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Draft: A Mapping of Best Practices for Spatial Development Planning and Appraisal

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Executive summary

The SPADE (Assessing the added value from **SPA**tial **DE**velopment as a factor in infrastructure planning) – project refers to the central question raised by CEDR on *How to achieve integrated project development of infrastructure and its spatial surroundings?* This draft report is the second deliverable from work package 3 in the SPADE project. The objective of Work Package 3 is to provide an up to date literature review and validation of best practices on the appraisal of infrastructure investments and projects, and their relation with spatial development both urban and rural.

In this paper, we review the basis of transport planning and appraisal processes from theory and practice. We start by reviewing the theoretical and empirical foundation of impact assessment of transport measure with focus on impacted not monetized in public guidelines (i.e. wider impacts). Then, we review the current practices in public guidelines for transport planning and appraisal, which turn out to have varying scope over countries. The assessment methods for transport infrastructure and policy measures evolved from a classical CBA, which has already been used several decades ago towards more qualitative and other quantitative methods. Multi-criteria analysis might play an important role by adding different stakeholder views with corresponding importance ratings and weights to the considered criteria. The scientific literature provides numerous approaches how a combination of CBA with MCA could improve the meaningfulness of the assessment results. In the national guidelines, however, this trend can be observed only in a few countries. This is partly due to the age of these guidelines and partly because it is hard to formalize further criteria and methodologies which fit every transport project.

The actual assessment of transport measures is in general only a small part within the overall planning procedure. Therefore, we next review and discuss the role and potential that lies within collaborative planning and how alternative assessment methods might shed light on impacts of transport measures. We argue that broadening and structuring the participation in decision-making processes may provide a better basis for including information from various stakeholders in the decision process in a neutral way. We conclude this chapter by presenting recommendations for tool to achieve this. We do this by building forth on an existing collaborative planning tool for infrastructure planning developed by (Kiel, Smith, & Ubbels, 2014). We reviewed other collaborative planning tools to enhance their tool to fit our purpose. The tool will be accompanied with a guideline for the mediator in which these principles are laid down.

Our contribution is both to provide an overview over the current status of the transport planning and appraisal field and to illuminate the potential that lies in further development.

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1 Introduction

The CEDR Transnational Research Programme was launched by the CEDR. CEDR is the Road Directors' platform for cooperation and promotion of improvements to the road system and its infrastructure, as an integral part of a sustainable transport system in Europe. Its members represent their respective National Road Authorities (NRA) or equivalents and provide support and advice on decisions concerning the road transport system that are taken at national or international level.

The participating NRAs in the **CEDR Call 2017: Collaborative Planning** are **Austria, Finland, Netherlands, Norway, Sweden** and the **United Kingdom**. As in previous collaborative research programmes, the participating members have established a Programme Executive Board (PEB) made up of experts in the topics to be covered. The research budget is jointly provided by the NRAs as listed above.

1.1 The SPADE Project

The SPADE (Assessing the added value from **SPA**tial **DE**velopment as a factor in infrastructure planning) – project refers to the central question raised by CEDR on *How to achieve integrated project development of infrastructure and its spatial surroundings?* The project relates to the assessment of an integrated spatial and infrastructure development (issue C in the DoRN). This issue focusses upon the assessment of the added value of the integrated plans and designs, in order to get an insight in the societal relevance of collaborative planning. In order to meet the main objective, a consortium of Panteia (lead), TØI, HaCon and AIT has taken the challenge to develop an assessment method, based upon a literature review and existing knowledge.

The proposed assessment method in the SPADE project is based on a process and a tool:

- The process comprises a description of collaborative planning in which stakeholders from different backgrounds, with different 'wish lists' and different planning procedures need to work together.
- The tool is a combination of a digital workshop and an assessment tool. The assessment tool has been developed for Rijkswaterstaat (NL) and combines a multicriteria analysis (MCA) with a cost-benefit analysis (CBA).

CEDR seeks inclusive methods for assessing costs and benefits of combined infrastructure and spatial development, building on existing knowledge and including specific contexts such as nation-wide, urban or rural regions. The development of an assessment method puts us for some challenges:

1. There is a need for improved understanding of the relation between spatial and multimodal infrastructure development
2. The question is how to assess the societal value of combined multi-modal infrastructure and spatial development for decision-making on investments. This requires answers to specific questions such as:
    a. How to make an assessment beyond the value-of-time and monetary terms?
    b. How to address topics such as social cohesion or health in the assessment?
    c. How to carefully weigh the different aspects?
    d. How to take the specific contexts (nation, urban and rural) into account?
3. How to capture the added value from combined infrastructure and spatial development and how to translate the added value as a driving factor for infrastructure planning?
4. Mapping of consequences from such an inclusive assessment and capturing added value for the NRAs responsibility for road infrastructure development.

1.2 The Objective of the Literature Review

This draft report is the second deliverable from work package 3 in the SPADE project. The objective of Work Package 3 is to provide an up to date literature review and validation of best practices on the appraisal of infrastructure investments and projects, and their relation with spatial development both urban and rural.

When it comes to the development of the transport system, investment strategies are often based upon a cost-benefit analysis (CBA). However, the broader benefits of infrastructure development are not always seen or taken into account and thus not sufficiently considered in planning and evaluation processes. A broader view can provide a better basis for agreement on transport investments and contribute to an efficient allocation of investments.

The transport user benefits are often labelled as direct effects and the additional economy wide effects caused by market imperfections as indirect effects or wider economic impacts. In addition, there is a growing literature on wider non-economic impacts such as wider environmental effects, health, quality and other wider social impacts of transport policy measures and infrastructure investments.

1.3 Structure

In this deliverable, we review the basis of transport planning and appraisal processes from theory and practice. After this introduction in chapter 1, we first elaborate on the research methodology in chapter 2. We continue with a review the on theoretical and empirical foundation of impact assessment of transport measure with focus on impacted not monetized in public guidelines (i.e. wider impacts) in chapter 3. Then, we review the current practices in public guidelines for transport planning and appraisal, which turn out to have varying scope over countries. Next, we review and discuss the role and potential that lies within collaborative planning in chapter 4 and how alternative assessment methods might shed light on impacts of transport measures in chapter 5. In chapter 6, we draw our conclusions.

2 Research methodology

2.1 Literature Review

The literature review will distinguish between different classes of direct and indirect effects, theoretical and empirical research, methods for calculating or assessing different impacts, and how different these impacts are treated in official guidelines for transport appraisal and their relation with spatial development.

The literature review should provide an overview and synthesis of previous research and current best-practice. The review should be an objective review of published research literature, official guidelines, technical reports and other written sources relevant to our topic. The DoRN (Direction of Research Needs) outlines the expected output as: A review of the state-of-the-art literature and good practice cases of valuation and capturing of combined spatial and (multi-modal) infrastructure development – taking into account different contexts (urban and rural regional contexts). As outlined in the description of *Topic C* in the DoRN, “an integrated planning approach calls for assessment of infrastructure investments beyond value-of-time, which addresses actual issues and future trends as: climate change, economic development potential, health, social cohesion and the spatial structure for future development of counties, as well as cities and rural regions.”

The literature review should:

1. Identify the key theories, concepts and ideas
2. Distinguish what has been done from what needs to be done
3. Identify how the knowledge on the topic is structured and organized
4. Identify major issues and debates
5. Place the research project in a historical context

The review is intended to bring valuable input both for the researchers in the project as well as for the client. For the researcher the review helps to clarify the scope of the research project by creating a narrative of what is and is not known in the field and where there are areas of dispute. For the customer of the research and other readers, the review also provides valuable context, establishes the researcher’s expertise, and relates the findings of the project to what is already known (Avni et al. 2015).

We have divided the literature review research task into the following sub tasks:

1. General literature on integrated transport and land-use planning strategies, as well as literature that review current practice in transport appraisal and/or spatial planning.
2. A review of the scientific literature on wider economic and non-economic impacts of infrastructure investments and transport policy measures and the relation to spatial development.
3. A review of literature on collaborative / integrated planning in transport appraisal and spatial development
4. Beyond cost-benefit analysis: A review of complementary and/or alternative assessment methods. With a focus on MCA and combinations of MCA and CBA.
5. Review of official guidelines for transport appraisal with the aim of identifying broader effects of transport policy measures that are considered important, classifying these effects and their accompanied suggested assessment methods

A systematic review is an explicit systematic method for reviewing literature based on certain predefined criteria by attempting to identify, appraise and synthesize all relevant studies in order to answer a particular question (Gough et al. 2013). In a systematic review, a set of inclusion criteria have to be established in the literature search process. Normally, these inclusion criteria are key words used in the active literature search in the literature databases. Examples of such databases for scientific literature are Google Scholar, Web of Science, TRID and Science Direct. The complete list of the collected literature is found in the reference list.

2.2 Literature Search

The literature search process in a literature review is an iterative process conducted across a series of sources and databases, it is a process that (Avni et al. 2015):

- Collects relevant material
- Merges and refines overall results, and
- Structures the results to add value.

To add to the list of literature contained through the systematic search process, one option is to apply snowballing techniques. Forward snowballing implies finding citations to a particular paper, while backward snowballing is to follow the citations in a particular paper. These techniques could add relevant literature omitted by the predefined inclusion criteria. Another option to check the relevance and completeness of the list of collected literature, is to circulate it among experts. Where the final list is a list of resources that have been identified as relevant to the subject and that brings information to the literature review. A common “problem” when working with literature reviews is that a search in the literature databases often results in too many papers being found for inclusion in the review. If this is the case, then we must impose selection or exclusion criteria. However, there should be a clear rationale behind the selection criteria such as publication year, number of citations, geographical area, etc.

Often there is a need to trim the initial literature search in order to identify what is relevant from the literature and what is not relevant. The retrieved sources can then be organized into three categories according to the relevance for our topic:

1. Definitely relevant
2. Possibly relevant
3. Not relevant

Snowballing techniques can then be applied on the sources categorized as definitely relevant.

A major part of the tasks connected to work package 3 in the SPADE project, is to review official guidelines for transport appraisal with the aim of identifying broader effects of transport policy measures that are considered important, classifying these effects and their accompanied suggested assessment methods. We have identified and included the following guidelines in our review. The complete reference of the guidelines are found in the literature list:

Australia (nationally)	(Commonwealth of Australia 2006), (Austroads 2011), (Australian Transport Council 2006), (Department of Infrastructure and Regional Development 2014), (Infrastructure Australia 2012)
Australia (New South Wales)	(Transport for New South Wales 2013), (Hensher et al. 2012), (Douglas and Brooker 2013)
Australia (Victoria)	(Department of Transport 2010), (Department of Transport 2012)
Austria	(Bundesministerium für Verkehr and Österreichische Forschungsgesellscaft Strasse – Scheiene – Verker 2010a, 2010b)

Belgium	Rebel (2013; 2014), De Lijn (2015)
Canada (nationally)	(Transport Canada 1994), (Treasury Board of Canada Secretariat 2007)
Canada (BC)	(Ministry of Transportation and Infrastructure 2014), (National Cooperative Highway Research Program 2014) Correspondence with The Highway Planning & Programming Branch's Manager for Economic Analysis
Denmark	(Transportministeriet 2003, 2015), (Copenhagen Economics 2014)
Finland	(Liikennevirasto 2011, 2013)
France	(Commissariat général à la stratégie et à la prospective 2013a, 2013b)
Germany	(Federal Ministry of Transport 2003a, 2003b) (Federal Ministry of Transport and Digital Infrastructure 2016)
Greece	(EU Structural Fund – ERDF et al. 2003b, 2003a)
Iceland	Correspondence with Icelandic Road and Coastal Administration and School of Science and Engineering, Reykjavik University
Ireland	(National Roads Authority 2011a, 2011b, 2011c), (National Transport Authority 2010), (T. a. S. Department for Transport 2016)
Italy	Ministero delle Infrastrutture e dei Trasporti (2017).
Japan	(Ministry of Land Infrastructure 2009, 2010)
The Netherlands	Romein & Renes, (2013a, 2013b), Centraal Planbureau (2018a, 2018b), Rijkswaterstaat (2018), Bruyn et al. (2017).
New Zealand	(NZ Transport Agency 2018), (Kernohan and Rognlien 2011)
Norway	(Vegdirektoratet 2014)
Spain	(Centro de Estudios y Experimentación de Obras Públicas (CEDEX)/ Ministerio de Fomento 2010), (Rus 2009)
Sweden	(Trafikverket 2014)
Switzerland	(Bundesamt für Strassen (ASTRA) 2003), (Bundesamt für Strassen and Ecoplan 2010)
UK (England)	Department for Transport (2013, 2014a, 2014b), (Environment Agency 2007), (DfT 2014b, 2014a), (DEFRA 2005)
UK (Scotland)	(Transport Scotland 2008, 2014)
USA (nationally)	(Federal Highway Administration 2003), (US Department of Transport 2012b, 2012a), (National Cooperative Highway Research Program 2014), (Strategic Highway Research Program 2014), (Weisbrod 2013)
USA (California)	(California DOT 2007), (American Association of State Highway and Transport officials (AASHTO) 2003)
USA (Kansas)	(Kansas DOT 2010)

USA (Minnesota)	(Minnesota DOT 2009, 2012), (American Association of State Highway and Transport officials (AASHTO) 2003)
USA (NC)	(North Carolina DOT 2014)
European Commission	European Commission (2014).
EIB	(European Investment Bank 2013)

2.3 Limitations

In our study, we cover a broad range of empirics, methods, practices and assessment tools in context of transport planning and appraisal processes This imply that we have not been able to cover everything in detail, but still we provide relevant literature references to readers interesting in a specific topic might pursuit. Our focus is particularly on wider impacts in theory and practice, and the potential that lies within combining cost-benefit analysis with multi-criteria analysis.

