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Empirical Analysis of the Relationship between Project Delivery Method on Project Performance in the Yemen Construction Industry

Fahd M. M. Nasser[1*], Nahg Abdulmajid Alawi[1], Abaidullah M.[1], Asniza Yusuf[1]

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ABSTRACT

This empirical paper analyzed the relationship between project delivery methods on project performance within the Yemen construction industry (YCI). This research incorporated two distinct project delivery methods (PDM) namely the traditional Design-Bid-Build (DBB) and Design-Build (DB) and gauging project performance (PP) through the lens of the triple constraints (time, cost, and quality) as the criteria for measuring success. A conceptual model was theorized and operationalized in a survey of 375 project managers and consultants from two Yemeni governorates, Aden and Hadramout. The questionnaire employed a 5-point Likert Scale. Subsequently, the data were evaluated using multivariate regression. The empirical findings revealed a significant relationship between the choice of project delivery method and project performance. Thus, exerting a positive influence on project success. This study contributes to the existing body of knowledge in two significant ways. First, by scrutinizing the dynamic mechanisms through which project delivery methods impact project performance. Secondly, offers valuable insights for decision-makers in the Yemeni construction industry (YCI) to plan their objectives and achieve the requisite project performance levels.

INTRODUCTION

The political history of Yemen undoubtedly affects the Yemeni Construction Industry (YCI). Since the political upheaval in 2011, the Yemeni Construction Industry (YCI) has been bouncing again despite facing various issues and challenges. The Construction industry is an important economic sector of Yemen in providing infrastructure like a transportation system, education facilities, and public health buildings to name but a few. However, project performance tarnished the development by several issues like delayed completion or failure to complete which might collapse the Yemeni Construction Industry. The project delivery method might affect project performance which warrants this research. The project delivery method determines the subsequent selection procedures of contractors for any project in Yemen. Project funding can be from the Yemeni Government or a Private Funding Initiative (PFI) by the private sector. However, project performance is important which aims at the successful completion of the construction project in the Yemeni Construction Industry (YCI).

As emphasized by Salma and El-Sayegh (2021), the choice of a project delivery method (PDM) plays a pivotal role in shaping project performance (PP). Selecting a PDM that aligns with the unique characteristics of a construction project is a critical decision, with far-reaching implications for project performance. In line with the insights of Qingping et. al., (2022), tailoring the PDM to the specific activities and processes involved is of paramount importance.

In the context of construction projects in Yemen, project owners have a primary focus on staying within budget, adhering to the estimated construction timeline, and achieving the desired quality outcomes. This is in line with the observations made by Stephen *et al.* (2009), who argue that the owner's decision to initiate a project is greatly influenced by the procurement method's ability to deliver on time, within budget, and with the expected level of quality.

Moreover, the Yemeni construction industry faces a myriad of challenges, affecting both public and private projects. Notably, a key challenge is the frequent, inappropriate selection of delivery methods, resulting in disputes between project owners and other stakeholders, including consultants and contractors. Furthermore, issues such as cash flow constraints during construction, delays in processing bill payments for contractors, poor project management practices, and slow decision-making on the part of project owners are critical factors that impact the success of construction projects in the Yemeni construction industry (Najib et. al., 2018). Basel Sultan (2012) also underscores the presence of significant issues within Yemen's construction industry, hindering progress at various project stages, from feasibility studies and design to cost management and project implementation.

According to Cody and Robertson (2022), in the 1980s, the construction industry predominantly favoured the Design-Bid-Build (DBB) and Design-Build (DB) construction delivery methods. However, they also note that there is a concerted effort within the industry to explore alternative delivery methods with the objective of enhancing construction project performance. Despite these developments, this empirical investigation focuses on two prominent delivery methods: the traditional

[1] IQRA Business School, Geomatika University, Kuala Lumpur, Malaysia
[*] Corresponding author's e-mail: fahdy62@gmail.com

method (DBB) and the design-build method (DB). As Basel Sultan (2012) has indicated, these two methods represent common approaches utilized in practice within the context of the Yemeni construction industry (YCI).

