Check for updates

Journal of Engineering

WILEY

RESEARCH ARTICLE OPEN ACCESS

What Makes Road Projects Successful? Lessons From an Evaluation Synthesis of 14 Road Engineering Projects

Morten Welde | Atle Engebø | Gro Holst Volden

Department of Civil and Environmental Engineering, Norwegian University of Science and Technology (NTNU), Trondheim, Norway

Correspondence: Morten Welde (morten.welde@ntnu.no)

Received: 13 April 2026 | **Revised:** 27 July 2026 | **Accepted:** 3 August 2026

Academic Editor: Assed Naked Haddad

ABSTRACT

Road infrastructure projects are a core element of modern engineering systems, yet their realised performance frequently differs from expectations formed during planning and appraisal. Despite this, systematic ex post evaluation that supports learning in engineering practice remains limited. This paper presents a synthesis of 14 evaluations of major road projects in Norway, drawing on comprehensive ex post evaluations conducted using a standardised framework inspired by the OECD DAC criteria. Project success is assessed across multiple engineering-relevant dimensions, including cost, time and quality performance, tactical effectiveness and longer-term outcomes related to relevance, sustainability and benefit–cost efficiency. By analysing evaluation reports produced several years after project opening, the study provides empirical insight into how engineering design choices, uncertainty management, constructability and client competence influence both delivery performance and long-term infrastructure value. The results show that most projects achieved acceptable performance in terms of schedule, cost control and technical quality, reflecting the role of structured governance and probabilistic cost estimation. However, recurring challenges were identified, particularly underestimated geotechnical uncertainty, overambitious schedules and weakly formulated goals. Ex post benefit–cost results often differed markedly from ex ante estimates, highlighting the sensitivity of appraisals to modelling assumptions and demand forecasts. The paper demonstrates how systematic ex post evaluation can strengthen feedback loops between planning, design and delivery, thereby fostering a more robust and learning-oriented approach to road infrastructure engineering.

1 | Introduction

Governments invest substantial resources in planning and appraising road infrastructure projects, relying on forecasts and assumptions about costs, traffic and societal impacts. Yet these projections often prove inaccurate, and unforeseen consequences may emerge, creating a gap between expected and actual outcomes [1–4]. Ex post evaluations play a crucial role in assessing the extent of these deviations, improving forecasting and appraisal methods and providing accountability for the use of public resources. Equally important, they create opportunities for learning by identifying lessons from completed projects that can inform future planning, decision-making and project delivery. Despite this, systematic ex post evaluations remain rare in the transport sector, limiting opportunities to learn from completed projects and improve future planning [5–8]. As noted by Volden and Klakegg [9], project governance arrangements have traditionally placed greater emphasis on control and accountability than on systematic learning from completed projects, resulting in missed opportunities to improve future investments. Strengthening ex post evaluations is, therefore, essential to bridge the gap between appraisal and reality and to ensure infrastructure investments deliver real value.

The transport system plays a vital role in delivering goods and services, connecting people to workplaces and serving as a foundational element of welfare and economic value creation. The success of a transport investment is inherently multidimensional,

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

Copyright © 2026 Morten Welde et al. *Journal of Engineering* published by John Wiley & Sons Ltd.

encompassing aspects such as project management performance (e.g., adherence to time, cost and quality targets), user benefits, cost–benefit efficiency and broader strategic goals—including sustainability, equity and regional development. Although the literature acknowledges this multidimensional nature of project success [10–12], empirical studies that systematically assess transport projects across these dimensions remain scarce. This gap highlights the need for more comprehensive evaluations that go beyond traditional metrics to capture the full spectrum of a project's impact.

Nicolaisen and Driscoll [13] conducted a comparative review of ex post evaluation schemes implemented by national transport authorities in England, Scotland, France, Australia, New Zealand, Norway and the United States. They pointed out that most ex post evaluation schemes in the transport sector use three monetised criteria, construction costs, traffic forecasts and accident reductions, to compare predicted outcomes with actual results. Broader assessments of value for money and societal impact are rare. Their analysis revealed that while ex post evaluations are practised, there is considerable variation in the quality, coverage and comprehensiveness of these schemes. A key concern was the absence of standardised methodologies at the national level, which hampers cross-country comparability and limits the potential for shared learning. The authors also highlighted persistent challenges in data archiving and retrieval, even in countries with legal mandates and long-standing evaluation traditions. Furthermore, they emphasised that the treatment of counterfactual scenarios, such as the do-nothing or do-minimum options, remains unresolved, significantly affecting the accuracy of benefit–cost ratios (BCRs) and assessments of environmental and social impacts. Notably, only the United Kingdom and Norway included meta-analyses in their evaluation frameworks.

Admittedly, the extent of ex post evaluation in the transport sector is better than in many others. In Norway, the Norwegian Public Roads Administration (NPRA) has conducted annual ex post assessments of cost–benefit analyses (CBAs) since 2006 [14]. In the United Kingdom, National Highways conducts so-called POPE evaluations (post opening project evaluations) of major schemes 1 and 5 years after opening [15]. In addition, the Department for Transport (DfT) requires local authorities to evaluate road projects that have received government funding. In France, several so-called permanent observatories have been established to monitor major transport developments over time, concerning economic, social and environmental aspects. However, beyond this, there is little evaluation activity in the transport sector internationally [16].

This paper aims to enhance our understanding of public project success by presenting empirical data on the actual performance of road projects. We present the results of comprehensive evaluations of 14 road projects, all assessed using the same evaluation model. Comparing results across evaluations through evaluation synthesis can help validate findings and enhance the accountability, credibility and quality of evaluation processes. It can extract more general findings and increase the accuracy of results by combining smaller studies into larger, more robust analyses [17–19]. While evaluations of individual projects, such as those presented by Welde [20] and Mirhosseini et al. [21], may be useful for learning about specific projects, they often only provide fragmented insights. Evaluation syntheses using larger samples, on the other hand, can enable us to draw conclusions that are valid for the entire sector. The paper seeks to answer two main research questions:

1. How successful are road construction projects from a multifaceted perspective? (descriptive—the actual success of projects)
2. What are the most important lessons learned from ex post evaluations that can contribute to improving future projects? (explanatory and normative—how to improve project success)

By systematically synthesising ex post evaluations of major road engineering projects, this paper contributes to engineering practice by demonstrating how design decisions, risk management and constructability expertise influence not only delivery performance but also the long-term value of infrastructure. The paper is aimed at bridging the gap between appraisal and reality, highlighting discrepancies between ex ante appraisals and actual project outcomes. It promotes systematic ex post evaluation and demonstrates how such evaluations can generate generalisable insights. By presenting a multidimensional view of project success, the paper encourages road engineers and planners to move beyond narrow economic metrics. Ultimately, it aims to provide valuable knowledge to enhance the governance of transport projects, promote transparency and accountability, inform future transport policy through evidence-based insights and facilitate a shift from appraisal to learning.

The evaluations presented in the paper have been conducted under the auspices of the Concept Research Programme, which researches large government-funded projects in Norway. The evaluations were based on a common framework inspired by the OECD DAC (Development Assistance Committee) criteria [22, 23]. Using a common framework enables better comparability of results. Although the paper focuses on Norwegian road projects, many of the challenges and success factors identified are likely to be common across countries. Therefore, the lessons derived can inform international practice by highlighting the value of standardised evaluation frameworks, cross-case learning and stronger alignment between appraisal results and decision-making. Applying these principles globally can enhance transparency, accountability and the societal value of transport investments.

The paper proceeds as follows: Section 2 discusses the definition of project success and how evaluation can be tailored to measure different aspects of success, and we briefly present the evaluation framework. Section 3 presents the evaluations on which this paper is based. In Section 4, we present and compare the evaluation results. Finally, in Section 5, we discuss our findings.

2 | Exploring Project Success Through Ex Post Evaluation

2.1 | Previous Studies of Project Success

Early studies of project success primarily defined success in terms of the 'iron triangle' of time, cost and quality, focusing on delivery performance [10]. However, this narrow perspective

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

has been widely criticised as insufficient for capturing the full value of projects. De Wit [24] and Pinto and Slevin [25] distinguished between project management success and project success and showed that success is multidimensional and partly dependent on stakeholder perceptions. Baccarini [26] further structured success criteria using a logical framework, linking project inputs and outputs to higher level outcomes and goals.

Building on these early contributions, scholars have argued for a broader conceptualisation that includes benefits realisation, stakeholder satisfaction and strategic alignment [11, 27]. Recent contributions emphasise that success is not a single dimension but a multidimensional construct encompassing operational efficiency, effectiveness in meeting objectives, sustainability and societal impact [12, 28]. Bannerman [29] proposed a multilevel framework distinguishing between project, organisational and societal success, reinforcing the need for holistic evaluation. Today, there is a broad consensus that project success must be assessed across multiple dimensions to reflect both short-term delivery and long-term value creation. Recently, Zheng and Zwikael [30] combined a systematic literature review with two empirical studies to explore the link between short-term project management success and long-term project success. Their findings revealed that, although numerous studies address various dimensions of project performance, the literature still lacks a clear explanation of how short-term success translates into long-term outcomes and offers conflicting perspectives on this relationship. Addressing this gap, this paper argues that advancing the field requires more ex post project evaluations using frameworks that assess both dimensions of success.