3 Direct and indirect effects of transport measures

3.1 *Introduction*

In this chapter, we categorized and provide the theoretical and empirical foundation of impacts from transport measures. In addition, we review the current practices.

3.2 *What Happens When We Invest in Transport improvements?*

If we consider the economic effects of investments in transport infrastructure, one has to make the distinction between direct and indirect effects, temporary and permanent effects, and market and non-market or external effects (Oosterhaven and Knaap, 2003).

Table 3.1: Type of effects of transport infrastructure investments (Oosterhaven and Knaap, 2003)

		Temporary	**Permanent**
Direct	via markets:	Construction effects	Exploitation and time savings effects
	external effects:	Environmental effects	Environmental, safety etc effects
Indirect	via supply:	Backward expenditure effects	Backward expenditure effects
	via demand:	Crowding out effects	Productivity and location effects
	external effects:	Indirect emissions	Indirect emissions etc.

The temporary effects occur during the construction period. These are both direct and indirect effects demand effects, indirect supply effects, and direct and indirect external environmental effects.

The permanent direct economic effects are linked to the use of the infrastructure and are often the primary reason for making the investment in the first place. The permanent direct effects include the exploitation of time and costs savings from the transport users. The use of the infrastructure will also have permanent effects on the environment, safety, etc.

In addition, there will be permanent indirect economic effects: (i) related to the backward expenditure effects of the exploration and use of the infrastructure, and (ii) related to the production and location decisions of firms and people. In addition, there are permanent indirect external effects such as indirect emissions, etc.

3.3 *Which Effects Are Considered in National Guidelines?*

In the appraisal of transport infrastructure investments, we normally apply cost-benefit analysis (CBA) to calculate and compare the benefits and costs of a project. Conventional CBA consider the priced consequences of a project, typically the direct user benefits of a project in addition to direct external effects on emissions or accident rates.

Cost-benefit analysis is an important way to overcome cognitive, structural and process-related limitations and biases in decision-making (e.g. Mackie, Worsley and Eliasson 2014) and to quantify project values. Impacts not included in the CBA-setup are instead treated by a comprehensive assessment framework for non-monetized impacts. Neither the English guideline nor other international guidelines have very explicit appraisal procedures for summing up monetized and non-monetized effects (e.g. Mackie and Worsley 2013).

Mackie and Worsley (2013) find that important improvements in English guidelines since 2003 regards wider economic impacts, crowding, reliability and air population. As possible improvement points for future guidelines, Mackie, Worsley and Eliasson (2014) point out time savings, congestion, crowding relief and reliability benefits in the business sector. Mackie and Worsley (2013) also find that the regional dimension is relatively more challenging to handle in countries with a federal structure.

In our review of official guidelines, we find different practice when it comes to how to group the different effects of transport infrastructure investments. In some guidelines, the effects are grouped into monetized and non-monetized effects (e.g. the Norwegian guideline for transport appraisal) while other guidelines group the effects into direct, indirect and external effects (e.g. the Belgian guidelines for transport appraisal). A third possible way of grouping the effects of infrastructure investments in the guidelines is thematically.

Table 3.2: Example of a thematical classification of effects from the UK WeITAG/WebTAG

Social impacts	**Economic impacts**	**Environmental impacts**
Physical activity	Journey time changes	Noise
Journey quality	Journey time reliability changes	Air quality
Accidents	Transport costs	Green house gases
Security	Induced investment	Landscape
Accessibility (to employment, and service)	Employment (labour supply, move to more/less productive job)	Townscape
Affordability	Productivity (agglomeration)	Historic environment
Severance	Land (agriculture)	Biodiversity
Option to non-use values	Capital and revenue scheme costs	Water environment

3.4 Theoretical Background: Wider Economic Impacts

CBAs are usually conducted as partial market analyses in which the effect in the primary market (the transport market) is assessed partially, while all prices in the secondary (adjacent) markets are assumed to remain constant. Assuming perfect markets, all relevant benefits in the CBA are captured in the calculated transport user benefits (Dodgson, 1973; Jara-Diaz, 1986). These permanent direct effects from use of the infrastructure (Oosterhaven & Knaap, 2003) are caused by the transport users' and merchandise owners' time and reliability benefits, the changes in their distance-dependent monetary costs (vehicle costs, toll fares, fare tickets), public budget effects and profits from companies in the transport sector. In addition, external effects from use of the infrastructure will arise, i.e. accident costs, emissions, noise costs, etc. In a perfect competitive environment, indirect effects in the secondary markets will equal direct user benefits in the primary market. However, this is not equivalent to infrastructure investments not producing rippling effects in the economy. Infrastructure investments will produce effects in secondary markets, even in a perfect competitive environment, but by default will perfectly equate the direct user benefits measured in the primary market. Adding spillover effects in a perfect competitive environment will therefore only result in double counting (Mohring, 1993).

However, if the secondary markets are distorted, the direct user benefits no longer equal the total benefits of a project. In situations characterized by deviations from the first-best solution, with prices exceeding marginal cost in secondary markets, market imperfections will produce benefits in secondary markets not cancelling out. There are many reasons for market imperfections, the most common being taxes and subsidies and market power, where, for example, economies of scale may lead to unregulated market power in product markets. Thus, in taking only the direct effects of a project into account, project appraisal may be an over- or underestimation of the total project specific benefits (Harberger, 1964; SACTRA, 1999), which in turn could lead to suboptimal public investment strategies.

In the event of prices in secondary markets not equaling marginal cost, the most important welfare effects not captured in a traditional and well-specified CBA are, according to SACTRA (1999), (i) agglomeration externalities, (ii) labour market effects, and (iii) impacts in markets with imperfect competition.

Agglomeration Externalities

Agglomeration externalities are the main focus of attention in the literature on the WEIs of transport infrastructure investments (e.g. Graham & Dender, 2011; Graham, 2007; Laird, Nellthorp, & Mackie, 2005; van Exel, Rienstra, Gommers, Pearman, & Tsamboulas, 2002; Venables, 2007). Economic performance is statistically correlated with geographic concentrations of economic activities. Improving the quality of the transport network increases the effective density of an area by bringing people, businesses and jobs closer together, in this way increasing productivity and enhancing economic output. Economies of agglomeration are positive externalities induced through the spatial concentration of economic activity, and are additional to transport user benefits from the CBA (Venables, 2007). Theorists offer possible explanations for a potential causal linkage from agglomeration to productivity by agglomeration arguments (e.g. sharing, matching and learning), competition arguments (e.g. firm selection, disciplinary effects and less misusage of market power) and other arguments about traveling costs reduction. There has been a growing consensus in the economic literature that there are causal linkages from economic congestion to productivity (see for instance Graham et al. 2010 and Behrens, Duranton and Robert-Nicoud 2014). The different rationales are not mutually exclusive but may coexist and explain different portions of the aggregate productivity impact. Different mechanisms might also come in to play at different level of aggregation, considering that productivity impulses from increased economic congestion might both be a result of improved productivity within firms and reallocation of factor inputs between firms.

The argument about firm selection can be found in Melitz (2003), building on Krugman's (1980) monopolistic competition model. He argues that higher average productivity of firms and workers in larger cities can be a result of stronger Darwinian selection of firms. Similar arguments could for instance be found in Fujita (1998) and Behrens, Duranton and Robert-Nicoud (2014). Other types of potential productivity impulses from increased competition include disciplinary competition effects and reduction in misusage of market power.

Arguments about agglomeration synergies can be traced all the way back to Marshall (1890), who study labor market pooling, input sharing and knowledge spillovers. Still, there are several types of agglomeration effects that Marshall does not discuss, including natural advantages, home market effects, urban consumption opportunities and rent seeking (Rosenthal and Strange 2004). Agglomeration may also induce direct cost savings on transportation (e.g. Venables 2007 and Shirley and Winston 2004).

A refined version of the agglomeration argument can be found in Duranton and Puga (2004). They distinguish between three agglomeration effects; sharing, matching and learning. Shorter distances and traveling time leads to sharing of larger product markets, factor markets and common goods. Consequently, more firms obtain scale and scope advantages, which in turn will stimulate firm-level productivity (e.g. Aschauer 1989 and Elberts and McMillen 1999 for common goods; and Rivera-Batiz 1988, Berliant, Reed and Wang 2006, Bernard, Moxnes and Saito 2014, Davis, Fisher and Whited 2014 and Holmes 1999 and Eeckhout, Pinheiro and Schmidheiny 2014 for buyer-purchases relations).

Implementation of major road construction projects may involve increase in agglomeration in terms of decreased traveling distances between economic actors. Such an increase in agglomeration may contribute to higher national wealth if it stimulates factor inputs to move to areas with higher factor return or result in higher regional income. Higher regional income could be a result of commuting to neighboring regions with higher factor return in neighboring areas or higher factor return locally. Conversely, there might be sorting mechanisms where some regions loose high-end factor inputs and scale effects to other regions, and thereby experience a negative impulse from agglomeration impulses nearby (see for instance Kanemoto 2013a and 2013b and Behrens, Duranton and Robert-Nicoud 2014). Thinking in terms of a general equilibrium framework, positive impulses for an industry at one location might also lead to displacement of activities in other regions further away, as well being beneficiary for customers in other regions.

Transportation network and economics of scale is also important for industry structure over space (e.g. Krugman 1991). Burmeister and Colletis-Wahl (1997) point out that non-material flows become more important when transportation costs are at a low level. They argue that transportation infrastructure in a network economy can be considered as resource for circulation. Banister and Berechman (2001) argues that a combination of agglomeration externalities, complementary political environment and investment design that supports network effects is needed to obtain growth impulses from investment in infrastructure projects. New road constructions different impacts on national welfare through agglomeration are most often analyzed separately, but some authors have built model frameworks that compile some of the effects (confer Krugman 1991, Venables 2007, Lakshmanan 2011, Behrens, Duranton and Robert-Nicoud 2014 and Davis, Fisher and Whited 2014 for example of models; confer Duranton and Puga 2013 for a review).[1]

In the literature, a distinction is often drawn between productivity gains that arise from firms in the same sector or along the same value chain geographically co-locating (intra-industry), and productivity gains from having a large and densely populated city (inter-industry) (Fujita & Thisse, 1996). The former is often referred to as localisation economies, and the latter as urban agglomeration economies (Duranton & Puga, 2004).

Labour Market Effects[2]

The scientific literature distinguishes at least five different labour market effects that may lead to WEIs of transport infrastructure investments (e.g. DfT, 2008; Elhorst & Oosterhaven, 2008; Laird & Mackie, 2009; Manning, 2003; Venables, 2007):

1. Changes in the number of workers choosing to work as a result of lower commuting costs
2. Changes of the number of hours worked as a result of changes in commuting costs
3. Re-localization of labour to more productive sectors
4. The effect of excess supply in the labour market
5. The effect of a “thin” labour market.

