

# Comparative analysis of transportation project appraisals

A comparison between the Netherlands and the United States

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## Summary

Cost-Benefit Analysis (CBA) is the most widely used tool for evaluating policy programs and capital expenditure. It involves estimating, where possible, the full direct and indirect private; and social costs and benefits associated with a policy action or potential project. The Netherlands is one of the countries that use CBA in transport project appraisal; and its practice is considered as state-of-the-arts in transports sector. However, there are a number of issues in its practice, which can be categorized into content- and process- issues. On one hand, from the perspective of spatial-infrastructure appraisal process, content-related issues are those issues regarding all the estimations of effects and the way the effects are presented in the CBA report. On the other hand, process-related issues are those issues pertaining to the use of CBA as a supporting/supplementing tool.

By comparing the way the Dutch CBA practice with the way another practice (the United States) deals with these issues, it is deemed that both countries can learn from each other. It is in the interest of the thesis to compare transport projects appraisal in several countries. However, by comparing many countries in one study through an in-depth analysis, one may struggle to analyze accordingly and make useful/practical recommendations to all the countries, due to various methods applied in these many countries. Furthermore, given the time allocated for this thesis projects, it is rather impractical to cover more than two countries in the project.

Hence, the thesis is set to compare the transport projects appraisal between two countries for the purpose of improvements in both countries' practices. The choice of a case study (country) - the United States - was made since there is long tradition of utilizing CBA in public sector decision-making; unavailability of comparative studies in this topic between the two countries; and cultural difference between the countries. Thus, the main research question is formulated as the following:-

**By comparing the similarities and differences in transport projects appraisal between the Netherlands and the United States, how can both countries learn from each other?**

The objectives of the thesis is to analyze differences and the similarities of the transport projects appraisal between the Netherlands and the United States which leads to reflections and recommendations, not just to the Dutch but also to the United States transports project appraisal. In order to achieve these goals, first, the methodology of ex-ante evaluation conducted in both countries was studied primarily through desk research, examining relevant formal reports, guidelines, legislation documents etc. These documents were put together in the frameworks of Social Cost-benefit Analysis or Combinatorial of Cost-Benefit Analysis and Multi-criteria Analysis for comparison purposes. Secondly, in order to confirm the utilization of those guidelines in transports projects appraisal, in-depth interview was conducted. Finally, comparison is made between the two countries.

Regarding the methodology of analysis and with an exception of the inclusion of Reliability indicator in the Dutch CBA, the comparison shows that the main commonalities are the inclusion of the conventional transport indicators (Value of Time (VOT), Value-of-a-statistical life (VSL), Value of Injuries and air pollutant emissions), their methodological basis and degree of monetization. The differences occur at (1) the use of lower discount rate for irreversible effects in the Dutch CBA; (2) the appraisal horizon; (3) the inclusion of other plans and policies (for instance Land Use and Economy) in the American CBA/MCA practice. The main differences occur mainly regarding the use of the results in the decision-making which include (1) responsibility bodies conducting and reviewing the analysis; (2) disclosure of content of evaluation; (3) stakeholders' involvement.

Reflections and recommendations following the comparison for both countries are as the following:

- i. The de-briefing procedure between the technical review teams and unsuccessful applicants in the United States is an interesting procedure for the Dutch CBA practitioners as it could enhance the use of CBA in the decision-making process; and
- ii. Both nations can learn from each other in stakeholders' involvement. The American practitioners can adopt the Effect Arena used in the Dutch CBA practice; and the Dutch practitioners can adopt the way the content of the evaluation is published (online) for stakeholders perusal/comments/inputs in the United States
- iii. For the Dutch CBA practice, it might be worth to think about adjusting the appraisal horizon project to justify the need to control uncertainties in the analysis; or at least, to ponder the reason 'why' it is currently set at 100 years;
- iv. There should be inclusion of any policies that are related/affected to/by the projects, explicitly in the Dutch CBA;
- v. The Dutch CBA inclusion of Quality Adjusted Life Years (QALY) and Disability Adjusted Life Years (DALY) is worthy of attention from the American practitioners;
- vi. The American practitioner may want to consider to include Reliability indicator in the ex-ante evaluation of transport projects appraisal as such an inclusion is suggested widely in the literature ; and
- vii. The American practitioners could look into the inclusion of indirect effects (agglomeration effects), such as employment, in the Dutch CBA as these effects have grown more attention in the United States nowadays.

For detail discussion on and reasoning behind the recommendations above, see 5.2.

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## List of Abbreviations

OEEI	Overview of Economic Effects of Infrastructure or Onderzoeksprogramma Economische Effecten Infrastructuur in Dutch
CPB	Central Planning Bureau
BCA or CBA	Cost-benefit Analysis or Benefit-cost Analysis
SP	Stated preferences
WTP	Willingness-to-pay
MPO(s)	Metropolitan Planning Organization(s)
DOT(s)	Department of Transportation(s)
FAA	Federal Aviation Administration
FTA	Federal Transit Administration
FHWA	Federal Highway Administration
TIGER	Transportation Investment Generating Economy Recovery
US DOT	United State Department of Transportation
TIP	Transportation Investment Plan
AASHTO	American Association of State Highway and Transportation
NEPA	National Environmental Policy Act
OMB	Office of Management Budget
FRA	Federal Rail Administration
MCA	Multi-criteria Analysis
US EPA	United State Environmental Protection Agency
VOC	Vehicle-operating costs
VMT	Vehicle-miles traveled
VOT	Value of time
VSL	Value of a Statistical Life
NHTSA	National Highway Traffic Safety Administration
SCC	Social Carbon Cost
SDR	Social Discount Rate

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## Chapter 1: Introduction and Defining Research Problem

### 1.1 Introduction

Cost-Benefit Analysis (CBA) is the most widely used tool for evaluating policy programs and capital expenditure. It involves estimating, where possible, the full direct and indirect private; and social costs and benefits associated with a policy action or potential project. It involves monetizing all costs and benefits related to a project or policy strategy and examining the ratio of total benefits with respect to total costs, i.e. the benefit–cost ratio (BCR) (Browne & Ryan, 2011).

CBA is generally used in ex-ante project appraisal in order to quantify social benefits and project costs and estimate which project alternatives yield the greatest net welfare benefits<sup>1</sup>. In transport projects appraisal process, typical criteria such as reduction in emissions, delays, crash costs or noise imposed by the policymaking bodies<sup>2</sup> have to be evaluated. The policymaking bodies designed CBA guidelines that analysts use as references (Nickel et al., 2009). In the Netherlands, it started as Overview of Economic Effects of Infrastructure (OEEI) and the latest revision is Romijn and Renes (2013).

Since the year 2000, the Dutch government has commissioned an obligatory Cost-Benefit Analysis or OEEI evaluation in large infrastructure projects. In its compulsory implementation, the report recommends the application of a social Cost-Benefit Analysis as an evaluation of government investments. The implementation is meant to raise the general level of analysis and promote uniformity in the appraisal methods used (Jong, 2013). It is concluded that the main practical advantage of the guidelines and of CBA in general, was that it serves as a framework for a transparent description of the economic and social effects of the project (Jong, 2013). In the CBA, all effects of an investment project are systematically evaluated and, when possible, given a monetary value (Nickel et al., 2009). The result is a social profitability analysis. Furthermore, CBA information is useful in almost every stage of policy preparation to facilitate decision-making (Jong, 2013).

There are, however, a number of flaws inherent in CBA (Ackerman, 2002; Gomez-Ibanez et al., 1999). Some of these flaws are the introduction of critical value assumptions through the discounting of non-monetary goods, performance of interpersonal utility comparisons and loss of information about the distribution of costs and benefits, and the aggregation of certain and uncertain costs on a common scale (Nickel et al., 2009). According to Damart and Roy (2009), an assessment of the reference project which is conducted through CBA procedure is subjected to hypotheses of its future states, which in such case, the assessor must take into account the accrued investments, which will have an impact on the reference situation, for instance by modifying traffic forecast and transferring travel by the population between modes of transportation (Damart & Roy, 2009). Thus, Grant-Muller et al. (2001) urges the search for a comprehensive appraisal approach since the context within which appraisal is used has become significantly more challenging.

Based on this rationale and the quest for a comprehensive appraisal approach, the topic of this thesis improvements on the Dutch CBA practice through a comparative analysis of the transport-projects

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<sup>1</sup> Another way to assess an action other than Benefit-Cost Ratio (BCR)

<sup>2</sup> Examples in transport projects appraisal in the Netherlands are the ECORYS and Central Planning Bureau (CPB).

appraisal between the Netherlands and another country. As a learning effect, improvements to the transport projects appraisal in the country in comparison could also be obtained.

In this chapter, in the next section, the problem definition is addressed through literature review, putting an emphasis on the current issues of the Dutch social CBA. This emphasis is done since the social CBA application is mandatory in transport infrastructure appraisal process in the Netherlands. Plus, it is argued by Mouter et al. (2013b) that the Dutch CBA practice is the state-of-the-art and can be regarded as representative for many countries that use CBA as an ex-ante evaluation tool in the decision-making process for infrastructure projects. Furthermore, Odgaard et al. (2005) assert that within the European Union nations, both the Dutch and Danish CBA practice accounts the highest variety of effects for infrastructure projects. Following this section are the identification of knowledge gap; formulation of the scientific and societal relevance of the subject.

## 1.2 Defining Research Problem

In defining the research problem, a review on the state-of-the-art practice in transport infrastructure appraisal in the Netherlands is conducted. It includes the use of CBA as an appraisal tool in decision-making process and the (perceived) issues in Dutch CBA practice. The issues in the Dutch CBA practice are divided into process- and content- related issues. On one hand, from the perspective of spatial-infrastructure appraisal process, content-related issues are those issues regarding all the estimations of effects and the way the effects are presented in the CBA report. On the other hand, process-related issues are those issues pertaining to the use of CBA as a supporting/supplementing tool. It has to be emphasized that the purpose of this section is to lift up the issues in the Dutch CBA practice which will determine the direction of the research; and it is not to undermine the Dutch CBA practice.

### 1.2.1 Content-related Issues Dutch CBA practice

Annema et al. (2007) was reviewed in order to gain insight into the CBA practice in the transport projects appraisal in the Netherlands. The article reviewed the Dutch standardized CBA practice from 2000 until 2007, the year the paper was published. Thirteen major transport infrastructure projects, which have gone through CBA, were being evaluated using benchmarks for 'good' CBA practices characterized by (i) transparency\*; (ii) completeness; (iii) risk and uncertainty; (iv) quality; and (v) policy impact\*. Three points of improvements needed to be addressed in the Dutch CBA practice were made based on the benchmarks. Firstly, an improvement has to be made on transparency benchmark. It was summarized that only three projects passed the benchmark, in which the CBA should be comprehensible for non-welfare economists. Secondly, a well-developed methods and assumptions have to be made in risk and uncertainty benchmark. Only half of the analyzed projects passed this benchmark, in which uncertainties were not being reflected in different scenarios and sensitivity analysis. Thirdly, on the policy impact, only six of the CBAs analyzed can be considered as being suitable for contributing to decision-making. The rest of the CBAs have major weaknesses with respects to methods and assumptions.

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\* These two benchmarks are considered as process related issues.

These thirteen CBAs only fairly passed two benchmarks. Firstly, on the completeness benchmark, most of Dutch CBAs were evaluated as to be fairly complete – twelve out of thirteen CBAs. Secondly, on the quality benchmark, it was concluded that the Dutch CBA practice fulfilled the requirement by being reviewed by the Central Planning Bureau (Netherlands Bureau for Economic Analysis), a legally independent agency in the Netherlands for economic policy analysis. All in all, the paper concluded that, in the Dutch CBA practice, improvements have to be made on important issues such as a lack of quality in methods and assumptions; an unclear treatment of the wider economic impacts; and poor transparency.

While Annema et al. (2007) evaluated the Dutch CBA practice based on a few benchmarks, Mouter et al. (2013b) took different approach by investigating the perceptions of the key participants in the Dutch CBA practice when appraising spatial-infrastructure projects using the tool. In the paper, methodologically, the authors conducted an in-depth interview with 86 key actors in the Dutch CBA practice. The authors concluded that the key participants in the Dutch CBA practice experience a large variety of substantive problems regarding the appraisal of spatial-infrastructure projects using CBA. Secondly, 'problems with the estimation of the non-monetized project effects' is considered as the most important substantive problem cluster. Thirdly, the large parts of the substantive problems identified through the paper are not specifically related to CBA. The authors states that if the main problem is on the estimation of the non-monetized effects, the same problem could arise using other ex-ante impacts studies such as multi-criteria analysis or environmental impact analysis.

### 1.2.2 Process-related Issues Dutch CBA practice

Mouter et al. (2013a) provides a systematic overview of the attitudes of key actors in the Dutch CBA practice towards the role of CBA in the decision-making process for spatial-infrastructure projects. The paper included two research methods to study the key actors' attitudes: (i) 86 key actors (e.g. consultants, scientists, policy-makers) were interviewed in-depth; (ii) 74 out of them answered a written questionnaire.

Results, firstly, show that the key actors agree on two aspects regarding the role of CBA in the decision-making process for spatial-infrastructure projects: (i) almost all the respondents believe that CBA must have a role in the appraisal of spatial-infrastructure projects; and (ii) the respondents prefer the use of CBA in the ex-ante evaluation to support 'go' or 'no-go' decisions for investments in classic infrastructure projects and spatial projects<sup>3</sup> over a situation in which no ex-ante decision-support system (like Cost-benefit Analysis or Multi-criteria Analysis) is used.

Secondly, there is a controversy pertaining to the role of the CBA in the decision-making in this environment among the economists and spatial planners. The economists think that the CBA's role is too weak as opposed to the spatial planners who think of the opposite. The paper analysis also shows that spatial planners mention four disadvantages categories more than often than the economists. The categories are (i) an inherent limitation of CBA pertaining to the uncertainty of the estimations; (ii) the role of CBA is too strong in the decision-making process; (iii) the inherent limitation of CBA studies which are always incomplete; and (iv) the imperfect presentation of CBA limitations in the CBA report. It is concluded in that both the economists and the spatial planners

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<sup>3</sup> In the written questionnaire, 'highways' and 'railroads' were stated as examples of classic infrastructure projects and 'integrated land use and transportation projects' and 'flood protection projects' were stated as examples of spatial projects. (Mouter et al., 2013b).

believe that the controversy mentioned above is problematic as it induces debates about the advantages and disadvantages of CBA instead of the advantages and disadvantages of the spatial-infrastructure projects that are being evaluated.

In another study, Beukers et al. (2012) explored how the process related issues of CBA, especially when assessing integrated transport plans, play out in Dutch planning practices. Two methods were applied in the paper, namely focus group sessions and open in-depth interviews among the Dutch CBA practitioners.

From the focus group sessions, firstly, the results show that the participants experienced that the national government uses the CBA results to decide a 'go' or 'no-go' decision rather the original intended purpose of CBA which was to support the decision-making process. Secondly, the CBA was experienced as being used in a rigid way, in which some participants experienced that there was little or no possibility of negotiating how effects are treated in the calculation. Lastly, there are frictions between the civil servants, policy-makers, and politicians in one camp; and the researchers with financial or economic backgrounds who conducted the calculation on CBAs in another camp.

From the interview sessions, the authors summarized the issues perceived by the respondents in the following themes (Beukers et al., 2012):-

- Insufficient communication among participants: experienced as contradiction between the civil servants, policy-makers, and politicians in one camp; and the researchers with financial or economic backgrounds who conducted the calculation in CBAs in another camp;
- CBA as black box: without explanation, the tool is perceived as not understandable;
- Parties act strategically with CBA input (composition of the plan) and output to make the plan look according to their desires;
- The criteria for testing CBA reports are unclear and process of testing is unstructured;
- Even though CBA may not be suited for each assessment question, CBA is being used for all of them because it is compulsory in the planning procedure;
- Too little attention paid to process matters. This leads to time pressure, due to underestimation of discussion length on assumptions and starting points;
- CBA is used as final assessment, which is indicated as wrong, because the CBA will never give the 'whole picture'; and
- There is too little room for uncertainties and nuance in the decision-making process.

### 1.2.3 Problem Statements

Concluding from previous sections, those issues in the Dutch CBA practice are divided into process and content related issues.

#### **Content-related**

Estimation of non-monetized project effect, monetizing non-market goods and the accounting techniques used (i.e. Stated Preferences in Willingness-to-pay) are the recurring issues. Additionally, Mouter et al. (2013b) advised not to neglect the issues of discounting, project cost estimation and value-of-a statistical life.

## **Process-related**

The recurring issue of transparency of CBA or CBA being perceived as a 'black-box' could be considered as an issue of participatory process. Furthermore, although the Dutch CBA practitioners agree that CBA should have 'a' role, disagreement occurs on how the role should take place in decision-making.

### **1.3 Identification of the knowledge gap**

The Dutch CBA practice is one of the practices that are considered as 'best practices' (Mouter et al., 2013b). However, there are still a lot of substantive and process challenges as stated in Section 1.2.1 and 1.2.2. By comparing the way the Dutch practice deals with these issues with the way another practice deals with these issues, improvements can be made in three-folds (Mouter, 2014b; Nakamura, 2000). Firstly, Nakamura (2000, p. 5) emphasizes that the sharing of information, which is made available by researchers from various nations with different backgrounds, should prove extremely useful for improvement of evaluation method as well as application; and the comparison will "provide experts with sufficient material to persuade skeptics to reconsider the implementation of such evaluation in their respective countries." Secondly, if one claims that his own practice is 'state-of-the-art', one is obliged to underpin why his own practice is 'better' than other practices which can be considered as a learning effect (Mouter, 2014b). Thirdly, if both practices have some favorable features, one can try to combine these features and create 'the best of both worlds' (Mouter, 2014b).

As stated in 1.1, CBA is the most common methodology used in transport projects appraisal. Thus, it carries an important role in as an *ex-ante* evaluation tool in the field. Comparative analysis of CBA practice, of which the importance are highlighted in the previous paragraphs, has been done in previous research (see Bristow and Nellthorp (2000); Hayashi and Morisugi (2000); Mackie and Worsley (2013)). However, none of these studies carried in-depth analysis as this thesis is aimed to do.

It is in the interest of the thesis to compare transport projects appraisal in several countries. However, by comparing many countries in one study through an in-depth analysis, one may struggle to analyze accordingly and make useful/practical recommendations to all the countries, due to various methods applied in these many countries. Furthermore, given the time allocated for this thesis projects, it is rather impractical to cover more than two countries in the analysis. Hence, the thesis is aimed to compare the transport projects appraisal between two countries for the purpose of improvements in both countries' practices.

Currently, there is no study in the literature which thoroughly studies the comparisons of CBA practices between the Netherlands and the United States in transport project appraisal. Hence, this thesis is aimed to rectify this gap. The rationale of having the United States as a comparison country with the Netherlands is in four folds for this thesis (Fuquitt & Wilcox, 1999; Hayashi & Morisugi, 2000).

- Firstly, the United States has a long tradition of using CBA in public decision-making. It was the first country to adopt the formal practice of CBA as an aid to the government decision-making, in 1936 through Flood Control Act.

- Secondly, since a study conducted in Hayashi and Morisugi (2000), no study has been conducted which thoroughly compared European CBA practices with the United States CBA practices. Plus, Hayashi and Morisugi (2000) makes a good attempt to compare international practice between several countries, namely Japan, United Kingdom, France, the United States and Germany; however, The Netherlands is to no avail in the analysis.
- Thirdly, from the culture perspective, there are some studies that survey the comparisons and differences between European appraisal practices namely, Bristow and Nellthorp (2000); Grant-Muller et al. (2001); Odgaard et al. (2005), but not with the United States. Thus, lessons can be drawn from comparing the Dutch CBA practice and the American's from the difference in either nations; or European and American in general.

#### 1.4 Formulation of the scientific & societal relevance of the subject

According to McLaughlin and Howard (2005), comparative analyses permit evaluating competition, providing benchmarks, identifying areas of weakness, and guiding policy development. The contributions of this thesis project both the scientific and societal ones can be obtained from the expected conclusions from the thesis project which is an improvement of transport projects appraisal in the Netherlands by means of comparison with the United States and vice versa.

## Chapter 2: Methodology

In this part, the methodology applied in the thesis is described covering the formulation of the research questions; research design; validity, reliability and objectivity of the research; comments on the data classification; and their application in answering research questions.

### 2.1 Thesis Objective & Research Question

#### Objective and deliverables of the project

The objectives of the thesis is to analyze differences and the similarities of the transport projects appraisal between the Netherlands and the United States which leads to reflections and recommendations for improvements, not just to the Dutch but also to the United States transports project appraisal. It should be made clear, that this thesis includes *no* calculations or estimations of specific parameters, it is instead dealing with the structure and criteria of the *methods* being used by the countries and their influence on the overall outcomes of the appraisal processes. Furthermore, the focus of the thesis is regarding the methodological issues of appraisal and not the accomplishment of a full CBA itself. The expected deliverables of the projects are in the form of comparison analysis. Moreover, the reflections are drawn from the analysis to be served as recommendations to the Dutch practice.

#### Research Questions

One can observe the issues stated in 1.2 cover the methodology of analysis in *ex-ante* evaluation and the utilization of the evaluation results in decision-making in transport projects appraisal. Moreover, as justified in 1.3, comparative analysis of transport projects appraisal between the Netherlands and the United States will be conducted with the following main research question (in accordance to Nakamura (2000)):-

Main research question: **By comparing the similarities and differences in transport projects appraisal between the Netherlands and the United States, how can both countries learn from each other?**

The following sub-questions will be answered from both the American and Dutch practices:-

#### **A. Methodology of the analysis**

- (a) What items are evaluated? How far are non-marketable values and indirect economic impacts on the relevant region incorporated in the evaluation?
- (b) Which items are monetized or quantified? In particular, if monetary evaluation is conducted for environmental impacts and other non-marketable values, what are the results of such evaluation?
- (c) What kind of method is used to integrate values of various items which have been included? Are they all monetized or is the evaluation of each item weighted to obtain an integrated value?
- (d) What kinds of accounting concept underlie the benefit/cost used? Is the basis of market price, shadow price of resource, or willingness to pay employed in the evaluation?
- (e) What kinds of values are used for such parameters as the value of travel time and the value of damage by a traffic accident?

#### **B. Utilization of the evaluation results for decision-making**

- (f) To what extent is evaluation compulsory? How are the results of evaluation utilized for actual decision-making?
- (g) How far and to whom are the contents of evaluation disclosed?
- (h) Who is responsible for conducting evaluation work and making the necessary judgments?
- (i) To which extent are stakeholders involved before, during and after the CBA?

## 2.2 Research Design

According to Bell and Bryman (2007), a research design provides a framework for the collection and analysis for data. It is “the logic that links the data to be collected (and the conclusions to be drawn) to the initial questions of the study” (Yin, 2008, p. 24). Generally, there are different research designs named in the literature, of which the **qualitative** and **explorative research design** in the form of a “case study” (Bell & Bryman, 2007, p. 62) is most applicable to this thesis. “A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context” (Yin, 2008, p. 18). Since Mouter et al. (2013b) states that the Dutch CBA practice is the state-of-the-art and can be regarded as representative for many countries that use CBA as an ex-ante evaluation tool in the decision-making process for infrastructure projects, taking Dutch CBA practice counts as a contemporary phenomenon. Additionally, the widespread use of economic appraisal techniques can be seen as an occurrence which contributes to the choice of a case study being appropriate for this thesis.

A case study is an appropriate design for this thesis because a case study is said to deal with a situation “in which there will be many more variables of interest than data points” (Yin, 2008, p. 18) i.e. the variables of interest are mainly of a qualitative nature, which applies to some of the appraisal criteria for investment projects (e.g. environmental impacts and decision-making process). Furthermore, a case relies on multiple sources of evidence and makes use of “prior development of theoretical propositions to guide data collection and analysis” (Yin, 2008, p. 18). This is true for the thesis as it will build up on reports, studies and governmental papers concerning the issue.

There are several variations within the design of case studies, of which this thesis will make use of the so called “comparative case method” (Yin, 2008, p. 19) since it will not just look at Netherlands but will compare it additionally to the United States where can be seen as one “case”.

The analytic technique being followed in the thesis can be categorized as “explanation building” where one analyzes “how” or “why” something happened or is existent (Yin, 2008, p. 141). The explanations that are built up should reflect and include well known theories. If done thoroughly, such a technique in the area of public policy processes “can lead to recommendations for future policy actions” (Yin, 2008, p. 141). Since this is what the thesis is aiming for, it is thought to be the most appropriate technique for carrying out the analysis in order to answer the formulated research questions.

## 2.3 Validity, Reliability & Objectivity

The terms validity and reliability are normally more connected to the use of quantitative data. Nevertheless, qualitative research also needs to reassure a specific quality of data in order for the results being thought of as trustworthy (Bell & Bryman, 2007).

The term validity of data “refers to the issue of whether or not an indicator (or set of indicators) that is devised to gauge a concept really measures that concept” (Bell & Bryman, 2007, p. 165). For the

research design of a case study, validity can be split up into three sub-categories, which are (Bell & Bryman, 2007; Yin, 2008):-

- Construct validity, which is to make sure that the correct operational measures were chosen for the subject being studied;
- Internal validity by which is meant to what extent the researchers' observations are in line with the mentioned theory and whether a good causal relationship was developed between those two; and
- External validity refers to the degree to which conclusions and findings can be generalized.

Reliability on the other hand is concerned with the question if the operations of a study (e.g. the data collection process) can be repeated with leading to the same results (Yin, 2008). Other criterion for reassuring a good qualitative research is the objectivity. Even though "complete objectivity is impossible in business research" the author should be able to show that "personal values or theoretical inclinations" (Bell & Bryman, 2007, p. 414) have not been influencing the research process and the results out of it (*The achievement of these criteria shall be discussed in 5.3*).

## 2.4 Data Treatment

The data that is used can be classified as secondary and qualitative data. Concerning validity, even though the main case countries are the Netherlands and the United States and the conclusions will be drawn for both countries as well, the principles and steps of the analysis should be transferable to other settings and thus a generalization of the process itself should be possible. Objectivity is secured by critically dealing with the sources that are used and by considering a broad range of different sources, trying to avoid biased and inappropriate ones.

The literature in the second part of the thesis (theory) is mainly based on relevant guidelines and books within project appraisal in the transport sector and CBA as an appraisal method. The third part of the thesis, namely the analysis, includes a broad literature study of the United States guidelines concerning political frameworks in project appraisal, methods and relevant examples; and in-depth interviews with relevant transports practitioners in the United States.

## 2.5 Answering Research Questions

On the basis of 'how' for 'explanation building', those sub- research- questions in *Methodology of Analysis* (see 2.1) were answered primarily through **desk research**. Formal reports, guidelines, legislation documents etc. were studied in order to answer this question. On the basis of "why" **in-depth interviewing** method was used.

### 2.5.1 CBA Guidelines in transport project appraisal in the United States and the Netherlands

The desk research was primarily conducted through searching engines of Google, Google Scholars, Scopus and ScienceDirect. The search was done using keywords "Transports project appraisal", "United States", "Cost Benefit Analysis", "the Netherlands" and "Benefit Cost Analysis". This has led into three major guidelines that are deemed useful for the thesis. The references made in these guidelines were also collected.

From the United States, these guidelines are issued by the Federal Transit Administration (FTA), Federal Highway Administration (FHWA) and Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant program, together with a few supplement documents (such

as Social Carbon Cost and American Association of State Highway and Transportation's Red Book), *(the guidelines will be elaborated later in Chapter 4)*. Furthermore, at the end of each in-depth interview, the respondents were asked to recommend/provide reports/guides/articles related to transport project appraisal in the United States. Meanwhile, from the Netherlands, General CBA Guideline (Romijn & Renes, 2013) was obtained and many references are made to publications by Rijkswaterstaat (Ministry of Infrastructure and Environment).

## 2.5.2 In-depth interviews with the US transports key participants

In order to gain in-depth clarification in the guidelines above, interviews were conducted with their key participants/main users. The following paragraphs describe the selection of respondents, the structure of the interviews, and the way the interview results were analyzed.

### **Selection of respondents**

The writers of the above guidelines were contacted for interviews. Unfortunately, none of the writers responded to the requests. Due to this deadlock, another way of finding relevant respondents, who are related to the topic, was used through TIGER Grant proceeding conducted in 2010.

In 2010, TIGER Grant proceeding was conducted to guide the grant applicants on a 'proper' Benefit-Cost Analysis (the term used in the US practice, instead of Cost-Benefit Analysis used in the Netherlands). In the proceeding, representatives from the Federal Transit Administration (FTA), the Federal Highway Administration (FHWA), the Federal Railroad Administration (FRA), and the Maritime Administration (MARAD) spoke about benefit/cost analyses for the different modes. The speakers in the proceeding discussed measuring the benefits of the U.S. DOT's strategic goals – safety, livability, state of good repair, economic competitiveness, and environmental sustainability – and measuring costs (Turnbull, 2010). Since this federal discretionary program proceeding was attended by the United States key practitioners in transportation, the key speakers were contacted for the interviews. *(Refer to Appendix I for the full list of these speakers and those who participated in the interviews)*

All 10 speakers, in the proceeding, were contacted for the interviews. Only six of them replied back agreeing for the interview, with one respondent agreed to answer the questions through mail rather than interview due to hectic schedule.

However, from those six respondents, two of the respondents from the U.S. DOT office eventually declined the interviews. According to one of them, representing another respondent too, the request of the interview was forwarded to the U.S. DOT Office of International Programs that deals with requests for international information. The office has an agreement with Rijkswaterstaat, its Dutch counterpart, where the office undertakes collaborative work on technical issues. Neither the Office of International Program nor Rijkswaterstaat is aware of this thesis project. Thus, the conclusion from the respondent's was to work through their Office of International Program and Rijkswaterstaat.

At this time, one interview has been conducted with one respondent from the U.S. DOT Office. Due to his high position in the office and enough insights (answering research questions) have been covered over the interview, no further contact was made with the aforementioned two respondents.

The three respondents agreeing for the interviews were asked who, in their views – besides those were already being interviewed –, were paramount in order to be certain that the questions regarding the guidelines could be answered without biases. According to one of them, interviews have to be conducted with representatives on the state-level too, as the respondent claimed that “It is worthwhile to study the federal practice. It is not a waste at all. It is just that it controls a very small fraction of the money”; and TIGER Grant or federal discretionary grants are “not the primary process in the US mainstream CBA”. From these respondents, three respondents from the state-level Department of Transportation; and one respondent who is claimed by the previous respondents as the ‘antagonist’ of CBA, were contacted. All of them agreed for the interviews.

In total, six respondents were interviewed and one respondent answered the interview questions through mails. Figure 1 below describes the process of obtaining the respondents.

