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Evidence-Based Comparison of Technology in Project Delivery

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Technology has been a significant driver for decision risk analysis on construction projects. New and upcoming technologies, combining human experience and technological data output, introduce complexity when making decisions related to cost, time, quality, and safety. Evidence-based practices have traditionally been used within project delivery methods to manage these risks. Technology further influences project risk management by integrating expert knowledge with data analysis. Moreover, technology creates risks associated with projects using expert knowledge to assess and manage project risks. Evidence-based decision processes provide a problem-solving approach that bridges best practices and human expertise. Research has been conducted suggesting differences between the use of design-bid-build (DBB) and design-build (DB) methods in how technology affects risk management within and between them. A survey of industry practitioners collected and analyzed data using a two-way analysis of variance (ANOVA) to determine commonalities and differences related to technology in the DBB and DB approaches. The research supports findings that the DB method fosters greater communication through a more collaborative environment when using technology during the early stages of project delivery.

Keywords: Evidence-Based, Technology, Project Delivery

Introduction

The medical profession has used evidence-based practices for many years. The use of evidence-based practices in medicine has been used to improve patient outcomes through clinical expertise, research, assessment, and experimentation using a problem-solving approach to decision-making (Mackay & Bassendowski, 2017). Most importantly, evidence-based practices use evidence and expertise to navigate a complex set of decisions. In comparison for the construction industry, the project is like a patient in medical terms; it provides its own set of conditions where owners, constructors, or the project team will deploy a host of different ideas on how to bring a project together within budget and time, at the highest level of quality required by the owner, and with safety in consideration at all levels. In many cases, evidence-based technology practices and tools are used to manage the risk by providing the research and information necessary for the project team to make decisions on cost, time, quality, and safety. In the medical profession doctors and medical technicians make key lifesaving decisions (Hu et al, 2025). Construction is similar, where key stakeholders and experts including the owner, designer, constructor, and sub-consultants to both the designer and constructor work as a team

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to assess risk ahead of time in the beginning stages of the project to ensure a successful project outcome (Creedy et al, 2010).

The growth and application of technology in construction over the past several years has been a dominant force in assisting project teams to gather, synthesize, and distribute information to make critical evidence-based decisions in construction. With respect to project delivery, technology has assisted in providing decision models to aid in the process of delivering information to construction stakeholders so informed decisions can be made. Construction technologies utilized including drones, 3D modeling/printing, lasers, building information modeling (BIM), and virtual reality all aid in providing information to assist in the decision-making process. Ahmed & El-Sayegh (2022) studied how artificial intelligence as a smart decision support models can be used in the selection of different project delivery methods based on the risks associated with the project delivery method.

Construction project delivery methods exist to organize and optimize the numerous project risks and decision frameworks commonly found on construction projects. The most traditional method of delivering projects is the design-bid-build (DBB) method and is most widely used, it has shown to be the most stable method to deliver projects with defined costs and schedule durations for many types of projects (Park & Kwak, 2017). Alternatively, the design-build (DB) project method is also frequently used and has offered the construction stakeholders greater flexibility within and collaboration in the process (Hale et. al, 2009). Roles and responsibilities can change with both DB and DBB projects depending on the project delivery method. Table 1 and Table 2 provide a synopsis of the roles and responsibilities for the owner and contractor, or in the case for the DB process the DB team that incorporates the designer and constructor as one team (Loulakis et al, 2019).

Table 1. Comparison of Owner’s Roles and Responsibilities for DBB & DB Projects

Responsibility	**Design-Bid-Build (DBB)**	**Design-Build (DB)**
Contracting	Manages two separate contracts: one with the architect/designer and one with the general contractor.	Manages a single contract with one design-build entity (a firm or team responsible for both design and construction).
Design Control	Retains greater direct control and influence over the design process and selection of the design team.	Defines project goals and performance requirements upfront but has less day-to-day control over specific design decisions once the post contract execution.
Project Management/ Coordination	Serves as the primary link and coordinator between the design and construction teams, managing communication and resolving conflicts between them.	Has a single point of contact and less day-to-day management burden, as coordination is handled by the design-build team.
Risk Allocation	Assumes more risk for design errors, constructability issues, and potential delays or cost overruns that arise from design deficiencies.	Transfers significant project risk to the design-build entity, which is responsible for both design and construction quality and potential issues.

