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Contradictory outcomes of cost-benefit analyses – Findings from Norwegian public-investment projects



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| A R T I C L E I N F O | A B S T R A C T | | |
|---|--|--|--|
| JEL classification: R42 | This paper addresses the issue with contradictory outcomes of cost-benefit analyses (CBA) performed on the same project that can be seen in many Norwegian public-investment projects. Different stakeholders may order "their | | |
| JEL classification: R42 Keywords: Cost benefit analysis Technical bias Decision-making Public investment projects | own" appraisals of a specific project, which sometimes conclude quite differently from the other appraisals. This phenomenon is explored by studying the appraisals performed on eight Norwegian public-investment projects. Each of the projects analysed have been subject to many appraisals, which have all been compared and analysed. The following research questions have been explored: (1) How may various appraisals of the same project differ? (2) How may clients be able to influence the results of the appraisals? (3) How may the challenge with differing results, technical bias and low transparency of the appraisals be addressed in order to help decision-makers evaluate the various outcomes of CBAs? The findings show that the appraisals did vary in the projects stud- ied; for some of them, quite substantially. The differences between appraisals were mostly related to the benefit side of the projects, both regarding which types of benefits were quantified and how they were measured and monetised. Important project-specific assumptions also differed among the appraisals by, for example, impacting project specific assumptions and demanding certain methodologies and standards to be used when quantifying and valuing benefits. A CBA can never be a complete, objective description of the matters under consideration. However, it is crucial that the appraisals are transparent and report on important factors that have large impact on the results so that decision-makers can evaluate the various appraisals and are able to use the information from them in decision-making processes. | | |

1. Introduction

A project appraisal can be defined as the process of assessing, in a structured way, the viability of a project (Filicetti, 2016). Societal resources are scarce. It is therefore necessary to employ methods to analyse and compare possible outcomes of alternative uses of resources in order to be able to choose the alternative that better corresponds to the stated political objectives. Cost-benefit analysis (CBA) is such a tool (Mishan & Quah, 2007). This article is concerned with the application of CBA in public-investment projects.

In Norway, as in many other countries, it is common practice to undertake CBA in large public projects. In its strategy, the Norwegian government has stated that the results of the CBAs should play an important role in the resource allocation to various public projects (NTP, 2017). However, literature has revealed that it is unclear what role CBAs really play in the decision-making process, and that there may be factors other than net social benefits for society that are emphasised (see e.g.

Fiva & Halse, 2016; Hanssen & Jørgensen, 2015; Odeck, 1996; Odeck, 2010; Sager, 2016). There seems to be a mismatch between the stated wish to use CBAs in the decision-making process and their actual use.

The aim of this paper is to contribute with knowledge that may explain this mismatch by exploring a phenomenon seen in studies of single projects (see e.g., Kvalheim, 2015b), that of different CBAs performed on the same project varying widely in their conclusions sometimes in opposite directions. One appraisal may conclude that a specific project has net positive social benefits, while another may reject the same project, deeming it not profitable to society. This may occur even though the analyses are conducted by respected research teams with high levels of competence in the CBA field. The first research question explored is thus:

1. How may various appraisals of the same project differ?

The results of Kvalheim's (2015b) study indicated that the clients

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Table 1

Examples of critique of CBA found in the literature.

| Examples of critique | | Description Example of liter | |
|----------------------|---|---|--|
| 1 | Quantifying and monetising costs and benefits | Not all consequences are/ can be quantified and monetised; Comprehensiveness dilemma | Nyborg (2012) Sager (2013) Nyeng (2004) |
| 2 | Weighing of benefits and costs | It is immoral that some people should lose for others to win; Winners are reluctant to compensate the losers and/ or are not asked to do so | Van Wee (2011) Ackerman (2008) |
| 3 | Multiple objectives | Objectives other than efficiency are relevant for policies. | Welde et al. (2013) Boardman et al. (2014) The Norwegian Ministry Of Transport And Communications (2013) |
| 4 | Bias in the analytical process | Analysts are social individuals in interaction with their surroundings; Limited capacity to interpret complex data. | Ackerman (2008) Andersen, Samset, and Welde (2016a) Fiva and Halse (2016) Volden (2018) Flyvbjerg, Holm, and Buhl (2002) |
| 5 | The utility- maximising principle | From focus on maximising the utility of a road project to focus on minimum accessibility to avoid social exclusion. | Van Wee (2011) Lucas (2006) Lucas, Tyler, and Christodoulou (2009) Straatemeier (2008) Ingebrigtsen and Jakobsen (2009) |
| 6 | Discount future effects | If the degree of uncertainty of future outcomes is different in diverse alternatives, how to account for it? The precautionary principle. | Ackerman (2008) Osland, Leiren, Hoff, Tennøy, and Strand (2007) Turner (2007) |
| 7 | Aggregation of WTP | Although, every member of society has transitive preferences, it does not follow that aggregation of their preferences produces a transitive social ordering. It is possible that individual preferences are such that social ordering is cvelical. | Boardman et al. (2014) |
| 8 | Weighing of individual WTP | What weight should be put on each individual's opinion? Should they be weighed equally regardless of income, gender, or age? Distributional concerns. | Nyborg (2012) Ackerman (2008) Turner (2007) Kriström (2006) |
| 9 | Whose WTP should count? | How small must one individual time saving be in order to be considered significant enough to have alternative use? | Osland et al. (2007) |
| 10 | WTP based on individual stated preference | Framing effects; Limited view of human beings assuming they are unboundedly rational and maximise their utility; Preferences depend on personal history, interaction with others, and social context (endogenous preferences); Communicative process needed. | Nyeng (2004) Osland et al. (2007) Kahneman, Lilleskjæret, and Nyquist (2013) Hanssen (2012) Abrantes and Wardman (2011) Gowdy (2004) Sager (2013) |
| 11 | The individualistic approach | Alternative holistic view: society being greater than | |

who order the appraisals may influence their results, causing technical bias in the appraisals. Technical bias may result from strategic design or manipulation of CBAs to achieve the desired outcome by cherry-picking data that supports a desired conclusion or errors of judgment under uncertainty (Parkhurst, 2017). The study by Kvalheim (2015b) was based on a single case. In this paper we expand the number of case projects and explore the research question:

2. How may clients be able to influence the results of the appraisals?

For decision-makers it can be confusing when the results of the CBAs differ so much when these are to be used in the decision-making processes for the ranking of projects that are competing for resources. This invites them to question the reasons for the variation, but how are they able to evaluate the CBAs considering the high level of technicality in the methodologies and comprehensiveness of the analyses? A second study by Kvalheim (2015a) found several shortcomings in appraisal reports affecting the availability of the results to their various types of readers. Among others, several of the reports studied lacked a description of important assumptions and uncertainties both in their summaries, which are often the only part of the appraisal read by decision-makers, and elsewhere in the reports. In addition, the various consequences were often summed up without providing detailed descriptions of each component's contribution. All this may contribute towards undermining the legitimacy of the CBAs as a decision-making tool - as indicated by the informants in Kvalheim's (2015a) study, who expressed that the understanding of and trust in the reports among decision-makers was, in general, low.