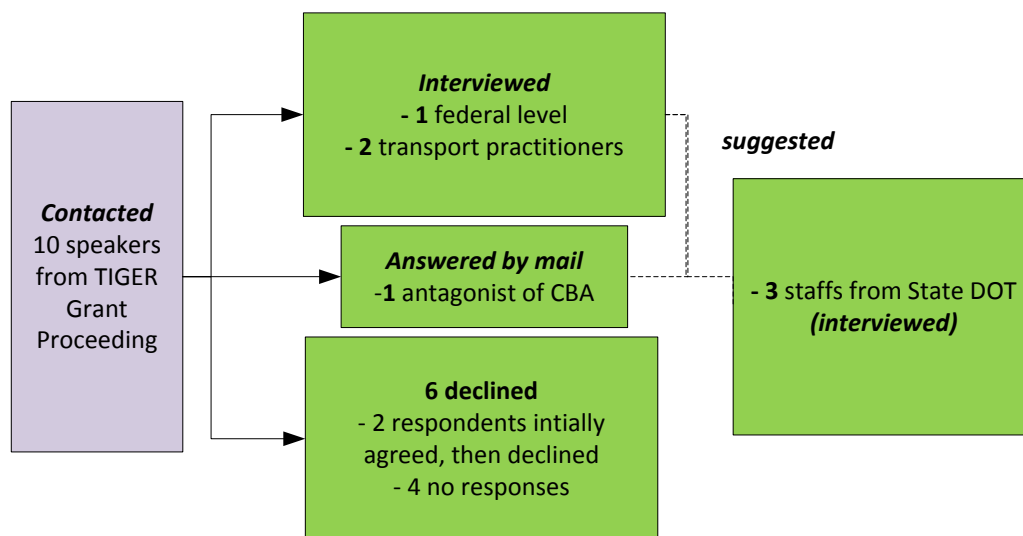


Figure 1: Process of obtaining the respondents for interviews

### Structure of the interviews

On the basis of “why” (refer to sub-research questions), in-depth interviewing method was used. The choice of this method is in two-folds. Firstly, it is the purpose of the thesis to analyze the CBA practice in the U.S. beyond the information provided in the CBA guidelines, for instance the acceptance of the method among the US practitioners; and how the CBA is applied in practice. For this reason, in-depth interviews are useful when detailed information about a person’s (a U.S. CBA practitioner) thoughts (acceptance of CBA); and behaviors (how CBA is applied in practice) are desired (Boyce & Neale, 2006). Secondly, pertaining to the previous reason, the nature of explanation/information from the respondents requires *open-ended* questions. For instance, from sub-research questions, “To what extent is evaluation compulsory? How are the results of evaluation utilized for actual decision-making?” According to Guion et al. (2001), in-depth interviews are most appropriate for situation in which open-ended questions that elicit depth of information from relatively few people are required.

The interview questions were divided into parts according to the 9 major-step of CBA (see3.2.1). Then, the sequence was put together based on the importance of the topics in the Dutch CBA as described in 1.2.3. Next, problems and issues in the Dutch CBA were stated and followed by

information obtained from the U.S. transports project appraisal guidelines for each topic. For several topics, the respondents were ask about their opinion and view on both Dutch and American practices. Lastly, the respondents were asked to give general reflections on both practices.

Furthermore, in each new round of interviews, insights gained from the previous interviews were used. For example, from an interview, a respondent commented that for discounting a project's impacts "most (of the states) use 3.5 or 4 percent". Later, in the interview with a state representative, one of the questions asked was "One previous respondent stated that most of the states use 3.5 or 4 percent discount rate to discount a project's impacts. Could you confirm this? And currently, what is the practice in your state?"

### **Analysis of the interview results**

All the interviews were transcribed<sup>4</sup>. As mentioned above, the interview questions were divided into parts according to the 9 major-step of CBA. The differences/similarities in the interviewees' opinions were coded based on these 9 major-steps. For instance, on the discount rates used in the CBA on federal level prescribed at 7 percent by the Office of Management Budget (OMB), the following are the answers to the question on "What is the rationale for the discount rate of 7 percent? To which extent does the discount rate consist of a risk-free discount rate and a risk premium?"

Question	Respondent 1	Respondent 2	Respondent 3
What is the rationale for the discount rate of 7 percent? To which extent does the discount rate consist of a risk-free discount rate and a risk premium?	OMB A-4 is vague (7 per cent is already risk-adjusted).	OMB A-4 is strange - 7 per cent is too high.	7 per cent is not risk-adjusted.

Table 1: Example of the analysis of the interview

Then, this led into observation that 'there is a diverging opinion among the respondents on the social discount rate prescribed by OMB.' The same process was conducted for all 9 major-steps of CBA (content related) together with the process-related such as Stakeholder Analysis. The results of the analysis are presented in 4.5.

## **2.6 Structure of the thesis**

The thesis is divided into four main parts which include six main chapters as the following:-

- **Part I:** Chapter 1 & 2

*Chapter 1* gives an introduction into the topic and describes the overall setting. Furthermore, it includes a short definition and termination of CBA in terms of decision-making process in transport projects appraisal. *Chapter 2* describes the methodology that is used by shedding light on the research design, research questions as well as comments on the data (desk research and interviews) that is used and their validity and reliability. Thus, both chapters together represent the overall framework for the whole thesis.

<sup>4</sup> Kindly use the contact information stated at the cover page for all the transcribed interviews.

- **Part II:** Chapter 3

Part II of the thesis builds up the theoretical and practical basis for the analysis in part III. *Chapter 3* contains the theoretical outline of Cost-benefit analysis (CBA) and Multi-criteria Analysis (MCA). Definitions, conceptual foundations, major steps and the practical use in the transport sector are conveyed for this method. It is rounded up by criticisms and limitations of the method. After that, the reader is provided with Dutch transport projects appraisal method.

- **Part III:** Chapter 4

The third part of the thesis is *Chapter 4* and contains information on appraisal methods in the United States and the analysis of the country. The results of the analysis are compared in the end of the chapter, serving as basis for the reflections on the Dutch setting in the subsequent part IV.

- **Part IV:** Chapter 5

On the basis of part III, *Chapter 5* presents the conclusions and reflections on the Dutch appraisal practice and gives information on limitations and further research on the topic.

## Chapter 3: Theoretical Framework

### 3.1 Political framework & the need for a comprehensive evaluation of transports project appraisal

The need for analyzing public projects stems from the fact that society has a limited amount of resources to accomplish any proposed infrastructure projects. If resources are used to fulfill one project, it means that the same resources will not be available for others (Gamper & Turcanu, 2007). Furthermore, within public sector, one finds competing projects with competing goals. The political framework is set by these facts and leaves the politicians with the choice of which projects should be taken to achieve the best allocation of the given resources, while at the same time reaching the highest targeted achievements. Thus, it is crucial that the politicians or decision-makers are informed in the most comprehensive overview how much resources the different projects will employ and all other impacts carried by these projects to the society and environment. Therefore, evaluation methods are needed to help the politicians or decision-makers rank and choose the projects based on their costs, benefits and impacts to the best of the society's welfare<sup>5</sup> (Haezendonck, 2007).

There are varying reasons for infrastructure planning and investments such as overstrained and congested existing systems; trying to sustain an acceptable level of service; national or regional development issues; promoting local and regional economic growth; or safety and environmental objectives. The question of what measures and analytical tools should be considered in order to evaluate and analyze public infrastructure investments; and which projects should be prioritized that are aligned with their goals and purposes are valid in public domain eyes, since these projects involve substantial amounts of financial resources and many different stakeholders (Hayashi & Morisugi, 2000; Jones et al., 2014; Salling & Banister, 2009; Thomopoulos et al., 2009).

Furthermore, transport project evaluation has become a very complex task due to —"[i]ncomplete information on, for example, the environmental impact of certain investments, uncertainty of exact traffic evolutions and pay-offs, an increasing set of regulations and regulatory bodies and controversy on the methodology to be used for the valuation of environmental and social impacts." (Haezendonck, 2007, p. 1). This reflects a good summary of the issues that are going to be relevant in the setting of this thesis. In addition it will be dealt with the question why "the use of complex methods and sophisticated evaluation tool" (Damart & Roy, 2009, p. 200) is necessary in order to take address all the matters before making a decision.

#### **Project Evaluation, Assessment and Appraisal.**

Although used interchangeably in the literatures, the terms "project evaluation", "project assessment" and "project appraisal" should be differentiated (Haezendonck, 2007). The definition of these terms in Berechman (2009, p. 2) are used for the purpose of this thesis. "Project evaluation" refers to the overall process in which different investment alternatives are "conceptualized, generated, assessed, ranked and finally chosen". This process involves economic and non-economic criteria. On the other hand, "project assessment" respectively "project appraisal" refer to "the

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<sup>5</sup> This criterion of evaluation is highly debated as some scholars claim that CBA cannot measure society's welfare (See 3.2.1)

structured procedure by which the transport-economic worthiness of each planning alternative is determined." Thus, project assessment/appraisal is a part of the overall project evaluation. In the public transport field, project evaluation involves contribution to the net social welfare by having insights on the projects' costs and benefits.

In theory, the decision and evaluation of infrastructure investments are influenced by three components, which are depicted in Figure 2. According to Preston (1996), in order to determine investment priorities, some mixture of operational/technical, strategic/political and socio-economic studies have to be conducted. As it can be seen in Figure 2 in the centre, there are (Preston, 1996):

- Operational analysis, which addresses questions concerning technical effectiveness of the investment to find the technically most superior solution, but it does not "contribute to questions of whether an investment is intrinsically worthwhile." (p. 5)
- Strategic/technological assessment, which is conducted to determine the potential of long-term, entirely new and innovative technology investments on a political level, are both influenced mainly by components in the blue arrows shown in Figure 2.
- The socio-economic evaluation, which is the focus of this thesis, tries to measure impacts of the investment on society now and in the future; to evaluate and estimate the social worthiness/social welfare of the project; and to achieve an optimal allocation of scarce resources.

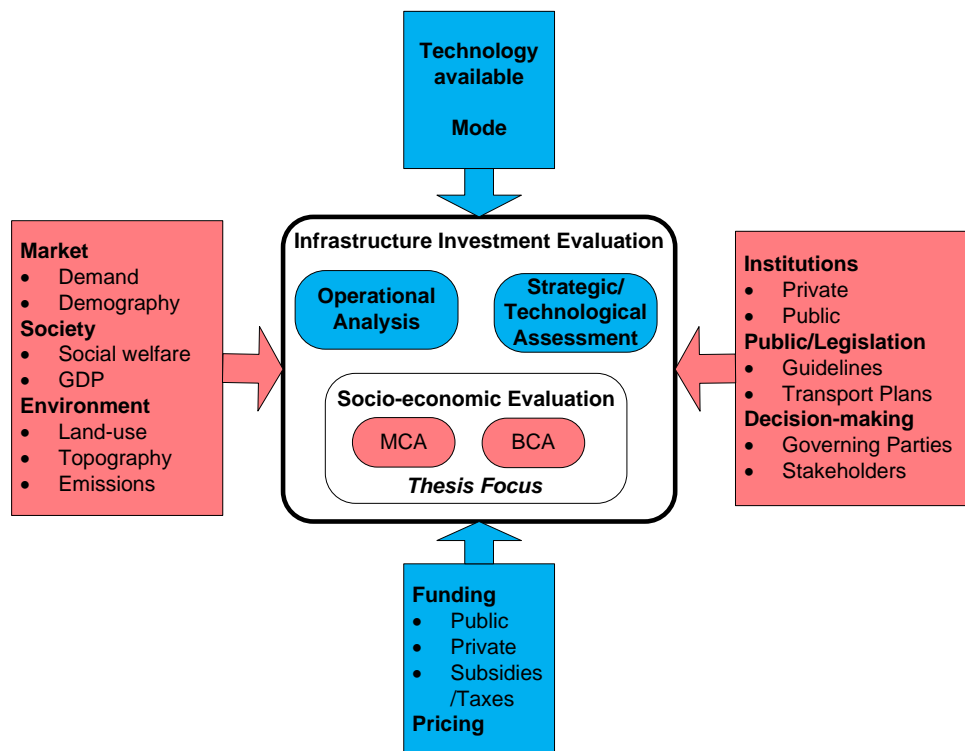


Figure 2: Components influencing infrastructure investment evaluation and its assessment tools (Dreyer, 2010).

The blue arrows and their components such as available technology, transport mode, funding and pricing certainly have influence in the evaluation process but these are not the focus of this thesis. The emphasis of this thesis are those components in the red arrows, which are market structure, societal issues and environmental matters, on the left-hand side; and institutional set-ups concerning transportation, policies and legislation surrounding it and the different issues of decision-making, on the right side.

The two most common used methodologies for socio-economic evaluation of infrastructure investments are Cost-benefit analysis (CBA) and Multi-criteria analysis (MCA)(Haezendonck, 2007). CBA and (a part of) MCA set out to quantify in monetary terms (e.g. the market demand or social welfare) or express in words (e.g. the environmental effects) components mentioned in the red arrows. Other aspects mentioned in Figure 2, like policies, guidelines and governing parties represent important influences on how and if the methods are used.

Given that this thesis deals with transportation issues, the definition of social welfare in transportation can appropriately “[b]e defined in terms of travel time savings, increased mobility, improved safety, and reduced negative externalities such as air pollution and release of greenhouse gasses. Yet, welfare maximization must be carried out under conditions of restricted resources, mainly of capital and space (e.g., land), as well as considerable uncertainty about the future value of key variables: transportation behavior, prices, interest rates, and demographics.” (Berechman, 2009, p. 10).

The following sections will focus on the relevant methodologies for this thesis used for making socio-economic transport investment appraisal, namely Cost-Benefit Analysis (CBA) and Multi-criteria Analysis (MCA). For those readers who are experienced in both of these tools, they can jump to section 3.6, in which results are discussed. For those readers who are unfamiliar with both tools, the next two sections will briefly discuss both tools and their limitation; and end with Social CBA and Combinatorial of MCA and CBA.

### 3.2 Cost-Benefit Analysis (CBA)

There are various definitions of CBA (Berechman, 2009; Boardman et al., 2011; Tudela et al., 2006). The estimation of 'social welfare effect' is the most important aim of Cost-Benefit Analysis (Mouter, 2014a). The measurement of changes in social welfare is done based on two criteria.

Firstly, Pareto Criterion is used to measure efficiency. According to Boardman et al. (2011, p. 27 & 28), “an allocation of goods is Pareto Efficient if no alternative allocation can make at least one person better off without making anyone else worse off”. Although the concept of Pareto efficiency is very appealing when only policies that yields positive benefits after providing full compensation to all those who bear costs be adopted (there will be no losers only winners), this criterion has its limitation in practice as the following (Boardman et al., 2011):-

- There will be great informational burden on the analysts not just to measure aggregate costs/benefits but also to measure costs/benefits for each person, a task that would make CBA too costly to use;

- The administrative costs of actually making specific transfers for each government policy would almost certainly be high once the distribution of costs/benefits at the individual levels was known;
- A practical system of compensation payments, which does not distort the investment and work behavior of households, is difficult to operate; and
- A strong incentive for people to always find ways to overstate the costs and understate the benefits that they expect to receive from policies would be created from the requirement that everyone be fully compensated.

Thus, in reality the alternative allocations are almost infinite and the settings are much more complex, but the whole idea behind this is that "the compensation needs not be direct" (Berechman, 2009, p. 30), which means that a Pareto optimum can also be achieved by a "potential" compensation of the "losers". This is an application of second criterion in CBA that is called Kaldor-Hicks criterion which states that (Boardman et al., 2011, p. 32) "a policy should be adopted if an only if those who will gain could fully compensate those who will lose and still be better off." In CBA practice, Kaldor-Hicks criterion gives the basis for the potential Pareto efficiency rule that is the net benefits criterion: adopt only policies that have positive net benefits.

The concepts of Willingness-to-pay (WTP) and opportunity costs are used to measure the benefits and costs for gainers and losers. WTP describes the maximum amount of a person (or group) who is (that is) willing to pay along with a change in policy without being worse off (Dreyer, 2010). It is a monetary measure of the benefit to them due to the policy change. If the outcome is negative, it represents their cost due to the change (Deardorff, 2010). Opportunity costs on the other hand are the costs of something in terms of a forgone opportunity (Deardorff, 2010). In the context of CBA, this concept is used "to place a dollar value on the inputs required to implement policies" and it "measures the value of what society must forgo to use the input to implement the policy." (Boardman et al., 2011, p. 31)

### 3.2.1 Major steps in CBA

In this section nine major steps that are normally followed when conducting a CBA are explained in accordance to and summarized from (Boardman et al., 2011; Pearce & Nash, 1981; Stevens, 2004; Walker, 2000). These steps, which are illustrated in Table 2, are not exhaustive. They are accounted for the most important stages and parts with the relevance to the thesis. The explanations of the steps are briefly provided thereafter.

A.	Specify the set of alternative projects
B.	Decide whose benefits and costs count (standing)
C.	Catalogue the impacts and select measurement indicators
D.	Predict Impacts quantitatively over the project's lifecycle
E.	Monetize all impacts
F.	Discount the benefits and costs to present values
G.	Compute the Net Present Value (NPV) of each alternative
H.	Perform sensitivity analysis

I. Make a recommendation

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Table 2: 9 Major Steps in CBA

**A. Specify the set of alternative projects**

This step prescribes the analyst to list and specify the potential alternatives of a project. In the context of project appraisal using CBA, the two main alternatives are normally to invest in a project or not; or 'go' or 'no go'. This is so called the "with/without evaluation principle" (Haveman & Weimer, 2003; Nas, 1996).

In this step, all the potential alternatives of a project should be listed and specified. As mentioned before, when doing CBA in the context of project appraisal the main two alternatives are normally, whether to invest in a project, or not. This is also called the with "without evaluation principle" (Haveman & Weimer, 2003; Nas, 1996). Deciding to do the project represents the "with", while the status-quo is often called the "counter-factual", meaning that there is no change in policy, respectively the project is not being accomplished (Boardman et al., 2011). For both scenarios/alternatives, it is tried to figure out "if the value of the output in the economy with the proposed project would be greater than the value [...] without the project." (Haveman & Weimer, 2003, p. 2846).

Worthy to mention that defining the base-case/status-quo is a crucial step and requires an accurate characterization (Damart & Roy, 2009). It is important since project alternatives' costs and benefits are compared with the base case which has a major impact on the CBA outcome.

**B. Decide whose benefits and costs count (standing)**

This step is about deciding the so called "standing" (Haveman & Weimer, 2003). It means which scale the costs and benefits, which are taken into account, should have; and who is being affected by the project. The 'standing' can be carried out from the perspectives of the local, state or provincial, national or rather global perspective (Boardman et al., 2011). This becomes crucial when thinking of non-economic variables such as environmental impacts of large scale (transport) investment projects (Tudela et al., 2006).

**C. Catalogue the impacts and select measurement indicators**

This step is about listing the physical impact categories (input and output) and measurement indicators. It needs to be pointed out that there is no quantification being done yet.

Boardman et al. (2011, p. 8&9) clarify that "in order to treat something as an impact, we have to know there is a cause-and-effect relationship between some physical outcome of the project and the utility of human beings with standing." Figuring out some of these relationships, extensive scientific research is necessary, while others are more obvious. Beneficial impact categories can be time savings, safety benefits or new users that could be gained by a new transport investment. Cost impacts include such as construction and maintenance costs. "The choice of measurement indicator depends on data availability and ease of monetization." (Boardman et al., 2011, p. 9) Measurement

indicators are for instance such as number of lives saved per year, number of person-travel hours saved or tons of air pollutants emitted.

#### **D. Predict Impacts quantitatively over the project's lifecycle**

Next, all impacts are quantified in each time period (which may be to the full lifecycle of the project). The analyst must make predictions for each project alternatives, for each year and each category. For instance category of driver, which may include trucks, passenger cars on business, passenger cars on vacation, has to be predicted by the total vehicle operating costs that users save, the number of accidents avoided, and the number lives saved (Boardman et al., 2011). In practice, this step is very important and very difficult as "projects are unique, have a long time horizon, or relationships among variables are complex." (Boardman et al., 2011, p. 10)

#### **E. Monetize all impacts**

The listed impacts in the previous step, both benefits and costs, need to be valued in monetary terms. There are two major groups of impacts which are tangible elements and intangible ones. Tangible elements are for instance capital equipment or land (Nas, 1996). Their values and prices can be normally obtained from markets, though sometimes need to be used with caution if the market is e.g. not competitive (i.e. a monopoly), because then one would face a market imperfection.

The examples of intangible elements are value of a human life, value of time, morality, noise, visual intrusion and other environmental factors (Nas, 1996; Tudela et al., 2006). They clearly represent elements, for which there is no market and thus their monetization is a challenging issue. The measurement methods for intangible elements remain one of the main critical issues within the use of CBA. This is mainly because, often time, neither the probability nor the potential damage to e.g. environment can be properly estimated (*This topic will be dealt with again in 3.2.2 below*).

#### **F. Discount the benefits and costs to present values**

The costs and benefits that are monetized in the previous step are now aggregated by discounting them to the present value. The reasons for this are in two folds: (1) there is an opportunity cost to the resources used in the project; (2) most people prefer to consume now rather than later (Boardman et al., 2011). Technically, a cost that occurs in the year  $t$  is converted to its net present value by multiplying it by  $(1+s)^{-t}$ , where  $s$  is the social rate of return or commonly called social discount rate (SDR). SDR is very crucial in CBA as it greatly affects the net present value. At a given period of time ( $t$ ) a high SDR results in lower values of the impacts being measured in the present day and vice versa.

Essentially, there are four alternatives in obtaining SDR (Boardman et al., 2011, p. 249), which are:

- i. Marginal rate of return on private-sector investment of which the best proxy is the real, before-tax rate of return on corporate bonds,
- ii. Social marginal rate of time preference of which the best candidate is the return to individuals from holding government bonds, the class of assets that have the lowest risk,

- iii. Government's real borrowing rate, which is an average yield for government's treasury bonds within a period of time that is adjusted for inflation, and
- iv. Weighted average of all the rates above, where the weights reflect the amount of the project's resources that are financed by investment (i), consumption (ii) and foreign borrowing (iii).

For more discussions on the appropriate SDR see Boardman et al. (2011); Burgess and Zerbe (2011, 2013); Moore et al. (2013a, 2013b); Szekeres (2011).

#### **G. Compute the Net Present Value (NPV) of each alternative**

This step is nothing more than adding up all the net present values of all the costs and benefits calculated in the previous step. According to Boardman et al. (2011, p. 13), "the basic decision rule for a single alternative project (relative to the status quo) is simple: adopt the project if its NPV is positive." On the other hand, if there is more than one alternative, select the one that has the largest NPV. There are two variables that can be derived at this stage other than the NPV itself, which are the internal rate of return (IRR) and benefit-cost-ratio (BCR), which are the rate of return for a project to have its benefits equal to costs (breakeven) and the ratio of benefits to costs, respectively.

#### **H. Perform sensitivity analysis**

CBA involves the prediction of future costs and benefits. The analysts might be uncertain about their estimations of these and their choice of impacts or values for e.g. the discount rate (Haveman & Weimer, 2003). "The purpose of sensitivity analysis is to acknowledge the underlying uncertainty." (Boardman et al., 2011, p. 167)

The procedure is to test how sensitive the estimations are to particular assumptions. The analysis itself "typically involves changing the assumed values of a few key parameters to see how net benefits change." (Haveman & Weimer, 2003, p. 2850) Since in reality the assumptions within CBA can be varied almost infinitely and specifically in transport projects the alternatives are very complex (Salling & Banister, 2009), there are limits in feasibility of a sensitivity analysis. Therefore, in practice, a sensitivity analysis is just done on the potentially most important assumptions, such as the discount rate, physical quantities of inputs or outputs or the project lifespan. "Although this can mean that CBA is vulnerable to the biases of the analyst, carefully thought-out scenarios are usually more informative than mindless varying of assumptions." (Boardman et al., 2011, p. 17)

#### **I. Make a recommendation**

Finally, according to Boardman et al. (2011); Nas (1996), the analysts have to recommend which projects are most desirable from the society welfare's point of view. In order to come to this decision, the alternatives need to be ranked (Boardman et al., 2011; Nas, 1996). The alternative with the highest positive value are the ones that are most likely Pareto improving, and which should therefore be recommended. However, Nyborg (2014) disagrees with this stating that 'When used to measure welfare, (CBA) is based on highly controversial value judgments. When used to measure efficiency, it is based on assumptions of limited relevance to democratic decision-making process.'

CBA only measures the population's total net Willingness-to-pay (WTP) (Nyborg, 2014). Thus, rather than making a conclusion that a project with highest positive value is 'the best' based on the highest social welfare, the analysts can only conclude that such a project has highest population's total net WTP.

### 3.2.2 CBA in transport sector practice, criticisms and limitations

CBA is used more often in transport than in other sectors (International Transport Forum, 2011). As mentioned in Chapter 1, in the Netherlands, the implementation of CBA is meant to raise the general level of analysis and promote uniformity in the appraisal methods used, besides acting as a tool for a transparent description of the economic and social effects of the proposed projects (de Jong & Geerlings, 2003).

It is important to note that in most cases CBA represents just one input to the decision-makers (Berechman, 2009). Multi-dimensional aspects of transport project desirability, such as sustainability, ethics and other social values cannot be measured in a traditional CBA (Haezendonck, 2007). Consequently, CBA provides information for the decision-making process, but it is insufficient to take decisions that necessitate multi-actor views. Thus, the most efficient project from an economic perspective (determined by the traditional CBA) "should not automatically be pursued, without considering other important criteria that can offer overall social desirability." (Haezendonck, 2007, p. 5)

Furthermore, if CBA is conservative in estimating benefits then it is possible that its use in transport weakens the political case for steering funds to the sector. On the other hand, the prominence of CBA for evaluating transport sector projects (at least in the countries that use it systematically) "means that the sector has a clear idea of how much value for money it generates, and this can strengthen its case in arguing for budgets." (International Transport Forum, 2011)

#### **Criticisms and limitations of CBA**

CBA has been subjected to criticism as a methodology in general, as well as its use for decision-making in the public sector. This section outlines the main criticisms and limitations on CBA. Jones et al. (2014) has made a good attempt to list the limitations and criticisms in the inputs and its calculation in a CBA, while van Wee (2012) and Hansson (2007) discuss this topic from ethical and philosophical perspectives, respectively.

The common criticisms and limitations of CBA can be split into two main areas, technical and qualitative limitations in accordance to Berechman (2009); Boardman et al. (2011).

**Technical Limitation** addresses the challenges to quantify and put the appropriate monetary values on the relevant impacts in CBA. Market imperfections or the existence of non-market goods characterize the technical limitations together with the considerable uncertainty about the future costs and benefits (Berechman, 2009; Damart & Roy, 2009). The analysts only provide the decision-makers with "output criteria based upon 'best guess' estimates" (Salling & Banister, 2009, p. 800). The point is that CBA only represents an appropriate decision-making tool if the Pareto principle can be applied (Boardman et al., 2011). Otherwise, "market failures, regulation, taxation, subsidization or

institutional arrangements may render the results obtained as non-optimal." (Berechman, 2009, p. 91)

**Qualitative limitations** of CBA are twofold. Firstly, for the fact that the main underlying principle of CBA is efficiency, CBA is criticized for its inability to include other policy goals, which may be important, such as equality of outcomes or opportunity (Boardman et al., 2011; Thomopoulos et al., 2009). According to Berechman (2009), CBA neglects the distribution of costs and benefits across socio-economic group and geographic space, and often at the expense of others. Secondly, CBA may disregard indirect effects of large transport infrastructure projects if the analysis is not designed properly. CBA then hardly captures "socio-economic and regional development impacts over and above the direct transport impacts." (Thomopoulos et al., 2009, p. 1) Also underlying the efficiency principle is the criticism that CBA tries to "weigh-up" e.g. human life, health or environmental aspects against economic concerns (Damart & Roy, 2009). Ackerman (2002, p. 16) criticizes the valuation of these impacts, since "on a philosophical level, human life may belong in the category of things that are too valuable to buy and sell...It is a biased and misleading premise to assume that individuals' willingness to pay to avoid certain risks can be aggregated to arrive at a figure for what society should pay to protect human life".

Even though inheriting limitations and criticisms, CBA is still the most commonly used approach in transportation project evaluation, despite the many criticisms (Berechman, 2009).

### 3.2.3 Multi-criteria Analysis (MCA)

The second appraisal methodology that is relevant for this thesis is Multi-criteria Analysis (MCA). MCA is one of the methods developed on basis of the criticism of CBA (Thomopoulos et al., 2009). It is "capable of eliciting the trade-offs between objectives (e.g. transportation efficiency, improved equity, and reduced environmental externalities) in ways that enable decision makers to make rational and systematic choices regarding the preferred project" (Berechman, 2009, p. 306).

This method has evolved as a multi-objective decision making approach for situations in which a single-criterion approach is incapable of providing the required assessment framework due to usually conflicting criteria (Berechman, 2009; Thomopoulos et al., 2009). MCA aims to "to allow each decision-making environment to engender its own set of criteria, measure and score them, and then generate a system of relative weights specific to the given context." (Berechman, 2009, p. 308) It needs to be pointed out clearly, that "[p]articipation of the decision-makers in the process is a central part of the approach." (Thomopoulos et al., 2009, p. 3). MCA differs from CBA in the following two main areas:

- MCA has no limits in the forms of criteria in the sense of that MCA allows also for "intangible" elements like for instance equity considerations; and
- MCA does not require the use of prices, MCA makes use of weights and scores (note that prices *might be* used though to derive these overall scores).

### 3.2.4 Main phases of MCA

In this section main major phases that are normally followed when conducting a MCA are explained in accordance to and summarized from (Berechman, 2009; Gamper & Turcanu, 2007; Stevens, 2004;

Thomopoulos et al., 2009; Tsamboulas, 2007). They are accounted for the most important stages and parts with the relevance to the thesis. The explanations of the steps are briefly provided thereafter.

A. Identification of criteria and preferences
B. Criteria evaluation and weights generation
C. Prioritization and ranking
D. Sensitivity analysis

**Table 3: Four Main Phases of MCA**

#### **A. Identification of criteria and preferences**

In this phase, from various alternatives, where each one is contrasted to a predefined set of objectives (by the decision-maker), preferences are established; and measurable criteria indicators are set up to test if the objectives are met. According to Berechman (2009), all transportation and non-transportation impact categories need to be systematically scored, making use of measurement scales (e.g. cardinal, ordinal, interval or ratio).

The ordinal measurement scale is applicable in this thesis. It is used when no cardinal (explicit numbers) score can be given or are too difficult to derive. By using an ordinal method, projects are ranked “on the basis of selected criteria without assigning quantitative values to them” (Berechman, 2009, p. 317). This requires that objectives need to be set for all the chosen evaluation classes. In the end, a comparison of the ordinal ranks, gives a clue about the most desirable alternative.

#### **B. Criteria evaluation and weights generation**

In this phase, the significance of each indicator is defined in a form of a weight for each impact category by the decision-makers. The weight is reflecting the relative importance of the criteria for decision-making. It is crucial to find the appropriate weights for each category (Berechman, 2009) because (1) if the final ranking of the alternatives is invariant according to the weights, the MCA as a decision-making tool is useless; and (2) if the ranking is sensitive to the weights chosen, the weights needs to be properly reflected. There are criteria categories for which weights can be easily established using data that is available. Otherwise, there must be made use of quality attributes, such as expert opinions and judgments (Tsamboulas, 2007).

#### **C. Prioritization and ranking**

In this phase, a final score is derived for each criterion, summed up to a total score for the alternative. The score is normally in between 0 and 1 respectively 0% to 100% (Thomopoulos et al., 2009). The weighted, total score aims to “assist decision makers to realize the time-order of implementation in the desired time horizon”(Tsamboulas, 2007, p. 19), which refers to short-, mid- or long-term respectively not at all.

#### **D. Sensitivity analysis**

Similar to CBA, within MCA it is common to do a sensitivity and/ or robustness analysis of the criteria/ weights chosen (Berechman, 2009; Gamper & Turcanu, 2007). This step is done in the same manner as in 3.2.1 Major steps in CBA, Step H.

The explicit attempt of the MCA method is “to eliminate subjectivity in the generation of decision weights and thereby make the overall” evaluation-selection process consistent and transparent. (Berechman, 2009, p. 311)

### 3.2.5 MCA in Transport Sector Practice, Criticisms and Limitations

MCA is commonly used in various disciplines and modes of transportations for project impact assessment, mostly within the environmental and social decision-making (Gamper & Turcanu, 2007; Tudela et al., 2006). The EU and United Nations “recommend the use of MCA in situations requiring consideration of criteria which cannot be easily expressed in monetary terms” (Gamper & Turcanu, 2007, p. 299). Due to the recommendations, “the use of MCA has lately increased in the public domain, e.g. in public transportation systems.” (Gamper & Turcanu, 2007, p. 299) Even though until now to a limited extent, MCA has been used “to provide a flexible means of assessing the multidimensional effects of transport projects” (Thomopoulos et al., 2009, p. 3)

### 3.2.6 Criticisms and Limitations of MCA

MCA may overcome some major disadvantages of CBA, e.g. including the intangible elements that CBA is struggling with. Nevertheless, MCA has also been subject to criticism. Table 4 gives a summary of MCA main strengths and weaknesses as an *ex-ante* evaluation tool for public decisions-making.

