Journal of Science and Technology in Civil Engineering, HUCE, 2026, 20 (2): 76–89

TARGET VALUE DESIGN AS A CONDITIONAL TOOL SYSTEM: HOW A3, CBA, AND BIM ENABLE VALUE-DRIVEN DECISION-MAKING IN CONSTRUCTION PROJECTS

Quan T. Nguyen[a,*], Juliana Brahim[b]

[a]*Faculty of Construction Economics and Management, Hanoi University of Civil Engineering, 55 Giai Phong road, Bach Mai ward, Hanoi, Vietnam*
[b]*Faculty of Built Environment, Universiti Teknologi MARA (UiTM), Shah Alam, Malaysia*

Article history:
Received 09/3/2026, Revised 21/5/2026, Accepted 04/6/2026

Abstract

Target Value Design (TVD) is increasingly adopted in construction projects as a means of aligning design decisions with cost and value objectives. However, existing studies largely focus on philosophical principles, contractual arrangements, or isolated tool applications, providing limited insight into how value-driven decisions are operationalised in practice. This gap contributes to the widely observed variation in TVD outcomes across projects, even when similar tools are formally applied. The paper argues that such variation cannot be adequately explained by differences in technical competence or Lean maturity alone. Instead, it conceptualises TVD as a conditional tool system whose effectiveness depends on the decision environments in which its tools are embedded. The study adopts an interpretive analytical review based on a structured corpus of International Group for Lean Construction (IGLC) publications (1996–2025), complemented by practitioner-oriented sources and documented project cases. It examines how core TVD tools - A3 reports, Choosing By Advantages (CBA), BIM-enabled dynamic cost modelling, and collaborative workshops supported by incentive mechanisms - function not as standalone techniques, but as an interdependent decision-support system. The analysis shows that these tools derive their value-generating capacity from mutual reinforcement across cognitive, analytical, technical, and behavioural dimensions of decision-making. When governance conditions support early multi-actor engagement, shared decision authority, and value-based justification, the tool system enables iterative learning and proactive management of value under cost constraints. Conversely, under constraining governance regimes, the same tools tend to degrade into symbolic or compliance-oriented practices. By reframing TVD from a set of methods to a governance-sensitive decision infrastructure, this paper contributes to construction management research by clarifying why TVD does not transfer easily across contexts and by providing a basis for more nuanced evaluation of its application in practice.

Keywords: target value design; decision-support tools; governance conditions; value-based decision-making; Lean construction; BIM-enabled cost modelling; collaborative decision-making; design-to-target.

https://doi.org/10.31814/stce.huce2026-20(2)-06

1. Introduction

Target Value Design (TVD) has attracted increasing attention in construction management research and practice as a response to persistent problems of cost overruns, design inefficiencies, and misalignment between client value and project outcomes. Closely associated with Lean Construction, TVD is commonly presented as an alternative to conventional delivery approaches through its emphasis on early collaboration, value orientation, and proactive cost steering [1, 2]. Consequently, TVD has been widely promoted in professional guidelines, policy discourses, and case-based reports, particularly in complex building and infrastructure projects. Despite this growing prominence, the

*Corresponding author. *E-mail address:* quannt@huce.edu.vn (Nguyen, Q. T.)

way TVD is conceptualised in much of the literature remains analytically ambiguous, particularly in relation to how it operates in practice.

TVD is frequently framed either as a management philosophy or as a holistic delivery model aligned with Integrated Project Delivery (IPD) or alliance contracting [3–5]. While such framings are valuable at a strategic level, they tend to obscure the operational mechanisms through which TVD actually shapes design and cost outcomes. As a result, TVD is often discussed in abstract terms, with limited analytical attention to how value-driven decisions are made, justified, and stabilised during the design process. Recent empirical work further reinforces this concern by highlighting the uneven and fragmented nature of TVD implementation across projects. Drawing on a maturity model of target value practices in the design phase, Ouma, Leicht [6] show that although TVD-related concepts are widely referenced, the processes through which performance targets are established, monitored, and adjusted are often weakly specified or inconsistently applied. Many projects operate at low levels of target value maturity, where value targets exist nominally but lack the procedural clarity, feedback loops, and learning mechanisms required to systematically guide design decisions. These findings challenge the assumption - implicit in parts of the literature - that early collaboration or contractual alignment alone is sufficient to deliver TVD outcomes [3, 4, 7]. The practical implications of this conceptual ambiguity are evident in the wide variation of reported TVD results. While some projects demonstrate significant cost savings, reduced rework, and improved stakeholder satisfaction, others report only marginal or symbolic benefits despite the formal adoption of Lean terminology or collaborative practices [4, 7]. These inconsistencies suggest that the success or failure of TVD cannot be explained solely by organisational intent or contractual form, but is closely related to how value is interpreted and operationalised in design decisions. From a value management perspective, value is created through decisions that balance functional performance, cost, and resource allocation [8, 9]. In contrast to conventional approaches such as design-to-cost, value engineering, and traditional cost control - which typically introduce cost considerations as constraints or corrective mechanisms - TVD embeds value–cost trade-offs within an iterative and decision-oriented process from the outset [1, 3–5]. However, existing studies tend to focus on high-level principles or governance arrangements, providing limited insight into the concrete mechanisms through which such value-based decisions are operationalised. An emerging pattern across academic and practitioner accounts is that TVD outcomes are highly sensitive to how decision-making is structured rather than merely to whether TVD principles are formally endorsed [4, 6, 7]. In practice, many projects selectively adopt elements associated with TVD - most commonly Building Information Modelling (BIM) or collaborative workshops - without establishing a coherent framework for value-based decision-making. Under such conditions, tools are often used in isolation or reduced to procedural functions, limiting their ability to shape design outcomes. This pattern is particularly evident in emerging and policy-driven construction contexts such as Vietnam, where Lean Construction and BIM have been increasingly promoted but are often embedded within governance regimes characterised by strong compliance orientation and fragmented decision authority [9–11]. Empirical studies indicate that tools are frequently applied for coordination and control purposes, with limited emphasis on value-based deliberation or shared decision-making [12, 13]. These observations further highlight the importance of examining how tools function within specific decision environments, rather than assuming their effectiveness as standalone techniques. Despite growing interest in TVD, a critical gap remains in understanding how decision-support tools contribute to the operationalisation of value-based decision-making. Existing studies have extensively examined TVD from philosophical, contractual, and organisational perspectives. However, limited attention has been given to the role of tools as constitutive elements