Source: Six, A & Frisa, K (2024), Warne (2005)

Table 2. Comparison of Contractor Roles and Responsibilities for DBB & DB Projects

Responsibility	**Design-Bid-Build (DBB)**	**Design-Build (DB)**
Scope of Work	Responsible solely for constructing the project according to the completed design plans and specifications provided by the owner's designer.	Responsible for both the design (either in-house or by engaging an architect/engineer) and the construction of the project.
Design Involvement	Not involved in the design phase and has no contractual relationship with the designer.	Involved from the project's inception, providing early input on cost, scheduling, and constructability, which helps align design with budget and schedule.
Bidding Process	Selected through a competitive bidding process after the design is 100% complete, typically based on the lowest qualified bid.	Selected based on qualifications and a proposal, with cost estimates developed early in collaboration with the design team.
Risk Allocation	Liability is limited to the construction execution; typically, not responsible for design flaws unless they deviate from the plans.	Assumes responsibility and liability for both design and construction quality, reducing the owner's exposure to risk.
Subcontractor Management	Hires and manages subcontractors after the main contract is awarded.	Subcontractors are often brought in earlier to provide input during the design phase, fostering better collaboration.
Change Orders & Flexibility	Follows a rigid process, and changes often require formal change orders and renegotiation, which can cause delays.	Offers greater flexibility for real-time adjustments and changes as design and construction overlap, often resulting in fewer change orders overall.

Source: Six, A & Frisa, K (2024), Warne, T (2005)

As mentioned by Six and Frisca (2024), depending on the project delivery method used “clear, consistent organization and accessibility of project information and open communication can help foster understanding and overall project success.” Evidence-based practices are like navigating a ship: the "evidence" is the accurate map and compass, telling you the safest route; "construction expertise" is the captain's skill in handling unexpected weather and steering the ship; and "project or owner values" are the desired destination, ensuring the journey is tailored to the passenger's needs and preferences. The process of construction is a series of carefully planned events executed in the field to manage cost, time, quality, and safety. Owner and contractor responsibilities to manage risk change depending on the project delivery method deployed (Six & Frisca, 2024 & Warne, 2005).

In comparing DBB and DB project delivery and use of technology, the New York State Department of Transportation (NYSDOT) compared the DBB and DB project delivery methods for two common goals. The first was to incorporate modes into legal contract documents and demonstrate a process.

The second was to leverage technology to streamline business operations for the entire lifecycle from design and construction to asset management. Within their study the commonalities they found for both delivery methods included visualization and simulation, collaboration and communication, data integrity and integration, and clash detection and conflict resolution. Differences included the timeline and phasing, contractual relationships, flexibility and adaptability, responsibility for model maintenance, risk and accountability and schedule integration (USFHWA, 2024)

While the project delivery method is important the processes to manage the delivery method and implementation of technology used on projects creates its own element of risk associated with the project. Many technological characteristics involve the management of a project and its physical components. More specifically, technological characteristics involve the integration of tools and equipment, building technologies, and project management expertise and software used to assist in making decisions. It has been stated that construction is a data intensive endeavor, and the most sophisticated management software can provide precise documentation but also provide large data to manage and challenge the decision-making process (Manuwar et. al, 2022).

Methodology

Using similar approaches from a previous study performed by Plugge (2007) the design of this research used the two project delivery methods and continuums established by Davies (2004) with the concepts of evidence-based inquiry provided by McMillan and Schumacher (2006) to validate how technology affects the two project delivery methods. Figure 1 identifies how technology was integrated within the five factors that drive this research, affect construction project delivery, and potentially impact construction risk.