LITERATURE REVIEW

Project Delivery Method (PDM)

A Project Delivery Method (PDM) serves as the structured approach by which a project's financial, design, construction, operation, and maintenance activities are carried out. It also defines the roles and responsibilities of the various participants involved in the project (Love et. al., 1998; John et. al., 2000). This PDM can be viewed as both a contractual framework and a compensation arrangement that enables project owners to achieve a completed facility that aligns with their specific requirements. Mafakheri et. al. (2007) similarly argues that the PDM serves as both a contractual structure and a compensation mechanism, facilitating the delivery of a finished facility that fulfils the owner's needs. Essentially, a PDM outlines the relationships and operational methods of project participants in the process of transforming the owner's objectives into tangible facilities (Chen *et al.*, 2011).

In contemporary practice, two major project delivery methods prevail: the traditional method, also known as Design-Bid-Build (DBB), and the Design-Build (DB) approach. However, alternative project delivery methods have emerged in response to the increasing complexity of projects, which sometimes leads to inefficiencies in project performance. These alternatives are designed to enhance and improve project performance and have gained popularity in both the design and construction industries. Some of these alternative methods include Construction Management at Risk (CMAR), Construction Manager/ General Contractor (CM/GC), Construction Manager Agent (CMA), Public-Private Partnership (PPP), and Integrated Project Delivery (IPD) (Francom et. al., 2014; Ibbs et. al., 2003; Sanvido et. al., 1998). These methods provide different approaches to project organization and execution, catering to the specific needs and objectives of various projects.

Traditional / Design –Bid -Build (DBB)

An owner using the Design-Bid-Build (DBB) project delivery method goes through two contracts. They first sign a contract with the consultant in charge of the project's design. Subsequently, an independent agreement is made with a building specialist to carry out the project (Salma & El-Sayegh, 2021). The classic DBB technique usually starts with the owner hiring a consultant or architect to design the project. subsequently creates bid paperwork, specs, and designs based on the owner's requests. The owner then requests bids from contractors for the construction work, and the lowest-priced contractor is often given the contract. This strategy has proven to be successful, particularly for initiatives that are simple or repeated (Francom et. al., 2014). One of the characteristics of Design-Bid-Build (DBB) is a staged and sequential project delivery method including the owner, the architect or designer, and the general contractor in construction. With this arrangement, the owner enters into separate agreements with the contractor and designer, supervising and tracking their actions to guarantee adherence to the terms of the contract (Sanvido et. al., 1998; Demetracopoulou., 2020). This method offers a distinct allocation of duties among the parties concerned with the owner assuming a managerial position to guarantee the project's advancement in compliance with the specified phases of design and construction.

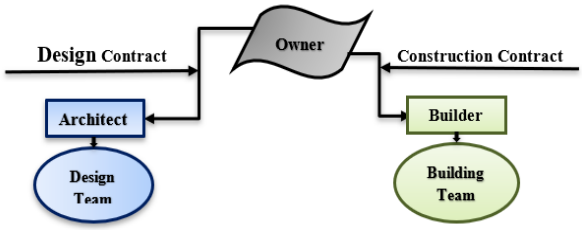

Figure 1: The contractual relationship of project parties in the traditional method (DBB).

Design-Build (DB)

In Design-Build (DB), a single legal entity has the sole responsibility to hire both the consultant/design and the construction under one contract representing a single commitment (Salma & El-Sayegh, 2021). The DB model creates an opportunity for increased collaboration between the designer and the constructor, and DB projects can often be fast-tracked since construction can begin before the design is complete (Cody & Robertson 2022). According to Main and George (2012), in the context of Design-Build (DB), a singular legal entity assumes complete responsibility for the hiring of both the consultant and the construction through a single contract, thereby establishing a unified commitment. The design-build entity assumes accountability for the design, specifications, and construction of the project. This approach guarantees that the performance criteria outlined in the contract are achieved.

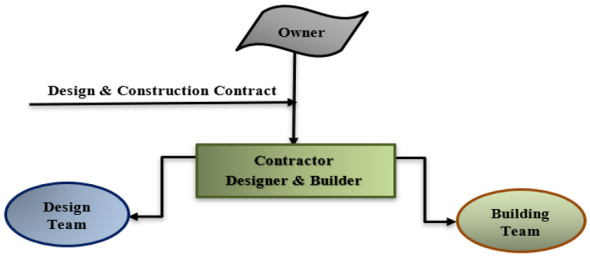

Figure 2: The contractual relationship of project parties in Design & Build method (DB)

Project Performance (PP)

Drucker P.F. is widely credited with coining the phrase "You can't manage what you can't measure," which was initially published in 1954 and continues to be frequently cited and used in various contexts today.

