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TARGET VALUE DELIVERY FOR RAILWAY INFRASTRUCTURE – A SEMI-SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Target Value Delivery (TVD) is a value-based project delivery approach originating from Lean Construction that integrates cost, value, and design decisions through early collaboration and target-driven processes. While TVD has been studied and applied in building projects, its applicability to railway infrastructure projects remains underexplored. Given persistent challenges related to cost overruns, uncertainty, and fragmented collaboration in railway project delivery, there is a need to examine whether TVD may be relevant in this context.

The purpose of this project is to assess TVD's potential relevance for railway infrastructure projects. The study is based on a semi-systematic literature review of journal articles and conference proceedings, identified through structured searches in Scopus and the International Group for Lean Construction (IGLC) database, supplemented by snowballing techniques.

The findings show that empirical applications of TVD are primarily documented within building projects, with no identified cases of formal TVD implementation in railway infrastructure. However, several challenges commonly reported in railway projects align closely with the problems TVD addresses. The study concludes that TVD shows conceptual potential for railway infrastructure projects and provides a foundation for further empirical research.

KEYWORDS

Target Value Delivery (TVD), lean construction, target costing, railway, infrastructure.

INTRODUCTION

Railway infrastructure projects are consistently associated with structural challenges such as cost overruns, maintenance backlog, and limited capacity in both network and rolling stock (Samferdselsdepartementet, 2016). While high costs can partly be explained by demanding topography and climate, they are also linked to project-specific requirements and solution choices (Leafhill AS, 2019). At the same time, railway projects are increasingly shaped by sustainability objectives. In Norway, the railway sector plays a central role in national climate strategies, particularly through ambitions to shift transport from road to rail (Samferdselsdepartementet, 2024). This places additional demands on infrastructure owners related to emission reduction, responsible supply chains, and sustainability reporting, increasing

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the complexity of early project phases where decisions on scope, cost, and technical solutions have long-term consequences (Bane NOR, 2025).

Public investment in railway infrastructure has increased significantly in recent decades and is expected to continue to grow. This development increases the pressure on public clients to improve cost control and delivery efficiency to ensure that limited resources generate the highest possible value. Although knowledge exists on how costs can be reduced without compromising value, there is a lack of motivation and organizational culture to consistently apply such knowledge in practice (Leafhill AS, 2019). Railway projects are also characterized by large scope and high complexity, making them particularly vulnerable to poor collaboration and coordination across disciplines and interfaces (Kurwi et al., 2022).

Value-based and Lean-oriented delivery approaches have gained attention in the construction industry as responses to recurring challenges such as cost overruns and inefficient early-phase decision-making. TVD represents one such approach, originating from Lean Construction and emphasizing the early integration of cost, value, and design decisions from the earliest project phases. In TVD, an allowable cost is defined based on client value, representing what the client is willing and able to pay, and design development is collaboratively steered toward a target cost within this constraint (Torp, 2019; Ballard & Morris, 2025). Through early collaboration, active stakeholder involvement, iterative design, and continuous cost-value steering, TVD aims to maximize project value within this cost constraint.

While empirical evidence from building projects demonstrates positive effects on cost and value outcomes, the applicability of TVD to infrastructure projects seems to be limited and not systematically documented. This gap in the literature motivates a systematic review of how TVD has been conceptualized and applied, and how its principles may be relevant to the specific characteristics of railway infrastructure projects.

The purpose of this project is to assess TVD's potential relevance for railway infrastructure projects through a semi-systematic literature review. The study focuses on reported implementation practices, challenges, and related approaches relevant to railway project characteristics. The findings are intended to support railway clients and project teams in making more informed decisions regarding cost management, collaboration strategies, and the potential adoption of value-based delivery approaches such as TVD. This leads to the two research questions: (1) how has TVD been conceptualized and applied in railway infrastructure projects? and (2) how do the characteristics and challenges of railway infrastructure projects influence the relevance of TVD as a project delivery approach?

METHODOLOGY

A semi-systematic literature review, based on the principles outlined by Snyder (2019), was conducted to identify research on TVD and its potential applicability to railway infrastructure projects. This approach aims to identify, evaluate, and synthesize research within emerging or fragmented fields, and is suited to research topics characterized by conceptual fragmentation and limited empirical evidence, as is the case for TVD in railway infrastructure projects. A literature review is therefore an appropriate method when empirical evidence is limited or lacking, as it allows for synthesis of existing knowledge, identification of conceptual alignment, and clarification of research gaps.

