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Socio Economic Analysis of Road Projects

Development of CBA during conceptual
phases

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Preface

This study was conducted at the Department of Civil and Transport Engineering at the Norwegian University of Science and Technology (NTNU), and aims to fulfil the requirements of TBA4910 - Master thesis in Project Management.

First of all, I would like to thank to my NTNU supervisors, namely Professor James Odeck and Professor Olav Torp for their guidance and support. I appreciate all the time that they took of their busy schedules to meet me, given always relevant inputs and feedback to this study. I also would like to thank to Ulf Tormod Haraldsen, the external supervisor from NPRA, who have contributed significantly within the topic of the study with so valuable and pertinent inputs.

Last but not least to my loved ones. Firstly, I would like to thank to my soulmate, Mafalda Silva, who have supported me through all this journey, giving me always a remarkable motivation. Secondly, I would like to thank my mother, who despite being in Portugal has given a great support, with simple but valuable words that only a mother can give. In addition, I would like to thank my closest friends who always have shown their support in all challenges that I set up for myself.

Trondheim, July 2018

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Abstract

A Socio Economic Analysis (SEA) is a complex and multidisciplinary assessment that evaluates the costs and benefits that a road project will create for the society. In Norway, it is performed in an early stage of a road project and it is comprised of two main processes, namely, conceptual study (KVU) and external quality assurance of conceptual study (KS1). Essentially, both processes have the same goal that is to assess the possible road project alternatives in terms of monetised and non-monetised impacts. However, the results from both processes can vary significantly, especially in terms of non-monetised impacts, raising thus questions regarding the method of assessment used and ultimately, the selection process of the assessed alternatives.

In this regard, this study aimed to address the differences in monetized results for both KVU and KS1 processes in an early stage of Norwegian road projects. This was done by assessing the reported key performance indicators (KPIs) of a total number of 26 road projects developed in Norway, as well as by performing in-depth interviews with a significant number of project managers from both public and private sectors. In addition, this study aimed to address possible changes that could be made to prevent the variation of results, leading consequently to an improved SEA process.

According to study findings, the interest rate and period of analysis are the main causes of variation between KVU and KS1 process results. In addition, it was found out that toll charges also play an important role in the variation of results. In this sense, an interest rate of 4% and a period of analysis of 40 years were suggested to be applied to road projects towards a more standardized process and hence towards a more transparent and better selection process of road project alternatives. Regarding the toll charges it was suggested that it should not be considered if its use is only focused on project's funding, as it might affect its scope. Regarding the assessment of the different alternatives, it was found out that alternative zero has associated a high level of subjectivity. In this sense, it was suggested that criteria to define the scale of investment considered in the alternative zero should be applied to avoid misunderstandings in the process selection by the Norwegian government. Furthermore, it was found out that that in some cases neither the KVU nor KS1 suggested alternative were considered in the selection process by the decision-makers, but rather one of the other assessed alternatives.

All in all, according to study findings it was concluded that there is a significant discrepancy between KVU and KS1 process results, and that the suggestions made throughout the study might help in the standardization of both processes. Nevertheless, it was also concluded that a further analysis is required and in such analyse more focus should be given to the decision-making process.

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List of Abbreviations

BCr	Benefit cost ratio
CBA	Cost benefit analysis
FRT	First year rate return
KPIs	Key performance indicators
KS	External quality assurance, *Ekstern kvalitetssikring* in Norwegian
KS1	External quality assurance of conceptual study
KS2	External quality assurance of project management and cost estimates
KVU	Conceptual study, *Konseptvalgutgredning* in Norwegian
NNRA	Norwegian national rail administration
NOK	Norwegian kroner
NPRA	Norwegian public road Administration
NPV	Net present value
PMs	Project managers
SEA	Socio-economic analysis

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1. Introduction

In this Chapter, the background is firstly presented outlining the importance of a socio-economic analysis (SEA) in road projects. The main issues associated with a SEA are also described, and emphasis is given to the assessment of monetised impacts through a cost-benefit analysis (CBA). Thereafter, the research questions and the scope of the study are presented in Sections 1.2 and 1.3, respectively. In Section 1.4 the thesis structure is outlined.

1.1. Background

A SEA is a complex and multidisciplinary assessment of the monetised and non-monetised impacts associated with a road project (NPRA, 2007). Essentially, it evaluates the costs and benefits that a road project will create for the society, by measuring them against an alternative zero that represents what would happen if the project did not occur.

In Norway, a SEA is performed in an early stage of a road project and it is comprised of two main processes, namely, the conceptual study, known as *konseptvalgutredning* (KVU), and the external quality assurance of KVU, known as *kvalitetssikring* (KS1) (NPRA, 2014a). Essentially, both processes have the same goal that is to assess the possible road project alternatives in terms of monetised and non-monetised impacts. However, the results from both processes can vary significantly, especially in terms of non-monetised impacts, raising thus questions regarding the method of assessment used and ultimately, the selection process of the assessed alternatives (Eliasson et al., 2015). In this sense, it is of high importance to further understand the method of assessment used and the main uncertainties associated with it.

The monetized impacts of a SEA, for both KVU and KS1 processes, are assessed through a CBA. This is a widely researched and used method to appraise road projects in an early stage, supporting decision-makers in public investments (Mouter et al., 2013; Odeck, 2004; Torp et al., 2016; Welde et al., 2017). It helps to prioritise the projects with higher benefits and lower associated costs throughout its lifetime, thus allowing to rank projects according to its viability and priority (Jones et al., 2014; Mouter et al., 2013; NOU 2012:16, 2012; Odeck, 2010). However, the parameters used to assess the benefits against the costs of a road project can vary significantly depending on its goal and scope.

In addition, a significant number of studies referred that there is a tendency to establish lower initial costs and higher time benefits estimations to get approval from the decision-makers (Eliasson et al., 2015; Mouter, 2017; Odeck, 2014; van Wee, 2012). Furthermore, even though CBA is a mandatory tool in the assessment of a road project in an early stage in Norway, Eliasson et al. (2015) and Odeck et al. (2010) referred that decision-makers do not take under consideration the CBA results when assessing project's viability.

In this sense, towards a clearer and standardized SEA process, and hence towards a clearer selection process of alternatives, it is of high importance to assess and better understand the differences in the CBA results reported in both KVU and KS1 processes. For this reason, an assessment of the reported costs and benefits, in monetary terms, in both KVU and KS1 processes, will be performed in this study.

1.2. Research questions

The purpose of the study is to address the differences in the reported CBA results by both KVU and KS1 processes in an early stage of Norwegian road projects. In this sense, this study will assess the KVU and KS1 reported results, in monetary terms, of a total number of 26 road projects developed in Norway. This will be done by using key performance indicators (KPIs) average results, thus allowing a comparison between the different project's alternatives as well as between the different selected projects. In addition, the study aims to address possible changes that could be made to prevent the variation of results between KVU and KS1 processes, thus leading to an improved SEA process and ultimately to an improved selection process of alternatives. Furthermore, in-depth interviews will be performed to project managers (PMs) involved in both KVU and KS1 processes, aiming to perceive the different perspectives of the PMs in both processes.

The following research questions will be discussed during this study:

- Which are the main causes for variation of results between KVU and KS1 processes in an early stage of Norwegian road projects?
- How are the different alternatives assessed in comparison with the alternative zero?
- What are the possible changes to prevent variation of results between KVU and KS1 processes?

1.3. Scope of the study

This master thesis is carried out as part of the Master of Science in Project Management, and the theme of SEA in road projects follows two main academic courses, namely Economics of Transport Infrastructures and Project Planning and Analysis, where the assessment of the monetised impacts of a SEA through a CBA was presented and further studied. Special attention is also given to the Norwegian conceptual study, namely KVU process and the associated KS1, which are performed in large scale in Norwegian road projects.

1.4. Thesis structure

The study is divided in 7 Chapters and includes 2 Appendices, which comprise all supporting information.

Chapter 2 presents the research methodology applied in this study. The chapter is divided into two main sections. In the first section an overview of the different research and interview methodologies is presented, Section 2.1. Thereafter, in Section 2.2, a further description of the methodologies applied in this study is given.

Chapter 3 presents the literature framework. In Section 3.1 the different phases of a road project are described, giving special emphasis to the early stage. Thereafter, in Section 3.2 the Norwegian official procedures to start a project since its inception are depicted and KVU and KS1 processes are further described. In Section 3.3, the general concepts of a CBA are presented and lastly, the challenges and uncertainties associated with CBA and the current problems of road project planning are addressed according to recent literature findings, in Sections 3.4 and 3.5, respectively.

In Chapter 4 the selected Norwegian road projects are presented and assessed. In Section 4.1 the main characteristics of the selected road projects is given. Thereafter, in Section 4.2 the KPIs used to assess the differences between KVU and KS1 processes results are presented and in Section 4.3 the selected road projects are further presented and assessed. The projects are presented per region, thus enabling the comparison of projects results between and within the different Norwegian administrative regions of NPRA.

Chapter 5 presents the results of the in-depth interviews. The different point of views of the interviewed parts are presented and discussed. Both the differences in the monetised results and the possible changes to the Norwegian process are addressed with the aim to present solutions towards an improved and standardised process. In the Section 5.1, the main influencing factors in an early stage of road projects are presented. Thereafter, in Section 5.2, the issues associated with alternatives zero and zero plus are presented and further discussed. In Section 5.3 it is addressed how decision-makers deal with the results in an early stage of a road project and lastly, in Section 5.4, further comments regarding the overall SEA process are presented.

In Chapter 6 the results from the analysis of the selected projects and from the interview process are further discussed and suggestions towards and improved SEA process are given.

Finally, Chapter 7 provides a conclusion based on the outcome of the analysis and on the research questions considered.

Figure 1 presents a flowchart of the study structure, depicting the different sections, the relation between them as well as the different inputs to the different sections.

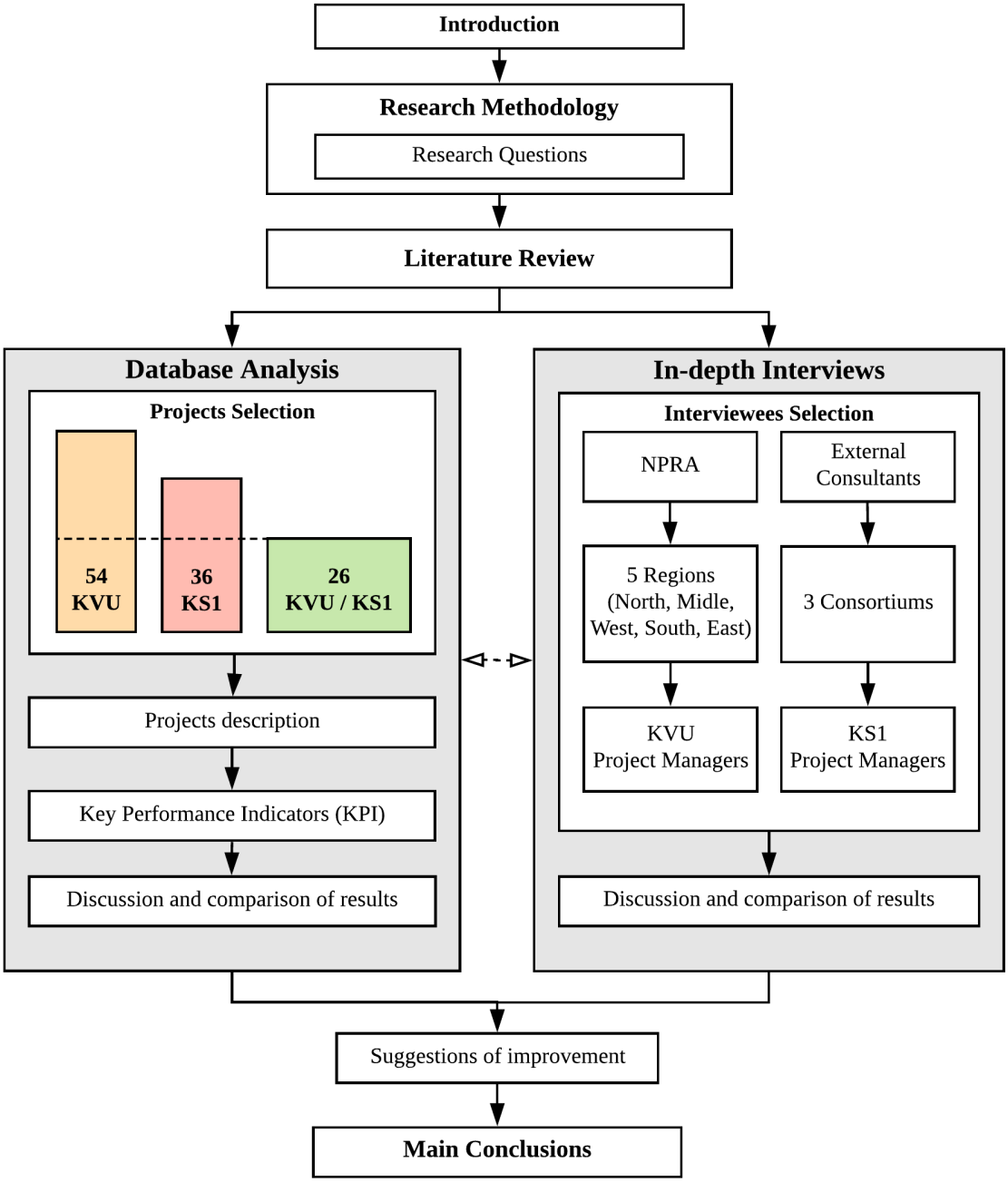

Figure 1: Project thesis structure flowchart

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2. Research Methodology

This Chapter describes the research methods applied in this study. Section 2.1 presents an overview of the different methods of research, while in Section 2.2 the chosen research methods are further described.

2.1. Overview of research methods

Depending on the nature of the problem and the strategy to tackle it, research methods comprise three main phases, namely data collection, analysis and results interpretation. In addition, the research methods can be subdivided into three main types, qualitative, quantitative and mixed (Creswell, 2014; Johnson et al., 2004; Kothari, 2004).

The qualitative research method is a process of research that is grounded on emerging questions and procedures. This method aims to understand non-numerical data in terms of the researcher perspective. Some examples of this method are: ethnographic research, focus group and in-depth interviews. Essentially, within a specific context, a qualitative method attempts to analyse and understand, through interpretations of a specific research topic (Creswell, 2014; Kothari, 2004).

On the other hand, a quantitative research method implies treatment of numerical data, which can be performed through a numerical database analysis, for example. It is considered a method for testing theories by analysing the relationship between variables. This method allows generalizations and replication of findings, which makes it strict for diverging opinions or alternative explanations (Creswell, 2014; Kothari, 2004).

Linked to the previously described methods is the mixed research method, which combines both quantitative and qualitative data. The approach for a mixed research methodology is based on the principle of complementarity, i.e., the interrelationship between qualitative and quantitative. This method is useful when the two types of data can be combined, enabling a better analysis and understanding of a research problem, thus having practical and strategic advantages (Creswell, 2014; Johnson et al., 2004; Kothari, 2004).

2.2. Chosen research methodology

In accordance with the research questions presented in Section 1.2, the research methods considered in this study are the qualitative, quantitative and mixed methods. Figure 2 depicts the chosen research methodology for the theory framework, in-depth interviews and database analysis processes.

In Section 2.2.1 the methodology used to perform the theory framework is presented. Thereafter, in Section 2.2.1 the methodology used to select the road projects assessed in this study is presented and in Section 2.2.3 the interview process as well as the interviewee's process selection are described.

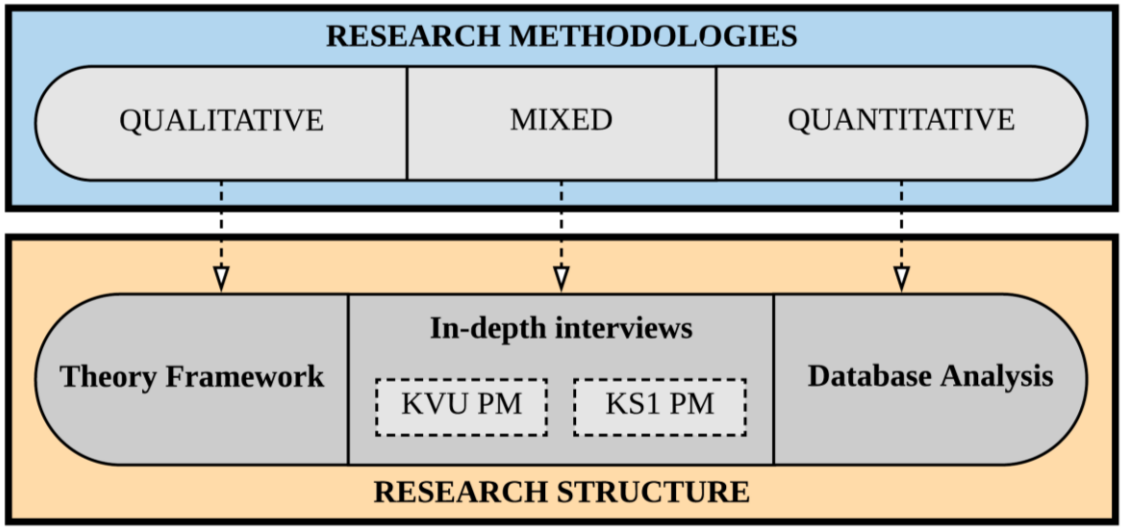

Figure 2: Chosen research methodologies

2.2.1. Theory framework methodology

In accordance with the goals of this study, previously presented in Section 1.2, the literature review is focused on studies that performed a SEA of road projects in an early stage, and that addressed the limitations and challenges of the different monetised aspects of CBA.

For the search of relevant articles within the stated topic, keywords were defined for a systematic academic literature review and relevant scientific databases were used. The search was made by using the following keywords: socioeconomic analyse, cost-benefit analysis, transport infrastructures, conceptual studies, road project, costs estimation,

benefits estimation; and by using the following scientific databases: Oria, Science Direct, Scopus and Web of Science. From the considered keywords searched in the mentioned scientific databases only 8 hits were considered relevant for the Norwegian framework.

2.2.2. Database analysis methodology

In this Section, the quantitative research method used to perform the database analysis is further described.

In Norway, 54 road projects were assessed by NPRA. However, from these, only 36 projects comprised KVU and KS1 processes in an early stage. Due to critical and significant differences between theses 36 projects, three major criteria were stablished to enable a further comparison between them. The first stablished criterion is focused on the type of projects and requires a clear defined goal towards road projects. Therefore, projects rather focused on rail and sea transport were excluded. On the other hand, the second and third criteria are focused on the projects' scope. The second criterion requires that only road projects' stretches connecting two locations are considered, while in the third criteria only urban areas where road projects are playing an important role are considered. The distinction between the second and third criteria was needed since otherwise one would be comparing road projects with different scopes and hence with possibly significant differences in results towards KVU and KS1. Noteworthy that in the third considered criteria, all transport facilities are considered on the urban network road projects. By using the described criteria, the number of considered road projects decreased to 26. To these, a database was created comprising data regarding its key performance indicators (KPIs) results, which are further described in Section 4.2.

Noteworthy that the data gathering of the selected 26 projects and the further development of the database was a very time-consuming process since it required the reading of 52 reports - KVU and KS1 reports and the collection of a significant number of data. Furthermore, it is important to notice that conversions were required in projects that presented different units in order to enable its further comparison.

Further in Chapter 4, the selected road projects are described in detail and an extensive quantitative analysis is performed.

2.2.3. Interview framework methodology

Research interviews are commonly used to explore the views, experiences and motivations of individual participants and they can be divided into two main groups, namely, quantitative and qualitative. The main difference between the two main groups of interviews is that qualitative interviews consist in open-ended questions, being also known as intensive or in-depth interviews. On the other hand, quantitative interviews refer directly to survey interviews, since it is performed in a survey-style question, with formatted answers. Quantitative interviewers are also normally used for gathering large data in a representative sample (Blackstone, 2012; Frels et al., 2013; Gill et al., 2008). In this sense, due to the nature of the study a qualitative method will be used.

Qualitative research interviews are divided into three main types namely, structured, semi structured and unstructured (Gill et al., 2008). Structured interviews are verbally performed questionnaires, where a list of determined questions are outlined with little variation and with no possibility for follow-up questions. Therefore, this type of interview should not be performed when a need of depth in interviewee's answers is required. On the other hand, it is a relatively quick and easy to manage type of qualitative research interview (Frels et al., 2013; Gill et al., 2008).

Unstructured interviews on the other hand are performed with little or no organisation. The unstructured interview can simply start with an opening and general question, and from there the interview will evolve mainly upon the answer initially provided. In this sense, this type of interviews can be extremely time-consuming and difficult to manage due a lack of guideline. Therefore, it is generally only considered when almost nothing is known about the topic under study (Frels et al., 2013; Gill et al., 2008).

The third type of interview is the semi-structured and consist in several key questions that help to outline the topic to be discussed. It also allows the interviewer or interviewee to diverge from the point, in order to present another perspective. This type of interview is the most used in research, since it provides some guidance to the participants on what to discuss about, which many consider helpful. Flexibility is the main advantage in this type of approach, particularly compared to structured interviews, which may lead to important findings that have not been thought previously of as relevant for the research (Frels et al., 2013; Gill et al., 2008).

In accordance with the semi-structured method, a relevant number of project managers (PMs) were interviewed, both in private and public sector. This method was performed with a high level of openness, and thus no response options were previously established. In addition, it should be noted that the participation in the interview process was voluntary and that the responses of individual participants are confidential. In this sense, in case of using an interviewee citation, the participant cannot be identified. Furthermore, as the interview follows the semi-structured method, it was established with interviewees that there was the possibility to clarify questions and to delve deeper into a particular topic of interest.

The interviews were conducted by using an interview guide, which can be found in Appendix A, which comprises the structure of the interview as well as the interview questions. The interview results are further presented in Chapter 5.

- **Interviewee's process selection**

The interview process aims to add to the discussion regarding the differences in the results as well as the possible changes that can be implemented in the Norwegian process according to interviewee's experiences.

In this sense, the selection of the interviewees was mainly based on one but very important characteristic: the interviewed PMs must have a broader knowledge and work experience within the KVU and KS1 processes performed in an early stage of Norwegian road projects. In this sense, with the support of the thesis supervisors, five PMs from the NPRA highly skilled within the KVU process were selected, representing the public sector and the five administrative regions – Northern, Central, Western, Southern and Eastern Norway. Regarding the private sector, four PMs from consortiums with large experience within the KS1 process were chosen.

In order to present an overview of the nine interviewed PMs, Figure 3 depicts their backgrounds and years of experience. The years of experience are depicted in the inner circle while the outer circle represents the background of the interviewed PMs in terms of percentage. For example, from the nine interviewed PMs, how many have a background in civil engineering? This overview is considered relevant due to the fact that the development of road projects in an early stage requires multidisciplinary expertise, thus being interesting to understand if that applies to the selected interviewees.

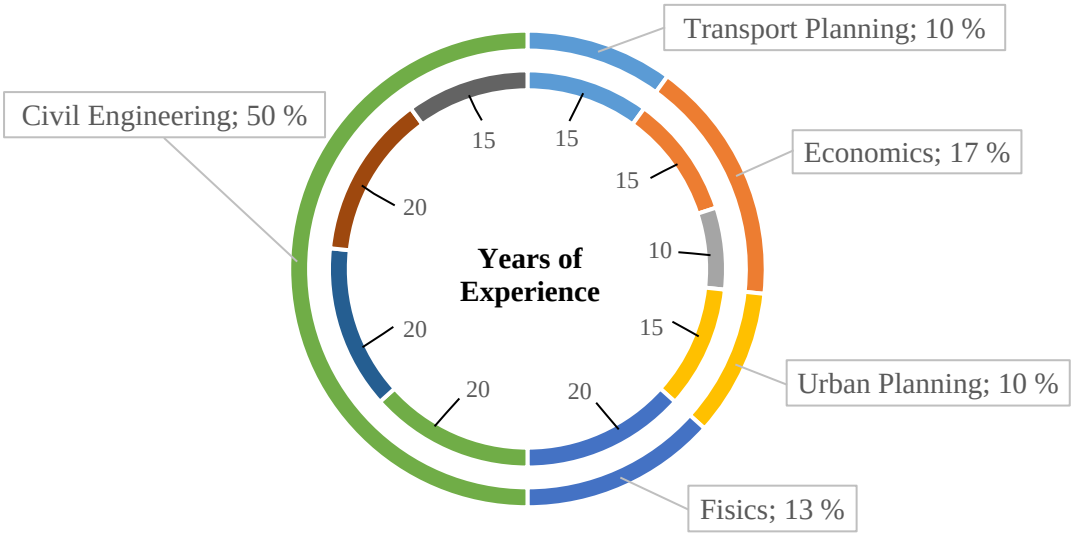

Figure 3: Overview of the interviewee's background and years of experience

According to the results, 50% of the interviewed PMs have a background in civil engineering, and 17% a background in economics. However, due to the technicity demanded in an early stage of a road project, which requires a high knowledge in economics and project management, these two backgrounds can be considered the most relevant ones. Nonetheless, it should be noted that a higher diversity of backgrounds may allow different and interesting perspectives.