The Iron Triangle, also known as the triple constraint in project management, represents the interrelationship between key performance criteria, primarily time, cost, and quality (or scope). However, there has been ongoing debate and disagreement over which specific criteria should be represented at the vertices of this triangle (Julien et. al., 2018). The result of this ongoing discussion is that much of the research in project management focuses on confirming the importance of time and cost as factors contributing to or assessing project success (Jugdev & Müller, 2005; Wateridge, 1998). These factors are often seen as critical aspects of project management. However, Fayomi et. al., (2022), argue that delays or time overruns, cost overruns, and quality deficiencies have become common issues in project performance. Therefore, ensuring compliance with techniques for controlling project schedule, cost, and quality restrictions in project delivery is another crucial aspect of efficient project performance. These management constraints collectively constitute the "triple constraint," "iron triangle," or "triple limitation" set of constraints (Chiguru, 2019; Gomes & Romao, 2016). These constraints reflect the challenges and trade-offs that project managers often face when trying to achieve project success while managing limited resources and meeting project objectives.

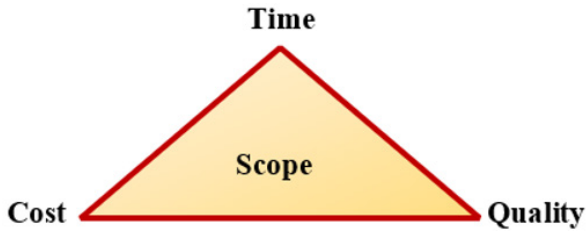

Figure 3: The triple constraints of Project performance

Theory of Contracts to Design and Manage Projects

In this study theory of contracts to design and manage projects is adopted, Kenneth J. Arrow (1962) hypothesized a theory pertaining to contracts for designing and managing projects for high project performance. Hart and Holmstrom (1987) refined Kenneth's (1962) work on project performance. According to Carl and Circo (2006), contract theory discusses the establishment of contracts in the presence of asymmetric information, which takes place when one party to an economic transaction possesses more valuable knowledge and experiences than the other party. The conventional approach, in construction process when the project's owner first contracts for the design with a consultant / architect and the second for execution with building contractor, and this is what is called the traditional method (DBB). There is also another type of contract is by the project's owner with one party (the contractor) responsible for the design and execution, and it is called the design and build method (DB). In these contracts, the project owner tries to use the experience, knowledge, and equipment of the other parties to execute his projects through a contractual relationship. (Ralf et. al., 2005).

The theory of contracts has a profound impact on the implementation of the project life cycle. According to IAPM (2023), theory of contract involves three key stages: Pre-Signing Stage: This stage encompasses several critical activities, including confirming the need to engage second and third parties, ensuring the availability of funds, establishing project specifications, conducting market research, initiating an inquiry into potential partners, determining the type of contract to be employed, drafting the contract, and conducting a thorough review and approval of the draft contract. Signing Stage: During this stage, negotiations are initiated, the contract is thoroughly reviewed and approved, and it is ultimately signed by all relevant parties involved. Post-Signing Stage: This stage involves the actual execution of the contract, the management of commitments outlined in the contract, handling contract amendments and variations as necessary, conducting regular contract reviews, and considering contract renewal if deemed necessary. These stages in contract management play a pivotal role in the successful execution of projects, ensuring that the contractual relationships between parties are well-defined, efficient, and conducive to achieving project objectives while minimizing risks and disputes.

The Project Delivery Method and the Project Performance

Project delivery methods (PDMs) and their influence on project performance (PP) have received extensive research attention, underscoring their vital role in project success. Numerous studies have underscored the pivotal significance of choosing the right project delivery method in shaping project outcomes and overall success (Sanvido et. al., 1998; Ibbs et. al., 2003; Al Khalil, 2002). The project delivery method (PDM) exerts substantial control over the ultimate project performance, as highlighted by Hosseini et. al., (2016). Research conducted by Sinem et. al., (2013) accentuates the profound impact of project delivery methods (PDMs), including design-build (DB) and design-bid-build (DBB), on team integration levels. It is well-recognized in the industry that higher degrees of team integration tend to lead to superior project performance and enhanced value for project owners.