A challenge arises when appraisals differ in results and clients are able to influence the results, while at the same time it is difficult for decision-makers to evaluate the results of the appraisals. This reduces the legitimacy of the outcome of the CBAs and makes it difficult to use them in decision-making processes. The third research question thus explores:

3. How may the challenge with differing results, technical bias and low transparency of the appraisals be addressed in order to help decision-makers evaluate the various outcomes of CBAs?

The research questions are explored by conducting an in-depth study of appraisals conducted in eight large public-investment projects in Norway.

The article is structured as follows. In section 2, a short introduction to the CBA framework is given along with a discussion of CBA as decision-making tool, including some critique against it. In section 3, the methodology and empirical findings are presented. The findings are discussed in section 4 and some concluding remarks are made in section 5.

2. Cost-benefit analysis as decision-making tool

2.1. The cost-benefit analysis framework and its critique

The aim of CBAs is to identify, quantify and value consequences (benefits and costs) of different alternative uses of resources (Mishan & Quah, 2007). The objective is to help decision-makers allocate society's resources more efficiently – that is, to demonstrate why a particular public-investment project, for example, is more beneficial to society relative to the alternatives, including the status quo (Boardman, Greenberg, Vining, & Weimer, 2014). The aggregated value of a public-investment project is measured by its net social benefits, which is equal to social benefits minus social costs. Since projects often have impacts that occur over years, future benefits and costs are discounted relative to present benefits and costs in order to obtain the net present value (NPV) of the project (Boardman et al., 2014).

The CBA methodology has been the subject of much debate, along

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Table 1 (continued)

| Examples of critique | | Description | Example of literature |
|----------------------|------------------|---|--|
| | | the sum of its parts; Cooperation instead of competition; Communication | Ingebrigtsen and Jakobsen (2009) Simon (1997) |
| 12 | Anthropocentrism | Individual WTP is assessment of reality through an exclusively human perspective; The environment has its own inherent value. | Schmidtz (2001) Ingebrigtsen and Jakobsen (2009) |
| 13 | Space and time | Guidelines for calculation in CBAs are universal, not considering space and time – preferences may change over time and differ between people at different locations. | Turner (2006) |

with criticism of it as an assessment tool (see e.g. Odeck, 1996, 2010, Nyborg, 1998, Welde, Eliasson, Odeck, & Börjesson, 2013, NOU, 2012, p. 16, 2012, Sager, 2016). According to Van Wee (2011), 'real criticisms' of CBA¹ are related to its content and process. The criticisms of content include both that consequences of interest are not included, and that consequences are incorrectly measured and monetised. The criticisms of process include the process of developing a CBA, its use in decision-making, and the communication of results (Van Wee, 2011). In Table 1, examples of critiques of CBA are presented along with examples of literature addressing the various critiques. The latter is by no means exhaustive considering the large volume of literature that exists, both regarding problems with CBAs and solutions for handling these. For example, Mouter, Annema, and Van Wee (2013a) give an overview of categories of literature on (solutions for) substantive problems of CBA found in transport-related journals, while Hwang (2016) discusses the use of CBA in environmental policy formulation with a focus on three critiques: monetary valuation, discounting, and inequality, and how these can be dealt with. It is beyond the scope of this paper to go into each of the critiques in detail. Below the table, only those critiques that are particularly relevant for this paper are described in further detail.

The critiques related to the analyst and the analytical process include, among others, the quantifying and monetising costs and benefits (critique no. 1) and bias in the analysis process (critique no. 4). To be included in CBAs, knowledge of consequences must be articulated explicitly. Since it is easier to include consequences that are easy to articulate, others, such as environmental ones, may not be properly included. For simplicity, there is the risk that only easily measurable aspects are considered (Nyeng, 2004). It is also be intuitively easier to relate to monetised costs and benefits (Nyborg, 2012). The result may be that important consequences are left out because they are difficult to measure, while other consequences, which are easy to measure and monetise, are included although they may be less important. On the other hand, it also opens up for cherry-picking of consequences that supports a desired conclusion (Parkhurst, 2017). Consequences that one analyst would not consider relevant, measurable or valuable, may be included by others, resulting in different outcomes of the analyses. Sager (2013) points to the problem that if all consequences were included in CBAs (assuming this was attainable), it would be impossible for decision-makers to relate to the analysis, as the analytical process would become less transparent and difficult to communicate. He calls it the comprehensiveness dilemma. That is, planners must choose between a narrow CBA, making good economic sense, and a comprehensive CBA,

with questionable economical content. However, a narrow CBA may be combined in a wider assessment where those impacts that in current practice are difficult to derive a reliable monetary value for are presented in other forms that give a clear sense of the severity of the impact. This is, for example, shown both in the English and Norwegian transport analysis guidance (Department Of Transport, 2014; NPRA, 2014).

Bias in the analysis process may come from the fact that analysts are social individuals formed by their interaction with other individuals in the family, groups, profession, and society. This influences what they see and how they choose to solve problems, which may cause bias in the analytical process. There may also be biases in the interpretation of complex, technical data. Research has shown that the costs of projects are often underestimated at the early phases. Several explanations are proposed for why this happens (see e.g. Austeng, Bruland, & torp, 2006; Cantarelli, Flyvbjerg, Molin, & Van Wee, 2010; Volden, 2018; Welde, 2017), and some of these point to the analysts and the analytical process not being properly conducted, where inadequate estimation methods and skills are used, estimations rely on weak information, opportunities are overestimated, or because of strategic and/or deliberate considerations (Andersen, Samset, & Welde, 2016b; Flyvbjerg et al., 2002). Although objectivity may be held as a goal, this is often difficult to obtain. This is important to be aware of when considering the outcomes of CBAs.