Additionally, interviews were performed to academic and research professionals at NTNU Concept Research Program. This was considered relevant to the overall interview process results since this program seeks to develop knowledge and expertise in order to improve the use of resources and enhance the effects of public investments (Samset et al., 2018). Furthermore, it was considered relevant to have the point of view of researchers that besides being highly skilled in SEAs and CBAs, do not work neither for the NPRA neither for external consultant companies. Therefore, it can be stated that they may have a different perspective of the entire process, and in a certain way, more freedom to criticise it.

3. Theory Framework

This Chapter is divided in five main sections. Section 3.1, presents the different phases of a road project, giving special emphasis to the early stage. Thereafter, in Section 3.2, the Norwegian official procedures to start a project since its inception are depicted, and thereafter, the general conceptions of CBA are presented in Section 3.3. Lastly, in Sections 3.4 and 3.5, the challenges and uncertainties associated with CBA as well as the current problems of road project planning are addressed, according to recent literature findings.

3.1. General conceptions of projects in an early stage

According to Samset (2010), a process to develop a road project can be divided into three main phases, namely, front-end, implementation and operational phase, being the front-end phase the shortest of the three, Figure 4. However, despite being the shortest, the front-end phase or early stage is the most crucial one.

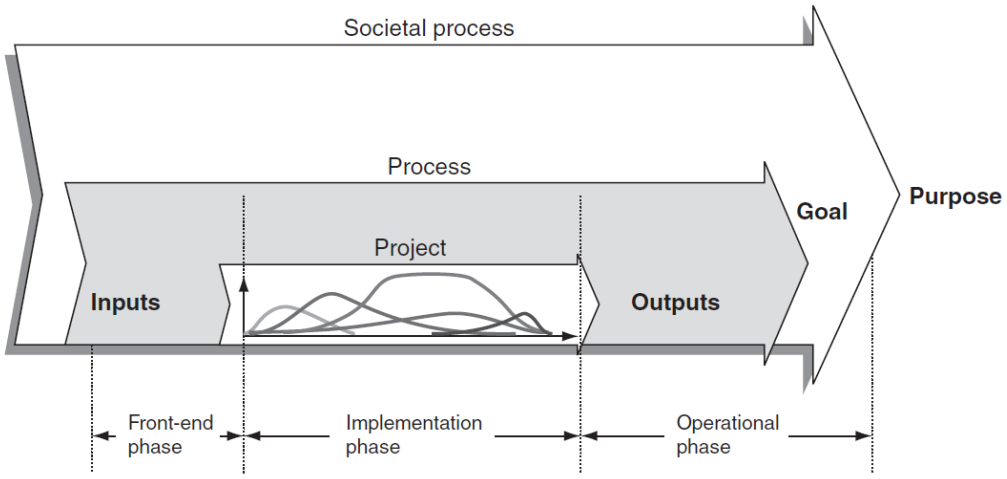

Figure 4: The different phases of a project process (Samset, 2010)

The early stage comprises a conceptual study and it is initiated with a general analysis of needs, addressing the problems and requirements in order to identify the most viable project strategy. This process aims to clarify the generic concept and the different conceptual alternatives that might be considered.

It is also of high importance to understand that at the early stage, the likelihood to influence the concept is the highest, while the knowledge about of what is ahead is

minimal. In this sense, the possibilities to influence the concept decrease as decisions are made, and alternatives are defined. This can be perceived in Figure 5, where the relation between uncertainty and information is presented.

The figure also shows that later changes in the project lead not only to changes in the goal and scope but also to extra costs. Therefore, it can be stated that it is progressively more difficult to make changes as the project is undergoing.

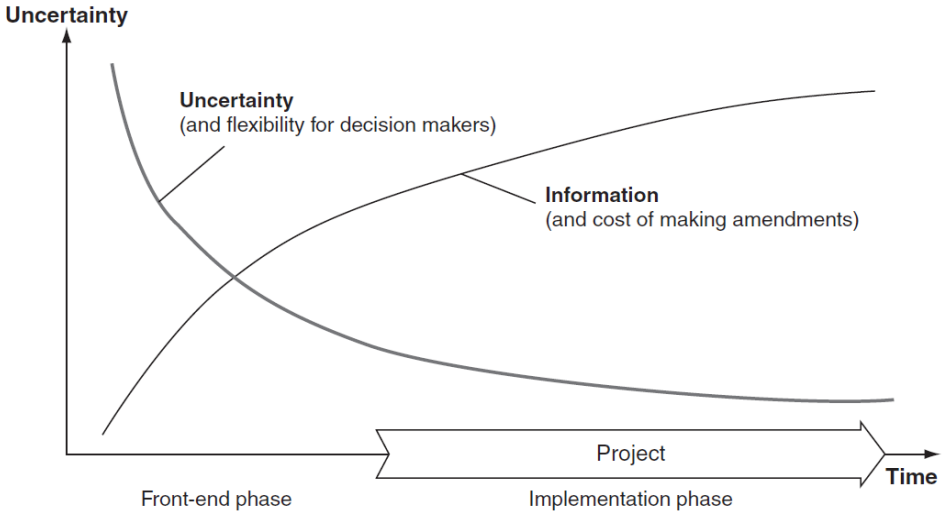

Figure 5: Uncertainty versus information in the early stage (Samset, 2010)

The cost of a road project is one of the most important parameters, however it is also the parameter with higher uncertainty associated in an early stage. This is due to the fact that the available information is limited and that the timeframe between this phase and the implementation phase is too long. However, as the process of a road project develops, the uncertainty associated to the cost estimation is expected to decline. For instance, the highest uncertainty allowed in estimation of Norwegian road projects is ±25% in the early stage, but when the budget is presented to the Parliament, the estimated uncertainty shall not be more than ±10% (Samset, 2010).

In public projects, such as road projects, occurs a phenomenon known as strategic underestimation, i.e. the stablished cost at the early stage, is much lower than the realistic cost, thus presenting an underestimation of the final budget, Figure 6 (Eliasson et al., 2015; Odeck, 2010; Samset, 2010).

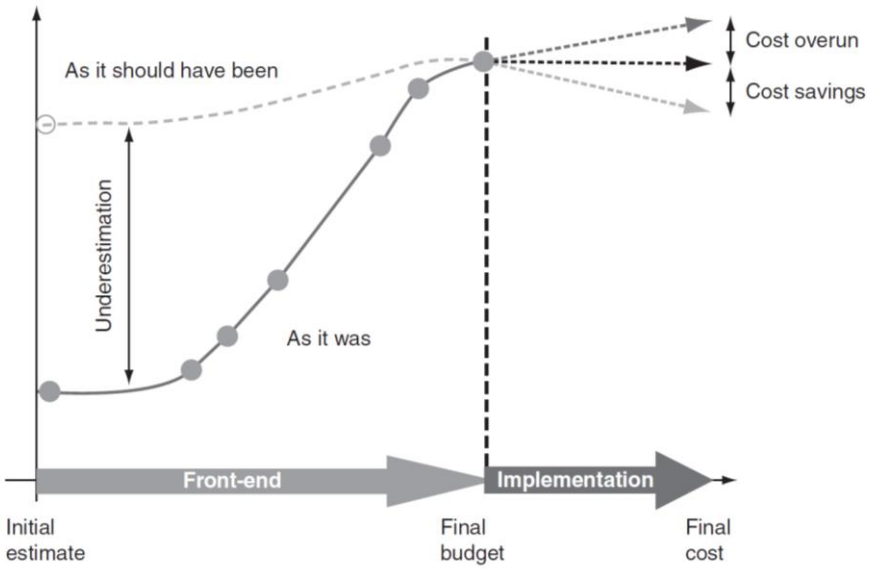

Figure 6: Strategic underestimation (Samset, 2010)

By analysing this phenomenon through a CBA perspective, it can be stated that by underestimating the costs of a projects an overestimation of the benefits will occur, which will lead to an overestimated final budget.

The Norwegian official instruments to develop a road from its initial phase will be addressed in the next Section. Nonetheless it is important to retain from this section, that the associated uncertainty and cost estimation play a major role in an early stage of a road project.

3.2. Norwegian procedures in an early stage of a project

This Section aims to illustrate the procedures used to assess a road project in Norway and it is further divided in two sections. Section 3.2.1 describes the conceptual study procedure, KVU, while Section 3.2.2 describes the external quality assurance procedure, KS. Noteworthy that both are part of the Norwegian official procedures of a road projects, in order to get further approval by the government.

3.2.1. Conceptual study procedure

In order to assess the consequences of the possible or implemented measures in road projects, a SEA is performed by the NPRA. A SEA is a systematic assessment of all relevant advantages and disadvantages that a project provides to the society. Its purpose is to support the comparison of investment and operating costs to the revenues from the sale of a product. In this sense, it enables the assessment of a product's profitability since a product will be considered profitable if the revenue exceeds the cost. Therefore, one can state that a SEA is very similar to a business analysis, but while the first is essentially focused on assess the advantages and disadvantages of a project to the society, the latter is only focused on the business perspective. (NPRA, 2006, 2007)

According to NPRA, a CBA is performed to calculate the monetized impacts, which associated with the assessment of non-monetised impacts makes the SEA, as depicted in Figure 7. Associated to this process is the impact assessment (IA), which is done in case of requirement before NPRA recommendation.

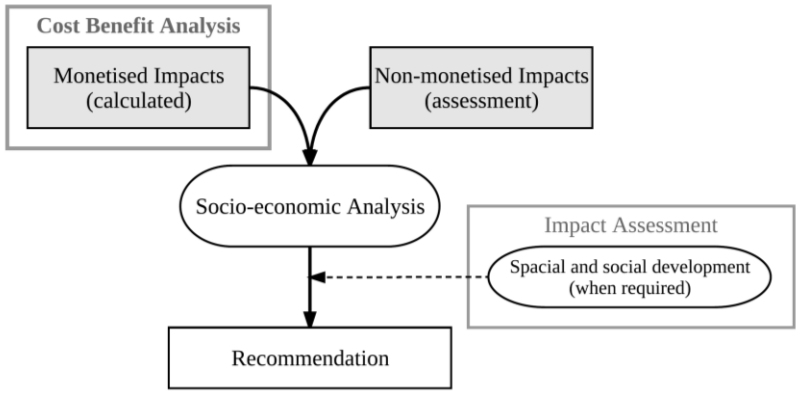

Figure 7: Procedure of a socio-economic analysis (NPRA, 2007).

NPRA established that both monetised and non-monetised impacts should be analysed for road projects. The method to identify each impact is done in a way that each impact is considered only under one theme, Table 1. Nonetheless, it should be noted that while the impacts on the development of the road and society are an integral part of SEA, it is sometimes desirable to make a separate assessment using other methods.

Table 1: Monetised and non-monetised categories (NPRA, 2007)

CATEGORY	MAIN THEME	PARTICIPANT
MONETISED	Benefit for transport users	Transport users
	Operator benefit	Operator
	Budget effect	The government
	Traffic accidents	Third parties
	Noise and air pollution	
	Residual value	
	Cost of government funds	
NON-MONETISED	Landscape	
	Community life and outdoor life	
	Natural environment	
	Cultural heritage	
	Natural resources	

Based on Table 1, NPRA outlined the four most relevant effects of monetised impacts in a CBA of a road project, which are the following: time and driving costs (benefits for transport user), investment costs and maintenance costs (budget effect), and costs of traffic accidents (society) (NPRA, 2014a).

After presenting the main procedures and effects considered when performing a CBA in Norway, the instruments and regulations followed by NPRA to assess a road project is further described.

One of the instruments used by NPRA is the KVU. KVU is an analysis through the different concepts that is performed in the early stage of major road projects and that aims to solve both transportation and society needs related with road infrastructures. The KVU report and the subsequent external quality assurance of the KVU should provide a basis for decision-makers on whether to start a municipal master plan based on the planning and building act, or not. Figure 8 presents the sequence of stages, from the transportation need until the road construction. For large projects, the external quality assurance will be carried out twice, firstly at the concept level (KS1) and secondly in connection with the start-up grant (KS2) (Samset et al., 2018).

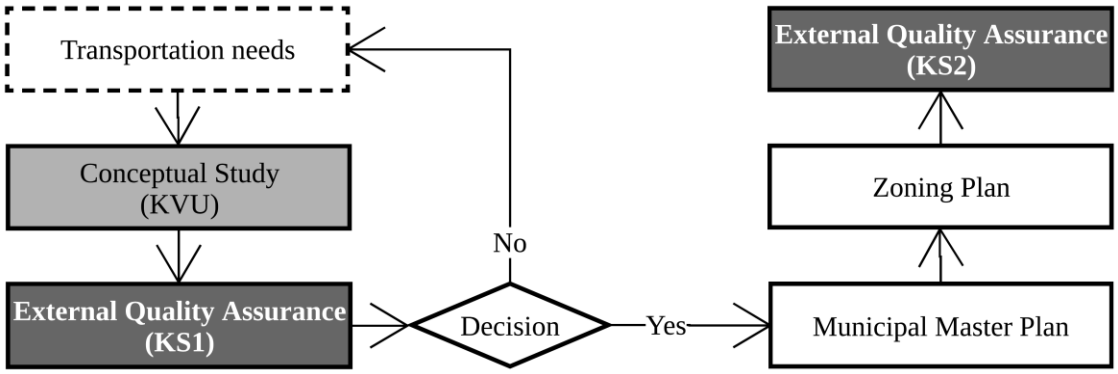

Figure 8: NPRA planning process (NPRA, 2014a)

In order to assess the different conceptual alternatives to solve the transportation needs and to assess the consequences of the road project, NPRA has been developing, since 1983, a program named EFFEKT to perform a socio-economic calculation, with several modules of analyse. The modules of EFFEKT in the present version, enables to calculate driving speed, fuel consumption, accidents rates, maintenance costs, expected needs for ferries, environmental impacts and road closure consequences. The results of the program present the statement to the methodology and assumptions for these calculations and how the considered parameters and effects are connected (NPRA, 2014a).

In addition to the development of the EFFEKT program by NPRA, it is important to mention that they also consider a remarkable methodology to discuss the results of the monetised and non-monetised impacts, namely methodology of compilation, which is presented in the Handbook V712 (NPRA, 2014a). This methodology is considered an overall analysis of the monetised and non-monetised consequences, where the benefits of different options are weighed against the disadvantages they might generate. Therefore, it is relevant for this study to understand this analyse since the benefits generated by the non-monetized impacts can in some cases compensate the negative monetised impacts and support reasonable options to decision-makers.

As it was outlined previously in this Section, in Figure 7, the non-monetised impacts are also a relevant part of a SEA performed by NPRA for road projects. In principle, there is not a simple way to compare these two types of impacts. However, considering that the SEA aims in a simplistic way to assess whereas a project is economically profitable, it is pointed out of by NPRA that in case of being profitable, the sum of the project benefits to the society needs to be greater than the sum of the project disadvantages (NPRA, 2014a). This can be done by using the net present value (NPV) which will be further

described in Section 3.3.1. Table 2 presents a relation between the NPV and the non-monetised impacts, which results in four different scenarios that are further described. Noteworthy that a positive NPV of a road project occurs when the discounted benefits are higher than the discounted costs, thus presenting a profitable economic result.

Table 2: Relation of monetised and non-monetised impacts in a SEA (NPRA, 2014a)

	Overall review of non-monetised impacts	
	Positive	**Negative**
NPV > 0	I	II
NPV < 0	III	IV

I. The alternative project is beneficial for the society since it provides improvements in relation to the alternative zero, both in terms of NPV and non-monetised impacts.

II. In this combination the overall assessment will be unclear since the NPV result is positive, but the non-monetised impacts are negative. Therefore, in order to consider this option, the benefits of the NPV should be so great that they outweigh the negative effects of non-monetised impacts.

III. This combination can be assessed in an opposite way of combination II. Therefore, to consider this alternative it should be clear that the non-monetised benefits are so great that they outweigh the negative effects of the NPV.

IV. In this combination, both aspects of relation are negative. Therefore, the alternative project should not be selected since the solution is not beneficial for both parts. However, there are some projects in Norway that have been selected in this situation, for example to complete a road network, some road sections had to be done, which might generate worse consequences.

After presenting the main methodologies developed by NPRA to perform CBA studies of road projects, the following Section presents the governmental instruments for the appraisal and selection of large scale road projects in the Norway.

3.2.2. External quality assurance procedure

In Norway, a framework agreement to perform the KS was established in 2000 by the Ministry of Finance (Samset et al., 2018). As the threshold for the KS is 750 million kroner, this instrument is only performed in large governmental investments, such as national road projects.

This Norwegian KS scheme consist of two external reviews in an investment project's planning process, namely KS1 and KS2, as further described and illustrated in Figure 9.

- KS1 – External quality assurance of the conceptual study that is presented to the government and after a cabinet decision the pre-project starts;
- KS2 – External quality assurance of project management and cost estimates that is submitted to the Parliament for approval and subsequent funding.

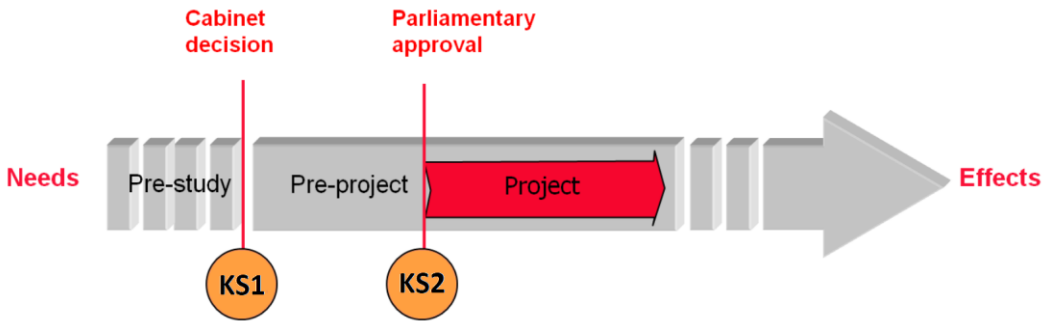

Figure 9: Norwegian scheme for quality assurance (Samset et al., 2018)

From the introduction of this Norwegian scheme for KS, approximately 230 KSs have been carried out, from which one third are KS1s and the remaining are KS2s. Another important aspect is that more than half of these projects were transport projects (Samset et al., 2018). In order to perceive the KSs' purpose and structure a description of KS1 and KS2 is further presented below.

KS1 - External quality assurance of the conceptual study

The main purpose of KS1 is to support the decision-makers on the selection of a concept to start a pre-project, by helping to select the best choice between the available alternative concepts. The basis for the KS1 is that in case of transportation needs, the NPRA should prepare a KVU, which should comprise:

1. Needs analysis
2. Overall strategy
3. General requirements
4. Opportunity study
5. Alternative analysis - CBA
6. Guidance for the pre-project phase

Thereafter, an external consultant reviews the KVU and checks the reliability of the concept project. At this phase, it is assessed if the alternatives given are relevant to the needs, strategy and requirements. The consultant shall also carry out an independent uncertainty analysis and a CBA, presenting recommendations about the ranking of alternatives and the decision approach. Finally, in this KS1, the consultant shall give recommendations regarding the implementation strategy and advice for the pre-project phase.

KS2 - External quality assurance of project management and cost estimates

The main goal of KS2 on the other hand is to perform a cost estimate based on the choice of concept. In addition, this quality assurance should look ahead by projecting the management challenges through the remaining phases of the project. In case of transportation needs, the NPRA should present the following documents:

1. A complete project management document (steering document)
2. A complete cost and income estimate
3. An assessment of at least two alternative contract strategies

The external consultant reviews these documents, and carries out an independent assessment of success factors and pitfalls, and quantifies the uncertainty associated to the total cost. Based on that, the consultant gives endorsements concerning:

- Total cost frame for the project, including contingency reserves for uncertainty;
- How the project should be managed to reduce the probability of cost overruns.

As previously stated, the use of a CBA is required to perform a SEA of a road project in the KVU and KS1 processes. Therefore, in the following section the general conceptions of CBA are presented.

3.3. General conceptions of CBA

The main fundaments of CBA are welfare economics and public finance (Boardman, 2006; Dobes et al., 2009; Mankiw, 2012). Public finance is important in the sense that governments raise funds by taxes and return this money by providing a diversity of public goods and services (Nas, 1996). Therefore, the essence of microeconomics is to deal with social welfare and the efficient allocation of resources, which are the main ideals of CBA.

It is important to perceive that a new road project will affect the welfare of three main groups: the individuals who will take advantage with the project, the taxpayers who will provide funds to the project, and the individuals who will have losses after the project has been approved (Boardman, 2006; Nas, 1996). However, when it comes to large projects such as a national road, the most important is to assess the project through the costs and benefits for these three groups taking as perspective the society welfare.

In Norway, CBA assessments have been widely discussed and it has become an increasingly relevant tool in the decision-making process. Nevertheless, a study published in 1996, concluded after ranking the road investments, that one of the reasons to not ranking investments in road project at that time, based in benefit cost ratio, was because decision-makers considered that some important impacts were not valuated in monetary terms (Odeck, 1996). After that, several other studies also recognized that the decision entities did not consider CBA results because there were many relevant factors that could not be quantified in monetary terms (Fridstrøm et al., 1997; Nyborg, 1998; Odeck, 2010).

In this sense, to perform a SEA through the use of CBA it is important to establish all impacts associated with a road project that can be assessed in monetary terms. Nonetheless, it is also important to distinguish the non-monetised impacts, even though they are not so tangible to quantify.

To assess the costs and benefits for the different groups of stakeholders, it is important to understand some economic terms that will affect the welfare and to what extent. In this sense, the following terms are further described below: Pareto and Kaldor-Hicks criteria, net benefits, social surplus and the associated externalities.

Pareto and Kaldor-Hicks criteria

The economic criteria most often cited is the Pareto criteria for welfare, which is based in allocation of resources in which no party is worse off and at least one party is better off. However, when considering transport projects, as road projects, it is almost impossible to do not have any losses. In this sense, and according to several authors Pareto criteria is limited and is very difficult to apply (Hausman et al., 2006; Rietveld et al., 2007; van Wee, 2012). A well-known solution to this problem is the criteria Kaldor-Hicks, which states that a project has a net positive welfare outcome if benefits are larger enough that wines compensate losses, thus making everybody better off (van Wee, 2012).

Figure 10, presents a graphical relation between Pareto and Kaldor-Hicks theories, where the Pareto and Kaldor-Hicks improvements for the same utility for two participants is compared. Associated with the area of Pareto improvements is the optimal frontier, which is in coherence with the Pareto criteria where no one has losses. In addition to Pareto improvements is the Kaldor-Hicks improvements, which is related with the potential Pareto frontier, where the compensation is a way to reach consensus. There is also a bargain area, where both participants lose utility, which is represented in Figure 10 in a grey colour (Boadway, 1974; Feldman et al., 2006; Krutilla, 2005).

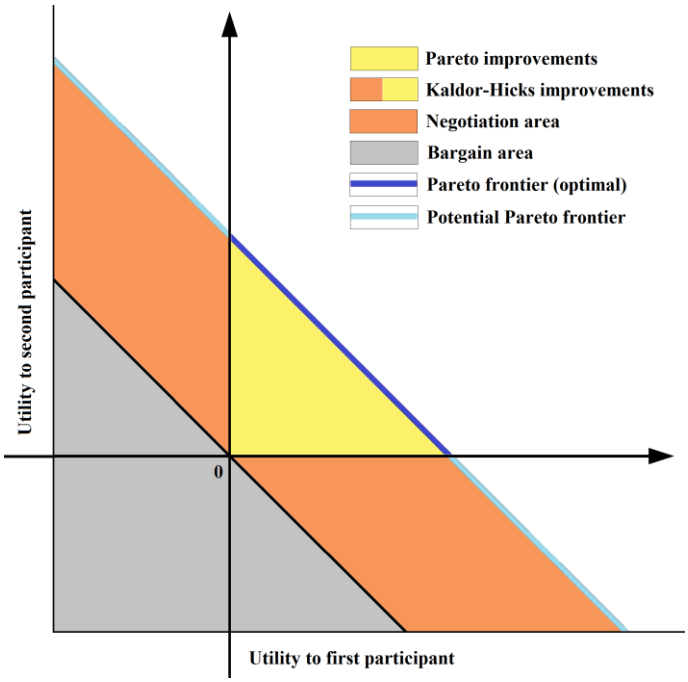

Figure 10: Pareto and Kaldor–Hicks improvements

Adapted from Feldman et al. (2006)

Net Benefits

The net benefits can be understood though two methods: the *willingness-to-pay* for valuing the outputs of a policy and the *opportunity cost* for valuing the resources required to implement the policy (Boardman, 2006). *Willingness-to-pay* is considered the amount of money that an individual or a group is willing to pay, without being penalised with it. And is therefore measured in monetary terms, i.e. if it is positive it represents a benefit, and in case of being negative it represents a cost (Deardorff, 2014). The *opportunity costs* are the costs of something in terms of an inevitable opportunity (Deardorff, 2014). When applied in CBA, the opportunity costs means the value of what the society must go for to use the input to implement the policy (Boardman, 2006).