The primary databases used were Scopus and the IGLC database, selected due to their coverage of articles and Lean Construction conference proceedings. Google Scholar was explored during an initial scoping phase but excluded from the final search strategy due to low precision and a high number of non-relevant results.

An exploratory phase was first carried out using alternative search strings to assess database coverage, relevance, and the suitability of different keyword combinations to refine the final

search strategy. Based on this phase, Scopus was selected as the main database for structured searches due to its quality control and filtering capabilities.

Two structured searches were conducted in Scopus, limited to publications from 2015 onward. The first search targeted literature on TVD and was applied to titles, abstracts, and keywords using the following string: *("Target Value Design" OR "Target Value Delivery") AND NOT ("manufacturing" OR "estate")*.
The abbreviation TVD was excluded, as it generated many non-relevant results. Exclusion terms were applied to avoid literature outside the construction and infrastructure domain.

The second search aimed to identify literature related to infrastructure projects and complementary approaches relevant to the study and was applied to article titles using the following string: *("railway" OR "rail" OR "infrastructure") AND ("cost overrun" OR "early contractor involvement" OR "value engineering")*.
No combined search string including both TVD and railway or infrastructure was applied, as initial exploratory searches conducted during a literature identification phase indicated that such combinations yielded no relevant results.

As some of the Lean Construction research is published in conference proceedings rather than indexed journals, an additional search for *"Target Value Delivery"* was conducted directly in the IGLC database. In addition, snowballing techniques were applied (Wohlin, 2014), including backward reference checking and inclusion of recommended literature, to identify relevant publications not captured through database searches.

65 identified publications were compiled in a spreadsheet and systematically screened based on abstracts and conclusions. The review was limited to peer-reviewed articles and conference proceedings published in English or Norwegian. Initial screening was guided by titles indicating relevance to TVD and similar methods in infrastructure and building projects, while non-relevant studies were excluded. Duplicate records were identified and removed in Excel by comparing titles prior to screening.

Each study was categorized into one of four thematic groups: TVD, Infrastructure, Case studies, or Other methods, and assigned a relevance score from 1 (high relevance) to 3 (limited relevance). The screening and scoring were conducted by the first author. To ensure consistency, some studies were re-evaluated during the screening process to verify alignment in scoring and categorization. Short summaries were produced to support structured comparison across studies. The literature identification and screening process is summarized in Figure 1 using a PRISMA 2020 flow diagram, ensuring transparency and reproducibility of the review process.

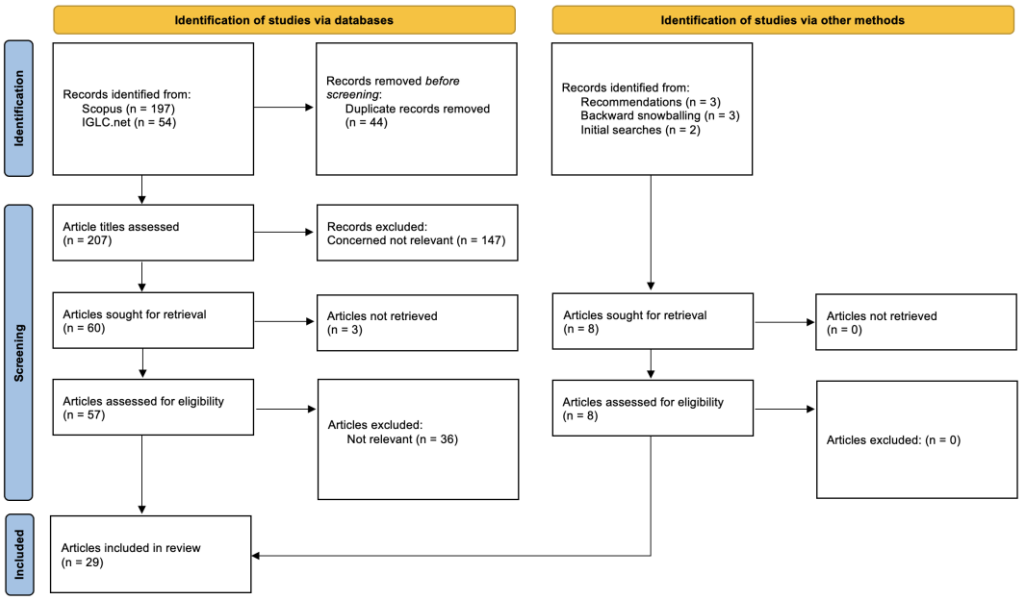

Figure 1: Flow diagram for literature review. Processed from PRISMA 2020 flow diagram, by Page, M. J. et al., 2020

Following the screening process, the included publications were analyzed through a qualitative synthesis. Studies assessed as highly relevant (score 1) were read in full and analyzed thematically in relation to the research questions. The analysis focused on identifying patterns relevant to TVD implementation, project characteristics, and delivery challenges. Findings were organized according to the thematic structure of the Results section, enabling comparison and synthesis across studies. Characteristics of railway infrastructure projects were identified inductively based on recurring descriptions in the reviewed literature and used to assess the relevance of TVD principles for the railway context.