Sinem et. al., (2013) further propose that the extent of integration within the chosen project delivery method directly affects project performance, particularly in terms of sustainability goals. Moreover, assert that a considerable portion of leadership within the construction and environmental design sectors believes that projects executed using approaches like design-build (DB) and construction management at risk (CMR) stand a higher chance of attaining sustainability objectives compared to those employing the traditional design-bid-build (DBB) method. Gordon's (1994) findings, highlight the potential for an average cost reduction of 5% for a project when an appropriate contracting method is chosen. Consequently, project performance in terms of cost, schedule, conflicts, claims, and disputes is significantly influenced by three

fundamental factors: the procurement approach used (the project delivery method), and the chosen payment method for the work performed (the contract type) (Wardani et. al., 2006; Mehany et. al., 2016). These elements collectively shape a project's performance and its capacity to efficiently and effectively achieve its objectives.

Conceptual Framework

This section delves into the theories surrounding project delivery methods and their influence on project performance. The choice of a suitable project delivery method can significantly enhance project performance (Hosseini et. al., 2016). Selecting the appropriate project delivery method serves as the cornerstone that ultimately determines a project's success, although it's important to acknowledge that under specific circumstances, this choice can also result in failure (Syed, 2018).

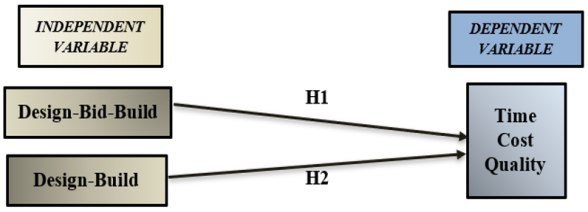

Figure 4: Conceptual framework of the research model with hypotheses

The aforementioned researches findings indicate a correlation between the chosen project delivery method and the project performance (time, cost and quality). This study aims to examine the applicability of the identified link between PDM & PP to the Yemeni construction industry (YCI) and ascertain if the results obtained support or refute this association. The research model above allows the development of the two basic hypotheses, as stated below:

H1: Traditional Delivery Method (DBB) has a positive effect on Project Performance in the Yemen Construction Industry.

H2: Design Build Method (DB) has a positive effect on Project Performance in the Yemen Construction Industry.

MATERIALS AND METHODS

This study employed a qualitative research methodology, which is specifically designed to gather non-numerical data for the purpose of obtaining insights. The data shown is not representative of a statistical sample, but rather reflects the information and replies gathered from participants who completed the questionnaire in response to the researcher's inquiries. We have selected a cohort of individuals who are actively engaged in the Yemen construction industry (YCI). The questionnaire was dispatched to the Aden and Hadramaut Governorates, where a total of 375 question papers were distributed among project managers and project consultants. Questionnaire papers were distributed to project managers and project consultants in collaboration with the Yemeni Engineers Syndicate (YES) in both governorates. The data obtained from the respondents by the questionnaire was analysed in stages. The first stage is analysis for the respondent's profile, and analysis of the statistical assumptions; and these achieved by using a Multivariate Regression Analysis.

Measurement of Study Variables

Project Delivery Method: to gauge the perceptions of participants regarding the management of project delivery methods, a measurement scale was employed that focused on traditional (DBB) and design-build (DB) methods. Following the recommendations of Johan et. al., (2016) and Guangdong *et al.*, (2018), the questionnaire was developed containing various items. These items were categorized into two groups, with three items allocated to each of the two different delivery methods, resulting in a total of six items. These items were devised to elucidate key distinctions between the two methods. For the traditional method (DBB), items (1 to 3) were used to assess various aspects, such as the level of friction between the consultant team and the contractor team. On the other hand, for design-build (DB), items (4 to 6) were crafted to explore factors like good to minimize cost and time. Respondents were asked to rate the extent to which they agreed or disagreed with these statements on a Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). In addition to the Likert-scale questions, the research incorporated additional factors that reflect project characteristics.