The multidimensionality of success may be illustrated by the different perspectives of project stakeholders. The project manager is often primarily concerned with traditional short-term metrics. The funding party is typically most concerned with the net value or benefits to costs, whereas the users, who often bear none of the costs, primarily care about the benefits they can derive from the project. Other stakeholders may be more concerned with potential external impacts, positive and negative. Investing in transport projects can bring benefits such as reduced travel time and lower traffic accident rates. Still, it may also generate wider economic benefits that can support project appraisal. However, these impacts can be challenging to assess both ex ante and ex post [31, 32].

Cost performance is a 'hot topic' in the project management literature, particularly in the literature on transport project performance. The popular narrative has long been that most public projects fail. Oxford professor Bent Flyvbjerg introduced the term 'iron law of megaprojects' to highlight a common and concerning trend in large-scale projects: They consistently go over budget and schedule, yield fewer benefits than expected and do so repeatedly [33]. Although sometimes criticised [34, 35], there is solid empirical evidence that cost overruns have been a persistent problem in transport projects worldwide. Odeck [1] reviewed 48 studies worldwide and found that overruns, rather than underruns, were prevalent across all of them. The typical cost overrun was 34%. However, later studies from individual countries, using more homogeneous data and allowing for a more accurate assessment of causation, have yielded more positive results. Welde and Klakegg [36] found that the mean underrun in Norwegian major public projects was 4.4%, whereas Chapman [37, 38] and Zani and Adey [39] found modest overruns between 2% and 5% in England, Sweden and Switzerland. In a review of project performance across Norway, Sweden and Denmark, Chapman [40] observed that final costs ranged from 25% over budget to 15% under budget. This indicates more variability than the so-called iron law suggests.

While early notions of success focused on traditional success metrics, contemporary perspectives emphasise the broader purpose of projects and their ability to deliver long-term value for stakeholders and society [12, 41]. In transport economics, CBA remains the dominant appraisal method, yet it is often criticised for overlooking distributional effects, environmental objectives and dynamic behavioural responses [42, 43]. For instance, new roads may initially reduce travel times, but induced traffic can lead to congestion and urban sprawl, eroding these benefits over time. Moreover, transport investments may affect land-use patterns and travel behaviour in ways that are difficult to predict ex ante, with implications for regional development, settlement patterns and environmental sustainability. Such complexities highlight the need for evaluation frameworks that integrate traditional performance metrics with broader societal impacts to ensure a more holistic understanding of project success.

In an ideal world, CBA would encompass all relevant results, effects and impacts and social return criteria such as net present value (NPV) or BCR would provide an accurate measure of project success. If so, an ex post CBA would also capture the most relevant evaluation criteria. However, as Welde and Volden [6] argued, potential undesirable distributional impacts and outcomes that run counter to political aspirations may question the role of CBA as an appraisal tool. Furthermore, several studies have demonstrated that the outcomes of CBAs have had a limited impact on investment decisions [44–47]. For example, the Norwegian government's latest strategic transport plan for 2025–2036 proposed new projects with a combined net BCR of −0.37 [48], effectively ignoring appraisals that estimated social returns to be strongly negative. The Swedish experience is similar. In the national transport plan for 2022–2033, the selected road and rail investments had a combined net BCR of −0.4 [49]. In short, while CBA is well regarded by many academics, its limited impact on decision-making makes it less relevant as an ex post evaluation tool.

While the literature increasingly recognises project success as a multidimensional construct, many empirical studies still rely on ex ante assessments or delivery-oriented indicators. Assessing whether projects ultimately achieve their intended results and longer term societal objectives requires ex post evaluation. Ex post evaluation therefore provides an important means of operationalising and measuring the multiple dimensions of project success identified in the literature.

2.2 | Ex Post Evaluation of Transport Projects

While many studies of project success are conceptual or rely on ex ante or at-completion assessments, a smaller but important strand of the literature focuses on ex post evaluations of public

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/jet/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

investment projects. Ex post evaluation has emerged as a critical tool for assessing these multiple dimensions of success after project completion. Unlike ex ante appraisal, which relies on forecasts and assumptions, ex post evaluation examines actual outcomes and impacts, enabling a more realistic understanding of project performance. Hirschman's classic study of World Bank–funded development projects demonstrated how actual outcomes, side effects and learning processes often diverge from ex ante expectations [50]. Building on this tradition, modern evaluation frameworks, such as those endorsed by the OECD DAC [23], explicitly incorporate criteria beyond efficiency and effectiveness, including relevance, sustainability and broader societal impacts. This approach aligns with the growing recognition that infrastructure projects should be judged not only by their delivery performance but also by their contribution to strategic objectives and long-term value creation [7, 41]. In the transport sector, international reviews have highlighted the lack of systematic ex post evaluations as a 'weak link' in infrastructure governance [13, 16], underscoring the need for robust methodologies that capture both operational and strategic dimensions of success.

Ex post evaluation is an important source of learning. It involves the systematic collection, analysis and assessment of data to determine an outcome. Evaluations may vary in scope and methods. They may have a broad or a more limited perspective. By triangulating quantitative and qualitative evidence, ex post evaluation can reveal discrepancies between planned and realised benefits, highlight distributional effects and identify lessons for future projects [13, 41, 51, 52]. This makes ex post evaluation a useful tool for learning, accountability and improving governance in large infrastructure investments, where success cannot be reduced to a single metric.

The evaluation framework being used by researchers to evaluate government-funded projects in Norway is illustrated in Figure 1. It is a broad framework that builds on the project's logic model and encompasses the operational, tactical and strategic levels of success; the three levels correspond to the project itself, the change process within the organisation or primary market and the change process at a societal level, respectively. The methodology was originally developed for USAID and later adopted by aid administrations in several countries. A standardised set of five criteria was endorsed by the OECD DAC [53, 54] and was later reviewed and slightly updated in 2019. Variants of the criteria have been used to evaluate other types of projects, including those in developed countries, as in the European Commission [55]. The framework used in Norway encompasses six evaluation criteria: *efficiency*: concerns project implementation and outputs and how economically the project organisation has converted inputs to outputs; *effectiveness*: whether the agreed outcome has been obtained; *other impacts*: consequences beyond the agreed outcome (i.e., side effects) that can be attributed to the project; *relevance*: whether the project is in line with society's need, including political priorities and stakeholders preferences; *sustainability*: whether the benefits are likely to persist throughout the project's lifetime; *benefit–cost efficiency*: whether the investment is good value for money. The framework is further described in Volden and Welde [41].

The framework is generic, and the criteria need to be operationalised in each project, depending on the project's goal hierarchy and context. This is undertaken by the evaluation team in each case. Usually, a combination of qualitative and quantitative information is used. Generally, the evaluations aim to provide an overall picture of the success of public projects. Each evaluation is a 'rapid' process with a budget corresponding to 3–4 person-months of work and cannot be too ambitious in terms of methodological rigour. Demonstrating effects through experimental designs is rarely feasible. Instead, evaluators must triangulate various data sources and methods of analysis, both quantitative and qualitative, to ensure validity and reliability. After defining specific evaluation questions, identifying data sources and collecting and analysing data, the evaluation team summarises each assessment by assigning a score between 1 and 6 for each criterion. Experience shows that this approach provides answers sufficient for the purpose [56]. Scoring will inevitably involve some personal judgement; however, Scriven [18] argued that balanced assessments are achieved by having a diverse team with varying professional backgrounds and perspectives.

While transport appraisal and ex post evaluation have traditionally focused on a relatively narrow set of indicators, including costs, traffic, travel times, safety outcomes and benefit–cost

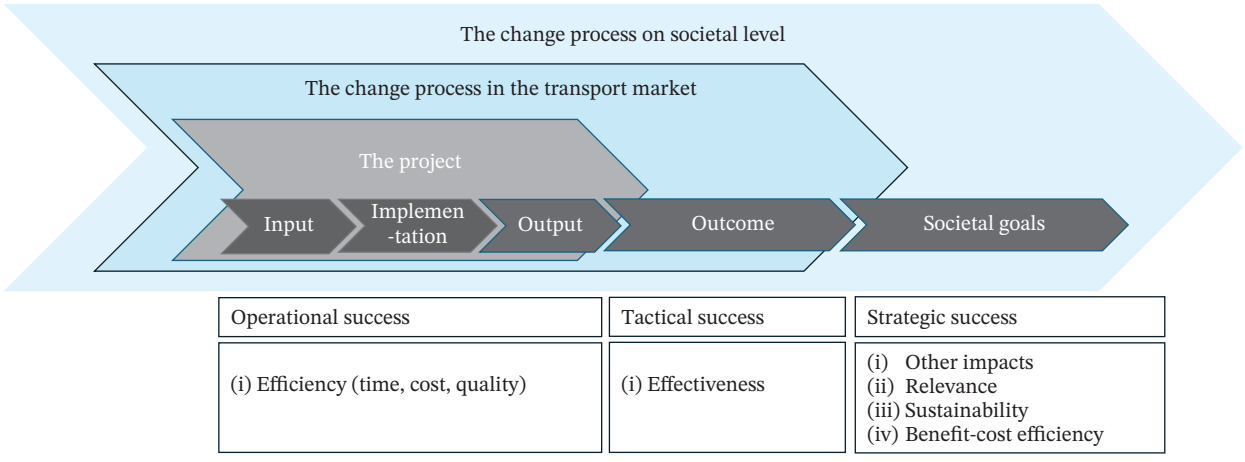

FIGURE 1 | Evaluating project success from multiple dimensions.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 | From conventional transport appraisal and ex post evaluation to a multidimensional assessment of project success.

