

Influence of Delivery Methods and Legislative Impediments on Project Performance Information

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The choice of a suitable delivery method plays a considerable role in the performance of a construction project. Previous research has attempted the development of a systematic approach to project delivery method selection focusing on performance information. However, such attempts did not properly address public agencies and legislative impediments are almost entirely neglected as suggested variables in such models. This paper addresses these limitations by presenting a quantitative analysis to test whether federal and state legal limitations do influence project performance. Project characteristics from the U.S. General Services Administration Capital Construction Project database are presented. The database is analyzed using cross-tabulation to determine potential correlations among the variables, and specifically their relation to project delivery method choice and performance information. Contributions from this research are reflected in presenting a methodology for choosing alternative delivery methods while considering project characteristics and specifically the legislative impediments associated with a construction project and their influence on project performance.

Keywords: Delivery Method, Legislative Impediments, Performance Information

Introduction

Researchers and practitioners are constantly seeking to determine which construction project delivery method best suits a project. This project delivery method selection process is part of the programming phase of a project, and typically is overshadowed by the need to determine sufficient program definition during the same phase. This problem is exacerbated in alternative project delivery methods in that the public owner does not have the design reviews that are common in traditional construction delivery methods. The construction industry has not established a standard definition of the project delivery method process, nor has it established accepted types and definitions of project delivery methods. Because of this, federal, state and local legislation and trade organizations have established their own definitions of the process and the types of project delivery methods. This has resulted in multiple interpretations of the project delivery method process.

In 2004, members from the American Institute of Architects (AIA) and The Associated General Contractors of America (AGC) trade organizations formed a task force to develop a basic understanding of the project delivery method process and definitions for the three primary project delivery methods: design-bid-build, construction manager at-risk, and design-build. Their goal was to “provide the industry with a set of definitions that others can use as a baseline...against which people can reconcile their own set of definitions” (AIA and AGC 2004). Those definitions are used as a baseline for this research, and are supplemented by federal and state legislation and a literature review of published research. The AIA and AGC have not

established a standard definition for the project delivery method process. Rather, they provide a discussion on “management” versus “delivery,” associating the term “delivery” with project delivery method. Delivery is termed as the assignment of responsibility for providing design and construction services. Management is the coordination of the design and construction process. The AIA and AGC associate the assignment of responsibility as the fundamental difference between project delivery methods.

In the construction industry, there are three primary methods of project delivery. Construction industry professionals commonly refer to a “traditional” form of project delivery known as design-bid-build. There are two variations of this traditional form: design-bid-build using separate-prime bidding method, and design-bid-build using single-prime bidding method for project delivery. These methods obligate public owners to award construction contracts based on the lowest, most responsible and responsive bidder. In the past decade, the choices of methods have expanded and are referred to as “alternative delivery methods.” These are the construction manager at-risk and design-build project delivery methods. These alternative delivery methods obligate the public owner to award contracts based on a combination of qualifications and cost, or best value.

The General Services Administration (GSA) applies several variations of these primary project delivery methods. First, GSA does not use the design-bid-build using separate-prime bidding method; however, GSA does use the design-bid-build using single-prime bidding and the design-build methods. GSA also has a variation of the design-build project delivery method, referred to as design-build-bridging. Instead of the public owner preparing a detailed project program as in design-build, in design-build-bridging, the public owner solicits a separate design entity, based on qualifications to complete the design through the design development phase. This design entity is referred to as a bridging architect. Once design is complete through the design development phase (approximately 35 percent), the public owner requests proposals to attract a design-builder to complete the design and perform construction. The balance of the design and construction phases is awarded to a single entity. Under this design-build variation, construction still typically begins before the design documents are complete, and the public owner hold two contracts, one with the design entity that completes the design through the design development phase, and a second contract with a design-builder who finishes the design and performs construction, as depicted in Figure 1. GSA also uses the construction manager at-risk method of project delivery; however, GSA also has a variation of this method and refers to that variation as construction manager as-constructor. GSA’s construction manager as-constructor has the same four sequential phases of project delivery as in the construction manager at-risk project delivery method: selection (of a designer), design, bid-selection (of a construction manager), and construction