that actively shape how decisions are framed, compared, and stabilised in practice. In particular, the interaction between tools and the conditions under which they operate remains underexplored.

To address this gap, this study adopts an interpretive analytical review of TVD literature and documented project practices. The paper argues that TVD should therefore be understood neither primarily as a philosophy nor as a monolithic delivery model, but as a decision logic enacted through a system of tools. In this study, TVD is conceptualised as a conditional tool system that operationalises value-oriented decision logic under specific governance conditions. From this perspective, the defining feature of TVD lies not in early collaboration per se, but in the mechanisms through which value and cost considerations are embedded into design decisions through interacting tools. This study makes three main contributions to the construction management literature. First, it reconceptualises TVD as a tool-mediated decision system rather than a philosophy or delivery model, thereby shifting analytical focus to decision mechanisms. Second, it identifies and structures core TVD tools into an interdependent system spanning cognitive, analytical, technical, and behavioural dimensions. Third, it introduces the concept of governance-dependent tool performance, explaining why similar tools produce divergent outcomes across different project environments.

Accordingly, the study deliberately shifts analytical attention from governance arrangements to the internal logic of tool-based practice. Rather than asking whether TVD "works," the paper examines how value-driven decision-making is operationalised through specific tools and their interaction. The analysis addresses the following research question: "What are the core tools that operationalise TVD, and how do they jointly enable value-driven decision-making in construction projects?"

2. Target value design: from concept to tool-based practice

The literature presents TVD as a lean-inspired design-to-target method, yet also warns that practitioners may mistake it for conventional cost planning or value engineering because many construction practices already use similar terminology [4, 7, 14]. Recent studies further highlight growing interest in TVD implementation challenges and the need to better understand how its underlying mechanisms operate in practice.

2.1. TVD as philosophy, contract, and toolset

Early contributions to the TVD literature predominantly frame it as an extension of Lean philosophy, emphasising value generation, waste reduction, and collaborative culture [1, 3]. Within this view, TVD is understood primarily as a normative orientation that encourages early collaboration and shared commitment to client value. While this philosophical framing is important, it offers limited analytical leverage for explaining how value-oriented intentions are translated into concrete design and cost decisions.

A second stream of literature situates TVD within specific contractual or delivery arrangements, most notably Integrated Project Delivery (IPD) and alliance contracting. Here, TVD is treated as an organisational or governance configuration enabled by relational contracts, shared risk–reward mechanisms, and early involvement of key stakeholders [4]. However, empirical studies consistently indicate that contractual alignment alone does not guarantee value-driven decision-making, and that projects operating under similar contractual forms may exhibit widely divergent outcomes [2, 4, 15], reflecting the broader lack of consistent empirical evidence linking Lean-based approaches to measurable performance improvements. Recent implementation studies further suggest that governance alignment, while necessary, is insufficient without corresponding decision-support mechanisms that structure how value trade-offs are actually negotiated in practice.

A third and increasingly prominent framing presents TVD as a set of tools or techniques, including target costing, set-based design, A3 reports, CBA, and BIM-enabled cost modelling. In much of the

literature, these tools are introduced descriptively and often discussed in isolation, with limited analysis of how they interact or under what conditions they enable systematic value-based decisions [5, 16]. More recent research has begun to explore the role of specific tools in supporting collaboration and decision-making; however, these studies largely treat tools as secondary implementation elements rather than as central components of an integrated decision system.

These three framings - philosophical, contractual, and tool-based - capture important aspects of TVD but remain analytically incomplete. What is largely absent is a coherent explanation of how these elements combine to form a structured decision system capable of governing design choices under cost and value constraints.

2.2. Target value design as a decision logic

Conceptually, TVD can be understood as a decision logic that governs how choices are framed, compared, and revised throughout design development. Its core premise is that allowable cost and value targets should guide design evolution from the outset, rather than emerge as constraints imposed after design solutions are formed [3].

This logic rests on three interrelated premises. First, value must be explicitly defined and shared among project participants, encompassing functional performance, user outcomes, and lifecycle considerations rather than initial cost alone. Second, cost targets should be treated as design parameters that shape exploration, not as fixed thresholds that trigger corrective action. Third, decision-making should be iterative and collective, allowing alternatives to be compared and refined as new information becomes available. Together, these premises reconfigure design from a process of solution optimisation to one of continuous value negotiation under cost and performance constraints [14].