The relation between the *willingness-to-pay* to a project output and the *opportunity costs*, from producer surplus, originate the net benefit to the society, which is shown in Figure 11. The overall outcome are the net benefits that the project reflects, i.e., "if a policy has positive net benefits that makes at least one person better off without making anyone else worse off" (Boardman, 2006).

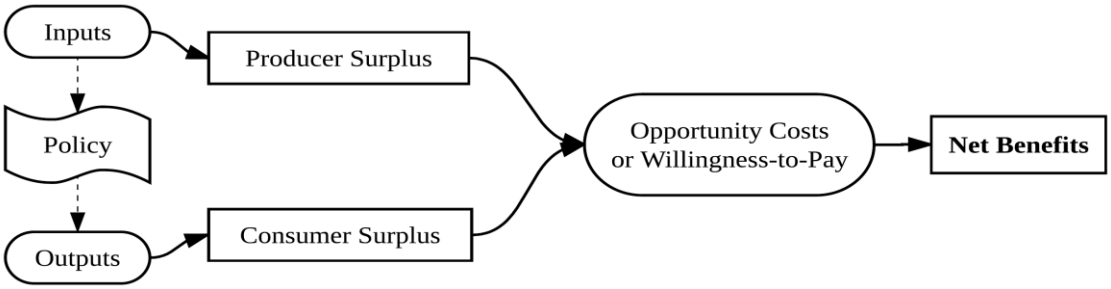

Figure 11: Categorization of Net Benefits of Projects (Boardman, 2006)

Social Surplus

The social surplus is used for public project evaluation in terms of social welfare to derive the total economic effects of a new project or service, improving the society welfare after implementation (Berechman, 2009; Boardman, 2006; Mankiw, 2012). It can be clarified by Equation 1, which measures the overall social surplus effect and is considered as one of the key measures of CBA (Berechman, 2009). From a theoretical point of view, the social surplus is maximized when the price is equal to the marginal costs (Grøvdal et al., 1998). The function of total social surplus (ΔSS), Equation 1, is the sum of *consumer surplus* (ΔCS), *producer surplus* (ΔPS) and *external costs* (ΔE).

Consumer surplus is a monetary measure that purposes a policy that would raise both an individual's income and the price of a non-inferior good (Willig, 1976). In terms of CBA, it represents the difference between the amount that an individual would be willing to pay for a good and the actual amount paid (Boardman, 2006). On the other hand, the *producer surplus* is the equivalent supply-side to the *consumer surplus*, based on the changes in prices due to government policies, which do not only affect demand, but also change economic profits in the market (Boardman, 2006). The definition for *producer surplus* represents the difference between the opportunity costs of adding another unit of service (e.g. transport) to the market, and the returns earned by selling that additional unit (Mankiw, 2012).

To better illustrate Equation 1, Figure 12 presents the equilibrium (P1/Q1), where the consumer and producer surplus are maximized and the allocation of resources is done efficiently. In Figure 5 the *consumer surplus* is the area between the equilibrium price P1 and the demand, i.e., B, C, P1, while the *producer surplus* is depicted with the triangle P1, C, A.

$$\Delta SS = \Delta CS + \Delta PS + \Delta E \qquad \text{(Equation 1)}$$

As illustrated, in case of a higher service quantity than service equilibrium, the costs for producers will exceed the consumer's willingness-to-pay, established by the demand. On the other hand, a lower service quantity than service equilibrium will lead to a value for consumers that exceed the costs for the producers (Mankiw, 2012).

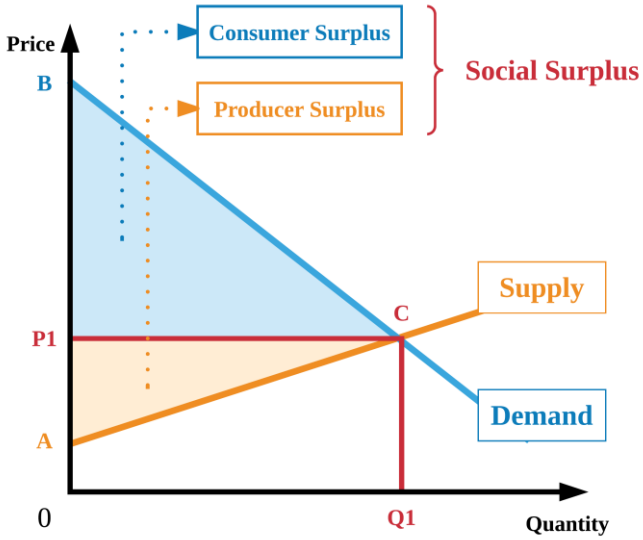

Figure 12: Social Surplus, Consumer Surplus and Producer Surplus

Adapted from Mankiw (2012)

Externalities

The function for social surplus also take into account external costs, *externalities*, which are considered if any market influence occurs. When a market failure occurs, the allocation of social resources becomes inefficient and thus it not meet Pareto efficiency (Mankiw, 2012). Since the estimations of social surplus of a project can be incorrect in a real and imperfect market, the true contribution of welfare value in the project can impact the outcome of the CBA quite substantially (Berechman, 2009).

The main concern about externalities is that it makes the precise measurement of change in social surplus very complex and challenging. Externalities are mainly goods and services for which there is no production and consumption, making the prices and willingness-to-pay extremely difficult to estimate (Boardman, 2006). Commonly, external effects can be both negative and positive, reflecting costs and benefits imposed on third parties (Nas, 1996). The most relevant examples of negative externalities in the transport sector are environmental impacts and traffic accidents. In terms of external benefits, it is common to consider examples such as an increased transportation efficiency or positive effects in projects developed in smaller regions (Grøvdal et al., 1998; Nas, 1996). Therefore, when performing a CBA of a road project one should account for the most possible number of effects because their omission could lead to an over- or underestimation of costs or benefits. Noteworthy that regarding the indirect effects, the established values for externalities can in most cases be considered shadow-prices and refer to the marginal social value, when the extent cannot be measured through market prices in monetary terms (Boardman, 2006).

In the following Section, 3.3.1, the main steps of CBA required to assess a road project are presented.

3.3.1. Main steps of CBA

In order to perform a study assessing the challenges associated with the results of a CBA it is essential to understand the main steps of it, i.e. how a generic CBA is stablished. In this sense, Table 3 presents the main steps of CBA according to Boardman (2006), which are commonly accepted as the most relevant steps through which a CBA study should be developed.

Table 3: Major steps to develop a CBA (Boardman, 2006)

1.	Specify the set of alternative projects – promote an impartial comparison
2.	Decide whose costs and benefits should be included
3.	List impacts and select measurement indicators
4.	Monetize all predicted impacts
5.	Account for uncertainty and choose discount rates for benefits and costs
6.	Perform a sensitivity analysis
7.	Rank the projects and make a recommendation

In this study, focus is given to point number four, where the monetized impacts are assessed in order to reach an economic result between the costs and benefits of the project. In order to assess a road project in monetized terms it is essential to clarify some economic terms used by NPRA. In this sense, two terms will be firstly clarified, namely the discount rate (r) and the increase in annual benefit (a). Thereafter, three important terms for this study are also presented, NPV, BCr and first-year rate of return (FRT).

Discount rate (r)

The discount rate is commonly identified as the interest rate that the banks use. This means that the money applied in a bank generate an earn interest, and therefore after a years' time, the amount of money returned from the bank will be higher when compared to the initial value.

Therefore, to measure the amount of money earned in a period of time (X_n), the Equation 2 should be considered, where the money applied (X_0) is related with the discount rate (r).

$$X_n = X_0 \cdot (1 + r)^n \qquad \text{(Equation 2)}$$

On the other hand, if the inverse is calculated as shown in Equation 3, the amount of money owed today (X_n) can be perceived when a project had an initial investment (X_0) relative to the discount rate (r).

$$X_0 = X_n/(1 + r)^n \qquad \text{(Equation 3)}$$

When this term is used to estimate future benefits, it is called discounting and it is very relevant in CBA. In this sense, as it is presented in Equation 4 and illustrated in Figure 13, applying the discount rate (r) through the project time (i), one can measure the annual benefits (B^i).

$$B_0^i = \frac{B^i}{(1+r)^i} \qquad \text{(Equation 4)}$$

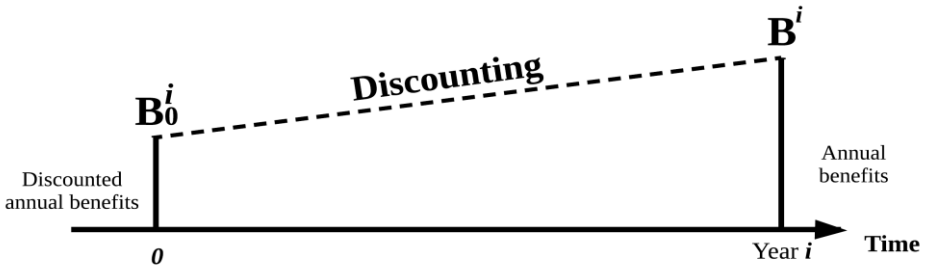

Figure 13: Discounting of annual benefits

Increase in annual benefit (a)

In order to calculate the total discounted benefit (B_t), presented in Equation 5, it is important to assume that in a road project the increase in the annual benefit (a) grows in the same proportion of the traffic growth rate. In this formulation, it is used the discount rate (r), the increase in annual benefit (a) and the project life time (t).

$$B_t = B_0 \cdot \sum_{t=1}^{n} \frac{(1+a)^t}{(1+r)^t} \qquad \text{(Equation 5)}$$

Nonetheless, instead of using the theory behind this formulation it is recommended to use pre-established tables for an accumulated discount factor, where it is established the discount rate (r), the increase in annual benefit (a) and the project life time (t).

When assessing road projects through CBA there are three parameters that are the most relevant ones: *NPV*, *BCr* and *FRT*, which are further described below. Noteworthy that in Chapter 4 the selected projects are assessed through KPIs that are calculated by using these parameters.

Net Present Value (NPV)

In order to evaluate whereas a project is profitable in socio-economic terms it is important to have a positive NPV. This means that the relation between costs and benefits should be measured by taking into account the discount rate considered for the project life time. Equation 6 presents the formula for NPV, and is considered a financial analysis which give a time value to money (Khan et al., 1999; NPRA, 2014a; Žižlavský, 2014).

$$NPV = -I_0 + \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t} \qquad \text{(Equation 6)}$$

Where: $I_0 =$ investment cost; $B_t =$ benefits; $C_t =$ costs; $r =$ discount rate

Benefit Cost ratio (BCr)

BCr is the most used criteria in CBA since it is an economical measure which allows to compare results between different project alternatives. It can be calculated by dividing *NPV* by the government's budget, thus giving a measure for the socio-economic profitability, as shown in Equation 7.

$$BC_{ratio} = \frac{NPV}{C_{government\ budget}} \qquad \text{(Equation 7)}$$

First Year Rate of Return (FRT)

The FRT is mainly used as a time criterion, Equation 8. This parameter enables to find out when it is the optimal time to start a project. If FRT is greater than the discount rate then this is an indication that the project is profitable from year 1. However, one should take into consideration that this parameter should not be used as a decision criterion since it does not account for what happens after year 1.

$$FRT = \frac{B_1}{Inv.C} \qquad \text{(Equation 8)}$$

Where: $B_1 =$ Benefits in year 1; $Inv.C =$ Investment costs

After describing the main conceptions of CBA, relevant findings from recent literature addressing CBA studies are presented in the following section.

3.4. Challenges and uncertainties dealing with CBA results

This section addresses the most relevant challenges and uncertainties when performing a CBA of road projects in Norway. The approach for this section is to report the most relevant scientific articles where the topic of CBA is discussed covering the important effects of monetised impacts.

According to a study developed by Eliasson et al. (2015), which addressed how benefit-cost efficiency affects road investment decisions in Sweden and Norway, considerable resources are spent on analysing suggested investments through the use of CBA. In this sense, according to the author, the results are supposed to play a major role when prioritizing alternatives in a road project. The most used parameters in Norwegian CBAs and its associated costs were summarized by the same author and are presented in Table 4.

Table 4: Central parameters used in Norwegian CBAs (Eliasson et al., 2015).

Time saving	Private trip > 100 km	84 NOK/h
	Private trip < 100 km	160 NOK/h
	Business trips	415 NOK/h
Traffic safety	Life	33 MNOK
	Severe injury	8.9 MNOK
	Light injury	0.67 MNOK
Emissions	CO_2	0.23 NOK/kg
	Particles	4.39 NOK/kg
	NO_X	55 NOK/kg
General parameters	Discount rate	4.5 %
	Appraisal period	25 years

Based on the values presented in Table 4 it is possible to perceive the importance of time saving, traffic safety and emissions costs in the CBAs performed in Norway, being traffic safety one of the most important parameters. Table 4 also presents the discount rate and the appraisal period established by NPRA (2014a) for KVU process. However, as most of the assessments performed by external consultants in KS1 consider that the discount rate is too high and that the appraisal period is too short for road projects, it is important to notice that it is common to consider a discount rate of 4% and an appraisal period of 40 years instead, thus representing a more accurate situation (NPRA, 2012a).

Still regarding the study developed by Eliasson et al. (2015), despite the fact that considerable resources are spent on analysing suggested investments through the use of CBA, no evidences were found that the appraisal results in Norway affects the project selection (Eliasson et al., 2015). In this sense, according to the study results, neither the ratio of investment, nor the ratio of benefits were meaningfully to select a project (Eliasson et al., 2015). In fact, before the parliamentary approval, they could not found any measure of benefits, cost, or efficiency with a significant association with project selection. This statement holds for both Norwegian government and NPRA. Therefore, the study concluded that "project selection in Norway is apparently decided by processes and considerations unrelated to any documented investment characteristics" (Eliasson et al., 2015). Besides, it was mentioned that the controversial decision of do not rely on CBA results during the project selection might be related to indicators such as cost/traffic and benefits/traffic, when considering a road project. For that it is stated that "ideally, decision-makers should motivate their project selection by openly stated criteria and decision rules" (Eliasson et al., 2015).

However, in order to try to explain such facts, the author referred that this bias might be due to the following:

- Projects are selected with certain standards, rather than to produce benefits;
- Investments may be figurative actions against the perceived problems;
- Projects may be selected based on problem-oriented planning;
- The government support in one region suggests that projects matters more than cost efficiency.

A significant number of other studies also stated and documented a negative bias in the appraisal of road projects by the decision-makers through CBA results. For example, Odeck et al. (2010) presented evidences that the *ex-ante NPV* was in general underestimated in road projects. Odeck et al. (2015) also provided evidences that in Norway construction projects, such us large road projects, were underestimated, in a scale of seven out of ten projects. Therefore, it is possible to assume that projects in general were more efficient than as perceived by decision-makers, who in some cases emphasise other factors than those included in the CBA, which may cause unforeseen outcomes and a strategic distortion.

Another relevant study was performed by Mouter et al. (2013), which investigated the perceptions of decision-makers regarding to the most relevant problems when dealing

with CBA. However, as it focuses on the issues associated with CBA in Netherlands no further discussion will be performed with regards study' conclusions. Nonetheless, the study presented an important illustration of the main issues associated with the seven CBA-steps, previously presented in Table 1, Section 3.2.1, as shown in Figure 14.

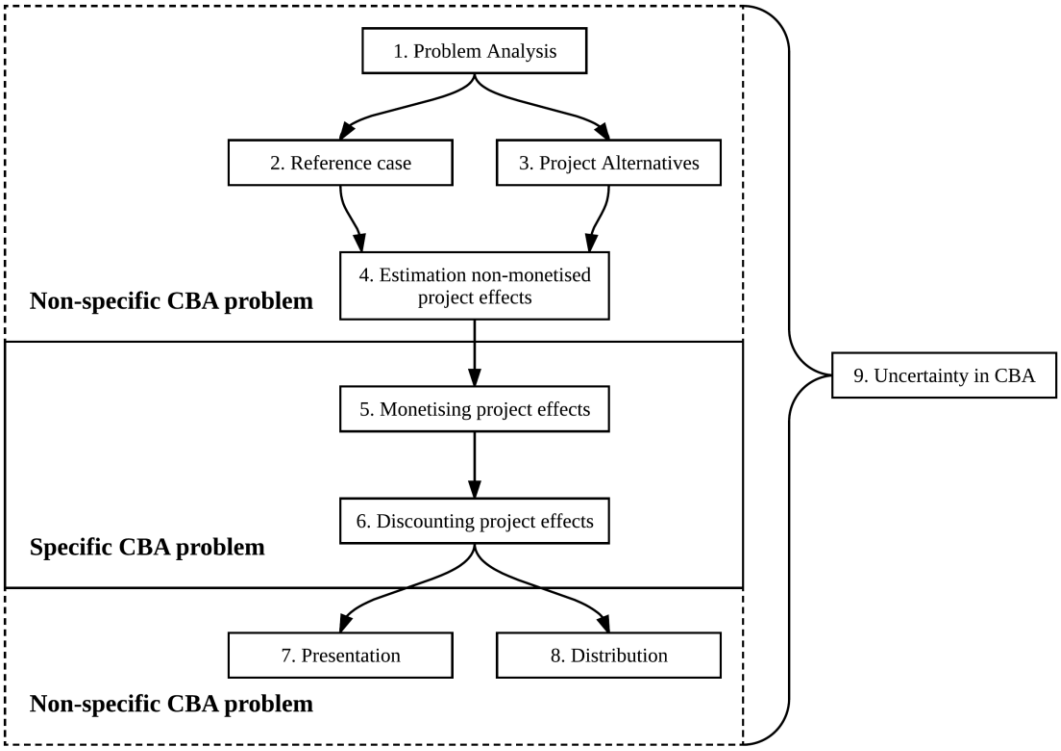

Figure 14: Problems in Dutch CBA practice. Adapted from by Mouter et al. (2013)

In the next section, the issues associated with the performance of road projects in an early stage are presented, addressing the effectiveness of the Norwegian market.

3.5. Project effectiveness in an early stage

A significant number of studies have discussed the problematic of effectiveness of road projects (Jones et al., 2014; NPRA, 2012a; Odeck, 1996; Odeck et al., 2015; Volden, 2018).

According to Samset et al. (2018), if one considers all Norwegian projects assessed through the KS scheme, more than 53% were road projects, followed by railway projects with only 9%. This shows the relevance of road transport infrastructure projects in Norway. However, it is of high importance to notice that from these 53% only a small share as associated high effectiveness. A recent study assessed a total of twenty projects

and concluded that only two had associated a maximum score of effectiveness (Volden, 2018). The reason behind this maximum score is associated with the increased time savings and reduced accident levels. However, the referred study, also stated that most of the projects were considered successful in more than one phase, especially in operational terms.

According to (NPRA, 2012a), when road projects are performed through the careful and detailed Norwegian plan presented in Figure 15, results are expected to be, in general, successful in operational terms. However, according to the same source, the time spent throughout the process of a road projects has been one of the most discussed characteristics towards the road planning effectiveness (NPRA, 2012a). As perceived in Figure 15, currently the entire process of a road project takes more than 10 years. In order to address this issue, the stakeholders have been challenged to develop strategies to reduce the time spent to a desired period of 5 years. This might seem too ambitious since it represents a reduction of 50%, however some of the identified processes can be performed simultaneously.

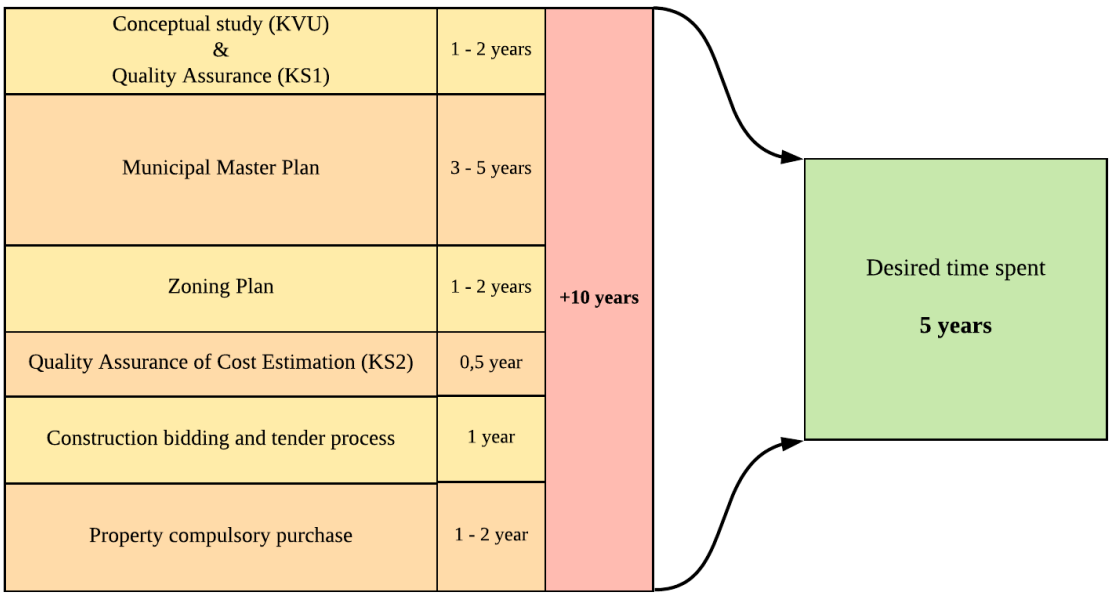

Figure 15: Time spent in the different processes in an early stage

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4. Database Analysis

In this Chapter the selected projects are presented and assessed. In Section 4.1 the main characteristics of the selected road projects is given. Thereafter, the KPIs used to assess the differences between KVU and KS1 processes results are presented in Section 4.2. Lastly, in Section 4.3, the selected road projects are further presented and assessed.

4.1. Selected road projects

The 26 selected projects are presented in Table 6. The projects are divided in 5 groups, based on the regions where they were developed, namely, Northern, Central, Western, Eastern and Southern. This will allow the comparison within and between the different regions. For each region, the projects are identified according to its main scope, i.e., if it is a road project connecting two locations (R) or rather an urban project (U), in accordance with the second and third criteria defined in Section 2.2.2. Noteworthy that for road projects developed within two regions, the administrative region responsible for the project is the one where the project is associated. Furthermore, the consortiums that have had an agreement with the Norwegian government to perform the KS1 process are identified from C1 to C6, being the detailed list of consortiums presented in Table 5.

Table 5: List of consortiums that performed KS1

Consortium no.	Companies
C1	Advansia AS; SNF AS; DNV GL AS
C2	Dovre Group; TØI
C3	Holte Consulting AS; A-2 Norge AS; SNF AS; Proba samfunnsanalyse AS
C4	Holte Consulting AS; Vista Analyse AS
C5	Metier AS; Møreforsking AS
C6	Atkins Norge AS (previous Terramar); Oslo Economics AS

Table 6: Selected projects

Region	Project no.	Project name	Scope	Consortium	Appx
Northern	P1	E6 Fauske – Mørsvikbotn	R	C1	B1
	P2	E6 Mørsvikbotn – Ballangen	R	C1	
	P3	E10 / Rv85 Evenes – Sortland	R	C1	
	P4	Rv80 Løding – Bodø centre	U	C1	
	P5	Harstad	U	C1	
	P6	E10 Fiskebøl – Å	R	C6	
Central	P7	E39 Ålesund – Bergsøya	R	C6	B2
	P8	E39 Bergsøya – Valsøya	R	C6	
	P9	E6 Trondheim – Steinkjer	R	C6	
	P10	Ålesund	U	C6	
Western	P11	Jæren	U	C1	B3
	P12	E39 Aksdal-Bergen	R	C2	
	P13	Bergen	U	C2	
	P14	Haugesund	U	C3	
	P15	E39 Skei – Ålesund	R	C6	
	P16	E16 Voss – Arna	R	C6	
Southern	P17	E134 Kongsberg – Gvammen	R	C2	B4
	P18	Hønefoss	U	C2	
	P19	Rv7 / Rv52 Gol – Voss	R	C3	
	P20	E39 Søgne – Algård	R	C4	
	P21	Tønsberg	U	C5	
	P22	Buskerud	U	C6	
Eastern	P23	Nedre Glomma	U	C1	B5
	P24	E16 Bjørgo – Øye	R	C5	
	P25	Oslo fjord	R	C6	
	P26	Moss – Rygge	U	C6	

In order to better illustrate the selected road projects, Figure 16 depicts the number of projects per region that fulfils the second and third criteria: road stretches and urban road projects, respectively.