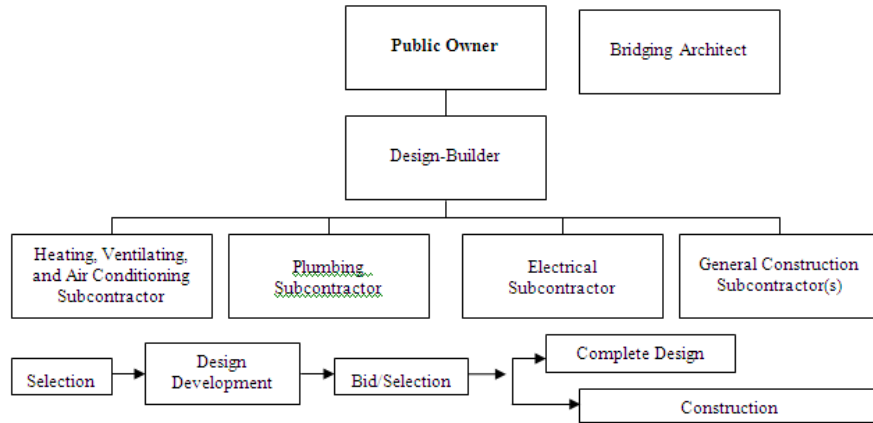


Figure 1: Design-Build-Bridging Organizational Chart

GSA develops the project program and then requests proposals from prospective designers and then awards the contract on the basis of qualifications. The designer then develops design documents. During this process, GSA requests proposals from prospective construction managers and selects on the basis of qualifications and of cost. Once the construction manager is selected, the contract has two phases of execution. In the pre-construction phase, the construction manager works with GSA and the designers for constructability reviews until the design documents are usually complete. GSA has the option to determine how complete the design documents should be before construction negotiations begin. GSA has an option to negotiate the cost of construction based on a guaranteed maximum price, based on a fixed cost or based on a cost-plus-fee. Figure 2 presents the construction manager as-constructor organization chart.

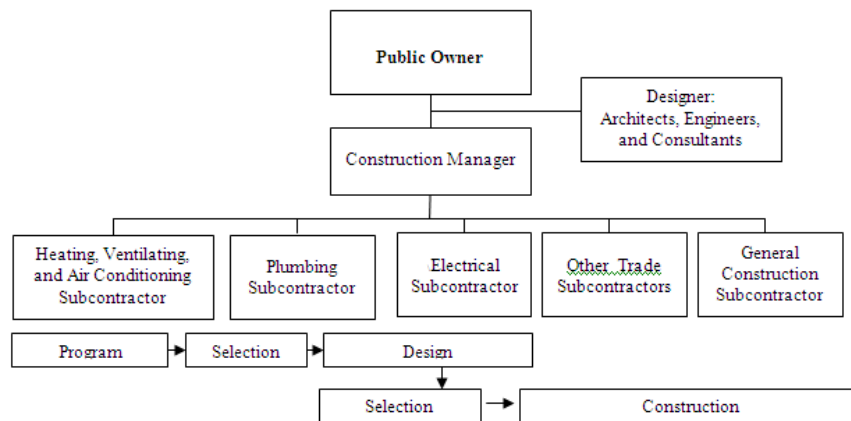


Figure 2: Construction Manager as-Constructor Organizational Chart

The use of project delivery methods can be traced back to the evolution of design and construction when ancient master builders provided a seamless service that included what is now referred to as design and construction, or design-build. In the past two centuries, in the dawn of the Industrial Revolution, the design and construction industry has become more specialized and segmented. In response to the growing segmentation of the construction industry, laws,

beginning with the Miller Act of 1935, have been enacted to legally separate the duties of design and construction on federal projects in the United States.