Strengths of MCA	Weaknesses of MCA
Openness to divergent values & opinions	Subjectivity of generated weights
Supports a broad stakeholder participation	Technical complexity (for instance the choice of parameters)
Preferences revealed in a more direct & practical way	Potentially time-consuming process
Capability to tackle qualitative & intangible impacts	Experts' reluctance to share their knowledge/power
Helps legitimize decision-makers' behavior	Information bias from certain stakeholder groups to strengthen their power

**Table 4: Main Strengths & Weakness of MCA as an *ex-ante* evaluation tool for public decision-making (adapted from Gamper and Turcanu (2007))**

As the table shows, one of MCA’s main criticisms lies within the involvement of the stakeholders in the process of making up preferences and weights and thus remains its major challenge “Paradoxically, the major weakness of the (MCA) method arises from its major strength: the value judgments by the decision makers.” (Thomopoulos et al., 2009, p. 4). It means that since the weights and criteria are chosen by the decision makers themselves, these preferences “do not necessarily reflect the preferences of the people as they are expressed when making choices under the restriction of limited resources” (Saitua, 2007, p. 31). Since various stakeholders will most likely have different priorities or objectives, MCA in that case could not help to find a single best solution. One way to avoid these potential negative effects for society is to set up rules and regulations for the

decision-makers behavior in a manner that secures the preferences of the society (Gamper & Turcanu, 2007).

Bots and Lootsma (2000) raise two valid questions on the applicability of MCA in decision-making. Firstly, without any contextual information, are the weights meaningful, if scoring alternatives on criteria and assigning weights to these criteria are performed by two different people (stakeholders)? The threat is that in practice the criteria have often a vague nature and it follows that "inconsistent weights are often produced, which may lead to unreliable decision outcomes." (Yeh et al., 1999, p. 131). Secondly, again, without any contextual information, can judgmental data generated by experts be properly interpreted by the decision-makers? (Bots & Lootsma, 2000). The point is "the first problem can be tamed, while the second remains elusive." (Bots & Lootsma, 2000, p. 4).

### 3.3 Social Cost-Benefit Analysis (SCBA)

For the purpose of this thesis, it is essential to introduce Social Cost-Benefit Analysis, since it was the framework adopted for the Dutch transport appraisal in the year of 2000 as a result of the Dutch OEEI (*see Transport project appraisal in the Netherlands*). SCBA is an extension of CBA, since the traditional CBA was criticized for not being able to integrate different stakeholders' opinion and choices in multi-actor setting in public decision-making (Haezendonck, 2007).

SCBA seeks to evaluate all the expected impacts of an option or a project on "all individuals of the society, not just the parties directly involved as consumers and producers." (Saitua, 2007, p. 23) Eijgenraam et al. (2000, p. 21) specifies it as an appraising that is done from the social perspective considering the profit for the national society as a whole as an "addition to appraising the project from a company's point of view (the project contractor)." It is an approach that enables "additional (often non-market) goals and effects to be quantified." (Haezendonck, 2007, p. 5) However, some common CBA limitations, such as monetization of the, now, social impacts, are still inherited in SCBA (Thomopoulos et al., 2009).

### 3.4 Combinational use of CBA and MCA

Also, it is crucial for this thesis is to understand the combination use of CBA and MCA. The case country that is under the study of this thesis mainly utilizes MCA with CBA embedded in it (*this will be further elaborated in Chapter 4*).

Berechman (2009, p. 325) suggests to select transportation "first and foremost, on the basis of their assessed transportation benefits" that is to avoid the subjectivity and also to overcome the criticism of solely using CBA. Subsequently, these benefits should be ranked by weights, scores and values generated through a MCA (Berechman, 2009). Then, an overall sensitivity analysis of the final ranking should be done to ascertain the robustness of the results with regard to changes in the weights. This combinational use of MCA and CBA is recommended in the literature as well such as Damart and Roy (2009); Grant-Muller et al. (2001); Macharis et al. (2010); Stevens (2004); van Wee (2012).

The bottom line for CBA, MCA as well as their combinational use for (transport) project appraisal is, that they represent tools and methods that are offered and recommended to politicians, and who in turn *can* - but most often are not obliged to – make use of. The EU for instance requires through the "Funds Regulation", the use of CBA for large investment projects in general since 2000. The criteria being used are not compulsory but rather recommendations. MCA is also a recommended tool, but

not obligatory in use (European Commission, 2008). Their outcomes seem to be one of many inputs for the decision-makers, and “can serve as a supplement for final decision makers to support more efficient policies, i.e. not only as a decision making, but as a decision-aiding tool.” (Gamper & Turcanu, 2007, p. 305)

### 3.5 History of Transport Project Appraisal in the Netherlands

In this section, a brief description on the context of planning and decision support for spatial-infrastructure projects in the Netherlands is provided. This is useful in order to put the use of CBA in the Dutch planning and decision-making process in spatial-infrastructure projects in the context of this thesis. Thus, it is not the intention of this section to supply an exhaustive discussion of the planning and decision support context in the Netherlands. For further information on this topic, refer to de Jong and Geerlings (2003).

#### **Rational planning**

In 1980s, in the Netherlands, views from Professor Voogd (1983) on the assessment methods dominated the discussion on planning and decision methods. The discussion was centered on the use of Multi-criteria Analysis (MCA) and Cost-Benefit Analysis (CBA)(de Jong & Geerlings, 2003), which are some forms of the classical policy analysis in the rational planning model.

In rational planning, according to Kørnørv and Thissen (2000, p. 192), a decision is considered rational "if the process leading to it is based on insight into the consequences of alternatives, and the selection follows the logic of choosing the alternative that is expected to best achieve one's goals or objectives." The process starts with the formulation of objectives or goals in a given decision context. Then, it is followed by identification or design of alternatives before the assessment of the impacts of these alternatives. Finally, one has to make a choice of the 'best' alternative in views of the goals stated earlier (Kørnørv & Thissen, 2000).

There are a few criticisms regarding to rational planning as it turns out that in reality rationality does not occur. Firstly, de Jong and Geerlings (2003) argues that in reality information is imperfect. This means that a rational procedure will not automatically lead into a rational choice as desired. Furthermore, due to multiple objectives, the preferences are usually not clearly established. Plus, the assumption in rational model for decision-making that people behave rationally is invalid in practice (de Jong & Geerlings, 2003). Secondly, taking into account the fact that decisions in planning and assessments process occur in multi-actor environments, Kørnørv and Thissen (2000) states that, stakeholders usually do not know what the problem is, what the goal is, how to achieve it, and what is the best way to achieve it. In such environments, the level of confusion and complexity is high when both the views and preferences diverge and change in the network-like process between the participants (Kørnørv & Thissen, 2000). Thirdly, the decision-makers need to consider uncertain outcomes, act in a political system and face many new and interlinked situations and problems. Thus, they continuously need to find new ways to handle these issues (Kørnørv & Thissen, 2000). Finally, in a multi-actor decision making, the planning and decisions were not an activity that could be restricted to analytical quantities and units. It was essential to become familiar with stakeholders and shareholders in the decision-making process, to understand their ideas and objections; and to compensate the incomplete resources for implementing the desired policy with the support of others (de Jong & Geerlings, 2003).

In the Netherlands, there was a consensus that policy-makers should not use traditional planning and decision support tools such as CBA & MCA. Thus, alternatives methods were adopted to facilitate an interactive planning process (Mouter, 2014a).

### **Interactive planning**

The idea of interactive planning is that participation by stakeholders will improve the planning and decision-making process in four different ways as pointed out by Guba and Lincoln (1989); and Mayer (1997). Interactive planning, firstly, increases richness of information and creativity, as the viewpoints and knowledge of a variety of actors are taken into account. Secondly, it allows for an increase in acceptance of the result of the assessment and/or decision process, as participation may lead to shared visions or and a sense of ownership of the results. Thirdly, it permits incorporation instead of exclusion of the dynamics and learning so characteristic of many such processes. In contrast to the traditional rational planning in which objectives and problems are fixed at the start, a participative process allows for emergent insights and shifts in problem perspectives and objectives over time, with the consent of all those involved. Fourthly, it contributes to the democratic character of the process, depending on how the participants are selected, how the process is managed, and how 'democratic' is defined.

There are various models that have been developed for application in multi-actor decision-making process. For examples, 'policy soups', 'garbage cans' or 'policy arenas' (Cohen et al., 1972; Kingdon, 1995) communicate the idea of multi-actor situations in which decisions surface in unpredictable ways from abundance of objectives, problems, and solutions. Meanwhile, in a 'rounds model' (Teisman, 2002) time dimension is in the focus. In the model, decision-making usually does not take place at one particular point in time, but it is rather a gradual and continuous process of interaction, negotiation and learning. One round is defined at every time agreement on a certain aspect of part is reached and accepted as a basis for the next round.

Initially, interactive planning seemed ideal since it resolved multiple and contradicting perspectives into a shared view reaching into solutions that were satisfying to the stakeholders in multi-actor planning and decision-making. Yet, based on evidence from various Dutch dissertation, de Jong and Geerlings (2003) conclude that fundamental oppositions in concepts and values from the stakeholders cannot be solved though the interaction and wider participation. Furthermore, if the decision-making process takes place in an unstructured manner, the crucial information can remain unused, of which the responsible party may ignore in the interactive process (de Jong & Geerlings, 2003). In the case where the information is unused by the actors, 'negotiated nonsense' can arise, in which the actors are poorly-informed in a dialogue (de Bruijn & Heuvelhof, 2002).

In the late 1990s, work was focused on integral assessment processes. Several projects were primarily intended to determine how actors could be involved and kept involved, and when that should happen (de Jong, 1999). The extensive public debates or 'green polder model dialogues' were laid down in reports. However, these had limited influence on the final investment decisions made by the responsible parties (de Jong, 1999). The impacts of the imbalanced situation of a state administration, which has major financial resources and thus sets the agenda, but has to leave the spatial implementation to lower government tiers, were costly (de Jong, 1999). The staffs from these

tiers were not able to implement the agenda due to the lack of a few measures in the reports. The examples of these measures were the economic and ecological impacts, which were expensive adjustments at a late stage of the projects (de Jong & Geerlings, 2003).

Then, during the first Overview of Economic Effects of Infrastructure (Onderzoeksprogramma Economische Effecten Infrastructuur – OEEI) progress conference in November 2001, the policy analysts began to feel that policy analyses should be able to separate what is useful or valuable from what is worthless. This is to prevent the implementation of totally unprofitable projects (de Jong & Geerlings, 2003).

### **Cost Benefit Analysis**

The Economic Effects Infrastructure Research program Overview of Economic Effects of Infrastructure (Onderzoeksprogramma Economische Effecten Infrastructuur, OEEI) was commenced by the Ministry of Economic Affairs and the Ministry of Transport, Public Works and Water Management. The program was initiated due to, firstly, the poor quality of the information submitted to the House of Representatives. Secondly, the economic effects of a major project, the Betuwelijn - a freight-transport railway line linking the Port of Rotterdam with the European hinterland -, in 1990s, were evaluated using diverse methods (Eijgenraam et al., 2000). The program concluded that CBA is a preferred method in order to standardize the assessment methods and to assess projects' welfare effects. The use of CBA as an ex-ante evaluation for a proposed project has gained consensus among the practitioners in the field (Mouter, 2014a).

Then, since the year 2000, it is compulsory for all large infrastructure projects including transport projects to use CBA (the OEEI) in the appraisal decision-making process. In the year 2003, the guidelines were revised and are now called the OEI Guideline (Overview Effects Infrastructure Manual). Then, an ad-hoc committee, Temporary Committee on Infrastructure Projects (TCI), was set to address the improvement on the ex-ante evaluation for infrastructure projects. The committee pointed out that a positive CBA is an insufficient condition for a decision to develop an infrastructure project; thus, a positive Benefit-Cost Ratio (BCR) is not considered a formal requirement for appraisal decisions (Mouter, 2014a). Instead, the CBA's official function was to supply transparent policy information for the preparation of infrastructure projects and public administrators were not bound to this information (Mouter, 2014a).

Later in the year 2010, the formal role of CBA in the planning and decision-making process for spatial infrastructure projects was modified again. The Manual for exploring spatial-infrastructure projects dictates that the National Government should use Cost-Benefit Analysis (Mouter, 2014a). The information from the CBA study is mainly used as a supporting information by the politicians in debate about specific projects, although the CBA is not used to decide the 'go' or 'no go' decision about spatial-infrastructure projects (Mouter, 2014a).

### **3.6 The Social Cost Benefit Analysis in the Netherlands**

For the comparison purpose to answer the research questions, the Dutch SCBA practice is described in two parts which are: A. Methodology of Analysis and; B. the Utilization of the evaluation results for decision-making.

### 3.6.1 Methodology of Analysis of Transport Project Appraisal in the Netherlands

#### A. Specify the set of alternative projects

Prior to this step, the Dutch CBA put a great emphasis on formulating the problem to be solved. According to the guide, a project initiator must have a clear picture of the problem, since it provides clues to conducting a sound CBA (Romijn & Renes, 2013). The project initiator also must consider how to structure the CBA (policy alternatives, base case, time horizon, sensitivity analyses) in connection with the problem formulated. Furthermore, the guide advises the project initiator to get different stakeholders involved in drafting of the problem. From the jointly-formulated problem, the various groups are also involved in the design of the CBA. Despite divergent interests, the stakeholders can have the same idea about the design of CBA, the same expectations about the questions with the CBA be answered; and the types of costs and effects that come into the picture. Yet, the project initiator remains responsible for the design and content of the SCBA (Romijn & Renes, 2013).

Then, in specifying the set of alternative projects, the Dutch CBA guide defines a policy<sup>6</sup> alternative as “the smallest possible set of interrelated measures expected to be technically and legally feasible, economically viable and a plausible relationship with the bottleneck identified in the problem.” (Romijn & Renes, 2013, p. 87). A policy alternative must be (Romijn & Renes, 2013):-

- independent that is further subdivision is impossible or carries no meaning;
- in-line with the policy aimed;
- technically and legally feasible;
- economically viable.

#### B. Decide whose benefits and costs count (standing)

The Dutch CBA general guideline (Romijn & Renes, 2013) does not specify the standing of the evaluation. However, according to the Dutch CBA practitioners “[C]BAs in the Dutch practice only include welfare effects for the Netherlands.” (Mouter, 2014a, p. 106)

#### C. Catalogue the impacts and select measurement indicators

##### Project Cost and Conventional Transports Indicators

Under direct effects, marketable effects, for instance investment costs and maintenance and administrative costs, are catalogued; and conventional transport indicators are travel time saving, the number of trips are included, and travel cost (Jong, 2013). The most common models in determining these effects are the National Model System (LMS) or Dutch Regional Model (NRM) (Romijn & Renes, 2013). Projections for the mobility on the main road and the rail network are done in LMS. Although similar to LMS, the projection in NRM can be done on regional basis too (Jong, 2013).

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<sup>6</sup> Note that the Dutch CBA is a general guideline for SCBA which is applicable in several government ex-ante policy evaluations (i.e transports, education, health and labor). Thus, the term ‘policy’ used in the guide is retained in this section, although it is meant ‘project’ in the thesis context.

### **Non-Marketable Indicators**

For a typical transport project, the non-marketable effects (1) under local effects are soil and water; nature; landscape and spatial quality; and archeology; (2) under direct effects are travel time benefits; and reliability benefits; (3) under indirect effect is employment; and (4) under external effects are emissions; noise; odor; and safety (Jong, 2013). The external effects are derived from Vehicle-Miles Traveled (VMT). Additionally, the effects on air quality and noise effect are, sometimes, determined from the Environmental Impact Assessment (Rijkswaterstaat, 2011d). Furthermore, a model designed for road safety, in which the calculation of the number of deaths and injuries from different infrastructure measures can be utilized (Rijkswaterstaat, 2011e).

In the Dutch CBA, indirect effects are defined as costs and benefits via market transactions which are transferred to other markets other than the transport market. In principle, to determine these effects, three options are recommended (Romijn & Renes, 2013):

- The use of a spatial general equilibrium model, RAEM (for comparison of the indirect effects output from RAEM and other indirect effects models see Hoefsloot and Pater (2011); Hof et al. (2011)) ;
- The use of estimated elasticity in determining employment effects through scientific studies (see Groot et al. (2010); Koopmans et al. (2011); Romijn and Zondag (2012)); and
- The use of uplift rate on travel time saving from 0 to 30 per cent.

#### **D. Predict Impacts quantitatively over the project's lifecycle**

In principle, the period of estimation, as prescribes by the Dutch CBA, depends on the life span of the project, which is also depends on the availability of the data for the estimation. Plus, it may be desirable to extend the period of the estimation if the desirable effects were not fully developed over time (Romijn & Renes, 2013). However, this can be operationalized in a 100-year time horizon after the project is commissioned (Ministry of Infrastructure and Environment, 2012).

#### **E. Monetize all impacts**

The general Dutch CBA (Romijn & Renes, 2013) gives general principles of conducting CBA. The choice of effect monetization is in the hands of the project initiators. The following impact monetization guides are recommended from the Ministry of Infrastructure and Environment (Rijkswaterstaat) in conducting CBA.

### **Local Effects**

Firstly, soil effect is determined from contamination, stability and fertility. Contamination is determined by grams of polluting substance per kilogram (kg) dry matter in the soil above a certain limit value. For instance the amount of cadmium per kg dry matter per year per 10,000 populations. This effect is monetized through damage cost that is damage to health from the contamination (Rijkswaterstaat, 2011c). Secondly, water effect is divided into two: (1) quality and (2) quantity. The earlier refers to the chemical and ecological status of water bodies and the latter refers to the water infiltration, storage room and drain regions. These effects are usually included in Environmental Impact Assessment (Rijkswaterstaat, 2011d). Water quality is monetized through WTP that is travel

time cost for recreational purpose for swimming or fishing purposes; and water quantity is monetized through damage cost in terms of chance of flood damage, water shortages and wet/drought properties and productions (Rijkswaterstaat, 2011d).

Thirdly, the scenery or historical geography refers to the interaction between the human and physical environment which is reflected in the landscape elements and spatial patterns (Rijkswaterstaat, 2011f). The benefits of landscape and spatial patterns are all related to the attractiveness of the landscape which are monetized using hedonic pricing (Rijkswaterstaat, 2011f). Fourthly, archaeology is concerning spores in the soil that provide information on past human societies. The main benefits of archaeological grades are related to educational purpose. It can involve recreational experience of information, but only should the archaeological elements are still visible. For the inheritance value of archeology there are no separate price indices found; thus it is not monetized (Rijkswaterstaat, 2011f).

### **Direct effects**

Travel time benefits are converted into VOT on hourly basis; and the values are divided into passenger and freight transports. The earlier is further broken down into the purposes of the travel (i.e. live/work, business) and modes; and the latter are divided into road, rail, inland, shipping and air (Rijkswaterstaat, 2011a). VOT is considered to be related to the real wage growth that is revealed preferences in the private sector (Rijkswaterstaat, 2011a). The reliability benefits are simply calculated as 25 per cent of the travel time benefits, following a literature review on this topic and recommendation by CPB (Besseling et al., 2004).

### **Indirect effects**

In 2011, Decisio<sup>7</sup>, a Dutch consulting company, has conducted a study on the indirect effects for CBA, directed by the Ministry of Infrastructure & Environment (Rijkswaterstaat). The results of the study (Hoefsloot & Pater, 2011) are applied as a rule-of-thumb to calculate indirect effects, especially in the labor market. This effect only counts when the policy affect labor productivity; thus, there is welfare gain. The productivity gain is divided into two which are (1) innovation and; (2) agglomeration (clustering). For the earlier, an increase of 10 per cent or more in ICT Capital is prescribed as an increase of 0.3 to 1.1 per cent increase in labor productivity; and for the later, an increase of 1 per cent in agglomeration leads into 0.023 per cent increase in wages (Rijkswaterstaat, 2011b).

### **External Effects**

Firstly, air quality and climate are measured on the basis of the concentrations of air polluting substances in the air which are PM10, SO<sub>x</sub>, NO<sub>x</sub> and CO<sub>2</sub>. Monetization of these effects is done through shadow pricing that is the cost of health treatment (Rijkswaterstaat, 2011g). Additionally, CO<sub>2</sub> is counted towards climate change effect and it is priced at EUR 62.66 per ton in circulation. The amount does not represent the damage that occurs in the Netherlands by climate change, but the cost of climate measures that the Netherlands should take as a result of international climate agreements.

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<sup>7</sup> Decisio supports public authorities and corporations during all stages of the strategic decision making cycle by means of designing strategies, comparing alternatives, implementing policies and measuring effects.

Safety indicator counts towards the benefit of improving road that is divided into (1) avoidance of damage as repair costs; (2) avoiding congestion by accidents; and (3) avoidance of fatalities and injuries (Rijkswaterstaat, 2012a). In 2012, Rijkswaterstaat and ECORYS jointly produced a guideline (Linde et al., 2012) to measure the safety indicator. According to the guide, firstly, Value-of-a-statistical life can be utilized at Euro 2.7million per death (2010 price), which is monetized through WTP (Linde et al., 2012). It is crucial to understand that this value is defined as a mortality risk reduction benefits, which is not a Value of a person's life. Secondly, other methods prescribed are Quality Adjusted Life Years (QALY) and Disability Adjusted Life Years (DALY). QALY is a measure of disease burden, including both the quality and the quantity of life lived; and it is used in assessing the value for money of a medical intervention. Meanwhile, DALY is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death (Linde et al., 2012). *(See Appendix II for the monetization of the effects discussed above)*

#### **F. Discount the benefits and costs to present values**

Through the advice from the Working Group of Long Term Discount Rate (see Working Group on Long-term Discount Rate (2009)), The Dutch SCBA suggests the use of general risk premium, along with the real risk-free discount rate provided by the Dutch Cabinet. In the most recent revision (dated 2011), the real risk-free discount rate is set at 2.5 per cent and the default risk premium at 3 per cent. Hence, 5.5 per cent discount rate in total. Furthermore, the irreversible effects<sup>8</sup> are discounted at the rate of 1.5 per cent, which is half of the default risk premium. In the opinion of the working group, the use of 1.5 per cent, instead of 3 per cent, for a project's discount rate, has to satisfy the following conditions (Working Group on Long-term Discount Rate, 2009):-

- The project involves negative externalities<sup>9</sup> induced and addressed by the project; and
- There are irreversible effects resulted from the project.

The first condition indicates that the negative externalities from the project have been taken into accounts; and actions to mitigate them have been decided upon in the analysis. The second condition implies that the effects from the project still exist/continue after the lifetime of the project. Generally, for large infrastructure projects, the application of this specific risk-premium is applicable (Working Group on Long-term Discount Rate, 2009).

#### **G. Compute the Net Present Value (NPV) of each alternative**

The general Dutch SCBA advises the use of net present value (net present value of benefits minus net present value of costs) to measure the welfare effects of the project. However, the main disadvantage of this measure is the policy alternatives are difficult to be compared. For instance, there are two policy alternatives, A and B, which both have 10 million Euros NPV. However, preferences are hard to establish if the costs are 100 Million Euros and 200 Million Euros for project A and B, respectively (Romijn & Renes, 2013).

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<sup>8</sup> Those long-term, negative, or/and adverse effects such as climate change and rise of sea level (Romijn & Renes, 2013).

<sup>9</sup> A negative externality is a consequence of an economic activity that is experienced by unrelated third parties. An example is pollution emitted by an increase amount of automobiles on a highway, due to its expansion, which could increase the amount of carbon dioxide in the air and affects the health of nearby residents.

Another variant to measure the social profitability of the alternatives is BCR. This measure corrects the aforementioned NPV's disadvantage by expressing the benefit and cost ratio. From the previous example, the BCRs for policy A and B are 1.1 and 1.05, respectively. Thus, policy A has a better payoff than policy B. Yet, BCR also carries an inherent issue which is in the valuation of costs and benefits which can differ in the calculations (Romijn & Renes, 2013)

#### **H. Perform sensitivity analysis**

Sensitivity analysis in the general Dutch SCBA is performed in relation to two types of uncertainty: (1) knowledge uncertainty; and (2) policy uncertainty. Knowledge uncertainty concerns the confidence level in the effects measurement/valuations. Meanwhile, policy uncertainty relates to the influence the alternative policy in question affects other policies. An example is a proposed transport infrastructure that is analyzed with or without road pricing policy.

In conducting sensitivity analysis, an analysis is advised to (1) use different scenarios and the risk premium in the discount rate (3 per cent default); (2) provides a solution on how to deal with the uncertainty and how to mitigate risk; and (3) not deviate from the prescribed real risk-free and risk premium discount rate.

Suitable for transport projects and planning policy which includes spatial policy on the nature and environment is the scenarios Prosperity and Environment (see CPB et al. (2006)). By exploring how land use and various aspects of the living environment may develop on the long run (2040), the study shows when current policy objectives may come under pressure, and which new issues may emerge. Two critical factors of uncertainty stand out: (1) to which extent will nations and international trade blocks cooperate and exchange, giving up some of their cultural identity and sovereignty? (2) how will governments balance between market forces and a strong public sector? These international political choices determine four possible scenarios for the Netherlands (CPB et al., 2006):

- Global Economy: emphasis on international cooperation and private responsibilities;
- Strong Europe: emphasis on international cooperation and public responsibilities;
- Transatlantic Markets: emphasis on national sovereignty and private responsibilities; and
- Regional Communities: emphasis on national sovereignty and public responsibilities.

Among the effects under these four different scenarios are energy (coal, gas, renewable), carbon emissions, and transports (passenger, freight, congestion hours) (CPB et al., 2006). With 2002 as the base year, projections were made (either decrease or increase in percentage) under these four different scenarios.

The following Table 5 summarizes the Methodology of Analysis of Transport Project Appraisal in the Netherlands.

Effects	Items evaluated	Quantitative/ Qualitative	Monetized?	Accounting Technique
<b>Marketable effects</b>	Project cost	Quantitative	Yes	Market Price
<b>Non-marketable Effects</b>	Travel time benefits	Quantitative	Yes	Revealed Preferences
	reliability	Quantitative	Yes (multiplier on Value of Time)	Revealed Preferences
	Soil	Quantitative (through contamination, stability, fertility)	Yes	Damage cost (to health)
	Water	Quantitative (through quantity and quality)	Yes	1) Quality (hedonic pricing) 2) Quantity (damage cost)
	Nature	Quantitative (through biodiversity and water purification)	Yes	1) Biodiversity (hedonic pricing) 2) Water purification (damage cost to health)
	Landscape & Spatial quality	Quantitative	Yes	hedonic pricing
	Archeology and Historical sites	Quantitative	No	-
	Emissions	Quantitative	Yes	Shadow pricing (cost of health treatment)
	Noise	Quantitative	Yes	Shadow pricing (cost of health treatment)
	Odor	Quantitative	Yes	hedonic pricing
	Value-of-a-statistical life (VSL)	Quantitative	Yes	Damage cost
	Value of injuries	Quantitative	Yes	Damage cost
<b>Indirect Effects</b>	Employment	Quantitative	No	-

Table 5: Methodology of Analysis of Transport Project Appraisal in the Netherlands

### 3.6.2 Utilization of evaluation results for decision-making

In this section, the sub-research questions *Utilization of the evaluation results for decision-making* are answered.

#### **The use of CBA in decision-making**

Rienstra (2008 cited in Mouter (2014b)) concluded that between 2000 and 2008 in infrastructure projects, CBA was not a decisive element in the Dutch decision-making process. Furthermore, CBA plays a far more important role for large projects (more than 1 billion Euros) than small ones. However, during financial crisis, the Coalition Agreement of the Dutch National Government emphasized that projects with positive CBA ratios shall be carried out accordingly (Mouter, 2014b). Besides the National Government, municipalities such as Eindhoven, Rotterdam, Amsterdam and The Hague have started to use CBA in assessing their own projects. Those large cities such as Rotterdam and Amsterdam require CBA as a compulsory analysis for large infrastructure proposal applying for funding from the respective municipalities (Mouter, 2014b).

In the Netherlands, Central Planning Bureau (CPB) and PBL Netherlands Environmental Assessment Agency are the responsible bodies for conducting evaluation work, despite private consulting companies. Also, the Transport Department of the Municipality of Amsterdam even enacted a 'CBA team' of civil servants who assist civil servants of smaller municipalities in the region with carrying out CBAs. In a letter to the House of Representative (House of Representatives, 2013 cited in Mouter, (2014b)) 'to enhance the transparency and quality of CBAs, all CBAs that are (partly) initiated by the National Government, should be sent to the House of Representatives. Also, all CBAs should be published on the website of the National Government.' Thus, it can be concluded that, currently, CBAs are not disclosed to other stakeholders other than the project initiators and the analysts themselves.

Worthy to note that, in the Netherlands, the House of Representatives ordered that CBAs for all large national projects are subject for reviews by second opinions (Mouter, 2014b). The rationale of the order was that the review could contribute to a better quality of the research, which could lead into a better political decision-making process. In the early years of the Dutch CBA introduction, the review was conducted by the Netherlands Bureau for Economic Policy Analysis. Currently, the review is mostly done by the institutes that are part of or affiliated with the Ministry of Infrastructure and the Environment.

#### **Stakeholders Involvement**

According to Mouter (2014b), the stakeholders involvement on the CBA process is intense. The author personally witnessed the discussion on the rationale of proposed projects which is organized spontaneously by the Dutch CBA practitioners in a kick-off meeting. During the discussion the stakeholders were asked which effects they perceived; and discussed the basics of CBA methodology (Mouter, 2014b). Specifically, a method that is frequently used structure the discussions is the 'effect survey meeting' (Effect Arena). The reason for the meeting is for the actors to have the opportunities to express which effects they think will accumulate from the project. However, only those effects which increase national welfare are included in the CBA. Furthermore, beside the aforementioned pre-phase of the CBA, the stakeholders are also frequently involved in the discussion of the mid-term results, prior to being asked to comment on the final draft (Mouter, 2014b).

### 3.7 Transport project appraisal process in the Netherlands in practice

In this section, the project appraisal process in the Netherlands, in practice is described mainly from Mouter (2014a), which has acquired a thorough understanding of the way CBA is perceived by different key individuals that use, carry out or study CBAs. In accordance to the sub-research questions, selective findings are withdrawn from Mouter (2014a) and they are divided into six different clusters which are:

- Appraisal tools
- Problem Analysis
- Estimation of the effects
- Monetization of the effects
- Discount Rate
- Presentation
- Stakeholders Involvement

#### **Appraisal Tools**

The key actors in the Dutch CBA agree on two aspects regarding the role of CBA in decision-making process for spatial-infrastructure projects. Firstly, almost all the respondents believe that CBA must have 'a' role in the appraisal of spatial-infrastructure projects. Secondly, also, almost all of the respondents prefer the use of CBA in the ex-ante evaluation to support 'go' or 'no go' decisions for investments in classic infrastructure projects and spatial projects over a situation where no ex-ante decision-support system (i.e. CBA or MCA) is used.

However, there is a disagreement on among Dutch key actors regarding the role of CBA in the decision-making process. Particularly, those respondents who identified themselves as economists think that, currently, too much value is attributed to CBA, whereas the self-identified spatial planners think that too much value is attributed to CBA in the decision-making process.

#### **Problem Analysis**

Concerning spatial-infrastructure projects, the Dutch practitioners simply miss a high quality independent problem analysis in both CBA and decision-making process. Two causes for this absence mentioned by the key participants are (1) most clients of CBAs do not see the absence of a problem analysis as worrisome, because clients often perceive that they already carried out an appropriate problem analysis themselves; and (2) According to the interviewed respondents, it is unclear what makes a problem analysis a 'high quality' problem analysis.

#### **Estimation of the effects**

According to respondents, a problem with the quality of the estimation of non-monetized project effects on the transport market is that the effects in the Dutch practice are frequently estimated for one future year and, subsequently, the transport effects for the other years in the future are extrapolated. As a result, the respondents claimed that estimations of transport effects are highly contestable.

