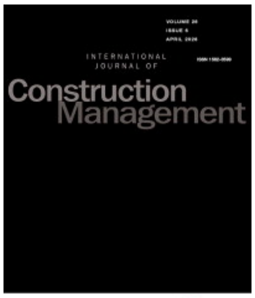

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Predictability of cost, time and quality in design–build construction contracts – evidence from 100 public projects

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ABSTRACT
The study examines the predictability of cost, time and quality in public construction projects delivered through design–build (DB) contracts, employing a mixed-methods approach that combines quantitative analysis with interviews. Based on data from over 100 completed DB contracts, the study assesses schedule adherence, cost deviations and the DB model's impact on project quality. The research finds that infrastructure contracts demonstrate a schedule predictability with nearly 75% completed on or before the agreed deadline. However, there is substantial variance in the data set, with actual completion times ranging from one year early to more than two years beyond the deadline. The data from building contracts showed significantly less overall variation but were more prone to modest delays, with two out of three contracts completed one to three months late. Regarding costs, the average increase from the original contract amount was 14%, with a median of 10%. Approximately half of the contracts had change volumes of 10% or less, and around 80% fell within a 20% range. Regarding quality, the findings suggest that DB contracts often encourage delivery to minimum standards; therefore, their use should be approached with caution in projects requiring high degree of quality predictability but with poorly defined requirements.

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Design–build; design–bid–build; project delivery methods; predictability; cost management; time management; construction projects; project governance

Introduction

The design–build (DB) contract is a project delivery method in which a single contractor assumes responsibility for both the design and execution of the project. Over the past decade, the construction industry has seen a significant rise in the use of DB contracts (Korman 2021). In the United States, this delivery method represents approximately 50% of construction spending (Korman 2021; FMI Consulting 2023).

The increasing popularity of DB contracts can be attributed to project owners' expectations regarding the potential benefits they offer. A part of this is the perception that the model produces predictable results in terms of time and cost while delivering a high-quality-to-cost ratio (Songer and Molenaar 1996; Moon et al. 2020).

Numerous empirical studies have examined the performance of projects under DB contracts, comparing them with projects under other project delivery methods. However, most studies focus on the overall performance of DB contracts in terms of productivity, rather than on predictability in isolation. Hence, project owners concerned with the predictability of key parameters such as time, cost and quality often make decisions about project delivery methods based on assumptions and personal experience rather than on well-documented studies of the model's expected performance and the conditions required for its effective use.

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The objective of this study is to provide insights into the extent to which the DB project delivery method ensures predictability in construction contracts with respect to time, cost and quality and to identify which characteristics of this model contribute to such predictability.

To answer the research question, we empirically investigated results from over 100 unique construction contracts from public building, road and rail projects. We also interviewed client representatives, consultants and contractors with experience in DB construction contracts.

Theoretical background and literature review

The DB project delivery method

One of the fundamental differences between construction contracts lies in the allocation of responsibility for design. Somewhat simplified, we can distinguish between design–bid–build (DBB) contracts and DB) contracts. In DBB contracts, the client is responsible for all or most of the design and, depending on the project contract structure, some of the production planning. In a DB contract, the client entrusts the design and construction work to the contractor, thus shifting more of the planning and management of the design and production processes (Konchar and Sanvido 1998). The degree of detail in the documentation that forms the basis for the DB contractor's design can vary from general functional descriptions to detailed drawings. However, the key point is that, under a DB contract, responsibility and risk for the design are transferred from the client to the contractor upon contract signing (Welde and Dahl 2021).

It should be emphasized that the division into two contract models is a rough simplification. Both DB and DBB contracts exist in many variants. Some well-known variants of DB contracts are often referred to as turnkey or engineering–procurement–construction contracts (Lædre 2006). There are also more recent models designed to promote a higher degree of collaboration between the client and the contractor during design and execution, such as alliancing and integrated project delivery models, commonly referred to as collaborative project delivery methods (Engebø et al. 2020). In this paper, we simplify somewhat and use the term DB to refer to contracts in which the contractor has primary responsibility for developing the design.

DB contracts in construction are often multidisciplinary and involve comprehensive deliveries or functions. The contracts are typically larger than the average DBB contract in projects of comparable size and require significant expertise in managing design processes, production planning and project execution (Shrestha et al. 2007; Beard et al. 2001). This is significant for both the project's and the contract's organizational structures, including the determination of who manages consultants and subcontractors.

The choice of project delivery method is a strategic decision

Selecting the appropriate project delivery method is a strategic decision, as it sets the foundation for the project organization, defines the distribution of responsibilities and governs the relationship between contractors, consultants and the owner of the project (Turner 2004). In short, it shapes the framework for how the project will be executed. Miller et al. (2000) discuss several key principles of public procurement that transcend delivery methods. Among them are the need or desire to influence project outcomes, project value, transparency, competition, scope of work, risk, revenue and owner sophistication. The project delivery method can significantly impact the efficiency of project execution and the effectiveness of the outcomes in meeting the owner's goals and broader objectives.

DB contracts are by many regarded as a project delivery method offering several advantages. A key benefit of DB contracts is that by assigning responsibility for detailed design and construction to a single party, the communication and management of project processes can be streamlined, resulting in better performance and productivity (Songer and Molenaar 1996). Additionally, the risk allocation to the contractor in DB contracts creates strong incentives for careful planning and cost control, ultimately reducing delays and cost overruns. Transferring a larger share of engineering and production planning responsibility to the contractor enables them to leverage their expertise to develop cost-effective solutions, thereby enhancing the investment's relative value (Songer and Molenaar 1996).

Moreover, DBB contracts are often associated with opportunistic bidding practices, where contractors submit unrealistically low tenders to win contracts, only to file costly claims and disputes later (Bajari et al. 2009; Hinton and Hamilton 2015). Since DB contractors are responsible for the design, they have less opportunity to shift blame to the client, leading to greater accountability and fewer disputes (Songer and Molenaar 1996).

However, DB contracts also have potential disadvantages. Compared to traditional DBB contracts, they can limit the client's ability to influence the execution of the contract/project and the quality of the project results after the contract is signed (Ling and Poh 2008). Additionally, while DB contracts might offer greater cost and time predictability, this comes at a price, as the contractors will require compensation for assuming cost-related risks through a risk premium.

A key success factor in project management is the ability to forecast project outcomes regarding investment costs, time and quality (PMI 2021). While costs often receive the most attention, time and quality are also important parameters. It is essential to distinguish between *predictability* and *efficiency* or productivity, even though these concepts are related. A process can yield predictable outcomes without being efficient. As noted by Moon et al. (2020), the DB model is often considered superior to the DBB model due to its typically lower cost growth. However, this perception may be influenced by the procurement approach used in DBB contracts, which often involves intense price competition. Such competition can lead to lower initial bids and, subsequently, more change orders. Although DBB contracts may experience greater cost growth, they could still be completed at a lower total cost than similar DB contracts.

However, predictability has intrinsic value. Projects with predictable outcomes facilitate planning, make prioritizing across a portfolio of projects easier, reduce the need for financial contingencies, and increase the likelihood of maximizing returns and benefits from investments (Shrestha et al. 2007). Projects plagued by cost overruns, delays, or poor quality can negatively impact the project owner's reputation and credibility, not only with the public but also among investors and financial markets (Flyvbjerg 2009; Álvarez-Pozo et al. 2024). Since construction costs account for a significant share of total project expenses, predictability in deadlines, quality, and final costs is a key driver for effective project and portfolio management. Therefore, selecting a project delivery method based on its expected reliability in delivering predictable outcomes can be a strategic decision for project owners.