There is a close link between the transport market and the labour market, the latter typically being subjected to several market imperfections such as distortionary taxation, imperfect information, and imperfect competition. Distortionary taxation creates an efficiency loss in the labour market, that is, while workers make their choices based on net wages, the productivity gains for society equal his/her gross wages. Hence, the benefits of increased wages are only partly captured by the consumer surplus used in the CBA (Venables, 2007). The tax impacts of moving to more productive jobs are often calculated by multiplying the tax rate with the relative productivity adjusted wages. It is the net effects that are important, and it is often assumed in transport appraisals that there is no net additional employment.

[1] We are only interested in new road constructions impact on agglomeration in this review, but they will of course affect conditions beyond agglomeration as well (e.g. investment costs for the construction, changes in operating costs for the route, safety concerns, environment concerns, esthetics concerns, offer of public transportation and traffic mobility for cyclist and pedestrians).

[2] The description of labour market effects and the impacts in markets with imperfect competition, are taken from Wangsness, Rødseth and Hansen (2017).

In cases of involuntary unemployment, the wage that clears the labour market lies below the actual wage, and the actual employment below the market clearing level. If employment increases as a result of investments in infrastructure, the welfare gains will be greater than the user benefit associated with the change in commuting costs. Elhorst and Oosterhaven (2008) study four different variants of the Dutch Maglev-line projects, and find WEI additionality due to impacts on involuntary unemployment in the range –1% to +38% of the CBA calculated user benefits. This challenges the traditional view that involuntary structural unemployment is not relevant to a CBA in mature transport networks (Laird & Mackie, 2014).

Labour markets in rural areas are often characterised as thin, giving firms power over workers (Manning, 2003). In such cases, the rate of exploitation (Hicks, 1932; Pigou, 1924) drives a wedge between the marginal productivity and marginal costs of workers. The employer will increase his profit by hiring an additional worker, but the fact that the wages for the entire stock of workers will have to be increased gives no incentive to hire. Transport infrastructure improvements may result in lower job search costs for unemployed workers, and hence reduce the market distortion of imperfect information creating additionality in the CBA calculated commuter benefits (Pilegaard & Fosgerau, 2008). In addition, larger labour markets increase the incentive for workers to acquire skills, and thereby increase their productivity, without the danger of being held-up by the monopsonist employer, since they can always threaten to take their specialist skills elsewhere (Matouschek & Robert-Nicoud, 2005). Laird and Mackie (2014) identify the importance of WEIs in rural areas and discuss how these might be captured in ex ante project appraisal.

Impacts in Markets with Imperfect Competition

In many cases, the absence of a functioning and well-developed infrastructure will act as an entry barrier to goods and service markets in rural areas. An investment in infrastructure that provides increased accessibility and lower transport costs may result in new entries in markets characterized by few actors prior to the investment (Laird & Mackie, 2014). New entries will increase competition and efficiency in the economy and have welfare effects beyond user benefits in the CBA. Jara-Diaz (1986) studies two regions with one monopolist in each region producing homogenous goods. Reduced transport costs enable the monopolists to attract customers from the adjacent region by lowering the price of the product. Increased competition reduces prices, raises total production, and reduces the deadweight loss of monopoly. Lower production costs and enhanced efficiency may, in turn, lead to the development of regional specialization and greater intra-industry and inter-regional trade and freight movements over an expanded production space (Lakshmanan & Anderson, 2002). Product differentiation (monopolistic competition) allows firms to exercise some market power over consumers. In a market structure like this, a reduction in transport costs may permit firms to explore their economies of scale by spatially expanding their markets. This leads to an additional welfare effect for consumers, as they experience a larger variety of supplied products (Rouwendal, 2002).

3.5 Empirical Evidence of Wider Economic Impacts

The theoretical foundations of WEIs are well defined, but their empirical verifications are debatable. In a review of the empirical literature on the relationship between transport infrastructure investments and productivity and economic growth (Deng 2013), the author argues that while most studies reveal positive but modest contributions from transport infrastructure to growth, there is a great deal of controversy concerning the direction and magnitude of the growth-enhancing effects. Whereas older studies of the topic often are macro oriented, new studies focus increasingly on firm-level evidences and causal identification.

The standard approach to estimating the impact of agglomeration externalities on economic output has been to use a production function framework, see Melo et al. (2009) for a review of

729 elasticity estimates from 34 studies covering the period 1965 – 2002. Melo et al. (2009) show that the findings in the literature on the relationship between agglomeration and productivity differ substantially, depending on sector, geography and method of measurement. They find that average elasticity of productivity with respect to the magnitude of the functional city area is 0.058. Presence of controls for both unobserved cross-sectional heterogeneity and differences in time-variant labor quality may give rise to large differences in the results. Correction for reverse causality of agglomeration does not appear to change the urban agglomeration estimates noticeably. The authors' review also indicates that the impact that the agglomeration impact is stronger in service industries than manufacturing industries, a finding supported by other studies (e.g. Graham 2007, Glaeser and Gottlieb 2009, Graham, Gibbons and Martin 2009, Combes et al. 2012, Deng 2013 and Holl 2016).

Rosenthal and Strange (2004) find similar results in a survey of cross sectional evidences on productivity effects, with average elasticity of productivity with respect to city size of between 0.04 and 0.11. Similar findings with elasticities around five percent are found in newer studies (Behrens, Duranton and Robert-Nicoud 2014 and Davis, Fisher and Whited 2014). In a cross-sectional study, Ciccone (2002) finds that the elasticity of labor productivity with respect to employment density is 4.5 at average in Europe, compared to 5.0 in the US. Rice, Venables and Patacchini (2006) find that doubling the working age population in a given area is associated with a 3.5 percent direct increase in productivity, while the occupational composition effect is not robust to different model specifications.

In case of increased economic congestion, the strength of different underlying agglomeration and competition effects will depend on industry and geographical configuration. Investigating agglomeration impacts on sharing of ideas, goods and labor in industries collocated in the US, Ellison, Glaeser and Kerr (2010) evidence for all three Marshallian agglomeration impulses with input-output linkages being the most important. Data for UK industries and from US areas where the two industries are not collocated are used as a control to reduce possible reverse causality. In line with Ellison and Glaeser (1999), they also assess the expected co-agglomeration of each industry pair caused by the uneven spatial distribution of natural advantages.

Applying an empirical spatial general equilibrium model with heterogeneous firms, Gaubert (2015) finds that nearly two thirds of the observed higher productivity in cities than rural areas is due to firm sorting. She finds that political actions that decrease local congestion increase aggregate total factor productivity and welfare, while regional policies for rural areas have negative aggregate effects. Behrens, Duranton and Robert-Nicoud (2014) applies a calibrated regional economy model to study regional productivity differences. By the same token as Gaubert, they find support for geographic reallocation of economic activity caused by agglomeration and vice versa, where firm and individual sorting and agglomeration effects complements each other. Their results are based on calibrated model. Studying trade between cities in the context of US interstate highways, Duranton, Morrow and Turner (2014) find that cities with a more highways specialize in sectors producing heavy goods.

A growing literature has documented productivity effects from agglomeration by decreasing traveling times through road constructions. Until recently, studies of wider economic impact of infrastructure of transportation were typically macro studies (confer Melo, Graham and Brage-Ardao 2013 for a review). For instance, Aschauer (1989) finds in an early study that infrastructure for transportation and water systems are the types of public capital yielding the highest productivity impact. Since the turn of the millennium, research on wider impacts from infrastructure projects has become more micro-oriented. Several researchers find that highways attract economic activities, thereby increasing local economic activities (see for instance Chandra and Thompson 2000, Holl 2003 and 2016, Duranton and Turner 2012, Gibbons et al. 2016; confer Redding and Turner 2014 and Combes and Gobillon 2015 for reviews).

Graham et al. (2010) explore the causal linkage between productivity and road investments in United Kingdom, using a panel vector autoregressive model. Their results indicate that both localization and urbanization Granger cause productivity, and vice versa. Combes et al. (2012) apply a nested model of selection and agglomeration synergies, which utilizes productivity distributions over area densities, on a French panel data set from 1994 and 2002. The authors find that firm selection is not enough to explain spatial productivity differences alone. Aggregate productivity is not only determined by firm-level productivity, but also the development in employment in firms and regions. Duranton and Turner (2012) find that a ten percent in a city's initial stock of highways causes about a 1.5 percent increase in its employment over a twenty years' period.

A growing consensus in the economic literature agrees upon substantial causal linkages from economic congestion to productivity (see for instance Graham et al. 2010 and Behrens, Duranton and Robert-Nicoud 2014). Holl (2016) finds support for productivity effects from Spanish highways, investing firms traveling distance to the highway network, particular in urban areas and for manufacturing firms. As sources for exogenous variation, she exploits ancient Roman routes, assessments of geodesic market potential from 1900 and geological conditions. Gibbons et al. (2016) find that new road infrastructure in United Kingdom provide positive employment effect for small-scale geographical areas, while productivity increases in other areas with negative employment effects. The authors interpret their results that new transport infrastructure attracts transport intensive firms to the local area from other areas. They address the possible reverse causality challenge related to road constructions by fixing traveling times within buffer zones over time. Combes et al. (2010) find that reverse causality from productivity to agglomeration is a minor problem in practice.

Some studies substantiate that the agglomeration effects decline with traveling time. Rice, Venables and Patacchini (2006) find that the effect of proximity on productivity decline steeply with traveling time, ceasing to be important beyond approximately 80 minutes. By the same token, Duranton and Overman (2005) find positive effects from collocation within 50 kilometers. A similar result is found by Graham, Gibbons and Martin (2010) and Rosenthal and Strange (2003). Graham, Gibbons and Martin (2010) also establish that the effects of agglomeration on productivity diminish less rapidly with traveling time for manufacturing firms than for service firms, while Rosenthal and Strange (2003) find that industrial structure and corporate organization affect the clustering benefits within a given industry, in line with the finding of Saxenian (1994). In an early contribution, Hansen (1959) demonstrate how economic gravity could be assessed in a logistic market potential framework.

Bernard, Moxnes and Saito (2015) find that Japanese high-speed train line improves firm performance through decreased traveling time, inter alia by contributing to new wholesaler-retailer links and lowering cost of passenger traveling without increased shipping costs. Shirley and Winston (2004) find that highways reduce firms' logistics costs by reducing the inventory stocks. Similar results are found by Datta (2012) and Li and Li (2013). Investigating Canadian manufacturing establishments operating over the period from 1989 to 1999, Brown (2013) find that young, small, domestic and single-plant firms in general obtain more agglomeration gains than older, larger, foreign-controlled and multi-plant firms do. His empirical results suggest that the former group obtain stronger productivity gains from the matching of workers and knowledge spillovers, whereas the latter group obtain stronger productivity gains from the presence of upstream input suppliers.

3.6 Current Practice on Wider Economic Impacts from National Guidelines

In a review of how 23 industrialized countries (Wangsness, Rødseth and Hansen, 2017) treat wider economic impacts in their official guidelines for transport appraisal, the authors identify 12 different types of impacts treated in official guidelines, where *agglomeration impacts* and *production changes in imperfect markets* are identified as the most widely accepted, being recognized by 14 and 10 countries respectively.

In the figure below, the findings from Wangsness, Rødseth and Hansen (2017) are sorted from most widely recognized to least recognized.