However, this decision logic should not be interpreted as a standalone conceptual construct. Instead, it is enacted through a coordinated set of decision-support tools that translate abstract principles into operational practices [4, 5].

This decision logic cannot be enacted through abstract principles alone. Empirical studies repeatedly show that projects often adopt the language of TVD while continuing to rely on conventional decision routines, particularly when structured mechanisms for early value–cost trade-off analysis are absent [14, 17]. Recent studies on TVD implementation maturity further confirm that the presence of value targets does not necessarily translate into effective decision-making unless supported by systematic feedback, coordination, and learning mechanisms [6]. This gap between rhetoric and practice highlights the need to conceptualise TVD not only as a decision logic, but as a tool-mediated system through which such logic becomes operational.

2.3. Tool infrastructure and decision support

From a tool-system perspective, TVD is more accurately understood as a system of interdependent tools that collectively enable value-driven decision-making under uncertainty. Rather than functioning as independent techniques, tools such as target costing, set-based design, structured evaluation frameworks, and BIM-enabled cost feedback operate together to make assumptions explicit, compare alternatives, and support learning across iterations [2].

Detailed descriptions of individual tools are well documented elsewhere and are therefore not repeated here. What matters analytically is not the presence of specific tools, but how they are configured and coordinated within a coherent decision infrastructure [2, 16]. When tools are adopted selectively or used outside their intended context [18] - for example, using BIM primarily for visualisation or conducting workshops without decision authority - the logic of TVD collapses back into conventional cost-control practice.

Recent maturity-based studies reinforce this interpretation of TVD as a tool system. Ouma, Leicht [6] show that TVD begins to influence design outcomes meaningfully only when projects develop coherent mechanisms for value planning, alignment, control, and organisational learning. Where these decision-support functions are weak or disconnected, TVD tools tend to operate symbolically rather than performatively. Similarly, recent research on BIM-enabled decision processes suggests that digital tools only contribute to value-based outcomes when integrated with explicit decision frameworks, rather than being used as standalone technical solutions [19].

2.4. Analytical implications

Reframing TVD as a conditional tool system has important implications for both research and practice. Rather than asking whether a project has "implemented TVD," analysis should focus on how decision-support tools are configured, how early decisions are structured, and how value and cost are negotiated over time [2, 20]. This analytical shift moves attention away from labels and towards the operational mechanisms that explain variation in outcomes across projects.

Conceptually, TVD does not compete directly with design-to-cost or value engineering as alternative techniques. Instead, it represents a distinct configuration of tools that embeds value exploration within the continuous governance of design decisions. Understanding TVD from this perspective provides a clearer foundation for analysing why partial or fragmented adoption often yields disappointing results, and why tool alignment with decision environments is critical.

In this study, this perspective is formalised by conceptualising TVD as a conditional tool system that operationalises value-oriented decision logic under specific governance conditions, thereby ensuring consistency with the positioning established in the Introduction.

3. Methodology and analytical approach

This study adopts an interpretive analytical review to examine how TVD is operationalised through a specific set of decision-support tools in construction projects. Rather than evaluating the quantitative performance of TVD implementations, the research focuses on understanding how tools function, how they interact, and how they collectively shape value-driven decision-making during project development.

3.1. Research design

The research design is grounded in an interpretive review of existing TVD literature and documented project practices. This approach is appropriate given that TVD is not a standardised method but an evolving socio-technical practice whose outcomes depend on how tools are configured and applied in context. Prior studies consistently report substantial variation in TVD outcomes even among projects that nominally adopt similar Lean principles, indicating that differences in operational mechanisms warrant closer analytical attention [6, 7].

Accordingly, the study does not seek causal attribution between TVD adoption and project performance indicators such as cost or schedule. Instead, it develops an analytical understanding of TVD as a conditional tool system, focusing on the internal logic through which value, cost, and design decisions are structured, negotiated, and stabilised over time [2, 3].

The objective of this review is not to provide exhaustive coverage of the literature, but to develop a mechanism-based understanding of how TVD operates through tool-mediated decision processes. The analysis therefore prioritises conceptual relevance and explanatory depth over completeness.

3.2. Data sources

The analysis draws on three complementary sources of qualitative evidence selected to capture both the conceptual articulation of TVD and its operational enactment through specific tools. First, peer-reviewed academic literature on TVD and Lean construction was reviewed, with emphasis on studies that explicitly describe decision processes, design iterations, and collaborative practices [3, 7]. Second, practitioner-oriented materials produced by the Lean Construction Institute (LCI) and affiliated organisations were examined to clarify intended tool functions and implementation [2]. Third, documented project cases reported in the literature were used as illustrative evidence of tool use in the practice [4].

The core analytical corpus was constructed from the proceedings of the International Group for Lean Construction (IGLC) (1996–2025) (https://iglc.net/Papers), which represent the primary academic venue for Lean Construction research. All available papers were exported in RIS format from the IGLC database and organised into a structured EndNote library to support systematic filtering and review. This corpus provides a longitudinal and domain-specific basis for tracing the development of TVD concepts and associated practices.

Literature identification was conducted through keyword-based filtering within this corpus. The primary search strings included "Target Value Design", "TVD", and "Target-Value-Design", yielding approximately 45 relevant publications. Additional keyword groups were applied to support tool-specific analysis, including "Choosing By Advantages" (41 results) and "Building Information Modelling/BIM" (151 results). These searches were iteratively refined, with priority given to more recent publications and foundational contributions, followed by broader reading where necessary to clarify specific mechanisms or tool applications.