Previous studies of DB and DBB contracts

As mentioned above, DB contracts might be a means of enhancing the predictability of final costs and project timelines while ensuring cost-efficient quality. But to what extent is this documented in empirical studies? In the following section, we will examine prior research on DB and DBB contracts in this context.

In the United States, state transport authorities have traditionally used DBB contracts, but since the 1990s, DB contracts have become more prevalent (Minchin et al. 2013). Konchar and Sanvido (1998) analysed 351 US construction projects completed with DB, DBB, and construction management at risk (CMR) contracts and found that DB contracts provided better time and cost predictability than the other models assessed, with a median cost increase of 2.2%, compared to 3.4% for CMR and 4.8% for DBB. CMR contracts offered better schedule predictability, while projects based on DB contracts outperformed DBB with fewer delays and less variance. No significant differences were found in quality.

Ibbs et al. (2003) analysed 67 projects using DB, DBB and other project delivery methods. Their findings indicated that DBB contracts offered greater cost predictability, while DB contracts provided better schedule reliability.

Dornan et al. (2006) conducted a survey involving 62 project managers. According to the respondents, DB contracts were perceived as less susceptible to delays but more prone to cost increases than DBB contracts.

Shrestha et al. (2007) benchmarked four large DB contracts, ranging from 126 to 1.4 billion USD, against eleven DBB contracts valued between 50 million and 100 million USD. They found that DB contracts had the lowest cost and schedule increases relative to estimates, though only the cost difference was statistically significant.

Hale et al. (2009) compared the results of 39 DBB contracts and 38 DB contracts in the defense sector and found that cost predictability in DB contracts was somewhat better than in DBB contracts. For the former, the final cost was, on average, 2% above the agreed contract amount, while for the DBB contracts, it was 4% above. The standard deviation was 2.2% for the DB contracts versus 4.4% for the DBB contracts. The authors found that DB contracts had an average delay of 76 days compared to 194 days in DBB contracts and a standard deviation of 115 versus 189.

Minchin et al. (2013) compared the completion times of 30 DBB and 21 DB road contracts with their respective contractual deadlines. They found that all DBB contracts experienced delays, with an average delay of 23% and a standard deviation of 18%. DB contracts had an average delay of 20% with a standard deviation of 25%.

Chen et al. (2016) examined 418 DB contracts reported by the Design–Build Institute of America and found that over 78% of DB contracts were completed on or before schedule. However, the average deviation from the original contract amount was +7%, with 55% of contracts exceeding the contracted amount, while 18% were completed below it. The analysis revealed significant variations in results across project type, ownership, procurement method, and pricing format.

Park and Kwak (2017) analysed data from 255 DB and 1257 DBB contracts completed by the Florida Department of Transportation between 2001 and 2010. The authors found that DB contracts had fewer changes to the original contract amount than DBB contracts, but the differences were not statistically significant. On average, schedule growth, measured by the difference between the original contract schedule and actual completion time, was approximately equal for both models.

Based on qualitative input from 77 industry experts, Khalef and El-Adaway (2024) reported that DBB contracts are associated with 6% higher perceived cost growth and 7% higher perceived schedule growth than DB contracts in airport projects.

Although the results vary, most studies conclude that DB contracts offer better schedule predictability than DBB and other project delivery methods. Cost predictability findings are more mixed. Some studies conclude that DB contracts offer greater predictability than other models, while others show the opposite. Quality is less emphasized, though it is addressed in some studies. Table 1 summarizes the studies and their findings on time and cost predictability.

However, the most significant variation among the studies lies in what they have investigated and measured. Most studies focus on the performance of DB contracts in terms of productivity, like unit costs or construction time, compared to other delivery methods, rather than predictability itself. The variables used to measure predictability also vary. Some measure cost predictability at the project level; others assess contract costs using project estimates as a reference; and a few examine outcomes at the contract level. The results further suggest that data across studies come from organizations with differing processes and practices, such as procurement methods, project types, levels of detail in tender documents, pricing formats and reference points in time, making direct comparisons across studies questionable. It is also striking that almost all the studies mentioned above use empirical data from the United States. Welde and Dahl (2021) observed the same American dominance in studies of DBB contracts. Notably, we found no study specifically focused on predictability at the contract level, highlighting a research gap that this paper aims to fill.

Research method

Research design

The primary goal of this study was to assess the expected outcomes of DB contracts in terms of predictability of final contract costs, timelines and quality. Additionally, we explored the potential advantages and disadvantages of the DB project delivery method for achieving consistent, predictable results across these parameters. This necessitated the use of both quantitative and qualitative data within a

Table 1. Summary of results from previous studies on the predictability of time and cost compared to other delivery methods.

Authors	Year	Predictability of time	Predictability of cost
Konchar and Sanvido	1998	Fewer delays. Less variance of deviations.	Lower cost growth than in DBB contracts
Ibbset al.	2003	Fewer changes of schedule than in DBB contracts	Higher cost growth than in contracts with other formats
Dornan et al.	2006	Less prone to prolonged construction time than similar DBB contracts	Higher cost growth than in DBB contracts
Shrestha et al.	2007	Findings not statistically significant	Lower cost growth than in DBB contracts
Hale et al.	2009	Less delayed on average than DBB contracts	Lower cost growth than in DBB contracts
Minchin et al.	2013	DB contracts were less delayed on average but with higher variance	Not applicable
Chen et al.	2016	78% of DB contracts completed on or before schedule	Half of the DB contracts experienced overruns, some completed below
Park and Kwak	2017	Equal for DB and DBB models	Lower percentage of changes in DB contracts, but not statistically significant
Khalef & El-adaway	2024	Experts perceived a higher schedule growth in DBB contracts	Experts perceived a higher cost growth in DBB contracts

mixed-methods research design. Our approach aligned with what Bell et al. (2019) described as a 'convergent parallel design', where qualitative and quantitative data were collected simultaneously, and both findings were subsequently integrated. The core objective of this method was to achieve triangulation, enabling a more comprehensive exploration of the research questions by examining them from multiple perspectives and providing deeper insights into the quantitative analysis results.

The quantitative data in the study were derived from document analysis, while the qualitative data were primarily collected through interviews with various stakeholders from different parts of the construction industry. The quantitative data mainly pertains to the 'end state' of costs and progress. In this context, the qualitative interview data provided valuable insights to clarify the quantitative findings and uncover aspects of DB contracts that are not readily apparent through numerical analysis. Regarding quality outcomes, obtaining relevant and comparable quantitative data is challenging, particularly across different sectors. Therefore, for this aspect, we relied solely on qualitative data. Table 2 presents the research questions, operationalized through their corresponding indicators.

Definitions of the terms used in the paper – the contract and the project

Note how this paper defines the distinction between the *project* and the *contract*. A construction contract is a part of the project. The contractor delivers the contracted work to the client, while the client, acting as the project management organization, delivers the overall project to the owner. Figure 1 illustrates these principles and key differences between projects based on the DB and DBB project delivery methods.

Measuring predictability – the validity of the indicators

Practitioners might perceive 'predictable' simply as results 'turning out as expected, without major surprises'. To them, the results should ideally not deviate substantially from what is planned or agreed, and any deviations should be easy to anticipate.

However, an analysis of predictability requires more precision. In this paper, we define predictability as 'the degree to which future states of an object may be predicted'. Predictability is thus related to forecastability, described by Clements and Hendry (1998) as the ability to predict future values with some degree of systematic accuracy. Predictability may thus be understood as a question of how observed deviations compare to a given prediction. It concerns, first, bias, whether observed deviations are systematically higher or lower than predicted and, second, the dispersion of such deviations.

