TRR
JOURNAL OF THE TRANSPORTATION RESEARCH BOARD

Infrastructure

Transportation Research Record
2019, Vol. 2673(1) 261–268

DOI: 10.1177/0361198118822315
journals.sagepub.com/home/trr
SAGE

Critical Comparison of Progressive Design-Build and Construction Manager/General Contractor Project Delivery Methods

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Abstract

Progressive design-build (PDB) is an emerging variation of alternative contracting methods (ACMs) in the highway construction industry. It is widely used in water/wastewater and airport projects, but it is new to federally-funded highway projects. A few state department of transportations (DOTs) have begun to experiment with the method, using their experience with qualification-based selection (QBS) and a subsequent negotiated construction price from construction manager/general contractor (CMGC) contracting. There has been little written that provides guidance to public highway agencies who are interested in implementing PDB. Therefore, the purpose of this paper is to first describe the mechanics of PDB project delivery to provide consistent foundation information from which DOTs can inform their decision as to when to use it. The paper also provides a comparative analysis of PDB with CMGC and finds that they are nearly identical with regard to format, differing only in whether the owner retains the design responsibility in CMGC or assigns it to the design-builder in PDB. It also finds that PDB is more appropriate than traditional design-build (DB) for projects in which the owner needs to engage the design-builder in the preliminary engineering and environmental permitting process.

The use of alternative contracting methods (ACMs) for highway construction is no longer a novel event in the nation with few, if any, state department of transportations (DOTs) not having some form of enabling legislation to use design-build (DB), construction manager/general contractor (CMGC), public private partnerships (P3), alternative technical concepts (ATC), indefinite delivery/indefinite quantity (IDIQ), or one of the many variations that have evolved in the past decade (*1*, *2*). Each alternative contracting method (ACM) involves increasing the degree of integration and collaboration between the owner, the engineer/design consultant, and the construction contractor (*3*).

Most of the project delivery related research has indicated that early contractor involvement of any type consistently reaps benefits for the project owner by producing a more constructible project, which often translates into earlier cost and schedule certainty (*4–8*). Although the recognized benefits of ACM delivery are well-documented in cost and schedule performance metrics, one benefit that has been not been widely recognized is the ability provided by several ACMs to negotiate the project's risk profile before awarding the prime contract for design and/or construction. This benefit is particularly useful in projects delivered using CMGC and a variation of DB called progressive design build (PDB) because both permit the selection of the CMGC contractor or the design-builder on a basis of qualifications with the project price being negotiated after the award of the prime contract.

This paper will describe and compare PDB, an emerging ACM in the highway sector, to CMGC, to provide a straightforward description of the advantages and disadvantages of PDB versus CMGC.

Background

Most of the studies on DB describe the one or two-phase solicitation, selection and award process that results in the best-value award (6–8). In a typical process, the first phase is devoted to the development of a shortlist based

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on statements of qualification (SOQ) submitted in response to a request for qualifications (RFQ). Once complete, the members of the shortlist are then invited in the second phase to submit technical and price proposals in response to a request for proposals (RFP). The issues with this approach are addressed in the following words of one author:

> "While the two-phase process can work quite well, it has some notable drawbacks. First, the RFP usually includes a mandatory baseline design that is approximately 35 percent complete, with requirements being stated in terms of specific design approaches that the design-build offers must follow. This approach not only limits innovation, but it creates a potential liability to the owner if there are problems in what it has furnished in the RFP. Second, the process of creating the RFP and evaluating the proposals can be costly and time-consuming" (*9*).

PDB provides the means to avoid the above noted drawbacks and provide an added measure of procurement flexibility. By selecting the design-builder on a basis of qualifications and past performance, the owner can engage its services at a very early point in the design process. In fact, it is common to award the PDB contract before entering the environmental clearance and right of way acquisition processes, assigning the design-builder the responsibility for clearing those hurdles (*9*). The time and resources necessary to develop the DB best-value RFP are considerable. A recent study of ACM project performance found that the mean agency design duration was 1,139 days for DBB, as compared to 638 days for DB and 281 days for CMGC (*10*). As the project development and procurement timeline for PDB is almost identical to CMGC, an average savings of nearly a full year (357 days) could potentially be accrued by the move from the two-phase best-value DB to qualification-based selection (QBS) selection using PDB delivery.