This growing segmentation in the industry also prompted Congress to enact the Federal Property and Administrative Services Act of 1949, the first public contract laws mandating the separation of design and construction. This law requires the selection of builders on public contracts through open competition and based on the lowest responsible bid. The Brooks Architect-Engineer's Act, enacted in 1972, is believed to have solidified the separation of design and construction by requiring public owners to award architectural and engineering contracts based solely on qualifications. The theory behind the law is that, since federal projects are built by the lowest cost builder, the designs for the project should be developed by the highest qualified design firm. The enactment of these two laws is the basis for much debate and research in the public construction industry. Public owners who are without experience in alternative project delivery methods or who are unsure about the appropriate application will opt for the traditional method of project delivery, design-bid-build, and face the risks associated with its low-bid process.

Previous research has demonstrated that the selection of an appropriate delivery method contributes significantly to the outcome of a design and construction project (Chan et al. 2002; Love 2002; Chan et al. 2004). And while no one system is superior in all circumstances, there is probably a best choice for any specific project (Dell'Isola et al. 1998). Many owners base their project delivery method choice upon biased experience of in-house experts and/or advice from external consultants (Masterman 1992; Masterman and Duff 1994). Other owners use project delivery methods based on over-simplified practices that "take into account the characteristics of each job rather than adopt a method developed from detailed consideration of both the projects themselves and their effects on the ongoing business of the organization" (Griffith and Headley 1997). Skitmore and Marsden (1988) explored the development and application of a more systematic approach to project delivery method selection. Since then, there is substantial research that suggests and even attempts to develop a systematic approach to project delivery method selection. However, existing literature rarely addresses public agencies and legislative impediments are almost entirely neglected. Over the past several decades, there has been growing dissension toward the design-bid-build project delivery method. Critics claim that choosing a builder based on the lowest price under the design-bid-build method supports unscrupulous behavior. This growing dissension has led to court cases to challenge the Brooks Act, which evolved to the passage of the National Defense Authorization Act of 1996, re-named the Clinger-Cohen Act. This Act allows all federal agencies to award one contract to an entity or team of entities to design and build the construction project. However, many federal agencies and state governments have yet to embrace design-build as a viable procurement system. Five years after the Clinger-Cohen Act was passed, almost half of all states did not allow design-build. And 10 years after its enactment, there are still five states that forbid design-build, and of those that allowed it, many are highly restrictive in its use.

This paper addresses legal legislative limitations inherent in the public construction industry by presenting an analysis that can be integrated into existing models and taken into consideration when choosing a project delivery method. The analysis uses a series of multivariate flowcharts that reflect how project delivery methods influence project performance. These flowcharts guide

public owners in determining the advantages and disadvantages of alternative project delivery methods, such as design-build and construction manager at-risk. The analysis aids public owners and the construction industry by identifying, testing and analyzing the impact of legislative impediments in the delivery method selection process and on project performance.

Research Hypothesis and Data

The data used to test the research hypothesis, whether benefits exist to public owners when using alternative project delivery methods and whether benefits exist to public owners when legislative impediments are lifted, and alternative project delivery methods are allowed to be used, is provided from GSA's Project Information Portal (PIP). The PIP is a nationwide system for tracking the GSA Public Buildings Services (PBS) capital construction program, where users can obtain project information, from its design renderings, construction photos, or completed project views.

The database includes project characteristics or variables to assist Congress and GSA executives to track the progress of such projects. These variables are: (1) Region; (2) Project Type; (3) Program Area; (4) Project Delivery Method; (5) Political Party; (6) Gross Area; (7) Usable Space; (8) Congress Authorization; (9) Conference Appropriation; (10) Central Office Allowance; (11) Estimated Total Prospectus Cost; (12) Estimated Total Prospectus Cost Site; (13) Estimated Total Prospectus Cost Design; (14) Estimated Total Prospectus Cost Construction; (15) Congress Authorization Year; (16) Planning Phase Duration; (17) Design Phase Duration; and (18) Construction Phase Duration. Several of these variables were grouped to analyze the data in more detail: (19) Congress Authorization to Construction Finish Duration; (20) Planning Start to Construction Finish Duration; and (21) Design Start to Construction Finish Duration. To test the hypothesis, whether benefits exist when alternative project delivery methods are used and whether legislative limitations allowing the use of alternative project delivery methods impede any such benefits to be realized, the researcher adds two new variables to the database: (22) Federal Legislation and (23) State Legislation.