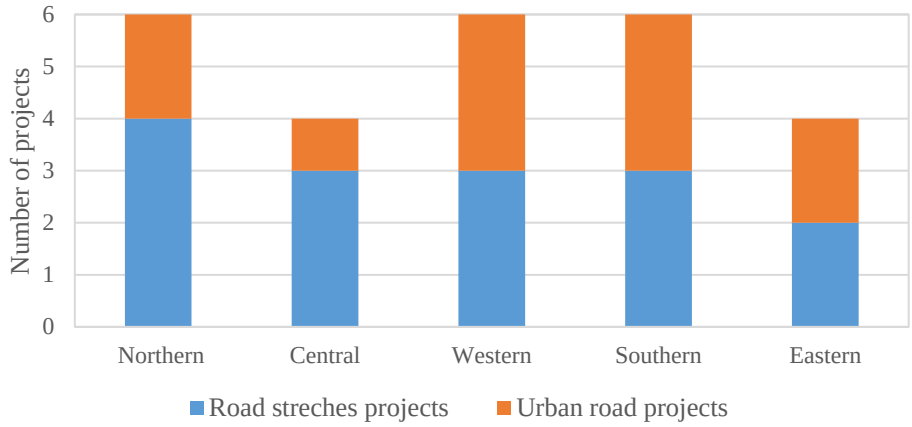


Figure 16: Projects' scope per Region

4.2. KPIs used to assess the selected projects

Five KPIs were used to assess road projects in terms of CBA as follows:

- **Road user benefit** – This parameter represents the collective benefits of road users who travel on the road. It includes, among other things, time spent, distance costs, health effects of increased walking and cycling and losses with ferries and road closures;
- **Public cost** – This parameter represents the budgetary implications for the public sector. It includes investment costs, operation and maintenance and transfers;
- **General society** – This parameter includes healthcare costs, residual value of the project, tax expense (efficiency loss in public funding) and air and pollution costs;
- **NPV** – As previously presented in Equation 6, Section 3.3.1, this parameter enables to assess whether the project has more revenues (benefits) than costs. Therefore, a positive NPV means that the project is economically profitable;
- **BCr** – This parameter was previously presented in Equation 7, Section 3.3.1, and allows to compare results between different project alternatives since its dimension represents the relative profitability.

Notwithstanding, the only KPI that allows a direct comparison of projects' results is the BCr. In this sense, the BCr results are further used to distinguish if the average of results in each region is in accordance with the major part of the projects or if there is any discrepancy. Regarding the remaining indicators, they are also assessed since they can be used to discuss project's characteristics related to CBA.

4.3. Assessment of the selected projects

The following five sections presents a brief description of the selected projects per region, followed by the KPIs average results for each region. The average results were achieved in two phases. Firstly, an average of the KPIs results for the different alternatives suggested per project was performed. Then the projects were grouped per region and an average of the KPIs for the total number of projects comprised in a certain region was performed. For further details please see the Appendix B.

4.3.1. Northern region

(P1) - E6 Fauske – Mørsvikbotn

The Fauske - Mørsvikbotn stretch is 75 km long and has 16 tunnels. The tunnels and intermediate roads, comprises a total of 53 km on the E6 from Megården to Mørsvikbotn. According to NPRA the road stretch was not fulfilling the requirements for safety and was presenting significant standard deficiencies. (DNV GL et al., 2015; NPRA, 2015a)

Regarding the KPI, the only difference between KVU and KS1 processes is the comparison year to which the benefit is discounted. In the KVU the comparative year is 2023 while in KS1 is the 2017 year. However, different assumptions were considered in both KVU and KS1 processes. For example, the traffic utilization is explained in detail in KS1, distinguishing tourists and other road users, while KVU does not. Due to the fact that KS1 distinguished tourists and other road users, it leads to a positive difference towards the alternative zero plus for traffic utilization when compared against KVU results. Based on that, KS1 has estimated higher benefit, associated to lower cost than KVU. In this sense, KVU recommended alternatives zero and 3, while KS1 recommended the alternative zero plus for this project. Notwithstanding, the alternative zero plus was not considered by the government, so the KS1 presented an additional alternative called zero plus plus (0++), which presents a lower complexity level than the suggested alternative 1. (DNV GL et al., 2015; NPRA, 2015a)

(P2) - E6 Mørsvikbotn - Ballangen

This project is road stretch with 125 km long connecting Mørsvikbotn to Ballangen. As this road stretch is dependent on a ferry connection between Bognes and Skarberget, the aim of the project was to develop a ferry-free solution.

In terms of KPI, both processes made the same main assumptions, except for the period of analysis. KVU assumed a period of analysis of 25 years while KS1 assumed 40 years, both with and interest rate of 4.5%.

The KS1 process, besides considering a longer period of analysis also considered a lower traffic utilization. The KS1 approach led to a more realistic analysis because the road user's benefits will be considered over a longer period of time, even considering a lower traffic utilization. In terms of social benefits, the KVU is more beneficial than the KS1, the reason behind that it could be associated to residual values included in the KVU.

The KVU recommendation in this project was the alternative 1. The KS1 firstly mentioned that all alternatives had associated a negative NPV, and based on that, a recommendation to alternative zero plus was given. However, the government have decided to follow alternative 1, presented in KVU. (DNV GL et al., 2012a; NPRA, 2012b)

(P3) - E10 / Rv.85 Evenes - Sortland

This project was a road stretch comprised of 104 km in E10 from Evenes to Lødingen, plus 20 km in Rv.83 towards Harstad and 35 km in Rv.85 to Sortland. The main goal of this project was to improve the road standards and reduce the travel time, as well as improve the transport conditions during winter time.

In this project the assumptions used in both KVU and KS1 processes were mostly the same, except for the period of analysis. KVU considered a period of 25 years and KS1 a period of 40 years. As previously discussed, the longer period of analysis allows the benefit to be retrieved over several years and thus the road user benefit become larger. The public costs is approximately 20% higher in KS1, however the social benefits are lower in KS1 due to no residual value and higher tax costs related to public funding.

In this project KVU recommended alternative 2, justified by the fact that this alternative presented a positive NPV. The KS1 have followed the same justification about the NPV, and recommended alternatives 0+, 2 and 3. The government decided to review the

alternatives 2 and 3 in more detail for further consideration. (DNV GL et al., 2012b; NPRA, 2012c)

(P4) - Rv. 80 Løding – Bodø centre

This project was an urban project mainly focused in the urban area of Bodø, which main goal was to improve the main city's traffic corridor. The traffic along this road was reported with a high rate of growth, where the road network capacity was reaching the limit with high congestion. Alongside with the road capacity problem, this projects also comprised two of the most accidental crossing intersections in the northern Norway, thus being considered of high intervention priority.

In terms of KPI, both KVU and KS1 processes assumed mostly the same considerations, except the period of analysis, where KVU considered 25 years, while KS1 considered 40 years. The consortium responsible for the KS1 used a slightly different methodological approach, which led to significant differences. For example, KS1 considered toll charges, which led in a large extent to a reduced road user benefits.

The chosen alternative in both processes was the alternative 5, which was based on a combination of measures presented in alternatives 1 and 2. Alternative 5 has a major focus on environmental friendly modes, such as walking and cycle paths and improvement on collective transport system. The selected alternative had a relatively high NPV, when compared with the other alternatives, however the non-monetised impacts for the selected alternative were not as good as the others. (DNV GL et al., 2011c; NPRA, 2011j)

(P5) - Harstad

The aim of this project was to work on new traffic solutions for the city of Harstad, and was initiated due to the increased traffic volume in the preceding years. Besides, this project also aimed to improve the walking and cycle paths along the road for environmental reasons.

The KVU process used a shorter period of analysis, which have influenced the overall results as discussed previously. Since KS1 had considered a longer period of analysis as well as toll charges, the results were better than the one presented in the KVU process. However, both KVU and KS1 presented alternative 2 as the best solution, which

comprised a tunnel to cross the city and release traffic capacity in the city centre. (DNV GL et al., 2011a; NPRA, 2011i)

(P6) - E10 Fiskebøl – Å

The project is the road stretch of E10 connecting Fiskebøl to Å in Lofoten's archipelago, which is connected to the mainland since 2007. Most of the parts of this road were identified with low standards, and some of the parts presented a real danger, and therefore the need of refurbishment and major maintenance was of a great need.

The connection from Fiskebøl to Å had 160 kilometres and the travel time was around 2 hours and 40 minutes. The analysis of this road was performed in several stretches divided through the main municipalities, namely: Fiskebøl – Svolvær; Svolvær – Kabelvåg; Kabelvåg –Leknes and Leknes – Moskenes.

In terms of KPIs, both KVU and KS1 processes have considered almost the same assumptions, with a simple exception: the comparison year. In KVU the comparison year was 2022, while in KS1 was 2016. In the assessment of traffic utilization, KVU and KS1 had achieved very similar results in the first part, however in the last three parts of the project the KS1 have estimated higher traffic.

Both KVU and KS1 agreed in alternative 1 for the last section, but gave different recommendations for the other stretches, as further presented in Table 7.

Table 7: KVU and KS1 alternative selection in P6

	KVU	**KS1**
Fiskebøl – Svolvær	Alternative 1	Alternative 0
Svolvær – Kabelvåg	Alternative 3	Alternative 0
Kabelvåg – Leknes	Alternative 4	Alternative 0
Leknes – Moskenes	Alternative 1	Alternative 1

It should be noticed that KS1 have given an additional recommendation that the tunnel throughout the Lyngvær Mountain, in the stretch Kabelvåg – Leknes, should be further investigated before any preliminary decision. (NPRA, 2015b; Oslo Economics et al., 2016)

- **Northern region projects results**

In this section the average results for the different KPIs are presented in Table 8 for the selected projects located in the northern region. For further details please see Appendix B1, which presents calculations and average results for the different considered road projects.

Table 8: KPIs average results for northern region projects

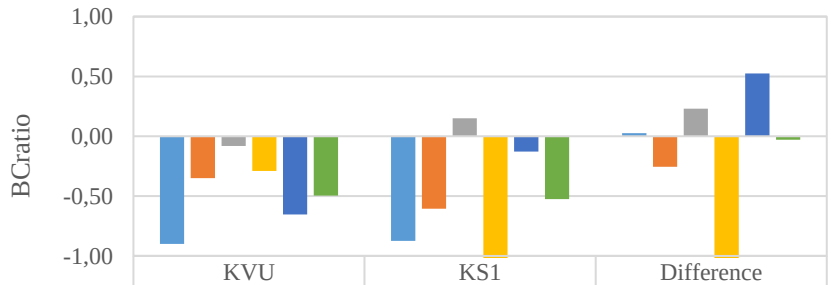
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1947	-3432	-164	-1647	-0,46
KS1	508	-2459	16	-1935	-2,57
Difference	-1439	973	180	-288	-2,11
	-74 %	28 %	110 %	-17 %	

In terms of road user benefits, Table 8 shows that KS1 process presented a decrease, in average, of 74% when compared with KVU process. This difference is linked to projects P4 and P5 results, Rv. 80 Løding – Bodø centre and Harstad projects, respectively. Both projects represent the only two urban projects of the total selected projects in the northern region, and therefore, one can state that the scope of the projects can influence to a large extent the overall results. Moreover, one can state that KVU process was much more optimistic in terms of road user benefits in these two urban projects than the KS1 process.

Regarding public costs, the average results in the northern region do not present significant differences between KVU and KS1 processes: KS1 presented, in average, 28% increase. Once more, this difference is linked to projects P4 and P5, where KS1 reported much higher pubic costs than KVU process. Moreover, based on the average results per project developed in the northern region - Appendix B1, one can conclude that in this region urban projects have associated, in average, much higher public costs than road stretch projects connecting two locations.

Still according to results shown in Table 8, one can notice that KS1 also presents a significant increase towards the social benefits, 110% increase. This increase, is linked to the project P5 in which the KS1 process presents, in average, a much higher value than the KVU process, thus leading to a higher overall result towards this KPI in the northern region.

Regarding the NPV, both KVU and KS1 processes do not present significant differences. Most of the road projects located in the northern region presented a negative NPV. This is justified by the fact that in the CBA the returns of the benefits do not have a high relevance, in an early stage of a road project. Due to this fact, the average results of BCr in this region is negative in both processes, with KS1 process presenting a much worst result than KVU process. The reason behind this is associated with project P4, where the assessment performed by the external consortium C1 reported much worst results towards NPV in most of the considered alternatives. To better illustrate this situation, Figure 17 presents the BCr average results for each project located in the northern region for both KVU and KS1 processes.



	KVU	KS1	Difference
(P1) E6 Fauske - Mørsvikbotn	-0,90	-0,87	0,03
(P2) E6 Mørsvikbotn - Ballangen	-0,35	-0,61	-0,26
(P3) E10/Rv. 85 Evenes - Sortland	-0,08	0,15	0,23
(P4) Rv. 80 Løding - Bodø centre	-0,29	-13,46	-13,17
(P5) Harstad	-0,65	-0,13	0,53
(P6) E10 Fiskebøl - Å	-0,50	-0,52	-0,03

Figure 17: BCr average results for projects located in the northern region

As shown, the road projects located in the northern region do not present a significant difference towards the BCr indicator between and within KVU and KS1 processes, except for project P4.

4.3.2. Central region

(P7) - E39 Ålesund – Bergsøya

The stretch of the road E39 between Ålesund and Bergsøya was treated in a specific KVU process. However, the assessment of the KS1 was performed over the whole road stretch between Skei and Valsøya, which comprises two other KVU process, the Bergsøya to Valsøya (project P8) and the Skei to Ålesund (project P15).

Between Ålesund and Bergsøya there is a long ferry connection, which contributes to high travel times between these locations. By solving this issue as well as some other road improvements, a significant potential reduction of travel time was identified. This project had the ambition to stablish a solution ferry-free, as stated in the national transport plan as long-term goal.

In terms of the KPI, both KVU and KS1 have considered different interest rates and different period of analysis. KVU considered a 4.5% interest rate while KS1 have considered 2%. In terms of period of analysis, the difference was the same as in previous projects, 25 years in KVU and 40 years in KS1. These differences have influenced the results in large scale, as previously discussed. KVU have reached much lower values in the road user benefit when compared with KS1.

The KS1 consortium have mentioned that the SEA was insufficiently developed and that was the reason why KVU presented more negative results. In overall, KVU have suggested alternative 2 and KS1 suggested alternative 2 and 3. Noteworthy that both processes have agreed in further investigation in the alternative KA, between Molde and Bergsøya. (NPRA, 2011f; Oslo Economics et al., 2012a)

(P8) - E39 Bergsøya – Valsøya

The KVU of this project was also quality assured in the same KS1 of the previous project, the KS1 Skei – Valsøya. Due to the assumptions reported in the previous project the differences in results were mainly in road user benefit. However, despite the differences in results, both studies recommended the alternative 4. The selected alternative in the KVU process was the second worst alternative, but as it was the alternative with higher associated road user benefits it was considered the best option. (NPRA, 2011c; Oslo Economics et al., 2012a)

(P9) - E6 Trondheim – Steinkjer

This project assessed how the road E6 and the railway between Trondheim and Steinkjer can be developed to serve society's development in the next thirty years. The main project’s goal was to strengthen the region along this transport corridor. In order to help the development between these two transport modes, it was considered an important long-term strategy for transport network.

The interest rate and the period of analysis in this project were different for both KVU and KS1 processes. KVU stablished 4.5% interest rate while KS1 2%. Regarding the period of analysis, KVU considered 25 years and KS1 40 years. Due to these assumptions the road user benefits in the KS1 were much higher than in the KVU.

The KVU process have considered that the best solution was the alternative 1, even though it represented the worst alternative in terms of the BCr. However, on the other hand, it was the one that presented major improvement in the network. KS1 also considered the alternative 1, but without major railway improvements, and the alternative 3. Both recommendations were justified with a positive NPV, and despite alternative 1 did not considered the railway improvements it did not excluded a possible future intervention. (NPRA et al., 2011; Oslo Economics et al., 2012b)

(P10) - Ålesund

This project was stablished to develop the city network and to improve the road safety for all road users and transport modes, towards an urban sustainable development. The situation before the project start was reported as low collective offerings, as well as little development of cyclist's infrastructures. Moreover, it was reported that the road capacity had reached the limit and that was presenting a high rate of road congestions.

In order to funding this project, it was stablished by local and national authorities that toll charges would be installed with the aim to serve as a partial financial support to the project as well as to avoid congestions in city centre.

Both KVU and KS1 processes considered the same main assumptions. However, KS1 presented a road user benefit 30% lower than the KVU. In terms of recommendations, KVU process suggested alternative 4, in order to fulfil all project requirements and to be reasonable in socioeconomic terms, while KS1 suggested alternative 2, because it presented best results towards NPV. (NPRA, 2013c; Oslo Economics et al., 2014c)

- ## Central region projects results

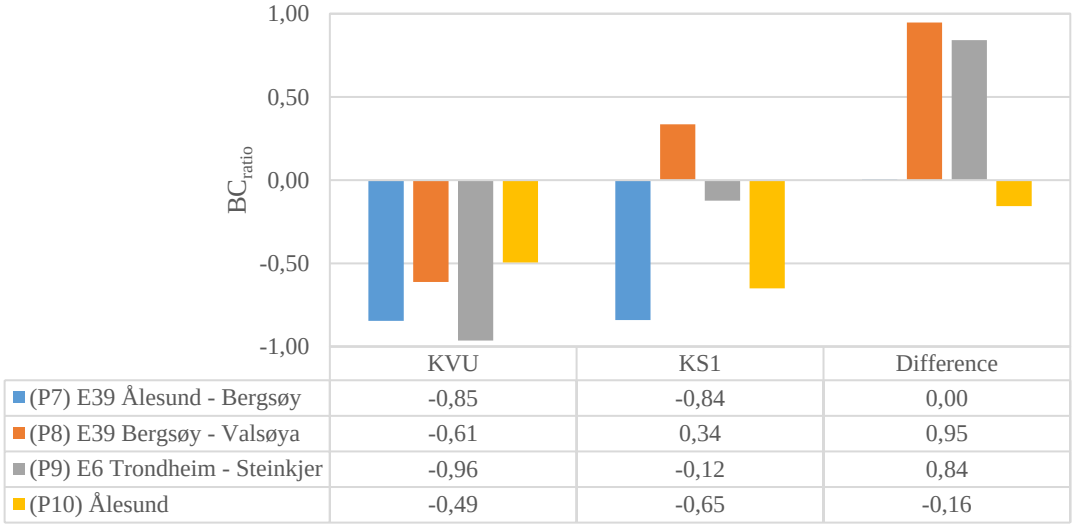
In this section the average results for the different KPIs are presented in Table 9 for the selected projects located in the central region. For further details please see Appendix B2, which presents calculations and average results for the different considered road projects.

Table 9: KPIs average results for central region projects

AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2285	-8960	-674	-7447	-0,73
KS1	5587	-7498	-270	-1960	-0,32
Difference	3302	1463	404	5487	0,41
	144 %	-16 %	-60 %	-74 %	

From the selected projects located in the central region, three were road stretches and one was an urban road project. However, even though the scope of the projects was mostly the same, KVU and KS1 processes diverged in terms of KPIs average results. KS1 process presented, in average, higher road user benefits, but, on the other hand, worst results towards the remaining KPIs, when compared with KVU process.

Projects P8 and P9 results are the ones that led to differences in the total average results, as further shown in Appendix B2. This is linked to the projects characteristics and assumptions done when performing the SEA at the early stage of each project, by both KVU and KS1 processes, especially in terms of interest rate and period of analysis. However, this was not the case in other projects located in the central region, such as the case of project P7. In P7 both KVU and KS1 processes have done significantly different assumptions to perform the SEA but at the end, both presented the exact same result towards BCr. To further discuss this situation, Figure 18 presents the BCr average results for each project located in the central region for both KVU and KS1 processes.



	KVU	KS1	Difference
(P7) E39 Ålesund - Bergsøy	-0,85	-0,84	0,00
(P8) E39 Bergsøy - Valsøya	-0,61	0,34	0,95
(P9) E6 Trondheim - Steinkjer	-0,96	-0,12	0,84
(P10) Ålesund	-0,49	-0,65	-0,16

Figure 18: BCr average results for projects located in the central region

4.3.3. Western region

(P11) - Jæren

This project was performed based on the urban development of Jæren area, which comprises eight municipalities, being Stavanger the biggest city. The KVU process was developed under the responsibility of the Rogaland County in collaboration with the NPRA which was responsible for the transport models and the SEA.

In terms of interest rate the differences between KVU and KS1 were rather small, 4.5% and 4% respectively. However, the considered period of analysis was quite different, 25 years for KVU and 40 years for KS1. Notwithstanding, the KVU considered a residual value of 40 years to the investment, while the KS1 did not considered any residual value. These differences in terms of interest rate and period of analysis, might be the reason why the road user benefit estimated was much higher in KS1 than in KVU.

The recommended alternative in KVU was the 3C, however the consortium responsible for the KS1 have criticised this recommendation arguing that KVU's SEA was override, which led to the great achieved results. In this sense, the KS1 process have recommended the alternative 3A instead, which was at the end chosen by the government. (DNV GL et al., 2012c; Rogaland, 2012)

(P12) - E39 Aksdal – Bergen

This project aimed to develop a ferry-free solution for the coastal road E39 between Aksdal and Bergen, which at that time required a time travel of more than 3 hours to drive over 140 kilometres.

The assumptions made in both process were quite different, thus leading to significant differences in KPI results. The considered interest rate was 4.5% in KVU and 2.2% in KS1, and the period of analysis was 25 years in KVU and 40 years in KS1. As discussed previously, this led to higher road user benefit in KS1.

In terms of recommendations KVU suggested the two best alternatives in terms of BCr: alternative 4A and 5B. On the other hand, KS1 recommended alternative 4C, according to their considerations it was the alternative with the highest NPV and the one that allowed the fulfilment of all project goals. (Dovre Group et al., 2012b; NPRA, 2011b)

(P13) - Bergen

This urban project aimed to improve the transport facilities around the city of Bergen, and considered twelve municipalities.

In this project KVU and KS1 processes also considered different values for the interest rate and for the period of analysis. 4.5% over 25 years and 2.2% over 40 years, in KVU and KS1, respectively. These considerations led once more to much higher road user benefits in the KS1. The final recommendations in the KVU were alternatives 3 and 4, while KS1 recommended alternatives 2 and 4. (Dovre Group et al., 2012a; NPRA, 2011h)

(P14) - Haugesund

The Haugesund concept study was initiated to clarify the strategy for transport infrastructure in the city and municipalities around it, as Tysvær, Karmøy and Sveio. The main points stablished by NPRA were:

- Improvement of the walking and cycling network, associated with restrictive rules to zero growth in car traffic in the urban area;
- Development of the road E134 from Helgan to Ørpetveit, and the E39 which crosses the city with four lanes, where two of them are reserved for collective traffic.

In this project due to the fact that both process have considered the same interest rate of 4% and a period of analysis of 40 years, the results in the KPI were very similar. Nonetheless, KVU suggested alternative 5, while KS1 developed a completely new alternative 6, being the one suggested. (Holte Consulting et al., 2016; NPRA, 2015c)

(P15) - E39 Skei – Ålesund

This project was carried out jointly with central and western region and is associated with the projects P7 and P8, as previously mentioned. Noteworthy that the management of the project was performed by the western region.

The aim of this project was to promote the research of a technological solution for fjord cruises. As the stretch between Skei and Ålesund had three ferry connections, this presented significant impacts towards the time spend driving over 160 kilometres - approximately 4 hours.

In terms of the assumptions considered in KVU and KS1 processes, they were in line with other previous projects. KVU considered a period of analysis of 25 years and an interest rate of 4.5%, while KS1 considered 40 years and 2%, respectively. Due to the different considerations KPI results presented a significant difference in both processes.

The project recommendations were divided in two stretches, from Skei to Volda, and from Volda to Ålesund. In the first stretch the KVU suggestions were alternatives 10 and 7, while KS1 suggested alternatives 6 and 7. In the second stretch from Volda to Ålesund, KVU recommended alternative 4 and KS1recomended alternative 5, due to a high NPV. (NPRA, 2011d; Oslo Economics et al., 2012a)

(P16) - E16 Voss – Arna

This project was developed to assess the strategies for transport development, and comprised the road E16 and the rail connection from Voss to Arna. By considering the characteristics of this project, the management was performed in collaboration with NPRA and the Norwegian National Rail Administration (NPRA et al.). The road improvement in this stretch considered the re-design of parts of the road such as curves that were not dimensioned for the traffic that it was serving. Moreover, most of the 32 tunnels were considered too old thus requiring a significant share of maintenance. Furthermore, some safety issues were aroused, due to the fact that the road capacity had been reached some years ago.

In terms of considerations both KVU and KS1 processes have made mostly the same assumptions for analyse. For that reason, no significant differences were obtained in the KPIs. However, due to the fact that all alternatives presented a negative NPV, the KS1, recommended the alternative 0, while the KVU recommended the alternative 5, which represented the alternative with highest decrease in travel time. (NPRA et al., 2014; Oslo Economics et al., 2014b)

- **Western region projects results**

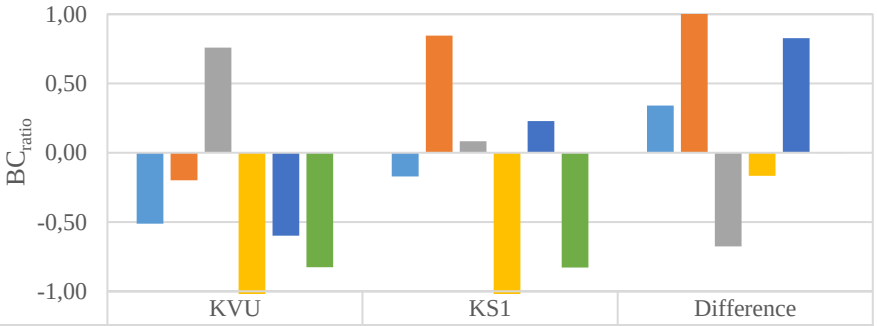
From the selected projects located in the western region, three were urban projects and three were road stretches. Table 10 shows the average results for the different KPIs for the selected projects. For further details please see Appendix B3, which presents calculations and average results for the different considered road projects.