2.2. CBA as decision-making tool

As mentioned in the introduction, although CBAs are undertaken for public-investment projects, CBAs seem to play a minor role when ranking between public-investment projects in Norway (see e.g. Odeck, 1996; Odeck, 2010; Sager, 2016). There are several possible explanations for this.

First, the literature has suggested that decision-makers may have problems understanding how to use CBAs (Sager & Sørensen, 2011). This may be particularly true when the outcomes of the appraisals differ extensively. Politicians are often not economists and may therefore have difficulty understanding the theoretical reasoning behind CBAs. The literature has shown that decision-makers' professional backgrounds may influence how they see the role of CBA and use it in decision-making. Economists may emphasise monetised consequences to a greater degree than e.g. spatial planners, who may emphasise other aspects more strongly (Mouter et al., 2013a, 2013b). The theoretical assumptions behind CBA corresponds better with the theoretical background of economists compared to those occupied with e.g. politics and laws. This may result in mistrust between different types of decision-makers, as seen in a Dutch study exploring the use of CBA as an appraisal instrument for integrated land use and transportation plans in the Netherlands (Beukers, Bertolini, & Te Brömmelstroet, 2012). They found that the biggest challenge lied in reducing the level of mistrust and communication deficits between plan owners and analysts conducting the CBA and their respective frames of thinking in the process.

A second reason may stem from the fact that, in reality, the prioritising of projects often occurs at an early stage when the documentation of impacts of the project is poor. There are two main ways in which projects may arise (Minken, Olsen, Leiren, & Strand, 2014): they either arise because norms and standards are violated, requiring actions to be taken, or because local users, politicians, or business activity take the initiative to implement projects in their interests. Both reasons often imply that the project will eventually be implemented regardless of what a CBA conducted at a later stage may recommend, either because the violation of norms and standards is unacceptable, or because of strong lobbying activity from stakeholders.

Third, there seem to be factors other than monetised consequences that are emphasised in prioritising between projects in Norway (see, e.g. Odeck (1996, 2010); Nyborg (1998); Hanssen and Jørgensen (2015); Fiva and Halse (2016); and Welde et al. (2013)). For Norwegian road projects, this can partly be explained by multiple objectives being

¹ Van Wee (2011) categorises the criticisms of CBA into either 'opportunistic criticisms' or 'real criticisms'. The former are those that disagree with the outcomes of CBA, while the latter relate to its content and process.

considered, including distributional effects and non-quantified consequences, and not only efficiency (NPRA, 2014). It can be difficult for decision-makers to consider the profitability of a project from a welfare perspective when there are many other objectives to consider.

Fourth, it is possible that the decision-makers are aware of the limitations of CBA, more or less consciously, and therefore use it in a limited way.

De Rus and Socorro (2017) discuss why governments deviate from welfare-maximising behaviour when continuing the construction of High-Speed Railways in low demand corridors in Spain. They propose the following reasons for this based on earlier literature: (1) government tries to maximise the probability of re-election; (2) interest groups apply pressure to guide government policies to their advantage; (3) the absence of economic principles in the public agencies dealing with transport infrastructure; and (4) the presence of various levels of government with different roles regarding who is to finance the infrastructure. They argue that if the national government is to finance the project, then the regional government has the incentive to overestimate benefits and underestimate costs, as well as the loss of incentive to reduce costs and charge users to raise revenues.

One could ask why make the effort to conduct the CBAs if the decision-makers do not use the results? However, earlier studies have indicated that the CBAs are desired as analytical input, although they are not used directly to rank projects (Sager & Sørensen, 2011). The role of CBA in decision-making processes may also differ depending on the context. Sometimes they may be used merely as a rough screening technique to determine which projects are to be pursued (Nyborg, 1998). In other instances, the decision-making process; however, they use them in a non-monetary way (Odeck, 2010).

In an institutional perspective, one could see CBA simply as a tool for legitimising political plans and the process leading up to them (Sager, 2013; Sager & Sørensen, 2011). The CBAs represent input from experts, and it is important to show the public that expert advice has been considered in the decision-making process. From the perspective of new institutionalism, CBAs can be seen as part of the myths and rituals used to legitimise the decision process (Selznick, 1996). In this perspective, formal structures are institutionalised to reflect prevailing concepts of how work should be organised.

The CBAs represent highly technical information in the decisionmaking. The identification, quantification and valuing of consequences in CBAs require the use of specific tools, standards and methodologies, and the CBAs are therefore performed by trained professionals. In this process, technical bias may arise.

In order to effectively link assessments and decision-making, the information created needs to be credible, salient and legitimate (Cash et al., 2002). Credibility refers to the information being authoritative, believable and trusted; salience refers to how relevant the information is to decision-making bodies or publics; and legitimacy refers to how "fair" an information-producing process is and whether it considers the appropriate values, concerns, and perspectives of different actors. The fact that several assessments are ordered for the same project by different stakeholders may be seen as a sign that one or more of these three dimensions are not met. In the case of assessing the costs and benefits of public-investment projects, the study by Kvalheim (2015b) stated that the analyses were conducted by well-known and trusted research teams and that the information was relevant for decision-makers. This points to the last dimension, legitimacy, as one dimension to be further explored.