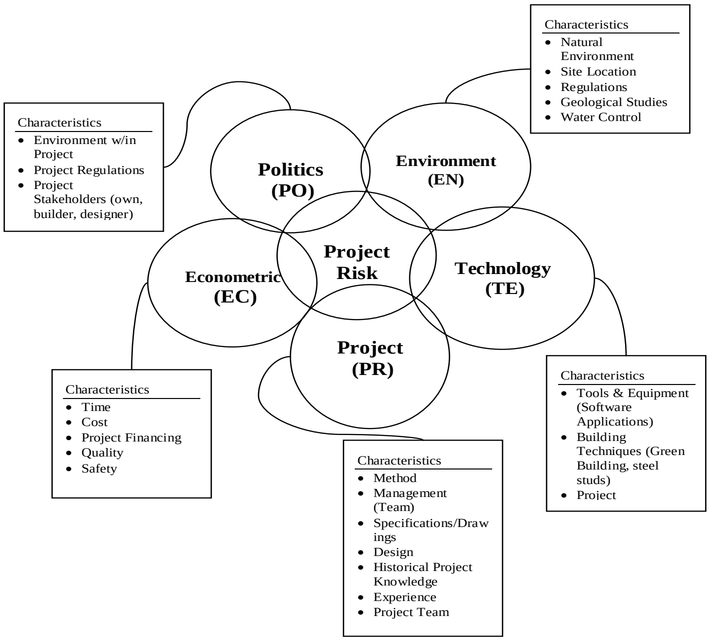

Figure 1. Conceptual Model of Project Risk Complexity
Adopted From Plugge (2007)

As mentioned, this study is a sub study of a broader look at the two project delivery methods of (DBB and DB) to focus on the technology element in the model. The original study utilized independent variables of DBB and DB with participants who voluntarily completed surveys based on experience working within the DBB and DB project delivery environment. The participants had extensive experience and knowledge of both delivery methods. The larger study included the dependent measures consisting of five constructs of econometrics, environment, politics, project, and technology. Responses by the experienced professionals were important to identifying differences between and within the project delivery methods on these five different constructs (Plugge, 2007). The technology construct was a significant construct that is being further investigated within this study.

The methodology for this study follows a similar paradigm to expose differences and similarities between and within the two project delivery methods but focuses entirely on the technology element of the evidence-based practices found on the DBB and DB project delivery method. The research methodology attempts to answer the research questions as follows:

1. What technological factors are important across the two project delivery methods for DBB and DB?
2. What are the differences between the DBB and DB project delivery methods that help evidence-based project delivery practices related specifically to technology?

Study Phasing

The significance of this study is that it measures and compares potential risks associated with DBB and DB project delivery methods, focusing on evaluating the perceptions of experienced professionals in architecture, engineering, and construction disciplines regarding the technology variable shown above.

The study was conducted in two different phases, including a pilot study to qualify the questions or items used for the final study. A factor analysis process was also used to ensure a “measure of the degree of generalizability between each variable or item and each factor is calculated and referred to as a factor loading” (Gorsuch, 1983). Simply explained, factor loadings identify quantitative relationships between the factors to be measured. Therefore, the researcher observed how far from zero the factor load exists within the data focusing on technology. If the technology factor loading is large, then greater generalizability can be assumed about the specific factor. In this study, conceptual factor analysis was used to determine the item factor loading for technology. Within this study the technology factor was one of the significant factors that was exposed by the data making it a significant element to focus on (Gorsuch, 1983). Most importantly, factor analysis as used in this study on technology focused on tools and equipment, building technique or means and methods, and project management.

To ensure the quality and validity of the survey instrument the pilot test was used to fine tune the final questionnaire with thirty (30) potential participants and ten items focusing on technology as it related to the different project delivery methods. Participants for the pilot were recruited through personal industry contacts and interviewed to determine their level of experience with the two project delivery methods. Participants also provided feedback to ensure the validity of the items incorporated into the survey. The ten items related to technology focused on quality, historical project experience and data, green building and environmental techniques, quality inspection, schedule, cost, and safety. Questions centered on technology concepts related to tools and equipment, building techniques (or means and methods), and project management.