Table 2. Research questions and indicators.

To what extent does the design–build project delivery method ensure predictability regarding time, cost and quality in construction contracts?		
Indicators	Time	- The average deviation between the actual time of completion and the contract deadline - The spread of the deviations from the variable above
	Cost	- Average deviation between the final contract cost and the original contract amount - The spread of deviations from the variable above - Total number of change requests to the contract
	Quality	- Assessments by professionals from various sectors of the industry regarding the quality delivered under DB contracts
What key characteristics of the design–build project delivery method contribute to the predictability of contract outcomes regarding time, cost and quality?		
Indicators	Time	- Assessments from professionals regarding their experience with time management and causes for timeliness and deviations from schedule in DB contracts
	Cost	- Assessments from professionals regarding their experience with causes of change orders to DB contracts
	Quality	- Assessments from professionals regarding their experience with quality and quality management in DB contracts

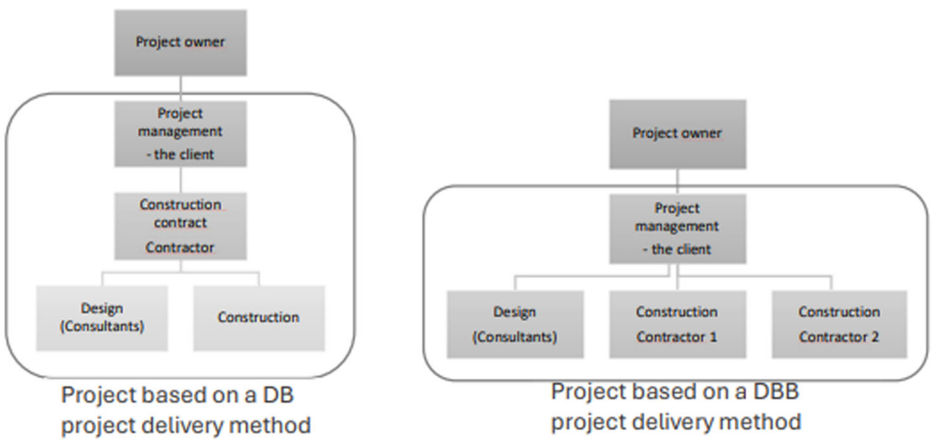

Figure 1. Our model of projects organized with design–build (DB) and design–bid–build (DBB) project delivery methods (based on Shrestha et al. 2007).

In our study, we treat the agreed time and cost frames as predictions. We therefore examine, first, the magnitude of any deviations in time and cost and whether these exhibit systematic bias, for example, frequent delays relative to the agreed deadline (expected value compared to the prediction). Second, we assess the extent to which deviations in time and cost vary (variance/standard deviation). These indicators, the average deviation and the spread, inform us about what to expect in terms of contract cost increases at the time of signing and the level of uncertainty associated with them. The measures are valuable for both practitioners and academics. For example, practitioners can use it to estimate final contract costs and compare DB contracts with other project delivery methods. Academics can investigate the root causes of cost increases and explore broader implications.

An important issue to address when measuring deviations is the choice of reference points, as these define the indicators. Figure 2 shows the reference points used here.

One measure is the deviation between the estimated duration and cost of the contract works before the tender process (1) and the actual completion time and contract cost (3). This reflects our ability to estimate the time and cost of a contract scope. Another measure is the difference between the estimated contract amount (1) and the awarded contract amount (2). This reflects how accurately market prices for contracts can be predicted. We measured the deviation between the awarded contract amount and the agreed-upon deadline by signing (2) and the actual contract costs and completion date (3).

Before comparison, the contract amount was adjusted for pre-agreed elements such as compensation for general increases in labour and material prices, quantity adjustments and contract options, ensuring

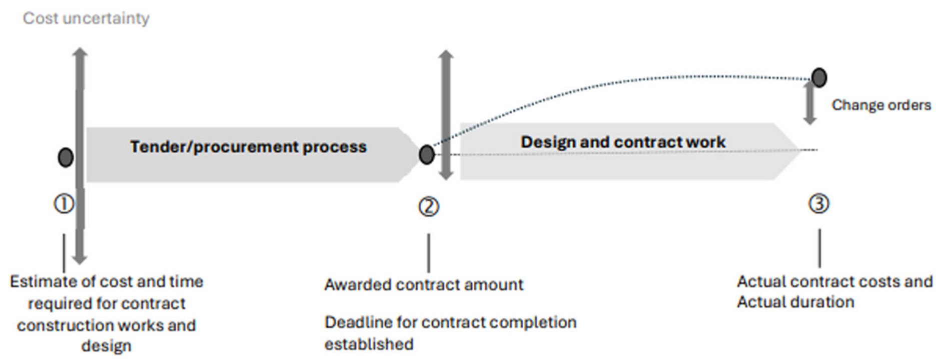

Figure 2. Reference points for measuring the predictability of contract progress and costs.

an accurate reference point for measuring the change volume of the contract. It should be noted that the term 'change' here refers to any modification in the contract scope or execution prerequisites that was not anticipated or agreed upon at the time of contract signing.

Quality is more challenging to measure. In the ISO standard, quality is defined as the ability to satisfy specified requirements (International Organization for Standardization 2015). In construction contracts, such requirements may be expressed either as detailed specifications or as broader functional descriptions, the latter often associated with DB contracts. However, specifying requirements presupposes an understanding of the underlying need and, to some extent, how it may be addressed. According to Juran (1999), the term quality encompasses both 'freedom from deficiencies', meaning a product without defects, and the 'features of products', referring to the product's ability to meet the customer's needs, commonly summarized in the expression 'fitness for use'.

Obtaining objective and quantitatively measurable data on quality, particularly for analyses across projects and sectors, is thus inherently challenging. In this study, the data on quality is based solely on interviews. During the interviews, quality was discussed in a project management/governance dimension and introduced to the interviewees as a broad concept, framed around who governs, controls and ultimately determines 'what is to be built'. Based on the responses, our impression was that the breadth of the quality concept described above was largely captured. Compared with indicators of time and cost, where data can be quantified, our data on quality pose greater challenges for empirical validity and reliability. Nevertheless, we consider the qualitative data useful within the context of this study, provided that the dataset's limitations are acknowledged.

The practitioners interviewed had diverse backgrounds, experiences and perspectives shaped by their roles within their respective organizations. Our thought was that if their judgments aligned significantly, this convergence provided a valid indication of the expected quality outcome of DB contracts.

Collection of quantitative data

The dataset for the quantitative analysis comprised 105 unique contracts from public infrastructure and building construction projects in Norway. Seventy-eight of the contracts were from building projects, while the remainder were from road and rail projects (see Figure 3).

Contract sizes ranged from small contracts valued at under 5 million USD to large contracts worth several hundred million USD (see Figure 4).

A complete list of the projects from which the quantitative contract data were derived, including the original contract value and the date on which the tenders were announced, is provided in the Appendix.

The quantitative data were sourced from primary materials, including original contract documents, cost reports from accounting systems and various protocols, to ensure the quality and reliability of the dataset. The data were structured at project and contract levels, incorporating comprehensive metadata such as execution period, project delivery method variants, contractor name and size, procurement procedure, pricing format and other relevant details. This contextual information was deemed essential for

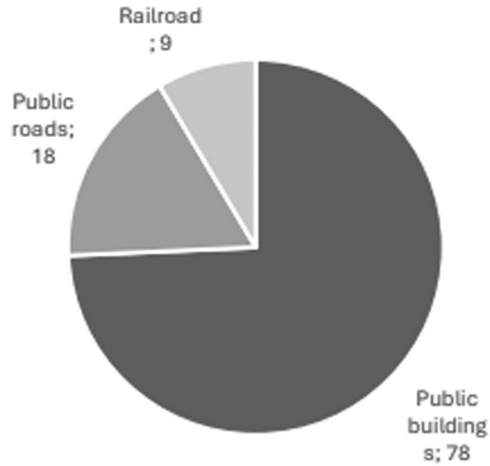

Figure 3. The number of contracts from each sector in the dataset.