RESULTS

This section presents the results of the literature review on TVD, focusing on how TVD is implemented in practice, its application in infrastructure projects, and insights from documented case studies. In addition, related project delivery approaches are reviewed to provide context for understanding TVD in complex railway project environments. The section concludes with a synthesis of the main findings.

IMPLEMENTATION OF TVD IN PRACTICE

The literature shows that TVD is implemented inconsistently across projects. An analysis of studies, practitioner surveys, and focus group discussions identifies five core elements of TVD: owner value, team organization, financial or contractual incentives, collaborative culture, and TVD-specific tools. While owner-defined value, integrated team organization, and collaboration are commonly emphasized, elements such as relational contracts, budget fluidity, financial incentives, and formal TVD tools are applied unevenly. Many projects described as TVD only implement selected elements, which contributes to variation in reported outcomes (Rybkowski et al., 2022).

A study from Ki & Alsaedi (2021) identifies factors influencing successful TVD implementation. Literature reviews and industry surveys consistently highlight early integration of project stakeholders, clear value definition by the owner, and process- and culture-related factors such as trust, communication, cooperation, and early involvement of project stakeholders as the most critical success factors. In contrast, external conditions such as market competition, project size, and social demand are found to be less influential. These findings

suggest that organizational integration and strong owner leadership in early project phases are more decisive for TVD success than project-specific or market-related factors.

APPLICATION OF TVD IN INFRASTRUCTURE PROJECTS

No documented railway projects applying TVD formally were identified. The literature addressing TVD in railway infrastructure projects is therefore limited and indirect. Insight can be drawn from studies of infrastructure projects more broadly, as well as from documented challenges related to cost estimation, decision-making, and organizational structures in railway project delivery.

A central finding in a government-commissioned review of major Norwegian road and rail projects concerns weaknesses in early-phase cost estimation and decision-making. The review shows that early cost estimates frequently underestimate uncertainty and rely on limited data and optimistic assumptions (Samferdselsdepartementet, 2016). The review emphasizes the need for clearer definition of project objectives and functional requirements, improved transparency in cost estimation, and stronger alignment between project scope and allowable cost. Although TVD is not explicitly addressed, these findings align closely with the cost and value logic underlying TVD. In railway projects, where early design decisions have long-term implications for cost, capacity, and system performance, this conceptual alignment is particularly relevant.

Kurwi et al. (2022) identified collaboration and information flow critical challenges in the design phase of railway projects. Their study shows that a lack of structured collaboration during design limits the availability of relevant information at the right time, increasing the risk of coordination problems in complex projects. Given the high number of technical interfaces and disciplinary dependencies in railway infrastructure, fragmented project organizations may represent a key barrier to applying value-driven approaches such as TVD.

Empirical studies from Norwegian infrastructure projects provide further insight into conditions relevant for TVD-related approaches. Experiences from projects delivered by Nye Veier, a state-owned company responsible for planning, delivering, and operating major road infrastructure projects in Norway, indicate that treating cost as an input rather than an outcome of design can contribute to improved cost control (Guttormsen & Larsen, 2021). This study further highlights early collaboration, trust, and shared project goals as prerequisites for success, while rigid regulations, limited experience data, and incentive structures encouraging cost underestimation are identified as barriers to the implementation of TVD and similar value-based and collaborative delivery approaches.

Contract strategy selection emerges as another relevant theme. A comparative study of large infrastructure projects in Northern Europe shows that contract strategies are often chosen based on tradition or local expertise rather than systematic analysis (Hosseini et al., 2017). Despite national differences, the literature indicates a general trend toward increased use of collaborative contract strategies in public infrastructure projects. Such contracts may provide organizational conditions supportive of TVD principles, even though TVD itself is not explicitly examined.