In addition, most of the key participants in the Dutch CBA practice experience issues with the estimation of external effects, particularly, intangible effects. According to some respondents, the underlying issue with estimation of intangible effects is that the inclusion of these effects is based on the wishful thinking of project initiators rather than sound research. Meanwhile, some respondents stated that it is difficult, if not impossible, to 'prove' these effects. Furthermore, a problem mentioned by the respondents is that it is cumbersome to operationalized vague (positive) external

effects, for instance, quality of life and enhanced spatial quality, which are frequently perceived by the project initiators as positive project effects

### **Monetization of the effects**

Firstly, as a general problem concerning monetization of project effects, the respondents stated the cost in time and money for estimating the WTP for an effect in specific projects. Secondly, respondents see the following as a problem: in CBAs, standardized national numbers are frequently used as the basis for monetizing external effects and these standard national numbers lead to an incorrect valuation of external effects in specific cases.

### **Discount Rate**

Firstly, the respondents perceived that the discount rate, which is used for negative external effects, particularly, the irreversible ones, is still too high; and it leads into an underestimation of these effects in CBAs. Secondly, respondents in the Dutch CBA practice perceived that the risk premium is rigidly applied. For specific cases, according to the respondents, this rigid risk premium is incorrect, which leads into an incorrect CBA score.

### **Presentation**

Thirty two key participants stated that the quality of CBA reports is low and it should be enhanced. The four most-mentioned sub-categories of the problems in the presentation are:

- Abundance of jargon in the texts of CBA reports;
- Conclusions in the CBA reports are stated as ‘false certainties’ which lead the readers of the CBA reports into insufficiently aware of the contestability of the conclusions;
- CBA reports insufficiently clarify which effects are and are not taken into consideration;
- It is hard to validate the computation of the effects in the CBA reports because the reports insufficiently elaborate the computations.

Eighteen respondents stated three different problems with the way the Dutch CBAs deal with uncertainty of the future:

- Scenarios used in the Dutch practice are not related to the specific project alternatives under scrutiny and they are often incorrect;
- Regularly, the respondents see that effects are estimated using different scenarios, however, only the outcomes of the middle scenarios are presented in the summary of the CBA report, whereas the outcomes of other scenarios are only discussed in the appendix;
- Some CBAs only use one scenario in estimating project effects.

### **Stakeholders Involvement**

One group of the respondents, which is the spatial planners, perceives CBA as an instrument to contemplate the design of the project and a proper discussion platform which encourages different stakeholders to cooperate. Furthermore, CBA advisors perceived that stakeholders are not structurally involved in CBA process; and the stakeholder groups are involved selectively by government parties (Beukers et al., 2012).

## Chapter 4: Transport Project Appraisal in the United States

Similar to the previous sections on the Dutch SCBA practice and to answer the research questions, the American transport project appraisal process is described in two parts which are: A. Methodology of Analysis and; B. the Utilization of the evaluation results for decision-making

### 4.1 History of Appraisal Practice

The federal regulation requiring a comparison of the benefits and costs of proposed infrastructure projects dates back to Flood Control Act 1939. The act recognized controlling flood waters to be “in the interests of the general welfare” and stipulated that specific projects were economically justified “if the benefits to whomsoever they accrue are in excess of the estimated costs.” Thus, the public flood control, which generates value in the form of products or services benefitting members of the society, is acknowledged by the United States Congress. From the act, the estimation of such public benefits together with costs was authorized (Fuquitt & Wilcox, 1999).

Starting late 1970's, the country began to use CBA extensively in regulatory decisions such as health and safety regulations. There were series of executive orders signed by the President requiring the use of CBA in the federal decisions in regulatory requirements, which is called Regulatory Impact Analysis (RIA)<sup>10</sup>(Wells, personal communication, 2014). The National Environmental Policy Act (NEPA) of 1969, a regulation that is tightly integrated into transport project appraisal in the U.S., also called for cost-benefit analysis for regulatory programs(Weisbrod, 2013).

The use of CBA in RIA has led into the development of staff in various federal agencies which are familiar with CBA together with the guidance on some of the keys parameters in CBA. For example, in 1993, the U.S. DOT issued its first guidance on the value-of-statistical- life (VSL), which is the dollar value assigned to the lives saved as the results of the safety regulations. Then, in the late 1990's, the department adopted the value-of-time (VOT) (Wells, personal communication, 2014). At this time, the U.S. DOT has developed within the federal government a widespread practice of using CBA in regulatory decision-making; and still has not developed a comprehensive and extensive practice of CBA for infrastructure investment (Wells, personal communication, 2014).

Then, on January 26<sup>th</sup>, 1994, President Clinton's Executive Order 12893 has put in place the first federal government mandate for the widespread use of CBA, which required all federal agencies to adopt CBA for the “systematic analysis of benefits and costs.” (Weisbrod, 2013) It called for “all benefits and costs to be quantified and monetized to the maximum extent possible, including environmental and non-market benefits and costs, for those measures to be discounted for a project's life cycle, for effects of uncertainty to be addressed either quantitatively or qualitatively, and for analysis to compare a comprehensive set of options” (Wells, personal communication, 2014). Consequently, the Office of Management (OMB)<sup>11</sup> has mandated the values of discount rates to be used in benefit-cost analyses for federal projects (Weisbrod, 2013). The real discount rate established for analyses was originally set at 7 percent; then the guidance indicated that 3 percent could be used

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<sup>10</sup> Regulatory Impact Analysis (RIA) is a systemic approach to critically assessing the positive and negative effects of proposed and existing regulations and non-regulatory alternatives  
<<http://www.oecd.org/gov/regulatory-policy/ria.htm>>. In other words, it is a Cost-Benefit Analysis conducted prior to implementation of a regulation

<sup>11</sup> OMB assists the President in preparing the budget. The OMB also measures the quality of agency programs, policies, and procedures and to see if they comply with the President's policies.

alongside 7 percent for comparison purposes as prescribed in OMB Circular A-94 (OMB, 1992) (*the application of this Circular will be described later*).

## 4.2 Multi-Level Governmental Responsibilities & Multi-Modal CBA

In this section, the multi-level governmental administration and multi-modal CBA in transports project appraisal in the U.S are explained. This section is somehow crucial in explaining the transport project appraisal process in the U.S. due to (1) the different ownership and financial control; (2) federal formula funds; (3) transport planning between the state DOTs that separate the decision-making process between the State DOTs, MPOs; and (4) the discretionary grants used in different transport modes. Understanding the separations, one can then see that, generally, transport project appraisal on the federal level utilizes CBA. Meanwhile, State DOTs and MPOs, mainly, adopt MCA. These explanations, if not stated differently, are based on Weisbrod (2013).

### 4.2.1 Ownership & Financial control

In the U.S., highway facilities, public transportation systems, airports, seaports and rail stations are almost and always planned, built, owned and operated by state and local governments. The state governments construct, own and operate highways, including those designated as part of the national highway system. All of the states finance transportation projects through state motor fuel taxes, along with state vehicle registration fees; and in most states this is constitutionally protected. For instance, at state level of Minnesota, the fund spent on a particular project is constitutionally protected by the constitution of the state. Any money collected from the automobile registration or from gasoline tax can only go into highway projects (Christianson, personal communication, 2014). Local governments are responsible for constructing, owning and operating local roads, using their own funds (which may be a combination of sales tax, property tax and occasionally income tax revenues) (Weisbrod, 2013).

### 4.2.2 Federal Formula Funds

Most of the federal money is distributed to state DOTs and MPOs by formulas set by the U.S. Congress to reflect perceived needs and priorities (*see later in State-level Transportation Planning*). The funding formulas are based on factors such as population, traffic volumes, etc. (Weisbrod, 2013). For example, the New York state, California and Alabama are given 8.2, 12.1 and 4.7 percent, respectively, of total funding available (Wells, personal communication, 2014). The State DOTs and MPOs make their own project prioritization, selection and funding decisions, regardless of whether the projects use federal formula funds, state funds or a combination of the two.

Furthermore, the formula funds cover the allowable categories of spending. For most spending categories, there is also a requirement that the federal funds must not pay for more than 80 percent of a project. Thus, a particular state brings at least 20 percent of the money. However, many states put up far more than 20 percent of the cost, and sometimes the states pay for the entire cost of transportation projects – depending on the category of project and availability of remaining unspent funds from the federal source (Vickerman & Gillen, 2013).

### 4.2.3 Federal Discretionary Grants

Besides the formula funds, the federal government also maintains money for its own “discretionary” grant programs, which provide money to state and local agencies for deserving airport projects,

harbor/marine projects; high speed rail projects; major highway; and transit capital investments that require more funds than available from the formula distributions. Congress sets the funds available for each of these discretionary grant program categories, and the U.S. DOT then accepts applications from state and local authorities for those grants (Weisbrod, 2013). These federal funds only account for 10 percent of major transports projects in the United States (Rall et al., 2011).

In the case of these discretionary grants, U.S. DOT does sets its own application requirements that call for CBA as well as statements on how the projects support various stated social, environmental and economic development goals(Vickerman & Gillen, 2013). An example of such a discretionary program is the Transportation Investment Generating Economy Recovery (TIGER), which is a part of measures to stimulate economy following the major economic downturn (Weisbrod, 2013)

From 2010 to 2012, the TIGER program provided grants from U.S. DOT to state and local governments for multi-modal surface transportation projects that pass a CBA test and aid the economic development of communities. A key element of the TIGER grant application process was that it specified U.S. government recognition of a newer version of CBA that explicitly included wider economic benefits (Adams & Marach, 2012). The regulations stated that “Priority consideration will be given to projects that: (i) improve long-term efficiency, reliability or cost competitiveness in the movement of workers or goods (including, but not limited to, projects that have a significant effect on reducing the costs of transporting export cargoes), or (ii) make improvements that increase the economic productivity of land, capital or labor at specific locations.” (US DOT, 2012a, 2012b) Furthermore, TIGER Grant started because President Obama wanted to help the economy to get out of the recession. Projects that are ready to go and create jobs instantly are funded. Thus, there is a time-frame for the projects since instant job creation is a target; and to push the economy out of the recession. The TIGER grant has a few important aspects that make it unique (Weisbrod, personal communication, 2014):-

- Firstly, the projects have to be what they call ‘the shovel ready’, which meant that the project is ready – the land is acquired, environmental approvals are gained; and
- Secondly, priority is given to area with high unemployment, although any local governments can apply. The high unemployment will get extra credits.

TIGER program guides are being promoted as a recommended new standard for formalizing CBA analysis for multi-modal transportation projects in the U.S. (Turnbull, 2010). The details of the program’s CBA guidance will be further elaborated shortly.

#### **4.2.4 State-level Transportation Planning & Appraisal Methods**

Prior to the distribution of the funds, the federal government requires the state DOTs to maintain asset management plans, and provide a state airport system plan, a state highway system plan, and a state rail system plan (Weisbrod, 2013). All the state DOTs are required to do a long-range multi-model transportation plan – 25 or 30-year plan and short-range plan- a 5-year plan- called Transportation Improvement Plans (TIP), which listed all the transportation projects. MPOs only make TIP and it is rolled into the state DOTs TIP. Project prioritizing takes place in these plans before both state DOTs and MPOs apply for fund from the federal government (Weisbrod, 2013).

In conclusion, the U.S. Department of Transportation (DOT) sets criteria and rules for selecting projects to be federally funded by its discretionary grants, while the state DOTs and MPOs have their own sets of criteria and rules for projects that are funded with state or local money (or a combination of state/local funds and federal formula funds). This is well-summarized by Transportation Research Board report,

*“[t]he importance of this arrangement (different level of transport planning) is that it gives wide latitude to states and metropolitan planning organizations to decide upon their own procedures for prioritization and selection of projects. And each level of government faces a different set of criteria and considerations for setting transportation investment priorities. Thus, a variety of different forms of benefit-cost analysis, multi-criteria analysis and economic impact analysis are utilized for project prioritization and funding decisions.”* (Vickerman & Gillen, 2013, p. 72).

Every U.S. State DOT has some process for evaluating and prioritizing proposed projects, including requests for enhancement of individual roads and rail transportation facilities that are submitted by local communities, regional agencies, or district offices of the State DOT (Vickerman & Gillen, 2013). The use of economic analysis in the project appraisal process varies widely among states, ranging from required to voluntary. In some states (e.g., Vermont and Washington State), there is a statutory requirement to conduct benefit cost analysis to show that all major programs and projects have costs that do not exceed their benefits, though broad definitions of benefit are used for some types of projects. In other states, for an instance Minnesota, all projects must have either BCR greater than 1 or a qualitative assessment justifying the project (accompanied by official written approval of that justification). In yet other states, for an instance Wisconsin, large projects and state-to-local grant programs require BCR greater than 1, while the primary prioritization of highway projects is made based on multi-criteria ratings (Weisbrod, 2013).

The technical methods used by State DOTs for project prioritization fall into three main classes namely, Multi-criteria Analysis practiced by Ohio DOT (2011), Wisconsin DOT (2007), and Missouri DOT (2004); Benefit-cost Analysis<sup>12</sup> practiced by Minnesota DOT (2009, 2012) and California DOT (2007); and Composite Scoring System<sup>13</sup> practiced by Kansas DOT (2010) (Vickerman & Gillen, 2013) (see Appendix V for the full descriptions of these tools). All of these tools have CBA to a various degree (Weisbrod, 2014). Thus, it can be concluded that CBA is compulsory in almost all state-level appraisal process. MCA is the overriding principle of the appraisal in most of the states, *including* the CBA. Essentially, these states are using the combinational use of CBA and MCA (see 3.5 Combinational of CBA and MCA).

### **Environmental Impact Assessment (EIA)**

All states CBA/MCA guides for project appraisal do not address historic preservation, biodiversity, noise impacts, water quality impacts, property impacts or equitable treatment of low income and minority populations (referred to as environmental justice). This is because all of those impacts are

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<sup>12</sup> Note that the definition of BCA here is different than CBA formulated in Chapter 3: Theoretical Framework. Given such a description here, this is considered a MCA in this thesis (see Appendix V).

<sup>13</sup> This is a variant of MCA with an inclusion of GDP impacts coming from different modes of transportations (see Appendix V).

covered by laws that require an Environmental Impact Analysis for all major projects, as well as minor projects determined by state or local authorities as having potential impacts on those factors (Weisbrod, 2013) (see Textbox for a brief summary of items included in EIA conducted in Minnesota).

Textbox: A brief summary of items included in EIA conducted in Minnesota (Minnesota Environmental Quality Board, 2000)

Not all development projects require environmental review. The nature, size and location of a project determine this, and the specifics are spelled out in a detailed set of rules. If environmental review is required or desired, the governmental body with jurisdiction over the project works with the developer to complete one or both of the following documents:

- **Environmental assessment worksheet (EAW):** A screening tool to determine whether a full environmental impact statement is needed. The worksheet is a questionnaire about the project's environmental setting, the potential for environmental harm and plans to reduce the harm.
- **Environmental impact statement (EIS):** An in-depth analysis used for major development projects that will significantly change the environment. The statement covers social and economic influences, as well as environmental impact, and looks at alternate ways to proceed with the project.

The Environmental Quality Board's rules define "environment" to include: land, air, water, minerals, flora, fauna, ambient, noise, energy resources, and man-made objects or natural features of historic, geologic or aesthetic significance. There are 30 items need to be included in EAW, including Project Description, Project Magnitude Data, Land Use, Fish, wildlife and ecologically sensitive resources, Physical impacts on water resources, Traffic, Vehicle-related air emissions, Odors, noise and dust, Compatibility with plans and land use regulations, Cumulative impacts.

#### 4.2.5 Multi-modal Transportation

Since the U.S. DOT is comprised of separate modal agencies, and each modal agency controls its own discretionary grant programs, and each has developed its own guidance on benefit-cost analysis. This includes CBA guidance pertaining to highway asset management (FHWA, 2003), freight intermodal project investment (FHWA, 2008), rail transit New Starts Program (FTA, 2008), and aviation improvement (FAA, 1999). The Federal Rail Administration also had a CBA guide (FRA, 1997), but it has become obsolete since FRA no longer issues grants for freight rail projects (Weisbrod, 2013). In general, each of these guides recognize user travel time, vehicle operating cost, safety and emissions benefits (Lewis, 2014). The freight, rail and airport guides also allow for inclusion of wider productivity benefits associated with shipper costs and supply chain logistics costs, though they left it to the analysts to develop and apply methods to calculate those effects (Weisbrod, 2014). With an exception of FTA guide that utilizes MCA, these various CBA guides issued by the modal agencies of U.S. DOT apply to applications for federal discretionary grants that are filed by state, metropolitan or municipal governments.

To summarize, the following Figure 3 depicts the relationship between the ex-ante evaluation tools; and project financing and planning in the US transport project appraisal process. The key points from the figure are:-

- 90 percent of the U.S. transports infrastructure investment decisions are in the hands of State DOTs. Most of the state DOTs use MCA in the decision-making process for transport project appraisal;
- Only 10 percent of the U.S. transports infrastructure investment decisions are in the hands of federal government (U.S. DOT and different transportation modes), of which are obliged to use CBA and apply OMB Circular A-94;
- Thus, the main *ex-ante* evaluation tool used in transport project appraisal in the US is MCA.

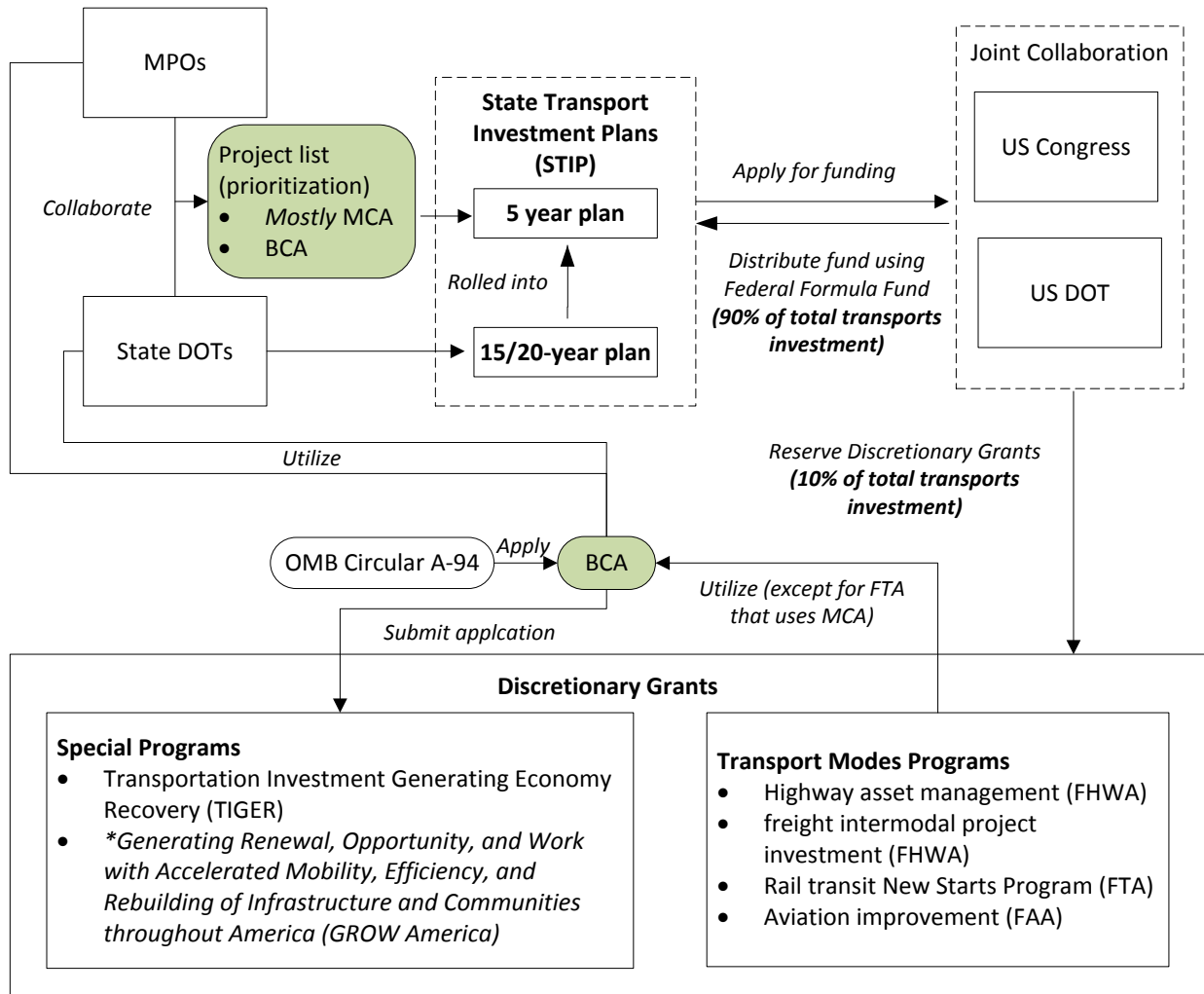


Figure 3: The relationship between the ex-ante evaluation tools, projects financing and planning in the U.S. transport appraisal process (own figure)

#### 4.3 The Methodology of Analysis of Transport Project Appraisal in the United States

The following sections describe the methodology of analysis of transport project appraisal in the United States on both federal and state levels, in accordance to the following sub-research questions

A. the Methodology of Analysis.

Generally, CBA is used on the federal level; and combinatorial of CBA and MCA are used on the state level. For the purpose of presenting the evaluation process in the proper frameworks presented in

Theoretical Framework, FTA project evaluation process, which utilizes combinatorial of CBA and MCA framework, is presented separately in Federal level section.

On federal level, TIGER Grant (US DOT, 2012b), FHWA (FHWA, 2003) and FTA (FTA, 2008) are referred to. Then, on state level, Minnesota DOT (Minnesota DOT, 2012) and Washington State DOT (WS DOT, 2000) are utilized.

#### 4.3.1 Federal Level

##### **CBA practices by FHWA and TIGER program**

The results presented here are described in the order of *9 major steps of CBA presented in Chapter 3* answering the sub-research questions A. Methodology of Analysis. Although the research questions only require answers from step C-H (*Catalogue the impacts and select measurement indicators until Perform sensitivity analysis*), step A and B (*Specify the project alternatives & Standing*) are also considered important due to their effects in the CBA.

TIGER program covers multi-modal transportation, while FHWA specializes in highways. This means that most of the impact categories FHWA are covered in TIGER Grant. The conventional transport indicators such as travel-time savings, vehicle-miles travelled (VMT) and vehicle-operating costs (VOC) are quantified and monetized. Under environmental benefits, improvement on energy efficiency and reduction on fuel dependency; air pollutant emissions; Value-of-a Statistical Life (VSL); and impact of motor vehicle crashes are quantified and monetized, too.

##### **A. Specify the set of alternative projects**

In this step, TIGER CBA addresses the importance of ‘framing’ the problems through a rigor analysis of problem causes. Framing is an analytic technique that formulates the problems according to the right causes. For instance, according to TIGER CBA guide, if congestion on a roadway is an issue, the applicant should consider why the road is congested and what would impact the amount of congestion (Adams & Marach, 2012). The framing of a problem directly affects the solutions that seem to logically fix the problems. The guide also emphasizes the importance of this step so that “the applicant is considering all possible alternatives.” (Adams & Marach, 2012, p. 14) Moreover, the guide also stresses that “alternatives” are generally to mean projects that significantly differ from the proposed project in technology, alignment/location, design and/or construction schedule. “Alternative projects would generate different levels of benefits and costs in the various societal benefit/cost categories such as travel time savings, emissions, safety, life cycle costs, externalities, etc.” (Adams & Marach, 2012, p. 17)

FHWA guidance asks for a full range of reasonable alternatives in the analysis. The guidance cautions the project’s sponsor on the foremost cause of error in the analysis that is the selection of an unrealistic base case. According to the guidance, the base case must be premised on intelligent use and management of the asset during the analysis period. For instance, allowances should be made for traffic diversion and changing peak periods as congestion builds in the base case. (FHWA, 2003) “Failure to do this can lead to overly pessimistic estimates of delay levels in the base case, to which by comparison any alternative would look attractive.” (FHWA, 2003, p. 25) CBA results can also be biased by the comparison of only one design alternative to the base case, even though less costly alternatives exist (FHWA, 2003).

## **B. Decide whose benefits and costs count (standing)**

TIGER CBA clearly states that the most “the most appropriate standing to take would be the costs and benefits to the whole nation.” (Adams & Marach, 2012, p. 15) With such a standing, the project’s sponsor are warned about the two common mistakes in CBA, namely, double-counting and transfer. Double-counting occurs when the value of an intermediate good that has been measured in some other way is counted as additional benefit in its contribution to the value of downstream production (Boardman et al., 2011). Meanwhile, “[a] transfer is the movement of a benefit from one area to another without a gain in efficiency or the creation of additional value.” (Adams & Marach, 2012, p. 15) This standing is applied throughout the analysis, except for emissions. The project’s sponsor are required to use global standing for greenhouse emissions because “the effects of the greenhouse gas emissions are felt throughout the world.” (Adams & Marach, 2012, p. 15). FHWA guidance does not specify the standing of the analysis, except for Carbon Dioxide emission which uses Social Carbon Cost guidance (Interagency Working Group on Social Cost of Carbon, 2010) taking from global standing.

## **C. Catalogue the impacts and select measurement indicators**

### **Project Cost and Conventional Transports Indicators**

TIGER program and FHWA guides recognize **Project Cost** as an indicator which is under State of Good Repairs and Economic Competitiveness for TIGER Program; and Agency Costs under FHWA. Criteria of Economic Competitiveness and Environmental Sustainability under TIGER program; and Benefits/Costs associated with Work Zones and Facility Operations under FHWA, all use travel-time savings and vehicle-miles travelled (VMT) as measurement indicators. VMT is calculated using Simplified Trips on-Projects (STOPS) model, utilizing national data; and it is used to calculate most of the environmental indicators such as emission reduction and energy efficiency improvement.

### **Non-Marketable Indicators**

Among the non-marketable effects under **Environmental Benefits** in TIGER program are improvement on energy efficiency and the reduction on fuel dependency. These indicators are quantified using VMT. Under the same category, TIGER program guide includes air pollutant emissions. Motor Vehicle Emission (MOVES) model (US EPA, 2010) is used to generate the amount of air pollutant emissions, namely, Volatile Organic Compounds (VOCs), Nitrogen oxides (NOx) Particulate matter (PM), Sulfur dioxide (SOx), Carbon Dioxide (COx) for proposed projects. Moreover, under Safety and Externalities for TIGER Program and FHWA, respectively, value-of-a statistical life (VSL) and value of injuries are identified. Also, under this category, damage by a traffic accident is quantified by comparing the current number and types of crashes; then, estimation on how a proposed project will affect these figures are made.

In recognizing **indirect effect**, TIGER Grant differs greatly than FHWA through Livability criterion. Under this criterion, the project’s sponsor can justify the proposed project through (1) increasing in user mobility, (2) increasing connectivity, (3) aiding in the mobility of disadvantaged groups, and (4) efficiency of the project on land use. FHWA does not recognize any indirect effects. *(See Appendix III for detailed list).*

#### **D. Predict Impacts quantitatively over the project's lifecycle**

In accordance to OMB Circular A-4, TIGER grant requires “both benefits and costs must be estimated for each year after work on the project is begun and for a period of time at least 20 years in the future (or the project’s useful life, whichever is shorter).” (Adams & Marach, 2012) Meanwhile, FHWA gives a rule of thumb for the analysis period that should be long enough to incorporate all, or a significant portion, of each alternative’s life cycle, “including at least one major rehabilitation activity for each alternative (typically a period of 30 to 40 years for pavements, but longer for bridges).” (FHWA, 2003, p. 15).

#### **E. Monetize all impacts**

##### **Value-of-Time (VOT) and Vehicle-operating-cost (VOC)**

**Travel-time savings** are quantified and converted into **value-of-time (VOT)** based on personal or business on local; intercity or local travel; and surfaces mode or high-speed rail travels (*See Appendix IV for the conversion table*). The concept of WTP is employed for VOT, specifically revealed preferences. For business travel purpose, VOT “is assumed to be equal to a nationwide median gross wage, defined as the sum of the median hourly wage and an estimate of hourly benefits.” (US DOT, 2011, p. 11) Meanwhile, for personal travel purpose VOT is “estimated at 50 percent of hourly median household.” (US DOT, 2011, p. 11) The U.S. DOT justifies this method as the following (US DOT, 2011):

- The simplest model evaluates savings in paid business travel time. While workers are assumed to be indifferent between travel and other ways to spend time for which they are compensated, employers perceive their employees’ gross wages (including payroll taxes and fringe benefits) as the value of the productivity sacrificed to travel. In general practice, VOT for business-related travel is not estimated empirically but is defined by the gross wage.
- VOT for personal travel leisure time is seen as an object of consumption that can be substituted for other desirable objects according to individual preferences.

**Vehicle operating costs (VOC)** is calculated using the American Association of State Highway and Transportation Official’s Red Book (*see textbox: American Association of State Highway and Transportation Official’s Red Book*), primarily for FHWA projects. Assessing VOC of transportation interventions revolves around three tasks (AASHTO, 2010):

- Estimating the unit VOC rates (i.e. \$/vehicle-mile) with and without intervention;
- Estimating the VMT before and after the intervention; and
- Calculating the user VOC benefits of the intervention.

For the VOC components, individual items associated with vehicle operation on which expenses are directly incurred are calculated using market price, for instance the market price of fuel, tires, repairs, and mileage-dependent depreciation costs. For the purpose of uniformity, the U.S. DOT advises the CBA analysts to use AASHTO (2003) Package, Highway Economic Requirements System (HERS) Package, and Surface Transportation Efficient Analysis Model (STEAM) to obtain the VOC.

Textbox: American Association of State Highway and Transportation Official's Red Book

In 1977, AASHTO issued its first "Red Book" – The Manual for User Benefit Analysis for Highways. The Red Book was updated in 2003 and 2010. It focuses specifically on the user benefit/cost measurement, including benefits associated with effects of changes in volume, speed, distance, safety and pollution emissions. Considerable effort has gone into specifying vehicle speed / user cost relationships, based on value of time, vehicle occupancy and vehicle operating cost. It also draws from the "Highway Capacity Manual" (first issued in 1950 and last updated in 2010), which has been a foundational source for establishing the speed-flow relationships. While the AASHTO Red Book only presents recommendations for user CBA calculations, they are very widely accepted and are used by most state DOTs (Weisbrod, 2013)

### **Non-marketable effects**

For all federal funded programs, U.S. DOT utilizes Oak Ridge National Laboratory (ORNL) work to estimate the reduction in a gallon of gasoline, due to the reduction of fuel dependency (Leiby, 2007). The report provides an updated range of estimates of marginal energy security benefits of reducing U.S. oil imports, in dollar value, using the oil premium calculation methodology which combines long- and short-run costs and benefits.

The accounting technique underlying the monetization of air pollutant emissions is damage cost through the guidance in Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks (US DOT & NHTSA, 2010). Damage cost relates unit increases in a pollutant to various health effects, such as probability of material deterioration, damage to the natural environment, and health. These effects are weighted by dollar values (Boardman et al., 2011).

While it is computed from MOVES, Carbon Dioxide is monetized using a different guidance published by Interagency Working Group on **Social Cost of Carbon** (SCC). The monetization of this impact is damage cost too. The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year; and in the report a projection up until the year of 2050 is listed (Interagency Working Group on Social Cost of Carbon, 2010)

Under Safety indicator **Value of a Statistical Life (VSL)** is defined as the additional cost that individuals would be willing to bear for improvements in safety (that is, reductions in risks). U.S. DOT clarifies that it is crucial to correct the misunderstanding on this terminology, which is risk that is evaluated but not the valuation of life (US DOT, 2014a). In 2013, U.S. DOT compared VSL from nine meta-analyses studies that utilized data from Bureau of Labor Statistics of Fatal Occupation Injuries to arrive into the average VSL of USD9.1 million. **Values of injuries** are then derived from VSL based on the severity of the injuries - minor to unsurvivable that is 0.3 to 100 per cent, respectively. For instance, value of injuries for an expected minor injury is USD27,300 (0.03 times USD9.1 million) for the year of 2014. The accounting technique underlies this valuation is WTP through revealed preferences, which a method of analyzing choices made by individuals.