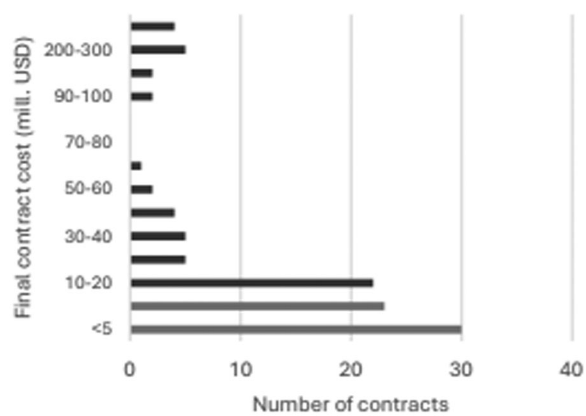

Figure 4. The size of the contracts in the sample.

evaluating the data's reliability and representativeness. Cost data included the original contract amount, the volume and number of change orders and the final contract sum.

For progress, the dataset included the agreed-upon deadlines initially set for the completion or handover of the contract works, as well as the actual completion or handover dates. The sample consisted of DB contracts considered complete deliveries, such as a road or rail section or a building comprising multiple disciplines. It does not include contracts that consist solely of a single discipline or subsystem.

Since data for all indicators have not always been available for each contract, there are variations in the number of data points for each subject. This is shown in Table 3.

The collection and registration of data were conducted in part in dialogue with the data contributors to verify the correct interpretation and clarify potential misinterpretations of the documentation. This process proved valuable in ensuring data quality.

Collection of qualitative data

To complement the quantitative analysis, we conducted 21 interviews with 23 people representing the client (11), contractor (4) and consultant perspectives (3). We also interviewed representatives from three trade organizations representing contractors and consulting engineers. The strategy used to recruit respondents can be categorized as purposive sampling, as defined by The SAGE Dictionary of Social Research Methods (Oliver 2006). We chose this approach due to the nature of the research theme. We needed to interview respondents with first-hand knowledge and experience in DB contracts and managerial perspectives on projects. Furthermore, we aimed to recruit respondents with diverse perspectives, including owners, contractors, consultants and others. Lastly, practical factors, such as availability and willingness to participate, also influenced the selection process.

Table 3. Data points for each subject.

Subject	Sector	Observations (*N*)
Cost		
	Public buildings	76
	Public roads	18
	Railroad	9
Time		
	Public buildings	40
	Public roads	16
	Railroad	6
Number of unique contracts in total		
	Public buildings	78
	Public roads	18
	Railroad	9

All interviewees had senior-level experience and were recruited to capture various perspectives across different roles and sectors. The majority of respondents were selected from client organizations. This approach was chosen to ensure representation of all project types in our dataset, as the study focuses on the perspectives of the project owner and client. Table 4 summarizes the interviews and the interviewees.

The interviews were semi-structured, guided by an interview guide that ensured consistency while allowing open-ended conversations with participants. This is in line with Fellows and Liu (2015), who provide a structured framework to keep discussions focused on the research questions while allowing flexibility to explore unforeseen aspects. The guide was broadly structured around the research questions to provide a foundation for data analysis and comparison with the quantitative findings, though with minor sector-specific adjustments. The interviews lasted 45–90 min, were recorded and transcribed (a total of 45,855 words) and were then deleted. Interviewees who wished to do so were given the opportunity to review the summary from their interview.

Data quality and limitations

Ensuring the reliability and quality of quantitative data was strongly emphasized. Data were exclusively drawn from primary documents to minimize the risk of misinterpretation or bias. The documents were thoroughly scrutinized before use, and metadata about the projects from which the contract data were extracted was carefully reviewed to ensure that nothing had distorted the data.

However, there is still reason to be aware of some limitations in the data, especially regarding representativeness. The data consists of a mixture of contracts from the building and construction industry. Although these sectors share many similarities, the average contract may vary in terms of size, complexity and risk profile. The contract price format, procurement procedure and the maturity of the tender basis may also vary between contracts in similar projects within the same sector. One should also note that the sample of building contracts primarily consists of purpose-built structures, in contrast to, for example, office buildings or private residences. Road and rail construction projects must likewise be regarded as unique objects in terms of purpose, design and stakeholder considerations.

A potential source of bias may also characterize the selection of interviewees. It consists of people with experience from DB contracts, but the client's choice of project delivery method is neither random nor necessarily characterized by perfect rationality. Several government organizations have a policy of only using or increasing the proportion of DB contracts. The choice of DB contracts may introduce confirmation bias – the tendency to seek, interpret and recall information that supports existing beliefs or values (Nickerson 1998). See also the section 'Collection of qualitative data' for a further discussion of the limitations of the qualitative data for quality.

Finally, like others, our study is vulnerable to the counterfactual problem. Clients actively choose the contracting format based on what they consider most suitable for the individual project. Additionally, the data from different studies are not always directly comparable. Pricing formats, contract scope definitions, contract standards, procurement procedures, governance and project management practices vary significantly between countries and client organizations. Also, variations in the design of

Table 4. List of interviews and interview participants.

ID #	Time of interview	Organization	Position	Number of attendees
1	August 23	The Norwegian Railway Infrastructure Manager	Client representative	1
2	August 23	The Norwegian Railway Infrastructure Manager	Client	1
3	November 23	The Norwegian Public Roads Administration	Client	1
4	October 23	The Norwegian Public Roads Administration	Client	1
5	October 23	The Norwegian Public Roads Administration	Client	1
6	June 23	Public Norwegian Road Construction Company	Client	1
7	June 23	The Norwegian Directorate of Public Construction and Property	Client	1
8	June 23	The Norwegian Defence Estates Agency	Client	1
9	August 23	The Norwegian Hospital Construction Agency	Client	1
10	July 23	Consulting company – Norconsult AS	Consultant	1
11	August 23	Consulting company – Norconsult AS	Consultant	1
12	October 23	Contractor – HENT AS	Contractor	1
13	October 23	Contractor – PEAB AS	Contractor	1
14	September 23	Contractor – Vedal AS	Contractor	1
15	November 23	Contractor Veidekke AS	Contractor	1
16	June 23	Consulting company – Sweco AS	Consultant	1
17	June 23	Consulting company – WSP	Consultant	1
18	August 23	Consulting company – Small Project administration company	Client	2
19	September 23	The Norwegian Contractors Association	Trade organization	1
20	September 23	The Norwegian Association of Heavy Equipment Contractors	Trade organization	2
21	November 23	Norwegian Association of Consulting Engineers	Trade organization	1

measurement parameters across studies further reduce the validity of direct numerical comparisons. Awareness of these issues is essential when comparing our results with results from other studies.

Results and analysis

Predictability of time

Initially, we aimed to assess how the DB contract format influences schedule predictability and the likelihood of on-time delivery by the DB contractor. 62 of the contracts in the dataset allowed us to compare the originally agreed-upon completion deadline with the actual completion date. It is crucial to be precise about data sources and reference points, as deadline extensions are often renegotiated during the construction phase for various reasons. Additionally, contracts may include multiple milestones and deadlines, such as the handover of parts of the project and the start of test periods.