Another significant drawback in the typical best-value DB process is the reliance on a lump sum price before the design is advanced to a point where contingencies for scope and quantity growth can be minimized. A study by Castro-Nova *et al.* on DB geotechnical risk management found that fixing the price before conducting the geotechnical investigations and subsurface characterization caused competing design-builders to "include a large contingency in the proposed price to cover the worst possible case" (*11*). The same study identified a statistically significant difference in the perception of the geotechnical risk between DOTs geotechnical personnel and competing design-builders. The industry professionals perceived the risk to be considerably higher than that perceived by the DOTs. The study went on to infer that the difference results in larger contingencies being included in proposed prices than were in the owners' estimates at the time the RFP was issued. That study concluded that "if those [geotechnical] risks are shared in some manner; the DOT can potentially benefit from reduced proposal contingencies. This mitigates the risk that the project cannot be awarded in timely manner because all proposals are over budget." Awarding the DB contract using QBS obviates that problem as the final price is negotiated in the PDB delivery process, providing an opportunity to avoid, minimize or share the risk in the price negotiations (*12*).

CMGC project delivery affords the same opportunity to the owner to negotiate the risk profile of the project during the negotiation of the guaranteed maximum price (GMP) (*13*). In fact, the project development and delivery processes of CMGC and PDB are almost identical. Figure 1 illustrates the sequences of DBB, DB, PDB and CMGC. The design percentages shown in the figure are approximate, but nevertheless, it shows that the owner can engage the design-builder in PDB as soon as it has the authority to proceed with preliminary engineering. The same can be done in CMGC if desired, but in practice, most DOTs will bring the CMGC contractor on board at a later point closer to the construction of the project. For example, if the plan is to assign the utility coordination responsibility to the CMGC, then it is selected at a point in the preliminary engineering in which it is both possible and practical (*14*). Figure 1 graphically illustrates the potential to reduce the overall project delivery period with CMGC and PDB as both methods do not require the owner to fully define the project's scope of work before advertising as both allow the final scope of work to be determined during the design phase (*9*).

Progressive Design-Build Mechanics

The distinguishing feature of PDB is the process used to set the initial target budget and then negotiate the construction price as the design is advanced from the time of design-builder selection to the point at which the GMP is established. At the time of this writing, there is no standard procedure for doing this in the highway construction sector. The airport, transit, and water/wastewater sectors have used PDB for at least two decades. The Water Design-Build Council has been actively involved in promoting PDB in its sector and produced a 5-volume set of PDB procurement documents (*15*).

Figure 2 shows a conceptual diagram of the PDB process promoted by the Water Design-Build Council. The point at which the CMGC would be selected if the owner chose that method over PDB is shown for reference purposes. Figure 2 shows three important concepts that apply to PDB but not to traditional DB.

