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Dissertation
104

Assessment of welfare impacts in transport system planning

Katja Estlander

VTT SCIENCE 104

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Katja Estlander

Thesis for the degree of Doctor of Science in Technology to be presented with due permission for public examination and criticism in auditorium R1, at Aalto University, on the 23rd of October, 2015 at 12:00.

ISBN 978-951-38-8336-2 (Soft back ed.)
ISBN 978-951-38-8337-9 (URL: http://www.vttresearch.com/impact/publications)

VTT Science 104

ISSN-L 2242-119X
ISSN 2242-119X (Print)
ISSN 2242-1203 (Online)

JULKAISIJA – UTGIVARE – PUBLISHER

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Juvenes Print, Tampere 2015

Abstract

The goal of this thesis was to define what kind of impacts take place on the preconditions for welfare in the everyday life of people and the condition of the environment, when the transport system is being modified. Another main aim was to introduce a process for decision-makers to compare these so-called welfare impacts of different implementation schemes of transport plans, programmes and policies. The research questions were the following: 1) What kind of innovative combination of multi-criteria approaches would be applicable for assessment of welfare impacts of a transport plan, programme or policy and would allow the valuations of stakeholders to be taken into consideration? 2) What kind of impacts can modifications in transport systems have on the welfare of individuals, communities and the environment in Finland, and what criteria can be formulated to assess the impacts? and 3) Is it possible to use the evaluation criteria in practice and get representative and sufficient information about the welfare impacts of a transport plan, programme or policy?

Firstly, potential welfare impacts were sought for from literature and by interviews. Then a long list of potential criteria was discussed by means of postal survey, Internet survey and group interviews. The resulting list was reconstructed by using a multi-criteria method called Analytic Hierarchy Process (AHP) and after this, by discussing the study project with the stakeholders. The two surveys, the AHP analysis and the ensuing discussions led to a new version of the list of criteria. The criteria were tested in two Finnish case studies. These case studies were the enhancement project of the Seinäjoki–Oulu railway connection and the Helsinki Metropolitan Area Transport System Plan 2007. The welfare impacts of these two plans were evaluated by using the already existing evaluation data of the plans.

After the impact assessment, another application of the multi-criteria analysis was used. This method is called Measuring Attractiveness by a Categorical-based Evaluation Technique (MACBETH). MACBETH served as a tool to imply the values of the decision-makers or stakeholders in the impact assessment and to define the comprehensive list of welfare impacts. The MACBETH analysis was carried out solely on the basis of the data from the Helsinki MA Transport System Plan, but this data was used both in Helsinki and Oulu. However, the comprehensive list was not a direct result of the MACBETH process. These results were

again discussed with the project stakeholders, and the list was finished according to their valuations.

The main results of the study are the list of criteria of potential welfare impacts of modifications in the transport system, and a MCDA process called Assessment-Aid, for implying values of the stakeholders in the impact analysis of a transport plan or project. The list consists of six sub-groups of criteria and 15 assessment criteria thereunder. The following sub-groups were identified: 'Accessibility', 'Health', 'Safety and security', 'Quality of life', 'Environment', and 'Economic conditions'.

Other results are 1) information about the welfare impacts of the two case studies, 2) information about the preference order of the plans when welfare impacts and values of the stakeholders are included in the impact analysis, and 3) information about experience in using multi-criteria methods in impact assessment within the Finnish transport sector. Also, the study contributed to the wider co-operation between the different branches of administration that are involved in the strategic transport system planning.

Keywords Transport system, assessment of welfare impacts, evaluation criteria, multi-criteria analysis, accessibility, health, traffic safety, feeling of safety, quality of life, environment, nature, economic conditions

Tiivistelmä

Tämän väitöskirjatyön yksi tavoite oli selvittää, millaisia vaikutuksia liikennejärjestelmän muokkaamisella on ihmisten ja luonnon hyvinvoinnin edellytyksiin. Toinen tavoite oli luoda päätöksentekijöiden käyttöön prosessi, jonka avulla voidaan vertailla liikennejärjestelmän muokkaamisen eri toteutusvaihtoehtojen hyvinvointivaikutuksia.

Tutkimuskysymykset olivat seuraavat: 1) Miten monikriteerianalyysin sovelluksia innovatiivisesti yhdistelemällä voidaan arvioida liikennejärjestelmän muokkaamisen hyvinvointivaikutukset siten, että otetaan huomioon sidosryhmien arvovalinnat? 2) Millaisia vaikutuksia liikennejärjestelmän muokkaamisella voi Suomessa olla ihmisten ja luonnon hyvinvointiin sekä millaisin kriteerein näitä vaikutuksia voidaan tarkastella? ja 3) Onko edellä mainittuja kriteerejä mahdollista käyttää ja saada niiden avulla tietoa liikennehankkeen, -strategian tai -politiikan hyvinvointivaikutuksista?