Conventional ex post transport criteria	Additional dimensions emphasised in this study
- Construction cost performance and cost overruns	- Relevance: Alignment with societal needs, policy objectives and stakeholder priorities
- Schedule performance	- Sustainability: Whether benefits are likely to persist over the long term
- Traffic forecasts and traffic growth	
- Travel time savings and accessibility effects	- Other impacts: Wider positive and negative consequences beyond stated objectives
- Traffic safety outcomes	- Assessment of both intended and unintended outcomes
- Benefit–cost efficiency and value for money	- Acknowledgement of multidimensionality of success
- Verification of ex ante forecasts against actual outcomes	- Cross-case synthesis of lessons learned across multiple evaluations
	- Lessons for future governance and project development

performance, the framework applied in this study assesses project success across a broader set of operational, tactical and strategic dimensions, including those that are difficult to monetise, such as broader societal, environmental and distributional effects. Table 1 summarises this distinction.

In addition to assessing the degree of success for the six criteria, the evaluator must also identify the causes of the results and extract lessons for future projects. This is usually presented in a separate chapter of the evaluation report.

3 | Data and Methodology

This section describes the research design for the evaluation synthesis and the dataset of analysed road projects. We proceed in four main steps. First, we outline our research design and define the evaluation framework (Section 3.1). Second, we present the evaluation reports serving as our data sources (Section 3.2). Third, we outline how the evaluations were coded and analysed (Section 3.3). Fourth, we summarise the characteristics of the evaluated projects and reflect on the limitations of our approach (Sections 3.4–3.5). Together, these steps form the empirical and analytical basis for the paper's conclusions.

3.1 | Research Design/Approach

The paper adopts a meta-approach to systematically analyse and integrate findings from 14 evaluation reports of road infrastructure projects in Norway. The purpose of this analytic design is to synthesise findings from multiple primary studies to generate broader conceptual insights [57]. Although originally developed for published qualitative research, we apply it to evaluation reports by treating them as primary empirical sources and including only those that meet predefined standards of methodological rigour. The evaluation reports are treated as individual cases of road infrastructure projects. Their shared structure, methodological consistency and empirical depth allow for meaningful cross-case comparison. This enables the evaluation synthesis to uncover recurring patterns (exploratory) and document specific project outcomes and contextual factors (descriptive).

This study is an evaluation synthesis of 14 road engineering project evaluations. The purpose is to identify common findings, patterns and lessons learned across them. Unlike a meta-evaluation, which assesses the quality of evaluations, this study synthesises findings from a set of evaluations. The methodological approach is therefore best characterised as an evaluation synthesis based on cross-case analysis [58] or cross-case synthesis [59].

Our case-based approach reflects a view of knowledge as grounded in real-world experiences and shaped by the specific context of each project. Thus, this paper takes a pragmatic stance, aiming to generate useful insights from existing evaluations. From an epistemological perspective, it adopts a pragmatic and interpretive approach, acknowledging that evaluation reports reflect both empirical observations and contextually shaped findings. While the analysis seeks to identify observable patterns and recurring outcomes (implying a realist ontological orientation), it also recognises that stakeholder perspectives also shape knowledge about project success and lessons learned, the evaluation framework used, institutional settings and national context. Our position aligns with the research questions, which combine an interest in assessing performance outcomes (RQ1) with extracting meaning and insight from the evaluations (RQ2).

3.2 | Data Sources

The primary data source for our study was 14 evaluation reports. Each report is treated as an individual case, following established qualitative research practice [59, 60]. The reports ranged in length from 55 to 110 pages and were published as stand-alone documents detailing their own data collection, analyses and conclusions. All evaluations typically occurred approximately 5 years into the projects' operational phase.

All evaluated projects had previously undergone the Norwegian State Project Model, which serves as a prerequisite for funding.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Their primary purpose is to examine the realised benefits of each project and to provide a basis for judging the efficiency of public spending. At the same time, the evaluations are intended to support learning for future projects: The findings are presented to and discussed with the responsible project owners, clients and/or relevant ministries.

The State Project Model is a quality assurance scheme designed to improve the planning and governance of major public investments. It applies to projects with an estimated cost above c. EUR 90 million (or c. EUR 27 million for digitalisation projects) and sets mandatory requirements for methodology and quality before approval [61]. The model includes structured decision gates, external quality assurance of cost estimates and CBAs and probabilistic cost estimation to manage uncertainty. By enforcing these requirements, the State Project Model aims to reduce optimism bias, improve forecasting accuracy and ensure strategic alignment with societal goals.

Although the evaluations were not originally designed for cross-case comparison, they all adhere to the same common evaluation model (see Figure 1), which provides a shared logic and structure. This common framework enables us to treat the published reports as primary empirical material for a secondary, cross-case analysis. The evaluations were conducted by a team of three to eight experts with expertise in evaluation, project management, engineering and transport economics. Overall, 68 individuals contributed to the evaluation reports. The evaluations primarily relied on the following data sources:

1. Interviews: A total of 160 interviews were conducted across the 14 evaluations
2. Written documents
3. Quantitative data
4. In some cases, site inspections

Furthermore, the responsible agency, the NPRA and the commissioning ministry supplied supplementary documents. Core documents included impact assessments, quality assurance reports, business cases and, when available, the project's final report.

Of the 14 evaluations, two were conducted directly by Concept researchers, whereas the remaining 12 were carried out by external organisations selected through procurement processes. In total, the evaluations spanned a period of 12 years (2012–2024) and involved around seven different external evaluators. While the sample is not statistically representative of all Norwegian road infrastructure projects, it encompasses all road evaluations conducted during the period. It thus provides a robust empirical foundation for identifying recurring challenges and transferable lessons in road infrastructure projects.

3.3 | Data Analysis

The analysis first followed a structured process using a framework grounded in six predefined assessment criteria and their associated subthemes—efficiency, effectiveness, other impacts, relevance, sustainability and benefit–cost efficiency. Second, results were summarised in a comparative matrix, enabling cross-case synthesis of both quantitative indicators (e.g., cost deviations and travel time savings) and qualitative judgements. Third, thematic analysis was applied to identify recurring explanations for success or failure and to extract lessons for future projects.

Three researchers collaborated and conducted regular checks to ensure an accurate and consistent interpretation. The results were summarised in an Excel spreadsheet including both qualitative and quantitative elements. Where applicable, quantitative metrics such as scores, costs and traffic figures were extracted from the reports. The evaluation scores assigned to each criterion were particularly important, as they represented the evaluators' overall professional judgement of performance, informed by both qualitative and quantitative data. Additionally, we recoded certain evaluation results as binary variables (i.e., achieved/not achieved and similar). However, the number of projects is too small for robust statistical analysis. Much of the information in the evaluations was also qualitative.

As an additional data source, we organised a workshop with 20 NPRA staff members in August 2024. The participants had extensive expertise in project appraisal and planning, and many had detailed knowledge of the evaluated projects. The workshop aimed to discuss cross-case findings and key takeaways. All workshop participants also had the opportunity to provide written feedback on the evaluation synthesis. Before the study was completed, we also presented the results to the Ministry of Transport for further input and discussion on the findings and key learning points.

3.4 | The Evaluated Projects

The projects' investment decisions spanned from 2002 to 2016. All the projects were explicitly approved by parliament, as required for major government projects in Norway, based on a parliamentary bill prepared by the government. Before political approval, the NPRA had prepared final business cases outlining the projects' strategic rationale and detailed objectives.

The projects opened to traffic between 2005 and 2020. Their final costs ranged from c. EUR 70 million to 960 million (mean 275 million). Today, Norwegian road projects employ a range of contract strategies, such as traditional design–bid–build, design–build and public–private partnerships (PPPs), with an increasing trend towards early contractor involvement and the transfer of risk to contractors. However, when the evaluated projects were implemented, design–bid–build was the dominant contract strategy, leaving little scope to compare results by contract strategy and implementation model.

Table 2 shows the projects included in our evaluation synthesis.

The total length of the roads, including access roads, ranged from 4 to 34 km. The sample of evaluated projects included motorways (M), primary A-roads (dual- and single-carriageway) (A), tunnel projects (T), bridges (B) and subsea tunnels (ST). Half of the projects were motorways, five were bridges and tunnels to replace ferry services and the rest were ordinary

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 | The evaluated projects, sorted according to year of evaluation.

No.	Project	Evaluated	Investment decision	Construction started	Road opened	Final cost million EUR, 2024 prices	Road length (km)	Project type
1	Rv 3/Rv 25 Løten-Elverum	2024	2016	2018	2020	665	26	M
2	Rv13 Ryfast/E39 Eiganestunnelen	2024	2012	2014	2020	960	27	M/ST
3	Rv7 Sokna-Ørgenvika	2022	2010	2011	2014	225	18	A
4	E136 Tresfjordbrua/ Vågstrandtunnelen	2021	2012	2012	2015	240	11	A/T
5	Fv64 Atlanterhavstunnelen	2019	2005	2006	2009	120	10	ST
6	Rv13 Hardangerbrua	2018	2005	2009	2013	340	6	B
7	E6 Åsgård-Halmstad	2017	2003	2004	2005	70	11	M
8	E6 Svingenskogen-Åsgård	2017	2005	2006	2008	390	34	M
9	Rv519 Finnfast	2016	2006	2006	2009	90	8	ST
10	E16 Kløfta-Nybakk	2015	2004	2005	2007	120	11	M
11	E6 Riksgrensen-Svingenskogen	2014	2002	2002	2005	155	4	M
12	E10 Lofoten fastlandsforbindelse	2014	2003	2003	2007	215	29	A
13	Rv653 Eiksundsambandet	2014	2003	2003	2008	165	19	ST
14	E18 Momarken-Sekkelsten	2012	2005	2005	2007	95	7	M

single- or dual-carriageway projects. As Norway has challenging topography and often complex geological conditions, all projects, including motorway projects, include bridge and tunnel sections, that is, expensive engineering elements. About 35% of the projects' total length was made up of bridges or tunnels.