This database is selected for this research and the variables contained within it are used because GSA's Project Information Portal (PIP) is the most comprehensive database that could be found. This database also is required through congressional mandate and so the variables within it are required through such mandate. The goal is to take a quantitative approach to determining whether benefits exist to a public owner when alternative project delivery methods, specifically design-build, are used for a construction project, and whether legislative limitations allowing the use of such alternative methods impede such benefits to be realized. To test the hypothesis, whether benefits exist when alternative project delivery methods are used and whether legislative limitations allowing the use of alternative project delivery methods impede any such benefits to be realized, Federal Legislation was added as a new variable to the database. Federal Legislation represents if the 1996 Clinger-Cohen Act is passed into law when Congress authorized funding for the project. The 1996 Clinger-Cohen Act allows qualifications-based selection of builders using the design-build and construction manager as-constructor forms of project delivery. This new variable provides information to explore the benefits of using alternative project delivery

methods. Within GSA's database, more than half of all projects are built using design-bid-build using single-prime bidding, or 252 projects, as presented in Table 1.

Table 1

Project Delivery Method Distribution

Delivery Method	Frequency	Percent	Valid Percent	Cumulative Percent
Design-Bid-Build (Traditional)	252	50.8	50.8	50.8
Design-Build	100	20.2	20.2	71.0
Design-Build Bridging	69	13.9	13.9	84.9
Construction Manager as Constructor	75	15.1	15.1	100.0
Total	496	100.0	100.0	

Fifty-six projects in the database are approved by Congress before the Clinger-Cohen Act is enacted; these projects were approved by Congress before 1996. Three hundred and twenty-five projects in the database are approved after the Clinger-Cohen Act is enacted, or from fiscal year 1996 to 2008. And 115 projects in the database do not provide such information and those projects have missing data. These results in the database are depicted in Table 2.

Table 2

Descriptive Statistics of Federal Legislation

Clinger-Cohen Act of 1996	Number of Projects (Frequency)	Percent
Enacted before 1996	56	11.3
Enacted after 1996, and including 1996	325	65.5
Missing	115	23.2
Total	496	100.0

Quantitative Analysis

Cross-tabulation analyzes the relationships between independent and dependent variables, or between defined problems and factors contributing to those problems. This investigates cause-and-effect relationships, looking at the extent to which one variable (i.e., the cause) influences another variable (i.e., the effect) (Leedy and Ormrod 2005). A variable that is studied in research as a possible cause of something else is the independent variable. A variable that is potentially influenced by the independent variable is the dependent variable, because it depends on the independent variable. In this paper, the dependent variable is the project delivery method and the independent variables are the project characteristics, and specifically the variables to test the hypothesis, the legislative impediments. Cross-tabulations are performed using the dependent and independent variables to test the relationship of the associations. As explained before, there are 22 independent variables and one dependent variable (i.e., project delivery method) in the database, and all independent variables are analyzed using cross-tabulations in this section. While cross-tabulations provide the relationship among two variables, it does not address the

strength of the association. While it is possible to examine the strength of the relationship by modeling two or more independent variables, the scope of this paper is to extrapolate information from the project variables and explore their relationship with project delivery method selection.

Project Prospectus Cost Performance Information

Figure 3 shows the performance relationship between the mean Estimated Project Prospectus Cost and the project delivery method, for several project stages. The Estimated Total Prospectus Cost (ETPC) for the dataset reveals that projects using the design-bid-build delivery method, on average, are funded most heavily, with an average of \$39,821,994 for all projects. Projects using construction manager as-constructor delivery method rank second in funding, with an average of \$79,664,448. Design-build projects rank third with an average of \$25,360,700 in funding and design-build-bridging rank last with an average of \$13,306,191 in funding. The Estimated Total Prospectus Cost for site work suggests that more monies are projected for projects using design-build than all other project delivery methods, with \$8,583,303. However, monies distributed for site work seem to be, on average, about the same for design-bid-build and construction manager as-constructor, higher for design-build and lower for design-build-bridging. Projects using construction manager as-constructor, on average, allocate \$7,245,120 for site work, and projects using design-bid-build allocate an average of \$7,239,317. Projects using design-build-bridging rank last with an average of \$6,258,827 for site work.

