



BEST PRACTICES FOR THE DESIGN PROCESS FOR THE HORIZONTAL DESIGN-BUILDER

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In early 1990s, the American driving public insisted that planned highway and bridge projects be completed quicker than was possible using the Design-Bid-Build (DBB) construction project delivery system, which had dominated the industry since 1930s. This led state Departments of Transportation (DOTs) to explore fast-track methods of construction. In late 1980s, some DOTs had experimented with Design-Build (D-B) delivery system. Forty-two state DOTs and numerous county and municipal transportation agencies now use the system and it remains the most popular integrated construction project delivery system in US transportation construction despite Federal Highway Administration efforts through the Every Day Counts initiatives to popularize newer methods such as Construction-Manager-as-General-Contractor and Alternative Technical Concepts. Its popularity is due to the speed with which projects move from conception through to completion and the ability through early contractor participation to implement innovative ideas that improve quality and further enhance the speed of the project. With all this speed, however, the design process has struggled to stay ahead of construction, especially when the Design-Builder is faced with new responsibilities such as Right-of-Way acquisition, the National Environmental Policy Act (NEPA) process, the environmental permitting process, utility re-location, etc. This paper recounts the research performed by a team led by the University of Florida to produce a guidebook to help both design-builder and owner with the design management process for transportation infrastructure construction.

Keywords: Design management, Delivery system, Fast-track, DOT.

1 INTRODUCTION

Beginning with the implementation of the Intermodal Surface Transportation Efficiency Act in 1991, Design-Build (D-B) has grown in popularity as a faster and in many applications, better alternative to the traditional Design-Bid-Build (DBB) construction project delivery system popularized in the first half of the 20th century. Along with the anticipated advantages of the new system, came inevitable disadvantages. The shorter project durations and advantages from contractor input into the design were welcomed. However, owners do not like the loss of control over the design process, and managing the design so as to keep pace in the evermore popular fast-track systems has been problematic. It is the latter problem that prompted the National Cooperative Research Program to sponsor research project NCHRP 15-46, "Guide for Design

Management of Design-Build and Construction-Manager-as-General Contractor Projects.” This paper focuses on the research on the D-B side of the guidebook.

An agency self-assessment outlined in the guidebook identifies elements within the agency that could hinder the successful D-B implementation. This assessment is particularly useful to agencies that only recently have adopted or are considering adopting an innovative project delivery method, since it allows them to address certain issues before experiencing their effects on projects. It also benefits agencies already using D-B to help them identify issues they might previously have overlooked.

One of the most difficult questions an agency can ask is whether it is prepared to adopt and implement an innovative project delivery approach, since it forces the agency to face the reality of its organizational culture. Because the decades-long use of the DBB method has so fundamentally shaped employee perceptions and organizational structures and practices, implementing a new delivery approach constitutes a major paradigm shift for the state agencies adopting it (Miller *et al.* 2000). Early studies have found that “as agencies attempt D-B for the first time, they are constrained by the low-bid culture in their organizations” (Molenaar and Gransberg 2001). The USDOT has acknowledged these difficulties, reporting that “states not accustomed to this method of procurement can find it difficult to oversee these types of projects” (USDOT-FHWA 2004). Moreover, although the D-B method’s combined procurement of services is expected to reduce transactional costs for delivering a project (Pietroforte and Miller 2002), this approach usually prompts state personnel to spend considerable time experimenting and developing new organizational routines to support the change (USDOT-FHWA 2004). This extra time is often justified by a wider concern that safeguards embedded in traditional approaches will be lost in the change process (USDOT-FHWA 2004). However, these concerns often appear with respect to the agency’s approach to design management (DM) under D-B, since losing control of design is one of the major agency concerns when D-B is implemented for the first time.

Challenges to changing the project delivery approach are common when an agency adopts any innovative delivery method (e.g., D-B or CM/GC) and often depend on an agency’s formal and informal cultures. When an agency is procedurally rooted in traditional means and methods, it is likely to face opposition to innovative delivery approaches. To mitigate this, the agency’s formal culture should be open to innovation, risk-taking, and improvement.

2 LITERATURE REVIEW

The two most commonly employed methods of delivery of infrastructure construction are now DBB and D-B. Gransberg and Senadheera (1999) conducted a national survey of 15 DOTs; the results showed D-B to be the alternative method commissioned by all surveyed DOTs. Through further analysis, Gransberg was able to identify three different systems that were used to advertise and award D-B. Low-bid, Adjusted Score and Best Value were then compared to identify their strengths and weaknesses.