Since the evaluations were conducted over an extended period, they do not necessarily reflect current practices in the appraisal, planning and delivery of road projects. This represents a general challenge in evaluation research. However, it also presents a potential advantage: The evaluation activity is not a one-off exercise but a continuous process. This enables the gradual refinement of evaluation methods and allows for learning from accumulated experience.

3.5 | Limitations

This study has some limitations. The analysis depends on the quality and consistency of the original sources and on the subjective judgements of individual evaluators, especially regarding score-setting. While all reports followed a standardised framework, they were produced by different teams over more than a decade, introducing variation in interpretation and emphasis. The data is largely qualitative, which supports insight but introduces ambiguity. Some evaluation criteria, such as 'quality', are subject to varying interpretations across reports, creating overlap with other categories, such as effectiveness or impact. The study is based on a small number of cases and does not allow for statistical generalisation. While the sample includes all public road infrastructure projects evaluated under the Norwegian State Project Model, it is not necessarily representative of the broader road infrastructure sector. The analysis draws on existing documentation and does not include new data from the projects. Finally, all source material is in Norwegian, which may limit accessibility and reuse by international researchers. These limitations have been considered when interpreting the findings and framing the conclusions.

4 | Results

In the following, we present our synthesis of the project evaluations, offering insights into project success and future lessons.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

4.1 | Operational Success

Operational success corresponds to the evaluation criterion *efficiency*, which involves the classic iron triangle of time, cost and quality. While this represents only one dimension of project success, it reflects the project's ability to deliver its outputs efficiently and thus constitutes an important prerequisite.

4.1.1 | Cost

The NPRA has a well-developed cost-estimation and risk-analysis system. Costs are estimated using probability-based estimation, and external experts must scrutinise all estimates before government approval. The budget is normally set at the P85 level, meaning that if an estimate is correctly calibrated, there should be an 85% chance of delivering the project within budget. In addition to the formal budget, the project business case includes a P50 estimate that serves as the target for the NPRA.

The proportion of cost overruns is higher than desirable. Figure 2 shows slight skewness in the results, with 67% of projects having final costs exceeding the P50 estimate (mean +7%). Meanwhile, 33% of the projects exceeded their budgets (mean −1%). These findings are less favourable than those of previous studies on cost performance in Norway [36, 62, 63], suggesting that the sample of projects in this paper is not fully representative of the sector.

Upon closer examination of the evaluations of projects with the largest cost overruns, the evaluators suggested that the reasons are as outlined in Table 3.

All three projects with overruns were large and complex road projects. Two of the projects that experienced significant cost overruns also experienced delays. The third project included two tunnels totalling 5000 m, plus a 6400-m-long single-carriageway between them.

Geology is a recurring cause of complications in civil engineering projects, in Norway as in other countries. Factors such as soil composition, rock stability, groundwater conditions and seismic activity can impact the design and construction of infrastructure projects.

Common to the three projects with the largest cost overruns (> 10%) was an underestimation of the cost uncertainty. Their estimated relative standard deviation was only 7%–8%. This may indicate that their uncertainty provision (the contingency) in the budget was set too low.

4.1.2 | Time

Time is a crucial factor in project success. Delays can increase investment costs and push benefits beyond the planned timeline, thus lowering benefit–cost efficiency. Given the high costs of projects, benefits must materialise as soon as possible.

On average, the evaluated road projects were delayed by 4 months, equivalent to some 4% of the planned delivery time. Three projects were delayed by 12 months or more; however, the median delay is zero, indicating that a typical road project opens as planned. Some were also opened before the agreed date. Figure 3 illustrates some skewness in the results, with delays exceeding premature openings. This is as expected, as there is a limit to how quickly a project can be delivered, whereas there is almost no limit to how long it can be delayed. Premature completion may not even be desirable due to contractual obligations or interfaces.

Three projects were significantly delayed. Two were subsea road tunnels (including the longest in the world at the time), and one was a 1380-m-long suspension bridge. Table 4 sets out the causes of the delays as identified in the evaluations.

An overly ambitious construction schedule was identified as the primary cause of delays across all three projects. They also experienced a delayed start-up. Delays at the start of a project are difficult to recover from later.

4.1.3 | Quality

Most evaluations focus on quality criteria, including the constructed road quality and adherence to client or contract

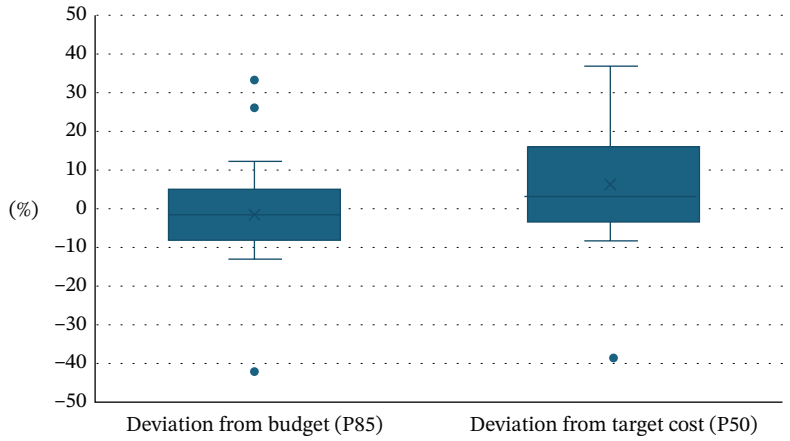

FIGURE 2 | Deviation from budget and target cost.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

requirements. However, some evaluation teams interpreted the quality criterion more broadly, including elements such as road capacity or safety. These could also relate to other dimensions (e.g., effectiveness or impact). The evaluations primarily concluded that the constructed roads met functional and technical requirements, including road standards and tunnel classifications. There are very detailed requirements for road construction, leaving little room for manoeuvring on the projects. Most conclude that the projects have delivered the planned scope in accordance with the quality specified in the contracts.

Regarding capacity, some evaluations discussed whether overdimensioning roads compared to forecasted traffic was the right choice. Others discussed a lack of capacity at intersections. This illustrates the challenges of forecasting traffic during periods of high economic activity and higher-than-anticipated population growth [4].

The best delivered projects in our sample shared a commonality: The NPRA provided substantial operational experience and expertise within the project organisation. This fostered positive and constructive processes with designers and contractors, enabling them to identify effective solutions in advance and address challenges as they arose.

TABLE 3 | Causes of cost overruns.

Project no. (overrun)	Causes of cost overruns
2 (33%)	• Poor competition in the market when the contract was tendered. • Inadequate design. • Standard creep due to new standards and regulations. • Demanding geological conditions.
4 (26%)	• Demanding geological conditions. • Deposit of surplus materials not properly prepared. • Demanding cooperation with the contractor.
5 (12%)	• Demanding geological conditions. • Delay. • Underestimation.

4.1.4 | Lessons Learned

- *The contingency must be realistic*. There is a need for improved estimation practices; in particular, greater emphasis should be placed on empirical data regarding cost distributions derived from systematic ex post evaluation.
- *Ensure sufficient skills, capacity and continuity in the client organisation*. Expertise in constructability is crucial. This also applies to the planning phase, which requires the same skills to devise effective solutions without incurring costly re-regulation during construction. A competent and attentive client should not restrict the contractor's freedom to manage resources and production.
- *Use sufficient resources to assess ground conditions at an early stage*. When projects overrun their budgets, it is often due to unforeseen ground conditions. The client should consider whether the risk posed by unstable ground conditions can be reduced early. This can be done by conducting additional ground investigations, which are typically cheaper than the costs from unexpected issues during implementation.
- *Ensure a well-considered balance between progress and total cost*. In several of the evaluated projects, the goals for the opening date may have been unrealistic but nevertheless became binding for the implementation of the project. This resulted in costs for acceleration measures and limited flexibility, for instance, to adapt tenders to the market. Tight schedules should be avoided unless the project is genuinely time-critical.

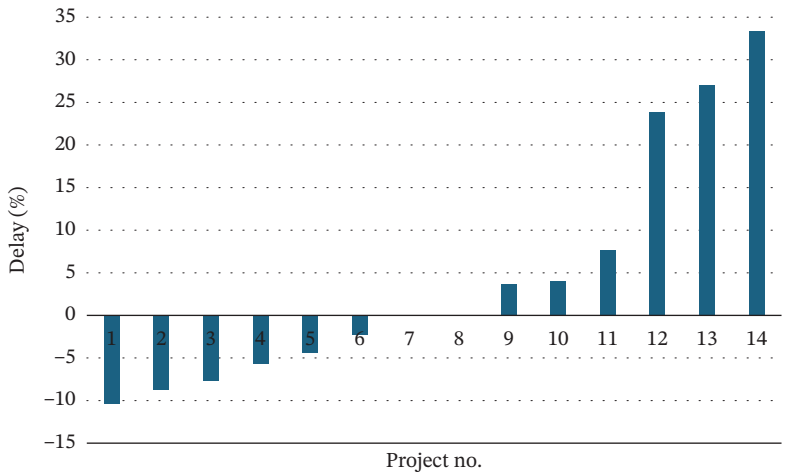

FIGURE 3 | Distribution of delays.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

4.2 | Tactical Success

Tactical project success corresponds to the *effectiveness* criterion and is related to the project's first-order effects on transport markets. The evaluations primarily assessed tactical success based on the projects' impact on accessibility and traffic safety.