Most data points were sourced from primary documents, including contracts, meeting minutes and protocols, while a few were obtained from self-reported data from project managers. It should be emphasized that this analysis focuses on the contractual agreements concerning the completion of contract works rather than the overall project deadlines. Table 5 presents descriptive statistics related to time.

Figure 5 illustrates the deviation from contract deadlines, measured in months from the originally agreed-upon dates. Positive values indicate delays, while negative values represent on-time or early completions ahead of the original contractual deadlines.

As Figure 5 shows, around half of the contracts (53%) experienced delayed completion compared to the initially agreed deadline. The average delay was two months. Figures 6 and 7 display the distribution of the results, differentiated by infrastructure and building contracts, respectively.

As Figure 6 shows, 73% of the infrastructure contracts in the sample were completed on or before the agreed deadline. The delays were up to 28 months. For building contracts in Figure 7, the situation was the opposite. Only 33% were completed on or before the agreed deadline, with delays of up to 15 months. However, 75% of the contracts experienced delays of less than 3 months.

At first glance, there appears to be a substantial difference in deviations between infrastructure and building contracts. To test for statistical significance, we performed a Welch two-sample t-test to compare the mean deviations between the two contract categories. The test indicated that the difference was significant ($p = .004$) when the extreme value of +28 was excluded. As the datasets could not be assumed to follow a normal distribution, we also conducted a Mann–Whitney U test. This test likewise indicated a statistically significant difference between infrastructure and building projects ($p < .001$), the extreme value included.

Table 5. Schedule predictability – descriptive statistics.

Sector	N	Min. (months)	Max (months)	Median (months)	Mean (months)	Standard deviation	Before or on time (%)	≤2 months delay (%)	≤3 months delay (%)
Infrastructure	22	−12	28	−2	0	8	73	77	77
Buildings	40	−2	15	2	3	3	33	53	75
Infrastructure + buildings	62	−12	28	1	2	6	47	61	76

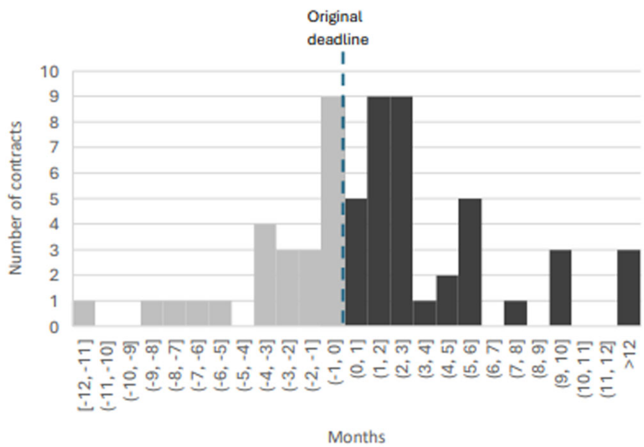

Figure 5. Deviation of the actual completion of contract work from the originally agreed deadline (N(infrastructure) = 22, N(buildings) = 40).

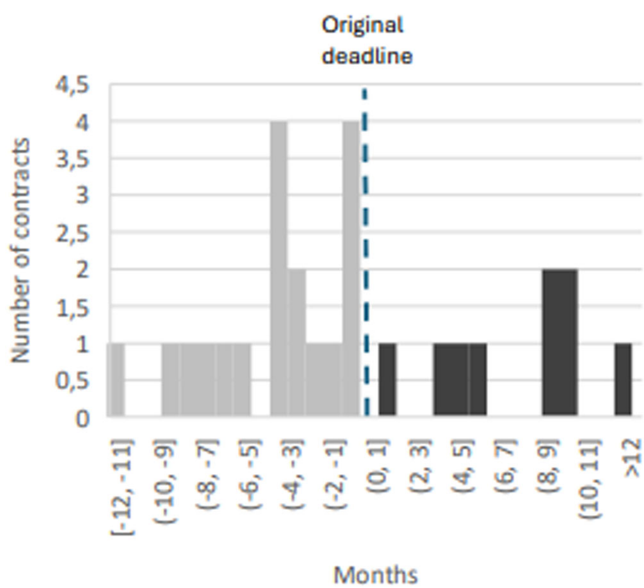

Figure 6. Deviation of the actual completion of infrastructure contracts from the originally agreed deadline ($N = 22$).

As the contracts in the sample varied substantially in size, we also examined whether time deviations were associated with contract size and with the number of changes relative to contract value (measured as the number of individual change orders per 10 million USD of contract value). No statistically significant correlations were found ($r = -0.077$, $p = .555$; $r = 0.094$, $p = .480$).

Since three out of four infrastructure contracts were completed on or before the initially agreed-upon deadline, time predictability for these contracts appears good. However, the results show considerable variation, with completion times ranging from one year ahead of schedule to over two years of delay. For building contracts, delays of 1–3 months were relatively common. Few were completed on time, but the overall variation was smaller than for infrastructure contracts.

Through the interviews, we aimed to investigate whether, why and how DB contracts could contribute to more predictable progress. The following points were highlighted by the interviewees as reasons why DB contracts may be beneficial:

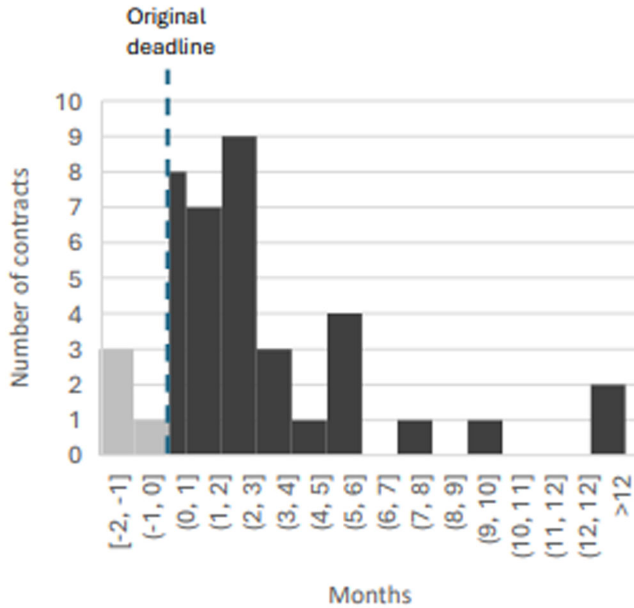

Figure 7. Deviation of the actual completion of building construction contracts about the originally agreed deadline ($N = 40$).

- Simplified planning and follow-up: By entrusting design, production planning and construction work to a single party, the risks associated with organizational interfaces are reduced.
- Greater expertise in production management: DB contractors typically have more experience and knowledge in planning and managing production than clients, leading to more realistic and robust progress plans.
- Stronger incentive structures: DB contracts are often well-suited to compensation models encouraging faster progress and timely completion.
- Parallel design and construction: DB contracts facilitate simultaneous design and construction, saving time and enabling more efficient resource utilization.

(Note that the points represent a synthesis of the interviewees' statements, not the authors' analysis.)

Most respondents agreed that DB contracts could enhance efficiency and improve the predictability of progress when used correctly, though opinions varied in the extent of these benefits. However, some contractors expressed frustration that the DB contract format was often misused or applied with the intent to shift all risks from clients to contractors, creating an illusion of predictability and control. Interviewees from all sides, including the client, consultant and contractor, emphasized that to fully leverage the contractor's expertise and realize the benefits of the DB format, the contractor must have the flexibility to plan, manage and optimize the production process and utilize its resources effectively.