In addition to keyword-based filtering, a targeted author-focused search strategy was employed to extend the analytical corpus. Key authors identified through foundational and recurrent contributions in the IGLC dataset were further traced across other publication outlets, including peer-reviewed journals and international conferences. Particular attention was given to studies that represent extended or refined versions of earlier conference papers, especially those published in high-ranking journals such as Construction Management and Economics and related outlets, as well as relevant academic books, doctoral dissertations.

This process allowed the study to capture the evolution of core concepts and tools beyond the IGLC corpus, ensuring that influential contributions that have been further developed or validated in broader academic contexts are incorporated into the analysis. Rather than expanding the dataset indiscriminately, this step was used selectively to deepen understanding of key mechanisms and to triangulate interpretations derived from the primary corpus.

To strengthen the practical grounding of the analysis, supplementary searches were conducted using Google, with particular attention to practitioner-focused materials. Priority was given to sources published by the Lean Construction Institute (LCI) and affiliated organisations, as these provide detailed descriptions of tool implementation, intended use, and decision logic in practice. These materials were used selectively to complement the academic corpus, especially where operational details of tools are not fully elaborated in journal or conference publications.

The identification of foundational literature was guided by three criteria: (1) concept-defining role, referring to contributions that introduce or formalise key principles of TVD; (2) recurrence across the corpus, indicating their role as intellectual anchors; and (3) methodological influence, reflecting their impact on how subsequent studies conceptualise decision-making, collaboration, and cost–value iteration.

Building on this foundation, the selection of tools followed a second-stage screening process. All tools mentioned in the corpus were first catalogued and then filtered based on (1) functional relevance to decision-making (i.e., direct influence on design or cost decisions) and (2) empirical presence (documented application in project contexts). The resulting set of tools is not exhaustive but functionally representative of the core dimensions of TVD decision-making.

Following this process, four tools were identified as functionally central to TVD implementation: A3 reports, Choosing By Advantages (CBA), BIM-enabled cost modelling, and collaborative workshops supported by incentive mechanisms. These tools form the analytical focus of Section 4.

These sources enable triangulation between conceptual arguments, prescribed tool functions, and observed practices, supporting an integrated analysis of TVD as a tool-mediated decision system.

3.3. Analytical strategy

The analysis proceeded in three main stages: (1) tool identification, (2) functional coding, and (3) system synthesis.

First, recurrent tools associated with TVD implementation were identified across academic and practitioner sources. Tools were considered recurrent where they appeared consistently in descriptions of TVD practice, indicating functional relevance to decision-making processes [4, 5]. Second, each tool was analysed in terms of its dominant decision function and the type of uncertainty it addresses. The analysis focused on how tools support problem framing, alternative evaluation, cost feedback, and coordination among project participants, rather than on their technical features [2, 3]. Third, tools were grouped into four higher-level dimensions: cognitive, analytical, technical, and behavioural, based on their role in the decision system. These dimensions provide a consistent framework for analysing how different tools contribute to value-driven decision-making, and are used to structure the analysis in Section 4.

The analytical process was iterative, moving from identification to abstraction and synthesis, with the aim of developing a coherent conceptual model rather than an exhaustive classification of tools.

The overall analytical process is illustrated in Fig. 1.

Figure 1. Research design and analytical process of the study

The figure provides a simplified overview of the sequence from literature selection to system-level synthesis.

4. Core tools of target value design

To address the research question regarding how core TVD tools jointly enable value-driven decision-making, this section analyses the principal tools through which TVD is operationalised in construction projects. Rather than treating TVD as a generic Lean philosophy, the analysis conceptualises it as a coordinated tool system - a set of interdependent decision-support instruments that structure how value, cost, and design choices are negotiated and stabilised over time. Consistent with the analytical framework developed in Section 3.3, these tools are examined in terms of their contribution to four interrelated dimensions of decision-making: cognitive, analytical, technical, and behavioural. While not exhaustive, the tools discussed here represent those most consistently reported across international TVD implementations and case-based studies [4, 5].

4.1. A3 reports: structuring value-based reasoning

The A3 report is a foundational cognitive tool in TVD, derived from Lean management practices, but adapted in construction projects to structure value-oriented decision-making rather than process control alone. In TVD, A3 reports frame design and cost problems as value problems, linking project objectives, constraints, alternatives, and consequences within a coherent visual logic [2, 3].

Rather than functioning as retrospective documentation, A3 reports function as decision artefacts that support collective sense-making among project participants. By making assumptions and trade-offs, they shift design discussions from implicit negotiation to structured reasoning based on shared value criteria [3, 5, 14, 16]. Empirical accounts suggest that this explicit articulation of trade-offs alters the nature of design conversations by shifting debates from positional bargaining to reasoned comparison grounded in shared value criteria [5, 14].

Within TVD practice, A3 reports play a critical role in sustaining iterative decision-making. By documenting unresolved alternatives and their value implications, they help prevent premature design convergence and enable learning across successive design cycles [2, 4, 14].

However, their effectiveness is conditional. When A3s are treated as compliance artefacts or formal approvals rather than shared boundary objects, their ability to support value exploration diminishes. In such cases, they tend to reinforce hierarchical decision-making rather than enabling collaborative reasoning [7]. This highlights that the contribution of A3 reports lies not in their format, but in the decision context and interaction patterns they are embedded within [2].