4.2.1 | Accessibility

All projects aimed to improve accessibility. The evaluated projects reduced travel time by 2–60 min (average 19 min), reflecting substantial variation in project type (Figure 4). The largest time savings were achieved by projects replacing ferry connections, highlighting the particularly strong accessibility effects of fixed links.

Assessing the effects of a project can be more challenging than it initially appears. While randomised controlled trials are often considered the gold standard in evaluation, they are ill-suited for case studies in this context. Transport models can simulate travel times under various conditions, but these remain theoretical exercises rather than empirical measurements.

Complicating matters further, the definition of accessibility goals varied across projects, and the level of ambition was not always clearly articulated—some projects, for instance, vaguely aimed to 'reduce travel time' without specifying targets. In many cases, high-quality baseline data were also lacking, making rigorous evaluation difficult.

TABLE 4 | Causes of delays.

Project no. (delay)	Causes of delays
2 (24%)	• Overambitious schedule. • Postponed start-up after government approval.
5 (33%)	• Overambitious schedule. • Postponed start-up due to insufficient resources with the contractor. • Demanding geological conditions (landslide and tunnel leakage).
6 (27%)	• Overambitious schedule. • Higher tenders than expected, with subsequent need for retendering.

4.2.2 | Traffic Safety

Nine of the projects had goals for improved traffic safety. Goal achievement was generally good across most projects, as evidenced by seven of the nine evaluations, which concluded that the new roads had led to fewer casualties and/or reduced accident severity. The contributing factors to this effect generally involved constructing wider, straighter roads and adding medians to separate lanes in each direction.

However, evaluators noted considerable uncertainty in the results, particularly regarding the impact of improved infrastructure relative to broader improvements in traffic safety. Since 1975, the number of casualties on Norwegian roads has decreased from 560 to fewer than 100 per year. This is partly due to safer roads, legislative changes, better training and improved vehicle standards. Thus, a reduction in casualties cannot be attributed to better infrastructure alone.

4.2.3 | Relationship Between Problems and Solutions

In some of the cases, evaluators indicated that a large road construction project may have been an overengineered response to the initial problem. The quality of the tactical-level goals was generally poor. In some cases, the goals may have been too ambitious. None of the projects had ranked their goals, even when goals could conflict. For example, objectives related to shorter travel times may favour higher speed limits, whereas objectives related to traffic safety may favour lower speed limits. Some problems could have been solved by simple means if they had been considered in isolation, but to achieve the full set of goals, the only solution is new high-standard infrastructure.

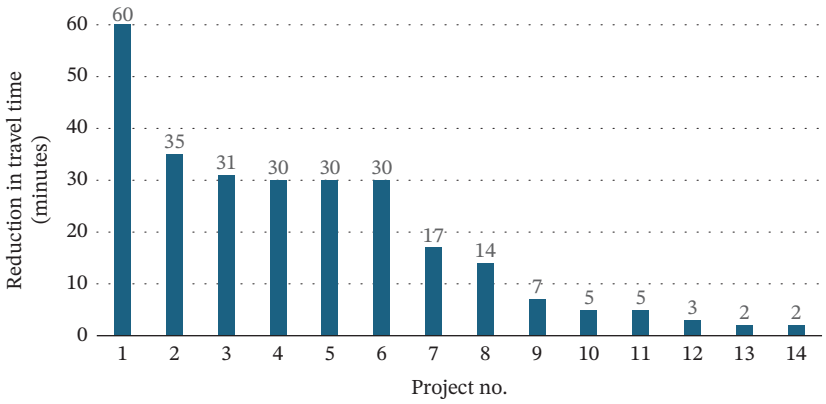

FIGURE 4 | Reductions in travel time.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

4.2.4 | Lessons Learned

- *Goals must be well-formulated and possible to use in benefits management processes*. Goals at the tactical level are supposed to guide the changes we want to make and thus need to be specific, measurable, achievable, relevant and time-bound (SMART) [64]. When there is more than one goal (and not enough funding to achieve them all), the project owner must ensure they are ranked.
- *Prioritise solving the project-triggering problem*. Road construction over a long corridor is most suitable where the identified problem affects the entire corridor, such as capacity and accessibility issues. However, if the issue concerns specific points along a corridor, such as accident-prone curves or landslide-prone areas, smaller investments may be more appropriate. A solid business case is needed to address the problem. One must avoid conflating multiple perceived problems into a single justification for a large investment that may not be economically viable.
- *Benchmarking of effects*. What level of ambition should be set for the desired effect? What is good enough? To assess project performance, it is useful to compare performance across projects, and empirical data derived from systematic ex post evaluation can be very useful in this regard. It makes sense to use the same indicators for goal achievement across projects and to collect empirical data on these indicators before and after.

4.3 | Strategic Success

Strategic success corresponds to the four evaluation criteria: *other impacts*, *relevance*, *sustainability* and *benefit–cost efficiency*. The results are presented below.

4.3.1 | Other Impacts

The evaluations also explored impacts beyond achieving the projects' first- and second-order goals. Such unintended impacts can be positive or negative, occurring in both the short and long terms, for both the target group and other affected parties, and they can be anticipated to varying degrees. For road projects, some categories of other impacts are consistent across all the evaluations, particularly impacts related to business, the housing and labour markets and negative environmental impacts. The evaluations found that some projects had led to increased commuting, especially among residents of small municipalities near urban areas. This may have improved people's options in the labour market, but it also had potentially negative environmental effects and increased car dependence. Overall, the evaluations found that few projects had significant (positive or negative) impacts beyond their primary objectives.

4.3.2 | Relevance

A project is relevant if it aligns with the government's overall strategies and goals and is efficient in achieving those objectives. Relevance is often the most fundamental success criterion in major public projects but also the most fuzzy and difficult to assess.

In Norway, the overall societal goals for the transport sector are outlined in the National Transport Plan. They have been relatively stable over time and include (1) improved accessibility to support economic growth, (2) reducing carbon emissions and caring for the environment, (3) improving traffic safety towards Vision Zero and (4) value for money.

Figure 5 summarises how the 14 projects contribute to each goal. The projects were mostly in line with political goals but less so for the goal relating to climate change and the environment. This suggests that if the government has serious ambitions for the transport sector to contribute to the green transition, it must employ measures beyond building new roads.

Many projects also had high expectations of wider economic impacts, including regional development and growth, as part of the first goal. Still, the evaluations found limited evidence of such impacts. In some cases, the potential for such impacts is probably very limited. In other cases, there may be an unrealised potential. In general, the evaluations showed that goals for regional development are often unstated, ownership of such effects is not explicitly allocated and little to no effort is made to achieve them.

4.3.3 | Sustainability

Sustainability refers to whether the project's net effects will be positive both in the present and throughout the life cycle of the road. The two criteria of relevance and sustainability were closely related in most evaluations, as high relevance was often associated with sustainability, and vice versa.

4.3.4 | Benefit–Cost Efficiency

A large share of Norwegian road projects has traditionally been estimated to deliver negative value for money. This may be caused by low population density (15/km^2), long distances, challenging topography and ambitious regional development goals. It can be argued that Norwegian road projects have been implemented *despite*, not because of, the CBA results. Figure 6 shows the share of projects estimated to deliver a negative, neutral (net BCR ±0.1[1]) or positive return on investment at the time of the investment decision. Only four of the projects were estimated to have a positive net BCR. The total NPV was estimated to be only EUR 25 million. The average net BCR was 0.1. This reflects a persistent gap between economic efficiency and decision-making. While appraisal methods such as CBA provide technical recommendations regarding efficiency and expected impacts, political decisions are typically based on a broader set of economic, social, environmental and distributional considerations.

Figure 7 shows the results of the CBAs in the evaluations. The evaluations used today's model assumptions for travel time, discount rate, appraisal period and other relevant factors in their

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

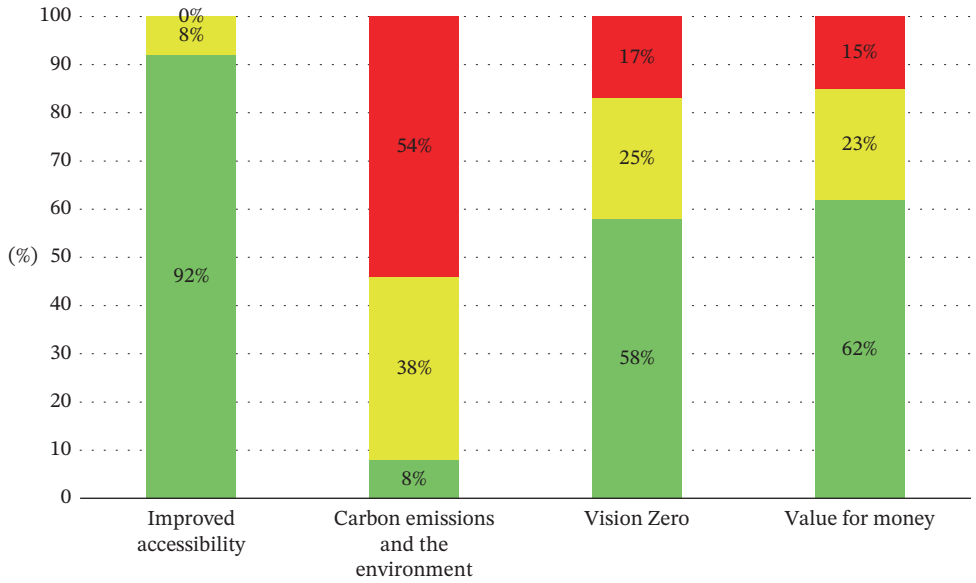

FIGURE 5 | Other impacts from the road projects.