An analysis of the Estimated Total Prospectus Cost for the design phase reveals that more funds, on average, are allocated for projects using the construction manager as-constructor delivery method, with projects receiving an average of \$6,052,676. Significantly fewer funds are allocated to projects, on average, under other delivery methods. Projects using design-bid-build received an average of \$4,435,802, while projects using design-build-bridging receive \$3,551,847, and those using design-build receive \$2,681,195. Design costs for projects using design-build are one-third of design costs for projects using construction manager as-constructor.

The estimated total prospectus cost for construction is significantly higher for projects using construction manager as-constructor, with an average of \$80,747,864. Projects using design-build-bridging are allocated an average of \$52,838,345, while those using design-bid-build average \$47,689,315, and those projects using design-build average \$41,991,151.

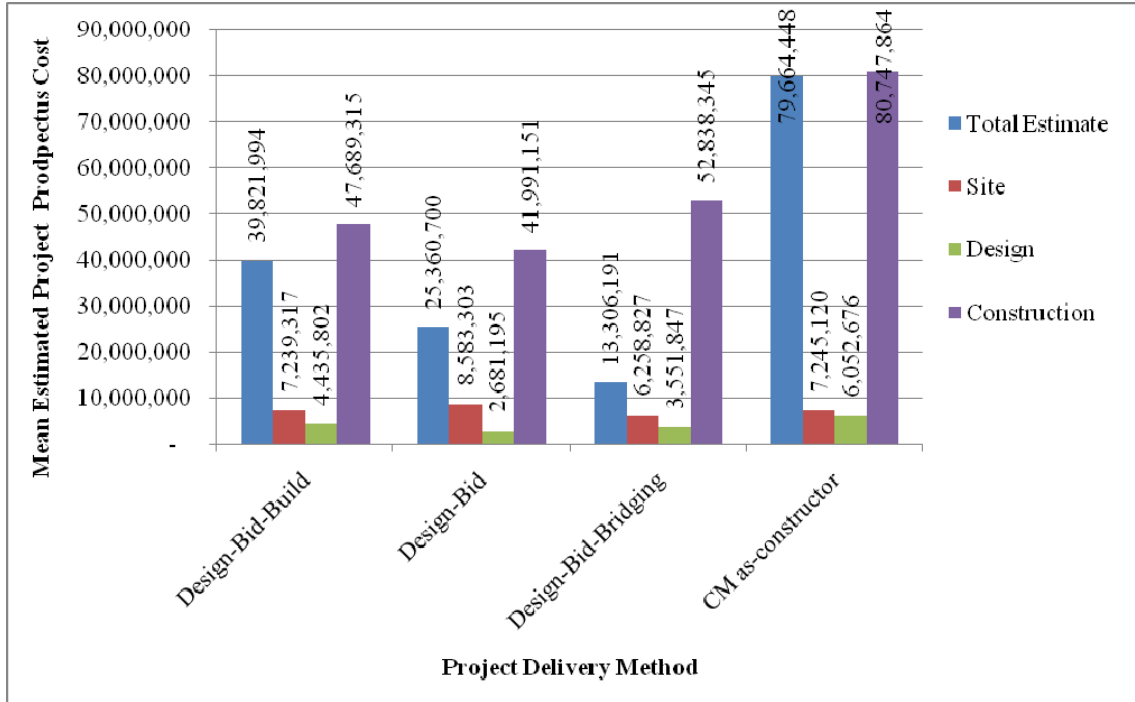


Figure 3: Cross-Tabulation of Estimated Project Prospectus Cost and Project Delivery Method (Dollars)

Project Phase Duration Performance Information

The cross-tabulation analysis reveals that the average number of days in the planning phase varies only slightly between project delivery methods. Figure 4 shows the average number of days in several phases of project development. As seen in the figure, the average number of days in the planning phase for design-build-bridging is 996 and the average for design-bid-build is 970; the figure also shows an average of 950 days for construction manager as-constructor, and 928 days for design-build.