4.2. CBA: making value trade-offs explicit

CBA is a structured decision-making method that functions as a core analytical tool and is widely adopted in TVD to compare design alternatives based on their relative advantages rather than weighted scores or lowest cost criteria. Developed originally outside construction, CBA has gained prominence in Lean and TVD contexts because it aligns closely with the principle that value cannot be reduced to aggregate numerical scores. Within TVD, CBA functions as a structured mechanism for articulating and negotiating value judgments among project participants [4, 5, 16].

CBA separates the identification of value advantages from cost considerations, allowing teams to assess whether additional cost is justified by incremental value. This separation is central to TVD's decision logic, as it prevents cost considerations from prematurely dominating value discussions while maintaining financial discipline through explicit comparison with target costs [2, 3].

Within the tool system, CBA depends on prior definition of value criteria and on integration with other tools [5]. Without clear value framing (e.g., through A3) or cost feedback (e.g., through BIM), CBA risks becoming a formalised evaluation exercise detached from actual decision-making [14].

Accordingly, its effectiveness is conditional. When applied without alignment to decision authority or value objectives, CBA may reproduce conventional ranking practices rather than supporting value-based trade-offs [7]. This reinforces the broader argument that analytical tools contribute to value only when embedded within a coherent decision system [4].

4.3. BIM and dynamic cost modelling: enabling design-to-target loops

While A3 reports and CBA structure cognitive and comparative aspects of decision-making, BIM provides the technical infrastructure that enables TVD to function dynamically. In this context, BIM supports design-to-target loops by linking evolving design solutions with continuously updated cost information [3, 18, 19].

Rather than generating decisions, BIM functions as a feedback mechanism that makes the cost and performance implications of design choices visible and actionable, thereby enabling iterative exploration of alternatives while maintaining alignment with allowable cost targets [7, 19].

Within the tool system, BIM supports set-based design by enabling parallel evaluation of alternatives and preventing premature lock-in. By facilitating rapid iteration between design and cost feedback, it allows decisions to remain provisional during early design stages [3, 14].

However, BIM's contribution is highly dependent on integration. When used primarily for visualisation or coordination, its role in supporting value-based decision-making remains limited. Effective use requires reliable cost data, modelling standards, and organisational willingness to adapt design decisions based on feedback [7, 19]. This highlights BIM's conditional role as an enabling infrastructure rather than a standalone solution, whose value emerges only when connected to decision-making processes and aligned with other tools in the system [2].

4.4. Collaborative workshops and incentive mechanisms: organising behaviour for value delivery

Collaborative workshops and incentive mechanisms form the behavioural dimension of the TVD tool system. Workshops provide the setting in which A3 reasoning, CBA analysis, and BIM feedback are collectively interpreted and translated into decisions [2, 4].

These workshops function as decision arenas rather than coordination meetings. By enabling cross-disciplinary interaction, they support the development of shared understanding and collective ownership of value-based decisions [4, 5, 17].

Incentive mechanisms, such as painshare–gainshare arrangements, reinforce this process by aligning individual interests with project-level outcomes. They encourage participants to prioritise overall value rather than discipline-specific optimisation [4, 20].

Within the tool system, workshops and incentives act as behavioural enablers that sustain engagement with value-based decision processes over time [7]. Without such mechanisms, technical and analytical tools tend to operate in isolation [2, 3].

Their effectiveness is therefore conditional. In the absence of aligned incentives or decision authority, workshops become consultative rather than decision-oriented, and TVD tools risk being applied symbolically rather than substantively [7].

This reinforces the interdependent nature of the TVD tool system: behavioural mechanisms are essential for stabilising and activating the contributions of cognitive, analytical, and technical tools [2, 4].

5. Discussion: target value design as a conditional tool system

Building on the analysis of individual tools, this section synthesises findings to explain how the interaction of these tools enables or constrains value-driven decision-making in response to the research question.

The analysis of core TVD tools indicates that TVD should not be understood as a modular collection of techniques that can be selectively adopted. Rather, TVD operates as a conditional tool system whose effectiveness depends on the alignment between tools, decision logic, and the surrounding decision environment [2, 3]. This perspective provides a unifying explanation for the persistent gap between formal adoption of TVD tools and the uneven quality of value-driven decision-making observed in practice [2, 3, 7, 15].

This interpretation is consistent with empirical observations reported in healthcare and infrastructure projects, where TVD performance depends on the integration of tools within iterative and collaborative decision processes rather than on their isolated application [4, 7].

Recent maturity-based evidence further shows that TVD breakdowns are rarely caused by the absence of tools, but by underdeveloped mechanisms for alignment, feedback, and organisational learning [6]. Seen in this light, TVD failures reflect limitations of the decision system rather than shortcomings of individual techniques.

5.1. Beyond individual tools: interdependence and system effects

A central theoretical implication of this study is that TVD tools derive their effectiveness primarily from interdependence rather than from individual performance. A3 reports, CBA, BIM-enabled dynamic cost modelling, and collaborative workshops address distinct dimensions of decision-making - cognitive framing, comparative evaluation, technical feedback, and behavioural coordination - but none of these tools is sufficient on its own to sustain value-driven design under cost constraints [2, 5].