**Damage by a traffic accident** is monetized with the guidance from Economic Impact of Motor Vehicle Crashes (Blincoe et al., 2014). By referring to the monetary values for motor vehicle crashes in the report, one is adopting shadow price from secondary sources. The report provides comprehensive

estimates including property damages, the costs of emergency and medical services, productivity losses, and travel time delay to other motorists (Blincoe et al., 2014).

**Indirect effects** accounted for in TIGER program, an increase in property price as an effect from a proposed project can be monetized in the Livability indicator. *(See Appendix IV for the monetization of the effects discussed above)*

Finally, related to non-marketable effects evaluation is National Environmental Protection Act 1969. All federal programs are subject to this act. The decision-making that incorporates NEPA and Transportation is described in the following textbox.

Textbox: NEPA and Transportation Decision-making (FHWA & US EPA, 2006)

The Council on Environmental Quality (CEQ) regulation addresses the basic decision-making framework and action forcing provisions established in the National Environmental Policy Act (NEPA). The principles or essential elements of NEPA decision-making include:

- Assessment of the social, economic, and environmental impacts of a proposed action or project
- Analysis of a range of reasonable alternatives to the proposed project, based on the project's sponsor defined purpose and need for the project
- Consideration of appropriate impact mitigation: avoidance, minimization and compensation
- Interagency participation: coordination and consultation
- Public involvement including opportunities to participate and comment
- Documentation and disclosure.

FHWA adopted the policy of managing the NEPA project development and decision-making process as an "umbrella," under which all applicable environmental laws, executive orders, and regulations are considered and addressed prior to the final project decision and document approval. Conclusion of the NEPA process results in a decision that addresses multiple concerns and requirements. The FHWA NEPA process allows transportation officials to make project decisions that balance engineering and transportation needs with social, economic, and natural environmental factors. During the process, a wide range of partners including the public, businesses, interest groups, and agencies at all levels of government, provide input into project and environmental decisions

## **F. Discount the benefits and costs to present values**

All those impacts monetized in the previous paragraphs are discounted into Net-Present Value using Social Discount Rate (SDR) in accordance to the federal directive OMB Circular A-94 *(see Textbox: Office of Management Budget (OMB) and transportation project)*. This directive, which is applicable to all federal funded programs, prescribes SDR as 7 per cent as a default position. According to the circular, the 7 per cent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy (OMB, 1992). It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector. Plus, it is broad a measure that reflects the returns to real estate and small business capital as well as corporate capital (OMB, 1992).

However, the circular also advises the use of 3 per cent SDR in providing the estimates of net benefits. The use of this rate is stemmed from the concept of "social rate of time preference" that means the rate at which "society" discounts future consumption as the measure of the social rate of

time preference. Using the real rate of return on long-term government debt as an approximation, the 3 per cent SDR is obtained considering the average annual rate of change in Consumer Price Index (OMB, 1992). Thus, in conducting CBA for federal funded programs, the analysts need to apply both SDRs.

Textbox: Office of Management Budget (OMB) and transportation project

OMB assists the President in preparing the federal budget. The OMB also measures the quality of agency programs, policies, and procedures and to see if they comply with the President's policies. All federal funded transportation projects are advised to use OMB Circular A-94 regarding the discount rate in CBA. In 1970s and 1980s, the office required most agencies to use a real discount rate of 10 per cent. The latest revision of this circular was done in 1992 in which the use of 7 per cent SDR together with 3 per cent SDR. The 7 per cent rate is based on low-yielding forms of capital (e.g. housing), as well as high-yielding corporate capital (Boardman et al., 2011)

### **G. Compute the Net Present Value (NPV) of each alternative**

Taking the NPV of all benefits and subtract the NPV of all costs to reach into the net gains or losses in total benefits for the project in this step, TIGER CBA guide states that the general rule for CBA is a positive outcome shows that the project has efficiency gains and therefore is a possible option for implementation and vice versa for a negative outcome (Adams & Marach, 2012). According to the guide, the CBA's decision rule "only takes efficiency gains into account and leaves out a significant number of other valid considerations such as equity or the distribution of benefits" (Adams & Marach, 2012, p. 22). FHWA recommends the use of either the NPV or BCR measures for most economic evaluations (FHWA, 2003). However, according to FHWA CBA guide, other measures such as the equivalent uniform annual value approach converts the NPV measure into annuity amount<sup>14</sup>; and the internal rate of return (IRR) may be used depending on the applicant's preference.

### **H. Perform sensitivity analysis**

TIGER CBA guide advises the applicant to perform sensitivity analysis for all crucial inputs. Two examples are gas prices and discount rate. Firstly, for gas prices, the guide argues that if a transport infrastructure project saves drivers gasoline due to decreased idling times, the applicant has to choose the prices of gas in the future. The guide asks the applicant to use the Annual Energy Outlook (AEO) (US Energy Information Agency, 2014) for the guidance of future gas prices. Through AEO, the project's sponsor may use high and low oil price as an upper and lower bound for the benefits that result from saved gas. Secondly, for discount rate, the guide states that "project's sponsor can use both a 3 percent and 7 percent discount rate to show how the choice of discount rate affects the benefits of the project." (Adams & Marach, 2012, p. 22).

According to the guide, it is crucial to clearly state the calculations, the facts and figures that the calculations are based upon to. The overall figures should be discussed in the project description when the applicant discusses NPV. Thus, the NPV discussion should include the NPV of the upper bound, lower bound, and the figure that applicant believes is most reliable (Adams & Marach,

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<sup>14</sup> An annuity is an equal, fixed amount received (or paid) each year for a number of years.

2012). Table 6 summarizes the Methodology of Analysis of Transport Project Appraisal for TIGER and FHWA programs.

Effects	Items evaluated	Quantitative/ Qualitative	Monetized?	Accounting Technique
<b>Marketable</b>	Project Cost	Quantitative	Yes	Market Price
	Vehicle operating cost (VOC)	Quantitative (use VMT as an input)	Yes (through Red Book)	Market Price
<b>Non-marketable</b>	Travel-time savings	Quantitative	Yes (to Value of Time - VOT)	Revealed preferences
	Vehicle-miles traveled (VMT)	Quantitative	No - Use as Input for environmental indicators	-
	energy efficiency	Quantitative	Yes	(projection) Market Price
	reduction in oil dependence	Quantitative	Yes	(projection) Market Price
	air pollutant emissions	Quantitative	Yes	Damage cost
	value-of-a-statistical life (VSL)	Quantitative	Yes	Revealed preferences
	Value of injuries	Quantitative (percentage of VSL)	Yes	Revealed preferences
	mobility/connectivity	Qualitative	No	-
<b>Indirect effects</b>	Property prices	Quantitative	Yes	Shadow pricing

Table 6: Methodology of Analysis of Transport Project Appraisal for TIGER and FHWA programs

## **Combinatorial CBA and MCA in FTA New and Small Starts Program**

### **A. Identification of criteria and preferences**

In this step, FTA has outlined six project justification criteria as the following (FTA, 2008):

- Mobility improvements
- Cost-effectiveness
- Environmental Benefits
- Economic Developments
- Congestion Relief
- Land Use

### **B. Criteria evaluation and weights generation**

Cost-Effectiveness and Environmental Benefits are quantitatively measured and monetized; Land Use and Mobility Improvements are qualitatively measured but not monetized; Economic Developments is qualitatively measured. Currently, all projects are given an automatic Medium rating for Congestion Relief, since FTA is conducting a research for the breakpoints to determine the measures it will use for this new criterion (FTA, 2008).

When possible, FTA established the breakpoints for ratings based on available research that recommended the values. When such research was not available for a particular criterion or measure, FTA established an initial set of breakpoints based on the performance measures available from projects previously and currently in the program. FTA revisits the breakpoints as performance measures are accumulated from additional projects over time. Any changes in the breakpoints will be proposed in future policy guidance for comment by the public (see US DOT (2013) as an example).

Furthermore, FTA gives “comparable, but not necessarily equal” **weight** to the six project justification evaluation criteria. This final policy guidance specifies that FTA gives equal weight to each of the project justification criteria to arrive at a summary project justification rating. Thus, each of the six is given a weight of 16.66 percent. FTA believes that each of the project justification criteria provides important information about project merit and thus, feels that equal weights are appropriate (FTA, 2013b). Some types of projects may do well on some of the criteria, but not as well on other criteria. Examining the merits of the project as a whole against all of the project justification criteria combined balances what can sometimes be competing policy goals (FTA, 2013b).

### **Cost-effectiveness and Environmental Benefits**

The following paragraphs describe the steps prior to the evaluation of Cost-Effectiveness and Environmental Benefits. These include Set of Alternatives Specification, Standing of the Analysis, Estimation Period of the effects, and Discount Rate.

FTA has dedicated a separate and comprehensive guide (FTA, 2006) for a careful consideration to the development of **alternatives** to be studied. According to the guide, in identifying problems in a corridor, the following key principles should be considered to ensure a well-structured set of reasonable alternatives is developed (FTA, 2006):

- The set of alternatives must address the purpose and need for considering a major transportation investment;
- The set of alternatives must include the necessary baseline options;

- Alternatives designed to address differing goals and objectives should be included;
- The set of alternatives should include all options that have a reasonable chance of becoming the locally preferred alternative;
- The alternatives should encompass an appropriate range of options without major gaps in the costs of the alternatives;
- Where questions remain on feasibility of specific alternatives, other alternatives should provide related fallback options; and
- The number of alternatives should be manageable so that decision-makers can realistically be expected to understand the implications of each and make a thoughtful choice.

In defining individual alternative, the guide advises the following consideration evaluate the adequacy of the alternatives proposed for analysis (FTA, 2006):

- The alternatives must, within the limits of their technology, respond to the transportation problems identified in the corridor;
- Each alternative should be defined to optimize its performance;
- The policy and land-use setting in which the alternatives are defined and analyzed must be unbiased and consistent across the alternatives; and
- The alternative definitions must specify their operating plans, institutional setting, and financing strategy.

FTA guidance does not specify the **standing** of the analysis but the qualitative valuation of Land Use and Economic Development have to be done based on regional and local plans and policies (FTA, 2008). The guidance also gives an option to “calculate the evaluation criteria using a **horizon year**, either 10 or 20 years in the future” (FTA, 2008, p. 3) for transit programs. The **discount rate** used to calculate the annualized Operation & Maintenance (O&M) cost is 7 or 3 per cent in accordance to OMB A-4 (see 4.3.1)

**Cost-effectiveness** measure is computed as the annualized capital cost plus annual Operation & Maintenance (O&M) cost of the project divided by the annual number of estimated trips on the project. The inputs for the calculations are specified in the following ways (FTA, 2008);

- A project’s capital cost estimate includes costs for planning, design and construction. It includes labor and material for construction of the improvement – such as guideways, stations, support facilities, site work, special conditions and systems – as well as costs for vehicle design and procurement, right-of-way acquisition, relocation of existing households and businesses, planning, facility design, construction management, project administration, finance charges, and contingencies. Historical bid prices will typically be used to develop costs for common construction elements.
- Trips on the project are the number of linked trips using the project, with no extra weight given to trips by transit dependent persons. Trips may be calculated using either the FTA developed simplified national model (STOPS) or the local travel model at the project sponsor’s option.

FTA evaluates and rates the **environmental benefits** criterion based upon the dollar value of the anticipated direct and indirect benefits to human health, safety, energy, and the air quality environment scaled by the annualized capital and operating cost of the project (FTA, 2013b). These

benefits are computed based on the change in vehicle miles travelled (VMT) resulting from implementation of the proposed project (FTA, 2008). VMT is obtained using STOPS model. Meanwhile the monetization of these benefits is done in the similar ways as TIGER Program and FHWA (see 4.3.1).

### **Mobility Improvements and Land Use**

FTA evaluates **mobility improvements** for projects as the total number of linked trips using the proposed project (FTA, 2013b). Linked trips using the proposed project include all trips made on the project whether or not the rider boards or alights on the project or elsewhere in the transit system. Again, STOPS Model is used to estimate the trips in which trips made by transit dependent persons are trips made by persons in households that do not own a car (FTA, 2008).

The **land use** criterion is based primarily on quantitative measures of existing corridor conditions. This includes station area population densities, total employment served by the project, and the proportion of “legally binding affordability restricted”<sup>15</sup> housing within ½ mile of stations areas to the proportion of “legally binding affordability restricted” housing in the counties through which the project travels (FTA, 2013b). According to the guide, poor pedestrian accessibility may reduce the rating, as it reduces the effective amount of population and employment directly served by the system (FTA, 2013b).

### **Economic Development**

The measure of **economic development** effects is the extent to which a proposed project is likely to induce additional, transit-supportive development in the future based on a qualitative examination of the existing local plans and policies to support economic development proximate to the project (FTA, 2013b). For this measure, FTA evaluates transit supportive plans and policies, the demonstrated performance of those plans and policies, and the policies and tools in place to preserve or increase the amount of affordable housing in the project corridor (FTA, 2008). Examples of the policies and plans the project’s sponsor can incorporate are Transit Supportive Corridor Policies, Supportive Zoning Regulations near Transit Stations and Tools to Implement Land Use Policies (FTA, 2013b).

#### **C. Prioritization and ranking**

Each criterion has rating ranging from “High” to “Low” based on the breakpoints. For instance, under Mobility Improvements, a project that has estimated annual trips more than 30 million is given rating “High”; and rating “Low” if the estimated trips are lower than 2.5 million (FTA, 2013b). As noted earlier, each criterion carries 16.66% weight to be summed up to the final score.

#### **D. Sensitivity analysis**

According to the guide, appropriate sensitivity analyses may be included in the study, if desired, to explore the implications of different service, fare, and/or land use policies (FTA, 2008). For instance, a sensitivity analysis of ridership and costs with different access strategies should be

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<sup>15</sup> A legally binding affordability restriction is a lien, deed of trust or other legal instrument attached to a property and/or housing structure that restricts the cost of housing units to be affordable to households at specified income levels for a defined period of time and requires that households at these income levels occupy these units (FTA, 2013b)

conducted to assess the potential trade-offs among ridership attraction, the availability of space for park/ride facilities, and the cost of operating feeder bus services (FTA, 2008).

Table 7 summarizes the Methodology of Analysis of Transport Project Appraisal for FTA program.

#### 4.3.2 State Level

In providing the description of appraisal methods adopted on the state-level, examples from two states' practices are presented. It is observable that these two states use Combinatorial MCA and CBA in their transport project appraisal process (see 3.5)

##### **Combinatorial MCA and CBA in Minnesota and Washington State DOTs**

###### **A. Identification of criteria and preferences**

For this step, both state DOTs describe the criteria and preferences which are the (traditional) CBA social, environmental, and community goals, except for Minnesota DOT that also includes business impacts (Minnesota DOT, 2009; WS DOT, 2000). Washington State DOT further specifies environmental criteria as Wetlands, Water Quality & Permitting, Noise, Modal Integration and Land Use.

###### **B. Criteria evaluation and weights generation**

None of the state DOT publishes the weights of the criteria (Weisbrod, 2014). However, the way the criteria are evaluated are specified as the following:-

##### **Cost-Benefit Analysis (CBA)**

Both state DOTs apply ASSHTO Red Book in CBA for **quantification of the effects** (see textbox: American Association of State Highway and Transportation Officials' Red Book). Under Red Book's direction, travel-time savings and vehicle-miles traveled (VMT) are quantified. For Minnesota DOT, travel-time data is often generated using travel demand models or traffic operations models, by making measurements of existing (base case) travel times and adjusting them for the alternative(s), or using general engineering approaches and judgment (Minnesota DOT, 2012). On the other hand, Washington State DOT generates the travel data through data available from Transportation and Data GIS Office (TDGO) (WS DOT, 2000).

Under **non-marketable** effects for both Minnesota and Washington State DOTs, safety analysis results in the number of crashes expected for each severity type (fatal, type A injury, type B injury, type C injury, and property damage only). The numbers are estimated based on existing and anticipated future crash rate, severity rate, and average annual daily traffic volumes or vehicle-miles travelled (VMT) (Minnesota DOT, 2012; WS DOT, 2000). For the evaluation of environmental effects Minnesota DOT uses document produced from Environmental Assessment Worksheet (EAW) (see textbox: A brief summary of items included in EIA conducted in Minnesota) (Minnesota DOT, 2012). For Washington State DOT, those environmental criteria described in step A are evaluated on the

Effects	Items evaluated	Quantitative/ Qualitative	Monetized?	Accounting Technique
<b>Marketable</b>	Project Cost	Quantitative	Yes	Market Price
<b>Non-marketable</b>	Number of Ridership	Quantitative	No	-
	Energy efficiency	Quantitative	Yes	(Projection) Market Price
	Reduction in oil dependence	Quantitative	Yes	(Projection) Market Price
	Air pollutant emissions	Quantitative	Yes	Damage cost
	Value-of-a-statistical life (VSL)	Quantitative	Yes	Revealed preferences
	Value of injuries	Quantitative (percentage of VSL)	Yes	Revealed preferences
	Number of linked trips	Quantitative	No	-
	Land Use	Quantitative (Legally binding affordability within 0.5 mile from the station)	No	-
	Economic Development	Qualitative (Effects on local economic policies)	No	-
<b>Indirect effects</b>	None	-	-	-

Table 7: Methodology of Analysis of Transport Project Appraisal for FTA program

basis of 'yes/no' in which project initiators are asked if the projects are parallel with the existing Land Use, Wetlands, Modal Integration, and Water Quality and Permitting policies and plans (WS DOT, 2000).

Minnesota DOT has given the following guidance for selecting the **period of analysis** (Minnesota DOT, 2012):

- The timeframe should be long enough to capture the majority of benefits, but not so long as to exceed capabilities to develop good traffic information;
- The analysis timeframe should be consistent with that used for other analyses being undertaken for the project, such as transportation demand forecasts or life-cycle cost models;
- The timeframe should be consistent for all alternatives; and
- All benefits and costs occurring or accruing over this timeframe should be included in the analysis.

An analysis period of 20 years is typical for transportation improvement projects, because traffic and demographic information is generally available for this timeframe (Minnesota DOT, 2012). Washington State DOT also advises an analysis period of 20 years as “[t]he traditional project life cycle, the length of time generally used in planning and forecasting transportation projects, is 20 years.” (WS DOT, 2000, p. 13) While emphasizing that majority of projects are well-suited for 20-year time frame, Washington State DOT does recognize those projects that require a longer period of analysis of which residual value methodology is used to adjust the BCR to account for the value of the improvement remaining after 20 years.

The **monetization** of time-travel savings and vehicle-operating cost (VOC) in both state DOTs CBA are done in the similar manner as the federal level practice (see 4.3.1). The same documents and accounting principles are used in the guides (Minnesota DOT, 2014; WS DOT, 2000)

According to the Minnesota CBA guide, existing monetary value estimates vary extensively for most environmental effects; and until the estimates converge on a consensus value or range, it is Minnesota DOT policy to avoid **monetizing environmental effects** and perform the benefit-cost analysis (focusing on transportation-related benefits and costs) as part of environmental documentation (Minnesota DOT, 2012). Minnesota DOT encourages including quantified, but not monetized, effects in environmental documents (Minnesota DOT, 2012). Washington State DOT also holds the same principle for not monetizing the environmental effects (WS DOT, 2000). The only non-marketable effect that is monetized in both state DOTs is safety and value-of-a-statistical life (VSL). These benefits are monetized the same way as the federal practice (see 4.3.1).

Minnesota DOT uses **discount rate** determined as a five-year average for real interest rates (market rate less inflation) on 30-year treasuries, of which the current value is 2 per cent (Minnesota DOT, 2014). Meanwhile, Washington State DOT advises the use of 4 per cent, which is “a discount rate that reflects only the real cost of capital, or the rate at which the money to be used in a given project could be alternatively invested.” (WS DOT, 2000, p. 13)

Both state DOTs uses **BCR** in evaluating the CBA component of projects. Minnesota DOT specifies that the projects are considered to be “cost-effective if the present value of benefits exceeds the present value of the cost of implementing the projects (a BCR greater than 1.0).” (p. 2) Washington State DOT holds the same ground stating that “[t]he cost-efficiency of a project is measured by the

benefit/cost ratio, which is the present value of the monetized project benefits divided by the project costs.”(WS DOT, 2000, p. 2)

### **Environmental, social and community criteria**

Under Minnesota DOT investment prioritization process, projects that have BCR lower than 1.0 are reassessed if they can be re-scoped to yield BCR greater than 1.0. Any projects that have BCR lower than 1.0 but “preferred” to be moved forward in the draft environmental document have to gain approval by the District Engineer or Officer Director (Minnesota DOT, 2009). Then, any social, environmental, or community goals and business impacts critical to the project and document how the proposed improvement addresses or affects these goals, either positively or adversely are quantitatively or qualitatively identified. The projects may address, effect, or be affected by critical goals such as “minimum accessibility to a transportation system or service, protection of an environmental asset, or specific regional or transportation system goals.”(p. 5).

On the other hand, **Washington State DOT** evaluates the criteria identified above as the following (WS DOT, 2000, pp. 3-4),

- (1) Community Support - The community support category consists primarily of yes/no questions that assess financial participation, endorsement, and opposition by local governments, local organizations, and private groups or individuals.

Environment:

- (2) Wetlands - It considers the acreage of any wetlands within 300 feet of proposed projects and assigns penalty points weighted according to the classification of the encroached wetlands. In this category, projects with lower scores are more favorable.
- (3) Water Quality & Permitting - Analysis consists of yes/no questions primarily regarding the number and nature of permitting requirements for a proposed project. The subtotal score reflects the magnitude of permitting requirements and is divided in half if no foreseeable permitting conflicts exist. In this category, projects with lower scores are more favorable.
- (4) Noise - Points are accrued on the basis of a calculated “risk factor,” which is based on the number of lanes for the proposed project, as well as the number of noise receptors and their proximity to that project. Risk factor points are weighted twice as heavily for new projects as they are for improvements to existing projects. In this category, projects with lower scores are more favorable.
- (5) Modal Integration - This category consists of yes/no questions concerning efficient use of existing capacity; connectivity between existing systems; integration of alternative modes such as bicycling and walking; and “multimodally” packaged projects. In this category, projects with lower scores are more favorable.
- (6) Land Use - Land-use criteria consist of yes/no questions concerning coordination between Washington State DOT engineers and planners, provision of convenient accessibility to transit, connectivity between urban activity centers, and consistency with regional and local comprehensive and/or transportation plans. In this category, projects with higher scores are more favorable.

### C. Prioritization and ranking

**Minnesota DOT** gives equal consideration for the qualitative measures consideration in decision-making, while it is desirable to meet the cost-effectiveness standards (Minnesota DOT, 2009). The Transportation Program Committee will be responsible for approving projects that do not meet Cost-Effectiveness criterion (Minnesota DOT, 2009).

For **Washington State DOT**, once proposed projects have been screened, evaluated, and scored in the seven criteria categories, they are ranked with a mathematical ranking procedure. The projects are compiled into an evaluation matrix in which the rows define the different projects to be ranked and the columns contain the seven criteria categories. The algorithm used to rank projects, called TOPSIS<sup>16</sup> (Technique for Order of Preference by Similarity to Ideal Solution), allows elements with disparate units (in this case, projects with disparate criteria) to be easily evaluated. The premise of TOPSIS is that it:

- normalizes the scores in an evaluation matrix into dimensionless units;
- multiplies each of the scores by their relative assigned weights;
- formulates a theoretical “ideal-best” project and a theoretical “ideal-worst” project; and
- prioritizes proposed projects by calculating their relative distances between the ideal solutions.

The theoretical “ideal-best” project is determined by combining all of the best scores in each of the separate criteria categories. The “ideal-worst” project is determined by combining all of the best scores in each of the criteria categories. TOPSIS is based on the concept that the chosen alternative should be closest to the ideal-best solution and farthest from the ideal-worst solution.

### D. Sensitivity analysis

**Minnesota DOT** does not specify the inputs that are used to test for sensitivity. Generally, Minnesota DOT, advises that those data that are given as range should be tested in sensitivity analysis such as travel time or operating costs (Minnesota DOT, 2012). Analysis planning should include time and resources for sensitivity analyses; and a well-planned analysis produce credible results consistent with the purpose of the analysis and available data issues and budget (Minnesota DOT, 2012).

Meanwhile, **Washington DOT** is rather specific on the variables that have to be tested their sensitivity towards the final CBA. The examples of the variables are Average Vehicle Occupancy, Discount Rate, No- Build/Posted Speeds, and Roadway Type/Capacity.

The following Table 8 summarizes the Methodology of Analysis of transport project appraisal process for Minnesota and Washington State DOTs.

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<sup>16</sup> The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is MCA which is based on the concept that the chosen alternative should have the shortest geometric distance from the positive ideal solution and the longest geometric distance from the negative ideal solution.

Effects	Items evaluated	Quantitative/ Qualitative	Monetized?	Accounting Technique
<b>Marketable</b>	Project Cost	Quantitative	Yes	Market Price
	Vehicle operating cost (VOC)	Quantitative (use VMT as an input)	Yes (through Red Book)	Market Price
<b>Non-marketable</b>	Travel-time savings	Quantitative	Yes (to Value of Time - VOT)	Revealed preferences
	Vehicle-miles traveled (VMT)	Quantitative	No - Use as Input for environmental indicators	-
	Through Environmental Assessment Worksheet - Land, Water, Minerals, Flora Fauna, Ambient, Noise, Energy Resources, Historical and Geological significance(Minnesota)	Qualitative but quantify as much as possible	No	-
	Land Use, Wetlands, Modal Integration, Water Quality and Permitting (Washington State)	Qualitative	No	-
	value-of-a-statistical life (VSL)	Quantitative	Yes	Revealed preferences
	Value of injuries	Quantitative (percentage of VSL)	Yes	Revealed preferences
<b>Indirect effects</b>	None			

Table 8: Methodology of Analysis of transport project appraisal process for Minnesota and Washington State DOTs

#### 4.4 Utilization of the evaluation results for decision-making

In this section, the sub-research questions *Utilization of the evaluation results for decision-making* are answered.

##### The use of CBA/MCA in decision-making

From sections 4.1 and 4.2, it is noted that CBA is compulsory for all federal-funded programs as required from President Clinton’s Executive Order 12893 that calls for a “systematic analysis of benefits and costs”. Then, the CBA result is used as the main criterion in the actual decision-making deciding a ‘go’ or ‘no go’ of a project. On the state level, most of the states require CBA in the combination with MCA in prioritizing transport investments. Project prioritizing takes place in Transport Investment Plans (TIP) before both state DOTs and MPOs apply for fund from federal government.

For **TIGER program**, the CBA reports submitted by the project’s sponsor go through four stages prior to the selection (see Figure 4). At the Initial Review stage, the CBAs are cross-checked between the Modal Evaluation Teams, and combined into four final lists of “highly recommended” projects within each mode; and projects that are “highly recommended” advance to the next stage. At Modal Review stage, the CBA is evaluated for overall quality, reliability, and usefulness “as well as whether the overall result showed project benefits exceeding project costs” Cavaretta (2013, pp. 7-8). Furthermore, The Environmental Review Team will review several additional issues, including construction readiness, as indicated by Project Development & Engineering (PD&E) studies; compatibility with environmental regulation; and anticipated political or environmental challenges.

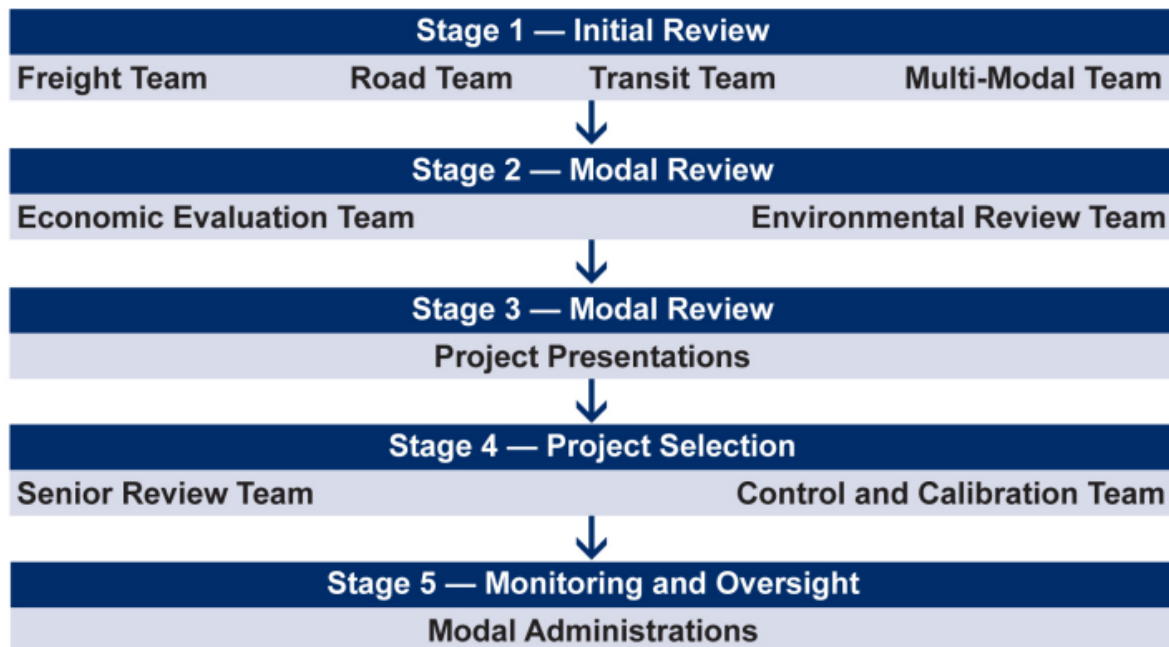


Figure 4: TIGER Grant Evaluation Process (Cavaretta, 2013)

After each round of TIGER grant, those projects that are awarded are published on U.S. DOT website. Projects’ modal administration, Rural/Urban, Project Type, Project Description and the amounts awarded are displayed on the website (see US DOT (2014b))

The authorizing legislation guiding **FTA and FHWA** programs was entitled the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). SAFETEA-LU requires the U.S. Department of Transportation to submit an annual report to Congress that includes the Secretary's evaluation, ratings, and a proposal on the allocation of funds among applicants for amounts to be made available to finance grants and loans for capital projects (FTA, 2013a). SAFETEA-LU mandates that proposed projects must receive FTA and FHWA's approval to advance from "alternatives analysis" to "preliminary engineering," and from "preliminary engineering" to "final design." (FTA, 2013a) Specifically, a project must achieve an overall rating of at least Medium in order to advance into each stage of development. Both agencies' evaluation includes a review of the information submitted to support each proposed project and the assignment of a rating to each evaluation criterion. Based on these criteria specific ratings, the agencies assigns candidate projects summary ratings for project justification and local financial commitment, and develops the overall project rating (FTA, 2013a).

FTA published the awarded programs on its website. Summary description of the projects are provided which includes Total Capital Cost, FTA's share of funding, Annual Forecast Year Operating Cost, and Opening Year Ridership Forecast (see FTA (2014)). Similarly, FHWA published the awarded projects which includes the projects' Cost, Funding Sources, and Forecast Benefits (see FHWA (2014))

### **Stakeholders Involvement**

In the United States, stakeholders' involvement takes place at planning and decision-making stages. U.S. DOT has published a nation-wide guide for stakeholders involvement for transportation decision-making (US DOT, 1996), which is aligned with SAFETEA-LU. SAFETEA-LU incorporates National Environmental Policy Act (NEPA) in transport decision-making in the U.S.. Since highway facilities, public transportation systems, airports, seaports and rail stations are almost and always planned, built, owned and operated by state and local governments (see 4.2.1), the guide is applied for almost all state DOTs.