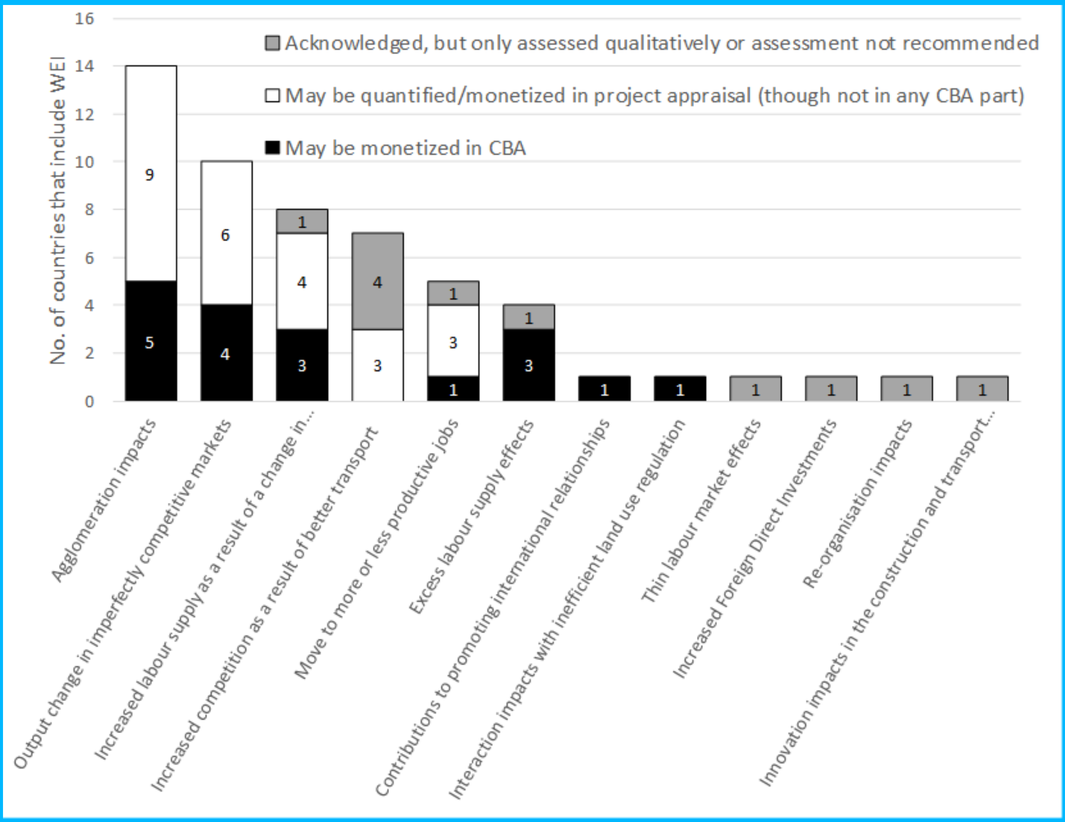

Figure 3.1: The types of WEI that are acknowledged in reviewed countries (Wangsness, Rødseth and Hansen, 2017)

The figure also shows another aspect of the status of the various types of WEI, namely how they may be included in transport appraisals, cf. the description of how observations are categorised above. Looking at all 12 types at once, we can see that the types of WEI that are most “mainstream” are those that to the greatest extent are allowed monetisation. The most common category of recognition is WEIs included in the guideline may be monetised/ quantified but presented separately from the CBA (25 out of 54).

The output from the review in Wangsness, Rødseth and Hansen (2017) is summarized in the table below. In the table, the identified WEIs are classified into three classes:

A. WEIs may be monetized and included in the CBA as part of the net present value (NPV) and/or in the benefit-cost ratio (BCR)
B. WEIs may be monetized/quantified but presented separately from and CBA-part in the project appraisal, e.g. as an account of its own in a multi-criteria analysis, impact assessment or other form of appraisal
C. WEIs may be presented, but only as a qualitative assessment, or not recommended to be assessed at al.

Second, the observations are classified according to whether the guidelines have specific recommendations with respect to the type of method to be used.

M: The corresponding type of WEI is included in the country guideline, with method recommendations.

NM: The corresponding type of WEI is included in the country guideline, but with no method recommendations.

Table 2. Overview of country guidelines for including WEIs in transport appraisal.

	WEI1: Agglomeration impacts			WEI2a: Output change in imperfectly competitive markets			WEI2b: Increased competition as a result of better transport			WEI3a: Increased labour supply as a result of a change in commuting costs			WEI3b: Move to more or less productive jobs			WEI3c: Excess labour supply effects			WEI3d: Thin labour market effects			WEI4a: Increased Foreign Direct Investments			WEI4ab: Contributions to promoting international relationships			WEI5a: Interaction impacts with inefficient land use regulation			WEI5b: Re-organisation impacts			WEI5c: Innovation impacts in the construction and transport sector			SUM
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Australia		M			NM				NM		NM			NM																							5
Belgium	M			M					NM							M																					4
Canada		NM																																			1
Denmark		NM			NM					M																											3
Finland		NM						NM			NM																										3
France	M			M																																	2
Greece																																					0
Ireland		NM			M				NM			NM			NM			M			NM			NM									NM				9
Iceland																																					0
Italy																																					0
Japan																																					0
Luxembourg																																					0
The Netherlands	M			M						M			M			M												M									6
New Zealand	M			M						M																											3
Norway																																					0
Portugal																																					0
Spain		NM			NM			NM																													3
UK		M			M				NM		M			M																							5
Switzerland		M																																		NM	2
Sweden		NM			NM			NM			NM			NM																							5
Germany																M									M												2
USA	M																																				1
Austria																																					0
SUM	5	9	0	4	6	0	0	3	4	3	4	1	1	3	1	3	0	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0	1	54

A = "May be monetised in CBA", B = "May be quantified/monetised in project appraisal (though not in any CBA part)", C = "Acknowledged, but only assessed qualitatively or assessment not recommended", M = The corresponding type of WEI is included in the country guideline, with method recommendations, NM = The corresponding type of WEI is included in the country guideline, but with no method recommendations. Grey = WEI are not included in country guidelines, Black = There are no country guidelines.

3.7 Wider Non-Economic Impacts

Environmental Impacts

The literature on environmental impacts is relatively fragmented with few overall reviews. Among public guidelines, the British guideline for transport investments are generally considered to be state of art. It distinguishes between two main categories of environmental impacts from transport investments, which we will refer to as environmental traffic impacts and environmental area impacts. Traffic impacts are impacts that arise from change in traffic such as noise, local air pollution and global air pollution. Environmental area impacts are impacts that arise in arise in surrounding areas as a result of new improved infrastructure and associated spatial development including impacts on landscape, townscape, biodiversity, heritage and water environment (Department of Transport 2015). Generally, environmental traffic impacts are more captured and quantified in the current CBA frameworks than environmental area impacts. Defining wider environmental impacts of transport investment and other spatial measures as recognized environmental impacts not captured by CBA therefore largely coincides with environmental area impacts.

Landscape value:

- Kaltenborn, B. P., & Bjerke, T. (2002). Associations between environmental value orientations and landscape preferences. Landscape and urban planning, 59(1), 1-11.
- Brown, G., & Raymond, C. (2007). The relationship between place attachment and landscape values: Toward mapping place attachment. Applied geography, 27(2), 89-111.

Townscape:

- Hubbard, P. (1993). The value of conservation: a critical review of behavioural research. Town Planning Review, 64(4), 359.

Biodiversity:

- Pearce, D., & Moran, D. (2013). The economic value of biodiversity. Routledge.
- Nunes, P. A., Van Den Bergh, J. C., & Nijkamp, P. (2003). The ecological economics of biodiversity: methods and policy applications. Edward Elgar Publishing Ltd.
- Randall, A. (1988). What mainstream economists have to say about the value of biodiversity. Biodiversity, 217, 217-23.
- Humphries, C. J., Williams, P. H., & Vane-Wright, R. I. (1995). Measuring biodiversity value for conservation. Annual review of ecology and systematics, 26(1), 93-111.

Heritage:

- Navrud, S., & Ready, R. C. (Eds.). (2002). Valuing cultural heritage: Applying environmental valuation techniques to historic buildings, monuments and artifacts. Edward Elgar Publishing.
- Choi, A. S., Ritchie, B. W., Papandrea, F., & Bennett, J. (2010). Economic valuation of cultural heritage sites: A choice modeling approach. Tourism Management, 31(2), 213-220.

Water environment:

- Kneese, A. V. (2013). Measuring the benefits of clean air and water. RFF Press.

Noise:

- Navrud, S. (2002). The state-of-the-art on economic valuation of noise. Final Report to European Commission DG Environment, 14.

In general:

- Arrow, K. J. (2001). Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU, and developing countries. Oxford University Press on Demand.

Social Impacts

As for social impacts, the British guideline for transport investments are generally considered to be state of art on social impacts. The guideline distinguishes between eight types of social impacts, namely accident, physical activity, security, severance, journey quality, option and non-option values, accessibility and personal affordability. Accident impacts are recommended monetized, while journey quality and physical activity impacts may be monetized if they are considered substantial, and the magnitude may be determined with reasonable certainty. The guidance leaves impacts related to security, severance, journey quality, option and non-option values, accessibility and personal affordability for qualitative assessment (Department of Transport 2015), so this impacts might be considered as wider social impacts.

Jones and Lucas (2012) distinguish between five direct social outcomes of transportation measures; accessibility, severance, activity location, health, finance and community organization. Furthermore, they distinguish between spatial, temporal and socio-demographics dimension of the distributional impacts. The authors point out that comprehensive data collection and forecasting tools on social impacts are needed to improve forecasts of social consequences of different spatial policy measures.

A challenging with the existing appraisal and evaluation literature is that economic, environmental and social impacts partly are overlapping (e.g. local air omission and traffic congestion; see also Geurs et al. 2009 and Shergold and Parkhurst 2009). Jones and Lucas (2012) aim to clarify concepts and definition related to social impacts, how these differs from economic and environmental impacts, as well as notions of distributional challenges. They propose to first define impacts and then assess whether the impact have economic, environmental and social efficiency effects, or potential distributional effects. Most developed public guides do however not leave any uncertainty regarding overlapping effects (e.g. Department of Transport 2015).

Social impacts of transport project may receive much public and political attention, but are less focused upon in transport policy appraisals. This partly because these impacts are considered smaller than other impacts and partly because their magnitudes are subject to uncertainty Including social impact is transport appraisal are often challenging, since the impacts often are hard to be quantify. In addition, it might be hard to draw the distinction between efficiency impacts and distributional impacts in practice.

Guers et al. (2009) focus on determining categories of impacts and identifying gaps in the treatment of social impacts in public guidelines. They define social impact of transport as changes in transport sources that might positively or negatively affect preferences, well-being or perception of individuals, social groups or society in general.

They further argue that social impacts mainly are influenced through three channels; people, transport and land-use. These factors are mutually dependent and might also reinforce each other. By the same token, direct impacts (e.g. road investments and choice of transport mode), economic impact (e.g. higher income and choice of transport mode) or environment impact (e.g. local air pollution and perception of a neighborhood) may affect individuals’ preferences. For instance, higher individual income might result in increased use of cars, while better roads might affect preferred mode of traveling.

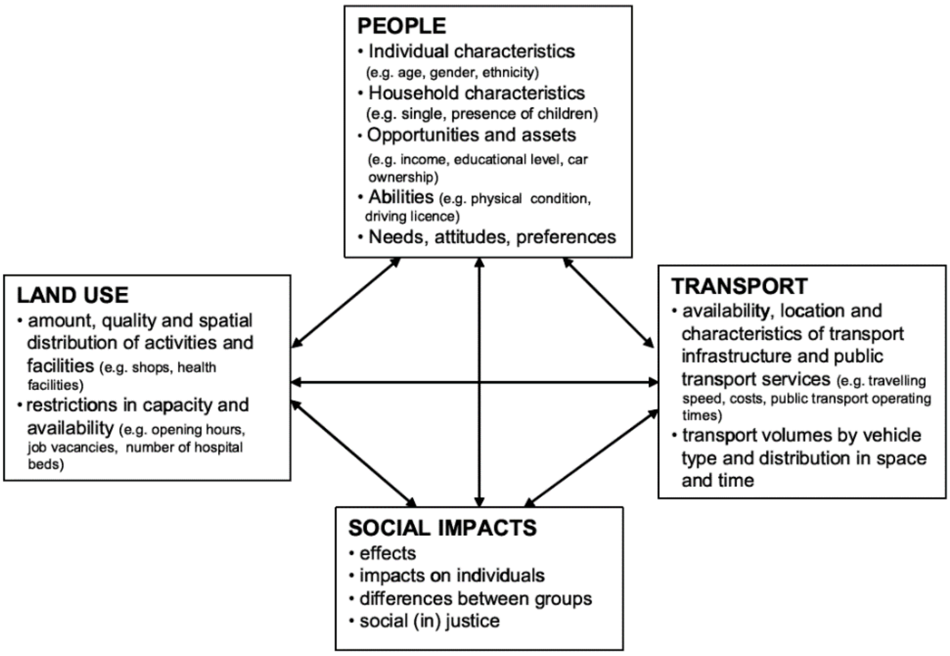

Figure 3.2: Conceptual model for the factors affecting social impact of transport (Geurs et al. 2009)

Guers et al. (2009) also propose to identify social target groups of impact assessments and policy intervention, in order to make targeting of policy measures more manageable. Social injustice in terms of unacceptable social differences according to values of the society is regarded as a subjective and often political decision.