Table 10: KPIs average results for western region projects

AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	333	-14525	1292	-10889	-0,99
KS1	10164	-17323	4755	-4238	-0,76
Difference	9832	-2798	3462	6651	0,23
	2957 %	19 %	268 %	-61 %	

As shown in Table 10, KS1 presents, in average, much higher road user and society benefits than KVU process. However, it also presents lower NPV and thus, lower BCr in comparison. According to results presented in Appendix B3, the identified major differences are linked to P11 and P12 project results, which presented quite different assumptions regarding the period of analysis and interest rate in both KVU and KS1 processes. This is quite evident in projects P14 and P16 where both processes used the same value for interest rate and period of analysis which led to quite similar results.

However, one can state that KVU and KS1 average results towards BCr present minor differences, which can be explained by the fact that projects' scope is equally distributed in the western region since it comprises three urban road projects and three road stretches projects, as previously referred. However, for a detailed overview, Figure 19 presents for each project the average results towards BCr.



	KVU	KS1	Difference
(P11) Jæren	-0,51	-0,17	0,34
(P12) E39 Aksdal - Bergen	-0,20	0,85	1,04
(P13) Bergen	0,76	0,08	-0,68
(P14) Haugesund	-4,55	-4,72	-0,17
(P15) E39 Skei - Ålesund	-0,60	0,23	0,83
(P16) E16 Voss - Arna	-0,83	-0,83	0,00

Figure 19: BCr average results for projects located in the western region

According to Figure 19, P14 and P16 were the projects that presented the lowest variation in terms of BCr for both KVU and KS1 processes. This might be explained by the fact that both KVU and KS1 processes assumed the same interest rate and the same period of analysis, 4% and 40 years, respectively. Noteworthy that according to recent literature findings, an interest rate of 4% and a period of analysis of 40 years should be used when performing a SEA of a road project, as mentioned in Section 3.4. Therefore, one can state that when projects use these figures they present in average a more similar results. On the other hand, projects P12 and P15 show a significant difference between KVU and KS1 processes regarding BCr results. However, it should be noted that in both projects the KVU process results were a little bit more pessimistic, and the reason behind that might be related to the assumptions made in each SEA since these two projects were the only ones in this region with major differences in the assumptions of interest rate and period of analysis. It is also important to note that both projects are related, since both projects are within the same road, the E39 with high demanding improvement in the ferry connection of this coastal road. Besides, it should be noted that these two projects were assessed in the KS1 process by different consortiums - C2 and C6 consortiums.

4.3.4. Southern region

(P17) - E134 Kongsberg – Gvammen

The aim of this project was to improve a road stretch with 70 kilometres connecting Kongsberg to Gvammen. The process in the early stage focused in transport issues, business development and urban development.

In terms of considerations both KVU and KS1 processes presented significant differences and already identified in other projects. KVU considered an interest rate of 4.5% and a period of analysis of 25 years, while KS1 considered an interest rate of 2.2% and a period of analysis of 40 years. As previously reported, a shorter period of analysis and a higher interest rate leads to decreased road user benefits.

In terms of the suggested alternative both processes have agreed that the north corridor was the best option, although KVU recommended alternative N as the most profitable, while KS1 recommended alternative N, which had associated a higher investment cost, but according to their analysis the NPV was the largest one among the different alternatives. (Dovre Group et al., 2012c; NPRA, 2011g)

(P18) - Hønefoss

The city Hønefoss was identified as a car-based city, where road capacity has reached the maximum. This situation led to an unacceptable emission level that affected both the environment and people's health. Therefore, this project was initiated to solve problems as, future traffic development and road traffic safety. It is also important to mention that it was expected a strong population growth, due the improvement of rail and road connections to Oslo.

In terms of considerations, both processes assumed a period of analysis of 40 years, but with small differences in the interest rate, 4% in KVU and 4.5% in KS1. Due to this, the results were somehow comparable. However, it should be noticed that KVU calculated the costs according to the guidelines of the NPRA-handbook V712, while in the KS1 the costs are presented in a single item, thus making it difficult to compare.

The processes recommended different alternatives. KVU suggested alternative 2, while KS1 suggested alternative 3 as the best solution, due to high beneficial rates in non-monetised impacts, regardless the fact that the project presented a negative NPV. (Dovre Group et al., 2015; NPRA, 2015d)

(P19) - Rv.7 / Rv.52 Gol – Voss

This road project connects two locations, Gol and Voss, through two different roads, Rv.7 and Rv.52. These roads are part of important connections between eastern and western Norway. The area where these roads are located comprises areas with large and important natural and cultural values.

In terms of road user, particular factors related to winter conditions are extremely challenging. In this sense, it was stablished a need for a more efficient and winter-proof road connection. Therefore, the project aimed to find solutions towards reduced time travel and transport costs for both industry and passenger transport, with better winter facilities.

In this project both processes have considered the same values for interest rate and period of analysis, therefore the differences in conclusions have not been much different from other projects. To assess these two stretches, two alternatives were developed for each road with a solution with shorter tunnels and another with longer but fewer tunnels.

The alternative analysis was considered sufficient in both process. However, it was mentioned in KS1 process that part of the road E134 to Bergen along with some minor improvements on RV. 52 and Rv. 7 may prove to be less costly and beneficial than the concepts presented by the KVU process. Since the E134 mainframe construction has been planned, the presented concepts can provide a not optimal solution with lower utility to the community. The financing method stablished in the KVU stated budget without a toll charge, but as mentioned in the report, this financing solution was not entirely excluded. In the KS1 it is recommended toll charges with low rates over a longer period of time, justifying the potential of increase the net worth. (Holte Consulting et al., 2017; NPRA, 2015e)

(P20) - E39 Søgne – Ålgård

The E39 road stretch from Søgne to Ålgård has about 190 kilometres and serve has connection between the cities of Kristiansand and Stavanger. These two urban areas are also known for good facilities in terms of rail and boat transport. This stretch of E39 road crosses many valleys and hills, and passes through a small-scale landscape in southern Rogaland. This characterizes the road, with many rises, relatively much curvature and at the same time a great lack of overtaking possibilities. The road was characterized by heavy driving, and with a large gap between road standards and traffic needs.

Both KVU and KS1 process assumed the same period of analysis with 25 years, but in terms of interest rate, KVU considered 4.5%, while KS1 considered 2%. The alternative M, where M stands for median barriers, was the recommended alternative presented in both process, justified with the greater NPV value associated with it.

It was proposed by the KS1 the implementation of toll charges to fund the project. However, it was pointed out that toll charges can affect profitability and thus the outcome of the alternatives ranking. This means that by another choice of funding, another alternative may be more appropriate than the recommended alternative M. (Holte Consulting et al., 2012; NPRA, 2011e)

(P21) - Tønsberg

This project focused in the city of Tønsberg and aimed to improve its transport facilities, such as public transport, cycling and walking paths in the urban area, as well as a new connection between Nøtterøy and the mainland. The urban area of Tønsberg was defined as a robust region of housing and labour market. However, the road network has reached the capacity in some locations, because bus lines were having trouble to reach the city centre during the rush hours.

In terms of assumptions both processes have considered the same interest rate and period of analysis, 4% and 40 years, respectively. However, in terms of toll charges KS1 have considered lower charges associated with higher traffic utility, while KVU used higher rates of toll charges. Through each consideration, the KVU process recommended the Circle alternative, which implies more restrictions for traffic in the city centre and a tunnel to avoid traffic congestion in the city centre. On the other hand, KS1 process recommended the alternative with a bridge from Teie to Korten. The government decided to follow KVU's recommendation, the Circle alternative with a tunnel. (Metier et al., 2014; NPRA, 2013b)

(P22) - Buskerud

This project was established as an urban package and comprises several municipalities, namely Lier, Drammen, Nedre Eiker, Øvre Eiker, and Kongsberg. Buskerud urban area is today one of the urban's fastest growing areas in Norway. According to KVU report, Buskerud area will grow by close to 45%. Therefore, the analyses in both process were divided in assumptions for short- and long term.

The differences in both process regarding road user benefits can be explained by looking at the period of analysis and interest rate considered. KVU considered a period of analysis of 40 years and an interest rate of 4% while KS1, considered 25 years and 4.5% instead. Both reports have considered toll charges as a method of financing, but at lower rates.

KVU recommended the alternative entitled as common package alternative, *fellespakken*. This alternative package comprised improvements for cycling and walking paths, upgrading in the service level of collective transport, organization of transport hubs, and improvement in the traffic management. All measures comprised in the common package

were stablished to assure a better local environment, better accessibility to all transport modes and improved health of individuals.

Noteworthy that KS1 process stated that according to their assessment any other measure could turn the alternatives economically profitable, being this the reason why NPV reported results were in large scale so negative. For this reason, KS1 did not recommend the same alternative as KVU, but the alternative zero instead. (NPRA, 2013a; Oslo Economics et al., 2014a)

- **Southern region projects results**

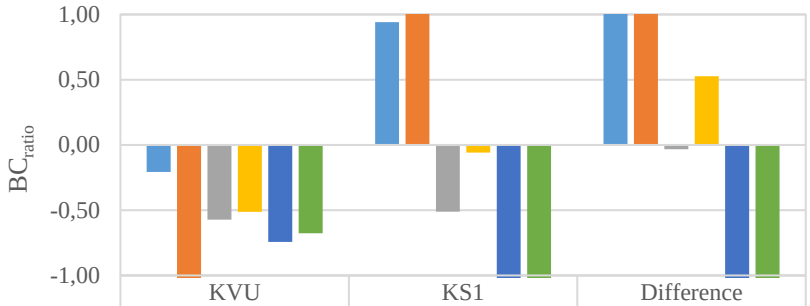
In this section the KPIs average results for the selected projects located in the southern region are firstly presented, Table 11. For further details please see Appendix B4, which presents calculations and average results for the different considered road projects.

Table 11: KPIs average results for southern region projects

AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-1521	-7255	193	-4764	-1,03
KS1	106	-6342	2267	-4100	-1,67
Difference	1627	914	2074	664	-0,65
	107 %	13 %	1073 %	14 %	

As shown, social benefits is the parameter that presents the highest discrepancy between KVU and KS1 processes: KS1 presents in average an increase of 1073% when compared with KVU. This is due to the assumptions made in projects P17 and P20. Both projects have considered a much different interest rate in the KVU and KS1 process, being the average results much optimist in the KS1. Similar situation occurred for the road user benefit, where the KS1 results were also considerably more optimistic in the two previously referred projects.

Table 11 also shows that the average results between KVU and KS1 processes towards BCr do not differ to a large extent. This reported difference in the BCr, -0.65, means that, in average, KS1 process is a bit more pessimistic that the KVU process. To further discuss this, Figure 20 presents the BCr average results for each project located in the southern region for both KVU and KS1 processes.



	KVU	KS1	Difference
(P17) E134 Kongsberg - Gvammen	-0,21	0,94	1,15
(P18) Hønefoss	-3,45	1,57	5,01
(P19) Rv. 7 / Rv. 52 Gol – Voss	-0,57	-0,51	-0,03
(P20) E39 Sogne - Algård	-0,51	-0,06	0,53
(P21) Tønsberg	-0,74	-3,49	-2,75
(P22) Buskerud	-0,68	-8,48	-7,80

Figure 20: BCr average results for projects located in the southern region

According to the results presented in Figure 20 one can state that the BCr results of four projects differ significantly from the remaining, namely projects P17, P18, P21 and P22. The reason behind such significant differences is not clear, however some plausible reasons could be pointed out. For example, the consortiums are different: in P17 and P18 the consortium responsible for performing the KS1 was C2 while in P21 and P22 were consortiums C5 and C6, respectively. The scope of the project might also affect the overall average results. Nevertheless, it should be noted that besides the fact that P21 and P22 presented in average a significant difference between KVU and KS1processes results towards BCr, the selected alternatives in both projects presented in fact a lower difference. Moreover, one should note that KS1 processes in this region present lower BCr results in the selected alternatives and much higher BCr results for the remaining assessed alternatives. This can be perceived as strategic management of alternatives by KS1 process, in order to justify the selected alternative since the referred fluctuation of BCr results was not perceived in the KVU processes. In this sense, one can state that KS1 results seem to have a high associated uncertainty. For further details please see the Appendix B4.

4.3.5. Eastern region

(P23) - Nedre Glomma

This project was described as an urban package. It is developed through the Nedre Glomma region, which comprises four main municipalities, namely, Fredrikstad, Sarpsborg, Råde and Hvaler. The KVU process started by stating that the project focus was the improvement of the traffic situation, something that KS1 strongly criticized and suggested that the project should have been analysed as a city development package.

A previously stated, differences in the assumptions in both KVU and KS1 processes led to significant differences in final considerations. The period of analysis was 25 years in KVU, while in KS1 was 40 years. However, the interest rate was in both process considered to be 4.5%. The difference between the reports is relatively large, in particular with the public costs. This value varies from approximately 2600 to 5400 million NOK. This is due to the fact that KS1 estimated far higher utility for the public than the KVU. In terms of recommendation, KVU process suggested alternatives AB and ABC, while KS1 recommended alternative 2 and AB.

The government chose to follow KS1's recommendation, i.e. the alternative 2. This alternative presented strong arguments, since it presented better results in terms of monetized impacts. However, it should be noticed that KS1 process stated that it should have been performed an improvement in the toll charges analysis. (DNV GL et al., 2011b; NPRA et al., 2010)

(P24) - E16 Bjørgo – Øye

This project was initiated in order to improve the standards of the E16 road that connects Bjørgo to Øye. This road stretch presented a high rate of accidents and low accessibilities and hence, the aim of the project was to clarify the development needs and the principles for further planning.

In terms of assumptions for the interest rate and the period of analysis both KVU and KS1 process have considered the same values, 4.5% and 25 years, respectively. However, the assessment of toll charges was performed in a different way thus leading to slightly differences in the results. KS1 have criticised the assessment performed by KVU, stating that KVU results were not completely realistic and arguing that NPRA performed a too simplistic analysis.

The recommendations were similar. KVU presented three alternatives: 1, 2a and 2b, while KS1 recommended the alternative 2b. The justification presented by the KVU for the selection of alternative 2b was also supported by the KS1, both argued that this alternative delivered higher benefits for road users. (Metier et al., 2011; NPRA, 2011a)

(P25) - Oslo fjord

This project have been discussed since 1990, when a construction of a subsea tunnel from Moss to Horten was investigated. However, after 17 years, in 2007, governmental decisions were taken to develop a fixed connection between the road E6 in Østfold and the E18 in Vestfold.

Both processes, KVU and KS1 have considered the same assumptions, with an interest rate of 4% and a period of analysis of 40 years. The road user benefit was in all alternatives lower more than 50% in the KS1, because this process included toll charges. In the KS1 process it was also discussed whether the alternative zero in the KVU is realistic in a reference basis. This question was aroused because KS1 believes that the alternative zero did not satisfy the requirements, and should therefore be excluded from the analysis.

KVU process recommended alternatives 3 and 4, which have the same location with a different construction solution, a bridge and a tunnel, respectively. On the other hand, KS1 process recommended alternative 4, due to the fact that it was the alternative with the higher NPV. (NPRA, 2014b; Oslo Economics et al., 2015)

(P26) - Moss – Rygge

This project was defined as a city project focused in the municipalities of Moss and Rygge. These municipalities experienced strong population growth which led to an increased traffic load on the main network. This overload in the road capacity was also justified by the ferry connection from Moss to Horten, which has associated heavy traffic. Associated to the heavy traffic, there was an increase in environmental problems such as noise, dust and particulate emissions. Besides, accidents and barrier effects were also reported as a clear consequence of traffic congestion. Therefore, the project aimed to improve this situation, thus facilitating a good urban development.

The assumptions made in both processes in terms of interest rate were mostly the same: KVU considered 4.5%, while in KS1 4%. However, the considered period of analysis was significantly different as reported in other projects: KVU considered 25 years and KS1 40 years. Based on the assessments developed in both processes the best alternative was the alternative 5, which was considered the best option in relation to the achievement of the project goals. (NPRA, 2012d; Oslo Economics et al., 2013)

- **Eastern region projects results**

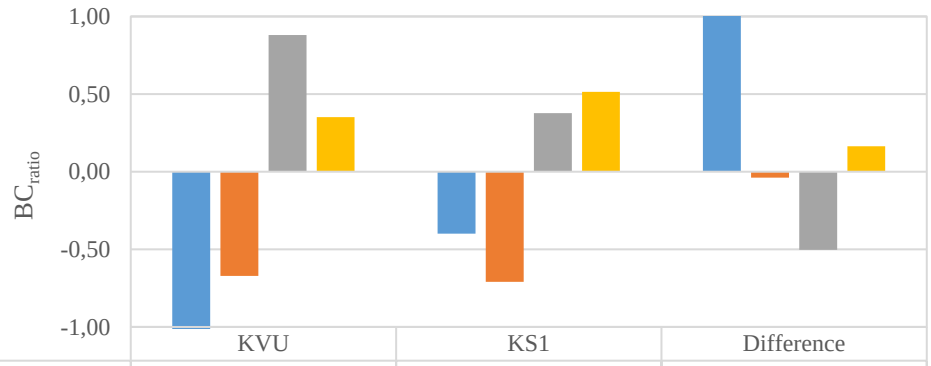
The selected projects located in the eastern region have a uniform scope distribution, with projects P23 and P26 representing an urban project and the other two, P24 and P25, representing a road stretch project. Table 12, presents the KPIs average results for the referred projects. For further details please see Appendix B5, which presents calculations and average results for the different considered road projects.

Table 12: KPIs average results for eastern region projects

AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	9475	-6489	-543	1928	-1,14
KS1	4541	-3932	-137	138	-0,05
Difference	-4934	2557	407	-1790	1,08
	-52 %	-39 %	-75 %	-93 %	

According to Table 12, the average KPIs results for the selected projects located in the eastern region, do not present a significant difference between KVU and KS1 processes. However, it is important to notice that KS1 process presented lower results towards the road user benefit and NPV when compared to KVU process. For example, regarding the NPV, KS1 presented a decrease of 93% when compared to the KVU. The reason behind this is linked to the fact that the average result of public cost for the KS1 processes was much more optimistic, which in turn led towards a better BCr result. From Appendix B5, it is possible to perceive that the assumptions to perform the CBA in each of the two processes were not too different, just differed in the period of analysis for projects P23 and P26. This standardization of criteria prove once more to affect the overall results.

To further discuss the BCr of the selected projects in the eastern region, Figure 21 presents the BCr average results for both KVU and KS1 processes.



	KVU	KS1	Difference
(P23) Nedre Glomma	-5,11	-0,40	4,71
(P24) E16 Bjørgo - Øye	-0,67	-0,71	-0,04
(P25) Oslo fjord	0,88	0,38	-0,50
(P26) Moss - Rygge	0,35	0,51	0,16

Figure 21: BCr average results for projects located in the eastern region

Table shows that KVU process performed a more pessimistic analyse for both urban projects, i.e. project P23 and P26. On the other hand, KS1 process presented similar results to KVU in projects P24 and P25, due to the fact that the same considerations were used to perform the CBA, furthermore the scope of the project was the same, a road stretch.

5. Interview Process Results

In this Chapter the interview results are presented and discussed, and it is divided in 4 Sections. In the Section 5.1, the main influencing factors in an early stage of road projects are presented according to the interviewed project managers (PMs) opinions and experiences. Thereafter, in Section 5.2, the issues associated with alternatives zero and zero plus are presented and further discussed. In Section 5.3 it is discussed how decision-makers deal with the results in an early stage of a road project and finally, in Section 5.4, further comments regarding the overall SEA process are presented.

Noteworthy that the content of this chapter is based on the interviewees' answers to the questions described in Appendix A.

5.1. Main influencing factors of road projects in an early stage

A significant number of PMs pointed out that the time spent by users between the alternative zero and the other alternatives is a factor that influences in a large scale the best solution. This is in accordance with the study results presented by Odeck (2013), who also concluded that the time spent in traffic by the different users is one of the most relevant factors in the selection process. In this sense, according to the interviewed PMs, it is of high importance to take into consideration the road users' opinions and feedbacks in an early stage of a road project and from there start to tackle the possible alternatives.

The interest rate was also identified as an influencing and one of the most difficult factors to predict, due to the high uncertainty associated with it. Several PMs with background in economics referred that the current situation of 4.5% of interest rate seems to be too high for nowadays situation. However, it was also stated that with the increase of the period of analysis to 40 years, the established interest rate became a more plausible and reasonable value. Nonetheless, it should be noticed that a few years ago, the interest rate was even higher, 7%, as referred by the interviewed PMs, which according to them, led to unrealistic results. Nevertheless, according to a large number of interviewed PMs, the actual interest rate value is expected to decrease in the upcoming years due to economic stability.

Another referred influencing factor is the period of analysis, which is used to assess a road project in an early-stage. Previously, the period of analysis was set to 25 years, but

it has been increased to 40 years in most of the reviewed projects. A period of 40 years was considered reasonable for most of the interviewed PMs. Therefore, it is reasonable that the majority of the projects assessed in this study considered a period of 40 years instead of 25 years. However, it should be noticed that an increased period of analysis will lead to an increased uncertainty since the effects will be more difficult to predict. Nonetheless, some PMs considered that a higher period of analysis should be adopted to mega road projects. One of the interviewed PMs with economic background also stated that technically 40 years is a too short period of analysis, but also referred that in terms of socio-economic analysis it presents the most realistic results. Adding to this discussion, it was argued that the assessment of road projects for a period of analysis higher than 50/60 years do not present realistic results. The reason behind this has to do with the fact that some road projects might have their utility reduced over the time due to changes in road users behave connected to technological developments in transport. For example, an increased use of cargo transport by train might lead to a subsequent decrease in cargo transport by road over the time.

The toll charge was also considered one of the most influencing factors in road projects, being the factor that generated more discussion among the different interviewees. This has to do with the fact that in some projects the toll charges are stablished in an early stage with high economic returns. This is done in order to increase the project's economic interest and hence to increase the probability of being approved. In this sense, the interviewed PMs stated that this factor should have lower influence in an early stage and that it should be predicted by performing a CBA. In addition, it was stated that due to the high uncertainty associated with the early stage, this factor should be rather considered in a later phase. By doing so, approved projects that considered too high toll charges would have not been approved by obvious reasons if they had followed the referred suggestions. Adding to this discussion, some PMs stated that the assessment of tolls charges should be considered based on a lower expectancy of traffic and lower toll charges. Furthermore, it was stated that toll charges can have other uses rather than only projects' financing such as control of the road capacity in urban areas, where the influence of such tool is reasonable and important for environmental reasons among others.

Alongside the factors discussed above, environmental effects on agriculture for example, were also identified as influencing factors and according to some of the interviewed PMs, such non-monetised impacts should be more valued.

5.2. Alternatives zero and zero plus

Regarding the alternative zero and zero plus, the interviewed PMs agreed that these alternatives are not clearly defined and it was reported a lack of information regarding its boundaries. Therefore, it was stated that some criteria should be applied towards to a standardized process. It was also mentioned that the alternative zero plus is easier to apply in road stretches connecting two locations, for example, than the alternative 1 and the subsequent alternatives. However, for projects with higher complexity, such as a road network of an urban area, the alternative zero plus is not usually considered but rather the following up alternatives. The reason behind this has to do with the KVU process. According to the interviewed PMs, when a KVU process is initiated in a road project, expectations are generated regarding the new project and thus the selection of a simplified alternative such as the zero plus is not well perceived by the society. In this sense, it is not unexpected the fact that the government tends to do not select the alternative zero plus and to over dimension road projects. By doing so, other than zero alternatives are selected when they are not necessarily needed. Nonetheless, interviewees agreed that in some cases it is good to realize how far it is possible to go, since in some cases the unrealistic alternatives represent a challenge for development of new technology, contributing for the evaluation of the construction industry. Furthermore, the interviewed PMs agreed that even if the KVU presents negative results regarding the NPV, the alternatives zero and zero plus are, in most cases, not selected. Referring to governmental road projects, such alternatives will not be selected even in cases where they might fit the needs simply because the government might want to boost the economy in certain areas or regions, through the improvement of transport infrastructures.