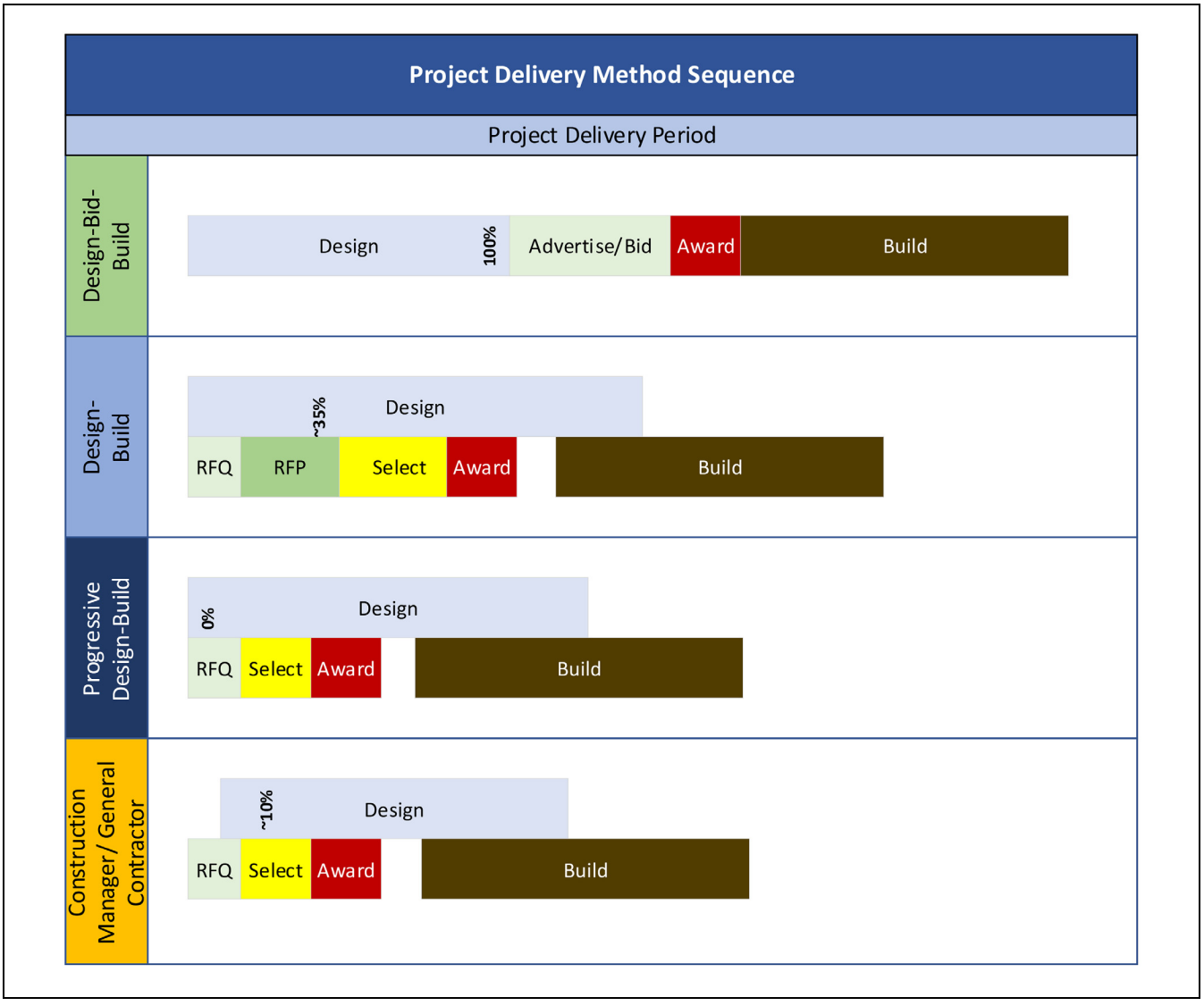

Figure 1. Comparison of project delivery sequence by project delivery method.

- The design-builder is selected and participates in the establishment of the target budget. The owner benefits from several aspects of this approach. First, it can ask the design-builder to generate price potential technical alternatives before having to commit to one preferred alternative as in the typical DB process. Second, the agency has access to the construction contractor's real-time pricing data, which provides higher cost certainty than estimates using bid tabulations based on historic rather than current pricing.
- The GMP negotiations are based on open book pricing. The design-builder's design/preconstruction services fee is established once the scope is solidified. It is also possible to negotiate the contractor's construction management fee (usually including the profit and overheads/general conditions) as a lump sum. Thus, subsequent GMP negotiations consist of direct costs, quantities, and other cost items that are auditable if the owner should lose confidence in the design-builder.
- In the event that a GMP cannot be mutually agreed, the PDB process includes an "off-ramp" in which the owner can choose to direct the design-builder to complete the construction documents, and then competitively bid the project's construction phase using DBB. However, the design process includes periodic progressive estimates as the design increases in detail and this not only assists in the early identification and control of scope creep, but also reduces the potential of not reaching an agreement on the GMP as the design

decisions can be continuously informed by the in-progress estimates.