An analysis of the time to complete design varies significantly between project delivery methods. Projects using design-build have the shortest design period, with only an average of 604 days, whereas projects using design-bid-build average 840 days, those using design-build-bridging average 930 days, and those projects using construction manager as-constructor average 1,077 days. There is a great difference in the number of days (duration), on average, for these methods and the cross-tabulation analysis suggests that it may take twice as long to complete design using construction manager as-constructor than it does using the design-build delivery method.

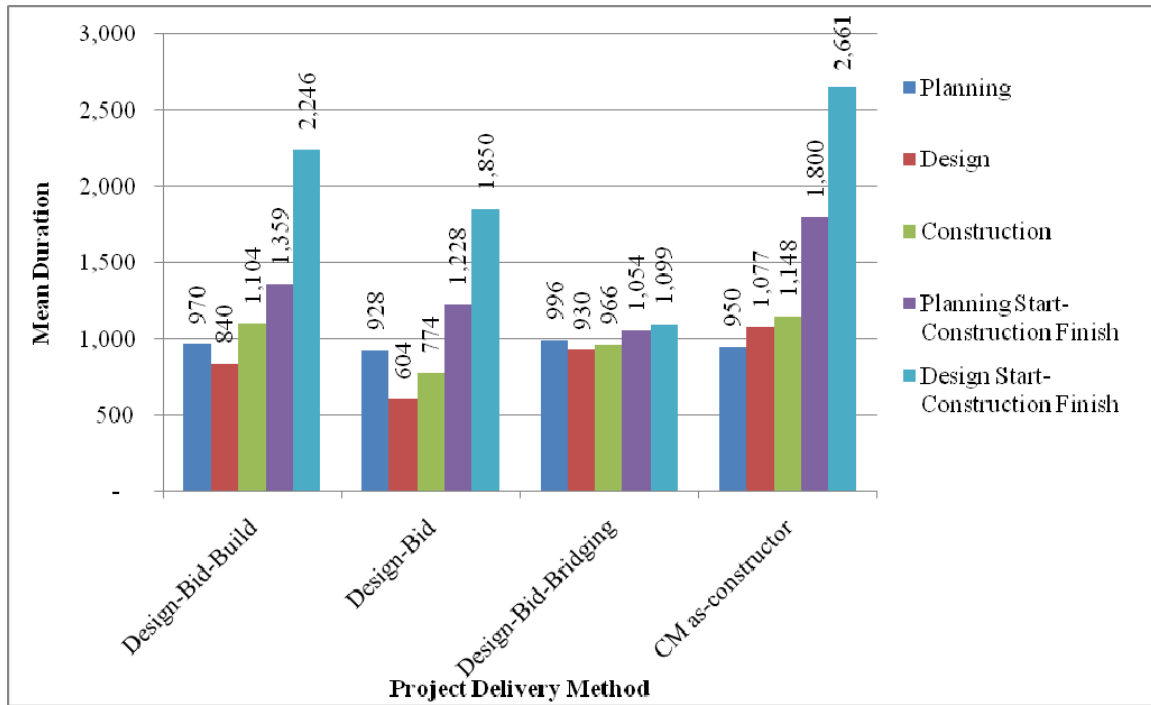


Figure 4: Cross-Tabulation of Project Phase Duration and Project Delivery Method (Days)

The construction phase using construction manager as-constructor and design-bid-build are almost the same. Projects using construction manager as-constructor extend 1,148 days, and projects using design-bid-build extend an average of 1,104 days. Projects using design-build-bridging and design-build suggest time savings. Design-build-bridging projects average 966 days for construction and projects using design-build average 774 days. The analysis reveals that there is a significant discrepancy in the amount of time to administer the construction using construction manager as-constructor versus design-build, with a savings of 32 percent.