As part of many provisions intended to streamline and expedite the environmental review process, SAFETEA-LU contains two sections, 6001 and 6002, that create a framework for early, pre-NEPA planning with the participation of agencies, stakeholders, and the public (Senner, 2011). Section 6001 requires MPOs to conduct early collaboration and integrated planning with agencies and stakeholders when Regional Transportation Plans are being developed. Section 6001 also directs that environmental impact mitigation activity be included in long-range planning (Senner, 2011). For mitigation to be explicitly incorporated, agencies and stakeholders developing transportation planning documents must participate in the planning process and consider the likely environmental impacts of modal and locational transportation infrastructure alternatives. Section 6002 defines "a pre-NEPA environmental review process, with timeframes for reviews, that requires the participating agencies and the public to be involved early in the planning process. It also provides funding those resource agencies can use to improve their planning and project review processes." (Senner, 2011, p. 503)

Thus, stakeholders' involvement only takes place at two points in practice, which are prior and after the CBA/MCA studies. An example of stakeholders' involvement prior to the CBA studies is during project development scoping phase in Minnesota DOT practice. During this phase, transport system deficiencies, which may be related to safety, traffic capacity, highway structure, and economic development, "may be identified by Minnesota DOT district or central office personnel, affected regions, counties, cities and/or township as well as individual citizens." (Minnesota DOT, 1999, p. 45) This phase is undertaken to determine what the project should entail and what potential impacts exist; and the level of complexity and need for widespread stakeholders involvement depends on what the critical deficiencies are, and the magnitude and potential impacts of the project.

On the other hand, after the CBA studies, the results are submitted for Environmental Assessment (see textbox NEPA and Transportation Decision-making) to develop Environmental Impact Statement (EIS). The EIS must summarize the scoping process, the results of any meetings that have been held, and any comments received during preliminary coordination (US DOT, 1996). Between the draft and final EIS, the state DOTs of transportation and FHWA must consider and respond to all substantive comments received on the draft EIS (Minnesota DOT, 1999). The final EIS must include copies of the comments received and the agency's responses.

#### 4.5 Transport project appraisal process in the United States in practice

In this section, the results from the interviews are discussed. In accordance to the sub-research questions, the results from the interviews are divided into six different clusters which are:

- Appraisal tools
- Problem Analysis
- Estimation of the effects
- Monetization of the effects
- Discount Rate
- Presentation
- Stakeholders Involvement

##### **Appraisal Tools**

From the interviews, the respondents have varying opinions on the best tools for ex-ante evaluation. Two respondents believe that CBA is the best tool since the general economic principles that are being employed by the federal government (mostly using CBA) are much more in-line with how they believe public money should be administered. One respondent argued that the best practice is to clearly distinguish the use CBA for funding 'go' or 'no go' decisions, from the use of CBA for prioritization. He claimed that CBA makes sense as a screener for funding decisions, as long as there are opportunities for other factors to also be considered, which may reverse that decision. However, he added, MCA makes more sense for prioritization of projects since it allows a broader set of factors to be considered. Another respondent stated that there is widespread appreciation among decision makers in government, and among some economists, that the narrow CBA practice has some severe limitations. The limitations are (1) incomplete coverage of social externalities which are difficult to accurately monetize, and (2) non-coverage of other socially important factors beyond efficiency – such as social equity among rich and poor, spatial equity of distribution, inter-generational equity, option value (enabling capacity for other future options) and cumulative effects (e.g., does the investment reinforce or undermine land use and social policies). He claimed that all of these factors are important to the public and to decision-makers.

### **Environmental Impact Assessment**

Two respondents highlighted the importance of Environmental Impact Studies in Project Development. According to one respondent, National Environmental Policy Act is the strongest in the world which is more powerful to decide a 'go' or 'no go' for a project. Furthermore, one respondent emphasized the importance of EIS as an overarching procedure to CBA. According to him, the incommensurable effects, which he believes should not be monetized, are seriously assessed in EIS. For instance, a project 'will be over' if it takes the Native American tribal lands, takes low-income areas, creates a lot of noise, or if it is planned on historical preservation sites.

### **Problem Analysis**

According to one respondent, programs are set up to have certain criteria. The projects are expected to demonstrate the criteria. So, the criteria set out the problem that particular programs want to have solved. There is no dispute among most of respondents when asked about the nature of this process except for one respondent, who highly disagreed with this process. According to him, these programs focus on increasing motor vehicle mobility (which one of the main criteria in any of the programs) rather than improving accessibility. Thus, it undervalues accessibility factors, besides vehicle travel speed such as the quality of alternative modes, roadway network connectivity, geographic proximity (and therefore development density and mix) and mobility substitutes such as telecommunications and delivery services. He added that this is particularly important because there are often conflicts between mobility and other accessibility factors, such as when wider roads reduce pedestrian access (called the "barrier effect") or when development occurs along urban fringe highways, which improves automobile access but reduces access by other modes.

### **Estimation of the effects**

Three respondents agreed with the OMB A-4 prescription of the period of estimation which is 20 years. All of them argued that it is for the purpose of handling uncertainties in the valuation; and estimation beyond 20 years will strain the credibility of the forecast. According to one respondent, the benefits beyond 20 years should be treated as residual value and only those projects that have unusually long life, for instance, tunnel project, can have estimation beyond than 20 years with lower discount rate. This is because such a project deals with inter-generational comparison of utility.

### **Monetization of the effects**

All respondents believe in monetization as much as possible. However, the practical degree of 'as much as possible' varies among the respondents. Firstly, one respondent believes that only primary (direct) effects should be monetized since, in practice, the monetization of higher level of effects does not converge on a consensus value or range yet. While, another respondent argued that only environmental benefits should not be monetized as opposed to two other respondents who believe that these benefits should be monetized. Secondly, two respondents suggested only quantifying hard-to-monetize effects such as wildlife, biodiversity and distributional effects. Finally, according to two respondents, as long as the uncertainty in the process is transparent, monetization helps more than anything else to help elucidate the significance/importance of an issue.

### **Discount Rate**

There is a diverging opinion among the respondents on the social discount rate prescribed by OMB. One respondent believes that 7 per cent SDR is risk-adjusted and another respondent thinks that it is not. Furthermore, one respondent stated that the two SDRs are not used to handle uncertainty and uncertainty should be treated in forecasting; but one respondent argues that it is a form of sensitivity analysis. According to him, in general it is suggested that public investment should be evaluated using 3 per cent discount rate, but the alternative way of looking at it is that there is always possibility that if this fund is not spent on public sector projects, it could be a return to the taxpayers as tax reduction. If the programs do not exist at all, then the funds might be returned to the taxpayers in the form of lower taxes; and in that case, arguably the appropriate discount rate is 7 rather than 3 per cent discount rate. So, the appropriateness of the 3 percent discount rate is somewhat uncertain and the use of two discount rates is also for sensitivity analysis purpose - that is if the projects have benefits greater than costs using 7 per cent discount rate, then it gives the practitioners a higher level of confidence that these are worthwhile projects<sup>17</sup>.

Three respondents agreed that the 7 per cent discount rate is too high; and one of them claimed that the OMB failed to revise this value since 1996. A respondent from a state level stated that the discount rate used in the state is based on the state's treasury bonds. Another respondent from a different state, however, states that the state's discount rate is based on general practice in that particular state. The reason is that the practitioners at the State DOT want a consistency rather than precision in an analysis.

### **Presentation**

On the state level, two respondents stated that CBA presentation is not a problem since the analysis and reviews are done internally. However, according to one respondent, this does not mean that the CBA can be too technically savvy. He added that it is his state governor's order that requires all the documents disseminated to the public to be published in 'plain speech' that is readable and verifiable for non-technical readers. One respondent gave an example on how to give a good explanation as the following,

*"When you talk about expanding the fiber optic cable, we are talking about extending communication that will allow connections between multiple sources. Then, you explain what those sources are. For us, in the transportation world, we know what VMS (Variable message-sign) is, but the public does not understand that VMS sign is connected to the traffic management center, which can be used for broadcasting public information for motorist information and how that relates weather conditions, how that relates to traffic situations – like collisions, delays, and news event."*

Notably, most of the respondents indicated that there is no issue in the independent reviews of the CBA results. On federal level, according to two respondents, the existence of Government Accountability Agency and Office of Inspector General which oversee all the decisions made in transportation investments is sufficient. However, one respondent would like the review to be done

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<sup>17</sup> Unfortunately, a few officials from the OMB, who were contacted for interviews, refused to participate. Their responses were that they are not familiar with the application of OMB A-4 in transportation field.

by an independent non-governmental organization. According to him, such an organization does exist in the United States, Eno Center for Transportation, but it does not review the decisions on case-to-case basis. On the state level, since almost all the CBA is conducted internally, according to two respondents, it is the responsibility of the senior technical teams to make sure the CBAs are properly conducted.

Moreover, for TIGER program, those applicants, who are unsuccessful for funding, are de-briefed by the technical review teams and the applicants. The strengths and weaknesses of the applications are discussed and applications can be submitted again for the next round of funding (Wells, 2014).

### **Stakeholders Involvement**

According to two respondents, stakeholders involvement is necessary prior to and after the result of CBAs is obtained. One of the respondents stated that challenges will arise if the authorities do not get buy-in from the stakeholders. For instance, if a solution is put forward, the stakeholders can go to their local representatives - the legislators - to challenge it if they do not agree with the solution; and the legislators can halt the project in response to the challenge. Another respondent disagrees with too much involvement from the stakeholders especially when the stakeholders challenge the analysis that they do not have adequate knowledge of. According to him, one can make a 4-Step Multi-Logic Modeling and makes it accessible to stakeholders for comments but that does not guarantee that the discipline will force the best methodological process because the lay stakeholders alone is inadequate and they need to be relying on their own expert.

In practice, one respondent argues that if a proper process is put in place, stakeholders' involvement is manageable. According to him, his department receives various comments which some of them are very useful. The department even reply back to the nonsensical comments.

## **4.6 Comparison Transport Project Appraisal between the Netherlands and the United States**

In this section, the similarities and differences between the two countries are described based on the methodology of the analysis and the utilization of the results for decision-making (see Table 9). Then, it follows the comparison of the practices from the practitioners' perspectives, utilizing interview results and selective results from Mouter (2014a). The following paragraphs summarize Table 9 and Table 10.

### **Appraisal tools**

- In the Netherlands, Social CBA is used as the ex-ante evaluation tool in the transport project appraisal process. However, various ex-ante tools are used namely, (1) Social CBA for TIGER program; (2) CBA for FHWA; (3) MCA for FTA, Minnesota and Washington State DOTs. Among the Dutch CBA practitioners, there is an agreement that CBA should have 'a' role in the appraisal of spatial infrastructure projects, but the American practitioners are still divided between the use of MCA and CBA.

Methods/Item	the Netherlands	the United States		
		FHWA & TIGER Program	FTA	State DOTs (Washington State & Minnesota)
<b>CBA</b>	√	√	X	X
<b>MCA</b>	X	X	√	√
<b>Appraisal horizon</b>	100 years	20 to 30 years	10 to 20 years	20 years
<b>Social discount rate</b>	1) Risk-free rate 2.5 % 2) Premium rate 3.0 % *only 1.5% for those projects that have irreversible effects	Default rate 7% with a variant of 3%		1) Minnesota: Government treasury bonds - 2 % 2) Washington State: Government treasury bonds - 4 %
<b>Monetized Non-marketable effects</b>	1) Value-of-time (VOT) 2) Reliability 3) Soil, Water, Nature 4) Emissions, Noise & Odor 5) Value-of-a-statistical life (VSL), Values of Injuries, Quality Adjusted Life Years (QALY) and Disability Adjusted Life Years (DALY)	1) Value-of-time (VOT) 2) Reduction in oil dependence & Energy efficiency 3) Emissions 4) Value-of-a-statistical life (VSL) & Values of Injuries		1) Value-of-time (VOT) 2) Value-of-a-statistical life (VSL) & Values of Injuries
<b>Non-Monetized Non-marketable effects</b>	Archeology and Historical sites	Mobility & Connectivity	1) Number of Ridership 2) Number of linked trips 3) Land Use 4) Economic Development	1) Minnesota - Land Use , Water, Minerals, Flora Fauna, Ambient, Noise, Energy Resources, Historical and Geological significance 2) Washington State - Land Use, Wetlands, Modal Integration, Water Quality and Permitting

Indirect effects	Employment	Increase in property Values (indirect effects)	None	
Measures of profitability	Net present values (NPV)	1) Net present values (NPV) 2) Benefit-cost-ratio (BCR) 3) Internal Rate of Returns (IRR)	Cost-effectiveness	1) Net present values (NPV) 2) Benefit-cost-ratio (BCR) 3) Internal Rate of Returns (IRR)
Responsibility bodies to conduct CBA	1) Central Planning Bureau (Government body) 2) Private Consultants	1) State DOTs 2) MPOs		State DOTs (Washington State & Minnesota)
Responsibility bodies to review CBA	Central Planning Bureau (Government body)	Experts in Transports Modes (Transit, Road, Freight and Multimodal), Environment, and Economy		
Formal use of result in decision-making	Prior to 2011, CBA was used to assess usefulness and necessity of a project. After 2011, CBA is used to assess different alignments of the projects.	1) CBA is one of the main inputs of the evaluations 2) Projects are ‘shovel ready’ for TIGER Program	Cost-effectiveness in CBA is used with other qualitative measures such as Land Use and Economic Policies	1) CBA results are used in MCA in Transport Improvements Program (TIP) 2) MCA results are used as inputs Environmental Impact Assessment prior to decision-making
Disclosure of Content Evaluation	Most of the CBAs reports are available on the government website	Publish only the projects' scores but not full CBA/MCA reports		Publish all the technical reports on project specific websites
Stakeholders involvement	Effects Arena (discussion on what effects to be considered)	1) TIGER - no stakeholders involvement 2) FHWA cooperates with Environmental Protection Agency - stakeholders involvement prior and after CBA/MCA reports	FTA cooperates with Environmental Protection Agency - stakeholders involvement prior and after CBA/MCA reports	State DOTs cooperates with Environmental Protection Agency - stakeholders involvement prior and after MCA reports

Table 9: Summary of Methodology of Analysis & Utilization of the results in appraisal process between the Netherlands and the United State

	the Netherlands	the United States
<b>Appraisal tools</b>	1) CBA must have 'a' role in the appraisal of spatial-infrastructure projects 2) Prefer to use CBA to support 'go' or 'no go' decisions in the absence of other ex-ante evaluation tools	1) Divided between MCA and CBA as the best tool 2) Half of the respondents prefer CBA for 'go' or 'no go' and another half of the respondents prefer MCA for decision-making
<b>Problem Analysis</b>	Concerning spatial-infrastructure projects, the Dutch practitioners simply miss a high quality independent problem analysis in both CBA and decision-making process	Criteria set out the problem that particular programs want to have solved - no dispute among the respondents on this process.
<b>Estimation of the effects</b>	Effects in the Dutch practice are frequently estimated for one future year and, subsequently, the transport effects for the other years in the future are extrapolated.	All respondents agreed with 20-year period of estimation prescribed by the federal government arguing that it is a good way to handle uncertainties
<b>Monetization of the effects</b>	Most of the respondents experience issues of: 1) Costly time and money to conduct research estimating WTP 2) National standard numbers are incorrect for specific cases	All respondent believe in monetization with varying degree of: 1) Only primary effects should be monetized 2) Environmental benefits should not be monetized; and these effects should be quantified.
<b>Discount Rate</b>	1) Discount rate for negative externalities is too high 2) Risk premium of 3% is too rigidly applied - not applicable to specific cases	1) No consensus on what 7% discount rate entails (risk-adjusted or not) 2) 7% discount rate is too high 3) Contradiction if discount rates of 3% and 7% are to be used in sensitivity analysis
<b>Presentation of CBA reports</b>	Respondents stated that the quality of CBA reports is low and it should be enhanced - 1) Abundance of jargon; 2) 'False certainties' in the conclusions; 3) Unclear what are the effects are and are not being considered; 4) Only using one scenario in estimating project effects	Respondents concurred that the presentation CBA reports in the US practice faces no issues since the reports are reviewed by the technical experts either internally or externally.

<b>Stakeholders Involvement</b>	Respondents perceives CBA as an instrument encouraging different stakeholders to cooperate	<p>Diverging opinions about stakeholders involvement although it is compulsory prior/after CBA reports.</p> <p>1) One side claimed that lay public (a part of the stakeholders) is inadequate to understand complicated methodology in CBA</p> <p>2) One side claimed that it is necessary to include public so there will not be any opposition when the project has commissioned</p>
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Table 10: Comparison of the practitioners' perspectives on transport project appraisal practices (selective topics)

- In the United States, the ex-ante tools are tightly connected to the funding and planning for each program and state DOT. For instance, project prioritization takes place at Transport Improvement Program (TIP) on the state level DOT, which includes criteria that are not assessed in CBA such as Land Use and Economic Policies. Thus, MCA is applied in those state DOTs.

#### **Appraisal horizon**

- The appraisal horizon applied in the Dutch CBA is 100 years, while it is 10-30 years in the American practice. The American practitioners all agreed with the appraisal horizon used in the analysis arguing that it is a good way to handle uncertainties.

#### **Social Discount Rate (SDR)**

- The SDRs applied in the Dutch CBA differs greatly than the American practice on the application of lower rate for negative externalities or irreversible effects in the Dutch CBA.
- The SDRs are also used in performing sensitivity analysis in both countries' practices.
- Practitioners from both countries think that the rates applied in the CBA are high, with an exception of the state level practitioners in the United States. These practitioners do not ponder much of the rates used as according to one of them "We use 4 % because everybody is using it." (Neeley & Izakawa, 2014)

#### **Monetization of Non-marketable effects**

- Almost all the conventional transports effects are included in both countries' practices, namely, Value-of-time, air pollutant emissions, Value-of-a-statistical life (VSL), and Value-of-injuries. However, the Dutch CBA also includes Quality Adjusted Life Years (QALY) and Disability Adjusted Life Years (DALY).
- The Dutch CBA practice differs than the American practice by the inclusion of Reliability as an indicator, which is not included in any other evaluation tools in the United States.
- Soil, water, nature, land use, and wetlands are included in different evaluation tools in both countries' practices such as Environmental Impact Assessment and MCA (in the U.S.) or CBA in the Netherlands.
- The Dutch CBA practitioners mostly experience issues of the cost in time and money to conduct research estimating Willingness-to-pay (WTP) on these effects and the incorrectness of the national numbers in specific cases. Meanwhile, the American practitioners believe in monetization of these effects to a various degree. Mouter (2014a) observes that the Dutch CBA practitioners do not perceive VSL as a substantive issue but some American practitioners believe that this is an issue as some of them believe that this effect should not be monetized.

#### **Indirect Effects**

- The Dutch CBA definitely has an advantage by operationalizing indirect effects (agglomeration effects), especially, effect on Employment, while the American practitioners are still in the early stage of including indirect effects. According to one respondent from the American practitioners, "the inclusion of indirect effects in American practice is very early days. I would say for the most parts that is still a working progress. There is a lot of research going on" (Lewis, 2014); and this is concurred by another respondent stated that "indirect

effect is something that has been getting a lot of funding in the US, and it is the weakest link in the chain as references to the British research..”(Weisbrod, 2014)

### **Responsibility bodies to conduct and review the analysis**

- In the Netherlands the CBA is conducted by Central Planning Bureaus (CPB) or private consultants; and the analyses are reviewed by CPB. Meanwhile, in the United States almost all the analyses and reviews are done internally by the State DOTs, MPOs, or central government transportation modes, such as FTA and FHWA themselves. The internal analyses and reviews done in the United States face no issues as these are done by transportation experts (Weisbrod, 2014) (for instance see Figure 4).

### **The use of analysis result is decision-making**

- In the Netherlands, prior to 2011, CBA was used as to assess usefulness and necessity of a project, for instance, ‘is this project necessary?’ Then, CBA’s formal role changes as to assess different alignments of a project, for instance, ‘should we build a new road through the city around it?’<sup>18</sup> (Mouter, 2014b). In the United States, CBA is used as a main input in together with other criteria for decision-making. For instance, in TIGER program, CBA is used as an input to be assessed by different transport modes, environment, and engineering experts.
- CBA/MCA results are used as inputs for Environmental Impact Assessment (EIA), in the United States. The respondents in the interviews highlighted the importance of this process since EIA covers many effects that are not measured in CBA/MCA, such as archeological effects. According to one respondent, many projects get ‘blocked’ at Environmental Impact Assessments.

### **The disclosure of content of evaluation**

- The Dutch CBAs are not publicly published, although a few CBAs are available at government website<sup>19</sup>. In the United States, for TIGER, FTA and FHWA programs, projects’ scores are published in the respected bodies. On the state-level, in most of the State DOTs, it is a statutory requirement to publish all CBA/MCA, technical reports, and Environmental Impact Assessment results on websites dedicated to the projects for stakeholders’ perusal, comments and inputs.

### **Quality of CBA/MCA results and the presentation**

- CBA/MCA practitioners from both countries face challenges of low quality of CBA/MCA and the presentation as described in Table 10. Interestingly, for TIGER program, those applicants, who are unsuccessful for funding, are de-briefed by the technical review teams and the applicants. The strengths and weaknesses of the applications are discussed and applications can be submitted again for the next round of funding (Wells, 2014).

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<sup>18</sup> Note that the change of the CBA role in decision-making in the Netherlands does not violate theoretical foundation of CBA as explained in 3.2.1.

<sup>19</sup> For instance, ECORYS website < <http://www.ecorys.nl/nl/projects/>>

### **Stakeholders' involvement**

- The Dutch CBA practice includes Effects Arena, which is a discussion platform on effects to be considered in the analysis. Meanwhile, in the United States, stakeholders' involvement takes place primarily in the EIA prior to/after the analysis is conducted.
- The Dutch CBA practitioners perceive that CBA is an instrument to encourage different stakeholders to cooperate. However, despite the mandatory requirement to include stakeholders prior to/after CBA/MCA, the American practitioners have diverging opinions on stakeholders' involvement on the basis that (1) lay public is inadequate to understand complicated methodology in CBA/MCA; and (2) opposition from the stakeholders can be avoided if they are included in the process.

## Chapter 5: Conclusion, Recommendations, Limitations and Further Research

This chapter represents part IV of the thesis. The differences and commonalities in the methods of the United States are used to reflect on the Norwegian appraisal practice. The structure will follow the scheme used for the analysis, i.e. first there will be reflections on the general methods applied, followed by the way the evaluations are used in the decision-making. After this, a summary and conclusions are given. Finally, limitations and further research areas are pointed out.

### 5.1 Conclusion

By accomplishing this thesis, the introductory mentioned goals of the thesis can be rated as fulfilled. Chapter 1, 2 and 3 built the basis and theoretical foundation for subsequent chapters by giving an outline with the most commonly used appraisal methods, CBA and MCA.

Chapter 4 answered the research questions A and B concerning the analysis of appraisal methods and the utilization of the results for decision-making in the United States. This covers the federal level discretionary program (TIGER), highways and freights (FHWA), and transit (FTA) programs, as well as two state Department of Transportation (Minnesota and Washington State DOTs). The main research question, which was **‘By comparing the similarities and differences in transport projects appraisal between the Netherlands and the United States, how can both countries learn from each other?’** was answered as the following:-

- In the United States, Social CBA is used predominantly in discretionary program and FHWA, while Combinatorial of CBA and MCA is used by FTA and state DOTs. Meanwhile, Social CBA is used in the Netherlands. Furthermore, additional methods are used to cover further impacts of transportation investments in the United States such as Environmental Impact Assessment and Transportation Improvement Plans.
- Regarding the methodology of analysis and with an exception of the inclusion of Reliability indicator in the Dutch CBA, the main commonalities are the inclusion of the conventional transport indicators (Value of Time (VOT), Value-of-a-statistical life (VSL), Value-of-Injuries and air pollutant emissions).
- The methodological basis of effect estimations, which is how the estimations of the effects is conducted, is similar in both countries’ practices.
- The degree of effects monetization, which is the accounting techniques used, is also similar in both countries’ practices.
- On content-related basis, the differences occur at (1) the use of lower discount rate for irreversible effects in the Dutch CBA; (2) the appraisal horizon; (3) the inclusion of other plans and policies (for instance Land Use and Economy) in the American MCA practice.
- On process-related basis, the main differences include (1) the responsibility bodies conducting and reviewing the analysis; (2) disclosure of content of evaluation; (3) stakeholders’ involvement.

### 5.2 Recommendations

#### 5.2.1 Issues in the Dutch CBA practice in literature (revisited)

Once the similarities and differences between both countries’ transport project appraisal are examined, an analysis of the need and usefulness of any proposed recommendations is made. For

such a purpose, it is necessary to revisit 1.2 (Problem Definition). It is the intention of the thesis to recommend solutions to the problems stated in the section. For brevity purposes, the following Table 11 summarizes section 1.2.

CBA	Theme	Explanations
Process-related	Presentation	1) An improvement has to be made on transparency benchmark that it should be comprehensible for non-welfare economists (Annema et al., 2007; Beukers et al., 2014; Mouter et al., 2013b).
		2) Conclusions in CBA reports are stated as 'false certainties'. As a result readers of CBA reports are insufficiently aware of the contestability of conclusions (Mouter et al., 2013b).
		3) CBA reports do not sufficiently make clear which effects are and are not taken into account (Mouter et al., 2013b).
		4) It is not possible to check the way effects are computed in the CBA reports because the reports do not elaborate in detail on computations (Mouter et al., 2013b).
	CBA in decision-making	5) A controversy pertaining to the role of the CBA in the decision-making in this environment among the economists and spatial planners. The economists think that the CBA's role is too weak as opposed to the spatial planners who think of the opposite (Mouter et al., 2013b); and insufficient communication among the economists and spatial planners (Beukers et al., 2014).
		6) The criteria for testing CBA reports are unclear and process of testing is unstructured (Beukers et al., 2014).
Content-related	Estimation of the effects	7) Weaknesses with respects to methods and assumptions (Annema et al., 2007).
		8) The estimations of travel time savings for project alternatives are contestable (Mouter et al., 2013b).
		9) Intangible effects are not or not sufficiently taken into account; and based wishful thinking of project initiators rather than on sound research (Mouter et al., 2013b).
	Uncertainty	10) Uncertainties were not being reflected in different scenarios and sensitivity analysis (Annema et al., 2007; Mouter et al., 2013b)
		11) Scenarios used in the Dutch practice are often incorrect scenarios for the future and they do not relate to the context of the specific project alternatives under scrutiny in the CBA (Mouter et al., 2013b).
		12) It is a problem that some CBAs only use one scenario to estimate the project effects (Mouter et al., 2013b).

Table 11: Dutch CBA issues in practice

### 5.2.2 Recommendations

The following recommendations are made perceiving that they may rectify the issues in the table above:-

#### Process Related

- The **de-briefing procedure** between the technical review teams and unsuccessful applicants in TIGER program is an interesting procedure for the Dutch CBA practitioners.

This could enhance the use of CBA in the decision-making process as the technical review teams could guide the applicants on how to conduct a good CBA rather than leaving the frustration of using the tool to the applicants. By implementing this procedure, almost all the **presentation issues** could be rectified. The two-way communication between the technical review team and the project initiators on the CBA reports is believed to improve the CBA reports by addressing those insufficient information, contestability of the conclusions, effects that are/are not taken into account; and missing details in the computation.

However, it has to be made clear that this procedure is to improve the reporting and not for the project initiators to fudge in information. Furthermore, further research has to be conducted on how the project initiators are not manipulating this procedure to produce a weak CBA report in the first round.

- ii. Regarding **stakeholder involvement** in the CBA analysis, the Dutch CBA practice is definitely more advanced by including the Effect Arena, prior to the full analysis. However, the process the American practice includes once the report is published (all the technical reports have to be published online for public perusal, comments, and inputs), is something worth to learn by the Dutch CBA practitioners. Specifically, in Hear Every Voice policy, stakeholders' input and comments are distinguished and filtered. Those useful inputs are considered in the project's design; and feedbacks are given to those rejected comments/inputs. This recommendation is also deemed to rectify the **presentation issues** as the project initiators will strive to produce CBA reports that are comprehensible to the lay readers.

Though, further research on the explicit way to include this procedure in the decision-making process has to be conducted. How the inputs/comments are obtained and taken into account in the final CBA reports should be explicitly spelled out in the process.

### **Content Related**

- i. The **appraisal period** used in the Dutch CBA is in comparison to the United States relatively long, which is 100 years (Ministry of Environment & Infrastructure 2012). As mentioned (see 4.5), in the United States practice, the appraisal period is clearly defined that is in the range of 10-30 years to control the uncertainties. The American practitioners stated that estimation beyond 20 years will restrain the credibility of the forecasts and benefits beyond that period should be treated as residual values. Only those projects that have unusually long life can have estimation period more than 20 years, but with lower discount rate, since these projects deal with intergenerational comparison of utility.

Adjusting the appraisal horizon project to justify the need to control uncertainties in the analysis is believed to handle an uncertainty issue (item 11 in the table above). The instance of limiting the appraisal horizon project to 20-year period could reduce the burden to the project initiators to generate credible estimates for long-period (i.e. 100-year) effects. Plus, it

may also assist the project initiators in elucidating realistic scenarios. Therefore, for the Dutch practice, it might be worth to think about adjusting the appraisal horizon project to justify the need to control uncertainties in the analysis; or at least, to ponder the reason 'why' it is currently set at 100 years.

- ii. In the United States, almost all the guides (TIGER, FHWA, FTA, Washington State and Minnesota DOTs) include at least one criterion of evaluation pertaining to **transports, land use, or economic policies and plans**. Such an inclusion is in-line with the way ex-ante evaluation should be conducted in theory (see Figure 2 in 3.1). Although, it is advised in the Dutch CBA general guide, under Uncertainty section that Policy Uncertainty should be evaluated (see 3.6.1), this is hardly put in practice. Thus, it is recommended there should be inclusion of policies related/affected to/by the projects, explicitly in the Dutch CBA.

Not all the issues addressed in Table 11 are covered in the recommendations of improvement above, especially the use of CBA in the decision-making. Notably, the issues on the estimation of the effects faced by the Dutch CBA practitioners are similar to the American practice. Thus, on the basis of comparison (only for two countries), the Dutch CBA practice could be considered as well-established.

On the whole, a systematic comparison of the appraisal methods for transport projects between the Netherlands and the United States has not been done before. Therefore, this thesis represents a relevant contribution to the field of study.

### 5.3 Limitations & Further Research

As it became clear throughout the thesis, there are still some problematic and challenging areas concerning the topic of this work which are reasonable to be in the focus of further research. Therefore, this section states the limitations of this thesis as well as gives an insight on further research.

One of the challenges was to achieve thesis Validity, Reliability and Objectivity as discussed in 2.3. Concerning Validity, the difficulty arises in finding data that correctly matched the theoretical framework set in 3.1, specifically, finding the guides from both countries that underpin the connections among the components in Figure 2. Then, regarding Reliability, the author believes that the process of obtaining the guides used in this thesis can be repeated leading to the same results. However, the data collected from in-depth interviews may be different due to (1) inability to contact the authors of the guides; and (2) the fast-moving development in transport and spatial planning. Finally, concerning Objectivity, the author can confirm that my personal values or theoretical inclinations do not influence the process, for instance, by also gaining views from the antagonist of CBA.

Regarding reliability, it was difficult to obtain respondents for in-depth interviews. There is a lack of interest among the contacted respondents as they think that they cannot give any contributions to the research. For instance the replies I got from three of the officers from Office of Management Budget in the United States were mainly stating that they are not familiar with the application of OMB A-4 in transportation sector.

Another challenge was the limited availability of official guides on the Utilization of the results of the analysis from both countries, specifically the guides on how CBA results are used formally in practice

and other criteria included for decision-making. Adding to this challenge was that almost all the guides from the Dutch practice are in Dutch. I am incapable of understanding Dutch and had to use translation software and help from a Dutch native speaker to translate the documents.