The flow chart in Figure 3 increases the level of detail found in Figure 2. It also illustrates the need to approach PDB as series of design and related construction packages in much the same manner as is done in CMGC. The primary benefit to packaging the project is found during price negotiations (*16*) in which the focus becomes tied to the value of a particular design package and the quantities of work contained within it. This simplifies the preparation of the progressive estimates by reducing the scale of each negotiation. It also permits the owner to approve completed design packages for the release for construction if desired and establish incremental GMPs for groups of related design packages. This process is called using a progressive GMP (*17*). While the owner can still choose to establish a single GMP, by following the design and construction package approach, it leaves the door open to commencing construction as early as is practical. The system also provides an early warning if the project's estimated cost is in danger of exceeding the established budget, allowing the design-builder and owner to initiate value engineering at a point at which substantive changes can be made to recover the budget.

One of the rarely used mechanisms for aligning the scope and budget is making changes to the initial project risk profile. The highway industry has a long history of risk-shedding regardless of project delivery method (*3*, *4*, *11*, *12*). This is mainly because in DBB and traditional DB, the project price is fixed at the time of the contract award. The downside is that construction contractors and design-builders must include contingencies to account for the risk transfer from the owner. If those risks are not realized, for example, no differing site conditions are encountered during construction, then the owner still pays for the unrealized risks because the contingencies are buried in the unit prices and lump sum contract amounts (*11*).

When the contractor or design-builder is selected using a QBS process, the price is still unknown at the time of the initial contract award. Thus, when the initial budget is established it can not only include the value of the technical scope of work, but also the value of the risk as mutually agreed. Research has proven that risk sharing is less costly than risk shedding (*11*). Therefore, PDB and CMGC provide the means to jointly discuss the risk profile and even furnish the owner with the estimated costs of risk sharing and/or shedding alternatives. Thus, the risk assignment decisions are made in an environment of actual information rather than by professional judgement and assumption.

Each decision point shown in the Figure 3 flowchart is a jointly developed set of the best possible information currently available. It will include the costs of risk as appropriate. While not explicitly shown in Figure 3, both PDB and CMGC include the negotiation of line item,