Cross-tabulation analysis indicating the duration between when the planning phase begins and when construction is complete suggests that projects using the construction manager as-constructor method have the longest duration, extending an average of 1,800 days. The analysis suggests that projects using design-build-bridging have the shortest duration with an average 1,054 days. Projects using design-bid-build rank second in longest durations with an average 1,359 days, and projects using design-build rank third with longest duration with 1,228 days.

The duration, on average, from when a design begins and when construction ends is telling. Similar to other cross-tabulations of time, projects using the construction manager as-constructor, on average, have the longest durations, with 2,661 days, as depicted in Figure 4. Cross-tabulations also suggest that projects using design-build-bridging have significantly lower durations, with an average of 1,099 days for design and construction phases. Projects using design-bid-build rank second in longest durations with an average of 2,246 days, and projects using design-build for project delivery average 1,850 days for design and construction activities.

Legislative Impediments and Performance Information

For both federal and state scenarios, it was tested whether performance benefits exist when alternative project delivery methods are used and whether legislative limitations allowing the use of alternative project delivery methods impede any such benefits to be realized.

Federal Legislation

Cross tabulation of the project delivery method and whether the 1996 Clinger-Cohen Act was passed when Congress authorized funding for the project is analyzed, as presented in Table 3.

Table 3

Cross-Tabulation of Project Delivery Method and Federal Legislation (Number of Projects)

	Federal Legislation			Total
	No	Yes	Missing	
Design-Bid-Build	44	173	35	252
Design-Build	4	73	23	100
Design-Build-Bridging	1	16	52	69
Construction Manager as Constructor	7	63	5	75
Total	56	325	115	496

This analysis reveals that design-bid-build is the project delivery method chosen more often project after the Clinger-Cohen Act is enacted. GSA public owners have lessened legislative restrictions on using an alternative delivery method and still choose design-bid-build. There are significant numbers of projects that choose design-build, design-build-bridging and construction manager as constructor once those legislative barriers are lifted. Only four projects choose design-build before 1996, and 73 choose design-build after 1996. There seems to be a trend using cross tabulation for the analysis.

State Legislation

Similar to Federal Legislation, cross-tabulation is explored to determine if there is trend in project delivery method selection and if design-build is authorized in the state when Congress authorized funding for the project. This tests whether benefits are realized when an alternative delivery method is chosen for a federal project when there are lessened legislative barriers at the state level. The results are presented in Table 4. The analysis reveals that more federal projects choose an alternative delivery method if state legislation (i.e., in the state the project is located) allows the use of design-build. This is true in all delivery methods, except for design-build-bridging. The use of design-build for federal projects doubled in states that allow design-build. The use of design-bid-build stays almost stable and yet there is only a slight increase when there are lessened state legislative barriers. Using cross tabulation indicates a trend in the use of design-build with lessened state legislative barriers.

Table 4

Cross-Tabulation of Project Delivery Method and State Legislation (Number of Projects)

	State Legislation			Total
	No	Yes	Missing	
Design-Bid-Build	81	86	85	252
Design-Build	22	49	29	100
Design-Build-Bridging	8	4	57	69
CM as Constructor	25	28	22	75
Total	136	167	193	496

Conclusions

The cross-tabulation analysis reveals that the largest projects in size use alternative delivery methods, such as design-build and construction manager as-constructor. Design costs are lower using design-build and design-build-bridging than other methods, and projects using construction manager as-constructor have the longest duration. This may be because one contract is awarded for design and construction and two or more contracts are awarded for the other methods. The cross-tabulation analysis also reveals that there is an increase in the use of alternative delivery methods, especially design-build, once federal and state legislative barriers are lifted. Before Clinger-Cohen was passed in 1996, only 4 projects choose design-build; after this law is passed, 73 projects choose design-build. Design-build is selected twice as much after state legislative barriers are lifted. Cross-tabulations suggest a relationship among legislative impediments and project delivery method selection.

However, while cross-tabulation as an analysis technique describes the relationship among two variables, it does not measure the strength of the relationship and does not describe whether a statistically significant relationship exists among the variables. This methodology proves to be a valuable approach in analyzing the effect of legislative impediments on the performance of a construction project, and is recommended for future research in the construction industry.

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