Parkhurst (2017) has proposed a legitimacy framework for evidence-informed policy processes. It states that legitimacy of the outcome can be achieved either by goal clarification (explicit identification of policy concerns; critical reflection on evidentiary needs in reference to policy goals), applying quality criteria for multiple forms of evidence (unbiased; methodologically rigorous; systematic), or reducing bias or making bias more evident (making structures and rules that make

| Projects | analysed | in | the | study |
|----------|----------|----|-----|-------|
| 110,000 | undigood | | | orady |

| Project | Description |
|---------------------------------------|---|
| E10 LOFAST | A 51-km-long stretch of road including several tunnels and bridges connecting Lofoten in the northern part of Norway to the mainland. |
| Airport Helgeland | A new airport in Mo i Rana in northern Norway |
| Ocean Space Centre | New facilities for maritime research in Trondheim, Norway |
| Hardanger Bridge | A bridge replacing a ferry on the western coast of Norway |
| Stad Ship Tunnel | A tunnel for ships to bypass the Stad peninsula on the western coast of Norway |
| High-speed railway | Infrastructure for high-speed railway in southern Norway |
| E8 Sørbotn-Laukslett/ Tindtunnelen | Improved road stretches and a road tunnel in northern parts of Norway |
| Ferry-free E39 | A 1100-km-long stretch of road along the western coast of Norway including several fjord crossings |

technical bias, issue bias and irrationality less likely, more evident and/or open to scrutiny).

In order to practise good governance of evidence, Parkhurst (2017) proposes that it is necessary to establish both rules and norms that direct practices, and to make procedural efforts to overcome technical bias. In Norway, the first is materialised in the national appraisal guidance of public projects (NOU, 2012, p. 16, 2012) and, for example, the transport sector specific guidance by the NPRA (2014). Procedural efforts to overcome technical bias may, for example, be to institutionalise internal rules and procedures that serve to address sources of bias or to use alternative analysis (sensitivity analysis) (Parkhurst, 2017). The latter may help analysts and policy-makers stretch their thinking through structured techniques that challenge underlying assumptions and broaden the range of possible outcomes considered. This may hedge against the tendency to perceive information selectively through the lens of preconceptions, to search too narrowly for facts that would confirm rather than discredit existing hypotheses, and to be unduly influenced by premature consensus within analytic groups close at hand.

A procedure that serves to address sources of bias is to create a multidimensional typology of the appraisals, making the use of evidence more transparent and open to challenge and appeal. By considering key dimensions in the appraisals that address possible sources of bias, and presenting them in a comprehensible manner, the typology may help decision-makers judge the various appraisals on dimensions as important for the outcomes of the appraisals. The aim of this paper is to identify the factors that differ in appraisals of public projects in Norway and to propose a typology that will make the use of evidence more transparent and open to challenge and appeal, thus helping decisionmakers make use of the information from the appraisals.

3. Comparison of appraisal reports in eight Norwegian publicinvestment projects

3.1. Methods and description of case projects

For a project financed by the Concept research program, Norway,² eight Norwegian public-investment projects were studied in depth by analysing documents reporting the results of various appraisals of the projects conducted over time by different research teams. A short description of the eight projects studied is presented in Table 2. A more thorough description can be found in Bardal and Reinar (2018). Only two of the projects have so far been built, namely E10 LOFAST and the Hardanger Bridge. The others are still in the planning process, but all of them have support to be built from the politicians at the national level. All of the projects show negative net present value in most of the appraisals conducted, although a few of the individual appraisals do show

² https://www.ntnu.no/concept

positive net present value.

Different criteria were used in the selection of case projects. First, in order to be able to compare various appraisals conducted for one specific project, it was essential that at least two different appraisals were available. Second, in order to reveal how different clients were able to impact the results of the analyses, it was necessary that the available appraisals were ordered by at least two different clients. It follows from these first two criteria that the projects most suitable for selection were those that had been in the planning process for some time and to a certain degree had some controversy related to them. A third selection criterion was that the appraisal reports were available to the research team. Not all analyses regarding a project are publicly available, and some may be difficult to locate; those ordered by private clients can be particularly difficult to get hold of. Fourth, the projects were chosen in order to represent different public sectors. The chosen projects were four road investment projects including bridges and subsea road tunnels; one airport investment project; one ship tunnel; one research facility; and one railway project. Finally, the projects were chosen so that all the dimensions analysed were covered in at least one of the projects.

The appraisal reports were analysed and compared according to six dimensions: investment costs, number of benefits measured, measurement methodology used, valuation of the benefits, project-specific assumptions behind the analyses, and type of clients ordering the different assessments.

3.1.1. Investment costs

This dimension addresses the total costs of building the specific infrastructure in question. The literature has shown that investment costs for public-investment projects have a tendency to increase over time (Welde, 2017). Several reasons for this have been suggested. It may partly be because the projects have a tendency to increase in size due to changes in the demand for quality and increased requirements regarding, for example, safety (Austeng et al., 2006). Strategic underestimation of costs in earlier phases of projects has also been suggested in the literature as a reason for cost escalation (Flyvbjerg et al., 2002). For further reading on cost escalation see e.g. Cantarelli et al. (2010), Andersen et al. (2016a) and Welde (2017). The fact that investment costs have a tendency to increase over time made it difficult to compare investment costs in appraisals conducted over the long term. How the analyses were carried out differed somewhat between the projects based on the author's professional judgement of each case. In some instances, the appraisal reports conducted within a time period of up until five years were comparable. In other cases, where two alternative concepts were considered in the projects, the difference in costs between the two alternatives were compared over years.

3.1.2. Number of benefits measured

This dimension addresses the benefit side of the CBAs. If the investment costs of a project are high, the benefits for society need to be correspondingly high for the project to be profitable for society. Some benefits are relatively easy to measure, such as travel-time savings in a road project. Other benefits are more difficult to measure. Among others, this applies to wider economic benefits. Wider economic impacts are defined as impacts that go beyond a conventional transport costbenefit appraisal, such as economic density and productivity, induced private investment and associated land-use change, and employment effects (Laird & Venables, 2017). Wider economic impacts may be both positive and negative and are then called wider economic benefits and wider economic costs, respectively.