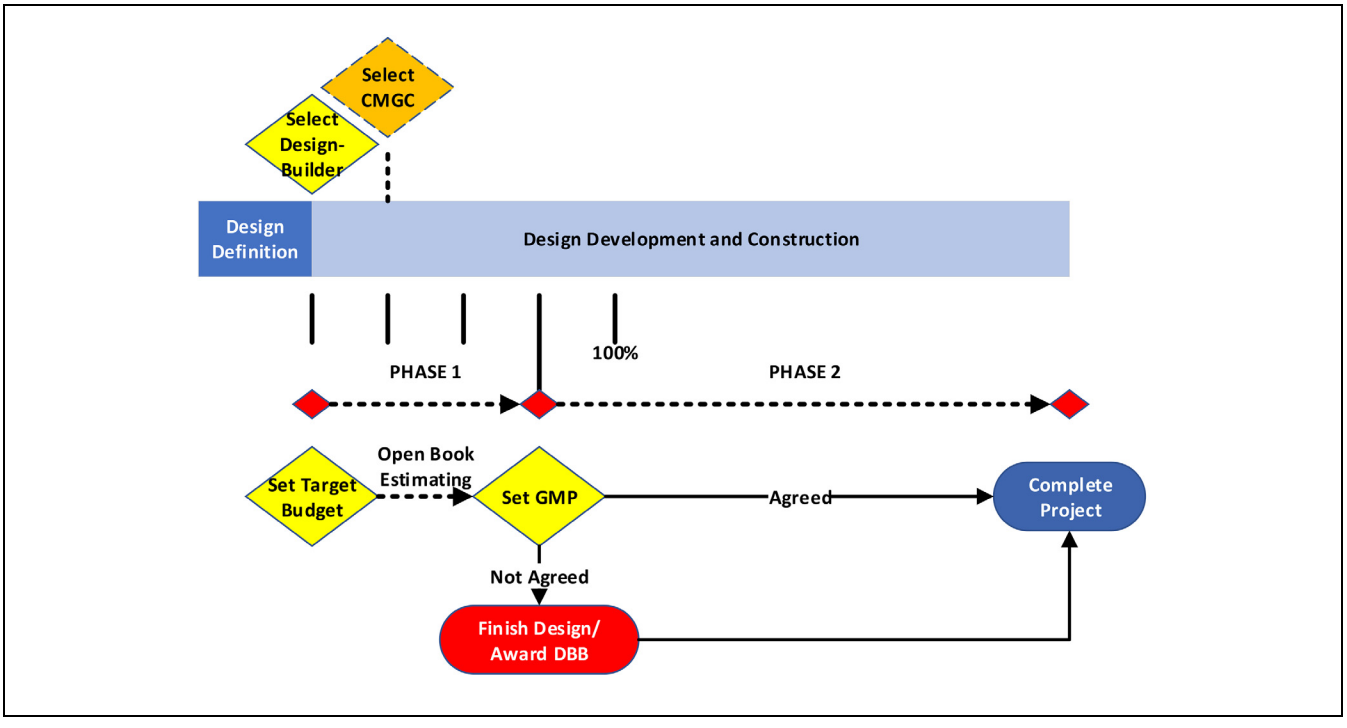

Figure 2. Progressive design-build conceptual process with CMGC shown for comparison (Adapted from *18*).