Adding to this discussion, one of the interviewed PMs stated that there is an instrument that prevents simplified solutions to be suggested before the KVU starts, this instrument is the *mulighet studie*. In the *mulighet studie* the problem and the needs are discussed and presented and it is further required the definition of a possible solution and how the solution can be financed. Another interviewee referred that simplified solutions that do not fit the needs of a project can be easily excluded by performing the *behovsanalyse* firstly and independently of the whole concept study. By doing so, it was further stated that the KVU process would become easier and less time-consuming since the most important needs that are required to fulfil are straight away clarified. This suggestion was presented based on PM' experience, being also referred that the previous KVU process

was not as complex as it is nowadays. Noteworthy that according to some PMs the process of discarding alternatives within KVU process should be taken more carefully, since in theirs opinion the best alternative was in some cases sorted out without a relevant reason.

5.3. Decision-makers selection process

This subsection aims to discuss in generic terms whereas decision-makers have enough knowledge based on their academic background to select the best solution in terms of road projects.

The interviewed PMs did not agree on the importance of decision-makers academic background for the selection of the best solution. On the one hand, interviewees stated that generally decision-makers do not have enough academic knowledge to guarantee, based in technical analysis, which is the best solution. However, the majority agreed that decision-makers know what the best solution for the society is, and stated that the lack of knowledge might be compensated by the external quality assurance (KS1).

The external quality assurance is an instrument created by the government to guarantee the standardization of the concept study. So, one can state that it standardizes how the concept study is performed in the different regions of road administration, thus bringing more transparency to the process selection. Nonetheless, PMs in road administration criticised this instrument, referring that the quality assurance consortium groups are not all the same. They stated that some of the consortiums are capable and technically advanced to cover all areas of analysis, whereas others are not. Adding to this discussion, it was stated that the conclusions regarding the best option might differ between the road administration and the consortium responsible for the external quality assurance. In this sense, it is expected that in some cases the best solution pointed out by the external quality assurance is the one that is selected by the decision-makers, while in other cases they rather choose the solution pointed out by the road administration as a result of the KVU process. Nonetheless, it was stated that in some cases neither the KVU nor KS1 suggestions were considered in the selection of the best solution by the decision-makers, but rather other assessed alternative. In such cases, it was referred that the selection might be based on political ideology without taking into consideration technical fundaments. To further understand this issue, it was asked to the interviewed PMs to state in a scale of zero to five, “how strongly do they believe that KVU/KS1 results are considered by decision-makers?”. The results of this question are presented in Figure 22.

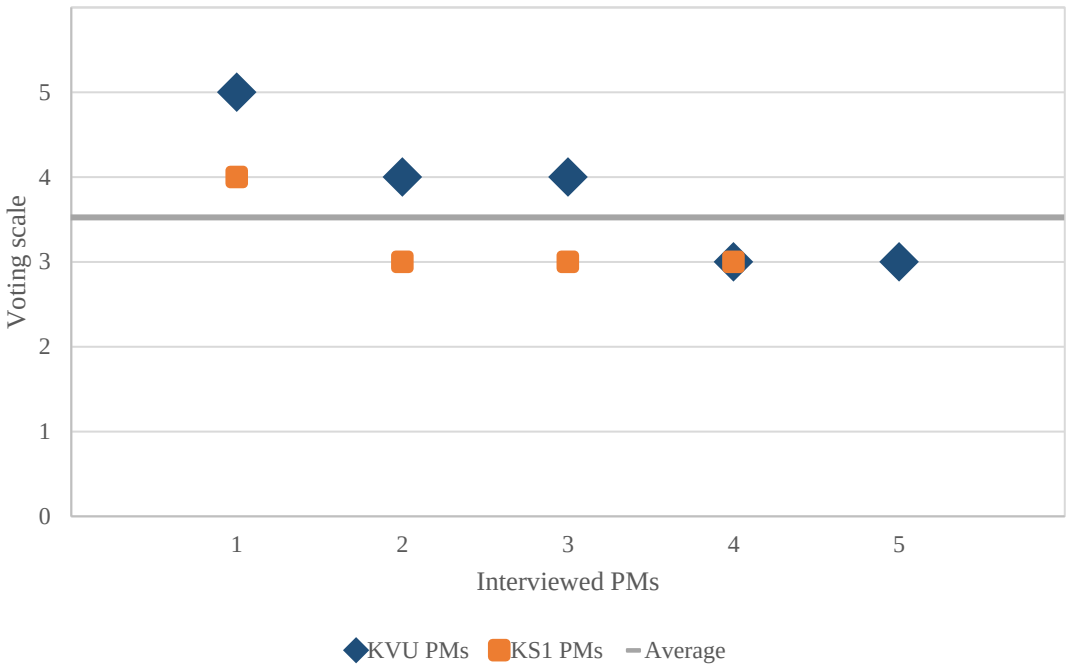


Figure 22: Scale of KVU/KS1 results considered by decision-makers

According to Figure 22, PMs from the public sector (KVU PMs) believe more strongly than external quality assurance consortiums (KS1 PMs) that KVU/KS1 results are taken into account by the decisions makers in the selection process of the best solution. Results also show that, in average, in a scale of 3.6 both entities believe that KVU/KS1 results are considered. Regardless, PMs agreed that decision-makers tend to select more often the KS1 suggested alternative which might be due to the fact that KS1 process is generally more focused on the economic profit of a road project.

Regarding the differences between KVU and KS1 suggestions towards the best solution, PMs in the road administration stated that KS1 reports should have at least the same level of deepness. It was stated that KS1 reports may differ significantly between the different consortiums, whereas in the KVU reports this does not happen. In this sense, it is understandable when some decision-makers ask for clarifications about something that is not clear and reasonable explained.

Nonetheless, it should be stated that from interview results it is unclear what could be done, i.e., what measures could be implemented, to prevent wrong decisions by the decision-makers regarding the best solution.

5.4. Further comments

In this subsection further comments regarding SEA process are presented based on interview results.

The interviewed PMs responsible for the external quality assurance stated that the SEA process should in some cases be performed more precisely. However, PMs of road administrated referred that KS1 reports can be too much detail focused, hence missing the overall picture of the problem. In addition, it was stated that in some cases a high level of detail can lead to double counting of road construction impacts, which is not desired in a so expensive process, and from which decisions are based.

In order to improve the assessment of the impacts, the EFFEKT program was recognized as a good but not flawless tool. The interviewed PMs stated that it improved significantly, over the last years, and credits were given to the RTM (regional transport model) and the NTM (national transport model) models in this regard. However, PMs stated that the EFFEKT program should be further improved and that it should keep aiming better results. The main criticism was associated with how the program assess the toll charges, which has led some projects to be discarded because of wrong estimations. Besides that, it was stated that in some cases the external quality assurance performed the toll charges analyse by using a different approach which led to project's approval, which would not be able by using the EFFEKT program. Another aspect that was suggested to be improved in EFFEKT was the queueing model, being referred that some external consultants use other tools that are much more accurate.

Regarding the utility and effectiveness of the CBA as a method of assessment for road projects in an early stage, it was consensual that this method is the most effective. Besides, it was of general agreement that other methods such as multi-criteria decision analysis, were not considered to be better than CBA, mainly because of the large subjectivity associated with it.

6. Discussion

In this Chapter the main findings from project analysis and interview processes are further discussed and suggestions are given towards standardized KVU and KS1 processes and hence towards an improved selection process.

According to results from both project analysis and interview processes, the different considerations taken to perform a CBA of a road project in an early stage have associated a significant level of uncertainty. This situation was also assessed and discussed by several studies, as reported in Section 3.4. Such uncertainties are mostly associated with the definition of interest rate, period of analysis and toll charges. In the interview process, most of the interviewees agreed in the importance of such elements in a CBA of a road project and that such elements can affect to a large extent the overall results. Furthermore, the interviewed PMs agreed that in an early stage of a road project the interest rate and period of analysis should be set at 4% and 40 years, respectively, as proposed by NPRA, Section 3.4. Moreover, the results from project analysis showed that when KVU and KS1 processes considered the referred interest rate and period of analysis, the differences in the overall results were in average negligible. This was perceived in projects P1, P6, P16 and P19 which results presented minor BCr differences.

Regarding the tolls charges, this topic was massively discussed during the interview process. The interviewed PMs from both public and private sectors did not agree in the uncertainty associated with it when performing a CBA in an early stage of a road project. Most PMs from road administration argued that toll charges should not be considered because it might lead to a traffic overestimation thus affecting the scope of the project. Besides, it was argued that project's financing is not clearly defined at the conceptual study. In addition, it was stated that in Norway most of the expected road traffic is not as high as in other countries, where the high traffic flow allows low and plausible toll charges. In this sense, as in Norway most of road projects do not present enough traffic to support project's financing through toll charges, it should not be included in an early stage. On the other hand, most PMs from private sector argued that despite the uncertainty associated with this element, it should still be considered since it has impact in other elements, such as traffic regulation and fuel combustion and its associated impact on the environment. Regardless of arguments from both sides, one can state that most PMs from private sector argued in favour of toll charges because KS1 process is generally more

focused on the economic profit of a road project than KVU process. This assumption is based on the high consideration of economic results of a road project in the KS1 process. However, despite being highly relevant that a road project presents high profitability, other criteria should also be considered. Economy development can be one of these criteria, for example. To improve the Norwegian economy in all parts of the country, it is important to support some regions that are more isolated or that are not so attractive due to weak road connections. Therefore, by assessing road projects based on economy development, the northern and western regions, where this situation applies, could be boosted. Moreover, by doing so, more egalitarian road infrastructures throughout Norway would apply. Notwithstanding, the application of this criterion is not as easy as it looks due to the high dependency on political ideologies by the Norwegian government.

Regarding the process selection, results from both project analysis and interview processes showed a significant level of subjectivity associated with the alternative zero and the alternative zero plus since they are not clearly defined. Results also showed that this lack of definition affects the scale of how the other alternatives are developed. For example, in project P1, KS1 process selected the alternative zero plus (0+) as the best alternative while KVU process selected the alternative zero. However, as the alternative 0+ was not considered by the government, KS1 process presented an additional alternative: zero plus plus (0++). This alternative presented an increased level of complexity when compared to the previously suggested alternative 0+ and a decreased level of complexity towards the previously suggested alternative 1. In this sense one can state that alternative 0++ suggested by KS1 process is more or less the alternative 1 suggested by KVU process and that such lack of clarification and standardization might lead to misunderstandings in the selection process by the Norwegian government. In this sense, to standardize the results from both KVU and KS1 processes, criteria to define the scale of investment considered in the alternative zero should be defined. By doing so, alternatives that are similar to alternative zero but that require large investments for simplified improvements would be more clearly defined. Noteworthy that some of the interviewed PMs agreed that criteria such as the suggested one should be developed and applied towards a better and more transparent process selection.

Notwithstanding, the interviewed PMs agreed that in most cases alternatives zero and zero plus are not selected. This can also be perceived in Chapter 4 where from a total of 26 projects, in only 8 the alternatives zero or zero plus were recommended by KVU and/or

KS1 processes. As discussed in Section 5.2, such alternatives might not be selected even in cases where they fit the needs simply because the government might want to boost the economy in certain areas or regions through the improvement of transport infrastructures. In addition, it was stated that when the KVU process is initiated, expectations are generated regarding the new project and thus the selection of a simplified alternative such as the zero or zero plus is not well perceived by the society.

Still regarding the process selection, this study tried to address whereas decision-makers' background played a role or not. According to interview process results, the importance of decision-makers academic background for the selection of the best solution was not consensual. On the one hand some of the interviewed PMs stated that generally decision-makers do not have enough expertise to select the best solution while the majority agreed that decision-makers always know what the best for the society is. Regardless, it was also stated that in some cases neither the KVU nor KS1 suggested alternative was considered in the selection process by the decision-makers, but rather one of the other assessed alternatives. In such cases, it was referred that the selection might be based on political ideologies without taking into consideration technical fundaments. Therefore, one can state that in some cases decision-makers have already a clear idea about what they intend with the project and that in such cases they will not follow the suggestions made by either process. Nonetheless, it was also stated that decision-makers select more often the suggested alternative made by KS1 process than the one made by KVU process. This might happen because KS1 process is more focused on the economic aspects of road projects than KVU process, as previously discussed.

Regarding KVU and KS1 processes, the interviewed PMs agreed that both processes have proven to be very useful for the selection process and that one complements the other, i.e. KS1 complements KVU process. However, some PMs criticised the KVU process complexity and stated that it is too time consuming. On the other hand, it was argued that such complexity might present advantages such as the fact that prevents weak project solutions to be further approved, since it gives the opportunity in an early stage to discuss the really needs, thus making it more efficient. Nevertheless, it was referred that simplified solutions that do not fit the needs of a project can be easily excluded by performing a *behovsanalyse* firstly and independently. By doing so, it was further stated that the KVU process would become easier and less time-consuming since the most important needs that are required to fulfil would be straight away clarified. Furthermore,

it was stated that a simplified KVU process would lead to a decrease of the pressure exerted by the society and mainly by the decision-makers to present results as fast a s possible. With regard KS1 process, it was of general agreement that the benefits associated with it are much higher than the potential losses that might occur if the KS1 was not performed. However, some drawbacks associated with it were pointed out by the PMs from the public sector. It was stated that the different consortiums responsible for the KS1 do not have the same qualifications and that the results presented by one consortium might differ quite significantly from one other. Despite the recognized improvement that these external consortiums have brought to the assessment of projects in an early stage, it was stated that the criteria to approve and select them should be reviewed. Moreover, it was referred that the selection process of consortiums should not be exclusively based on technical qualifications but as well as in the work experience that such consortiums have proven to have in the assessment of road projects in an early stage through the use of CBA.

All in all, throughout the performed interviews it was asked how PMs perceived the consideration of decision-makers to their suggested alternative and it was clearly perceived that the answers were carefully rethought towards a more positive feedback. This is not in line with Eliasson et al. (2015) and Odeck et al. (2010) findings, previously referred in Section 3.4. However, PMs' feedback is expected with such a paradoxical situation: on one hand PMs were too critic about how decision-makers assess results, but on the other hand if they had stated that their suggestions were not being considered in the process selection they were somehow stating that their work has no meaning. In this sense one can state that the selection process has associated a significant level of subjectivity and hence some criteria should be developed and applied towards a more transparent and improved process. Nevertheless, it is ones believe that politicians would not accept to base their decision on purely technical assessments and that rather prefer a much higher level of flexibility.

7. Conclusion

The main goal of this study was to address the differences in the monetised results of the KVU and KS1 processes by using KPIs average results and by performing in-depth interviews. In addition, the study aimed to address possible changes that could be made in order to prevent the variation of results, thus leading to an improved SEA process and ultimately to an improved selection process.

According to result findings, the interest rate and period of analysis are the main causes of variation of results between KVU and KS1 processes. Besides, it was concluded that toll charges also play an important role in the variation of results. In this sense, it was concluded that in order to minimize the differences in results an interest rate of 4% and a period of analysis of 40 years should be used in an early stage of assessment of road projects by both KVU and KS1, towards a more standardized processes and hence towards a more transparent and better selection process. Regarding toll charges it was concluded that it should be only considered in an early stage of analysis if it aims to decrease traffic congestion and/or environmental impacts. However, if it is only considered to funding a road project it should be then excluded since in an early stage it might affect the scope of the project and lead to a traffic overestimation in order to justify the investment effectiveness.

Regarding the assessment of the different alternatives in comparison with the alternative zero it was concluded that alternative zero has associated a high level of subjectivity and that should be further clarified in order to avoid misunderstandings in the process selection by the Norwegian government. In addition, it was concluded that criteria to define the scale of investment considered in the alternative zero should be applied thus leading towards standardized results from both KVU and KS1 processes. The example of project P1 was given, where KS1 suggested alternative zero plus plus (0++) which is quite similar to alternative 1 suggested by KVU process. In this sense, it is ones believe that if these criteria were applied, alternatives that are similar to alternative zero but that require large investments for simplified improvements would be more clearly defined, hence allowing a more transparent selection process of the selected alternatives.

In what concerns possible changes towards standardization of both KVU and KS1 processes, it was concluded that it might not be as simples as it may seem. Nevertheless, towards a simplification and increased efficiency of both processes, it was suggested that

a *behovsanalyse* should be performed firstly and independently of KVU. By doing so it was argued that the most important needs that are required to fulfil in a road project would be straight away clarified, thus leading to a subsequently decrease of the pressure exerted by the society and mainly by the decision-makers to present results as fast a s possible.

In addition, it was concluded that significant differences in results might be obtained when the same road project is assessed by different consortiums. In this sense, it was suggested that a stricter evaluation of the consortiums responsible by KS1 process should be applied since they do not present the same level of qualification.

Regardless, of the level of standardization of both KVU and KS1 processes, it was concluded that in some cases neither the KVU nor KS1 suggested alternative was considered in the selection process by the decision-makers, but rather one of the other assessed alternatives. In such cases it was concluded that the selection process is in some cases not based on technical fundamentals but rather on political ideologies. It was then concluded that in some cases decision-makers have already a clear idea about what they intend with the project and that in such cases they will not follow the suggestions made by either process. Nonetheless, it was also concluded that decision-makers select more often the suggested alternative made by KS1 process than the one made by KVU process.

Overall, by taking into consideration this study findings, one can conclude that there is a significant discrepancy between KVU and KS1 process results, and that measures need to be applied towards a more transparent and better selection process. In this sense, it is ones believe that the suggestions made throughout this study might help in the standardization of both processes. Nevertheless, a further analysis is required and in such analyse more focus should be given to the decision-making process.

References

Berechman, J. (2009). *The evaluation of transportation investment projects* (Vol. 42). New York: Routledge.

Blackstone, A. (2012). Interviews: Qualitative and Quantitative Approaches. In V. Gennarelli (Ed.), Sociological Inquiry Principles: Qualitative and Quantitative Methods

US. Retrieved from https://2012books.lardbucket.org/books/sociological-inquiry-principles-qualitative-and-quantitative-methods/index.html.

Boadway, R. W. (1974). The Welfare Foundations of Cost-Benefit Analysis. *The Economic Journal, 84*(336), 926-939.

Boardman, A. E. (2006). *Cost-benefit analysis : concepts and practice* (3rd ed.). Upper Saddle River, N.J: Pearson Prentice Hall.

Creswell, J. W. (2014). *Research design : qualitative, quantitative, and mixed methods approaches* (4th ed.). Los Angeles: SAGE.

Deardorff, A. V. (2014). *Terms of Trade : Glossary of International Economics* (2nd ed.). Singapore: World Scientific Publishing Company.

DNV GL, SNF, & Advansia, Å. (2011a). *KS1 Harstad*. Oslo.

DNV GL, SNF, & Advansia, Å. (2011b). *KS1 Nedre Glommaregionen*. Oslo.

DNV GL, SNF, & Advansia, Å. (2011c). *KS1 Rv. 80 Løding – Bodø sentrum*. Oslo.

DNV GL, SNF, & Advansia, Å. (2012a). *KS1 E6 Mørsvikbotn - Ballangen*. Oslo.

DNV GL, SNF, & Advansia, Å. (2012b). *KS1 E10/Rv.85 Evenes - Sortland*. Oslo.

DNV GL, SNF, & Advansia, Å. (2012c). *KS1 Jæren*. Oslo.

DNV GL, SNF, & Advansia, Å. (2015). *KS1 E6 Fauske- Mørsvikbotn*. Oslo.

Dobes, L., & Bennett, J. (2009). Multi-Criteria Analysis: "Good Enough" for Government Work? *Agenda: A Journal of Policy Analysis and Reform, 16*(3), 7-29.

Dovre Group, & TØI. (2012a). *KS1 Bergen*. Stavanger.

Dovre Group, & TØI. (2012b). *KS1 E39 Aksdal - Bergen*. Stavanger.

Dovre Group, & TØI. (2012c). *KS1 E134 Kongsberg – Gvammen*. Oslo.

Dovre Group, & TØI. (2015). *KS1 Hønefoss*. Southern region.

Eliasson, J., Börjesson, M., Odeck, J., & Welde, M. (2015). Does Benefit-Cost Efficiency Influence Transport Investment Decisions? *Journal of Transport Economics and Policy (JTEP), 49*(3), 377-396.

Feldman, A., & Serrano, R. (2006). *Welfare Economics and Social Choice Theory* (2nd ed.). Boston, MA: Springer US: Boston, MA.

Frels, R. K., & Onwuegbuzie, A. J. (2013). Administering Quantitative Instruments With Qualitative Interviews: A Mixed Research Approach. *Journal of Counseling & Development, 91*(2), 184-194.

Fridstrøm, L., & Elvik, R. (1997). The barely revealed preference behind road investment priorities. *Public Choice, 92*(1), 145-168.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *BDJ, 204*(6), 291.

Grøvdal, A., & Hjelle, H. M. (1998). *Innføring i transportøkonomi*. Bergen-Sandviken: Fagbokforlaget.

Hausman, D. M., & McPherson, M. S. (2006). *Economic Analysis, Moral Philosophy and Public Policy* (2nd ed.): Cambridge University Press.

Holte Consulting, A-2 Norge, SNF, & Proba samfunnsanalyse. (2016). *KS1 Haugesund*. Oslo.

Holte Consulting, A-2 Norge, SNF, & Proba samfunnsanalyse. (2017). *KS1 Rv.7 / Rv.52 Gol – Voss* Oslo.

Holte Consulting, & Vista Analyse. (2012). *KS1 E39 Søgne - Ålgård*. Oslo.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher, 33*(7), 14-26.

Jones, H., Moura, F., & Domingos, T. (2014). Transport Infrastructure Project Evaluation Using Cost-benefit Analysis. *Procedia - Social and Behavioral Sciences, 111*(Supplement C), 400-409.

Khan, M. Y., & Jain, P. K. (1999). *Theory and Problems in Financial Management*. New Delhi, India: Tata McGraw-Hill.

Kothari, C. R. (2004). *Research Methodology : Methods and Techniques* (2nd ed.). New Delhi: New Age International Pvt. Ltd., Publishers.

Krutilla, K. (2005). Using the Kaldor-Hicks tableau format for cost-benefit analysis and policy evaluation. *Journal of Policy Analysis and Management, 24*(4), 864-875.

Mankiw, N. G. (2012). *Principles of macroeconomics* (6th ed.). Australia: South-Western Cengage Learning.

Metier, & Møreforsking. (2011). *KS1 E16 Bjørgo - Øye*. Eastern region.

Metier, & Møreforsking. (2014). *KS1 Tønsberg*. Southern region.

Mouter, N. (2017). Dutch politicians' attitudes towards Cost-Benefit Analysis. *Transport Policy*, *54*(Supplement C), 1-10.

Mouter, N., Annema, J. A., & van Wee, B. (2013). Attitudes towards the role of Cost–Benefit Analysis in the decision-making process for spatial-infrastructure projects: A Dutch case study. *Transportation Research Part A: Policy and Practice*, *58*, 1-14.

Nas, T. F. (1996). *Cost-benefit analysis : theory and application*. Thousand Oaks, Calif: Sage Publications.

NOU 2012:16, O. N. R. (2012). *Cost-benefit analysis : Review from a committee appointed by Royal Decree of 18 February 2011 : submitted to the Ministry of Finance on 3 October 2012* (Vol. NOU 2012: 16). Oslo: Government Administration Services, Information Management.

NPRA. (2006). *Konsekvensanalyser: Håndbok 140*. Oslo.

NPRA. (2007). *Impact assessment of road transport projects: Summary*. Oslo.

NPRA. (2011a). *KVU E16 Bjørgo - Øye*. Eastern region.

NPRA. (2011b). *KVU E39 Aksdal – Bergen*. Western region.

NPRA. (2011c). *KVU E39 Bergsøya - Valsøya*. Central region.

NPRA. (2011d). *KVU E39 Skei - Ålesund*. Western region.

NPRA. (2011e). *KVU E39 Søgne - Ålgård*. Southern region.

NPRA. (2011f). *KVU E39 Ålesund - Bergsøya*. Central region.

NPRA. (2011g). *KVU E134 Kongsberg - Gvammen*. Southern region.

NPRA. (2011h). *KVU for transportsystemet i Bergensområdet*. Western region.

NPRA. (2011i). *KVU Harstad*. Northern region.

NPRA. (2011j). *KVU Rv. 80 Løding – Bodø sentrum*. Northern region.

NPRA. (2012a). *Effektivisering av planlegging. Forprosjekt*. Oslo.

NPRA. (2012b). *KVU E6 Mørsvikbotn - Ballangen*. Northern region.

NPRA. (2012c). *KVU E10/Rv.85 Evenes - Sortland*. Northern region.

NPRA. (2012d). *KVU Moss - Rygge*. Eastern region.

NPRA. (2013a). *KVU Buskerudbypakke 2*. Southern region.

NPRA. (2013b). *KVU Tønsberg*. Southern region.

NPRA. (2013c). *KVU Ålesund*. Central region.

NPRA. (2014a). *Konsekvensanalyser: Håndbok V712*. Oslo: Vegdirektoratet.

NPRA. (2014b). *KVU Oslofjorden*. Eastern region.

NPRA. (2015a). *KVU E6 Fauske - Mørsvikbotn*. Northern Region.

NPRA. (2015b). *KVU E10 Fiskebøl – Å*. Northern region.

NPRA. (2015c). *KVU Haugesund*. Western region.

NPRA. (2015d). *KVU Hønefoss*. Southern region.

NPRA. (2015e). *KVU Rv.7 / Rv.52 Gol – Voss*. Southern region.