3.1.3. Methodology used for measuring benefits

There is room to use different methodologies when measuring benefits both for benefits that are relatively easy to measure and those that are more difficult. The type of measurement method used may have a large impact on the results of the analyses. When building new airports, for example, the traffic prognosis for the new airport will have large

Table 3

Description of the case-projects regarding number of appraisals analysed and dimensions and compared within each project.

| Project | Number of appraisals | Dimensions analysed and compared |
|--------------------|----------------------|---|
| E10 LOFAST | 4 | Investment costs |
| | | Number of benefits measured |
| | | Valuation of benefits |
| | | Ordering clients (3) |
| | | Assumptions |
| Airport Helgeland | 11 | Methodology for measuring benefits |
| | | (traffic prognosis) |
| | | Assumptions |
| | | Ordering clients (5) |
| Ocean Space Centre | 8 | Number of benefits measured |
| | | Valuation of benefits |
| | | Ordering clients (2) |
| Hardanger Bridge | 5 | Investment costs |
| | | Number of benefits measured |
| | | Valuation of benefits |
| | | Ordering clients (4) |
| Stad Ship Tunnel | 13 | Investment costs |
| | | Number of benefits measured |
| | | Valuation of benefits |
| | | Ordering clients (7) |
| High-speed railway | 4 | Methodology for measuring benefits |
| | | (reduction in greenhouse-gas emissions) |
| | | Ordering clients (4) |
| E8 Sørbotn- | 7 | Investment costs |
| Laukslett/Tind | | Number of benefits measured |
| Tunnel | | Valuation of benefits |
| | | Ordering clients (3) |
| Ferry-free E39 | 12 | Number of benefits measured (wider |
| | | economic benefits) |
| | | Methodology for measuring benefits |
| | | (wider economic benefits) |
| | | Valuation of benefits (wider economic |
| | | benefits) |
| | | Ordering clients (3) |

impact on the total benefits measured in the project. By using different methods for making traffic prognosis, the reported benefits of the new airport may vary extensively.

3.1.4. Valuation of the benefits

This dimension addresses how the measured benefits are valued. Different methods for valuation of the measured benefits may contributed to differences in the total benefits calculated in a project. For example, the Norwegian Public Road Administration (NPRA) has standards for valuing the various types of benefits they use when valuing benefits in road projects (NPRA, 2014). Other studies exist that challenge the time values in the standards (see e.g. Halse et al., 2019). The time values used in the valuation may have a large impact on the outcome of the analyses.

3.1.5. Project-specific assumptions

This dimension addresses the project-specific assumptions underlying the analyses. These may, for example, be assumptions about future regional airport structure in an airport project, or assumptions about future effects on regional development of a transport projects.

3.1.6. Clients ordering the assessments

This dimension addresses if and how the appraisal reports differ with regard to whom has ordered them. Based among others on the study by Kvalheim (2015b), one hypothesis is that if the client who orders the appraisal is in favour of the project, it is more likely that the outcome of the appraisal will be positive, concluding that the project is profitable to society, as opposed to if the client is indifferent or negative to the project.

Due to lack of available data, it was not possible to analyse all the dimensions in each project. Table 3 summarises how many assessment



Fig. 1. First reported investment costs compared to the last reported investment costs of the case projects. For two of the case projects, E10 LOFAST and E8 Sørbotn-Laukslett/Tind Tunnel, two and three alternatives were analysed, respectively.

reports were available in each case project along with which dimensions were analysed in each case. The clients ordering the various appraisals varied from governmental agencies, such as the NPRA and the Ministry of Transport and Communications, to local authorities and organisations or private companies representing specific stakeholders.

3.2. Empirical findings

As Table 3 illustrates, several appraisals were available for each of the case projects. For the projects "Airport Helgeland", "Stad Ship Tunnel" and "Ferry-free E39", there were as many as 11, 13 and 12 appraisals available, respectively. There are several reasons why so many appraisals have been conducted in these case projects. First, the projects have been planned and discussed over a long period of time, sometimes several decades. This has made it necessary to update the analyses with new information. Second, it follows from the Norwegian quality assurance system for large public-investment projects (see e.g. Samset & Volden, 2013) that new assessments must be made in order to control and assure the quality of the ones already made. Third, in some projects, there have been conflicting interests among stakeholders. In these instances, the various stakeholders have sometimes ordered different assessments.

In all projects, the results from the various project appraisals varied regarding one or several of the dimensions mentioned in section 3.1. For some of the projects the differences in results were large. In Stad Ship Tunnel project, for example, the analytical teams reported results differing between at the one extreme, that the project had positive net present value, to the other extreme, that the net present value of the project was negative. Below, there follows a more detailed description of how the appraisals differed according to the six dimensions analysed. The first five dimensions – investment costs, number of benefits measured, measurement methodology used, valuation of the benefits, project-specific assumptions behind the analyses – are discussed in relation to the sixth dimension, which is related to the type of client



Fig. 2. Estimated benefits in the appraisals of the project Stad Ship Tunnel (million NOK, 2018).



Fig. 3. Traffic prognoses conducted for the route between the new airport in Mo I Rana and Oslo.

ordering the different assessments.

3.2.1. Investment costs

All the case projects were large, with investment costs above one billion NOK. The projects had been in the planning process for several decades, and the costs had increased extensively over the years. Fig. 1 illustrates this increase by comparing the first reported investment costs with the last. The investment costs for the "Stad Ship tunnel" and the "E10 LOFAST Hadselfjord Subsea Tunnel" projects had increased with as much as 954 and 996 percent, respectively. The large increase in costs observed can mostly be explained by the increase in size of the tunnels that have come over the years because of changes in societal needs and expectations, and the change in building standards for tunnels with, among others, higher safety requirements.

The lowest cost estimates for the "E10 LOFAST Hadselfjord Subsea Tunnel" were reported in 1986 by a private company, established with the aim of promoting the Subsea Tunnel, while the highest estimates were reported in 2018 by the NPRA on behalf of the Ministry of Transport. In the Stad Ship Tunnel project, the lowest cost estimates were reported in 1991 on behalf of the regional public authorities, and the highest in 2018 on behalf of the Ministry of Transport and Ministry of Finance.

An interesting observation was made in relation to the "E8 Tind Tunnel" project. In their reports, the private company promoting the tunnel emphasised in their analyses the cost estimates corresponding to the tunnel being built with one tunnel-run, although the length of the tunnel requires two tunnel-runs. This, of course, made the project look more profitable for society in their analyses. The NPRA's cost estimates corresponded to the tunnel being built with two tunnel-runs.

Despite the examples given above, the difference in investment costs between the appraisals, did not seem to be related to the clients ordering the appraisals.