On the practical side, the authors also study inclusion of social impacts in the Dutch appraisal guidance (OEI) and the UK transport appraisal guidance (WebTAG). In general, the British guideline covers social impact to a larger extent than the Dutch guideline quantitative and especially qualitative assessments, although not all impacts are dealt with. This is partly because the British guideline follows a relatively objective-led approach, while Dutch guideline follows a relatively strict welfare economic perspective.

The UK appraisal guidance includes a much broader spectrum of social impacts than the Dutch appraisal guidance through quantitative and qualitative assessments. Yet it does not cover the full range as identified in the literature. Guers et al. (2009) find that the guidelines lack clear operational definitions of social cohesion and related concepts. Social injustice and alternative welfare weights is not focused upon in neither guideline. They also conclude that the evidence on how transport investment or policy may affect people's level of participation in activities or the number of neighborhood contacts are missing (see also Forckenbrock et al., 2001; Centre for Transport Studies, 2006).

Lucas et al. (2016) develops a mixed method approach to assessment of social impacts, involving both desk-based quantitative analysis and qualitative methodologies to engage with local communities. Lucas et al.'s (2016) assessment method of social impacts entail four stages. First, potential impacts of projects including their spatial and social prevalence are identified. Second, the scoop of geographic areas, population groups and social challenges that are likely to be object to social and distributional impacts are delimited. Third, a detailed assessment of each issue of interest is conducting, involving desk-based qualitative analyses of publicity available information. Fourth, a qualitative community level fieldwork exercise is conducted, particularly targeting groups that might be difficult to reach in order to complement and validate analyses on the desk-based study.

Other works on social:

- (Hamersma 2017)
- (Delbosc 2012)
- (Carse 2011)
- (Thomopoulos and Grant-Muller 2013)
- Bocarejo S, J. P., & Oviedo H, D. R. (2012). Transport accessibility and social inequities: a tool for identification of mobility needs and evaluation of transport investments. Journal of Transport Geography, 24, 142-154.

4 Collaborative Planning

4.1 Introduction

Once we know which effects of transport projects are to be taken into account in the planning process (chapter 2), we need to know how different stakeholders can find an agreement on the policy measure(s) that should be taken. Therefore, in this chapter, we consider the methodologies that can be used by planners to reach consensus between stakeholders. Bearing in mind that SPADE project takes up the challenge of an all-embracing assessment method for different scales and context, we aim to theorize a flexible framework capable of accounting for all kinds of effects stemming from infrastructure planning and policy. Presumably, this is not possible if someone imposes apriori the assessment tools to employ. Thus, it is suggested to look at a series of tools, each of them with shortcomings and advantages relative to the specific case, and choose the most suitable. Specifically, this chapter focusses on the following topics:

1 What is collaborative planning? (section 3.2)

Here we reveal the principles of collaborative planning, i.e. the fundamentals on which our tool will be built. In doing this, we will also compare collaborative planning with other, more top-down oriented planning methods, such as managerialism. Starting at a theoretical level enables us to better frame our tool in the larger debate of appropriate planning methods, while at the same time highlighting the relevance of our proposed tool for contemporary planning practices.

2 What methodologies exists to implement collaborative planning? (section 3.3 and 3.4)

In section 1, collaborative planning is described on a theoretical level. But applying a theory to practice is another challenge. Therefore, in this section, we consider methodologies to apply collaborative planning in the planning process. We do this by focusing on two different dimensions. First, we discuss existing methods for assessing transport projects between multiple stakeholders. Second, we consider various strategies to facilitate the discussion between stakeholders

3 Towards a collaborative planning tool (not yet included)

In this section, we summarize the do's and don'ts that we have identified in the previous sections. We built forth on an existing collaborative planning tool developed by (Kiel, Muizer, & Taale, 2015) and expand the tool with the lessons we have learned.

4.2 Relevance of Collaborative Planning

A good starting point is (Ansell & Gash, 2007). Their work is one of the most cited theoretical accounts of collaborative governance. In planning theory, the most notable works are from (Healey, 2003) and (Innes, 1998). Theoretical works on collaborative planning in transportation are less widespread, but (Arts, Hanekamp, Linssen, & Snippe, 2016) and (Walter & Scholz, 2007) offer good insights.

- (Ansell & Gash, 2007) provide a model of collaborative governance, in which they identify the following four main components:
    1. Starting conditions: the contextual conditions with which stakeholders enter the planning process. For example: incentives to participate; power/resource imbalances and the prehistory of antagonism and cooperation
    2. Facilitative leadership: the role of the mediator in the planning process, widely seen as the critical ingredient to find consensus between parties together

    3. Institutional design: the basic rules and protocols for collaboration. Our tool will offer the institutional design for the collaborative process.
    4. The collaborative process itself, consisting of face-to-face dialogue, trust building, shared understanding and commitment from all stakeholders.
- Collaborative planning and its relevance are described in detail by (Healey, 2003), (Innes, 1998) and (De Roo & Voogd, 2007). Collaborative planning is rooted in Habermas' discourse ethics and his concept of communicative rationality and Giddens' structuration theory. We will not go into philosophical depth, however, this highlights the more fundamental concerns that collaborative planning seeks to address. The fundamental notion of collaborative planning the idea that planning decisions are made best by reaching consensus, rather than a presumed objective analysis of the situation by experts. Collaborative planning considers effects of planning to be always subjective, contested and subject to power imbalances. Hence, consensus building is the best way to make planning decisions. It is within this context that we build our tool.

4.3 Collaborative Planning Methods

This section focusses on the specific methods (or tools) that can be used to translate collaborative planning theory into collaborative planning practice. Here it is important to make a distinction between stages in the planning: problem identification, problem modelling and problem solving. Not only because the availability of information differs greatly, but also because different tools have varying potential in each phase. For example, little creativity is needed in the problem identification phase, whereas creativity plays an important factor in the problem modeling phase. Similarly, having quantitative information is much more important in the problem solving stage than in the problem identification stage.

A good starting point to valuate collaborative planning tools is provided by (Vacik et al., 2014), who documented and evaluated 43 collaborative planning methods according to their usefulness in different stages in the collaborative planning process. Moreover, an interesting example from te Brommelstroet and Bertolini (2008) deals with the necessity of a structured collaborative process in which graphic tools can be embedded and support transport and land planners in their discussion.

In the remainder of this section, we discuss different collaborative planning tools. Our aim is to identify the key components for a successful collaborative planning tool.

Problem identification stage

- Planning for Real (Kingston, Carver, Evans, Turton, 2000) is one of the first examples of public involvement by using real maps, which have developed becoming Participatory Geographic Information Systems (Tyrväinen, Mäkinen 2014);
- In general, e-Participation (Loukis et al., 2010) is taking over because of its clear advantages and multi-purpose applications, such as the e-Panels approach (Macintosh, Whyte, 2008);

Problem modelling stage

- Bayesian Causal Map - Ulengin, Onsel, Topcu, Aktas, Kabak (2006)
- Soft System Methodology – Burge (2015), Checkland (2000)
- Fuzzy MA – Kacprzyc, Wilbik, Zadrozny (2014)

Problem solving stage

- Joint Gains - Ehtamo, Kettunen, Hamalainen (2001)
- A'WOT - Kurttilaa, Pesonena, Kangasb, Kajanus (2000)

- Jones, Kelly, May and Cinderby (2009) describes some innovative approaches for option generation
- Future Search - Weisbord and Janoff (2010)

To conclude this section, we fill in the following table, in which the advantages and disadvantages the discussed tools are described. This will be included in the final version.

Table 4.1. Advantages and disadvantages of collaborative planning tools

Tool	*Advantages*	*Shortcomings*	*Planning phase*
Participatory GIS			
e-Participation			
World Café			
Bayesian Causal Map			
Soft System			
Fuzzy MA			
Joint Gains			
A'WOT			
DISTILLATE			
Q-Methodology			
Future Search			
[...]			

4.4 Discussion Strategies

In addition to collaborative planning tools, we pay specific attention to the discussions component that is part of any good collaborative planning tool. In this section, we review the role of the mediator and consider a specific tool to reach consensus between stakeholders, The Delphi method.

The mediator's role and practical advice for guidance

Leadership is widely considered to be crucial for facilitating the collaborative process. The main tasks for the mediator is setting out clear rules, facilitate the dialogue, build trust, explore mutual interest and principles of collaborative planning are adhered to. The primary challenge we face is understanding and generalizing the patterns of collaboration between agents in order to pursue a more efficient decision-making process. It is known that planning processes entail many discussions, namely long sequences of interactions that are not always constructive or well-instructed. One of the reasons is that the participants do not always have a precise idea about «what to think» even when they are experts. Indeed, the realization of complex infrastructure and spatial development projects can emanate effects in a multitude of fields. Involving experts from different domains should bring, in theory, the discussion to a higher level, and yet it does not always work out. In this section, we discuss the role of the mediator. We draw on the following contributions:

- Dhanapal and Ling (2013) propose a technique based on the Six Thinking Hats (De Bono, 2011) to structure the discussion and improving critical thinking
- Erduran, Simon, Osborne (2004) make use of the Toulmin's Argument Pattern (1958) to enhance the quality of scientific debates
- Hou, Chang and Sung (2008) – Advantages in Online Asynchronous Discussion and interaction analysis

The Delphi Method

The formulation of surveys, re-elaborated throughout the process in accordance with how the discussion is developing, is a very powerful tool for mediators. As of the introduction of the Delphi Method (Dalkey and Helmer, 1963), several strategies have been adopted for building consensus among the experts. All of them are based on an iterative process (feedback), in which every round should reduce the range of opinions and cluster the underlying reasons (Ludwig, 1994). Linstone and Turoff (2010) explain that the real scope of the Delphi Method is not to produce unanimous agreement, but giving a structure to the group communication process through repeated feedbacks. Indeed, achieving stability in the responses matters more than having all stakeholders aligned on one side. As they claim, a bipolar distribution of opinions is actually a very significant one and not a rare result. In this section, we consider Delphi method as a tool to build consensus between the stakeholders. We draw on the following work:

- Hsu and Sandford (2007) – A complete overview of Delphi Method (features, shortcomings, data analysis, and more)
- Okoli and Pawloski (2003) – Choice and involvement of stakeholders though the Schmidt's stepwise process (1997)
- Linstone and Turoff (2010) – Delphi method's evolution and future directions

5 Assessment methods for transport infrastructure projects and policy measures

5.1 Introduction

This section is devoted to assessment methods for transport projects and, more generally, measures in the transport sector. First, in Section 5.2 the history and general steps in transport and spatial planning are outlined with a review of best practices all around Europe and beyond. In the next two Sections 5.3 and 5.4 the basics of the most prominently used assessment methods, cost-benefit analysis (CBA) and multi-criteria analysis (MCA) are worked out with a special focus on how these methods are applied in the transport industry. In recent years, however, several limitations of these until then widely acknowledged tools have been revealed, which are discusses in Section 5.6. One of such a limitation is the lack of a clear display on different point of views of the different types of stakeholders. Therefore, an extension from classical MCA to the multi-actor multi-criteria analysis (MAMCA) has been proposed in the literature several years ago. This assessment methodology is often used in decision making processes which is reflected by the large number of scientific publications. Section 5.5 is dedicated to MAMCA. Although in the scientific community numerous extensions of classical methods are described, (national) guidelines usually need more time to adapt. Therefore, a review on the current state-of-the-art of assessment methods described in national guidelines is given in Section5.7. Since the developed assessment method in this project goes beyond CBA and combines it with an MCA the current literature of such combinations is reviewed in Section 5.8 Finally, an outlook beyond classical methods based on CBA or MCA is given in Section 5.9, in which alternative assessment methods are listed and briefly discussed.

5.2 Steps in Transport Planning

For starting the discussion about assessment methods in the transportation sector, first, the historic development of transport planning in two exemplary countries (Austria and Germany) is shown based on results of contributions to the 14th World Conference on Transport Research 2016 from members of a Special Interest Group on National and Regional Transport Planning and Policy, see (Emberger & May, 2017) for the editorial. The aim is to show the development of the transport policies in these countries which lead to current examples and best countries as of today. The second part of this chapter reviews currently used assessment methods for transportation projects and their role in the overall project planning process.