Another main limitation in drawing conclusion from this thesis was the inability to cover the wide state-level practice in the United States. Although some information on the general practice in all the states was made in 4.2.4, detail descriptions of the appraisal practice were only made for Minnesota (Midwest) and Washington State (West Coast) DOTs. Thus, taking the similar framework of this thesis, further research can be done analyzing transport projects appraisal in other states in the United States. Furthermore, as indicated in 2.5.2, one respondent from the American camp claimed that there is a collaborative work between the United State Department of Transportation and the Ministry of Infrastructure and Environment (Rijkswaterstaat) concerning the topic of the thesis. It is the author's opinion that if such collaboration exists, mobilization of the resources from both parties should be done in the future research.

As emphasized in 4.5, Environmental Impact Assessment plays an important role in ex-ante evaluation for transport projects in the United States. It acts like a 'red flag' procedure in the process. It is beyond the scope of the thesis to study this process. Thus, further research can be conducted to gain insight into the dynamic of MCA/CBA and EIA for a comprehensive understanding of the transport project appraisal in the United States.

As a whole, taking into consideration the usefulness of this topic in transport projects appraisal, academic researchers and transports/spatial planners could use the same framework to compare practices in different nations. Furthermore, further specification on comparative analysis can also be done, for instance, an implementation of high-speed train in Norway. For such a research, implementation of high-speed train in different nations can be analyzed taking into account the appraisal tools used, effects included, and the use of the tools in the decision-making process.

## 5.4 Reflections

Prior to reaching to the thesis research topic, I have been contemplating several other topics, especially participatory process in the Dutch CBA. This came into my interest, firstly, after CBA was introduced to me when I was studying the North-South Line Amsterdam (Noord-zuidlijn) Metro project. Three reports, which are Veerman (2009), Decisio (2008) and ECORYS & Infram (2009), give three different total estimated benefits for the projects. The differences piqued my interest to look into the Dutch CBA guides and made me think about contested information<sup>20</sup>, which could be an interesting topic to look into from participatory process' angle. Secondly, Impact Assessment & Technology Development course has enhanced my understanding of CBA parallel with other impact assessment tools such as Social Impact Assessment and Environmental Impact Analysis. Putting together these impact assessment tools, I still had the idea exploring ways to include participatory process into the Dutch CBA. Thus, I conducted literature review on participatory process in CBA.

However, the literature review has led me to analyzing the overall framework of the Dutch CBA, which is facing several issues as indicted in 1.2. Rather than just looking into participatory process, I

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<sup>20</sup> Information is contested when both technical and organizational complexity is high. In this project, the size of North-South Line project and the complexity of the project and advisory team characterized the contested information reported in those three reports.

changed the direction into improving the framework in general. With the help from my supervisor, I formulated the research questions and methodology to answer them.

The last sub-research question (*To which extent are stakeholders involved before, during and after the CBA?*) still gave me a good chance to look into participatory process in the Dutch CBA. Now, after concluding the thesis, I am still not satisfied with the answer for this question (see 5.1). Had I have to do this differently and still within the Dutch CBA, I would specifically concentrate on the inclusion of participatory process in the Dutch CBA because it is the topic was heavily emphasized mentioned in the in-depth interviews.

Regarding the methodology, the choice of desk research and in-depth interview seem to be the most appropriate to answer the research questions as mentioned in 2.5. The thesis project was scheduled in a way that desk research would be conducted prior to in-depth interview. However, this could have been simultaneously. Firstly, it was difficult to find guidelines/publications/reports during the desk research. Almost half of the guidelines used to answer the research questions are 'grey literature'<sup>21</sup>, which were provided by the respondents during the interviews. The results from the desk research (section 4.1 and 4.2) had to be rewritten multiple times due to new information from the interview. Secondly, the time scheduled for in-depth interviews, which included contacting the potential interviewees, formulating interview questions, arranging the interviews, and transcribing interview, was underestimated. Thus, had both desk research and in-depth interview were conducted simultaneously, the research process would have been smoother.

The comparison of the transport project appraisal practices between both countries does not only lead to recommendations for the Dutch CBA practice but also the American practice. The recommendations are as the following:-

- Although, almost all the conventional transports effects are included in both countries' practices, namely, Value-of-time, air pollutant emissions, Value-of-a-statistical life (VSL), and Value-of-injuries. The Dutch CBA inclusion of **Quality Adjusted Life Years (QALY)** and **Disability Adjusted Life Years (DALY)** is in-line with the advice by (Baker et al., 2010) on QALY and Hofstetter and Müller-Wenk (2005) on DALY. The earlier emphasizes that in assessing new technology, in health economic, typically QALY is adopted (Baker et al., 2010). The latter stated that the DALY accounting system supports the systematic monetization and the selection of relevant health endpoints, and that it may well be justified for Life Cycle Assessment purposes to perform some novel primary willingness to pay studies (Hofstetter & Müller-Wenk, 2005). Thus, the inclusion of these indicators is worthy of attention from the American practitioners.
- The American practitioner may want to include **Reliability** indicator in the ex-ante evaluation of transport projects appraisal. The inclusion of reliability in the Dutch CBA practice is justified since several studies strongly suggest that reliability (understood as punctuality) of public transport is crucial to leverage the demand (Bates et al., 2001; Hensher et al., 2003; Paulley et al., 2006). Plus, in their qualitative review, Redman et al. (2013) claim that reliability is the most important quality attribute of public transport for users.

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<sup>21</sup> Grey literature is informally published written material (such as reports) that may be difficult to trace via conventional channels such as published journals and monographs because it is not published commercially or is not widely accessible.

- In the United States, TIGER program was initiated by the federal government to promote the full-fledged CBA in transport project appraisal. The inclusion of Livability criterion is one of the federal government's effort to include **wider (indirect) economic benefits** in the ex-ante evaluation. However, according to the American practitioners, the operationalization of this indicator is still immature. This can be adopted from the Dutch CBA practice which included indirect effects (agglomeration effects) such as employment.
- The American transports practitioners could learn from the Dutch practice on how to include the stakeholder involvement in the CBA practice, such as Effect Arena, rather than just the transport planning in the current practice.

## References

- AASHTO. (2010). *User and Non-User Benefit Analysis for Highways* (3 ed.). Washington, DC, USA: American Association of State Highway and Transportation Officials.
- Ackerman, F., Heinzerling, (2002). Pricing the Priceless. Cost-Benefit Analysis of Environmental Protection. In G. E. L. a. P. Institut (Ed.), (pp. 1-35). Washington, DC: Georgetown University Law Center.
- Adams, T. M., & Marach, A. (2012). Using Benefit-Cost Analysis for Evaluating Discretionary Transportation Infrastructure Investment (pp. 1-32). Madison, Wisconsin, USA: National Center for Freight and Infrastructure Research and Education (CFIRE).
- Annema, J. A., Koopmans, C., & Wee, B. v. (2007). Evaluating Transport Infrastructure Investments: The Dutch Experience with a Standardized Approach. *Transport Reviews*, 27(2), 125-150. doi: 10.1080/01441640600843237
- Baker, R., Bateman, I., Donaldson, C., Jones-Lee, M., Lancsar, E., Loomes, G., . . . Wildman, J. (2010). Weighting and valuing quality-adjusted life-years using stated preference methods: preliminary results from the Social Value of a QALY Project. *Health Technology Assessment*, 14(27), 2-133.
- Bates, J., Polak, J., Jones, P., & Cook, A. (2001). The Valuation of reliability for personal travel. *Transportation Research Part E: Logistics and Transportation Review*, 37(2001), 191-229.
- Bell, E., & Bryman, A. (2007). *Business Research Methods* (2nd ed.). Oxford, the UK: Oxford University Press.
- Berechman, J. (2009). *The Evaluation of Transportation Investment Projects*. New York, New York, USA: Routledge.
- Besseling, P., Groot, W., & Verrips, A. (2004). Economic Assessment of Mobility (In Dutch: Economische toets op de Nota Mobiliteit) *CPB Document 65*. The Hague, the Netherlands: Central Planbureau.
- Beukers, E., Bertolini, L., & Te Brömmelstroet, M. (2012). Why Cost Benefit Analysis is perceived as a problematic tool for assessment of transport plans: A process perspective. *Transportation Research Part A: Policy and Practice*, 46(1), 68-78. doi: 10.1016/j.tra.2011.09.004
- Beukers, E., Bertolini, L., & Te Brömmelstroet, M. (2014). Using cost benefit analysis as a learning process: identifying interventions for improving communication and trust. *Transport Policy*, 31, 61-72. doi: 10.1016/j.tranpol.2013.12.002
- Blincoe, L. J., Miller, T. R., Zaloshnja, E., & Lawrence, B. A. (2014). The economic and societal impact of motor vehicle crashes, 2010 (Report No. DOT HS 812 013). Washington, DC: National Highway Traffic Safety Administration, Federal Railroad.
- Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weime, D. L. (2011). *Cost Benefit Analysis: Concepts and Practice* (4th ed.). Upper Saddle River, NJ, USA: Pearson.
- Bots, P. W. G., & Lootsma, F. A. (2000). Editorial: Decision Support in the Public Sector. *Journal of Multi-Criteria Decision Analysis*, 9(1-3), 1-5.
- Boyce, C., & Neale, P. (2006). *Conducting In-Depth Interview: A Guide for Designing and Conducting In-Depth Interviews for Evaluation Input P. I. Series* (Ed.) (pp. 1-15). Retrieved from [http://www.cpc.unc.edu/measure/training/materials/data-quality-portuguese/m\\_e\\_tool\\_series\\_indepth\\_interviews.pdf](http://www.cpc.unc.edu/measure/training/materials/data-quality-portuguese/m_e_tool_series_indepth_interviews.pdf)
- Bristow, A. L., & Nellthorp, J. (2000). Transport project appraisal in the European Union. *Transport Policy*, 7(2000), 51-60.
- Browne, D., & Ryan, L. (2011). Comparative analysis of evaluation techniques for transport policies. *Environmental Impact Assessment Review*, 31(3), 226-233. doi: 10.1016/j.eiar.2010.11.001
- Burgess, D. F., & Zerbe, R. O. (2011). Appropriate Discounting for Benefit-Cost Analysis. *Journal of Benefit-Cost Analysis*, 2(2). doi: 10.2202/2152-2812.1065
- Burgess, D. F., & Zerbe, R. O. (2013). The most appropriate discount rate. *Journal of Benefit-Cost Analysis*, 4(3). doi: 10.1515/jbca-2013-0016

- California DOT. (2007). *Life Cycle Benefit Cost Analysis Model*. Sacramento, CA, USA: California Department of Transportation Retrieved from [http://www.caltrans.ca.gov/hq/tpp/offices/eab/LCBC\\_Analysis\\_Model.html](http://www.caltrans.ca.gov/hq/tpp/offices/eab/LCBC_Analysis_Model.html).
- Cavaretta, A. (2013). Lessons Learned from the TIGER Discretionary Grant Program. Washington. DC: Eno Center for Transportation.
- Christianson, D. (2014, 06/06). [Telephone Interview by the author].
- Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A Garbage Can Model of Organizational Choice. *Administrative Science Quarterly*, 17(1-25).
- CPB, MNP, & RPB. (2006). Prosperity and Environment: A scenario study for the Netherlands in 2040 (In Dutch: Welvaart en Leefomgeving: een scenariostudie voor Nederland in 2040) *CPB Bijzondere Publicatie 64*. The Hague, the Netherlands.
- Damart, S., & Roy, B. (2009). The uses of cost-benefit analysis in public transportation decision-making in France. *Transport Policy*, 16(4), 200-212. doi: 10.1016/j.tranpol.2009.06.002
- de Bruijn, J. A., & Heuvelhof, E. F. t. (2002). Policy analysis and decision making in a network: how to improve the quality of analysis and the impact on decision making. *Impact Assessment and Project Appraisal*, 20((4) December), 232-242.
- de Jong, M. (1999). *Institutional Transplantation: How to adopt Good Transport Infrastructure Decision Making Ideas from other Countries?* Delft, the Netherlands: Eburon Publishers.
- de Jong, M., & Geerlings, H. (2003). Exposing weaknesses in interactive planning: the remarkable return of comprehensive policy analysis in The Netherlands. *Impact Assessment and Project Appraisal*, 21(4), 281-291. doi: 10.3152/147154603781766149
- Deardorff, A. (Producer). (2010). Deardorff's Glossary of International Economics. Retrieved from <http://www-personal.umich.edu/~alandear/glossary/w.html>
- Dreyer, S.-B. (2010). *Comparative analysis of the quality of appraisal practices for high-speed railway investment projects in Europe: A comparison of Norway, Sweden, Germany, the UK and Spain*. (Master of Science in Logistics), Molde University College, Molde, Norway.
- Eijgenraam, C. J. J., Koopmans, C. C., Tang, P. J. G., & Verster, A. C. P. N. (2000). Evaluation of Infrastructural Projects: Guide for Cost-Benefit Analysis. The Hague, the Netherlands: Centraal Planbureau; Nederlands Economisch Instituut (now ECORYS).
- European Commission. (2008). *Guide to Cost-Benefit Analysis of Investment Projects* Directorate General Regional Policy Retrieved from [http://ec.europa.eu/regional\\_policy/sources/docgener/guides/cost/guide2008\\_en.pdf](http://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf).
- FAA. (1999). *Federal Aviation Administration (FAA) Airport Benefit-Cost Analysis Guidance*. Washington, D.C., USA: Office of Aviation Policy and Plans, Federal Aviation Administration Retrieved from [http://www.faa.gov/regulations\\_policies/policy\\_guidance/benefit\\_cost/media/1999\\_FAA\\_Airport\\_Benefit\\_Cost\\_Analysis\\_Guidance.pdf](http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/1999_FAA_Airport_Benefit_Cost_Analysis_Guidance.pdf).
- FHWA. (2003). *Economic Analysis Primer*. Washington, D.C., USA: U.S. Department of Transportation, Federal Highway Administration, Office of Asset Management Retrieved from <http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer.pdf>.
- FHWA. (2008). *Cost Benefit Analysis*. Washington, D.C., USA: U.S. Department of Transportation, Federal Highway Administration, Office of Asset Management Retrieved from [http://ops.fhwa.dot.gov/freight/freight\\_analysis/cba/index.htm](http://ops.fhwa.dot.gov/freight/freight_analysis/cba/index.htm).
- FHWA. (2014). *Federal Highway Administration: Project Profiles*. Washington, D.C., USA: Federal Highway Administration Retrieved from [http://www.fhwa.dot.gov/ipd/project\\_profiles/](http://www.fhwa.dot.gov/ipd/project_profiles/).
- FHWA, & US EPA. (2006). *Federal Highway Administration (FHWA) and the National Environmental Policy Act NEPA*. Washington, D.C., USA: FHWA & US EPA Retrieved from <http://www.sgcity.org/traffic/upload/NEPA.pdf>.
- FRA. (1997). Methodology for Comparisons of Benefits and Costs. In F. R. Administration (Ed.), *High Speed Ground Transportation for America*. Washington, D.C., USA: Federal Railroad Administration.

- FTA. (2006). *Guidance on New Starts Policies and Procedures: Definition of Alternatives - Draft: Definition of Alternatives*. Washington, D.C., USA: Federal Transit Administration Office of Planning and Environment, US Department of Transportation Retrieved from [http://www.fta.dot.gov/12304\\_9717.html](http://www.fta.dot.gov/12304_9717.html).
- FTA. (2008). *Reporting Instructions for the Section 5309 New Starts Criteria*. Washington, D.C., USA: Federal Transit Administration, Office of Planning and Environment Retrieved from [http://www.fta.dot.gov/documents/FY10\\_Reporting\\_Instructions\\_FINAL\\_7\\_7\\_2008\(1\).doc](http://www.fta.dot.gov/documents/FY10_Reporting_Instructions_FINAL_7_7_2008(1).doc).
- FTA. (2013a). *Capital Investment Program FY 2013 Annual Report: Evaluation and Rating Process*. Washington, D.C., USA: Federal Transit Administration Retrieved from [http://www.fta.dot.gov/documents/FY13\\_Evaluation\\_Process.pdf](http://www.fta.dot.gov/documents/FY13_Evaluation_Process.pdf).
- FTA. (2013b). *New and Small Starts Evaluation & Rating Process: Final Policy Guidance*. Washington, D.C., USA: US DOT Federal Transit Administration, Retrieved from [http://www.fta.dot.gov/documents/NS-SS\\_Final\\_PolicyGuidance\\_August\\_2013.pdf](http://www.fta.dot.gov/documents/NS-SS_Final_PolicyGuidance_August_2013.pdf).
- FTA. (2014). *New and Small Starts Programs: Current Projects*. Washington, D.C., USA: Federal Transit Administration Retrieved from [http://www.fta.dot.gov/12304\\_14366.html](http://www.fta.dot.gov/12304_14366.html).
- Fuquitt, D., & Wilcox, S. J. (1999). *Cost-Benefit Analysis for Public Sector Decision Makers* Connecticut, USA: Praeger.
- Gamper, C. D., & Turcanu, C. (2007). On the governmental use of multi-criteria analysis. *Ecological Economics*, 62(2), 298-307. doi: 10.1016/j.ecolecon.2007.01.010
- Gomez-Ibanez, J., Tye, W. B., & Winston, C. (1999). *Essays in Transportation Economic Policy*. Washington DC, USA: Brookings Institution Press.
- Grant-Muller, S. M., MacKie, P., Nellthorp, J., & Pearman, A. (2001). Economic appraisal of European transport projects: The state-of-the-art revisited. *Transport Reviews*, 21(2), 237-261. doi: 10.1080/01441640119423
- Groot, H. d., Marlet, C. T., & Vermeulen, W. (2010). *Town and County (In Dutch: Stad en land)*. The Hague: Central Planbureau
- Guba, E. G., & Lincoln, Y. S. (1989). *Fourth Generation Evaluation*. California, USA: SAGE Publications.
- Guion, L. A., Diehl, D. C., & McDonald, D. (2001). *Conducting an In-depth Interview* Y. a. C. S. Department of Family, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida; (Ed.) (pp. 1-3). Retrieved from <https://edis.ifas.ufl.edu/pdf/files/FY/FY39300.pdf>
- Haezendonck, E. (2007). *Transport Project Evaluation: Extending the Social Cost-Benefit Approach* (E. Haezendonck Ed.). Northampton, Massachusetts, USA: Edward Elgar Publishing Inc.
- Hansson, S. O. (2007). Philosophical Problems in Cost-Benefit Analysis. *Economics and Philosophy*, 23(02), 163. doi: 10.1017/s0266267107001356
- Haveman, R. H., & Weimer, D. L. (2003). Cost-Benefit Analysis. In N. J. Smelser & P. B. Baltes (Eds.), *International encyclopedia of the social & behavioural sciences* (pp. 2845-2851). Amsterdam, the Netherlands: Elsevier.
- Hayashi, Y., & Morisugi, H. (2000). International comparison of background concept and methodology of transportation project appraisal. *Transport Policy*, 7(1), 73-88.
- Hensher, D. A., Stopher, P., & Bullock, P. (2003). Service quality—developing a service quality index in the provision of commercial bus contracts. *Transportation Research Part A: Policy and Practice*, 37(6), 499-517. doi: 10.1016/s0965-8564(02)00075-7
- Hoefsloot, N., & Pater, M. d. (2011). Indirect Effects: An exploration of indirect effects in Societal Cost Benefit Analysis (In Dutch: Indirecte effecten: Een verkenning naar indirecte effecten in Maat-Schappelijke Kosten Batenanalyses). Amsterdam, the Netherlands: DECISIO.
- Hof, B., Heyma, A., & Hoorn, T. (2011). Comparing the performance of models for wider economic benefits of transport infrastructure: results of a Dutch case study. *Transportation*, 39(6), 1241-1258. doi: 10.1007/s11116-011-9383-4
- Hofstetter, P., & Müller-Wenk, R. (2005). Monetization of health damages from road noise with implications for monetizing health impacts in life cycle assessment. *Journal of Cleaner Production*, 13(13-14), 1235-1245. doi: 10.1016/j.jclepro.2005.05.011

- House of Representatives. (2013). *Letter to the Cabinet with regard to the New Dutch CBA Guideline. December 6th, 2013*. The Hague.
- Interagency Working Group on Social Cost of Carbon. (2010). *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*. Washington, D.C., USA: Interagency Working Group on Social Cost of Carbon, United States Government Retrieved from <http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf>.
- International Transport Forum. (2011). *Improving the Practice of Cost Benefit Analysis in Transport*. International Transport Forum's Discussion Paper. International Transport Forum's Research Centre. Queretaro, Mexico. Retrieved from [www.internationaltransportforum.org/jtrc/DiscussionPapers/jtrcpapers.html](http://www.internationaltransportforum.org/jtrc/DiscussionPapers/jtrcpapers.html)
- Jones, H., Moura, F., & Domingos, T. (2014). Transport Infrastructure Project Evaluation Using Cost-benefit Analysis. *Procedia - Social and Behavioral Sciences*, 111, 400-409. doi: 10.1016/j.sbspro.2014.01.073
- Jong, G. d. (2013) International Comparison of Transport Appraisal Practice - Annex 3 The Netherlands Country Report. Leeds, The UK: Institute for Transport Studies, University of Leeds.
- Kansas DOT. (2010). *Expanded Highway Project Selection Process*. Topeka, KS, USA: Kansas Department of Transportation Retrieved from <http://www.tredis.com/images/pdf-docs/KDOT-project-selection-white-paper.pdf>.
- Kingdon, J. (1995). *Agendas, Alternatives, and Public Policies* (2nd ed.). New York, USA: Harper Collins.
- Koopmans, C., Knijf, A. v. d., Marlet, G., Ruijs, M., Smit, P., Stokkers, P., . . . Woerkens, C. v. (2011). Reallocation? Social Cost and Benefit of moving horticulture for housing (In Dutch: Verkassen? Maatschappelijke kosten en baten van het verplaatsen van tuinbouw ten behoeve van woningbouw) *SEO Report*. The Hague.
- Kørnø, L., & Thissen, W. A. H. (2000). Rationality in decision- and policy-making: implications for strategic environmental assessment. *Impact Assessment and Project Appraisal*, 18(3), 191-200. doi: 10.3152/147154600781767402
- Leiby, P. N. (2007). Estimating the Energy Security Benefits of Reduced U.S. Oil Imports. Oak Ridge, Tennessee, USA: U.S. Department of Energy.
- Lewis, D. (2014, 21/05). [Telephone Interview by the author].
- Linde, G. v. d., Donkelaar, J. v., Witmond, B., Devillers, E., & Spit, W. (2012). *Safety in Social Cost Benefit Analysis (In Dutch: Veiligheid in Maatschappelijke Kosten-Baten Analyse)*. Rijkswaterstaat & Ecorys. Delft, the Netherlands. Retrieved from [http://www.rijkswaterstaat.nl/images/Veiligheid%20in%20maatschappelijke%20kosten-batenanalyse\\_tcm174-332389.pdf](http://www.rijkswaterstaat.nl/images/Veiligheid%20in%20maatschappelijke%20kosten-batenanalyse_tcm174-332389.pdf)
- Macharis, C., Van Hoeck, E., Pekin, E., & van Lier, T. (2010). A decision analysis framework for intermodal transport: Comparing fuel price increases and the internalisation of external costs. *Transportation Research Part A: Policy and Practice*, 44(7), 550-561. doi: 10.1016/j.tra.2010.04.006
- Mackie, P., & Worsley, T. (2013). International Comparisons of Transport Appraisal Practice. Leeds, UK: Institute for Transport Studies University of Leeds.
- Mayer, I. (1997). *Debating Technologies: A Methodological Contribution to the Design and Evaluation of Participatory Policy Analysis*. Tilburg, the Netherlands: Tilburg University Press.
- McLaughlin, G., & Howard, R. (2005). *Comparison Groups: Data and Decisions* Paper presented at the Association for Institutional Research 45th Annual Forum, San Diego, California, USA.
- Ministry of Infrastructure and Environment. (2012). CBA to MIRT explorations: Framework for completing the OEI formats (In Dutch: KBA bij MIRT- verkenningen Kader voor het invullen van de OEI-formats). The Hague, the Netherlands: Ministry of Infrastructure and Environment.
- Minnesota DOT. (1999). *Hear Every Voice: A Guide to Public Involvement at Mn/DOT*. Minneapolis, MN, USA: Minnesota Department of Transportation.

- Minnesota DOT. (2009). *Implementation of Minnesota Statewide Transportation Plan Cost-Effectiveness Policy*. (Technical Memorandum No. 09-13-IM-01). St. Paul, MN, USA: Minnesota Department of Transportation Retrieved from <http://dotapp7.dot.state.mn.us/edms/download?docId=770804>.
- Minnesota DOT. (2012). *Benefit-Cost Analysis for Transportation Projects*. St. Paul, Minnesota, USA: Minnesota Department of Transportation Retrieved from <http://www.dot.state.mn.us/planning/program/benefitcost.html>.
- Minnesota DOT. (2014). *MnDOT Office of Transportation System Management Benefit-Cost Analysis Standard Value Tables*. St. Paul, Minnesota, USA: Minnesota Department of Transportation Retrieved from [http://www.dot.state.mn.us/planning/program/appendix\\_a.html](http://www.dot.state.mn.us/planning/program/appendix_a.html).
- Minnesota Environmental Quality Board. (2000). *Environmental Assessment Worksheet (EAW): Preparing Environmental Assessment Worksheets*. St. Paul, MN, USA: Minnesota Environmental Quality Board Retrieved from <http://www.eqb.state.mn.us/documents/eawrules.pdf>.
- Missouri DOT. (2004). *Missouri's Framework for Transportation Planning and Decision-making*. Jefferson City, MO, USA: Missouri Department of Transportation Retrieved from [http://www.modot.org/plansandprojects/planning\\_projects/documents/PG\\_march102504.pdf](http://www.modot.org/plansandprojects/planning_projects/documents/PG_march102504.pdf).
- Moore, M. A., Boardman, A. E., & Vining, A. R. (2013a). The choice of the social discount rate and the opportunity cost of public funds. *Journal of Benefit-Cost Analysis*, 4(3). doi: 10.1515/jbca-2013-0023
- Moore, M. A., Boardman, A. E., & Vining, A. R. (2013b). More appropriate discounting: the rate of social time preference and the value of the social discount rate. *Journal of Benefit-Cost Analysis*, 4(1), 1-16. doi: 10.1515/jbca-2012-0008
- Mouter, N. (2014a). Cost-Benefit Analysis in Practice: A study of the way Cost-Benefit is perceived by the key individuals in the Dutch CBA practice for spatial-infrastructure projects. Delft, the Netherlands: TRAIL Research Institute.
- Mouter, N. (2014b). *Institutionalizing Cost-Benefit Analysis: An International Comparison (A working paper)*. Delft University of Technology. Delft, the Netherlands.
- Mouter, N., Annema, J. A., & Wee, B. v. (2013a). 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. doi: 10.1016/j.tra.2013.10.006
- Mouter, N., Annema, J. A., & Wee, B. v. (2013b). Ranking the substantive problems in the Dutch Cost-Benefit Analysis practice. *Transportation Research Part A: Policy and Practice*, 49, 241-255. doi: 10.1016/j.tra.2013.01.020
- Nakamura, H. (2000). The economic evaluation of transport infrastructure: Needs for international comparisons. *Transport Policy*, 7(1), 3-6.
- Nas, T. F. (1996). *Cost-Benefit Analysis - Theory and Application*. California, USA: Sage Publications Inc.
- Neeley, M., & Izakawa, K. (2014, 05/06). [Telephone Interview by the author].
- Nickel, J., Ross, A. M., & Rhodes, D. H. (2009). *Comparison of Project Evaluation Using Cost-Benefit Analysis and Multi-Attribute Tradespace Exploration in the Transportation Domain*. Paper presented at the Second International Symposium on Engineering Systems, MIT, Cambridge, Massachusetts. <http://esd.mit.edu/symp09/submitted-papers/nickel-paper.pdf>
- Nyborg, K. (2014). Project evaluation with democratic decision-making: What does cost-benefit analysis really measure? *Ecological Economics*, 106, 124-131. doi: 10.1016/j.ecolecon.2014.07.009
- Odgaard, T., Kelly, C., & Laird, J. (2005). Current practice in project appraisal in Europe: Analysis of country reports *Developing Harmonised European Approaches for Transport Costing and Project Assessment* (Vol. 1, pp. 139). Denmark: European Commission EC-DG TREN.
- Ohio DOT. (2011). *Transportation Review Advisory Council: Policy & Procedures*. Columbus, OH, USA: Ohio Department of Transportation Retrieved from

- <http://www.dot.state.oh.us/trac/Documents/TRAC%20Policies%20and%20Procedures%2006.2.2011.pdf>.
- OMB. (1992). *Circular No. A-94 Revised: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. Washington, D.C., USA: Retrieved from [http://www.whitehouse.gov/omb/circulars\\_a094](http://www.whitehouse.gov/omb/circulars_a094).
- Paulley, N., Balcombe, R., Mackett, R., Titheridge, H., Preston, J., Wardman, M., . . . White, P. (2006). The demand for public transport: The effects of fares, quality of service, income and car ownership. *Transport Policy*, 13(4), 295-306. doi: 10.1016/j.tranpol.2005.12.004
- Pearce, D. W., & Nash, C. A. (1981). *The Social Appraisal of Projects*. London, the UK: The Macmillan Press Ltd.
- Preston, J. (1996). Transport Research APAS Strategic Transport VII-15: Cost Benefit Analysis and Multi-Criteria Analysis for Rail Infrastructure. Luxemburg: European Commission: Directorate General Transport.
- Rall, J., Wheet, A., Farber, N. J., & Reed, J. B. (2011). *Transportation Governance and Finance: A 50-State Review of State Legislatures and Departments of Transportation*. Washington, D.C., USA: The National Conference of State Legislatures and AASHTO Center for Excellence in Project Finance.
- Redman, L., Friman, M., Gärling, T., & Hartig, T. (2013). Quality attributes of public transport that attract car users: A research review. *Transport Policy*, 25, 119-127. doi: 10.1016/j.tranpol.2012.11.005
- Rienstra, S. (2008). The Role of Cost-Benefit Analysis in Decision-making (In Dutch: De rol van kosten-batenanalyse in de besluitvorming). The Hague, the Netherlands: Institute of Transport Policy (Kennisinstituut voor Mobiliteitsbeleid).
- Rijkswaterstaat. (2011a). *Overview Economic Investment: Accessibility - Key Figures Accessibility (In Dutch: Overzicht Effecten Investerings (OEI): Bereikbaarheidseffecten - Kengetallen bereikbaarheidseffecten)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/images/Bereikbaarheid\\_tcm174-332335.pdf](http://www.rijkswaterstaat.nl/images/Bereikbaarheid_tcm174-332335.pdf).
- Rijkswaterstaat. (2011b). *Overview Economic Investment: Indirect Effects (In Dutch: Overzicht Effecten Investerings (OEI): Indirecte effecten)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/images/Kengetallen%20indirecte%20effecten\\_tcm174-332374.pdf](http://www.rijkswaterstaat.nl/images/Kengetallen%20indirecte%20effecten_tcm174-332374.pdf).
- Rijkswaterstaat. (2011c). *Overview Economic Investment: Natural Effects - Soil (In Dutch: Overzicht Effecten Investerings (OEI): Natuureffecten - Bodem)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/images/Bodem\\_tcm174-332336.pdf](http://www.rijkswaterstaat.nl/images/Bodem_tcm174-332336.pdf).
- Rijkswaterstaat. (2011d). *Overview Economic Investment: Natural Effects - Water (In Dutch: Overzicht Effecten Investerings (OEI): Natuureffecten - Water)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/images/Water\\_tcm174-332366.pdf](http://www.rijkswaterstaat.nl/images/Water_tcm174-332366.pdf).
- Rijkswaterstaat. (2011e). *Overview Economic Investment: Safety (In Dutch: Overzicht Effecten Investerings (OEI): Veiligheidseffecten)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/zakelijk/economische\\_evaluatie/overzicht\\_effecten\\_infrastructuur/veiligheidseffecten/](http://www.rijkswaterstaat.nl/zakelijk/economische_evaluatie/overzicht_effecten_infrastructuur/veiligheidseffecten/).
- Rijkswaterstaat. (2011f). *Overview Economic Investment: Social-cultural Effects - Cultural (In Dutch: Overzicht Effecten Investerings (OEI): Sociaal-culturele effecten - Cultuurhistorie)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/images/Cultuurhistorie\\_tcm174-332338.pdf](http://www.rijkswaterstaat.nl/images/Cultuurhistorie_tcm174-332338.pdf).
- Rijkswaterstaat. (2011g). *Overview Economic Investment: Viability Effects (In Dutch: Overzicht Effecten Investerings (OEI): Leefbaarheidseffecten)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from