3.2.2. Number of benefits measured

In five of the projects, there were considerable differences between the assessments regarding the number of benefits included in the analyses. These were the "Ocean Space Centre", "Hardanger Bridge", "Stad Ship Tunnel", "High-speed railway" and "Ferry-free E39" projects. In the "Stad Ship Tunnel" project in particular, there were large differences in the benefit estimation between the various appraisals, as illustrated in Fig. 2. As seen, both the number of benefits included and the valuation of each of them differed between the appraisals. The figure also indicates what types of benefits the various appraisals included. The two appraisals ordered by Maritimt Forum Nordvest, which is an interest organisation for maritime businesses, have included various wider economic benefits such as increased tourism, value-chain effects and safety and comfort effects that amount to a large share of the total benefits of the project. In some of the appraisals there is also a benefit component related to the assumption that a new express ferry route for transport of passengers will be established when the ship tunnel is built. However, it is highly uncertain if this will happen and such a route is expected to be unprofitable for society. Some of the appraisals have thus not included this benefit component. The degree to which accident costs will be reduced has also been disputed, considering that the technological development in both ships and navigation equipment has reduced the risk of accidents in the area.

The aim of the last appraisal of the "Stad Ship Tunnel" conducted in 2018 on behalf of the Ministry of Fisheries and the Ministry of Finance, was to check the quality of the appraisal from 2017 as part of the quality-assurance program for large Norwegian public-investment projects.³ From Fig. 2 it can be seen that the quality-assurance appraisal has included a lower number of benefits in the appraisal compared to the appraisals ordered by Maritimt Forum Nordvest, which has a large interest in the tunnel being built but are not due to finance the project.

In the "Hardanger Bridge" project, the appraisals ordered by the private company promoting the bridge included two extra type of benefits compared to the Norwegian Public Road Administration's appraisal. First, a component was included corresponding to reduced administration costs based on the assumption that municipalities in the region would merge if the new bridge was built. There was great uncertainty both regarding if the municipalities would in fact merge and if this would provide any reduction in administrative costs. If not directly speculative, it was at least highly uncertain that this benefit component would be realised by the project. Second, a component for lower accident costs was included, the relevance of which the NPRA did not agree with.

In both the "Ocean Space Centre" and "Ferry-free E39" projects, various wider economic benefits were included in some of the appraisals. They were related to added value for customers, knowledge externalities in the first project, and agglomeration effects due to increased labour markets in the latter. In the "Ferry-free E39" project, an

³ Norwegian public-investment projects with total costs of 750 million NOK or more are subject to external quality assurance of their appraisals (https://www.regjeringen.no/no/tema/okonomi-og-budsjett/statlig-okonomis tyring/ekstern-kvalitetssikring2/hva-er-ks-ordningen/id2523897/).

interest group representing the ferry crews, among others, ordered an appraisal that critically reviewed the wider economic benefits calculated in the earlier appraisals and concluded that some of them were far too optimistic.

3.2.3. Methodology for measuring benefits

In three of the case projects, the results of the appraisals differed to quite an extent because different methodologies were used to measure the benefits of the projects: "Ferry-free E39", "Airport Helgeland" and "High-speed railway".

In the "Airport Helgeland" project, different methodologies were used to conduct traffic prognoses for the new airport. The results of the various traffic prognoses are summarised in Fig. 3. The prognoses are related to the route between the new airport in Mo i Rana and the capital of Norway, Oslo.

Generally, three different methods have been used to make the traffic prognoses: the point-elasticity method, the analogy method, and the transport model. The prognoses made by the analogy method and transport model were higher than those made by the point-elasticity method. "Polarsirkelen lufthavnutvikling" is a private company that has been working for the establishment of a new airport in Mo i Rana for several years. All the traffic prognoses it has ordered have been made by the analogy method or transport model approach (see, for example, the three made in 2014 and 2015 at the top of Fig. 3).

The "Ferry-free E39" project is a large project with a negative net present value of NOK –51 billion (Dunham, 2015). Several research projects have been conducted in order to find a method to include wider economic benefits in the appraisals to make the project look more profitable for society. These are, as the standard approach for urban applications, heavily dependent on labour market-related agglomeration (see e.g. Cowi, 2012; Norman & Norman, 2012; Ulstein, Skogstrøm, Aalen, & Grünfeld, 2015). However, there is high degree of disagreement between the research teams about the appropriate methodology to use and the results regarding how great the wider economic benefits of the project will be, and the results therefore differ extensively between the studies. Parts of the stretch of road is located close to the cities Bergen, Stavanger and Trondheim, while most of the road stretches are in sparsely populated areas where the effects of agglomeration of labour markets will be limited.

3.2.4. Valuation of benefits

The "Tind Tunnel" project is a good example of how different valuation of benefits could be used to increase the calculated benefits of the project. The company that was set up to work towards the realisation of the project partly followed the same methodology as the NPRA in their appraisal; however, they used higher time values, higher average passenger numbers in cars and higher valuation of the benefit of reduced accident costs compared to NPRA's standards (NPRA, 2014).

In the "Hardanger Bridge" project, the valuation of benefits was also different between the appraisals. In the appraisal conducted on behalf of the private actor promoting the project, both the time values and the traffic volumes were upgraded compared to the NPRA's standards. This contributed towards explaining why this appraisal showed higher benefits of the project than the others.

In the "Stad Ship Tunnel" project, different valuation of benefits also appeared in the analyses. As seen in Fig. 2, the benefit component related to fishing activities and the transport of goods was very differently valued in the appraisals. In some of the appraisals, such as the ones in 2007 and 2017 bought by the Ministry of Fisheries and the Norwegian Coastal Administration, this benefit component amounted to a large portion of the total benefits of the project.