History of transport (policy) planning

In (Emberger, 2017) the historic development of Austrian transport policy is presented. Between 1950-1970 road construction was seen as ‘instrument to reduce unemployment’ and financing of the roads was easily ensured by the tax income of the sold fuel. Later in the 1970s to 1990s during the Oil Crisis, it was first mentioned that all means of transport should be included in a national transport strategy, the Austrian Master Plan 1968. Road safety was an important issue, and in the 1980s a shift towards rail transport could be observed because of road restrictions for heavy vehicles. Since the 1990s updated versions of the Austrian Transport Masterplan were published in which a set of measures are provided, e.g., reduction of emissions stemming from road transport, increase attractiveness of public transport, taxing and prohibitions of trucks. (Emberger, 2017) lists a set of official documents regarding transport policy. In the most recent one, the ‘Transport Master Plan 2013’, specific objectives regarding social, safety, environment and efficiency aspects are set. These policy documents are evaluated against the ‘Ideal Decision Making Process’ (see figure 5.1), developed for sustainable transport planning in a European context. Results of this evaluation showed that

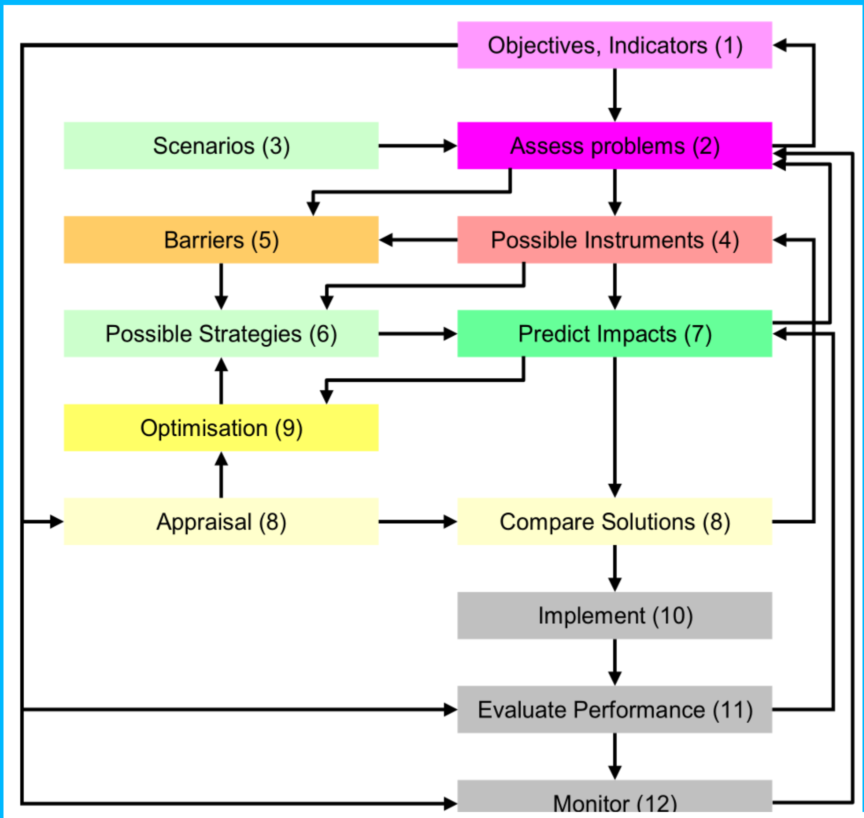

Figure 5.1 - Ideal Decision Making Process (Emberger, 2017)

the Austrian transport policy documents, especially, the Transport Master Plan, became more and more comprehensive and improved substantially over time.

In our second example, (Fichert, 2017) analyses the transport policy planning in Germany focusing on the 'Transport Master Plan 2000' and other policy papers. Main historic developments in the transport sector include a severe economic regulation of road haulage in the late 1920s due to the protection of the state-owned railway operator. Damages during World War II to the transport infrastructure led to severe challenges. The rapid economic recovery, however, led to mass motorization of the people further leading to a reduction of public transport usage. In further consequence huge investments in the highway system were done. In the late 1990s the financing of transport infrastructure investments became more and more challenging. In general, the motorization in Germany is very high which is also reflected in their transport policy planning. Also for Germany, there are objectives and measures listed within a masterplan from 2008. From the 1960s where no regulations existed how to invest public funds, the basic idea of the federal transport infrastructure master plan from the 1990s suggested to invest a predefined amount of money into the most beneficial projects. Therefore, project suggestions from different stakeholders are analyzed using a CBA and a 15-year traffic forecast (and some additional studies to assess harder to valuate effects like environmental aspects). The most recent masterplan is from August 2016 with a timeframe until 2030 and the underlying CBA methodology has been updated.

Overview of current best practices and examples

A good overview of practices in project appraisal (state 2006) in European countries is given in (Odgaard, et al., 2006). Results show that all countries use CBA, but it is not always required. Nine countries also use MCA in combination with CBA, but the level of detail is not specified. Apart from CBA and MCA, other quantitative and qualitative methods are used as well. As in (Vickerman, 2000), key effects of appraisal methods are identified to be time savings for

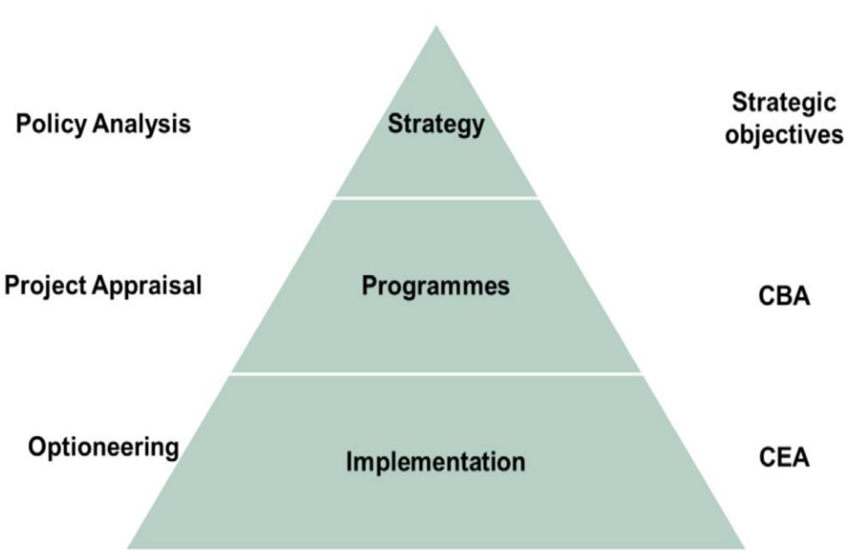

Figure 5.2 - The planning / decision making hierarchy. (Mackie, et al., 2014)

passengers and goods, safety issues, environmental impacts and indirect socio-economic effects.

Specifically for the UK, (Vickerman, 2000) reviews the methodologies of transport project evaluation and identifies key elements. Although this publication is already several years old a transition from a CBA which was compulsory and described in the official ‘Design Manual for Roads and Bridges’ to a more inclusive appraisal method could be observed. The basis for this transition is the ‘New Approach to Appraisal’ (NATA). Although a CBA still was the key element, also qualitative measures are included using a seven-point scale (similar to Ireland, see, e.g., (Gühnemann, et al., 2012))Key elements of road project appraisal procedures (still within a CBA) are identified to be demand forecasts, value of time, traffic safety, environmental impacts, regional economic effects, and equity considerations. In the NATA wider economic effects are still only considered using a simple indicator (at the time of that publication).

The question of the role of transport appraisal (with a focus on CBA) within the overall decision-making process is considered in (Mackie, et al., 2014) which includes a survey of several countries having included CBA in their decision-making process. The role of CBA within this process is shown in figure 5.2.

It shows that the project appraisal depends and is embedded in a larger process on top of which there are the strategic objectives of the decision makers. This suggests a policy-oriented project assessment method. However, there is evidence that the appraisal results do not significantly influence the final decision, partly because the influencing factors were not covered by the CBA (e.g., in Norway and Sweden). On the contrary it was shown that, e.g., in the UK, the benefit-cost ratio (BCR) is strongly correlated to project selection. Again, important impacts for the assessment are identified to be travel time savings, safety, travel time variability, crowding relief, fitness and health, carbon emissions, and more and more wider economic impacts. Three types of appraisal challenges are mentioned: technical, planning, and policy. In the first category there is uncertainty in the methods and data (e.g., for forecasts) which can lead to fragile results. Furthermore, there are problems in valuation of the business travel time savings, time savings for freight transport, congestion and crowding, and supply / demand interaction. Second, the integration in the planning process can be difficult due to a lack of alternative solutions to a given problem. Furthermore, some desirable effects like reliability, regeneration, and resilience are hard to quantify. Also, the overall planning concept in the strategy of the region is not covered within the formal appraisal framework. Third, spatial distribution is often not covered in the CBA, i.e., local and regional impacts are dismissed.

SCGE and LUTI methods could help solve the lastly mentioned problems.

More general recommendations and best practices are presented in a publication by NETLIPSE (Staal-Ong, et al., 2008), which is a network of experts working in the field of large transport infrastructure projects in Europe. The authors describe best practices regarding the management of such projects and review the past 10 years.

Regarding the development of transport policies, (Emberger & May, 2017) identifies several challenges for national plans: the need to specify clear objectives, distinguish between objectives, strategy, and selection of policy measures, adopt a multi-modal approach, avoid optimism bias, ensure the monitoring of the national transport plan against its objectives.

5.3 Cost-Benefit Analysis

(Romijn & Renes, 2013) present a comprehensive guide to cost-benefit analysis (CBA) with a step-to-step description on the how-to and the requirements. CBA is called “the single most important problem-solving tool in policy work” and is used for ex ante assessment of policy options. It supports the decision-making on policy measures or alternatives by quantifying the effects, risks, uncertainties and the resulting costs and benefits as a whole.

(Jones, et al., 2014) are critical about the main weaknesses of CBA as an evaluation tool. They conclude that “the right decision only results if prices used by decision makers correctly reflect the social values of inputs and outputs at the social optimum or shadow prices – market prices seldom do this” and that “CBA is extremely sensitive to the values used for the different assumptions”. Furthermore, they point out that the treatment of residual value (value of the infrastructure at the end of its project lifetime and the value that the asset generates over time) is inadequate in CBA.

5.4 Multi-Criteria Analysis

(Dodgson, et al., 2009) present a comprehensive framework for multi-criteria analysis (MCA) manual, in the light that MCA should not be regarded as a substitute but a complement of CBA. The main purpose of MCA is to address criteria that are beyond monetary terms, thus taking into account qualitative and quantitative aspects in decision making. The manual is divided into 2 parts, one for non-specialists as a non-technical overview of MCA, and one as detailed guidance for specialists.

(Schmale, et al., 2015) documents the MCA for a use case on planning measures in the passenger transport in Potsdam, Germany, between scientists, practitioners, and decision makers. The methodology reflects the city’s qualitative and quantitative goals to improve public transport and promote sustainability. The MCA evaluation was divided into 6 categories where the weighted sum was applied to compare different possible measures, followed by a comprehensive discussion on the applied approach.

(Boggia, et al., 2018) propose a new Model GeoUmbriaSUIT for evaluating areas at local, regional or national level with environmental, economic and social aspects with GIS. Their framework MCA-GIS is used as policy decision support tool in sustainability assessment and applied on a Malta as use case. In their study the region was divided into 6 regions and 3 indicator groups were evaluated

5.5 Extension to Multi-Actor Multi-Criteria Analysis

(Macharis, et al., 2008) and (Macharis, et al., 2012) present the MAMCA framework as an extension of the MCA by further adding different stakeholder views with corresponding importance ratings and weights to the considered criteria. They demonstrate the MAMCA approach on transport projects. Case studies include transport policy measures, alternatives for a possible modal shift of waste transport in the Brussels region, location of a new HST-terminal in Brussels, etc.

(Brucker, et al., 2013) point out 4 boundary conditions that need to be respected for a working MCA. Among others is the inclusion of multiple stakeholders which results in a criteria tree w.r.t. the stakeholders involved in the decision-making process. This is in line with the MAMCA approach, which is appropriate for analyzing complex projects.

(Cornet, et al., 2018) focus on the sustainability viewpoints in transport projects. They conclude that there is no standard practice for appraising transport projects against sustainable development objectives. Nevertheless, a dual approach is proposed that compares expert-based vs. principle-based approaches. The use case is on the appraisal of a high-speed rail connection from London to Birmingham with 3 options, and 3 stakeholder groups (sustainability experts, government transport experts and other transport experts).