Scott (2006) pointed out the problem associated with low bid in D-B; instead of getting the benefits of cost control, most of the time it will result in a decrease in the quality of the final product. Scott focused on the Best Value approach, which places the emphasis not only on the price but also on other factors. Investigation into the legislative regulation and nature of this contracting method was analyzed to help develop the Best Value procurement method.

Shr (2004) studied the growing popularity of incentive/disincentive bidding. This method was found to shorten the contract time by making it difficult for the contractor to not accelerate the project. Shr developed a model to establish reasonable incentive or disincentive rates based

on construction cost and time. But incentive/disincentive contracting may cause the quality of the final product to decline if the incentives are aimed only at time reduction.

Molenaar *et al.* (1999) studied the emergence of D-B into the public segment of the industry. Their work analyzed each party's responsibility with regard to the delivery system and also explains the procurement process and the structure of this particular method. Marwa *et al.* (2006) went more in depth than Molenaar by studying 76 D-B projects and identifying correlations between the procurement processes and the projects' overall performance. Chan (2002) sought specific project conditions that could help increase success rates of projects when using D-B. He noted that measures of success are defined by three factors—time, cost, and quality—but he believes that a more comprehensive metric should be established.

Gransberg and Sendheera (1999) conducted a survey aimed at all the DOTs in the United States. With the fifteen DOTs that employed D-B, they reviewed the three main methods of D-B—Low-bid D-B, Adjusted-Score D-B, and Best-Value D-B. Gransberg concluded that each of the methods can be utilized with different types of highway construction, depending on the nature of the project. Gransberg *et al.* (2008) also addressed the issue of quality assurance concerning D-B as it relates to transportation projects. One of the disadvantages of D-B is the lack of control over the detailed components of construction, which requires the agency to form a more comprehensive method to ensure the quality of the work. The report demonstrated the different ways in which DOTs have successfully controlled quality by focusing on all aspects of the construction phases; but this does not seem to be the case for all agencies. In the same year, Gransberg and Windel (2008) pinpointed the issue of communicating the quality requirements of public agencies on D-B projects. The study found that some owners tend to rely on the qualification evaluation process rather than being proactive on the issue.

Touran *et al.* (2009) presented on an evaluation process to help agencies identify the suitable delivery system to use for specific projects. They identified 24 key concerns that will determine the ideal delivery system. The paper includes a beneficial example that demonstrates how the evaluation should be conducted. However, the best option is not always available to the owner. Ghavamifar and Touran (2008) investigated all regulations that had been enacted by state legislation regarding public transportation projects. State statutes that address different innovative delivery processes were also provided.

3 RESEARCH METHODOLOGY

Initial research included a survey (Task 1) to determine how many state agencies have used D-B and when they began to implement it. About 80 percent of state agencies have used D-B, but many agencies have still not adopted this delivery method. Additionally, among the agencies that have used D-B, about half have used it sporadically and for fewer than ten projects. In light of these findings, the purpose of this research was twofold: while focusing on providing DM guidelines under D-B, it also summarized the results of previous research on D-B implementation so that all agencies can benefit from the experience of agencies around the country.

3.1 Level 1 Interviews (65 Agencies)

In Task 1, 52 DOTs (including Puerto Rico and DC) and 13 non-DOT agencies were interviewed by telephone, and all answered basic questions about their knowledge of, and experience with, design-build (D-B) and construction-manager-as-general-contractor (CMGC). These were designated as Level 1 interviews. Data from these interviews were compiled into a comprehensive spreadsheet denoting each state's knowledge and application of D-B; their frequency of use; and when the system was implemented.

It was found that D-B systems are recognized by all DOT agencies and 85% of non-DOT agencies. D-B is used by 81% of DOTs and 69% of non-DOTs, and for states that did not use D-B, 8% claimed to not have enabling legislation. The earliest use of D-B by DOTs dates to 1983 (Kentucky). For non-DOT agencies, D-B projects were implemented first in 2002. For both types of agencies, the majority influx was in the 2000s. Table 1 shows the level of implementation for agencies as of the time of the interviews. The first number in the body of the table is the number of agencies that have completed the number of D-B projects on that row (one, 2-10, etc.); the two percentages are the percent represented by that first number of total agencies interviewed, and of the total number of agencies interviewed that have executed D-B projects.

Table 1. Number of D-B projects executed by agency.

	DOT Agency Total (% of 52, of 42 using D-B)	Non-DOT Agency Total (% of 13, of 9 using D-B)
One Project:	3 (6%, 7%)	2 (15%, 22%)
2-10 Projects:	22 (42%, 52%)	7 (54%, 78%)
11-20 Projects:	8 (15%, 19%)	
21-50 Projects:	2 (4%, 5%)	
51-100 Projects:	2 (4%, 5%)	
Over 100 Projects:	4 (8%, 10%)	

3.2 Level 2 Interviews (9 Agencies)

The Level 2 interviews also were conducted by telephone and participants answered questions of a more intense and, at times, project-specific nature. Those who had a particularly high level of experience and knowledge were asked to fill out a supplemental form that asked for budget information and other particulars. The goal of this phase was to identify agencies to conduct a scan that would allow researchers to identify emerging features of DM under D-B.