CASE-BASED FINDINGS

Although most documented TVD cases originate from building projects rather than railway infrastructure, they provide transferable insights into cost definition, target setting, and collaborative design processes relevant to complex railway projects.

A case study of a 35-story mixed-use residential building demonstrates how TVD can be applied during design and preconstruction, resulting in cost savings and improved coordination (Lazarte, 2025). The project followed a structured TVD framework based on early stakeholder collaboration, continuous cost tracking, and use of a BIM-based common data environment.

The findings highlight the importance of training, management support, and standardized digital systems for effective TVD implementation.

Torp emphasizes the importance of early target cost definition, showing through a study of two Norwegian public agencies that stochastic cost estimates can be used to establish allowable and market costs prior to detailed design, thereby improving transparency and early risk management (Torp, 2019). Another study of Norwegian infrastructure projects applying TVD-related principles finds that projects perform best when target costs are set approximately 12–20 % below the allowable cost. This margin provides room for design development and innovation while creating a buffer for managing risk and uncertainty during later project phases (Johansen et al., 2021). Misalignment between owner and contractor expectations, immature scope definition, or unrealistic early targets are shown to undermine the process.

Two case studies examine how TVD principles can be integrated into traditional bidding processes (Musa & Pasquire, 2020). Involving pre-qualified bidders in workshops and cost-target sessions increased transparency, supported innovation, and enabled more realistic early cost development. Reported outcomes include cost savings of up to 35%, reduced rework, and improved stakeholder satisfaction. However, the cases are based on relatively small projects in lowest-bid environments, limiting direct transferability to public megaprojects.

Public-sector application of TVD is illustrated by a case study of the University of California, San Francisco hospital project (de Melo et al., 2016). Despite restrictions on multiparty contracts, the project achieved significant cost savings through cross-functional teams, co-location, shared incentives, and a structured innovation process. The study suggests that strong project culture, shared goals, and training can partially compensate for contractual limitations in achieving TVD outcomes.

RELATED PROJECT DELIVERY APPROACHES

The literature identifies several project delivery approaches that address challenges similar to those addressed by TVD in railway infrastructure projects. While these approaches are not presented as TVD implementations, they emphasize organizational, contractual, and process-related aspects that support value-based and collaborative project delivery.

Early Contractor Involvement (ECI) is frequently highlighted as relevant for infrastructure projects (Memić et al., 2023). Studies show that early contractor participation can improve constructability, information quality, workflow, and integration of sustainability objectives (Ishtiaque et al., 2022; Wondimu et al., 2016). Empirical evidence from Norwegian projects indicates that ECI is most effective when contractors are involved early enough to influence design and planning, and when fair risk distribution, compensation, and trust are present (Wondimu et al., 2016).

Value-Driven Project Development (VPU), presented in the Norwegian guide Verdistyrt prosjektutvikling 2.0 (Metier, 2021), emphasizes value management throughout the project life cycle. VPU highlights early-phase decision-making, integrated teams, shared incentives, and strong owner competence, closely reflecting the core logic of TVD within a Norwegian public-sector context.

Value engineering is identified as a complementary approach. A case study from a large railway project shows how systematic analysis of cost drivers can generate significant savings without compromising performance (Kwok, 2009). Opportunity management is also shown to strengthen value creation, particularly when combined with TVD mechanisms that align incentives and reward innovation (Malvik et al., 2021).

Another study examines Lean Construction approaches applied in the pre-construction phase of transportation projects. Risk identification, interdisciplinary design reviews, and early collaboration are identified as critical processes influencing cost overruns. TVD and Integrated

Project Delivery are highlighted as suitable frameworks for strengthening these processes, supported by tools such as Last Planner System and BIM (Mirdha & Calahorra-Jimenez, 2025).

A theoretical study using game theory explains how shared incentives, transparency, and trust reduce opportunistic behavior and promote collaboration in TVD and related delivery models (Jung, 2012). These mechanisms help explain why collaborative approaches outperform traditional contracts in complex project environments.

SUMMARY OF FINDINGS

The findings from the literature review are organized into four main categories: implementation of TVD in practice, application of TVD in infrastructure projects, case-based findings, and related project delivery approaches. Together, these categories capture how TVD is described in the literature, the extent to which it has been applied in infrastructure contexts, and how related approaches address similar challenges.

Table 1 provides a structured summary of the key findings across these categories, highlighting both the characteristics of TVD implementation and the relevance of TVD principles in relation to challenges in railway infrastructure projects.