5.6 Limitations of CBA and MCA

(Beukers, et al., 2012) criticize that “CBA and its process are perceived as problematic and characterized as frustrating when applied to assess complex infrastructure plans” due to the “logical result of clashing values and approaches”. They also fear that the ‘hard’ effects dominate over ‘soft’ effects in decision making.

(Jones, et al., 2014) mention the uncertainty in traffic forecasts and cost estimates such as value of a statistical life, value of time, value of accident, the wider regional and local impacts; the disregard of equity and the treatment of environmental impacts in CBA.

(Mouter, et al., 2013) and (Mouter, et al., 2014) take the Dutch CBA practice as reference and conclude that politicians are underrepresented in the contribution. Regarding the methodology, incompleteness and uncertainty are seemingly insolvable CBA limitations. Work-arounds exist to either minimize insolvable CBA limitations or to manage the insolvable CBA limitations (e.g., by appropriate communication).

(Treasury, 2015) criticize the CBA to only measure direct or ‘first-round’ effects and using simplified assumptions. All estimates of costs and benefits are based on uncertain forecasts or may be very difficult to estimate. However, they also mention other tools, such as multi-criteria analysis (MCA) to be even worse sometimes. Common problems of MCA include using qualitative analysis instead of quantitative analysis or the “do nothing” option is producing a bias towards action. The more these issues are solved, the more the MCA will look like a conventional CBA.
Regarding the MAMCA approach, (Macharis, et al., 2012) conclude that it is sensitive to the selection of criteria and the choice of weights. If properly chosen, it can lead to a strategic bias. MAMCA also avoids giving definitive statements or rankings of options as final results but is more intended to raise awareness as basis for discussions.

5.7 Current state-of-the-art based on national guidelines

In this section we present the currently recommended or even mandatory assessment methods as written in the official national guidelines of the selected countries. Table 5.1 gives an overview of the mentioned methods in which the green cells correspond to the methods that are used and the red cells to methods that are not used in the corresponding country.

Table 5.1 - Assessment methods in national guidelines.

Methods / Countries	CBA	MCA	Scoring / Qualitative methods	CEA / CUA	Other
Austria					
Germany					SEA
Switzerland					
New Zealand	Social CBA				
Canada					MAE
…					

Used abbreviations in the table:

- SEA: Strategic Environmental Assessment
- MAE: Multiple Account Evaluation
- CEA: Cost Effectiveness Analysis
- CUA: Cost Utility Analysis

5.8 Combining CBA and MCA

After establishing the basics of CBA and MCA in the previous sections, this section presents a literature overview of assessment methods that go beyond classical CBA. We first focus on some general papers appraisal methods beyond CBA and studies about different results from CBA and MCA. Then, methods combining CBA and MCA but also on variants of multi-criteria decision-making methods in which a CBA could be integrated, are presented. The goal is to present methods that overcome (some of) the weaknesses listed before.

General

An interview-based study with 21 Dutch politicians regarding their perspective on transport policy appraisal, especially on CBA / MCDM, was performed by (Annema, et al., 2015). In general, they all make use of the outcome of a CBA, but do not base their final decision on it and find its outcome to be ‘pretentious’. The interviewees further stated that they are more interested in the politically interesting trade-offs than in the aggregated result. This also forms the basis of the proposed supportive tool based on CBA and MCDM with the help of a trade-off sheets.

In (Vickerman, 2017) an overview of methods that go beyond a classical CBA and focus on user benefits is given. The inclusion of wider economic impacts is not easy in a CBA and often omitted because of the fear of double-counting benefits. Also, the authors state that a CBA focusing on welfare impacts must allow for distribution of costs benefits between groups in society and time periods.

The relevance and influence of MCA in public decision making is analysed in (Gamper & Turcanu, 2007) where the authors showed that even without any appearances in national laws or guidelines, MCAs are still performed and have an influence on the decision-making.

A more theoretical paper (Beria, et al., 2018) developed methodologies to compute consumer surplus using the theory of Rule of Half and ‘logsum’. They further identify the need for an ex-ante visualization of the results of decisions to the decision-makers (coinciding with the results of the politician's survey in (Annema, et al., 2015)). They achieve a visualization by a combination of CBA, GIS software, and a transport simulation model. An exemplary evaluation was done for the Milan's SUMP and the Milan Malpensa airport rail ring closure.

CBA versus MCA

Some studies thoroughly investigated the differences in the methodology, applicability, and results when applying CBA or MCA. A structured comparison between both methods is given by (Munda, 2017) who concluded that both methods are complementary in nature. On the other hand, (Gamper, et al., 2006) proposed decision criteria when and how to use CBA or MCA within implementation guidelines but the authors are not tackling the issue of combining them. The application domain was natural hazard management. When comparing results of CBA and MCA, (Khaki & Shafiyi, 2011) showed that both methods can lead to significantly different results in the priorization of projects.

Methods combining CBA and MCA

The potential gains that can be achieved by methods combining CBA and MCA has already mentioned in the previous sections. Here, we want to give successful examples from the

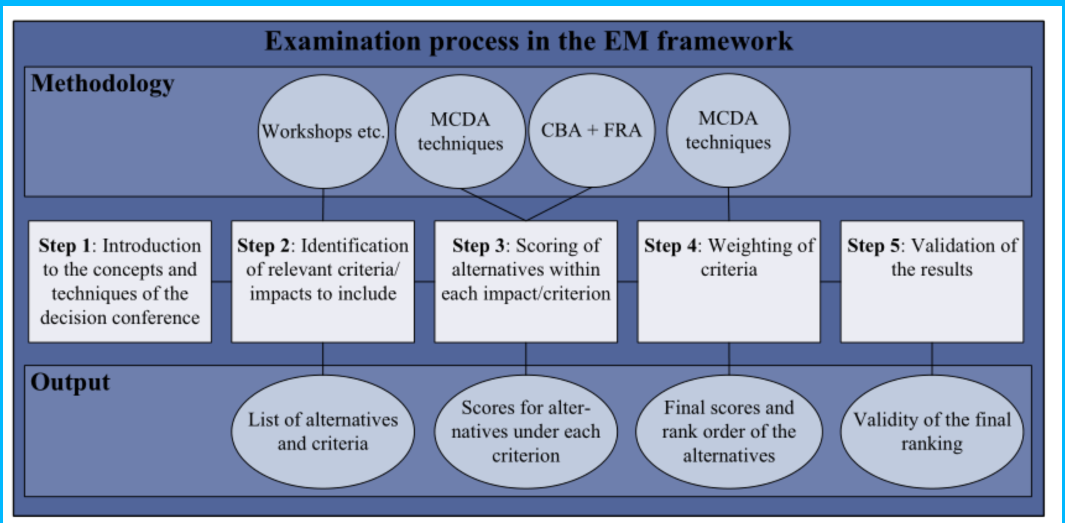

Figure 5.3 - EcoMobility Framework (Barfod & Salling, 2015)

literature where such combined methods are proposed. (Barfod & Salling, 2015) introduced the EcoMobility (EM) framework based on an excel-based software model (EM-DSS) with CBA, feasibility risk assessment (FRA), and MCDA with a customized examination process. The examination process consists of 5 steps as shown in figure 5.3.

CBA and MCDA play a role in the scoring of alternatives and the latter also in the weighting of criteria. The proposed method is applied to the Oresund fixed link between Copenhagen and Malmö. Results show that in this framework it is possible to include wider range of effects. Furthermore, the authors stated that documentation of the stakeholder involvement conference should be seen as integrated part of the decision-making approach. Limitations of this EM-Framework are, however, that there is no 'value-for-money' rating in the end.

Another variant of combining CBA and MCA is proposed by (Gühnemann, et al., 2012). They included preference values of the decision makers for road infrastructure projects priorization and evaluated their method on the National Secondary Road Network in Ireland. The five main criteria environment, safety, economy, accessibility and integration were given fixed weights of 10, 10, 35, 10, and 35%, respectively. Based on the national policies of Ireland, a scoring scheme of values between 1 (highly negative) and 7 (highly positive) is used for all effects (monetized and non-monetized). For monetized effects, a linear scoring function is used symmetrical around the neutral score of 4.0. It is modified to reduce the bias towards larger projects by normalizing it by costs (as they usually generate more benefits) and a threshold term is defined to determine the level of the impact which is considered highly positive (in this case a benefit-cost ratio (BCR) of 2.5 is considered highly positive). For the non-monetized effects, a maximum negative (score of 1.0) and positive impact (score of 7.0) is defined (e.g., for biodiversity any permanent impact on an internationally important site). The scoring function is then interpolated between 1.0 and 7.0. Sensitivity analyses on varying values for the BCR were performed and projects with extremely unacceptable impacts are given a red flag in addition to the low score of 1.0. For this method there is a need to define an investment worthiness threshold which is based on the BCR. (4+3/BCR). Advantages of this method are that the results allow a better evidencing for following policy objectives for the decision makers.

An approach named 'strategic option assessment' (SOA) is presented in (Prosser, et al., 2015) which is also a combination of MCA and CBA. Similar to other combined methods, here, the assessment is performed against policy objectives as well but additionally, spatial and temporal distributional effects are considered. The overall framework is shown in Figure 5.4. It shows that the CBA / MCA combination are the green steps (steps 6-8), after which the resulting benefits and costs can be compared.

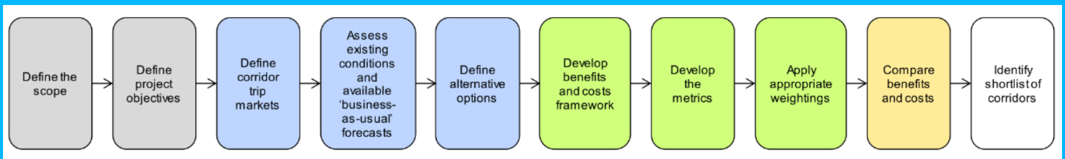

Figure 5.4 - Framework of SOA

A hypothetical example based on Liverpool, Australia is presented, and the results show that SOA lies in between MCA and CBA and has the advantage of an objective comparison of alternatives over MCA.

With the goal of developing a method for sustainable project evaluation, the tool named 'multi criteria cost benefit analysis' (MCCBA) is presented in (Sijtsma, 2006). As the name suggests it is a combination of elements taken from CBA and MCA. MCCBA consists of the following 8 stages, which are illustrated in figure 5.5. In this figure, a direct comparison of the new proposed method to classical CBA and MCA methods is made.

- Identify function, project alternatives and scale of the evaluation
- Involve a broad group of stakeholders
- Organise judgement criteria on 'Triple E' impacts
- Quantify impacts physically
- Aggregate monetary scores (consensus based among the stakeholders)
- Aggregate non-monetary scores (consensus based among the stakeholders)
- Interpret trade-offs
- Perform sensitivity analysis and reconsider alternatives

The evaluation was done in three case studies: Dutch Ecologische Hoofdstructuur, German Emssperrwerk, and the Sustainable Corporate Performance policy by a Dutch company.

MCCBA	CBA	MCA
Stage one: Identify function, project alternatives and scale of the evaluation	Stage one: Define the project (or policy) and impact population	Stage one: Identify objects and function(s) of the evaluation
Stage two: Involve a broad group of stakeholders		Stage two: Identify stakeholders
Stage three: Organise judgement criteria on Triple E impacts	Stage two: Identify project impacts	Stage three: Elicit and organise value dimensions/ attributes
		Stage four: Assess the relative importance of value dimensions/attributes
Stage four: Quantify impacts physically	Stage three: Quantify relevant impacts physically	Stage five: Estimate scores of alternatives on low level dimensions
Stage five: Aggregate monetary scores consensus based	Stage four: Value relevant effects monetarily	Stage six: Aggregate scores with importance values
	Stage five: Discount costs and benefits	
Stage six: Aggregate non-monetary scores consensus based	Stage six: Apply the Net Present Value test	
Stage seven: Interpret trade-offs		
Stage eight: Perform sensitivity analysis and reconsider project alternatives	Stage seven: Perform sensitivity analysis	Stage seven: Perform sensitivity analysis

Figure 5.5 - Comparison of the steps between MCCBA, CBA, and MCA. (Sijtsma, 2006)

A simpler and direct approach of combining CBA and MCA is followed by (Schutte & Brits, 2012). In their proposed method they focus on four decision criteria: optimal allocation of scarce resources, equity, sustainability, and compatibility to the stated objectives. The first criterion is evaluated using a CBA and the other three with MCA.