More specifically, the interaction between these tools follows a sequential and interdependent logic [2, 16]. A3 reports frame decision problems and articulate value criteria. CBA enables structured comparison of alternatives based on these criteria. BIM provides real-time feedback on the cost and performance implications of these alternatives. Collaborative workshops and incentive mechanisms then translate analytical outputs into collectively binding decisions. This sequence forms a continuous decision loop in which framing, evaluation, feedback, and commitment are iteratively aligned.

Empirical studies consistently show that partial or fragmented adoption leads to tool degradation [3–5, 18, 19]. BIM-based cost modelling without structured value reasoning tends to reproduce conventional design-first, cost-later workflows, albeit with greater computational efficiency [3, 19]. Similarly, workshops conducted without binding decision authority often devolve into consultative forums, where value discussions remain disconnected from cost commitments [4]. When such decoupling occurs, TVD tools are gradually repurposed to support familiar cost-reduction logics rather than sustained value exploration [5].

From a system perspective, failure occurs not because individual tools are absent, but because the interaction between them is disrupted. Without A3-based framing, value criteria remain implicit and unstable. Without CBA, trade-offs between alternatives become opaque. Without BIM-enabled feedback, design options cannot be evaluated dynamically against cost targets. Without organisational support through workshops and incentives, analytically sound decisions fail to translate into collective commitments.

These patterns reinforce that TVD tools function as a system of mutual reinforcement, in which weakening or removing one element destabilises the entire decision loop. This systemic perspective helps explain why projects that appear to "use the same tools" often exhibit markedly different outcomes.

5.2. Conditionality and decision environments

Understanding TVD as a conditional tool system helps explain why TVD does not transfer seamlessly across organisational and institutional contexts. Much of the existing TVD literature implicitly assumes that tools are context-neutral and that variations in outcomes can be attributed primarily to differences in Lean maturity or technical competence [7, 14, 17]. The analysis presented in this study challenges this assumption by demonstrating that TVD tools presuppose specific decision environments - namely, environments that allow deliberation over value, tolerate iterative decision-making, and allocate shared ownership of cost targets [2, 3].

Fig. 2 synthesises this conditionality by illustrating three key elements: (1) the central decision loop linking A3, CBA, BIM, and workshops; (2) the reinforcing interactions among these tools under supportive governance conditions; and (3) the decoupling of these interactions under constraining conditions.

In decision environments characterised by lowest-price procurement, compliance-oriented accountability, or fragmented design authority, TVD tools lose their decision-shaping capacity regardless of technical proficiency [4, 17, 18]. Under such constraining conditions - depicted on the right-

hand side of Fig. 2 - tools such as CBA and A3 reports tend to be reduced to formal documentation artefacts, while BIM-enabled cost models function primarily as visualisation or coordination platforms rather than as sources of real-time decision feedback [19].

Conversely, when governance conditions support early multi-actor engagement, shared decision authority, and acceptance of value-based justification - as shown on the left-hand side of Fig. 2 - the same set of tools operates as an integrated decision-support system. In these environments, cost targets function as generative design parameters rather than externally imposed constraints, and iterative feedback between framing, evaluation, and cost testing enables continuous learning and adjustment [2, 3].

More specifically, supportive decision environments include shared decision authority, early cross-disciplinary engagement, aligned incentive structures, and tolerance for iterative learning and revision. In contrast, constraining environments are characterised by fragmented authority, sequential approval processes, compliance-driven accountability, and the dominance of lowest-cost selection criteria. These conditions directly influence whether tool interactions remain active and reinforcing, or become decoupled and symbolic, thereby determining the extent to which value-driven decision-making can be sustained.

From this perspective, TVD does not "fail" because its tools are insufficiently robust, but because the decision environments required to activate them are institutionally constrained. Fig. 2 therefore positions TVD as a governance stress test: where deliberative, value-based, and collective decision-making cannot be sustained, the limitations of prevailing governance regimes become visible through the functional degradation of the TVD tool system.

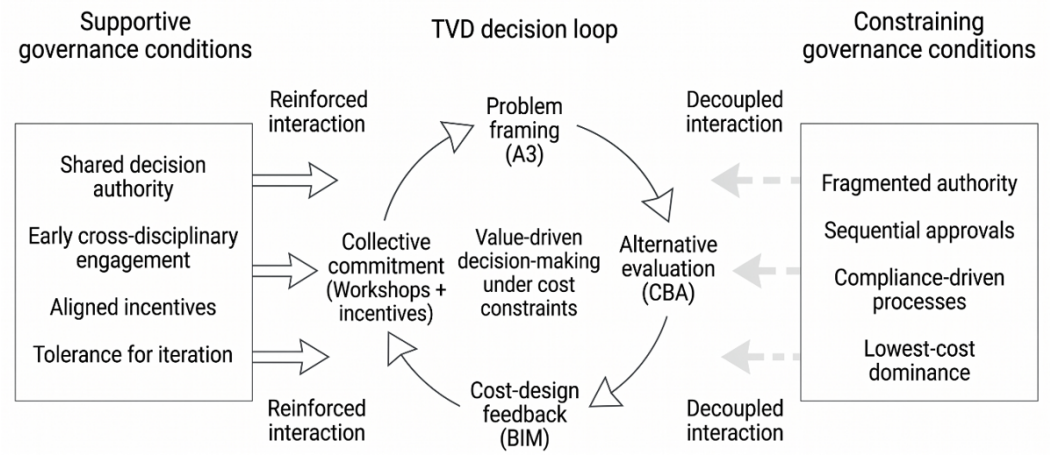

Figure 2. Target value design as a conditional tool system: interaction of decision-support tools under contrasting governance conditions

While the present study adopts a conceptual and interpretive approach, its analytical propositions are consistent with patterns observed in documented TVD implementations. Empirical studies in healthcare and infrastructure projects have reported that value-driven decision-making becomes effective only when tools such as A3, CBA, and BIM are used in an integrated and iterative manner, supported by shared decision authority and early stakeholder engagement [4, 7, 16].