- [http://www.rijkswaterstaat.nl/zakelijk/economische\\_evaluatie/overzicht\\_effecten\\_infrastructuur/leefbaarheidseffecten/](http://www.rijkswaterstaat.nl/zakelijk/economische_evaluatie/overzicht_effecten_infrastructuur/leefbaarheidseffecten/).
- Rijkswaterstaat. (2012a). *Overview Economic Investment: Safety (In Dutch: Overzicht Effecten Investerings (OEI): Veiligheidseffecten - Kengetallen Veiligheidseffecten)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/zakelijk/economische\\_evaluatie/overzicht\\_effecten\\_infrastructuur/veiligheidseffecten/](http://www.rijkswaterstaat.nl/zakelijk/economische_evaluatie/overzicht_effecten_infrastructuur/veiligheidseffecten/).
- Rijkswaterstaat. (2012b). *Overview Effects Measurements (In Dutch: Overzicht Effecten Investerings)*. Delft, the Netherlands: Rijkswaterstaat Retrieved from [http://www.rijkswaterstaat.nl/zakelijk/economische\\_evaluatie/overzicht\\_effecten\\_infrastructuur/](http://www.rijkswaterstaat.nl/zakelijk/economische_evaluatie/overzicht_effecten_infrastructuur/).
- Romijn, G., & Renes, G. (2013). *General Dutch CBA Guideline (In Dutch: Algemene Leiraad voor maatschappelijke kosten-batenanalyse)*. The Hague: Central Planbureau en Planbureau voor de Leefomgeving.
- Romijn, G., & Zondag, B. (2012). The Base Case for CBA's Large area projects: An exploration based on the case Schaalprong Almere (In Dutch: Het nulalternatief voor KBA's van grote gebiedsgerichte projecten: Een verkenning op basis van de casus Schaalprong Almere). In C. P. e. P. v. d. Leefomgeving (Ed.).
- Saitua, R. (2007). Some considerations on social cost-benefit analysis as a tool for decision making. In E. Haezendonck (Ed.), *Transport Project Evaluation: Extending the Social Cost-Benefit Approach* (pp. 23-33). Northampton, Massachusetts, USA: Edward Elgar Publishing Inc.
- Salling, K. B., & Banister, D. (2009). Assessment of large transport infrastructure projects: The CBA-DK model. *Transportation Research Part A: Policy and Practice*, 43(9-10), 800-813. doi: 10.1016/j.tra.2009.08.001
- Senner, R. (2011). Appraising the sustainability of project alternatives: An increasing role for cumulative effects assessment. *Environmental Impact Assessment Review*, 31(5), 502-505. doi: 10.1016/j.eiar.2011.01.013
- Stevens, A. (2004). The Application and Limitations of Cost-Benefit Assessment (Cba) for Intelligent Transport Systems. *Research in Transportation Economics*, 8, 91-111. doi: 10.1016/s0739-8859(04)08005-9
- Szekeres, S. (2011). Comment on Burgess and Zerbe's "Appropriate Discounting for Benefit-Cost Analysis". *Journal of Benefit-Cost Analysis*, 2(3). doi: 10.2202/2152-2812.1093
- Teisman, G. R. (2002). Models for research into decision-making processes: On phases, streams, and decision-making rounds. *Public Administration*, 78(4), 937-954.
- Thomopoulos, N., Grant-Muller, S., & Tight, M. R. (2009). Incorporating equity considerations in transport infrastructure evaluation: Current practice and a proposed methodology. *Eval Program Plann*, 32(4), 351-359. doi: 10.1016/j.evalprogplan.2009.06.013
- Tsamboulas, D. A. (2007). A tool for prioritizing multinational transport infrastructure investments. *Transport Policy*, 14(1), 11-26. doi: 10.1016/j.tranpol.2006.06.001
- Tudela, A., Akiki, N., & Cisternas, R. (2006). Comparing the output of cost benefit and multi-criteria analysis. *Transportation Research Part A: Policy and Practice*, 40(5), 414-423. doi: 10.1016/j.tra.2005.08.002
- Turnbull, K. F. (2010). *Benefit/Cost Analysis for Transportation Infrastructure: A Practitioner's Workshop*. Paper presented at the Benefit/Cost Analysis for Transportation Infrastructure: A Practitioner's Workshop, Washington, D.C., USA.
- US DOT. (1996). *Public Involvement Techniques for Transportation Decision-Making*. Washington, D.C., USA: United States Department of Transportation Retrieved from [http://www.fhwa.dot.gov/planning/public\\_involvement/publications/techniques/fhwapd96031.pdf](http://www.fhwa.dot.gov/planning/public_involvement/publications/techniques/fhwapd96031.pdf).
- US DOT. (2011). *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis*. Washington, D.C., USA: Office of The Secretary of Transportation, US Department of

- Transportation Retrieved from  
[http://www.dot.gov/sites/dot.dev/files/docs/vot\\_guidance\\_092811c.pdf](http://www.dot.gov/sites/dot.dev/files/docs/vot_guidance_092811c.pdf).
- US DOT. (2012a). *Notice of Funding Availability for the Department of Transportation's National Infrastructure Investments Under the Full-Year Continuing Appropriations, 2012*. Washington, D.C., USA: Federal Register Retrieved from <http://www.gpo.gov/fdsys/pkg/FR-2012-01-31/pdf/2012-1996.pdf>.
- US DOT. (2012b). *TIGER Benefit-Cost Analysis (BCA) Resource Guide*. Washington, D.C., USA: Retrieved from [http://www.dot.gov/sites/dot.dev/files/docs/tiger-12\\_bca-resourceGuide.pdf](http://www.dot.gov/sites/dot.dev/files/docs/tiger-12_bca-resourceGuide.pdf).
- US DOT. (2013). *Major Capital Investment Projects: Final Rule*. Washington, D.C., USA: Federal Transit Administration Retrieved from <http://www.gpo.gov/fdsys/pkg/FR-2013-01-09/pdf/2012-31540.pdf>.
- US DOT. (2014a). *Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses* Washington, D.C., USA: Office of the Secretary of Transportation, US Department of Transportation Retrieved from [http://www.dot.gov/sites/dot.gov/files/docs/VSL\\_Guidance\\_2014.pdf](http://www.dot.gov/sites/dot.gov/files/docs/VSL_Guidance_2014.pdf).
- US DOT. (2014b). *TIGER Grant Data*. Washington, D.C., USA: US Department of Transportation Retrieved from <http://www.dot.gov/policy-initiatives/tiger/tiger-grant-data>.
- US DOT, & NHTSA. (2010). *Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks*. Washington, D.C., USA: Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis Retrieved from [http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/MY2012-2016\\_CAFE\\_PRIA.pdf](http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/MY2012-2016_CAFE_PRIA.pdf).
- US Energy Information Agency. (2014). *Annual Energy Outlook 2014 (AEO2014)*. Washington, D.C., USA: US Energy Information Agency Retrieved from [http://www.eia.gov/forecasts/aeo/er/pdf/0383er\(2014\).pdf](http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2014).pdf).
- US EPA. (2010). *MOVES (Motor Vehicle Emission Simulator)*. Washington, D.C., USA: United States Environmental Protection Agency Retrieved from <http://www.epa.gov/otag/models/moves/>.
- 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. doi: 10.1016/j.tranpol.2011.07.001
- Vickerman, R., & Gillen, D. (2013). NCHRP Project 2-24 Economic Productivity & Transportation Investment: Task 1 Literature Review, Stakeholder Perspectives and Framework Outline. Washington, D.C., USA: Economic Development Research Group, Inc.; Systems Metric Group, Inc.; University of Leeds; David Simmonds Consultancy, Ltd.; Prime Focus, LLC.
- Voogd, H. (1983). *Multicriteria evaluation for urban and regional planning*. London: Pion Ltd.
- Walker, W. E. (2000). Policy Analysis: A Systematic Approach to Supporting Policymaking in the Public Sector. *Journal of Multi-Criteria Decision Analysis*, 9(1-3), 11-27.
- Weisbrod, G. (2013). *International Comparison of Transport Appraisal Practice: Annex 5 US Country Report*. Leeds, the UK: Institute of Transport Studies.
- Weisbrod, G. (2014, 02/06). [Telephone interview by the author].
- Wells, J. (2014, 01/05). [Telephone Interview by the author].
- Wisconsin DOT. (2007). *Economic Evaluation of Highway Major Investment Program*. Madison, WI, USA: Wisconsin Department of Transportation Retrieved from <http://www.dot.wisconsin.gov/business/econdev/highway-major.htm>.
- Working Group on Long-term Discount Rate. (2009). Advise on Long-term Discount Rate (In Dutch: Advies Lange Termijn Discontovoet). The Hague, the Netherlands: Working Group on Long-term Discount Rate (In Dutch: Werkgroep Lange Termijn Discontovoet).
- WS DOT. (2000). *WSDOT Mobility Project Prioritization Process*. Oakland, CA, USA: Dowling Associates Inc. Retrieved from [http://www.wsdot.wa.gov/mapsdata/travel/pdf/Mobility\\_Users\\_Guide\\_2001.PDF](http://www.wsdot.wa.gov/mapsdata/travel/pdf/Mobility_Users_Guide_2001.PDF).

- Yeh, C.-H., Willis, R. J., Deng, H., & Pan, H. (1999). Theory and Methodology: Task oriented weighting in multi-criteria analysis. *European Journal of Operational Research*, 119(1), 130-146.
- Yin, R. K. (2008). *Case Study Research: Design and Methods (Applied Social Research Methods)* (4th ed.). California, USA: SAGE Inc.

## Appendices

### Appendix I: List of contacted transport practitioners in the United States

Contacted Speakers	Topic covered in TIGER proceeding	Official positions	Agree/Disagree/No reply for interviews
Jack Wells	Introduction/Welcoming speech	Chief Economist at United States Department of Transportation	Agree
Glen Weisbrod	Being clear about BCA and EIA	President of Economic Development Research Group	Agree
David Lewis	Employment, Productivity and Real Estate Value in BCA	President HDR Engineering	Agree
Todd Litman	Incorporating Livability Indicators into Transportation Policy and Project Evaluation	Founder and executive director of the Victoria Transport Policy Institute	Agree
Rabinder Bains	State of Good Repair	Economist at Investment & Economic Analysis Team, Office of Transportation Policy Studies, FHWA	Agree
Kenneth Buttons	Economic Competitiveness	Professor; Director, Center for Transportation, Policy, Operations and Logistics	Disagree
Charles Griffiths	Measuring Environmental Benefits	Economist, Research and Program Support Division, National Center for Environmental Economics	Disagree
Daniel Graham	CBA: Introduction & Overview of the UK Approach	Professor of Statistical Modelling at Imperial College London	No reply
Richard Steinnman	Modal perspectives	Federal Transit Administration (FTA)	No reply
Mary Lynn Tischer	Researchers	Federal Highway Administration (FHWA)	No reply
Ronald Hynes	Researchers	Federal Railway Administration (FRA)	No reply
Darren Timothy	Measuring Safety Benefits	Program Development Team Leader, Office of Innovative Program, FHWA	No reply

## Appendix II: Monetization of the effects suggested by Ministry of Environment and Infrastructure in the Dutch SCBA

	Main criteria and sub-criteria	Welfare effects	price index numbers in Euros (2010 price excluded Value-Added-Tax)
<b>Accessibility</b>	Travel speed/time	travel time	<b>Passenger</b>
			Eur9.55 per hour for live/work
			Eur33.07 for business travel
			Eur6.59 for other transport
			Eur10.67 for all designs
			<b>Freight</b>
			Eur45.78 per hour for road
			Eur1101.27 per hour for rail
			Eur88.77 per hour inland
			Eur87.57 per hour shipping
			Eur9519.24 per hour aviation
	reliability	reliability gain	25% surcharge on the basis of reduction in congestion
	distance	transport cost	Eur0.084 per passenger km
			Eur0.255 per km lorry
	excise	excise tax revenues	Eur0.05 per passenger km
			Eur0.15 per km lorry
<b>Cultural</b>	Archeology - Informativeness	Inheritance archeological value	No price
	Landscape (historical geography) - Attractiveness	Landscape and enjoyment of the views and recreational amenities	Eur13 per household per year
			5% to 14% of the house value
	Historic architecture	Enjoyment in real estate value or land	Eur1 per visit orEur 15 per m2
			14.8% of the house value

	- authenticity (Field division and hist. façade features)	value	Eur1.70 per m2 for one additional monument per 100,000 homes
<b>Quality of life</b>	Air Quality:		
	a PM10.	Public Health (Lung)	EUR 87.95 - EUR 376.91 per kg PM101
	b. SOx		EUR 5.03 - EUR 12.56 per kg Sox2
	c. NOx		EUR 8.79 - EUR 15.08 per kg Nox2
	Sound	Health (migraine)	EUR 27.97 per dB per person
	Vibration	Health & damage buildings	No price
	Stench	nuisance c.q. loss of enjoyment	EUR 95.14 - EUR 185.42 per family per year
	climate (CO2)	climate protection	EUR 62,66 per tonne of CO2
	Biodiversity	Non-use Biodiversity	EUR 8 to 25 per household per year
	Purification	Saved treatment costs (N and P)	EUR 2.60 per kg N EUR 10.30 per kg P
<b>Water</b>	water quality	swimming & recreation benefits inheritance value clean water (2x)	EUR 4.25 per swim visit
			EUR 5 per household per year
	water quantity	avoided flood damage and water shortages and wet / drought damage properties and production	EUR 19.000 Wet damage per household
			EUR 1,300 per ha agricultural Wet damage EUR 2,500 per ha arable Wet damage
<b>Soil</b>	pollution	health (bone fractures and cancer with cadmium)	EUR 1,820 per fracture
			EUR 74,000 per DALY due to cancer
			EUR 10,000 per IQ point per exposed child
	Stability	construction costs	No value
	Fertility	agricultural yields	No value
<b>Safety</b>	Safety	only material damage & road casualties	EUR 4,334 per claim
			EUR 2,744,541 per death
			EUR 282 164 per inpatient
			EUR 8,945 per emergency aid victims
			EUR 5,223 per light-injury victim

<b>Indirect effects</b>	Image	increase in profit	No value
		increase in revenue	
		increase in labor	
	Identity	increase in profit	No value
		increase in revenue	
		increase in labor	
	Innovation	increase in labor	10 % increase in ICT capital is 0.3 to 1.1% increase in labor productivity in the services
	Agglomeration (clustering)	higher wages	1% more agglomeration = 0.023% higher wages
		higher land prices	
	appearance	all of the above effects are possible	No value
	synergy	Idem	No value

Sources: (Rijkswaterstaat, 2012b)

### Appendix III: Specific Guidance for CBA and MCA in the United States

#### Impacts measurements suggested TIGER program

Long-Term Outcomes	Descriptions	Sub-criteria	Indicators	Quantitative/ Qualitative	(Non) monetize
Livability	1) Use the six criteria that were developed by the US DOT, HUD, and EPA <sup>2</sup> 2) qualitatively how the project will improve connectivity to other transportation modes.	User mobility	travel time	Quantitative	Monetize <sup>1</sup>
			congestion metrics		
		(inter) Modal connectivity	vehicle miles affected		
			number of new trips	Qualitative (difficult to monetize)	Monetize if possible
		Aiding in the mobility of disadvantaged groups	An example could be property price		
Economic Competitiveness	1) priority will for projects that increase the productivity of Economically Distressed Areas <sup>1</sup>		Time savings	Quantitative	Monetize <sup>1</sup>
			Cost savings		
State of good repair	1) projected condition and performance, with an explanation of how the project will improve the facility or system's condition	Future efficiency	Project description (status quo & alternatives)	Qualitative	Non-monetize
	2) any quantifiable metrics of the facility or system's current condition and performance		Congestion metrics	Quantitative	Non-monetize

	3) performance and/or long-term cost structure, including calculations of avoided operations and maintenance costs		Project costs	Quantitative	Monetize
	4) associated delays				
Environmental Sustainability	1) Could be measured with different methods	Improve energy efficiency; Reduce dependence on fuel	Idling time for automobiles Average speed Modal split	Quantitative	Monetize <sup>3</sup>
		Reduce emissions(Volatile Organic Compounds (VOCs), Nitrogen oxides (NOx) Particulate matter (PM), Sulfur dioxide (SOx), Carbon Dioxide (CO <sub>2</sub> ))	Cost savings; Efficiency (age, type, and fuel source of the vehicles)	Quantitative <sup>4</sup>	Monetize <sup>5</sup> (except for Carbon emission that uses Social Carbon Cost) <sup>6</sup>
		Mitigate adverse environmental impacts	make use of the NEPA	Qualitative (NEPA)	Non-monetize
Safety	1) compare the current number & types of crashes	Safety	Statistical Life	Quantitative	Monetize <sup>7</sup>
	2) estimate how the project will affect safety		Injuries		
	3) rate and severity of crashes		Property Damage (Crashes)	Quantitative	Monetize <sup>8</sup>

Impacts measurements suggested FTA New Starts programs

Long-Term Outcomes	Descriptions	Indicators	Quantitative/Qualitative	(Non)monetize
Mobility Improvements	Simplified Trips-on-Projects (STOPS) model using national data	Vehicle-Miles Travelled	Quantitative	Non-monetize
		Estimated Ridership		
Cost Effectiveness	the annualized capital cost + annual Operation & Maintenance /the annual number of estimated trips	Annualized capital cost	Quantitative	Partially (ratio)
		Annual Operation & Maintenance cost		
		Annual number of estimated trips		
Congestion Relief	No information needs to be reported for this criterion at this time. FTA is determining the measures it will use for this new criterion			
Land Use	Using national data	Station area population densities	Quantitative	Non-monetize
		Total employment served by the project		
	The proportion “legally binding affordability restricted” housing within ½ mile of stations areas / the proportion of “legally binding affordability restricted” housing in the counties through which the project travels.	Proportion of “legally binding affordability restricted” housing within ½ mile of stations areas		
		Proportion of “legally binding affordability restricted” housing in the counties through which the project travels.		
Economic Development	Performance and Impacts of Land Policies	Transit supportive plans and policies	Qualitative	Non-monetize
		Performance of Land Use Policies; Potential Impact of Transit Project on Regional		

		Land Use		
	Tools to maintain or increase the share of affordable housing in the project corridor	Evaluation of Corridor-Specific Affordable Housing Needs and Supply; Plans and Policies to Preserve and Increase Affordable Housing		
	Optional but shall not be included in environmental benefits to avoid double-counting	Vehicle-Miles Travelled; Environmental Benefits	Quantitative	Monetize*
Environmental Benefits	Using Vehicle-miles traveled generated from STOPS model	Greenhouse gas emissions	Quantitative	Monetize*
		Air quality criteria pollutants		
		Safety		
		Energy use		

\*Note that for FTA, a worksheet is provided where most of the calculation is done internally by the FTA staff.

**Impacts measurements suggested by FHWA**

Benefits/Costs	Descriptions	Indicators	Quantitative/Qualitative	(Non)monetize
Agency Costs	Estimate these costs based on past experience, bid prices, design specifications, materials costs, and other information	Design and Engineering	Quantitative	Monetize
		Land Acquisition		
		Construction		
		Reconstruction/Rehabilitation		
		Preservation/Routine Maintenance		
		Mitigation (e.g., noise barriers)		

Associated With Work Zones	Utilizing Departmental Guidance on VOT in Economic Analysis	Delay	Quantitative	Monetize <sup>1</sup>
	Utilizing Value of statistical life (VSL)	Injuries & A statistical life	Quantitative	Monetize <sup>7</sup>
	Economic Impact of Motor Vehicle Crashes	Crashes	Quantitative	Monetize <sup>8</sup>
	Utilizing AASHTO's Red Book	Vehicle Operating Costs	Quantitative	Monetize <sup>9</sup>
Associated With Facility Operations	Utilizing Departmental Guidance on VOT in Economic Analysis	Travel Time and Delay	Quantitative	Monetize <sup>1</sup>
	Utilizing Value of statistical life (VSL)	Injuries & A statistical life	Quantitative	Monetize <sup>7</sup>
	Economic Impact of Motor Vehicle Crashes	Crashes	Quantitative	Monetize <sup>8</sup>
	Utilizing AASHTO's Red Book	Vehicle Operating Costs	Quantitative	Monetize <sup>9</sup>
Externalities (non-user impacts, if applicable)	Coordinated with National Environmental Policy Act 1969 <sup>10</sup>	Emissions	Quantitative <sup>4</sup> and Qualitative <sup>10</sup>	Monetize wherever possible <sup>3,5,6</sup>
		Noise		

<sup>1</sup> US DOT. (2011). Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis Washington, D.C., USA: Office of The Secretary of Transportation, US Department of Transportation Retrieved from [http://www.dot.gov/sites/dot.dev/files/docs/vot\\_guidance\\_092811c.pdf](http://www.dot.gov/sites/dot.dev/files/docs/vot_guidance_092811c.pdf).

<sup>2</sup> FHWA, & US EPA. (2006). *Federal Highway Administration (FHWA) and the National Environmental Policy Act NEPA*. Washington, D.C., USA: FHWA & US EPA Retrieved from <http://www.sgcity.org/traffic/upload/NEPA.pdf>.

<sup>3</sup> Leiby, P. N. (2007). Estimating the Energy Security Benefits of Reduced U.S. Oil Imports. Oak Ridge, Tennessee, USA: U.S. Department of Energy.

<sup>4</sup> US EPA. (2010b). MOVES (Motor Vehicle Emission Simulator). Washington, D.C., USA: United States Environmental Protection Agency Retrieved from <http://www.epa.gov/otaq/models/moves/>.

<sup>5</sup> US DOT, & NHTSA. (2010). *Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks*. Washington, D.C., USA: Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis Retrieved from [http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/MY2012-2016\\_CAFE\\_PRIA.pdf](http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/MY2012-2016_CAFE_PRIA.pdf).

<sup>6</sup> Interagency Working Group on Social Cost of Carbon. (2010). *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*. Washington, D.C., USA: Interagency Working Group on Social Cost of Carbon, United States Government Retrieved from <http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf>.

<sup>7</sup> US DOT. (2014). Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses Washington, D.C.,

USA: Office of the Secretary of Transportation, US Department of Transportation Retrieved from  
[http://http://www.dot.gov/sites/dot.gov/files/docs/VSL\\_Guidance\\_2014.pdf](http://http://www.dot.gov/sites/dot.gov/files/docs/VSL_Guidance_2014.pdf).

<sup>8</sup> The Economic and Societal Impact Of Motor Vehicle Crashes, 2010 <http://www-nrd.nhtsa.dot.gov/Pubs/812013.pdf>

<sup>9</sup> Andersen, D. G. (1978). A new manual for highway user economic analysis. *Transportation Planning and Technology*, 4(2), 81-87. doi:  
10.1080/03081067808717123

<sup>10</sup> FHWA; US EPA. (2006). Federal Highway Administration (FHWA) and the National Environmental Policy Act NEPA. Washington, D.C., USA: FHWA & US EPA Retrieved from <http://www.sgcity.org/traffic/upload/NEPA.pdf>.

#### Appendix IV: Monetization of the effects in the United States

	Elements					Remarks
<b>Monetize (attach dollar amounts to) all impacts</b>	Real term					· the US DOT provides guidance in the BCA resource guide for valuing many of the impacts that are difficult to monetize
	Value of Statistical Life (VSL) - \$2014	USD 9,100,000				Treatment of the Economic Value of a Statistical Life in Departmental Analyses (2008 revised guidance and 2011 update) <a href="http://ostpxweb.dot.gov/policy/reports.htm">http://ostpxweb.dot.gov/policy/reports.htm</a>
	Value of Injuries	AIS Level	Severity	Fraction of VSL	Unit value	Treatment of the Economic Value of a Statistical Life in Departmental Analyses (2008 revised guidance and 2011 update) <a href="http://ostpxweb.dot.gov/policy/reports.htm">http://ostpxweb.dot.gov/policy/reports.htm</a>  NOTE: Accident data (particularly those provided through law enforcement records) are typically reported as a single number (e.g. "X number of crashes in Year Y") and/or on the KABCO scale of crash severity. Applicants should convert these values to the AIS scale before
		1	Minor	0.3%	USD 27,300	
		2	Moderate	4.7%	USD 427,700	
		3	Serious	10.5%	USD 955,500	
		4	Severe	26.6%	USD 2,420,600	
		5	Critical	59.3%	USD 5,396,300	
		6	Unsurvivable	100.0%	USD 9,100,000	

					applying the recommended monetized values. See Part II Section 3 (“Converting Available Accident Data into AIS Data”).
	Property Damage Only (PDO) Crashes - \$2010	\$3,285 per vehicle crash			<p>The Economic Impact of Motor Vehicle Crashes 2000  <a href="http://www.nhtsa.gov/DOT/NHTSA/Communication%20&amp;%20Consumer%20Information/Articles/Associated%20Files/EconomicImpact2000.pdf">http://www.nhtsa.gov/DOT/NHTSA/Communication%20&amp;%20Consumer%20Information/Articles/Associated%20Files/EconomicImpact2000.pdf</a></p> <p>NOTE: PDO value of \$3,285 per vehicle crash is an updated value currently used by NHTSA and based on the methodology and original 2000 dollar value referenced in The Economic Impact of Motor Vehicle Crashes 2000 source document (Page 62, Table A-1, “Summary of Unit Costs, 2000”). Also, while the cost of PDO crashes is presented here in 2010 dollars, as it was in the source document, applicants should convert this value (along with other monetized values presented in this section) to dollars applicable to whatever base year you are using, using the methodology discussed below in Part II, Section 2 (“Converting Nominal Dollars into Real (Constant) Dollars”).</p>
	Value of Travel Time	<b>Recommended Hourly Values of Travel Time Savings (2009 U.S. \$ per person-hour)</b>			<p>Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (Revision 2 – corrected)  <a href="http://ostpxweb.dot.gov/policy/reports.htm">http://ostpxweb.dot.gov/policy/reports.htm</a></p>
		<b>Category</b>	<b>Surface Modes* (except High-</b>	<b>Air and High-Speed Rail Travel</b>	

			<b>Speed Rail)</b>		<p>* Surface figures apply to all combinations of in-vehicle and other transit time. Walk access, waiting, and transfer time in personal travel should be valued at \$23.90 per hour for personal travel when actions affect only those elements of travel time.</p> <p>** These are weighted averages, using distributions of travel by trip purpose on various modes. Distribution for local travel by surface modes: 95.4% personal, 4.6% business. Distribution for intercity travel by conventional surface modes: 78.6% personal, 21.4% business. Distribution for intercity travel by air or high-speed rail: 59.6% personal, 40.4% business. Surface figures derived using annual person-miles of travel (PMT) data from the 2001 National Household Travel Survey. <a href="http://nhts.ornl.gov/">http://nhts.ornl.gov/</a>. Air figures use person-trip data.</p>
		<b>Local Travel</b>			
		Personal	USD 12.00		
		Business	USD 22.90		
		All purposes**	USD 12.50		
		<b>Intercity Travel</b>			
		Personal	USD 16.70	USD 31.90	
		Business	USD 22.90	USD 62.60	
		All purposes**	USD 18.00	USD 44.30	
		Truck Drivers		USD 23.70	
		Bus Drivers		USD 23.60	
		Transit Rail Operators		USD 38.90	
		Locomotive Engineers		USD 33.00	
		Airline Pilots and Engineers		USD 73.30	
	Value of Emissions	<b>Emission Type</b>	<b>\$ / long ton (\$2007)</b>	<b>\$/ metric ton (\$2007)</b>	<p>Corporate Average Fuel Economy for MY2012-MY2016 Passenger Cars and Light Trucks (March 2010), page 403, Table VIII-8, "Economic Values for Benefits Computations (2007 Dollars)" <a href="http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2012-2016_FRIA_04012010.pdf">http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2012-2016_FRIA_04012010.pdf</a></p> <p>NOTE: Emissions units are commonly reported as "tons", but there is a</p>
		Carbon dioxide (CO2)	Social Carbon Cost	Social Carbon Cost	
		Volatile Organic Compounds (VOCs)	USD 1,300	USD 1,280	
		Nitrogen oxides (NOx)	USD 5,300	USD 5,217	

		Particulate matter (PM)	USD 290,000	USD 285,469	distinction between long tons and metric tons. In fact, only carbon dioxide emissions (as reported in the SCC guidance) are typically reported in metric tons, whereas emissions for VOCs, NOx, PMs, and SOx are measured in English (or “long”) tons. Global standing used in SCC "First, it involves a global externality: emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions."
		Sulfur dioxide (SOx)	USD 31,000	USD 30,516	
	Social Cost of Carbon (3%)	Year	Base Value	1) Determine the base year and the life cycle years for the project 2) Multiply the quantity of tons reduced in the projected year by the 3% SCC base value in that same year 3) Discount forward the carbon dioxide in the projected year to the base year present value at the same SCC discount rate (3%)	Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (February 2010), page 39, Table A-1 “Annual SCC Values 2010-2050 (in 2007 dollars)” <a href="http://www.epa.gov/oms/climate/regulations/scc-tds.pdf">http://www.epa.gov/oms/climate/regulations/scc-tds.pdf</a>  NOTE: - SCC values are per unit metric ton of carbon dioxide and already discounted forward to the reference year (in 2007 nominal dollars).
		2010	USD 21.40		
		2011	USD 21.90		
		.	.		
		.	.		
		.	.		
		.	.		
		2050	USD 44.90		

## Appendix V: Technical methods used by State DOTs for project prioritization

The technical methods used by State DOTs for project prioritization fall into three main classes. They are described below, drawing from Vickerman and Gillen (2013, pp. 79-80).

- **“Multi-Criteria Analysis (MCA),** which involves of rating projects along a variety of factors. MCA allows for qualitative and quantitative factor ratings to be considered together in a summary table. Ohio DOT (2011), Wisconsin DOT (2007), and Missouri DOT (2004) use variants of this method, with formally specified weights applied to each factor so that an overall total score can be computed for each project. These DOTs all calculate GDP or employment impacts from a regional economic impact model (REMI or TREDIS) that directly calculates productivity and economic growth impacts. The states then assign a weight to that predicted benefit. They also add weight to other factors affecting local productivity, such as connectivity (to intermodal terminals, key state-wide corridors and export gateways) and spatial development (supporting regeneration, cluster and in-fill development).”
- **“Benefit Cost Analysis.** This is typically done through a two-step process of quantitative CBA calculation and qualitative factor ratings. First, CBA is calculated considering only user benefits and costs, following guides of the Association of State Highway and Transportation Organizations (AASHTO, 2010). Then qualitative factors are considered that reflect non-user benefit categories including regional and local economic competitiveness and development, environmental and social impacts. Minnesota DOT (2009, 2012) and California DOT (2007) adopt this approach.”
- **“Composite Scoring Systems.** Kansas DOT (2010) developed a composite scoring method, which calculates GDP impact using the TREDIS economic analysis framework to account for labor market and freight market access impacts. The GDP impact rating is then combined with engineering CBA rating and a “local consultation” rating (from community meetings) to provide a composite score. (Environmental factors enter only insofar as they are raised by the local community consultation.) The Vermont Agency of Transportation (Vtrans) has a different points system for rail and aviation projects. The rail rating gives points to projects that increase use of the mode and reduce transport costs for the state’s industries. The aviation rating considers effects on job creation as well as activity levels and percentage of surrounding population served. There is also a rating for highway projects, which gives extra weight to projects that recognize impacts on productivity for the state’s trucking industry, which will in turn also reduce overall costs of doing business for Vermont manufacturers.