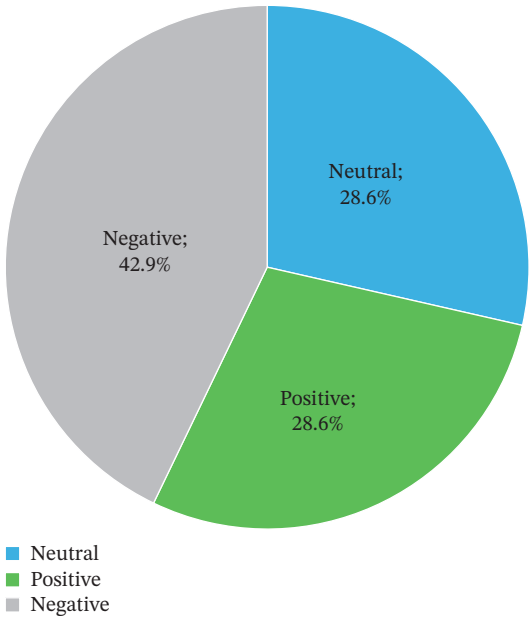

FIGURE 6 | Estimated net BCR ex ante.

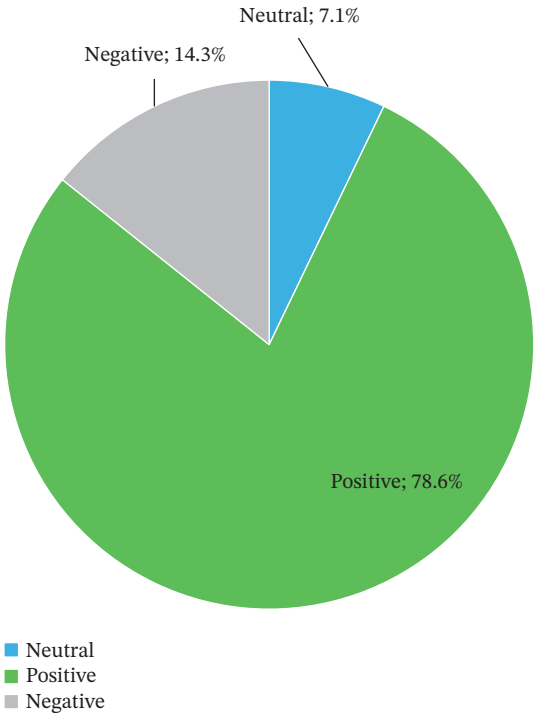

FIGURE 7 | Estimated net BCR ex post.

updated CBAs. These yielded a completely different result from the originals. While only four projects were estimated to deliver a positive return ex ante, the evaluations found that only two had negative net BCRs ex post. The total NPV has increased to EUR 1660 million.

The evaluations concluded that changes in model assumptions were the main reason most projects appear to offer higher value for money today. This illustrates that comparing CBA results over time or between regions may be problematic [65, 66]. The second most important reason was increased traffic. With only one exception, traffic has turned out to be higher, sometimes significantly higher, than estimated. In the absence of congestion, this yields greater user benefits.

The large differences do not necessarily mean that the original CBAs were inaccurate. Still, it shows that CBAs are uncertain and that an estimated net BCR may merely be a snapshot in a constantly changing world.

4.3.5 | Lessons Learned

- *Ensure that BCRs ex ante and ex post are directly comparable*. Our study indicates that unit prices, the discount rate and other crucial assumptions differ between the CBAs

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

conducted before and after, significantly affecting the analyses' outcomes. Software and transport models used to carry out CBAs are also regularly updated. This makes it almost impossible to compare results over time. Appraisals should store inputs and outputs on a common platform to prepare for future evaluations.

- *Large road projects must be planned in a wider perspective*. Road projects should be appraised according to their contribution to society's overarching goals, not only within the transport sector but also regarding whether alternative resource utilisation could be more appropriate. For example, suppose low regional growth in deprived areas is the triggering problem. In that case, regional growth should be formally defined as a goal, and road building should be evaluated against other measures that could provide more efficient solutions to the problem.
- *Hold project owners accountable*. Pursuing ambitious goals, such as 'wider economic impacts' and 'sustainable urban development', poses challenges due to the shared ownership of benefits among multiple stakeholders. These include project participants, municipalities, public transport companies, business organisations and commuter associations. Addressing their roles in benefit management and planning, supplementary measures are essential to enhance goal achievement and manage side effects. The Ministry of Transport, as owner of all major projects and the portfolio as a whole, must also engage and integrate various projects and measures to fulfil overarching objectives.
- *Reuse existing roads to a greater extent and prepare new ones for future expansions*. Given more limited transport budgets and heightened emphasis on sustainability, developing and repurposing existing roads will become more important than new roads on undeveloped land. For example, the E6 through the county of Østfold was already prepared for capacity expansion when it was first constructed in the 1960s. This minimised potential conflicts over new route choices when it was dualled 40 years later.

5 | Discussion and Conclusion

This paper has provided empirical evidence on the multidimensional nature of project success and demonstrated the value of systematic ex post evaluation for learning and governance.

5.1 | RQ1: How Successful Are Road Construction Projects From a Multifaceted Perspective?

The evaluation synthesis of 14 Norwegian road projects reveals that most projects have performed well on operational criteria such as cost and schedule, in contrast to international findings that often highlight widespread inefficiencies in large infrastructure projects [1, 67]. The results are, however, more in line with recent studies from the United Kingdom and Scandinavia [37, 38, 40, 63, 68], which have challenged the notion that large transport projects are invariably characterised by substantial cost overruns. Collectively, these studies suggest that governance arrangements, quality assurance regimes and probabilistic cost estimation can substantially improve delivery performance. Our findings support this emerging evidence but further demonstrate that delivery performance represents only one dimension of project success.

Recent literature has increasingly questioned the tendency to explain cost overruns solely through optimism bias or strategic misrepresentation. Chen et al. [35] argued that the causal mechanisms behind cost overruns are more complex than often assumed and that the actual role of optimism bias in project appraisal remains insufficiently understood. Similarly, Eliasson [68] showed that substantial cost escalation occurs during early planning stages when uncertainty is inherently high, and project scope remains fluid. From this perspective, the Norwegian State Project Model may be viewed as addressing both sources of forecasting inaccuracy: behavioural bias through external quality assurance and independent scrutiny and estimation error through probabilistic cost estimation and explicit treatment of uncertainty. The relatively strong cost performance observed in this study suggests that governance arrangements designed to mitigate both bias and uncertainty may be more effective than approaches focused on either explanation alone.

This aligns with research suggesting that institutional arrangements can be as critical as technical forecasting in achieving project success [69–71]. By enforcing structured appraisal processes and accountability mechanisms, the State Project Model reduces the risk of optimism bias and strategic misrepresentation while promoting transparency and learning. However, the persistence of projects with negative ex ante BCRs indicates that governance frameworks must also address the gap between appraisal results and political decision-making to fully realise their potential.

The paper also shows that success cannot be reduced to operational metrics alone. While most projects achieved their immediate objectives—typically related to travel time savings and traffic safety—evidence of broader societal impacts, such as regional development or environmental benefits, was limited. This finding aligns with critiques of CBA as a narrow appraisal tool that overlooks distributional and strategic considerations [42, 72, 73]. It underlines the need for evaluation frameworks that incorporate broader criteria [12, 29, 41].

The paper also highlights methodological challenges in ex post evaluation. Resource constraints and the absence of experimental designs limit the ability to establish causality, particularly for long-term and strategic impacts. Nevertheless, experience and prior research suggest that 'rapid' evaluations using triangulation can provide sufficiently robust insights for policy and practice [56, 61]. Importantly, the evaluation synthesis approach enhances learning by aggregating findings across cases, enabling benchmarking and the identification of recurring patterns, which is an area where the transport sector internationally has been criticised for weak practices [13, 16].

From a governance perspective, the findings raise questions about the alignment between political priorities and appraisal results. Several projects were implemented despite negative ex ante BCRs, reflecting a persistent gap between economic

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

efficiency and decision-making [46, 47]. While ex post evaluations show improved BCRs due to updated assumptions and higher traffic volumes, this variability illustrates the inherent uncertainty of CBA and the need for transparent documentation of appraisal inputs to enable meaningful comparisons over time.

Overall, the results support a shift from appraisal to learning in infrastructure governance. Ex post evaluation should not be seen merely as an accountability tool but as an integral part of road engineering and evidence-based policymaking. By capturing multiple dimensions of success and synthesising lessons across projects, an evaluation synthesis can inform better planning, enhance institutional learning and ultimately improve the societal value of transport investments.