Conversely, projects characterised by fragmented governance and compliance-driven processes tend to exhibit symbolic use of these tools, where BIM is reduced to coordination, workshops become consultative, and cost targets are externally imposed rather than collectively managed. These observations provide indicative empirical support for the argument that TVD performance depends

not on individual tools, but on their configuration within specific decision environments.

These observations provide indicative empirical support for the argument that TVD performance depends not on individual tools, but on their configuration within specific decision environments. They also reinforce the interpretation presented in Fig. 2, where the effectiveness of the decision loop is shown to depend on whether governance conditions sustain or disrupt the interaction among tools.

5.3. Reframing TVD contributions: from efficiency to decision governance

Conceptualising TVD as a conditional tool system fundamentally reframes its contribution to construction management theory. Rather than functioning primarily as a cost optimisation or efficiency-enhancing technique, TVD can be understood as a form of decision governance that restructures how value-related choices are negotiated, justified, and stabilised during design development [2, 3, 20].

This perspective shifts attention from performance outcomes to decision processes, highlighting how coordinated tool use enables learning-based, value-oriented decision cycles under cost constraints.

Through the coordinated use of tools such as A3 reports, CBA, and BIM-enabled cost feedback, TVD shifts attention away from defending individual design solutions toward collectively managing value trajectories over time [1, 19]. When governance conditions support shared decision authority and iterative deliberation, allowable cost operates as a generative design parameter rather than an externally imposed constraint [2].

At the same time, this reframing clarifies the limits of TVD. Where decision environments constrain deliberation, fragment authority, or prioritise rule-based compliance, TVD tools remain performative rather than operative, legitimising predetermined outcomes rather than shaping design reasoning [6, 7]. This perspective provides a more precise analytical basis for explaining variation in TVD outcomes across projects, beyond conventional explanations based on tools or contractual forms alone.

5.4. Implications for research and practice

Viewing TVD as a conditional tool system carries several implications for future research and practice. Empirical studies should move beyond evaluating isolated tools or correlating outcomes with single variables, and instead examine configurations of tools and the decision environments that enable or constrain their interaction [6, 7]. For practitioners, the findings highlight that partial or symbolic adoption of TVD tools is unlikely to produce meaningful value outcomes when decision authority, feedback mechanisms, and organisational learning capacity are not aligned. Rather than treating TVD as a transferable best practice, both researchers and project teams are encouraged to assess its feasibility as a governance technology whose scope and impact must be calibrated to context-specific decision conditions [2].

6. Conclusions

This study advances the understanding of TVD by conceptualising it as a conditional tool system, whose effectiveness depends on the alignment between tools, decision logic, and the surrounding decision environment [2, 3]. This conceptual reframing shifts attention away from questions of formal adoption toward the mechanisms through which value-oriented decisions are enacted and sustained during design.

From a theoretical perspective, the paper contributes to repositioning TVD within construction management research as a form of decision governance rather than a performance optimisation method. The findings demonstrate that TVD outcomes depend less on the presence of individual tools

than on their coordinated operation as a system [3, 7]. This mechanism-oriented view helps explain why projects that appear to adopt similar Lean practices often produce markedly different results.

Importantly, the findings indicate that TVD failures arise not from technical limitations of tools, but from misalignment between tool logic and decision environments. When deliberation, feedback, and organisational learning are constrained, TVD tools tend to become symbolic rather than operative [6, 15].

The study also highlights implications for future research. Evaluating TVD through isolated tools or outcome-based metrics risks obscuring the socio-technical mechanisms that shape its performance. Future research should focus on configurations of tools and the institutional conditions under which their interaction supports or undermines value-driven decision-making. In particular, the concept of institutional readiness - encompassing decision authority, feedback mechanisms, and learning capacity - offers a promising direction for explaining persistent implementation gaps [6, 15, 21].

This study is subject to several limitations. The analysis is based on interpretive synthesis rather than direct empirical investigation, which limits the ability to quantify the impact of specific tools on project performance. In addition, the study focuses on conceptual mechanisms and does not account for sector-specific or regional variations in TVD implementation.

From a practical perspective, the findings suggest that project teams should prioritise the alignment of tools, decision authority, and governance conditions rather than adopting individual TVD tools in isolation. Practitioners are encouraged to assess organisational readiness for iterative, value-based decision-making before implementing TVD-related practices.

Overall, the promise of TVD lies not in the wholesale transfer of Lean principles or advanced tools, but in the careful alignment between decision-support tools, value-oriented decision logic, and institutional capacity. Recognising TVD as a conditional socio-technical system reframes both its potential and its limits, shifting attention from rhetorical adoption toward the governance of decision-making under uncertainty.

Acknowledgment

The authors sincerely thank the editors and reviewers for their constructive comments and valuable suggestions, which greatly improved the quality of this manuscript.