3.2.5. Assumptions behind the analyses

Many of the appraisals differed regarding project-specific assumptions, some of which have already been mentioned – for example, the assumption about the establishment of an express ferry route giving an

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Table 4

Summary of findings from each case project.

| Project | Main reasons for differences between the appraisals |
|---------------------------------------|--|
| E10 LOFAST | Differing CBAs due to differing numbers of benefits |
| Airport Helgeland | Differing traffic forecast due to different methodologies used and different assumptions made about the regional airport structure |
| Ocean Space Centre | Differing CBAs due to different number of benefits measured and monetised |
| Hardanger Bridge | Differing CBAs due to a combination of differing numbers of benefits included in the appraisals and differing benefit valuation |
| Stad Ship Tunnel | Differing CBAs due to a combination of differing numbers of benefits measured and differing benefit valuation |
| High-speed railway | Differing CBAs due to different project-specific assumptions made and different measurement of reduction in greenhouse-gas emission |
| E8 Sørbotn-Laukslett/ Tindtunnelen | Differing CBAs due to a combination of differing numbers of benefits included in the analyses and differing benefit valuation |
| Ferry-free E39 | Differing total wider economic benefits of the project due to a combination of differing number of benefits included, differing methodologies used for measuring them and differing benefit valuation |

extra benefit component in the assessment of the "Stad Ship Tunnel", thus leading to higher profitability of the project. Another was the assumption that the municipalities surrounding the "Hardanger Bridge" would merge, where those in favour of the project assumed this and included reduced administration costs in their appraisal, increasing the net present value in their appraisals. A third example mentioned was the assumption regarding the "Tind Tunnel" if it would be built with one or two tunnel-runs. Those in favour of the project emphasised the costs of one tunnel-run in their appraisal, which increased the profitability of the project.

In the "Airport Helgeland" project, the various appraisals assumed differently regarding what would happen to the existing airports in the region. If nearby airports were shut down when the new airport was opened, this would result in a higher traffic prognosis at the new airport as opposed to if they continued to exist. However, it is difficult to see any pattern between whom ordered the prognoses and the type of assumptions made regarding the regional airport structure.

In the "High-speed railway" project, assumptions about passenger base and needed number of tunnels and stations led to large differences in appraisal results. In general, those in favour of the project, such as Norsk Bane, were the buyers of the appraisals concluding that the project had positive net present value, while the appraisals ordered by the national authorities (those who would finance the railway) showed negative net present value.

A summary of findings from each case project, with the main reasons for the large differences in their appraisal results, is presented in Table 4.

4. Discussion

For appraisals conducted in very different time periods, the investment costs of the projects varied a great deal, with an extensive increase in costs over time. This is fully in line with what earlier studies have revealed, as described in section 3.1, and many reasons for this have been suggested in the literature (see e.g. Welde & Odeck, 2017 for further details on this literature). For this paper it is interesting to notice that appraisals conducted at approximately the same time (within five years or so), the appraisals do not seem to differ so much in relation to investment costs, although the example of the "Tind Tunnel" shows that investment costs may be presented as lower in the appraisals due to assumptions made about the size of the project. In this example, the investment costs were approximately equal between the different appraisals ordered by different clients for a tunnel with two tunnel-runs. It High



Fig. 4. The effect of combining high/low measuring and valuation of benefits on the total value of benefits in the project.

was the fact that the client in favour of the project chose to present the costs of a tunnel with one tunnel-run that made the difference.

The analyses of the case projects show that the measuring and monetising of benefits sometimes differed extensively between the appraisals. In addition, important project-specific assumptions sometimes had a large impact on the conclusions of the appraisals, and thereby contribute towards explaining why they differed.

The high measuring of benefits combined with high valuation of each benefit will result in higher total benefits, and thereby higher profitability of the project compared to the opposite with a low measuring and valuation of benefits. Fig. 4 illustrates the effect of combining high or low measuring and valuation of benefits on the total value of benefits reported.

The most pronounced critique of CBAs, which can be associated with the introduction of new benefits in the analyses, is related to the fact that not all consequences are quantified and monetised (critique 1 in Table 1). As discussed, there may be good reasons for not including all consequences in a CBA, both because it is difficult or even impossible to do so, and because such a CBA could be too comprehensive to relate to for decision-makers (Sager, 2013). On the other hand, there are several reasons for trying to measure and monetise as many benefits as possible if one is in favour of a project. First, it is often easier to relate to monetised costs and benefits, and these are easier to communicate compared to other types of presentations, such as the use of colour-scales and consequence-fans (Nyeng, 2004). The latter are e.g. used by the NPRA for consequences associated with the natural and cultural environment, outdoor activities, nature-based resources and landscape (NPRA, 2014). Second, it can be a strategy towards preventing less important consequences from receiving too much attention at the expense of important consequences when the former are easy and the latter difficult to measure and monetise. These factors favour quantification and monetising benefits instead of using qualitative descriptions, although this may produce a CBA with questionable economic content. However, the challenge arises when different teams of analysts choose to measure and monetise different consequences. Then the results from the appraisals will differ, and if the reasons for the differences are not transparent in the appraisal reports, it is difficult for policy-makers to relate to the differing results.

Future benefits of a project are often difficult to measure because of uncertainty related to both future societal needs and expectations and what the effects of a project will be. Traffic prognoses represent inputs in transportation-project appraisals that have large impact on the results of the analyses. If there is no established standard stating which methodology is best to use in the performance of traffic prognoses, there is room to use different methodologies, resulting in differing appraisal results. In addition, it is difficult to reject one appraisal over another when there is no established standard. This could be seen in the "Airport Helgeland" project. Those in favour of the project had ordered the appraisals using the analogy method, which provided the highest traffic prognoses, while those who were to finance the project had ordered appraisals using the point-elasticity method, which provided lower traffic prognoses. However, it is difficult to judge which appraisal is most reliable because all three methodologies used in the different appraisals are accepted as reliable methods. In this particular project, it may be useful to mention that Solvoll, Mathisen, and Welde (2018) argue that the analogy method might be better to use than the point-elasticity method when traffic prognoses are made for projects that are expected to cause large changes in passengers' generalised transport costs.

When it comes to the valuation of benefits, the same problem arises as with the measuring of benefits, where no established standard exists. Then there is room for different valuation of benefits, something that could be seen in the "Ferry-free E39" project. There is no established standard for how to measure and value wider economic benefits of transport projects, and this opens for large differences in the appraisals. On the other hand, for valuing travel time savings in transport projects, the NPRA has established standards (NPRA, 2014). It is therefore more problematic when some analysts chose to use time values other than the established ones – at least if this is not transparent for those who use the appraisals.