Table 1: Summary of key findings from the literature review

Result Category	Key Findings
Implementation of TVD in practice	TVD is implemented inconsistently, with core elements unevenly applied. Success is linked to early stakeholder integration, clear owner-defined value, and collaborative culture, while contractual and financial mechanisms are less consistently used.
Application of TVD in infrastructure projects	No formal TVD applications in railway projects were identified. Key challenges include weak early cost estimation, fragmented collaboration, and misalignment between scope and cost, while principles such as cost-as-input and early collaboration show conceptual alignment with TVD.
Case-based findings	Case studies (from building projects) show that TVD can improve cost control, coordination, and stakeholder alignment through early collaboration, target cost setting, and continuous cost tracking. Success depends on clear targets, aligned stakeholders, and strong organizational support, while transferability to railway projects remains uncertain.
Related project delivery approaches	Related approaches support TVD principles through early collaboration, integrated teams, and value-focused decision-making. These approaches improve constructability, cost control, and value creation, highlighting enabling conditions such as trust, shared incentives, and strong owner involvement.

DISCUSSION AND CONCLUSIONS

This study conducted a semi-systematic literature review to examine how TVD has been conceptualized and applied, with particular focus on its relevance for railway infrastructure

projects. The review shows that no identified studies explicitly document the application of TVD in railway projects. Existing empirical research is instead dominated by building and vertical construction projects. However, this literature provides important insights into implementation mechanisms and conditions that are relevant when considering the transferability of TVD to railway infrastructure.

Across the reviewed studies, TVD is consistently associated with improved cost control and value delivery when implemented in an integrated manner. Successful implementation is strongly linked to early and clear definition of project value, strong client leadership, early stakeholder involvement, and trust-based collaboration. At the same time, the literature highlights that TVD is frequently implemented only partially, with inconsistent use of contractual arrangements, incentive structures, and formal TVD tools. These findings suggest that TVD should be understood as a holistic delivery model rather than a standalone method, requiring alignment between organizational structures, incentives, and collaborative practices to realize its full potential.

Even though most empirical evidence comes from building projects, the reviewed literature suggests that several identified TVD success factors may be transferrable to railway infrastructure projects. Early owner-defined value, integrated team organization, and trust-based collaboration addresses challenges frequently reported in railway projects, including fragmented responsibilities, complex technical interfaces, and weak alignment between decisions and cost objectives.

Although no formal TVD applications were identified in railway projects, the literature indicates that several TVD-related principles are already present in infrastructure delivery practices more broadly. Experiences from infrastructure projects demonstrate that treating cost as a guiding input to design, combined with early collaboration and information sharing, can improve cost control and decision-making. This suggests an openness toward value-oriented and collaborative delivery approaches, and that TVD may represent a structured extension of practices that are already partially in use rather than a fundamentally new framework.

Railway infrastructure projects share important similarities with building projects but are typically characterized by larger scale, higher complexity, more interfaces, longer life cycles, and strong public and regulatory constraints. In this context, TVD principles appear relevant but require adaptation. Rather than enabling reduction of overall project scope, the literature suggests that the relevance of TVD in railway projects lies in supporting value-based trade-offs within a fixed and regulated system. This implies that the railway system itself may represent a primary unit of value delivery in TVD, where resources are allocated across technical solutions, quality levels, and performance dimensions to maximize overall project value within a given cost constraint. These characteristics also suggest that the successful application of TVD depends on conditions such as early stakeholder integration, organizational alignment, and flexibility in decision-making. In highly regulated or fragmented project environments, the implementation of TVD may be constrained and associated with increased risk.

Overall, the findings suggest that TVD has potential relevance for railway infrastructure projects, but that empirical evidence is currently lacking. The reviewed literature indicates conceptual alignment between TVD principles and challenges commonly reported in railway projects, particularly those related to cost control, early-phase decision-making, and coordination in complex project environments.

While conceptual alignment between TVD principles and known challenges in railway projects is strong, there is limited knowledge on how these principles can be systematically integrated into a consistent TVD framework for railway infrastructure. Future research should therefore focus on empirical case studies from railway projects to explore how TVD principles can be operationalized in practice, including how target costs can be established under high uncertainty and how value-based trade-offs can be managed within strongly regulated and

technically complex project systems. Such studies are necessary to move from conceptual relevance to demonstrated applicability and to assess whether TVD can contribute to improved cost control and value delivery in railway infrastructure projects. A possible next step would be to conduct pilot case studies in ongoing railway projects or structured expert panels with industry practitioners to evaluate the applicability and adaption of TVD principles in real project settings.

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