A new, unified, integrated, comprehensive, and transparent transport measure appraisal method is proposed by (Kiel, et al., 2015). The authors named it ‘Assessment method for demand and traffic management’ (AMDTM) and it is based on nine steps. This method includes monetized effects based on the measures’ costs and benefits but also other quantifiable impacts as well as unquantifiable measures in a weighted manner. The nine steps are the following (Kiel, et al., 2015):

1. Determine the interaction between measures;
2. Determine the costs and benefits of the measures;
3. Determine the other quantifiable impacts of the measures;
4. Determine the unquantifiable impacts of the measures;
5. Determine for every measure the priority order of the impacts;
6. Determine the weight for the different aspects;

7. Perform a multi-criteria analysis;
8. Perform a sensitivity analysis;
9. Discuss the results and determine the best packages of measures

Focusing on incorporating equity in transport project evaluation is done in (Thomopoulos & Grant-Muller, 2012) within the 'Sustainable Mobility Inequality Indicator' (SUMINI) approach. In this study, equity is seen to be the distribution (over society, time, place, …) of other project impacts. Although not actually integrating a CBA it is seen as complementary to CBA. The main contribution is the inclusion of results in equity theory into project assessment. The method consists of the following 8 stages:

1. Project objectives identification
2. Stakeholder's identification
3. Re-evaulation of project objectives by stakeholders
4. Viewpoint on equity principle identification (e.g., utilitarian, equal shares, Rawlsian, …)
5. Viewpoint on priorities about equity types identification
6. Quantification of impacts using relevant indicators
7. Impact distribution evaluation
8. Linear sum of all equity impacts and contrast with pre-defined viewpoints

At the core of SUMINI there is an analytic hierarchy process (AHP). The authors claim that SUMINI is able to bridge the gap between CBA and MCA because although it is a MCDM method by using a composite indicator, a single metric is offered to decision makers.

Two more straightforward combinations of CBA and MCA are proposed by (Diakoulaki & Grafakos, 2004) and (BERIA, et al., 2016). In the first paper, a monetization strategy for environmental impacts using a MCA is presented which can then by integrated into a CBA. The second paper, which considers ex-ante evaluation of sustainable mobility assessments at a neighbourhood scale, suggests two general ways to combine CBA and MCA:

- Develop a CBA and evaluate soft effects with MCA
- Develop a MCA for a broad screening of options and evaluate public costs and consumer benefits with CBA.

5.9 *Other Assessment Methods*

Finally, this section gives a brief overview of other assessment methods, which might not be directly related to CBA, first and foremost 'land-use transport interaction' (LUTI) and spatial computable general equilibrium (SCGE) models. Then, an overview of variants of MCDM and other methods is presented.

Equilibrium Models

For adequately modeling the economic impact, spatially detailed models are necessary (OOSTERHAVEN & KNAAP, 2003). There are two prominent variations of such models, namely LUTI and SCGE models. The first link transportation models with location models and model system dynamics to predict future economic growth. The second are based on the theory of microeconomics using utility and production functions. (Wegener & Fürst, 1999) provide an overview of the state of the art of LUTI models at the time of publication. In (OOSTERHAVEN & KNAAP, 2003), an overview of different approaches to estimate economic impacts of investments in transport infrastructure (via LUTI and SCGE models) is given. The authors claim that LUTI models are most suited for infrastructure projects at the level of urban conglomerations and that SCGE models are more theoretically satisfying and suited to model interregional impacts at a larger spatial scale.

In (Oosterhaven, et al., 2001) the authors present their developed Dutch SCGE model which is then applied to a new railway link. An overview of pitfalls of and fine-tuning tips for SCGE models is presented in (Tavasszy, et al., 2002). The authors showed that by using this SCGE inaccuracies in transport project appraisal can be mitigated.

Multi-Criteria Decision-Making (MCDM)

In this section multi-criteria decision-making methods are presented, which do not directly include a CBA. Most of these methods focus on societal, environmental, and / or sustainable issues in the assessment. A generic approach to sustainability assessment is given in (Gibson, 2006). The authors list a set of criteria and trade-off rules, namely:

Criteria: Socio-ecological system integrity, livelihood sufficiency and opportunity, intragenerational equity, intergenerational equity, resource maintenance and efficiency, soci-ecological civility and democratic governance, precaution and adaptation, immediate and long-term integration

Trade-off rules: Maximum net gains, burden of argument on trade-off proponent, avoidance of significant adverse effects, protection of the future, explicit justification, open process (stakeholder involvement)

For a general overview of different MCDM methods we refer to (Velasquez & Hester, 2013), in which the following variants are reviewed and compared: Multi-attribute utility theory (MAUT), analytical hierarchy process (AHP), case-based reasoning (CBR), data envelopment analysis (DEA), fuzzy set theory, simple multi-attribute rating technique (SMART), goal programming (GP), ELECTRE, PROMETHEE, simple additive weighting (SAW), technique for order preferences by similarity to ideal solutions (TOPSIS).

Another review of MCDA methods in the very specific scope of sustainable bridge design is given in (Penadés-Plà, et al., 2016) where these methods are categorized into scoring methods, distance-based methods, pairwise comparison methods, outranking methods, utility / valuate methods, and other.

A meta-decision support for choosing the appropriate methodology is presented in (Guarini, et al., 2018) in the domain of real estate and land management.

Another variant of MCA is proposed in (Ward, et al., 2016), where a generic ‘Policy-led MCA’ (PLMCA) is presented. This method has a stronger emphasis on better incorporating social and environmental aspects and consists of three main steps:

- Project analysis: problem definition, design of PLMCA, context analysis and boundary definition, option identification, policy analysis, stakeholder identification, scenario building
- Model building: formulation of objective / appraisal criteria, derivation of weighting
- Module use: scoring and further development of issues, objectives/criteria, options, scenarios.

The results are then visualized in a decision matrix. Since PLMCA is a participatory assessment method, the participating stakeholders put values into this matrix of the agreed appraisal criteria against their policy goals.

Numerous applications of AHP can be found, e.g., in (García-Melón, et al., 2012) for evaluating sustainable tourism, (Shang, et al., 2004) for transportation projects in Ningbo, China, (Nedevska, et al., 2017) for choosing rail routes in parts of Macedonia, and (PIANTANAKULCHAI & SAENGKHAO, 2003) for aligning alternative motorways.
A combination of scenario analysis and MCA is shown in (Hickman, et al., 2012) and used for assessing the progress of policy making against a range of objectives. How the value of ecosystem goods and services can be assessed is presented by (Curtis, 2004) in a method combining elements of economic theory, MCA, and a Delphi panel to assign the weights for

the MCA. Finally, theoretical and methodological contribution for analysing a discrete set of alternatives using MCA is given in (Granat, et al., 2009) and the integration of uncertainty is handled in (Hyde, 2006).

6 Conclusions and Recommendations

Cost-benefit analysis constitutes an important tool for spatial planning and appraisal in general, and for transport planning and appraisal in general. The major advantage with this approach is that impacts are monetized such that cost and benefits from policy measures might be weighed against each other in a neutral way. However, many substantial impacts are not fully estimated within the current frameworks. Furthermore, cost-benefit analysis might not be listened to by decision-makers and only relying on cost-benefit analysis and easily accessible information might not provide a precise representative picture of stakeholders' perspective and valuation of impact. This indicate need of integrating wider economic environmental, and social impacts resulted in the development of more inclusive assessment methods.

In this paper, we review the basis of transport planning and appraisal processes from theory and practice. We start by reviewing the theoretical and empirical foundation of impact assessment of transport measure with focus on impacted not monetized in public guidelines (i.e. wider impacts). Then, we review the current practices in public guidelines for transport planning and appraisal, which turn out to have varying scope over countries. The assessment methods for transport infrastructure and policy measures evolved from a classical CBA, which has already been used several decades ago towards more qualitative and other quantitative methods. In the national guidelines which describe how to assess measures in the transport sector, however, this trend can be observed only in a few countries. This is partly due to the age of these guidelines and partly because it is hard to formalize further criteria and methodologies which fit every transport project.

Next, we review and discuss the role and potential that lies within collaborative planning and how alternative assessment methods might shed light on impacts of transport measures. We argue that broadening and structuring the participation in decision-making processes may provide a better basis for including information from various stakeholders in the decision process in a neutral way and contribute to a more stable decision climate over stakeholder. In particular, we argue that how multi-criteria analysis may supplement traditional cost-benefit analyses to obtain a better decision foundation in integrated assessment methods. The actual assessment of transport measures is in general only a small part within the overall planning procedure. Moreover, multi-criteria analysis might play an important role by adding different stakeholder views with corresponding importance ratings and weights to the considered criteria.

The scientific literature provides numerous approaches how a combination of CBA with MCA could improve the meaningfulness of the assessment results. Many authors noted that both methods are complimentary in nature. Most of these combinations either use MCA (for assessing non-monetized effects) within a CBA framework with the advantage of having single indicator for the decision makers. Alternatively, a CBA is used within a MCA framework in which the CBA evaluates the public costs and consumer benefits. Applying planning and appraisal does obviously come at a cost by itself, so a combination of cost-benefit analysis and multi-criteria analysis will especially be relevant for larger project and projects with large wedges between stakeholder interests. In addition, we discuss further development in quantification methods that might enable inclusion of wider impacts from transport measure in the cost-benefits analysis framework. There is plenty of scientific literature in the domain of general multi-criteria decision-making methods each with their own strengths and weaknesses. Evaluating transport measures against well-defined and agreed upon transport policies seems promising.

In collaborative planning, decisions in the planning process are made in a bottom-up fashion where the planner facilitates the stakeholders in coming to a consensus-based decision, rather than a top-down fashion where the planner makes planning decisions based on the presumption on having superior knowledge on the planning issue at hand. In short, the role of the planner in the planning process is based on facilitating rather than managerialism. To apply these principles of collaborative planning, we need to consider two aspects. First, a specific method or tool to incorporate collaborative planning in the planning process effectively. Second, the facilitative role of the planner, (or also referred to as the mediator) during the planning process.

In the collaborative planning tool, the realization of an efficient and effective all-embracing assessment method for different scales and context can be achieved allowing a flexible structure. Within this structure, the stakeholders and the mediator discuss and then choose the most suitable tools to employ. We do this by building forth on an existing collaborative planning tool for infrastructure planning developed by (Kiel, Smith, & Ubbels, 2014). We reviewed other collaborative planning tools to enhance their tool to fit our purpose. In doing so, we distinguish three planning macro-stages: problem identification, problem modelling, and problem solving. These tasks can be tackled using different tools. The advantages and the shortcomings of each tool are reported with respect to the scale of application. The reviewed tools are: online surveys and workshops, e-Participation, and Participatory GIS, The Bayesian Causal Map and the Soft System Methodology, tools integrated with MCA, tools involving digital workshops and more innovative tools, such as DISTILLATE.

Besides the structure of the assessment method, we provide practical advice for mediators and the use of the Delphi Method to achieve a neat decision-making process. The main tasks for the mediator is setting out clear rules, facilitate the dialogue, build trust and explore mutual interest. This involves investigating the expertise of the potential participants and prepare them to the discussion. Furthermore, mediators should recognize the key points and collect the main insights of the discussion, with the aim of preserving a constructive development in the dialogue. In addition, they should arrange questionnaires in various stages of the collaboration process to elicit the different viewpoint of stakeholders and refine the assessment method.

For accurately predicting the economic effects of transport measures more elaborate methods like use of equilibrium models (e.g. LUTI or SCGE) models are necessary. For these models, however, a high quality of the input data is essential.

Many decision-makers (e.g. politicians and bureaucrats) often ignore the outcome of traditional assessments methods like CBA in practice, because not all relevant effects are included, or they are not convinced by its outcome. Therefore, new assessment methods must be transparent, robust, and inclusive, as well as able to include wider impacts, environmental issues, and social effects which are now more important than ever. The Delphi Method is a useful technique to discover knowledge gaps, gather consensus and give feedback about the process itself in order to improve it. The tool will be accompanied with a guideline for the mediator in which these principles are laid down. Our contribution is both to provide an overview over the current status of the transport planning and appraisal field and to illuminate the potential that lies in further development.

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