5.2 | RQ2: What Are the Most Important Lessons Learned From Ex Post Evaluations That Can Contribute to Improving Future Projects?

Based on the evaluators' explanations of performance across the cases, several recurring lessons emerged. These insights are organised by success level: Operational lessons primarily target the NPRA, project managers and contractors, whereas tactical and strategic lessons target higher governance levels, particularly the Ministry of Transport. Other stakeholders, such as local authorities, environmental agencies and interest groups, should also be involved, as their engagement is crucial for benefits management and for mitigating unintended side effects.

The lack of systematic ex post evaluations of transport investments has long been recognised as a major weakness in infrastructure planning and delivery. This paper addresses this gap by demonstrating how a generic evaluation model can be applied to conduct a structured ex post evaluation. Furthermore, this evaluation model explicitly links short-term project management performance to longer term project outcomes, thereby responding to the research gap identified by Zheng and Zwikael [30] regarding the relationship between project management success and project success. The evaluation synthesis presented here offers actionable insights for actors involved in planning, implementing and governing road projects. However, evaluations only create value when their findings are actively used to improve future practices—a responsibility that ultimately rests with the NPRA and the Ministry of Transport.

It is important to acknowledge that the sample of projects analysed is not statistically representative; therefore, findings should not be generalised uncritically to other projects or contexts. Nevertheless, previous research suggests that many of the challenges and weaknesses observed in road projects are common across national borders. This suggests that the identified lessons may have broader relevance. Future research should explore cross-national comparisons by applying similar systematic evaluation frameworks to road projects in different countries. Such studies would deepen understanding of how institutional settings, governance arrangements and engineering practice influence project success across multiple dimensions.

Funding

No funding was received for this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1]The net BCR is defined as NPC/C, meaning that if, for example, the net BCR is 0.20, the interpretation will be that the return from government investment in the project will be 20%.

Data Availability Statement

The data that support the findings of this study are available upon request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

1. J. Odeck, "Variation in Cost Overruns of Transportation Projects: An Econometric Meta-Regression Analysis of Studies Reported in the Literature," *Transportation* 46, no. 4 (2019): 1345–1368, https://doi.org/10.1007/s11116-017-9836-5.

2. G. Lyons, and G. Marsden, "Opening Out and Closing Down: The Treatment of Uncertainty in Transport Planning's Forecasting Paradigm," *Transportation* 48, no. 2 (2021): 595–616, https://doi.org/10.1007/s11116-019-10067-x.

3. J. Odeck, and M. Welde, R. Vickerman, "Cost Overruns of Transportation Infrastructure Projects, in," in *International Encyclopedia of Transportation* (2021): Elsevier483–489, https://doi.org/10.1016/B978-0-08-102671-7.10089-2.

4. J. M. Hoque, G. D. Erhardt, D. Schmitt, et al., "The Changing Accuracy of Traffic Forecasts," *Transportation* 49, no. 2 (2022): 445–466, https://doi.org/10.1007/s11116-021-10182-8.

5. C. Kelly, J. Laird, S. Costantini, P. Richards, J. Carbajo, and J. Nellthorp, "Ex Post Appraisal: What Lessons Can Be Learnt From EU Cohesion Funded Transport Projects?," *Transport Policy* 37 (2015): 83–91, https://doi.org/10.1016/j.tranpol.2014.09.011.

6. M. Welde, and G. H. Volden, "Measuring Efficiency and Effectiveness Through Ex-Post Evaluation: Case Studies of Norwegian Transport Projects," *Research in Transportation Business & Management* 28 (2018): 33–39, https://doi.org/10.1016/j.rtbm.2018.05.001.

7. G. De Jong, S. Vignetti, and C. Pancotti, "Ex-Post Evaluation of Major Infrastructure Projects," *Transportation Research Procedia* 42 (2019): 75–84, https://doi.org/10.1016/j.trpro.2019.12.008.

8. N. O. Olsson, J. Nyström, and R. Pyddoke, "Governance Regimes for Large Transport Infrastructure Investment Projects: Comparative Analysis of Norway and Sweden," *Case Studies on Transport Policy* 7, no. 4 (2019): 837–848, https://doi.org/10.1016/j.cstp.2019.07.011.

9. G. H. Volden, and O. J. Klakegg, "Governance of Public Projects—Missing Out on Learning Opportunities," *Project Management Journal* 56, no. 1 (2025): 57–73, https://doi.org/10.1177/87569728241285557.

10. P. W. G. Morris, "Reconstructing Project Management Reprised: A Knowledge Perspective," *Project Management Journal* 44, no. 5 (2013): 6–23, https://doi.org/10.1002/pmj.21369.

11. M. Laursen, and P. Svejvig, "Taking Stock of Project Value Creation: A Structured Literature Review With Future Directions for Research and Practice," *International Journal of Project Management* 34, no. 4 (2016): 736–747, https://doi.org/10.1016/j.ijproman.2015.06.007.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

12. L. A. Ika, and J. K. Pinto, "The "Re-Meaning" of Project Success: Updating and Recalibrating for a Modern Project Management," *International Journal of Project Management* 40, no. 7 (2022): 835–848, https://doi.org/10.1016/j.ijproman.2022.08.001.

13. M. S. Nicolaisen, and P. A. Driscoll, "An International Review of Ex-PostProject Evaluation Schemes in the Transport Sector," *Journal of Environmental Assessment Policy and Management* 18, no. 1 (2016): 1650008, https://doi.org/10.1142/S1464333216500083.

14. J. Odeck, and A. Kjerkreit, "The Accuracy of Benefit-Cost Analyses (BCAs) in Transportation: An Ex-Post Evaluation of Road Projects," *Transportation Research Part A: Policy and Practice* 120 (2019): 277–294, https://doi.org/10.1016/j.tra.2018.12.023.

15. National Highways, *POPE Methodology Manual Post-Opening Project Evaluation for Major Projects* (National Highways, 2024).

16. ITF, *Ex-Post Assessment of Transport Investments and Policy Interventions, in ITF Roundtable Reports* (OECD Publishing, 2017).

17. R. O. Brinkerhoff, "Program Evaluation: A Practitioner's Guide for Trainers and Educators," in *Kalamazoo*, 3rd ed. (Western Michigan University, 1983).

18. M. Scriven, *Key Evaluation Checklist (KEC)* (Evaluation Checklists Project, 2015).

19. E. Kerimoğlu, M. N. Ö. Ülker, and S. Berk, "How to Conduct a Metaevaluation?: A Metaevaluation Practice," *Canadian Journal of Program Evaluation* 38, no. 1 (2023): 57–78, https://doi.org/10.3138/cjpe.71619.

20. M. Welde, "In Search of Success: Ex-Post Evaluation of a Norwegian Motorway Project," *Case Studies on Transport Policy* 6, no. 4 (2018): 475–482, https://doi.org/10.1016/j.cstp.2018.04.008.

21. A. F. Mirhosseini, K. Pitera, and J. Odeck, "Ex-Post Evaluation of Project Efficiency and Effectiveness Within a Norwegian Highway Project," *Case Studies on Transport Policy* 13 (2023): 101067, https://doi.org/10.1016/j.cstp.2023.101067.

22. OECD, "DAC Principles for Evaluation of Development Assistance," in *OECD, Development Assistance Committee* (OECD, 1991).

23. OECD, *Better Criteria for Better Evaluation: Revised Evaluation Criteria Definitions and Principles for Use* (OECD Publishing, 2019).

24. A. De Wit, "Measurement of Project Success," *International Journal of Project Management* 6, no. 3 (1988): 164–170, https://doi.org/10.1016/0263-7863(88)90043-9.

25. J. K. Pinto, and D. P. Slevin, "Project Success: Definitions and Measurement Techniques," *Project Management Journal* 19 (1988): 67–72.

26. D. Baccarini, "The Logical Framework Method for Defining Project Success," *Project Management Journal* 30, no. 4 (1999): 25–32, https://doi.org/10.1177/875697289903000405.

27. K. Samset, *Project Evaluation: Making Projects Succeed* (Trondheim, 2003).

28. J. K. Pinto, K. Davis, L. A. Ika, K. Jugdev, and O. Zwikael, "Coming to Terms With Project Success: Current Perspectives and Future Challenges," *International Journal of Project Management* 40, no. 7 (2022): 831–834, https://doi.org/10.1016/j.ijproman.2022.09.001.

29. P. L. Bannerman, "Defining Project Success: A Multilevel Framework," in *Paper Presented at PMI Research Conference: Defining the Future of Project Management* (PMI, 2008).

30. Z. Zheng, and O. Zwikael, "From Outputs to Outcomes: Meeting a Threshold of Short-Term Project Management Success as a Necessary Condition for Achieving Long-Term Impact," *International Journal of Project Management* 43 (2025): 102789.

31. J. Legaspi, D. Hensher, and B. Wang, "Estimating the Wider Economic Benefits of Transport Investments: The Case of the Sydney North West Rail Link Project," *Case Studies on Transport Policy* 3, no. 2 (2015): 182–195, https://doi.org/10.1016/j.cstp.2015.02.002.

32. T. Välilä, "The Economic Impact of Transport Infrastructure: A Review of Project-Level vs. aggregate-level evidence," *Aggregate-level evidence. Transport Reviews* 45, no. 4 (2025): 459–481, https://doi.org/10.1080/01441647.2025.2476012.