The authors also acknowledge the use of artificial intelligence tools (including ChatGPT and Gemini) to support language editing and preliminary content checking, and the preparation of illustrative figures. All AI-assisted outputs were carefully reviewed and revised by the authors, who take full responsibility for the final content of the manuscript.

References

[1] Ballard, G. (2008). The lean project delivery system: An update. *Lean Construction Journal*, 2008:1–19.

[2] Tommelein, I., Ballard, G. (2016). Target Value Design Introduction, Framework, and Current Benchmark. Technical report, Project Production Systems Laboratory, University of California, Berkeley.

[3] Ballard, G. (2012). Target value design. In *DS 70: Proceedings of DESIGN 2012, the 12th International Design Conference*, Dubrovnik, Croatia, 11–22.

[4] Zimina, D., Ballard, G., Pasquire, C. (2012). Target value design: using collaboration and a lean approach to reduce construction cost. *Construction Management and Economics*, 30(5):383–398.

[5] Rybkowski, Z. K., Munankami, M., Shepley, M. M., Fernández-Solis, J. L. (2016). Development and Testing of a Lean Simulation to Illustrate Key Principles of Target Value Design: A First Run Study. In *24th Annual Conference of the International Group for Lean Construction*, Boston, Massachusetts, USA, 133–142.

[6] Ouma, L., Leicht, R., Messner, J. (2025). A Target Value Maturity Model for Performance Target Management in the Design Phase of Lean Construction Projects. In *Proceedings of the 33rd Annual Conference of the International Group for Lean Construction (IGLC 33)*, IGLC, Osaka and Kyoto, Japan, International Group for Lean Construction, 199–210.

[7] Rybkowski, Z. K., Arroyo, P., Parrish, K. (2022). Assessment of current target value design practices: consistencies and inconsistencies of application. *Construction Management and Economics*, 40(7-8): 598–617.

[8] Melo, L. A. P., Oliveira, C. B. F. d., Melo, R. S. S. d. (2022). Allocating scarce financial resources effectively through function analysis in social housing projects. *Built Environment Project and Asset Management*, 12(1):96–110.

[9] Miles, L. D. (2015). *Techniques of Value Analysis and Engineering*. Miles Value Foundation.

[10] Luan, P. H., Hoang, N. D. (2018). Applying lean construction in managing design & build (D&B) project in Vietnam by using building information modeling (BIM) and last planner system (LPS). *Journal of Construction, Ministry of Construction, Vietnam*, (6/2018):178–182. (in Vietnamese).

[11] Nguyen, T. Q., Thieu-Thi, T.-T., Vu, N.-N. (2021). BIM-based competitive advantages and competitive strategies for construction consultancy SMEs: a case study in Vietnam. *International Journal of Sustainable Construction Engineering and Technology*, 12(3):1–11.

[12] Khanh, H. D., Kim, S. Y. (2014). Identifying causes for waste factors in high-rise building projects: A survey in Vietnam. *KSCE Journal of Civil Engineering*, 18(4):865–874.

[13] Nguyen, B. N. (2021). Evaluating outlook for lean construction in Vietnam through a study on perception of waste. *VNUHCM Journal of Economics, Law and Management*, 5(2):1404–1415. (in Vietnamese).

[14] Miron, L. I. G., Kaushik, A., Koskela, L. (2015). Target Value Design: The Challenge of Value Generation. In *23rd Annual Conference of the International Group for Lean Construction*, Perth, Australia, 815–825.

[15] Asmone, A. S., Pal, A., Murguia, D., Rathnayake, A., Middleton, C. (2025). Where Is the Evidence of Performance Improvement in the Lean Construction Literature? In *Proceedings of the 33rd Annual Conference of the International Group for Lean Construction (IGLC 33)*, IGLC, Osaka and Kyoto, Japan, International Group for Lean Construction, 1–12.

[16] Arroyo, P., Rybkowski, Z., Tran, D., Lieb, C. (2025). Plan Validation in TVD: a Healthcare Case Study Project in California. In *Proceedings of the 33rd Annual Conference of the International Group for Lean Construction (IGLC 33)*, IGLC, Osaka and Kyoto, Japan, International Group for Lean Construction, 153–163.

[17] Aravena, B., Castañeda, K., Atencio, E., Herrera, R. F. (2025). Design Management in High-rise Building Projects in Chile. In *Proceedings of the 33rd Annual Conference of the International Group for Lean Construction (IGLC 33)*, IGLC, Osaka and Kyoto, Japan, International Group for Lean Construction, 294–305.

[18] Blancher, M., Florez-Perez, L., Murguia, D. (2025). The Adaptive Interoperability Journey: Navigating Fragmentation in Digital AEC Projects. In *Proceedings of the 33rd Annual Conference of the International Group for Lean Construction (IGLC 33)*, IGLC, Osaka and Kyoto, Japan, International Group for Lean Construction, 1428–1439.

[19] Sacks, R., Eastman, C., Lee, G., Teicholz, P. (2018). *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*. Wiley.

[20] Bøen, S. R., Drevland, F. (2025). Metrics in Integrated Concurrent Engineering (ICE): Insights, Challenges, and Opportunities. In *Proceedings of the 33rd Annual Conference of the International Group for Lean Construction (IGLC 33)*, IGLC, Osaka and Kyoto, Japan, International Group for Lean Construction, 270–281.

[21] Ballard, G. (2012). Should Project Budgets Be Based on Worth or Cost? In *20th Annual Conference of the International Group for Lean Construction*, San Diego, California, USA, 761–770.