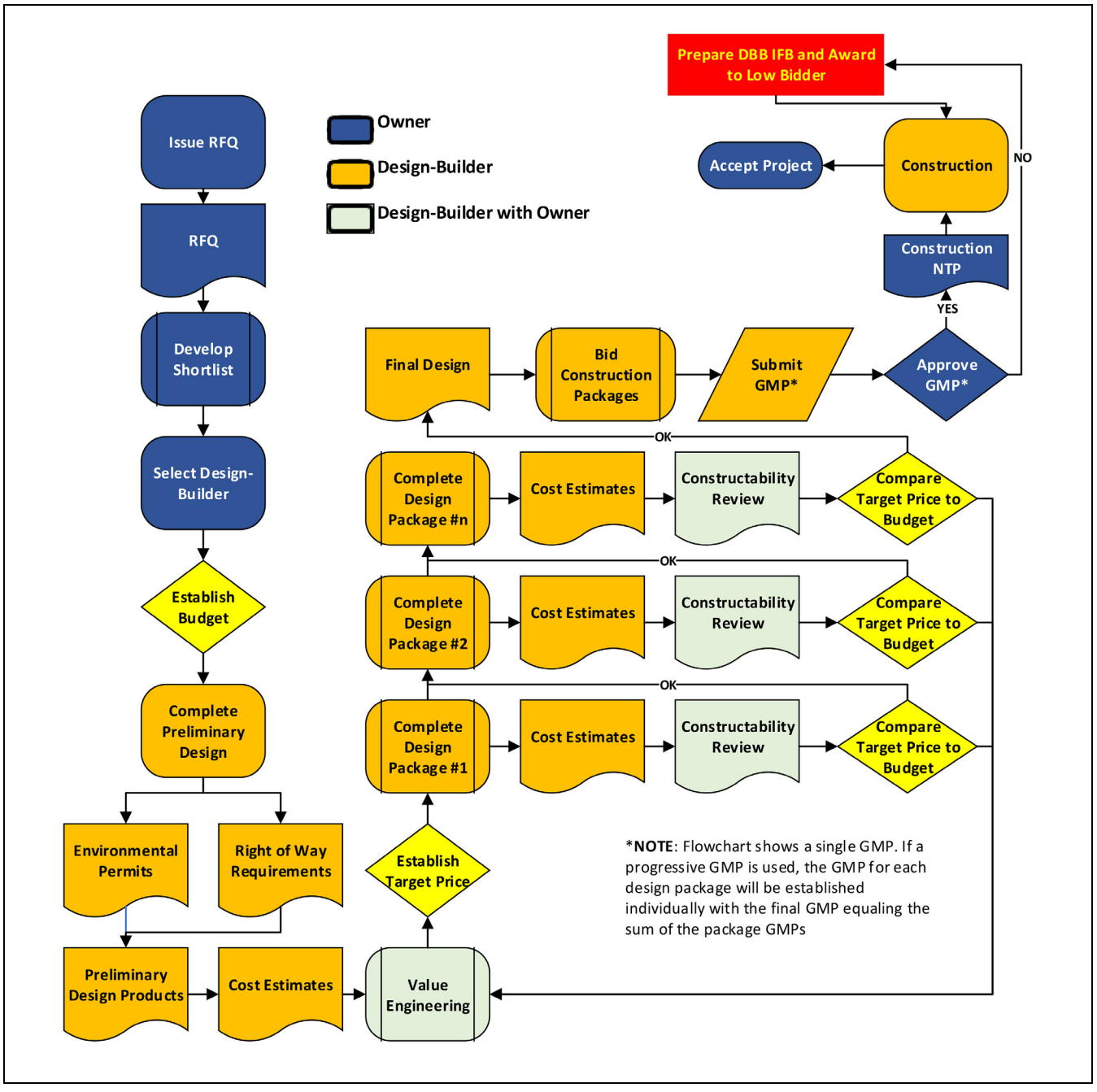

Figure 3. Progressive design-build flow chart.

lump sum contingencies in the GMP establishment process (*17*).

The open book nature of the pricing process keeps the contingencies visible throughout the process, providing an opportunity for retiring unrealized risk-related contingencies as the work progresses beyond a point at which the project is no longer exposed to that risk. A typical example is a contingency for utility risk. Once the project's excavations are complete, that risk can be retired, and the assigned contingency can be released.

PDB Compared to CMGC

A simple content analysis serves as the methodology to compare PDB and CMGC. NCHRP Synthesis 402 conducted a comprehensive literature review on the topic of CMGC and found several advantages that were unique

Table 1. PDB Advantages Compared to the Same Advantages found in CMGC

Advantage	NCHRP 402 (number of citations)	CMGC (Ref #)	PDB (Ref #)
Early contractor design involvement	12	*19*, *20–22*	*9*, 20, 22
Ability to fast-track	10	*23*, *20*, *22*	*9*, *20–22*
Enhanced cost certainty	10	*18*, *21–24*	*9*, *17*, *22–24*
Owner control of design contract	8	*18*, *19*, *21*, *25*	Not applicable
Open books pricing	6	*18*, *21–23*	*18*, *21–23*
Presence of "off-ramp"	6	*17*, *22*	*9*, *17*, *20*, *22*
QBS selection	4	*17*, *19*, *23*, *25*	*9*, *17*, *23*, *25*
Flexibility during design and construction	4	*19*	*19*, *21*, *20*, *24*
Fosters collaborative relationships	4	*19*, *22*, *23*, *25*	*21–23*
Negotiated risk profile	2	*21–23*	*21–23*
Single contract for design and construction	Not applicable	Not applicable	*15*, *21*
No *Spearin* design liability	Not applicable	Not applicable	*15*, *22*

to CMGC delivery (*5*). As both the CMGC and PDB share the QBS selection and construction price negotiation, the current literature on both methods was reviewed to determine whether the previously documented benefits of CMGC were also found in PDB. Table 1 shows the results of that content analysis.

Table 1 shows that PDB shares all of the advantages previously found in CMGC with one exception: owner control of the design contract. This exception is logical given the difference between DB and CMGC with respect to the contract structure. PDB also brings two additional advantages not found in CMGC. The first is merely the reverse of the exception and is the single contract for both the design and construction. The second deals with a longstanding legal principle called the *Spearin Doctrine* and requires a bit of explanation.

The *Spearin Doctrine* describes the owner's liability for the quality and completeness of the design content in the construction contract documents. Although it comes from a DBB case, the courts have consistently interpreted it in a broad manner to cover the issue of design liability in ACM projects as well. In essence, *Spearin* determines that an owner furnishes the contractor with an implied warranty on the quality and completeness of the design, making it liable for any errors and/or omissions present in the construction documents at the time the contract is awarded. As the owner holds the design contract in CMGC, it is exposed to *Spearin* liability (*15*). However, depending on how much preliminary design was completed before selecting the design-builder in PDB, this liability is essentially minimized and can be eliminated if the design-builder is selected to complete the entire design effort (*26*).

