facility startup process is critical to your business.	5	4	3	2	1		
Your operation cannot tolerate impacts from many callbacks.	5	4	3	2	1		
System quality							
Performance of MEP systems are critical to your business.	5	4	3	2	1		
Quality of the envelope and architecture is critical.	5	4	3	2	1		
Process equipment quality							
The performance of process equipment is critical to your business.	5	4	3	2	1		
The layout of process equipment is critical to your business.	5	4	3	2	1		

List the three metrics most critical to this project

1. _____ 2. _____ 3. _____

Figure 3. System Selector Matrix

Metric Facility Type	Unit Cost	Construction Speed	Delivery Speed	Cost Growth	Schedule Growth	Turnover Quality	System Quality	Equipment Quality
Light industrial		DB, CMR > DBB	DB, CMR > DBB				DB > DBB	
Multi-story dwelling								
Simple office			DB > DBB, CMR		CMR < DBB	CMR > DB, DBB		
Complex office		DB > DBB	DB > DBB, CMR		DB, CMR < DBB	DB > CMR, DBB		DB > CMR
Heavy industrial								
High Technology		DB > DBB	DB > CMR			DB, CMR > DBB	DB > DBB	

Legend

> or < Significant differences called out

No significant differences between systems

Significant differences

.....

Certain cells in the System Selector Matrix compare one system to another but not directly to the third. For instance, the construction speed of complex offices indicates that design-build performs significantly faster than design-bid-build. There is not enough significance to report the same difference between design-build and construction management at risk or between design-bid-build and construction management at risk.

A non-shaded circle indicates no significant difference between the systems. To enhance the usefulness of the System Selector Matrix, the user should consult the Glossary (Appendix B) and review each performance metric and its definition.

What if the system selector matrix does not specify a delivery system for a cell?

A further investigation of the System Selector Matrix suggests that unit cost and cost growth are unaffected by the type of facility. The reason for this peculiarity is simply that the type of facility alone does not explain the measured differences between the three systems in the areas of unit cost and cost growth.

Table 1 indicates average differences between each project delivery system, regardless of facility type, for the listed performance metrics. Use this table to understand the average differences between each system and to select a theoretically optimum system if it was not identified using the System Selector Matrix.

When considering the unit cost of a light industrial facility, the system selector matrix does not specifically explain which system should be chosen as the theoretically optimum system. In cases such as this, use Table 1 to select the theoretically optimum system. Table 1 indicates that on average, regardless of facility, in the area of unit cost, design-build is at least four and a half percent less than construction management at risk and at least six percent less than design-bid-build. Therefore, on average, an owner can expect these differences on their particular project, whether they are building a light industrial plant or a complex office. In this example, if the most important metric was to reduce the project unit cost, design-build would be the theoretically optimum project delivery system.

Table 1. Summary of Average Differences between Project Delivery Systems

Metric	DB vs. CMR	CMR vs. DBB	DB vs. DBB	Level of Certainty
	%	%	%	%
Unit Cost	4.5 less	1.5 less	6 less	99
Construction Speed	7.0 faster	6.0 faster	12 faster	89
Delivery Speed	23 faster	13 faster	33 faster	87
Cost Growth	13 less	7.8 greater	5.2 less	24
Schedule Growth	2.2 less	9.2 less	11 less	24

What about quality?

Quality is the least objective of all the performance metrics considered here. This is because the quality questions in the CII research project were asked of clients after project completion, where any number of factors could have affected the perception of quality performance. Significant quality differences did exist, however, and quality results have the same degree of statistical confidence (95 percent) as do other principal metrics. In general, the design-bid-build project delivery system offered the lowest quality; however the differences between the systems in the research were small.

What is the level of certainty?

The level of certainty is a statistical measure used to express the ability of a particular regression model to explain differences in each performance metric. The higher the level of certainty, the more confident one can be about the results shown. The level of certainty (R^2 or the coefficient of determination) is listed in the fifth column of Table 1. In the case of unit cost, the level of certainty indicates that we can explain 99 percent of the variation in unit cost and isolate the effect of the project delivery system used on the project. Low values for cost and schedule growth indicate that we cannot explain factors affecting a significant portion of cost and schedule growth variation.