After reviewing the responses to Level 1 interviews, the following criteria were identified for selecting states/agencies to interview in Level 2:

- An agency has used D-B within the last five years.
- An agency has used D-B on more than five projects.
- An agency has submitted the additional information on candidate case studies OR a member of the research team has identified potential case studies delivered by the state/agency (e.g., Maryland, Washington, North Carolina, Oregon).

Once the Interview Instruments were completed, the interview process was initiated by contacting all the chosen DOTs (10 total). Initial communications were conducted through e-mail. If a response was not received within a few days, a phone call was used to follow up. Since the project schedule was tight, researchers decided to consider this phase satisfactorily completed once a response rate of at least 50% (five agencies) was achieved. However, each agency was contacted at least three times independently after the research team received a commitment from at least five DOTs. The research team was able to complete the scan of the nine agencies listed below. Level 2 information was collected during the onsite visit for the D-B portion of the UDOT data collection. Level 2 information was collected on nine DOTs for a response rate of 90%. The agencies interviewed as part of Level 2 are Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Mexico, North Carolina, Oregon, Utah, and Washington.

3.3 Case Studies

Four Case Studies were conducted with three agencies. Case Studies were conducted through research team site visits and face-to-face interviews. Different research team members interviewed a completely different set of officials in each state. Some Case Studies were performed on an agency's program as a whole and some were performed on individual projects.

4 RESULTS

The team learned many lessons from the project. Among those are:

- Understand the importance of the project planning and procurement phase. The agency must understand that D-B is a more sophisticated project delivery method than DBB. The more work the agency performs up front, the less likely will be the occurrence of issues and disputes after contract award. In particular, an agency is expected to carefully define the project scope and develop contractual documents while involving all relevant project stakeholders in this process, including local government, public agencies, and utility companies.
- Perform a risk analysis to identify the project risks and allocate each risk to the entity (i.e., agency or design-builder) that can better manage it. The integration of design and construction services (and sometimes right-of-way acquisition and utility relocation) makes the risk allocation process under D-B more fluid than for DBB. This information will be used to develop a draft risk allocation that will undergo an industry review phase or be included in the RFP.
- Educate the agency and all project stakeholders about the D-B process that has been adopted. In general, D-B is a project delivery method. In practice, there are different ways to implement D-B within an agency. Some agency departments—such as regional offices—and project stakeholders—such as local government, public agencies, and utility companies—may not be familiar with D-B in general and with the way your agency is implementing it in particular. Thus, the agency must actively involve all interested agency departments and project stakeholders as soon as possible to educate them about D-B procedures and peculiarities. Contrary to DBB, the project scope must be defined clearly before the design phase in D-B projects.
- Clearly communicate to the proposers the selected payment method and how it can affect design activities. Since many proposers consist of constructors that contract out the design to design firms, they may not fully understand how the selected payment method can affect design activities. If the agency determines to pay each line of work when it is 100% complete and the proposer does not break down the design activities into multiple lines of work to obtain payments consistent with the accomplished design activities, the proposer and/or designers will have to finance some of the design activities. Since this may create adversarial relationships, the selected payment method should be spelled out clearly in the RFP documents, and its potential impact on design should be understood by the agency and communicated to the proposers during the procurement phase.
- Develop a process for pre-award value engineering (VE). The agency can highly benefit in terms of quality improvement, cost savings, and/or schedule reduction from pre-award VE concepts. When these innovations are outside the scope outlined in the RFP documents, they are submitted as alternative technical concepts. Furthermore, pre-award VE allows the agency to retain all cost savings while the cost savings from post-award VE generally are shared with the design-builder. On the other hand, the process for soliciting and handling pre-award VE concepts should be transparent and not detract from

the objectivity of the competition. Thus, the agency should develop a process that supports the proposers in proposing innovations.

5 SUMMARY AND CONCLUSIONS

At the program level, it is crucial how the agency allocates DM responsibilities among its units, and how the project delivery process is managed by units that deal with phases that deal with post-award design. At the project level, the approach to deal with pre-award design activities substantially affects post-award DM. During post-award DM, an agency's approach to DM is mostly shaped by how it establishes a collaborative partnering environment, how it handles communications and coordination, how it handles VE proposals, how it handles interdependencies between design and other activity, and especially how it handles formal DM processes.

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