Predictability of costs

The dataset included 103 contracts, from which we could extract and analyse data on cost development and change orders initiated from both the client and contractor. The volume of change orders was calculated as a percentage of the initial contract sum, adjusted as described in the section Collection of quantitative data. Table 6 presents descriptive statistics on contract changes.

Figure 8 illustrates the distribution of volume of change orders in contracts, expressed as a percentage of the original contract sum, in 5% intervals.

The average volume of change orders across the entire dataset was 14%, with a median of 10%. About half of the sample had a change volume of 10% or less; approximately 80% fell within a 20% range.

Table 6. Descriptive statistics for change orders in the dataset.

		N	Min.	Max	Median	Mean	Standard deviation (%)	≤10% change v olume (%)	≤20% change volume (%)
Infrastructure	Contract amount	27	$0,7 mill.	$332 mill.	$60 mill.	$109 mill.			
	Change orders/ contract sum	27	0%	46%	12%	13%	10	48	78
Buildings	Contract amount		$0.5 mill.	$45 mill.	$6 mill.	$10 mill.			
	Change orders/ contract sum	76	3%	72%	10%	14%	11	50	82
Infrastructure + buildings	Contract amount	103	$0,5 mill.	$332 mill.	$8 mill.	$36 mill.			
	Change orders/ contract sum	103	0%	72%	10%	14%	10	50	81

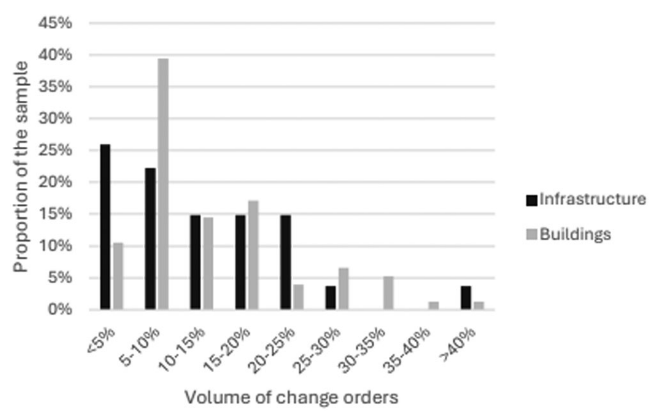

Figure 8. Volume of change orders in percent of contract amount.

There were slight differences between infrastructure and building contracts. Infrastructure contracts had a median change volume of 12%, while building contracts had a slightly lower volume of 10%. This is clearly shown in the bar chart, where 40% of building contracts had a change volume between 5% and 10%. The change volume was more evenly distributed for infrastructure contracts, ranging from 0% to 20%. The differences in standard deviation between the two sectors were minimal (0.9%). For the total change volume, no statistically significant difference was found between infrastructure and building contracts (Mann–Whitney *U* test, $p = .656$; Welch *t*-test, $p = .588$). Similarly, no statistically significant correlation was found between change volume and contract size ($r = -0.034$, $p = .744$). However, representativeness is a concern, as the sample size for contracts valued at 30 million USD or more is small.

As an additional measure, we recorded the number of independent change requests, regardless of their size or the outcome of the settlement between the parties. The data are summarized in Table 7, which expresses the number of change requests per 10 million USD.

The data indicate a statistically significantly higher number of change requests in building construction contracts than in infrastructure contracts (Mann–Whitney *U* test/Welch *t*-test, $p < .001$).

Furthermore, a statistically significant, moderate negative correlation was found between the relative number of individual change orders and contract size for both infrastructure contracts ($r = -0.489$, $p = .011$) and building contracts ($r = -0.434$, $p < .001$). This suggests that the number of individual change orders relative to contract value decreases as contract size increases. One possible, but speculative, explanation is that larger contracts are based on more thoroughly developed documentation, potentially resulting in fewer changes, although alternative explanations may also apply. Regardless, the observed number of changes indicates a substantial need for resources devoted to follow-up and change management for both small and large contracts, even though this need does not scale proportionally with contract value.

A detailed and systematic analysis of the reasons behind the changes was beyond the scope of this study. However, during the review and categorization process of quantitative data, as well as discussions

Table 7. Number of change requests per 10 million USD contract value.

Sector	*N*	Min.	Max	Median	Mean	Standard deviation
Infrastructure	26	2	216	10	35	50
Buildings	76	2	327	75	100	69
Infrastructure + buildings	102	2	327	62	83	71

of the underlying causes in the interviews, we gained a general understanding of the main drivers of contract changes. The primary causes of changes were:

- errors, deficiencies and ambiguities in the contract work descriptions
- inadequate contract prerequisites for completion
- modifications or additions to the deliveries initiated by the client

These factors are commonly associated with contract changes (Welde and Dahl 2021). However, the last bullet point illustrates that the issue of changes extends beyond the quality of the tender documents and contracts; it also involves the project owner's ability to articulate their actual needs before the contract is finalized.

The interviewees had differing opinions on whether DB contracts enhance cost predictability. Some respondents argued that DBB contracts could offer greater predictability, partly because they are based on a more mature design at the time of contract signing compared to DB contracts. Factors such as complexity, pricing format, contract type and whether the project involved infrastructure or buildings were all mentioned as having a greater impact on the predictability of the final contract cost than the project delivery method itself. Respondents from the contractor side clearly expressed that the uncritical risk transfer from the client to the contractor was a significant issue, increasing uncertainty for both parties. This is also due to the legal principle that unforeseeable and unquantifiable risks cannot be transferred to the contractor.

Predictable quality?

The quality of contract deliverables is a broad subject, encompassing everything from technical specifications to how the results meet the client's needs and goals. In DB contracts, contractors have the flexibility to select technical and functional solutions, provided they meet the client's requirements and remain within the contractual limitations. The interviews revealed the following key points regarding quality:

- In DB contracts, the contractor typically delivers the 'cheapest' solution unless otherwise specified. This results from the project delivery method's incentive structure and the competitive tendering process.
- The contractor primarily focuses on production and managing their own risks, which may not always align with the client's needs or the broader project goals.
- Giving the contractor sufficient flexibility is essential to realizing the potential benefits. While it is important to clearly define the desired quality in the tender documents, overly detailed descriptions in DB contracts can be counterproductive. DBB contracts may be a better alternative in such cases.

All respondents unanimously expressed that the incentive structures of DB contracts work with respect to quality. As one client put it: 'You get what you ask for, and never more, in a design–build contract'. The interviewees from the contractor side openly acknowledged that their primary focus is on their own economic interests, including risk management and production efficiency. Quote: 'We deliver according to the defined requirements, but nothing more. You get exactly what is specified, down to the minimum'. The clients were clear on this and stated that if achieving a specific, predictable level of quality is essential, the client organization must clearly define its needs and requirements and ensure proper follow-up and control.

Discussion

As shown in Table 1, findings on the predictability of time and cost in previous studies comparing DB with other project delivery methods vary considerably. Most studies report fewer delays in DB contracts, while results on cost are more mixed.

However, it is important to note that the numerical basis in the reviewed literature varies substantially, likely reflecting differences in what has been measured and in the contexts in which the studies were conducted. Project delivery practices differ across sectors, industries and countries, including variations in the level of detail in contract documentation, procurement processes, management approaches and pricing formats. In addition, terminology may be used differently and both the timing and measurement methods may vary across studies. As a result, comparing quantitative results across studies is challenging and not always meaningful.

Although this study does not compare DB and DBB or other project delivery methods, the results provide a clear indication of what to expect from the DB model in terms of predictability. We observe a statistically significant difference between infrastructure and building construction contracts. Infrastructure contracts are more likely to be completed on time (75%), although with significant variance. In contrast, building contracts often experience delays (with a 75% likelihood), although these are generally minor and some may be considered negligible. From the practitioner's perspective, time predictability can be regarded as adequate in both sectors: infrastructure contracts are typically completed on time, while progress in building contracts is predictable, albeit with a slight delay anticipated.