Project Performance: measurement of Project Performance (dependent Variable), the assessment of project performance has been a long-standing focus of research (Aragones-Beltran et. al., 2017; Liang et. al., 2017; Osei-Kyei & Chan, 2017). Numerous studies emphasize the importance of evaluating project success throughout the project lifecycle by measuring performance in terms of time, cost, quality, or scope (Teixeira et. al., 2019). In this context, respondents were asked to provide qualitative assessments and information related to the three critical constraints in their most recent project. These constraints include whether the project adhered to the schedule stayed within budget, and met the desired quality standards to gauge their perceptions of project performance in these areas, participants were asked to respond to three statements for each of the dimensions of time (1 to 3), cost (4 to 6), and quality (7 to 9) using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Additionally, the survey included supplementary questions pertaining to project-specific attributes, which were later incorporated into the sample method and utilized for multivariate regression analysis.

Participants

The current study used Multivariate Regression Analysis to examine the effect of project delivery method on project performance. 375 questionnaires were distributed to engineers (project managers and consultants) currently

working in the construction industry in Yemen, 286 questionnaires were returned, the response rate was 76 %, this response rate is considered to be satisfactory this study due to exceeded the average of response rate of 52.7% for studies in management and behavioural science (Al-Refaei, 2021). However, 9 questionnaire papers were deleted due to uncompleted responses or missing data. This procedure is the safest, easiest and most common method for handling missing data with incomplete questionnaires or cases with missing data (Zumrah, 2019), due to it can be used with different statistical methods, because it will not result in any biased estimates (Sahibzada et. al., 2019). Therefore, 375 questionnaires were used for the analysis, this sample size was suitable for employing structural equation modelling (Kline, 2016; Hiar *et al*, 2019).

RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics of the variables under consideration. The mean values for DBB, DB, and PP were found to be 3.09, 3.21, and 3.49, respectively, with standard deviations ranging from 0.559 to 0.668. The data exhibited a normal distribution, as indicated by Skewness and Kurtosis values falling within the range of ±2.58 (Alshuhumi et. al., 2023). To assess multicollinearity, the "variance inflation factor (VIF)" was employed, with the results revealing VIF values below the threshold of 10, as recommended by previous research (Al-Refaei et. al., 2023). The VIF values for the independent variables were observed to be 1.93. Furthermore, the results indicated a positive correlation between the variables, as depicted in Table 1.

Table 1: Descriptive statistics normality, multicollinearity of variables

Variable	Mean	SD	Skewness	Kurtosis	VIF	DBB	DB	PP
DBB	3.09	.660	-.114	-.994	1.936	-		
DB	3.21	.668	-.251	-.946	1.936	.695**	-	
PP	3.49	.559	-.363	-.396	-	.634**	.600**	-

Hypotheses Testing and Results

Hypotheses H1

The results of the regression analysis (see Table 2) provide support for the presence of a positive relationship between the independent variable (DBB) and the dependent variable (PP). Additionally, the analysis reveals that this relationship is statistically significant. The regression analysis table reveals that the beta coefficient has a value of 0.420, indicating a positive relationship. Additionally, the t-value is 6.73. This t-value is deemed sufficient to demonstrate the relative significance of the variable. In a similar vein, the obtained P-value of 0.000 is less than the conventional significance level of 0.05, indicating statistical significance as suggested by previous studies (Al-Refaei *et al*., 2019; Zumrah *et al*., 2021). The results clearly indicate that the hypothesis H1 has been determined to be valid.

Hypotheses H2

The results of the regression analysis, as presented in Table 2, offer support for the existence of a positive and statistically significant relationship between the independent variable (DB) and the dependent variable (PP). The beta coefficient, with a value of 0.308, indicates a positive relationship between these variables. The t-value of 4.93 further signifies the relative significance of the variable, and the obtained P-value of 0.000, which is less than the conventional significance level of 0.05, underscores the statistical significance of this relationship, consistent with previous studies (Al-Refaei *et al*., 2019; Ghumiem *et al*., 2022; Ghumiem *et al*., 2023). These findings confirm the validity of hypothesis H2.