Particularly in early phases of projects, there will be many uncertain aspects that the analysts need to make assumptions about in order to be able to conduct an appraisal. This also gives room for very different results. In these cases, it will be difficult to judge which appraisals are most reliable if uncertainty still exists. This was the case of the "Airport Helgeland" project. Future regional airport structure has been debated for a long time and is still undecided, so it is difficult to say which of the appraisals have made the right assumptions. However, in another project, the "Hardanger Bridge" project, it was more open for discussion whether it was right to include the assumption that the surrounding municipalities would merge due to the new bridge, and that this would lead to reduction in administration costs for the municipalities.

There are several ways in which the clients may impact the outcome of a CBA. First, the clients may impact the choice of concepts to consider and other types of assumptions important for the analysis. As mentioned in the previous section, varying assumptions between the different appraisals were seen in several projects such as "Airport Helgeland", "E8 Sørbotn-Laukslett/Tindtunnelen", "Ocean Space Centre" and "Ferry-free E39".

Second, the client may impact the outcome of the appraisals by demanding certain methodologies for measuring and valuation of costs and benefits. This was seen both in the "Airport Helgeland" project and the "Ferry-free E39" project. Different methodologies applied for making traffic prognoses and the measuring and valuation of wider economic benefits, respectively, gave large differences in the outcome of the appraisals.

A third way a client may impact the result of a CBA is by giving or withholding access to data and information necessary for the estimation. It is difficult to judge whether this has happened in the studied appraisals based on the documents available.

Finally, one imagines that the analysts could experience difficulties in delivering outcomes that they know the client will not appreciate. This concerns the integrity of the analysts. It is difficult to judge whether this has happened in the studied projects based on the documents analysed. However, there was one example that did indicate high analyst integrity. The documents revealed that the professional analyst teams that had been involved in the appraisal process of the "Tind Tunnel" project were only responsible for part of the analyses and had not been involved in the more speculative measurement and valuation of the benefits of the project. The reports indicated that the clients did not agree with the outcomes of the analyst teams and that they had adjusted the assessment results to achieve the desired outcomes.

Common to the projects was that those who were to finance the projects (national and/or region governments) had often ordered the more conservative or moderate appraisals, in contrast to those with large interests in the building of the projects, but who would not have to

A framework for comparing and evaluating different appraisals performed on a specific project.

| | Project specific assumptions | Number of benefits measured | Methodology used for measuring benefits | Method/standard used for valuing benefits | Investment costs |
|---|---------------------------------|-----------------------------|---|---|------------------|
| Appraisal 1 Appraisal 2 Appraisal 3 | | | | | |
| | | | | | |

finance them. The latter then has the incentive to overestimate benefits and underestimate costs, as argued by De Rus and Socorro (2017).

5. Concluding remarks

This study has addressed the problem of contradictory outcomes of appraisals of similar projects by analysing eight Norwegian publicinvestment projects. A common feature of the studied projects is that they have all been subject to several assessments during their planning periods, which for some of the projects have stretched over several decades. This is partly because there have been controversies related to the projects, with different stakeholders having various interests in them. The various appraisals differ, sometimes extensively, in their conclusions.

There are discrepancies regarding what types of benefits are included in the analyses, how they are measured, and how they are monetised. In addition, project-specific assumptions vary between the appraisals. There is a tendency toward appraisals showing great benefits for society when they are ordered by those in favour, and lower benefits when ordered by clients indifferent or reluctant to implement the projects. The latter are sometimes those who are to finance the projects. This indicates that the clients ordering the appraisals may in some cases have impacted the outcome of the appraisals either by: (1) impacting the choice of concepts to consider; (2) impacting project specific assumptions; (3) demanding certain methodologies and standards be used when quantifying and valuing benefits; (4) withholding data or information of the project; or (5) adjusting the conclusions because they disagree with the analysts.

In relation to the weaknesses of CBA identified in the literature, there seems to be disagreement both about which consequences to quantify and monetise in CBAs and biases in the analysis process. However, as Schmidtz (2001) argues that, even if CBAs have flaws, this is not sufficient reason to reject the very idea of CBA – no real-world decision-making procedure is perfect. One solution to the specific issue addressed here with varying outcomes of the CBAs is to require that the appraisals are made more transparent with regard to important factors crucial for the outcome of the appraisals. The document analyses performed in this study revealed that these factors were often poorly described in the reports, making it difficult for others to evaluate them. This is in line with the results from the study by Kvalheim (2015a).

The question is then how to make the assumptions and the use of evidence in the appraisals more transparent and open to challenge and appeal so that decision-makers are able to use the information from the appraisals in their decision-making processes.

In this study, six dimensions were identified as important in explaining why the appraisals differed: monetising of investment costs, types of benefits measured, methodology used for measuring benefits, method/standard used for valuing benefits, project-specific assumptions, and whom had ordered the appraisals. In order for the decision-makers to be able to evaluate the outcomes of each appraisal, a first step could be to require that the reports – preferably in their summaries, which is sometimes the only part of the reports read by decision-makers – document important factors determining the outcome of the appraisals, such as the ones revealed in this study. This could be in the form of a table reporting on the first five dimensions. For the decision-makers it would then be easy to compare and evaluate the appraisals such, as

illustrated in Table 5.

A more demanding suggestion would be to require that sensitivity analyses were made regarding specific important factors. This could, for example, be seen in the "Airport Helgeland" project, where some of the analyst teams presented several analyses based on different assumptions both regarding measuring methodology used and assumptions regarding future regional airport structure. When established standards exist, such as the standards for valuing travel time, this study suggests that these are used in the analyses. In addition, sensitivity analyses could be made using other non-established standards if the analyst team find this appropriate. The sensitivity analyses could then be presented alongside the appraisal results based on established standards, and thereby open up for discussion.

The findings from this study show that policy-makers need to be aware of how appraisals can differ in results, particularly with regard to the six factors that have been revealed in this study to be crucial for the results of the analyses. They are recommended to demand that the appraisals are made more transparent. It should also be in the interest of the analysts that the appraisals created can be judged as both credible, salient and legitimate and thereby contribute to effectively linking assessment results and decision-making.

This study has only explored eight public projects that were selected on the basis of specific criteria. This implies that the projects are not necessarily representative for the whole portfolio of public-investment projects in Norway. A suggestion for further studies is to extend the analysis to a larger pool of projects and see if the same results can be seen in these. Further research is also needed regarding which role CBA has in the decision-making process and how CBAs could be used in the decision-making process in a more transparent way.

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