Previous studies have argued that DB contracts include mechanisms that enhance predictability and efficiency in project execution. Our respondents identified the same factors when discussing the advantages of DB contracts in this context. Key factors include the ability to conduct design and production in parallel, as noted by Chen et al. (2016), greater flexibility for contractors to propose simpler and faster technical solutions based on experience, reducing the risk of delays, as argued by Ibbs et al. (2003) and improved project processes and communication due to fewer organizational interfaces, as highlighted by Songer and Molenaar (1996). Unlocking the potential of the DB contract in terms of schedule reliability requires granting the contractor sufficient freedom and flexibility to plan and manage production without unnecessary restrictions or overly tight client-imposed deadlines.

Regarding cost predictability, the data on cost trends indicate that DB contracts are prone to a substantial volume of change orders; on average, 14% across our sample. This figure is significantly higher than comparable estimates from previous US studies, which range from approximately 2% (Konchar and Sanvido 1998; Hale et al. 2009) to 7% (Chen et al. 2016). As noted above, there may be many reasons for these differences, and without more contextual information, it makes little sense to compare the figures directly. Nevertheless, it is interesting that the use of what appears to be the same project delivery method can produce such different results. This may indicate that the way the method is applied is decisive, rather than the method itself. The standard deviation in our dataset was 10%. Whether these results indicate acceptable cost predictability depends on tolerance for deviations and the ability to allocate contingency reserves effectively.

Although many interviewees in this study generally perceived DB contracts as more predictable than DBB contracts, neither the data from this study nor previous research provides a definitive conclusion. Comparing data from DB and other project delivery methods poses significant challenges for several reasons. First, the counterfactual problem complicates analysis; project delivery methods are not randomly selected, making it challenging to ensure valid data comparisons between DB and other project delivery methods. Second, DB contracts have a different cost structure, encompassing additional costs, such as design and site management, as well as higher risk premiums. Finally, the potential benefits of cost and time predictability must also be balanced against the quality.

The primary causes of the change orders were the 'usual suspects': errors and deficiencies in the contract description and prerequisites, as well as client-initiated demands for modifications or additional functionality. This highlights that transferring all risk to the contractor is neither practical nor desirable. Another key takeaway when discussing project delivery methods and project governance is the inherent difficulty clients/owners face in fully specifying their needs at the outset of the contracting process. To ensure proper quality in terms of functionality, clients often need to initiate changes, which must be accounted for in cost estimates, budgets and contractual mechanisms.

However, the implications extend beyond change management, raising broader questions about achieving the right quality. As noted at the outset of this article, the choice of project delivery method concerns how the project is organized, including who is best positioned to manage the design processes. If the project owner/client requires detailed control over the design, a model that offers a high degree of control should be chosen. This is also a question of incentives embedded in the DB model. It is well known that the goals and interests of contractors often diverge from those of clients in contract relationships. As stated in the interviews, clients may receive the 'cheapest' available solution, which may not meet their desired quality standards. However, attempting to counter this by detailing every aspect of contract deliverables is ineffective. It is worth noting that this concerns not only technical aspects, but also the extent to which the project outcome meets the client's explicit and implicit needs ('fitness for use' ref. Juran (1999)). Consequently, it is essential to recognize and carefully consider the differences in client/owner and contractor objectives when selecting a project delivery method, including the incentive mechanisms for quality. As our results indicate, managing the quality of delivered outcomes can be challenging, making it essential to carefully consider the trade-offs associated with the chosen project delivery method.

Conclusions

Evaluating predictability: conclusions related to the research questions

Our data indicates that infrastructure DB contracts generally demonstrate good time predictability, with nearly 75% completed on or before schedule. However, the data show substantial variance, with actual completion times ranging from one year early to more than two years late. In contrast, data from building contracts showed less overall variance but were more prone to modest delays. Delays of one to three months were relatively common, and only one-third of the contracts were completed on time. Thus, provided that a delay of around 1–3 months is accounted for, building DB contracts may also be considered to have acceptable predictability. The differences between infrastructure and building contracts were statistically significant. No correlation was found between contract size or contract changes and delays.

Regarding cost, the average volume of change orders across the dataset was 14%, with a median of 10%. Approximately half of the contracts had change volumes at or below 10%, and around 80% fell within a 20% range. The standard deviation was 10%. Whether this reflects sufficient cost predictability depends on the project owner's risk tolerance. However, the data indicates what to anticipate and plan for regarding financial reserves and contingencies. A statistically significant difference was found in the relative number of change orders between infrastructure and building contracts, with building contracts having on average more than three times as many changes. A moderate negative correlation was also found between contract size and the number of change orders.

Concerning quality, data from interviews with stakeholders, including contractors, clients and consultants, consistently suggested that the DB project delivery method creates incentives for contractors to minimize their own production costs, leading them to focus primarily on meeting the minimum requirements. Contractors in DB contracts tend to focus primarily on managing their own risk and streamlining production, rather than actively pursuing solutions that support the client's broader needs and project objectives.

Implications for the project owner

The choice of project delivery method is a strategic decision for the project owner that can significantly influence the efficiency of project delivery and the extent to which the outcomes align with the owner's goals and broader objectives. Predictability in contract outcomes is valuable, as it supports value optimization of the investment, facilitates project prioritization and reduces risk and the need for contingencies. The data and results of this study provide insights into what to expect in terms of time, cost and quality when using the DB project delivery method.

The study's findings highlight the impact on the project owner's project management organization and the resources required to manage design and production processes effectively. First, the high number of single, often minor, change requests recorded in our dataset warrants reflection. This may be more about efficiency than cost predictability. However, Songer and Molenaar (1996) identified reduced resource requirements for contract follow-up as one of the key reasons clients use the DB format. Our data indicate that substantial administrative resources are still required to manage changes.

The high volume of change orders also suggests that clients may struggle to clearly define their needs and desired functionality. Contractors acknowledge that investigating the client's or owner's needs and developing functional solutions, the core content of the delivery, is not their primary focus. Thus, project owners must take responsibility for their own business case. This underscores the need for resources on the owner/client side to oversee the design process, ensuring that technical solutions align with user needs and quality expectations. A practical governance function that reflects the project owner's priorities and perspectives is essential in this context.

In short, the DB contract model is not a tool to avoid involvement from the client side, neither in the design phase nor in the execution phase.

Further work

This study analyses and presents data from DB contracts in the public sector. The quantitative data is sourced from primary materials, ensuring highly reliable information from a substantial number of DB contracts. As such, the study contributes to understanding what can be expected when employing DB contracts in public construction projects.

Nevertheless, the ongoing debate among practitioners centres on whether to adopt various forms of DB contracts or other models, such as the traditional DBB approach. As previously noted, comparing the outcomes of the two delivery methods is challenging. However, such studies are not necessarily infeasible, and with careful consideration of the complexities and biases, meaningful insights could be provided to practitioners. A study that systematically compares DB and other project delivery methods on predictability, while thoughtfully addressing these challenges, would be a valuable avenue for further research in this field.

An interesting subject for further research is the investigation of the root causes of changes to DB contracts initiated by both the contractor and the client. More specifically, changes that stem from quality-related issues. Gaining a deeper understanding of the underlying causes of such changes in DB contracts, and of potential correlations and causal relationships, could help improve methods for organizing and managing projects at both the project and project-owner levels.