However, Table 3 provides information about the coefficient of determination (R2), which measures the extent to which the model can explain changes in the dependent variable. In this study, the adjusted R2 was used, and the calculated value of 0.45 suggests that the inclusion of independent variables in the model equations has enhanced project performance. It's worth noting that the remaining 55% of the factors influencing the outcome are not accounted for by the variables included in the regression model of this study.

The F-test, presented in Table 4, assesses whether all the independent variables collectively have a simultaneous effect on the dependent variable. The significance of the F-value, which is 0.001 and falls below the threshold of $\alpha = 0.05$, indicates a significant influence of DBB and DB variables on project performance. Moreover, the calculated F-value of 111.95 exceeds the critical F-table value.

Table 2: Results of Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	1.572	0.132		11.935	.000
	DBB	0.356	0.053	0.420	6.728	.000
	DB	0.257	0.052	0.308	4.929	.000

a. Dependent Variable: PP

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.671a	0.450	0.45	0.41587

a. Predictors: (Constant), DBB, and DB

Table 4: Results of ANOVA

Model		Sum of Squares	df	Mean Square	F	Significance F
1	Regression	38.724	2	19.362	111.954	.000
	Residual	47.214	273	0.173		
	Total	**85.938**	**275**			

a. Dependent Variable: PP
b. Predictors: (Constant), DBB, and DB

DISCUSSION

The findings revealed that: the project delivery method was positively associated with project performance. The first hypothesis indicated that" Traditional Delivery Method (DBB) has a positive effect on Project Performance in the Yemen Construction Industry", the result of this hypothesis shows that there is a positive and significant effect of the traditional delivery method (DBB) on project performance (time, cost, and quality), the results shown in (Table.6). This finding suggests that when project owners adopt the (DBB) method in construction projects, it leads to improved project performance. The positive effect implies that using (DBB) as the delivery method contributes to better outcomes, such as meeting project objectives, delivering within budget, schedule, and achieving agreed quality. The contractor is not responsible for the previous steps but instead carries out the implementation process for all the details mentioned in the previous steps. This method positively impacts the project performance according to cost, quality, and time previously specified in the contract between the two parties (the owner and the contractor). The positive effect of DBB method on project performance in some cases is higher than other methods because a complete owner's visions has been mentioned in advance, which mitigate the risk and reduce of changing orders. Due to these properties, it is still commonly used in the construction industry around the world, as well as in Yemen.

The second hypothesis indicated that" Design Build Method (DB) has a positive effect on Project Performance in the Yemen Construction Industry", the result of the analysis of this hypothesis shows that there is a positive and significant effect of the design and build delivery method (DB) on project performance (time, cost, and quality) in Yemen's construction industry, the results shown in (Table 2). This result due to the integrated of the design process and execution process under one executive identity, (DB) method combining the consultant and contractor responsibilities into a single contract. This enhances collaboration between the designer and builder as they are a single foundation, resulting in improved project performance. Moreover, (DB) projects have the benefit of being expedited, allowing construction to begin parallel with the design is finalized (Cody N. Robertson 2022). Using a (DB) approach allows the project team to integrate with the owner, provide innovative solutions, quickly resolve issues, speed up the review of design documents, and allow real-time decision-making on proposed changes (Francom *et al.*, 2014).

The study offers several recommendations for stakeholders, particularly owners and contractors in the construction industry, aimed at improving project time, cost, and quality. Firstly, stakeholders are encouraged to carefully consider and select the most appropriate project delivery method for each specific project. This decision should be based on the alignment between the method and the project's unique characteristics. It is further recommended that all stakeholders receive continuous education and awareness regarding both traditional delivery methods and design and build methods. This knowledge-sharing process should emphasize the benefits these methods can bring to the overall project performance, thus ensuring informed decisions.

The paper also suggests that individuals in the Yemeni construction industry explore and adapt alternative project delivery methods that are employed in other countries. By examining these diverse methods and their varying frequencies of use, stakeholders can identify common ground and reach a consensus that aligns more efficiently with the project's specific requirements and objectives. This approach promotes flexibility and innovation in project delivery.

In summary, the study advocates for informed decision-making in choosing project delivery methods and a more inclusive approach in considering the preferences and requirements of all key parties involved in the construction process. This can lead to enhanced project outcomes and success.

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