NPRA, & NNRA. (2010). *KVU Nedre Glommaregionen*. Eastern region.

NPRA, & NNRA. (2011). *KVU Trondheim - Steinkjer*. Central region.

NPRA, & NNRA. (2014). KVU Voss – Arna. In. Western region.

Nyborg, K. (1998). Some Norwegian politicians' use of cost-benefit analysis. *Public Choice, 95*(3), 381-401.

Odeck, J. (1996). Ranking of regional road investment in Norway. *Transportation, 23*(2), 123-140.

Odeck, J. (2004). Cost overruns in road construction—what are their sizes and determinants? *Transport Policy, 11*(1), 43-53.

Odeck, J. (2010). What Determines Decision-Makers' Preferences for Road Investments? Evidence from the Norwegian Road Sector. *Transport Reviews, 30*(4), 473-494.

Odeck, J. (2013). How accurate are national road traffic growth-rate forecasts?—The case of Norway. *Transport Policy, 27*, 102-111.

Odeck, J. (2014). Do reforms reduce the magnitudes of cost overruns in road projects? Statistical evidence from Norway. *Transportation Research Part A: Policy and Practice, 65*(Supplement C), 68-79.

Odeck, J., & Kjerkreit, A. (2010). Evidence on users' attitudes towards road user charges—A cross-sectional survey of six Norwegian toll schemes. *Transport Policy, 17*(6), 349-358.

Odeck, J., Welde, M., & Volden, G. (2015). The Impact of External Quality Assurance of Costs Estimates on Cost Overruns: Empirical Evidence from the Norwegian Road Sector. *Eur. J. Transport. Infrastruct. Res., 15*(3), 286-303.

Oslo Economics, & Atkins Norge. (2015). *KS1 Oslofjorden*. Oslo.

Oslo Economics, & Atkins Norge. (2016). *KS1 E10 Fiskebøl – Å*. Oslo.

Oslo Economics, & Terramar. (2012a). *KS1 E39 Skei - Valsøya*. Oslo.

Oslo Economics, & Terramar. (2012b). *KS1 Trondheim – Steinkjer*. Oslo.

Oslo Economics, & Terramar. (2013). *KS1 Moss - Rygge*. Oslo.

Oslo Economics, & Terramar. (2014a). *KS1 Buskerudbypakke 2*. Oslo.

Oslo Economics, & Terramar. (2014b). *KS1 Voss – Arna*. Oslo.

Oslo Economics, & Terramar. (2014c). *KS1 Ålesund*. Oslo.

Rietveld, P., Rouwendal, J., & van der Vlist, A. J. (2007). Equity Issues in the Evaluation of Transport Policies and Transport Infrastructure Projects. In M. Geenhuizen van, A. Reggiani, & P. Rietveld (Eds.), *Policy Analysis of Transport Networks* (pp. 19-36). Aldershot: Ashgate.

Rogaland, F. (2012). KVU Jæren. In. Stavanger: County of Rogaland.

Samset, K. (2010). *Early project appraisal : making the initial choices*. New York: Palgrave Macmillan.

Samset, K., Volden, G. H., Welde, M., & Røstad, C. C. (2018). The Norwegian scheme for quality assurance of major public investments (the QA scheme). *Concept Research Programme.* Retrieved from https://www.ntnu.no/concept

Torp, O., Belay, A. M., Thodesen, C., & Klakegg, O. J. (2016). Cost Development Over-time at Construction Planning Phase: Empirical Evidence from Norwegian Construction Projects. *Procedia Engineering, 145*, 1177-1184.

van Wee, B. (2012). How suitable is CBA for the ex-ante evaluation of transport projects and policies? A discussion from the perspective of ethics. *Transport Policy, 19*(1), 1-7.

Volden, G. H. (2018). Public project success as seen in a broad perspective.: Lessons from a meta-evaluation of 20 infrastructure projects in Norway. *Evaluation and Program Planning, 69*, 109-117.

Welde, M., & Odeck, J. (2017). Cost escalations in the front-end of projects – empirical evidence from Norwegian road projects. *Transport Reviews, 37*(5), 612-630.

Willig, R. D. (1976). Consumer's Surplus Without Apology. *The American Economic Review, 66*(4), 589-597.

Žižlavský, O. (2014). Net Present Value Approach: Method for Economic Assessment of Innovation Projects. *Procedia - Social and Behavioral Sciences, 156*, 506-512.

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Appendices

Appendix A - Interview Guide

Socio Economic Analysis of Road Projects

Development of CBA during conceptual phases

Introduction (5 minutes)

1. Presentation
    a. Entity represented:
    b. Department and years of expertise:
    c. Academic background

Discussion (45 minutes)

1. Which are the main causes/factors for variation of results between processes in an early stage?
    a. What is the **interest rate** that in your opinion should be used for Norwegian road projects? Is the current interest rate too high or too low? Is there any bias?
    b. Do you consider that the **period of analysis** is the most appropriated?
    What you think is most suitable in future projects? (25 years / 40 years / + years)
    c. In terms of **toll charges**, do you think that should or not be consider in an early stage?
    Do not you think that in an early stage, we may know too little whether the project will be financed by tolls?

2. Normally the alternative zero is not clearly defined and in some cases the definition is expanded to an **alternative zero plus**. In terms of dimension, how are the different project alternatives assessed in comparison with the **alternative zero**?
    a. Are government measures generally more ambitious than just an **alternative zero plus**?
    Do not you think that SVV might tend to **oversize** the projects to fit the governmental desire?
    b. Do you think that after initiating a KVU, opting for a simplified solution is not well perceived?

3. Considering the people responsible for the **decision making**, how are the KVU results perceived? Do you think that KVU is something that SVV is really interested on, or is it a result of being forced by the minister of finance to manage investments?
    a. Is the academic background of decision-makers supporting their alternative choice?
    (That might be the reason why they resort to external consultants for quality assurance?)

4. Do you believe that KVU results are totally considered by the decision-makers?
   a. How strongly do you believe that this results are considered? (in a scale of 0 to 5)
   b. Did you experienced that in some projects the best solution in your opinion was not considered?
   c. Why were the other suggested alternatives rejected? Which were the main causes?

5. What do you think that could be possibly made to change this situation?
   Should be implemented any other criteria to prevent wrong decisions to be taken?

6. There are some other measures / tools to standardize the assessment, as the EFFECT program.
   Which other measures could be taken to guarantee the best results?

Closing remarks (15 minutes)

- In terms of project valuation method, do you consider CBA the most effective?
  - If so, what make it better than others? Is it better than multi-criteria decision analysis?
  - If not, which method should be used instead?
- What do you think about the KVU process?
  - This process started after 2003, before there was nothing like that.
    Do you think that so far it has been useful?
- Do you think that the quality assurance regime (KS1), has been useful so far? And if so, how?
- Has the KS regime done something good? Or do you think that has been completely useless?

Appendix B - Key Performance Indicators

Appendix B1 - Northern Region Database

Tables 13-18 show the KPIs results of the different alternatives considered in the assessed projects developed in the Northern region, i.e., P1 to P6 projects. Then by using the averages presented at the end of Tables 13-18 an average of the KPIs for the total number of projects comprised in this region was performed, which results were previously presented in Table 8.

Table 13: Resume of KPIs in project P1

(P1) E6 Fauske - Mørsvikbotn					
Region	Northern		Interest rate	Period of analysis	Comparison year
County	Nordland	KVU	4,0 %	40	2023
Consortium	C1	KS1	4,0 %	40	2017
Alt. 0++	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-1200	-4000	-874	-6100	-1,50
KS1	-918	-2896	-633	-4447	-1,54
Difference	282	1104	241	1653	-0,04
	24 %	28 %	28 %	27 %	
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3000	-7200	-1040	-5400	-0,70
KS1	2620	-5728	-745	-3853	-0,67
Difference	-380	1472	295	1547	0,03
	-13 %	20 %	28 %	29 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3800	-8300	-1060	-5600	-0,70
KS1	3214	-6707	-879	-4371	-0,65
Difference	-586	1593	181	1229	0,05
	-15 %	19 %	17 %	22 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3400	-7800	-1180	-5600	-0,70
KS1	2997	-6156	-769	-3928	-0,64
Difference	-403	1644	411	1672	0,06
	-12 %	21 %	35 %	30 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2250	-6825	-1039	-5675	-0,90
KS1	1978	-5372	-757	-4150	-0,87
Difference	-272	1453	282	1525	0,03
	-12 %	21 %	27 %	27 %	

Table 14: Resume of KPIs in project P2

(P2) E6 Mørsvikbotn - Ballangen					
Region	Northern		Interest rate	Period of analysis	Comparison year
County	Nordland	KVU	4,5 %	25	2018
Consortium	C1	KS1	4,5 %	40	2018
Alt. 1A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3550	-5010	-280	-1740	-0,35
KS1	3021	-5792	-638	-3409	-0,59
Difference	-529	-782	-358	-1669	-0,24
	-15 %	-16 %	-128 %	-96 %	
Alt. 1B	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3270	-4710	-220	-1660	-0,35
KS1	2584	-5378	-550	-3344	-0,62
Difference	-686	-668	-330	-1684	-0,27
	-21 %	-14 %	-150 %	-101 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3410	-4860	-250	-1700	-0,35
KS1	2803	-5585	-594	-3377	-0,61
Difference	-608	-725	-344	-1677	-0,26
	-18 %	-15 %	-138 %	-99 %	

Table 15: Resume of KPIs in project P3

(P3) E10/Rv. 85 Evenes - Sortland					
Region	Northern		Interest rate	Period of analyse	Comparison year
County	Nordland	KVU	4,5 %	25	2018
Consortium	C1	KS1	4,5 %	40	2018
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2280	-3220	150	-790	-0,25
KS1	3991	-3938	-31	22	0,01
Difference	1711	-718	-181	812	0,25
	75 %	-22 %	-121 %	103 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3670	-3810	190	50	0,01
KS1	5683	-4511	-37	1136	0,25
Difference	2013	-701	-227	1086	0,24
	55 %	-18 %	-119 %	2172 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	4480	-4670	140	-50	-0,01
KS1	6694	-5484	-154	1055	0,19
Difference	2214	-814	-294	1105	0,20
	49 %	-17 %	-210 %	2210 %	

AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3477	-3900	160	-263	-0,08
KS1	5456	-4644	-74	738	0,15
Difference	1979	-744	-234	1001	0,23
	57 %	-19 %	146 %	380 %	

Table 16: Resume of KPIs in project P4

(P4) Rv. 80 Løding - Bodø centre					
Region	Northern		Interest rate	Period of analysis	Comparison year
County	Nordland	KVU	4,5 %	25	2014
Consortium	C1	KS1	4,5 %	40	2010
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1612	-2839	166	-1072	-0,38
KS1	-4710	-250	920	-4020	-16,08
Difference	-6322	2589	754	-2948	-15,70
	-392,18 %	91,19 %	454,22 %	-275,00 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	835	-3077	278	-1962	-0,64
KS1	-5560	1230	1410	-2930	-2,38
Difference	-6395	4307	1132	-968	-1,74
	-765,87 %	139,97 %	407,19 %	-49,34 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1450	-1962	304	-208	-0,11
KS1	-4180	-170	1150	-3200	-18,82
Difference	-5630	1792	846	-2992	-18,72
	-388,28 %	91,34 %	278,29 %	-1438,46 %	
Alt. C	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1612	-2307	294	-85	-0,04
KS1	-4710	210	1010	-3480	-16,57
Difference	-6322	2517	716	-3395	-16,53
	-392,18 %	109,10 %	243,54 %	-3994,12 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1377	-2546	261	-832	-0,29
KS1	-4790	255	1123	-3408	-13,46
Difference	-6167	2801	862	-2576	-13,17
	-447,79 %	110,01 %	-330,90 %	-309,68 %	

Table 17: Resume of KPIs in project P5

(P5) Harstad					
Region	Northern		Interest rate	Period of analysis	Comparison year
County	Troms	KVU	4,5 %	25	2014
Consortium	C1	KS1	4,5 %	40	2010
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	630	-1100	-70	-540	-0,59
KS1	-2710	1810	300	-610	-0,34
Difference	-3340	2910	370	-70	0,25
	-530,16 %	264,55 %	528,57 %	-12,96 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	540	-1480	50	-890	-0,64
KS1	-2900	1570	540	-790	0,50
Difference	-3440	3050	490	100	1,14
	-637,04 %	206,08 %	980,00 %	11,24 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	200	-1055	85	-770	-0,73
KS1	-3360	1710	710	-940	-0,55
Difference	-3560	2765	625	-170	0,18
	-1780,00 %	262,09 %	735,29 %	-22,08 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	457	-1212	22	-733	-0,65
KS1	-2990	1697	517	-780	-0,13
Difference	-3447	2908	495	-47	0,53
	-754,74 %	240,03 %	2284,62 %	-6,36 %	

Table 18: Resume of KPIs in project P6

(P6) E10 Fiskebøl - Å					
Region	Northern		Interest rate	Period of analysis	Comparison year
County	Nordland	KVU	4,0 %	40	2022
Consortium	C6	KS1	4,0 %	40	2016
Fiskebøl - Svolvær					
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	449	-883	-113	-547	-0,66
KS1	369	-786	-99	-515	-0,69
Difference	-80	97	14	32	-0,03
	-17,76 %	10,99 %	12,36 %	5,76 %	
Svolvær - Kabelvåg					
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	141	-730	-145	-735	-1,07
KS1	115	-712	-141	-737	-1,09
Difference	-25	19	4	-3	-0,02
	-17,97 %	2,53 %	2,59 %	-0,34 %	
Kabelvåg - Leknes					
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1149	-2427	-316	-1593	-0,69
KS1	975	-2095	-254	-1373	-0,68
Difference	-174	332	62	220	0,01
	-15,12 %	13,68 %	19,49 %	13,81 %	
Leknes - Moskenes					
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1103	-965	23	161	0,44
KS1	906	-830	10	86	0,37
Difference	-196	136	-14	-74	-0,07
	-17,81 %	14,05 %	58,57 %	46,27 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	710	-1251	-138	-678	-0,50
KS1	592	-1105	-121	-635	-0,52
Difference	-119	146	16	44	-0,03
	-16,72 %	11,65 %	11,92 %	6,44 %	

Appendix B2 - Central Region Database

Tables 19-22 show the KPIs results of the different alternatives considered in the assessed projects developed in the Central region, i.e., P7 to P10 projects. Then by using the averages presented at the end of Tables 19-22 an average of the KPIs for the total number of projects comprised in this region was performed, which results were previously presented in Table 9.

Table 19: Resume of KPIs in project P7

(P7) E39 Ålesund - Bergsøy					
Region	Central		Interest rate	Period of analysis	Comparison year
County	Møre og Romsdal	KVU	4,5 %	25	2020
Consortium	C6	KS1	2,0 %	40	2012
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	535	-4482	-798	-4785	-1,06
KS1	2499	-1547	-2818	-1963	-1,27
Difference	1964	2935	-2020	2822	-0,21
	367 %	65 %	-253 %	59 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	6808	-15207	-2001	-9914	-0,67
KS1	18904	-15823	-3324	868	0,05
Difference	12096	-616	-1323	10782	0,72
	178 %	-4 %	-66 %	109 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	7671	-15299	-2094	-9486	-0,63
KS1	21614	-15978	-3589	2572	0,16
Difference	13943	-679	-1495	12058	0,79
	182 %	-4 %	-71 %	127 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5574	-12221	-1793	-8311	-0,67
KS1	15641	-16383	-3643	-4160	-0,25
Difference	10067	-4162	-1850	4151	0,42
	181 %	-34 %	-103 %	50 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5710	-13220	-1829	-9236	-0,7
KS1	15681	-15097	-3581	-2795	-0,19
Difference	9971	-1877	-1752	6441	0,51
	175 %	-14 %	-96 %	70 %	

Alt. A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	826	-2009	-811	-2075	-0,99
KS1	3360	-549	-2780	-150	-0,27
Difference	2534	1460	-1969	1925	0,72
	307 %	73 %	-243 %	93 %	
Alt. B	Road user benefit	Public Cost	General society	NPV	BCr
KVU	538	-2066	-947	-2545	-1,2
KS1	2409	-325	-3266	-1340	-4,12
Difference	1871	1741	-2319	1205	-2,92
	348 %	84 %	-245 %	47 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3952	-9215	-1468	-6622	-0,85
KS1	11444	-9386	-3286	-995	-0,84
Difference	7492	-171	-1818	5626	0,00
	190 %	2 %	124 %	-85 %	

Table 20: Resume of KPIs in project P8

(P8) E39 Bergsøy - Valsøya					
Region	Central		Interest rate	Period of analysis	Comparison year
County	Møre og Romsdal	KVU	4,5 %	25	2020
Consortium	C6	KS1	2,0 %	40	2012
Alt. 1A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	445	-1051	13	-573	-0,56
KS1	1445	-851	191	834	0,98
Difference	1000	200	178	1407	1,54
	225 %	19 %	1369 %	246 %	
Alt. 1B	Road user benefit	Public Cost	General society	NPV	BCr
KVU	309	-713	43	-393	-0,53
KS1	1023	-559	42	449	0,80
Difference	714	154	-1	842	1,33
	231 %	22 %	-2 %	214 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2412	-4151	-389	-2006	-0,49
KS1	6093	-6575	-5	-220	-0,03
Difference	3681	-2424	384	1786	0,46
	153 %	-58 %	99 %	89 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2419	-8576	-713	-6749	-0,8
KS1	6160	-8339	66	-1840	-0,22
Difference	3741	237	779	4909	0,58
	155 %	3 %	109 %	73 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2854	-7254	-591	-4849	-0,68
KS1	7521	-7034	170	1031	0,15
Difference	4667	220	761	5880	0,83
	164 %	3 %	129 %	121 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1688	-4349	-327	-2914	-0,61
KS1	4448	-4672	93	51	0,34
Difference	2761	-323	420	2965	0,95
	164 %	-7 %	128 %	102 %	

Table 21: Resume of KPIs in project P9

(P9) E6 Trondheim - Steinkjer					
Region	Central		Interest rate	Period of analysis	Comparison year
County	Trøndelag	KVU	4,5 %	25	2020
Consortium	C6	KS1	2,0 %	40	2011
Alt. 0+	Road user benefit	Public Cost	General society	NPV	BCr
KVU	740	-5319	356	-4223	-0,79
KS1	1023	-1915	2140	1248	0,65
Difference	283	3404	1784	5471	1,45
	38 %	64 %	501 %	130 %	
Alt. 1-B	Road user benefit	Public Cost	General society	NPV	BCr
KVU	691	-12761	-15	-12085	-0,95
KS1	3542	-6317	2890	838	0,13
Difference	2851	6444	2905	12923	1,08
	413 %	50 %	19367 %	107 %	
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1911	-25832	-1203	-25124	-0,97
KS1	6511	-19094	2610	-9169	-0,48
Difference	4600	6738	3813	15955	0,49
	241 %	26 %	317 %	64 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1039	-18031	-1315	-22530	-1,25
KS1	2674	-15489	669	-12135	-0,78
Difference	1635	2542	1984	10395	0,47
	157 %	14 %	151 %	46 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1978	-16606	-40	-14668	-0,88
KS1	7256	-9461	3232	2275	0,24
Difference	5278	7145	3272	16943	1,12
	267 %	43 %	8180 %	116 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2678	-33602	-1451	-31583	-0,94
KS1	9326	-24982	3124	-12532	-0,50
Difference	6648	8620	4575	19051	0,44
	248 %	26 %	315 %	60 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1506	-18692	-611	-18369	-0,96
KS1	5055	-12876	2444	-4913	-0,12
Difference	3549	5816	3056	13456	0,84
	236 %	31 %	500 %	73 %	

Table 22: Resume of KPIs in project P10

(P10) Ålesund					
Region	Central		Interest rate	Period of analysis	Comparison year
County	Møre og Romsdal	KVU	4,0 %	40	2024
Consortium	C6	KS1	4,0 %	40	2013
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1355	-2436	93	-988	-0,41
KS1	945	-2480	-113	-1648	-0,66
Difference	-410	-44	-206	-660	-0,26
	-30 %	-2 %	-222 %	-67 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1611	-1878	-365	-632	-0,34
KS1	1108	-1864	-381	-1137	-0,61
Difference	-503	14	-16	-505	-0,27
	-31 %	1 %	-4 %	-80 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2629	-5566	-313	-3250	-0,58
KS1	1829	-4154	-292	-2605	-0,63
Difference	-800	1412	21	645	-0,04
	-30 %	25 %	7 %	20 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2440	-4348	-120	-2036	-0,47
KS1	1727	-3783	-255	-2311	-0,61
Difference	-713	565	-135	-275	-0,14
	-29 %	13 %	-113 %	-14 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1942	-3703	-744	-2512	-0,68
KS1	1402	-3005	-616	-2222	-0,74
Difference	-540	698	128	290	-0,06
	-28 %	19 %	17 %	12 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1995	-3586	-290	-1884	-0,49
KS1	1402	-3057	-331	-1985	-0,65
Difference	-593	529	-42	-101	-0,16
	-30 %	15 %	-14 %	-5 %	

Appendix B3 - Western Region Database

Tables 23-28 show the KPIs results of the different alternatives considered in the assessed projects developed in the Western region, i.e., P11 to P16 projects. Then by using the averages presented at the end of Tables 23-28 an average of the KPIs for the total number of projects comprised in this region was performed, which results were previously presented in Table 10.