The other advantages listed in Table 1 are generally self-explanatory. However, "flexibility during design and construction" and "negotiated risk profile" are worthy of elucidation. Neither are highly cited in the literature because their impact is largely attributed to the other more often cited advantages in the table. For example, the flexibility of awarding the PDB or CMGC preconstruction contract obviates the need to have the project's scope of work defined in detail. This allows the final scope to vary as budget, schedule, and technical constraints are identified during the design process. Additionally, the contractual terms relating to the relationship and responsibilities of the designer and the contractor provide the means to react to unforeseen situations during construction in an agile manner because of the pre-issue definition of roles and responsibilities in the contract. The ability to negotiate the risk profile as the design progresses literally results in enhanced cost and schedule certainty (*21–23*), the more highly cited advantage. This is accomplished because the scope can be adjusted to fit the budget and schedule changes imposed by new information such as the actual geotechnical conditions or utility locations that are obtained after selecting the design-builder or the CMGC contractor.

Discussion and Conclusion

This paper describes the mechanics of PDB project delivery to provide consistent foundational information from which DOTs can inform their decision on whether to use it. The following are key findings found in the literature with regards to why an owner would choose PDB over traditional DB or CMGC:

- "It enables owners to get the benefits of having the design-builder introduced to the project at the earliest possible point. This enables the design-builder to use its expertise to influence the design development process and avoids the time and expense

associated with having another designer create the design baseline" (*9*).
- PDB "facilitates having the design-builder involved in permit and other development activity" (*21*).
- PDB "requires that project features be adjusted, owner preferences prioritized, and construction costs verified. The objective of this process is that you'll never get to the end of the process with a budget surprise at the finish!" (*23*)
- PDB "integrates the owner, constructor and designer within the programming and planning process. An effective method if limited scope and cost information are available, or difficult to ascertain" (*19*).
- PDB "allow[s] design standards to be developed as part of the planning and design process which may allow more opportunity for value analysis (*19*).

Several conclusions can be supported by the above discussion and analysis. First, the differences between PDB and CMGC are minimal and all are related to whether the owner holds a direct contract for the design, performs the design in-house, or assigns design responsibility to the design-builder. Second, both methods permit the owner to receive early contractor design involvement as early in the project planning and development process as it would wish. The major benefits are access to real-time cost data, enhanced constructability, and the ability to make fundamental design decisions through the evaluation of priced alternatives. Finally, the QBS selection and negotiated pricing features of the two methods create a project delivery environment in which both cost and schedule certainty are greatly increased. The result in the words of the above author is a completed design without "a budget surprise at the finish" (*23*).

One limitation to the conclusions is worth mentioning. The traditional DBB procurement culture has resulted in an environment in which the public owner knows the contractors' bid prices before having to contractually commit to a specific constructor. While awarding to the lowest bid does not guarantee that the owner will receive the final lowest price, it does provide a measure of confidence that the owner is not over-paying for the project (*3*), as well as an objective justification for the award to the owner's stakeholders. A low bid award also eliminates the requirement for a sophisticated understanding of the current market conditions in the same manner as a construction contractor and allows the owner to use historical rather than real-time cost data for its estimates, trusting in the competitive process to furnish a fair and reasonable bottom-line project cost. In fact, this issue is one of the advantages listed in Table 1 for using PDB or CMGC. Nevertheless, the public owner must satisfy its statutory requirements to ensure value for money in its procurements (*15*). The limitation is often overcome by the retaining of an independent cost estimating (ICE) consultant to furnish a second opinion of probable project costs during the GMP negotiation process. Therefore, public owners must fully understand that the use of CMGC or PDB does not eliminate project cost, schedule, nor quality risks, but neither do the other project delivery methods. However, as mentioned in the preceding paragraph, the two methods do provide an opportunity to actively manage those risks during the design process by the negotiated sharing of those risks with the progressive design-builder or the CMGC contractor.

Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: Dr. Gransberg, data collection: Drs. Gransberg and Molenaar; analysis and interpretation of results: Drs. Gransberg and Molenaar; draft manuscript preparation: Drs. Gransberg and Molenaar; All authors reviewed the results and approved the final version of the manuscript.

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The Standing Committee on Project Delivery Methods (AFH15) peer-reviewed this paper (19-00834).