The final study participants included one-hundred eight (108) individuals recruited and selected from the researcher's personal connections and through national organizations including the American Association of Cost Engineers (AACE), Associated General Contractors of America (AGC), Construction Management Association of America (CMAA), and the Society of American Military Engineers (SAME).

There were limitations to this study regarding timing, as it was a single snapshot in time rather than a longitudinal study showing technological progression. Most importantly, the researcher relied on the professional experience levels of individual participants. Finally, a major limitation was the small number of participants. Assumptions were also made regarding technology; participants were surveyed on the general use of technology as it relates to project delivery. Because of the broad applications of technology in construction, specific types were not identified within the survey instrument.

After the data was received, combined, and synthesized, it was cleaned and checked for missing entries. Cronbach's alpha was utilized to assess the internal consistency of the survey instrument. While a coefficient of .70 or higher is generally preferred for established scales, values between .60 and .70 are often considered acceptable for exploratory research or newly developed constructs (Hair et al., 2010). As shown in Table 3, the alpha for DB (.76) and DBB (.63) met this threshold, while the overall Technology construct (.59) approached it. These values suggest a moderate level of internal consistency, likely influenced by the broad and varied nature of the technology variables being measured in this study.

Table 3. Survey Reliability

	M	**α**
Technology	3.65	.59
DBB	3.20	.63
DB	3.55	.76

Analysis and Results

To evaluate the impact of project delivery methods on technology, a two-way analysis of variance (ANOVA) was conducted. This method was selected to compare the two independent variables—Design-Bid-Build (DBB) and Design-Build (DB) against the dependent variable of technology (Huck, 2004). The ANOVA revealed statistically significant main effects for both the delivery methods and the technology construct, specifically identifying differences between the means of each method.

A sample of 108 participants was selected based on their current professional roles, years of industry experience, and history with DBB and DB projects. Screening indicated the data was normally distributed, meeting the assumptions for parametric testing. Reliability analysis yielded a Cronbach's alpha of .88 for DB (N = 54, M = 3.54) and .88 for DBB (N = 54, M = 3.33), suggesting strong internal consistency across the scales.

Participants included project managers, upper-level management, consultants, and architects with expertise in field supervision (28%), project management (36.1%), and design (41.7%). Most respondents had experience in commercial (36.1%) and civil (27.5%) construction, with 30.6% possessing 26 to 35 years of experience. Descriptive statistics confirmed a higher level of experience with the DBB delivery method. The study focused on three primary technology factors: tools and equipment, software applications, and project management techniques. The researcher was interested in what differences existed between the two project delivery methods related to technology.

To determine where differences existed between the two delivery methods, an ANOVA was conducted. Survey questions were categorized by syntax structure and language to identify specific areas of variance. Responses were captured on a Likert scale ranging from never, sometimes, often, somewhat often, and most often. These questions were purposely designed to identify the differences within the project delivery continuum as they related to the technology variable. Based on the findings they identified the potential areas of risk associated with technology as they are related to the DBB and DB project delivery methods. Statistical screening confirmed multivariate normality, with skewness statistics falling within acceptable limits for the ANOVA.

Within the technology variable the ANOVA was also used to answer the questions associated with the differences between DBB and DB project delivery methods to identify where and what differences exist along the project delivery continuum for technology. The ANOVA identified significant differences between DBB and DB delivery methods within the planning stages, specifically regarding tools and equipment, software applications, means and methods, and project management techniques. Data indicated that differences were most pronounced in the early phases of construction, where technology significantly affected management concepts related to cost and schedule. Table 4 provides the ANOVA source data for these differences.

Table 4. ANOVA Source Table for Where Differences Exist Between Project Delivery Methods on Technology

Variable	**Source**	**df**	**SS**	**MS**	**F**	**P**
Technology	Between groups	1	21.33	21.33	17.57	<.001
	Within groups	106	128.74	1.22		

Note: The ANOVA for the technology variable showed a significant difference between groups, $F(1,106) = 17.57$, $p < .001$.