Author contributions

CRediT: **Torbjørn S. Aass**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing; **Morten Welde**: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision; **Atle Engebø**: Data curation, Formal analysis, Investigation, Methodology; **Haavard Haaskjold**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology.

Disclosure of use of generative artificial intelligence

Generative Artificial Intelligence tools were used solely for language enhancement. ChatGPT (version 5.1) was used to search for terms and synonyms, and Grammarly (Pro) was used for spelling and related checks.

Disclosure statement

The authors report there are no competing interests to declare.

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Data availability statement

Some or all data, models or code that support the findings of this study are available from the corresponding author upon reasonable request. This encompasses

- Data about time/progress on contract level (agreed-upon deadlines, actual completion, etc.)
- Cost data on contract level (awarded contract amount, adjusted contract amount with description of the adjustments, change order amount, number of change orders recorded, etc.)

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Appendix: Overview of the projects from which the quantitative contract data were derived

Category	Project name	Tender announced (appr)	Contract amount (mill. USD)
Road	E6 Helgeland Nord	2014	179
Road	E6 Helgeland Sør	2015	205
Road	Fv 1390 GSV Osloveien	2021	5
Road	Rv. 52 Utbedringsstrekning	2022	14
Road	RV 3/25 Løten Elverum	2017	300
Road	Rv36 Bø–Seljord	2019	16
Road	E134 Århus–Seljord	2021	7
Road	Rv. 5 Kjøsnesfjorden	2019	80
Road	E16-Kvamskleiva	2020	48
Road	E16 Eggemoen–Åsbygda	2018	58
Road	E16 Åsbygda–Olum	2019	136
Road	Fylkesvei 541 fra Sakseid til Hestaneset	2018	15
Road	Rv. 41/Rv. 451 Utbedringsstrekning Timenes-Kjevik, Bygge	2022	14
Road	Rv4 Roa–Gran grense	2020	80
Road	E6 Tvedestrand-Arendal	2016	319
Road	E6 Kolomoen-Arnkvern	2016	171
Road	E18 Rugtvedt-Dørdal	2016	171
Road	E6 Arnkvern-Moelv	2016	210
Rail	Ski stasjon	2016	318
Rail	Intercity Drammen – UDK bergtunnel	2019	192
Rail	Intercity Drammen – UDK løsmassetunnel	2019	183
Rail	Hensetting Støren	2021	10
Rail	Steinkjer	2020	7
Rail	Jaren stasjon	2020	2
Rail	Jaren stasjon	2021	27
Rail	Monsrud kryssingsspor	2020	13
Rail	Plattformforlengelser Valnesfjord	2012	1
Buidling	NHH Nybygg	2010	28
Buidling	UiB, Bergen museum	2012	22
Buidling	HiST, Teknologibygg	2014	45
Buidling	Framsenteret	2011	34
Buidling	NHH, hovedbygget	2017	40
Buidling	PMV Prosjekt MedieVolda	2018	15
Buidling	Agder fengsel Mandal	2017	16
Buidling	Agder fengsel Mandal	2017	19
Buidling	Agder fengsel, Froland	2017	31
Buidling	Agder fengsel, Froland	2017	22
Buidling	UiT Narvik, oppgradering og utvikling	2018	17
Buidling	Longyearbyen, boliger	2013	21
Buidling	Ørje-2	2011	6
Buidling	Arendal politistasjon	2013	13
Buidling	Høgskolen i Sørøst-Norge, Campus Ringerike	2016	14
Buidling	Oslo fengsel, avd. A takrehab.	2017	8
Buidling	UiS Sv.bygg med auditorium	2012	13
Buidling	SVV Steinkjer kontorsted	2013	11
Buidling	Politiets utl.enhet Trandum 3	2015	10
Buidling	NTNU, Ålesund ombygging 4. og 5. etg.	2017	2
Buidling	Campus Ås, SHF	2011	27
Buidling	Tønsberg akutt	2010	3
Buidling	Oslo Fengsel, Aktivitetsbygg	2011	8
Buidling	Svolvær politistasjon	2013	7
Buidling	Nytt politihus i Tromsø	2013	33
Buidling	Hedmark fengsel	2013	1
Buidling	Samiske VGS, Karasjok	2014	4
Buidling	Junkerdal tollsted	2014	5
Buidling	Nasjonalbiblioteket Automatlager 2	2015	4
Buidling	Norsk Helsearkiv Tynset	2016	11
Buidling	Nbsk garderobebygg	2016	5
Buidling	UiT, nybygg for lærerutdanning	2016	34
Buidling	UiS, nytt laboratoriebygg	2012	6
Buidling	DIFI statens hus, Leikanger	2012	4
Buidling	Statens vegvesen Ålesund, tilb.	2013	2
Buidling	SVV/Politiet Stord, Vabakken	2013	8
Buidling	HiT avd. Porsgrunn	2012	5
Buidling	Statens hus i Vadsø	2014	5
Buidling	Statens vegvesen, Leikanger	2013	12
Buidling	Sametinget tilbygg	2013	5
Buidling	UiN nye kontorarbeidsplasser	2013	3

(*continued*)

Appendix. Continued.

Category	Project name	Tender announced (appr)	Contract amount (mill. USD)
Buidling	NTNU Gjøvik N bygget	2016	15
Buidling	HiH Evenstad, nytt hybelbygg	2014	6
Buidling	Huseby kompetansesenter	2015	3
Buidling	Kontorbygg høgskolen i Halden	2016	3
Buidling	SVV Gol sambruksstasjon	2017	4
Buidling	Politiets utl.enhet Trandum 2	2012	5
Buidling	Drammen Tinghus, nybygg	2020	15
Buidling	Bjørgvin ungdomsenhet	2013	6
Buidling	Bodø fengsel, påbygg adm.fløy	2015	1
Buidling	Skien barne-og familiesenter	2011	1
Buidling	HSN, nytt studenthus	2016	3
Buidling	Eidsvoll Ungdomsenhet, fase2	2015	2
Buidling	HVL Bragebygget	2017	9
Buidling	UiS, tilbygg Hulda Garborgs Hus	2016	5
Buidling	UiS, besøkssenter	2016	3
Buidling	BUF Bergen akuttsenter	2018	4
Buidling	UiA, påbygg bygg F	2018	4
Buidling	UiA, påbygg bygg G	2018	3
Buidling	UiA, påbygg bygg J	2018	3
Buidling	BUF Ungdomshjem Larvik	2019	6
Buidling	BUF Ungdomshjem Kongsberg	2020	6
Buidling	UiA, mellombygg D og F	2018	1
Buidling	NORD, Universitet Bodø, forskningshall resirkulering	2016	1
Buidling	AHO, Arkitektur- og designhøgskolen i Oslo, ombygging	2017	3
Buidling	Justismuseet, restaurering og ombygging	2019	4
Buidling	Ullersmo fengsel, avd. Zulu	2020	2
Buidling	PBB Prosjekt Blått Bygg, NORD	2020	39
Buidling	Kirkenes politihus, ombygging	2018	1
Buidling	Eidsberg fengsel, bibliotek og vaskeri Trøgstad	2018	1
Buidling	Kongsvinger fengsel, 20 celler	2015	2
Buidling	Justisbygget i Kristiansand, utbedring av fasader	2016	2
Buidling	Søbstadveien 65, ombygging	2016	1
Buidling	Forsyningsbygg trinn 2	2019	12
Buidling	100444/100464 – Evenes–mannskaps- og befalsforlegning	2019	14
Buidling	Velferds-og idrettsbygg	2019	12
Buidling	Etablering av gang- og sykkelvei–Totalentreprise	2022	1
Buidling	100444/100464 – Evenes–mannskaps- og befalsforlegning	2019	6