Table 23: Resume of KPIs in project P11

(P11) Jæren					
Region	Western		Interest rate	Period of analysis	Comparison year
County	Rogaland	KVU	4,5 %	25	2018
Consortium	C1	KS1	4,0 %	40	2018
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-1219	-12413	-863	-9463	-0,76
KS1	1756	-4824	-16	-3084	-0,64
Difference	2975	7589	847	6379	0,12
	244 %	61 %	98 %	67 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	19089	-21732	441	-2507	-0,12
KS1	30766	-18256	75	12585	0,69
Difference	11677	3476	-366	15092	0,81
	61 %	16 %	-83 %	602 %	
Alt. 3A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	12288	-28256	-1246	-11935	-0,42
KS1	22313	-21163	-1580	-430	-0,02
Difference	10025	7093	-334	11505	0,40
	81,58 %	25,10 %	-26,81 %	96,40 %	
Alt. 3C	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5102	-32585	-2058	-24480	-0,75
KS1	10978	-27531	-3130	-19683	-0,71
Difference	5876	5054	-1072	4797	0,04
	115 %	16 %	-52 %	20 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	8815	-23747	-932	-12096	-0,51
KS1	16453	-17944	-1163	-2653	-0,17
Difference	7638	5803	-231	9443	0,34
	87 %	24 %	-25 %	78 %	

Table 24: Resume of KPIs in project P12

(P12) E39 Aksdal - Bergen					
Region	Western		Interest rate	Period of analysis	Comparison year
County	Hordaland	KVU	4,5 %	25	2018
Consortium	C2	KS1	2,2 %	40	2012
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	800	-4300	1580	-1900	-0,66
KS1	5500	-5300		200	0,04
Difference	4700	-1000		2100	0,70
	588 %	-23 %		111 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	15100	-19500	1480	-4400	-0,23
KS1	62900	-32500		30300	0,93
Difference	47800	-13000		34700	1,16
	317 %	-67 %		789 %	
Alt. 4A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	6000	-7200	1680	-100	-0,01
KS1	26700	-13800		12800	0,93
Difference	20700	-6600		12900	0,94
	345 %	-92 %		12900 %	
Alt. 4C	Road user benefit	Public Cost	General society	NPV	BCr
KVU	14000	-18400	1410	-4600	-0,25
KS1	56500	-29100		27500	0,95
Difference	42500	-10700		32100	1,20
	304 %	-58 %		698 %	
Alt. 5A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	13500	-16600	1790	-2800	-0,17
KS1	55700	-28000		27700	0,99
Difference	42200	-11400		30500	1,16
	313 %	-69 %		1089 %	
Alt. 5B	Road user benefit	Public Cost	General society	NPV	BCr
KVU	11900	-11300	1810	1500	0,13
KS1	52300	-23400		29000	1,24
Difference	40400	-12100		27500	1,11
	339 %	-107 %		1833 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	10217	-12883		-2050	-0,20
KS1	43267	-22017		21250	0,85
Difference	33050	-9133		23300	1,04
	323 %	-71 %		-1137 %	

Table 25: Resume of KPIs in project P13

(P13) Bergen					
Region	Western		Interest rate	Period of analysis	Comparison year
County	Hordaland	KVU	4,5 %	25	2014
Consortium	C2	KS1	4,5 %	25	2012
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU		-7800	-10320	-18120	2,32
KS1		-7500	500	-6100	0,81
Difference		300	10820	12020	-1,51
		4 %	105 %	66 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU		-15440	9030	-6420	0,42
KS1		-16800	21900	5100	-0,30
Difference		-1360	12870	11520	-0,72
		-9 %	143 %	179 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU		-22890	14940	-7960	0,35
KS1		-34000	33500	-500	0,01
Difference		-11110	18560	7460	-0,33
		-49 %	124 %	94 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU		-22440	17380	-5050	0,23
KS1		-35300	42200	6900	-0,20
Difference		-12860	24820	11950	-0,42
		-57 %	143 %	237 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU		-18750	9710	-9040	0,48
KS1		-31600	28900	-2700	0,09
Difference		-12850	19190	6340	-0,40
		-69 %	198 %	70 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU		-17464	8148	-9318	0,76
KS1		-25040	25400	540	0,08
Difference		-7576	17252	9858	-0,68
		-43 %	212 %	106 %	

Table 26: Resume of KPIs in project P14

(P14) Haugesund					
Region	Western		Interest rate	Period of analysis	Comparison year
County	Rogaland	KVU	4,0 %	40	2016
Consortium	C3	KS1	4,0 %	40	2016
Alt. 1A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-29079	-1871	1478	-18618	-9,95
KS1	-27869	-2572	3129	-27312	-10,62
Difference	1210	-701	1651	-8694	-0,67
	4 %	-37 %	112 %	-47 %	
Alt. 1B	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-29079	-3871	1478	-20608	-5,56
KS1	-23234	-4836	2676	-25394	-5,25
Difference	5845	-965	1198	-4786	0,31
	20 %	-25 %	81 %	-23 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-27267	-6788	1571	-22530	-3,32
KS1	-26057	-6276	2507	-29826	-4,75
Difference	1210	512	936	-7296	-1,43
	4 %	8 %	60 %	-32 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-25035	-8120	1616	-21541	-2,65
KS1	-23825	-9128	2062	-30891	-3,38
Difference	1210	-1008	446	-9350	-0,73
	5 %	-12 %	28 %	-43 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-25340	-12973	1698	-30288	-2,23
KS1	-24130	-14683	1071	-37742	-2,57
Difference	1210	-1710	-627	-7454	-0,34
	5 %	-13 %	-37 %	-25 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-25387	-5859	1637	-21150	-3,61
KS1	-19542	-7618	2406	-13290	-1,74
Difference	5845	-1759	769	7860	1,87
	23 %	-30 %	47 %	37 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-26865	-6580	1580	-22456	-4,55
KS1	-24110	-7519	2309	-27409	-4,72
Difference	2755	-939	729	-4953	-0,17
	10 %	-14 %	46 %	-22 %	

Table 27: Resume of KPIs in project P15

(P15) E39 Skei - Ålesund					
Region	Western		Interest rate	Period of analysis	Comparison year
County	Sogn og Fjordane	KVU	4,5 %	25	2020
Consortium	C6	KS1	2,0 %	40	2012
Skei - Volda					
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	150	-2100	435	-2000	-0,87
KS1	461	-1868	621	-884	-0,47
Difference	311	232	186	1116	0,40
	207 %	11 %	43 %	56 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2300	-5000	463	-2900	-0,56
KS1	5918	-4907	1088	2682	0,55
Difference	3618	93	625	5582	1,11
	157 %	2 %	135 %	192 %	
Alt. 6	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5000	-8600	378	-4100	-0,48
KS1	12522	-8834	2193	7601	0,86
Difference	7522	-234	1815	11701	1,34
	150 %	-3 %	480 %	285 %	
Alt. 7	Road user benefit	Public Cost	General society	NPV	BCr
KVU	4300	-6500	434	-2200	-0,35
KS1	10575	-6792	2617	8216	1,21
Difference	6275	-292	2183	10416	1,56
	146 %	-4 %	503 %	473 %	
Alt. 9	Road user benefit	Public Cost	General society	NPV	BCr
KVU	800	-1800	517	-800	-0,4
KS1	2328	-2362	1096	1161	0,49
Difference	1528	-562	579	1961	0,89
	191 %	-31 %	112 %	245 %	
Alt. 10	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3200	-4500	565	-1100	-0,24
KS1	8409	-4685	1351	5492	1,17
Difference	5209	-185	786	6592	1,41
	163 %	-4 %	139 %	599 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2625	-4750	465	-2183	-0,48
KS1	6702	-4908	1494	4045	0,63
Difference	4077	-158	1029	6228	1,12
	155 %	-3 %	221 %	285 %	

Volda - Ålesund					
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5200	-9900	-726	-4500	-0,52
KS1	13950	-17990	-3315	-2839	-0,16
Difference	8750	-8090	-2589	1661	0,36
	168 %	-82 %	-357 %	37 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5500	-13500	-581	-8000	-0,8
KS1	14969	-17102	-1632	777	0,05
Difference	9469	-3602	-1051	8777	0,85
	172 %	-27 %	-181 %	110 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	130	-3900	-196	-4800	-1,08
KS1	1137	-3447	-723	-2954	-0,86
Difference	1007	453	-527	1846	0,22
	775 %	12 %	-269 %	38 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU	4600	-9700	-325	-5700	-0,62
KS1	11991	-10672	-779	3219	0,30
Difference	7391	-972	-454	8919	0,92
	161 %	-10 %	-140 %	156 %	
Alt. 6	Road user benefit	Public Cost	General society	NPV	BCr
KVU	4400	-8400	-439	-4600	-0,55
KS1	11368	-17897	-3	-3878	-0,22
Difference	6968	-9497	436	722	0,33
	158 %	-113 %	99 %	16 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3966	-9080	-453	-5520	-0,71
KS1	10683	-13422	-1290	-1135	-0,18
Difference	6717	-4342	-837	4385	0,54
	169 %	-48 %	-185 %	79 %	
E39 Skei - Ålesund					
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3296	-6915	6	-3852	-0,60
KS1	8693	-9165	102	1455	0,23
Difference	5397	-2250	96	5307	0,83
	164 %	-33 %	-1609 %	138 %	

Table 28: Resume of KPIs in project P16

(P16) E16 Voss - Arna					
Region	Western		Interest rate	Period of analysis	Comparison year
County	Hordaland	KVU	4,0 %	40	2018
Consortium	C6	KS1	4,0 %	40	2018
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-1800	-4200	400	-5700	-1,36
KS1	-1635	-5067	225	-6477	-1,28
Difference	165	-867	-175	-777	0,08
	9 %	-21 %	-44 %	-14 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	11800	-15000	-1900	-5900	-0,39
KS1	12148	-15944	-2114	-5911	-0,37
Difference	348	-944	-214	-11	0,02
	3 %	-6 %	-11 %	0 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3500	-34800	-5600	-35800	-1,03
KS1	3834	-41315	-6907	-44388	-1,07
Difference	334	-6515	-1307	-8588	-0,05
	10 %	-19 %	-23 %	-24 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	4100	-11000	200	-7000	-0,64
KS1	4355	-12299	-15	-7959	-0,65
Difference	255	-1299	-215	-959	-0,01
	6 %	-12 %	-108 %	-14 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU	13400	-32800	-4800	-23400	-0,71
KS1	13889	-36637	-5559	-28307	-0,77
Difference	489	-3837	-759	-4907	-0,06
	4 %	-12 %	-16 %	-21 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	6200	-19560	-2340	-15560	-0,83
KS1	6518	-22252	-2874	-18608	-0,83
Difference	318	-2692	-534	-3048	0,00
	5 %	-14 %	-23 %	-20 %	

Appendix B4 - Southern Region Database

Tables 29-34 show the KPIs results of the different alternatives considered in the assessed projects developed in the Southern region, i.e., P17 to P22 projects. Then by using the averages presented at the end of Tables 29-34 an average of the KPIs for the total number of projects comprised in this region was performed, which results were previously presented in Table 11.

Table 29: Resume of KPIs in project P17

(P17) E134 Kongsberg - Gvammen					
Region	Southern		Interest rate	Period of analysis	Comparison year
County	Buskerud	KVU	4,5 %	25	2020
Consortium	C2	KS1	2,2 %	40	2020
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	250	-299	51	2	0,01
KS1	981	-408	290	863	2,12
Difference	731	-109	239	861	2,11
	292,40 %	-36,45 %	468,63 %	43050 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	986	-1919	256	-677	-0,35
KS1	3833	-2524	1498	2807	1,11
Difference	2847	-605	1242	3484	1,46
	288,74 %	-31,53 %	485,16 %	514,62 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1397	-5168	818	-2953	-0,57
KS1	4737	-8548	4762	950	0,11
Difference	3340	-3380	3944	3903	0,68
	239,08 %	-65,40 %	482,15 %	132,17 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	2078	-4763	634	-2051	-0,43
KS1	7173	-8387	4022	2807	0,33
Difference	5095	-3624	3388	4858	0,77
	245,19 %	-76,09 %	534,38 %	236,86 %	
Alt. N	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1759	-2823	778	-286	-0,10
KS1	8151	-7080	3121	4192	0,59
Difference	6392	-4257	2343	4478	0,69
	363,39 %	-150,80 %	301,16 %	1565,73 %	

Alt. S	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1510	-2775	819	-445	-0,16
KS1	6667	-6544	3372	3495	0,53
Difference	5157	-3769	2553	3940	0,69
	341,52 %	-135,82 %	311,72 %	885,39 %	
Alt. F1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	923	-1193	464	194	0,16
KS1	3725	-2069	2051	3706	1,79
Difference	2802	-876	1587	3512	1,63
	303,58 %	-73,43 %	342,03 %	1810,31 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1272	-2706	546	-888	-0,21
KS1	5038	-5080	2731	2689	0,94
Difference	3766	-2374	2185	3577	1,15
	296 %	-88 %	400 %	403 %	

Table 30: Resume of KPIs in project P18

(P18) Hønefoss					
Region	Southern		Interest rate	Period of analysis	Comparison year
County	Buskerud	KVU	4,0 %	40	2014
Consortium	C2	KS1	4,5 %	40	2015
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-302	-562	-173	-1036	-1,84
KS1	-525	893		-729	0,82
Difference	-223	1455		307	2,66
	-73,84 %	258,90 %		29,63 %	
Alt. 1+	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-6895	-555	-21	-4148	-7,47
KS1	-7228	970		-2996	3,09
Difference	-333	1525		1152	10,56
	-4,83 %	274,77 %		27,77 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-6669	-1292	-525	-5177	-4,01
KS1	-7314	2338		-3724	1,59
Difference	-645	3630		1453	5,60
	-9,67 %	280,96 %		28,07 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-6290	-1591	-2	-4211	-2,65
KS1	-6590	2375		-3054	1,29
Difference	-300	3966		1157	3,93
	-4,77 %	249,28 %		27,48 %	

Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-6240	-1539	29	-4516	-2,93
KS1	-6667	2206		-3267	1,48
Difference	-427	3745		1249	4,42
	-6,84 %	243,34 %		27,66 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-5279	-1108	-138	-3818	-3,45
KS1	-5665	1756		-2754	1,57
Difference	-385,6	2864,2		1063,6	5,01
	-7,30 %	258,55 %		27,86 %	

Table 31: Resume of KPIs in project P19

(P19) Rv.7 / Rv.52 Gol – Voss					
Region	Southern		Interest rate	Period of analysis	Comparison year
County	Buskerud	KVU	4,0 %	40	2022
Consortium	C3	KS1	4,0 %	40	2022
Alt. B7L	Road user benefit	Public Cost	General society	NPV	BCr
KVU	16200	-19500	-3900	-7300	-0,31
KS1	15000	-18513	-2803	-6315	-0,34
Difference	-1200	987	1097	985	-0,03
	-7 %	5 %	28 %	13 %	
Alt. B7K	Road user benefit	Public Cost	General society	NPV	BCr
KVU	13300	-16000	-3200	-5900	-0,37
KS1	12000	-14569	-2014	-4582	-0,31
Difference	-1300	1431	1186	1318	0,05
	-10 %	9 %	37 %	22 %	
Alt. B52L	Road user benefit	Public Cost	General society	NPV	BCr
KVU	12800	-16900	-3400	-7400	-0,37
KS1	11400	-14453	-2191	-5243	-0,36
Difference	-1400	2447	1209	2157	0,01
	-11 %	14 %	36 %	29 %	
Alt. B52K	Road user benefit	Public Cost	General society	NPV	BCr
KVU	12800	-12400	-2500	-2100	-0,14
KS1	11400	-10796	-1459	-856	-0,08
Difference	-1400	1604	1041	1244	0,06
	-11 %	13 %	42 %	59 %	
Alt. P7L	Road user benefit	Public Cost	General society	NPV	BCr
KVU	7700	-19500	-3900	-15800	-0,67
KS1	8900	-19113	-4723	-14935	-0,78
Difference	1200	387	-823	865	-0,11
	16 %	2 %	-21 %	5 %	

Alt. P7K	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5800	-16000	-3200	-15800	-0,70
KS1	6900	-15169	-3734	-12002	-0,79
Difference	1100	831	-534	3798	-0,09
	19 %	5 %	-17 %	24 %	
Alt. P52L	Road user benefit	Public Cost	General society	NPV	BCr
KVU	7700	-16900	-3400	-12600	-0,62
KS1	7300	-14753	-3051	-10503	-0,71
Difference	-400	2147	349	2097	-0,09
	-5 %	13 %	10 %	17 %	
Alt. P52K	Road user benefit	Public Cost	General society	NPV	BCr
KVU	7700	-12400	-2500	-7200	-0,49
KS1	7300	-11096	-2319	-6116	-0,55
Difference	-400	1304	181	1084	-0,06
	-5 %	11 %	7 %	15 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	10500	-16200	-3250	-9263	-0,57
KS1	10025	-14808	-2787	-7569	-0,51
Difference	-475	1392,25	463,25	1693,5	-0,03
	-5 %	9 %	14 %	18 %	

Table 32: Resume of KPIs in project P20

(P20) E39 Sogne - Algård					
Region	Southern		Interest rate	Period of analysis	Comparison year
County	Vest-Agder	KVU	4,5 %	25	2010
Consortium	C4	KS1	2,0 %	25	2010
Alt. TS	Road user benefit	Public Cost	General society	NPV	BCr
KVU	0	-2800	700	-2000	-0,74
KS1	0	-3544	2561	-984	-0,28
Difference	0	-744	1861	1016	0,46
		-27 %	266 %	51 %	
Alt. U	Road user benefit	Public Cost	General society	NPV	BCr
KVU	200	-4300	500	-3600	-0,82
KS1	3526	-5991	2072	-392	-0,07
Difference	3326	-1691	1572	3208	0,75
	1663 %	-39 %	314 %	89 %	
Alt. V	Road user benefit	Public Cost	General society	NPV	BCr
KVU	7500	-13100	0	-5400	-0,41
KS1	16756	-19657	5223	2323	0,12
Difference	9256	-6557	5223	7723	0,53
	123 %	-50 %		143 %	
Alt. M	Road user benefit	Public Cost	General society	NPV	BCr
KVU	7800	-14200	500	-5700	-0,40
KS1	19015	-21633	7331	4713	0,22
Difference	11215	-7433	6831	10413	0,62
	144 %	-52 %	1366 %	183 %	
Alt. F	Road user benefit	Public Cost	General society	NPV	BCr
KVU	11100	-26500	800	-14500	-0,55
KS1	22719	-38524	4906	-10899	-0,28
Difference	11619	-12024	4106	3601	0,26
	105 %	-45 %	513 %	25 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	5320	-12180	500	-6240	-0,51
KS1	12403	-17870	4419	-1048	-0,06
Difference	7083,2	-5689,8	3918,6	5192,2	0,53
	133 %	-47 %	784 %	83 %	

Table 33: Resume of KPIs in project P21

(P21) Tønsberg					
Region	Southern		Interest rate	Period of analysis	Comparison year
County	Vestfold	KVU	4,0 %	40	2018
Consortium	C5	KS1	4,0 %	40	2022
Alt. T-K	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-15332	-2764	1000	-7908	-2,86
KS1	-5488	-3349		-8837	-2,64
Difference	9844	-585		-929	0,22
	64 %	-21 %		-12 %	
Alt. Koll	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-5633	-1347	1482	3370	2,50
KS1	-6739	-1413		-8152	-5,77
Difference	-1106	-66		-11522	-8,27
	-20 %	-5 %		-342 %	
Alt. Vestf	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-11907	-2064	900	-3861	-1,87
KS1	-3349	-3137		-6486	-2,07
Difference	8558	-1073		-2625	-0,20
	72 %	-52 %		68 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-10957	-2058	1127	-2800	-0,74
KS1	-5192	-2633		-7825	-3,49
Difference	5765	-575		-5025	-2,75
	53 %	-28 %		179 %	

Table 34: Resume of KPIs in project P22

(P22) Buskerud					
Region	Southern		Interest rate	Period of analysis	Comparison year
County	Buskerud	KVU	4,5 %	25	2018
Consortium	C6	KS1	4,0 %	40	2018
Alt. 2024	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-15073	-6589	716	-6361	-0,97
KS1	-23369	9563	7751	-6054	-0,63
Difference	-8296	16152	7035	307	0,33
	-55 %	245 %	983 %	5 %	
Alt. 2040	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-11821	-3496	1498	-5167	-1,48
KS1	-20006	6940	5057	-8859	-1,28
Difference	-8185	10436	3559	-3692	0,20
	-69 %	299 %	238 %	-71 %	

Alt. C2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-10005	-13570	-462	-9548	-0,70
KS1	-15420	-1278	6260	-6756	-5,29
Difference	-5415	12292	6722	2792	-4,58
	-54 %	91 %	1455 %	29 %	
Alt. C3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-6874	-9170	3860	-3615	-0,39
KS1	-11766	-1268	3538	-8939	-7,05
Difference	-4892	7902	-322	-5324	-6,66
	-71 %	86 %	-8 %	-147 %	
Alt. R1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-14380	-9565	3587	-7875	-0,82
KS1	-22369	-6266	763	-8945	-1,43
Difference	-7989	3299	-2824	-1070	-0,60
	-56 %	34 %	-79 %	-14 %	
Alt. R2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-13094	-12634	3724	-9799	-0,78
KS1	-20331	2549	7190	-11324	-4,44
Difference	-7237	15183	3466	-1525	-3,67
	-55 %	120 %	93 %	-16 %	
Alt. R3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-8397	-8980	6004	-4008	-0,45
KS1	-14079	216	3694	-10167	-47,07
Difference	-5682	9196	-2310	-6159	-46,62
	-68 %	102 %	-38 %	-154 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-183	-10231	4893	1742	0,17
KS1	-431	-5778	3389	-3719	-0,64
Difference	-248	4453	-1504	-5461	-0,81
	-136 %	44 %	-31 %	-313 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-9978	-9279	2978	-5579	-0,68
KS1	-15971	585	4705	-8095	-8,48
Difference	-5993	9864	1728	-2517	-7,80
	-60 %	106 %	58 %	45 %	

Appendix B5 - Eastern Region Database

Tables 29-34 show the KPIs results of the different alternatives considered in the assessed projects developed in the Southern region, i.e., P23 to P26 projects. Then by using the averages presented at the end of Tables 29-34 an average of the KPIs for the total number of projects comprised in this region was performed, which results were previously presented in Table 12.

Table 35: Resume of KPIs in project P23

(P23) Nedre Glomma					
Region	Eastern		Interest rate	Period of analysis	Comparison year
County	Østfold	KVU	4,5 %	25	2020
Consortium	C1	KS1	4,5 %	40	2017
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-9985	4074	521	-2858	-0,70
KS1	-9546	6831	688	-2032	-0,30
Difference	439	2757	167	826	0,40
	4 %	68 %	32 %	29 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-2399	-1477	841	-2062	-1,40
KS1	-2012	1139	1280	417	0,37
Difference	387	2616	439	2479	1,77
	16 %	177 %	52 %	120 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-5172	-2335	1489	-5016	-2,15
KS1	-4889	1504	2029	-1344	-0,89
Difference	283	3839	540	3672	1,26
	5 %	164 %	36 %	73 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-11130	-1285	1582	-7782	-6,05
KS1	-10139	4105	2346	-3696	-0,90
Difference	991	5390	764	4086	5,15
	9 %	419 %	48 %	53 %	
Alt. ABC	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-8749	-1977	1648	-6026	-3,05
KS1	-7404	3136	2395	-1852	-0,59
Difference	1345	5113	747	4174	2,46
	15 %	259 %	45 %	69 %	

Alt. AB	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-8038	176	1866	-3041	-17,31
KS1	-6410	4138	2429	180	0,04
Difference	1628	3962	563	3221	17,35
	20 %	2251 %	30 %	106 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-7579	-471	1325	-4464	-5,11
KS1	-6733	3476	1861	-1388	-0,40
Difference	846	3946	537	3076	4,71
	11 %	-838 %	41 %	69 %	

Table 36: Resume of KPIs in project P24

(P24) E16 Bjørgo - Øye					
Region	Eastern		Interest rate	Period of analysis	Comparison year
County	Oppland	KVU	4,5 %	25	2011
Consortium	C5	KS1	4,5 %	25	2011
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	600	-4300	219	-3473	-0,81
KS1	597,3	-4127,4	218,7	-3473,3	-0,84
Difference	-2,7	172,6	-0,3	-0,3	-0,03
	-0,5 %	4,0 %	-0,1 %	0,0 %	
Alt. 2A	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1410	-4700	430	-2619	-0,56
KS1	1417,2	-4172,4	430,5	-2618,8	-0,63
Difference	7,2	527,6	0,5	0,2	-0,07
	0,5 %	11,2 %	0,1 %	0,0 %	
Alt. 2B	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1630	-5000	485	-3066	-0,61
KS1	1628,8	-4813	485,8	-3065,7	-0,64
Difference	-1,2	187	0,8	0,3	-0,02
	-0,1 %	3,7 %	0,2 %	0,0 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1140	-4800	440	-3398	-0,71
KS1	1143,5	-4647,7	439,8	-3398,5	-0,73
Difference	3,5	152,3	-0,2	-0,5	-0,02
	0,3 %	3,2 %	0,0 %	0,0 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1195	-4700	394	-3139	-0,67
KS1	1197	-4440	394	-3139	-0,71
Difference	1,7	259,9	0,2	-0,1	-0,04
	0,1 %	5,5 %	0,1 %	0,0 %	

Table 37: Resume of KPIs in project P25

(P25) Oslo fjord					
Region	Eastern		Interest rate	Period of analysis	Comparison year
County	Østfold	KVU	4,0 %	40	2030
Consortium	C6	KS1	4,0 %	40	2015
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	1784	-997	-1012	207	0,21
KS1	991	-860	-610	-141	-0,16
Difference	-793	137	402	-348	-0,37
	-44 %	14 %	40 %	-168 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	35277	-30200	-3172	-3715	-0,12
KS1	19588	-21683	-2791	-6415	-0,30
Difference	-15689	8517	381	-2700	-0,17
	-44 %	28 %	12 %	-73 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	78350	-38165	-9202	24826	0,65
KS1	43471	-28170	-6475	7304	0,26
Difference	-34879	9995	2727	-17522	-0,39
	-45 %	26 %	30 %	-71 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	71835	-15933	-5556	44383	2,79
KS1	39887	-12766	-3785	21815	1,71
Difference	-31948	3167	1771	-22568	-1,08
	-44 %	20 %	32 %	-51 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	46812	-21324	-4736	16425	0,88
KS1	25984	-15870	-3415	5641	0,38
Difference	-20827	5454	1320	-10785	-0,50
	-44 %	26 %	-28 %	66 %	

Table 38: Resume of KPIs in project P26

(P26) Moss - Rygge					
Region	Eastern		Interest rate	Period of analysis	Comparison year
County	Østfold	KVU	4,5 %	25	2024
Consortium	C6	KS1	4,0 %	40	2012
Alt. 1	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-7517	4584	1276	-1660	0,36
KS1	-7140	4386	1106	-1649	0,38
Difference	377	-198	-170	11	0,01
	5,02 %	-4,32 %	-13,32 %	0,66 %	
Alt. 2	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3352	-3368	81	63	0,02
KS1	3283	-2388	-79	817	0,34
Difference	-69	980	-160	754	0,32
	-2,06 %	29,10 %	-197,53 %	1196,83 %	
Alt. 3	Road user benefit	Public Cost	General society	NPV	BCr
KVU	3184	-3476	-75	-369	-0,11
KS1	3121	-2420	-227	474	0,20
Difference	-63	1056	-152	843	0,30
	-1,98 %	30,38 %	-202,67 %	228,46 %	
Alt. 4	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-7263	3424	1410	-2514	0,73
KS1	-6882	3469	1140	-2274	0,66
Difference	381	45	-270	240	-0,08
	5,25 %	1,31 %	-19,15 %	9,55 %	
Alt. 5	Road user benefit	Public Cost	General society	NPV	BCr
KVU	4681	-3403	187	1464	0,43
KS1	4670	-2343	14	2340	1,00
Difference	-11	1060	-173	876	0,57
	-0,23 %	31,15 %	-92,51 %	59,84 %	
Alt. 6	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-11603	5469	2190	-3653	0,67
KS1	-10745	5926	1730	-3088	0,52
Difference	858	457	-460	565	-0,15
	7,39 %	8,36 %	-21,00 %	15,47 %	
AVG	Road user benefit	Public Cost	General society	NPV	BCr
KVU	-2528	538	845	-1112	0,35
KS1	-2282	1105	614	-563	0,51
Difference	246	567	-231	548	0,16
	-10 %	-105 %	-27 %	49 %	