Under the technology construct, the perceived importance of selecting modern construction means and methods to improve project functionality was significantly higher for the DB project delivery method (M = 4.04) than for the DBB project delivery method (M = 3.15). Additional analysis compared DB and DBB projects across factors such as quality, inspection, and environmental considerations during the feasibility stage. Table 5 presents the means comparison for these significant technology-related items. Notably, DB consistently outperformed DBB in mean scores for functionality improvement and quality during design.

Table 5. Project Delivery Means Comparison

Item	**Project Delivery Method**	**N**	**M**	**SD**	***d***
Technology to Improve Functionality	DBB	54	3.15	1.22	
	DB	54	4.04	0.97	
Total		108	3.59	1.18	.37

Quality During Design	DBB	54	3.72	1.28	
	DB	54	4.43	0.98	
Total		108	4.07	1.19	.29
Inspection During Planning	DBB	54	2.43	1.19	
	DB	54	3.15	1.31	
Total		108	2.79	1.30	.28
Inspection During Feasibility	DBB	54	2.31	1.24	
	DB	54	2.88	1.16	
Total		108	2.56	1.22	.23
Environmental Considerations During Design	DBB	54	2.37	1.26	
	DB	54	3.31	1.27	
Total		108	2.84	1.35	.34
Quality During Feasibility	DBB	54	3.15	1.43	
	DB	54	4.24	0.78	
Total		108	3.69	1.27	.42

As Cohen (1988) suggests, the effect size (*d*) can be used to explain the practical significance of the data. Cohen's *d* was calculated to determine the practical significance of the differences between delivery methods. According to Cohen (1988), an effect size of .20 is considered small, .50 is medium, and .80 is large. The results in Table 5 indicate a small to moderate effect size for Technology to Improve Functionality (*d* = .37), Quality During Design (*d* = .29), and Inspection During Planning (*d* = .28). These values suggest that while the DB method consistently results in a higher mean score for technological integration, the magnitude of the difference between DB and DBB, though statistically significant, represents modest practical impact in these specific areas.

The comparison of means indicates that the Design-Build (DB) method consistently yielded higher scores (M) across all significant items within the technology construct. These findings suggest that the DB framework may facilitate enhanced communication and collaboration among project participants compared to Design-Bid-Build (DBB). Specifically, the data indicates that technological integration significantly influences the project lifecycle, particularly regarding functionality, environmental considerations during design, and quality during the feasibility phase. Although the effect sizes (d) for these items were small to moderate, the consistently higher means for the DB method suggest a reliable trend: technology within the DB environment more effectively supports project delivery goals from the earliest stages of planning through construction.

Conclusion and Discussion

Comparing the integration of technology within project delivery methods is essential for assisting in risk analysis and decision-making, particularly during the initial phases of a project. This study investigated technology through the integration of tools, equipment, building technology, and project management software. The most significant factor identified was the participants' ability to utilize modern construction means and methods to improve overall project functionality. As Dagou (2025) suggests, technology enables stakeholders to achieve new levels of efficiency, enhance safety, and promote sustainability while managing risks related to cost, time, and quality. This research aimed to identify the critical technological factors across Design-Bid-Build (DBB) and Design-Build (DB) methods. The data suggests that early planning stages within these delivery methods facilitate the use of diverse technologies, such as Building Information Modeling (BIM), precise 3D models, artificial intelligence (AI), and digital twins. The construction industry can leverage these findings, as these technologies provide vital decision-analysis tools that foster greater collaboration, communication, and goal setting during the early stages of the DB process (Swarup et al., 2011).

Furthermore, the findings indicate that participants rely on professional judgment and experience to select the tools, materials, and management processes necessary for project delivery. Respondents expressed a greater ability to contribute within the DB framework compared to DBB. This suggests that constructors are not only better positioned to provide input but are also more willing to adopt advanced means and methods to create delivery efficiencies. A key takeaway for project owners is that technology provides an evidence-based approach to support early collaboration. Future research should utilize similar methodologies to explore other constructs of project risk, such as project politics, econometrics, and environmental factors.

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