33. B. Flyvbjerg, "Introduction: The Iron Law of Megaproject Management, in," in *The Oxford Handbook of Megaproject Management, Chapter 1* (Oxford University Press, 2017).

34. P. E. D. Love, and D. D. Ahiaga-Dagbui, "Debunking Fake News in a Post-Truth Era: The Plausible Untruths of Cost Underestimation in Transport Infrastructure Projects," *Transportation Research Part A: Policy and Practice* 113 (2018): 357–368, https://doi.org/10.1016/j.tra.2018.04.019.

35. Y. Chen, D. D. Ahiaga-Dagbui, M. J. Thaheem, and A. Shrestha, "Toward a Deeper Understanding of Optimism Bias and Transport Project Cost Overrun," *Project Management Journal* 54, no. 5 (2023): 561–578, https://doi.org/10.1177/87569728231180268.

36. M. Welde, and O. J. Klakegg, "Avoiding Cost Overrun Through Stochastic Cost Estimation and External Quality Assurance," *IEEE Transactions on Engineering Management* 71 (2024): 1984–1997, https://doi.org/10.1109/TEM.2022.3173175.

37. P. Chapman, "Project Delivery Performance: Insights From English Roads Major Schemes," *Project Leadership and Society* 5 (2024): 100128, https://doi.org/10.1016/j.plas.2024.100128.

38. P. Chapman, "Revisiting Project Delivery Performance: Evidence From Swedish Transport Infrastructure," *Project Management Journal* 55, no. 6 (2024): 689–707, https://doi.org/10.1177/87569728241257391.

39. D. Zani, and B. T. Adey, "Swiss Highway Project Cost Estimate Performance: Deviations From Norms and Expected Trends," *Case Studies on Transport Policy* 19 (2025): 101344, https://doi.org/10.1016/j.cstp.2024.101344.

40. P. Chapman, "On Cost, Over Time: How Scandinavian Transport Infrastructure Challenges Conventional Understanding of Project Delivery Performance," *International Journal of Project Management* 43, no. 8 (2025): 102787, https://doi.org/10.1016/j.ijproman.2025.102787.

41. G. H. Volden, and M. Welde, "Public Project Success? Measuring the Nuances of Success Through Ex Post Evaluation," *International Journal of Project Management* 40, no. 6 (2022): 703–714, https://doi.org/10.1016/j.ijproman.2022.06.006.

42. N. Mouter, J. A. Annema, and B. van Wee, "Managing the Insolvable Limitations of Cost-Benefit Analysis: Results of an Interview Based Study," *Transportation* 42, no. 2 (2015): 277–302, https://doi.org/10.1007/s11116-014-9539-0.

43. G. H. Volden, "Assessing public projects' value for money: An empirical study of the usefulness of cost–benefit analyses in decision-making," *International Journal of Project Management* 37, no. 4 (2019): 549–564, https://doi.org/10.1016/j.ijproman.2019.02.007.

44. J. Odeck, "Ranking of Regional Road Investment in Norway," *Transportation* 23, no. 2 (1996): 123–140, https://doi.org/10.1007/BF00170032.

45. J. Odeck, "What Determines Decision-Makers' Preferences for Road Investments? Evidence From the Norwegian Road Sector," *Transport Reviews* 30, no. 4 (2010): 473–494, https://doi.org/10.1080/01441640903138640.

46. J. A. Annema, K. Frenken, C. Koopmans, and M. Kroesen, "Relating Cost-Benefit Analysis Results With Transport Project Decisions in the Netherlands," *Letters in Spatial and Resources Sciences* 10, no. 1 (2017): 109–127, https://doi.org/10.1007/s12076-016-0175-5.

47. J. Eliasson, M. Börjesson, J. Odeck, and M. Welde, "Does Benefit-Cost Efficiency Influence Transport Investment Decisions?," *Journal of*

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/jet/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Transport Economics and Policy 49, no. 3 (2015): 377–396, https://doi.org/10.3828/jtep.2015.49.3.377.

48. "Meld. St. 14 (2023 –2024) National transport plan 2025–2036," (2023) https://www.regjeringen.no/en/documents/meld.-st.-14-20232024/id3030714/?ch=1.

49. "Nationell Plan för transport in frastrukturen 2022–2033," (2021)https://bransch.trafikverket.se/for-dig-i-branschen/Planera-och-utreda/langsiktig-planering-av-infrastruktur/nationell-plan/nationell-plan-20222033/.

50. A. O. Hirschman, *Development Projects Observed* (Bloomsbury Publishing, 1967).

51. P. H. Rossi, M. W. Lipsey, and H. E. Freeman, *Evaluation: A Systematic Approach* (Sage Publications, 2003).

52. K. Ponanan, and D. Satirasetthavee, "Ex-Post Evaluation Framework of Transportation Infrastructure Projects in Thailand Applying the OECD-DAC's Evaluation Criteria," *Engineering Journal* 29, no. 4 (2025): 39–52, https://doi.org/10.4186/ej.2025.29.4.39.

53. OECD-DAC, *DAC Principles for Evaluation of Development Assistance* (OECD Publishing, 1991).

54. OECD, *Glossary of Key Terms in Evaluation and Results-Based Management* (OECD, Development Assistance Committee, 2002).

55. European Commission, *The Resource for the Evaluation of Socio-Economic Development –Evaluation Guide* (European Commission, 2013).

56. M. Bamberger, J. Rugh, M. Church, and L. Fort, "Shoestring Evaluation: Designing Impact Evaluations Under Budget, Time and Data Constraints," *American Journal of Evaluation* 25, no. 1 (2004): 5–37, https://doi.org/10.1177/109821400402500102.

57. L. Timulak, U. Flick, "Qualitative Meta-Analysis, in," in *Qualitative Meta-Analysis* (SAGE Publications Ltd., 2014), 481–495, https://doi.org/10.4135/9781446282243.n33.

58. M. Q. Patton, "Qualitative Research & Evaluation Methods: Integrating Theory and Practice," in *Qualitative Research and Evaluation Methods*, 4th ed.Calif: (Sage, 2015).

59. R. K. Yin, *Case Study Research and Applications: Design and Methods* (Sage Publications, 2018).

60. R. Stake, *Art of Case Study Research* (Sage Publications, 1995).

61. G. H. Volden, and K. F. Samset, "Governance of Major Public Investment Projects: Principles and Practices in Six Countries," *Project Management Journal* 48, no. 3 (2017): 90–108, https://doi.org/10.1177/875697281704800306.

62. M. Welde, and A. Engebø, "Cost and Schedule Performance in Large Government Projects. IOP Conf. Series: Earth and Environmental," *Science* 1389 (2024): 012027.

63. J. Odeck, "Measuring Cost and Time Overruns: Median-Based Metrics, Reform Effect, and Simultaneous Estimation," *Transportation Research Part A: Policy and Practice* 199 (2025): 104587, https://doi.org/10.1016/j.tra.2025.104587.

64. G. T. Doran, "There's a S.M.A.R.T. Way to Write Management's Goals and Objectives," *Management Review* 70 (1981): 35–36.

65. N. O. E. Olsson, A. Økland, and S. B. Halvorsen, "Consequences of Differences in Cost-Benefit Methodology in Railway Infrastructure Appraisal—A Comparison Between Selected Countries," *Transport Policy* 22 (2012): 29–35, https://doi.org/10.1016/j.tranpol.2012.03.005.

66. T. E. Sandberg Hanssen, P. Helo, G. Solvoll, J. Westin, and L. Westin, "Dissimilarities Between the National Cost/Benefit Models of Road Projects: Comparing Appraisals in Nordic Countries," *Transportation Research InterdisciplinaryPerspectives* 8 (2020): 100235, https://doi.org/10.1016/j.trip.2020.100235.

67. B. Flyvbjerg, and D. Gardner, *How Big Things Get Done: The Surprising Factors That Determine the Fate of Every Project, From Home Renovations to Space Exploration and Everything in Between* (Penguin Random House, 2023).

68. J. Eliasson, "Cost Overruns of Infrastructure Projects – Distributions, Causes and Remedies," *Transportation Research Part A: Policy and Practice* 198 (2025): 104532.

69. M. Bourne, M. Bosch-Rekveldt, and O. Pesämaa, "Moving Goals and Governance in Megaprojects," *International Journal of Project Management* 41, no. 5 (2023): 102486, https://doi.org/10.1016/j.ijproman.2023.102486.

70. A. Ruiz Rivadeneira, and P. McMaster, "Mapping Institutional Arrangements for Infrastructure Governance in OECD Countries," in *OECD Working Papers on Public Governance, 62* (OECD Publishing, 2023).

71. R. Pathak, N. Turner, and L. Alinaghian, "Inter-Organisational Governance IN Megaprojects: A Systematic Review AND AN Agenda FOR Future Research," in *British Academy of Management (BAM) 37th Annual Conference* (Brighton, 2023), 2023.

72. P. Næss, "Cost-Benefit Analysis of Transportation Investments: Neither Critical Nor Realistic," *Journal of Critical Realism* 5 (2006): 32–60.

73. B. Flyvbjerg, and D. W. Bester, "The Cost-Benefit Fallacy: Why Cost-Benefit Analysis Is Broken and How to Fix It," *Journal of Benefit-Cost Analysis* 12, no. 3 (2021): 395–419, https://doi.org/10.1017/bca.2021.9.

3962, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1155/je/1697975 by Morten Welde - Ntnu Norwegian University Of S , Wiley Online Library on [12/08/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License