Mahdollisia hyvinvointivaikutuksia kartoitettiin ensin kirjallisuustutkimuksella ja haastatteluin. Näin muodostettua listaa muokattiin posti- ja internetkyselyiden sekä ryhmäkeskusteluiden perusteella. Listan eri kriteerien välistä suhteellista merkittävyyttä tutkittiin monikriteerianalyysin sovelluksella Analytic Hierarchy Process (AHP). Kriteerilistan uusi versio muodostettiin näiden kyselyiden, AHP-analyysin ja sidosryhmäkeskusteluiden perusteella. Kriteerejä testattiin käytännössä kahden suomalaisen suunnitelman yhteydessä. Suunnitelmat olivat Seinäjoen ja Oulun välisen ratayhteyden parantamishanke sekä Pääkaupunkiseudun liikennejärjestelmäsuunnitelma (PLJ) 2007. Näiden suunnitelmien hyvinvointivaikutusten arviointiin käytettiin edellä mainittua kriteerilistaa ja suunnitelmista jo olemassa olevia vaikutusarviointiaineistoja.

Vaikutusarvioinnin jälkeen käytettiin toista monikriteerianalyysin sovellusta: Measuring Attractiveness by a Categorical-based Evaluation Technique (MACBETH). Vaikutusarviointitietoa tulkittiin MACBETH-prosessilla päätöksentekijöiden ja sidosryhmien arvostusten mukaisena. Samalla tarkasteltiin myös kriteerilistan sisältöä ja muotoa. MACBETH-prosessia seuranneen keskustelun jälkeen lista viimeisteltiin tutkimuksen sidosryhmien arvostusten mukaisena.

Tutkimuksen tärkeimmät tulokset ovat liikennejärjestelmän muokkaamisen hyvinvointivaikutuksia kuvaava kriteerilista sekä MACBETH-prosessi, jota kutsutaan nimellä ArviointiApu. ArviointiApua käytetään soveltamaan päätöksentekijöiden tai sidosryhmien arvostuksia liikennehankkeiden tai -strategioiden hyvinvointivaiku-

tusten arvioinnissa. ArviointiApu, samoin kuin valmis kriteerilista, koostuu kuudesta kriteeriryhmästä sekä niiden alaisista 15 kriteeristä. Kyseiset ryhmät ovat 'Saavutettavuus', 'Terveys', 'Turvallisuus', 'Elämänlaatu', 'Ympäristö' ja 'Taloudelliset edellytykset'.

Tutkimuksen muut tulokset ovat 1) tieto kahden suunnitelman hyvinvointivaikutuksista, 2) tieto sidosryhmien arvostusten mukaisesta suunnitelmavaihtoehtojen keskinäisestä järjestyksestä hyvinvointivaikutusten suhteen ja 3) kokemus monikriteerianalyysin soveltamisesta liikennejärjestelmätutkimuksessa. Lisäksi tutkimus edisti osaltaan hallinnon eri alojen yhteistyötä liikennejärjestelmän strategisen suunnittelun yhteydessä.

Avainsanat Transport system, assessment of welfare impacts, evaluation criteria, multi-criteria analysis, accessibility, health, traffic safety, feeling of safety, quality of life, environment, nature, economic conditions

Preface

I began researching the topic in my licentiate study (Rusila 2004b; see References list) that provided preliminary information about welfare impacts and assessment methods. Having carried out most of my doctoral research work in 2003–2007, I updated the literature survey in 2010 and 2011 for my doctoral thesis. Several people and organisations have made this thesis possible. In this chapter, I would like to express my thanks to all of them.

I would like to thank Professor Matti Pursula for advising me in writing the thesis. He has given me an enormous amount of his time. Warm thanks also go to Professor Tapio Luttinen for supervision of the thesis work. I would also like to thank Professor Bert van Wee and Professor Cathy Macharis, the preliminary examiners for this doctoral dissertation.

I am in debt to Saara Pekkarinen, without whom this work would never have taken place. Saara's ideas and encouragement have been extremely valuable for my research.

Special thanks are due to Heikki Kanner, who enabled my research work at VTT and supported me with my research. Special thanks must also be given to Virpi Britschgi and Juha Heltimo for their help and enthusiasm in the research process.

I wish to thank Professor Alan Pearman for his help in the early stages of writing my thesis. I had an opportunity to work with him for some months at the University of Leeds, after which I have received guidance and encouragement from him.

I would like to give my warmest thanks to Raisa Valli, Mauri Heikkonen, Ulla-Riitta Soveri, Jaakko Ellisaari, Mirja Peljo, Mervi Karhula, Matti Holopainen, Arja Aalto, Suoma Sihto, Tapani Kauppinen, Tytti Viinikainen and Kalevi Luoma for giving their time and expertise to my use. A special thank you must also be given to all the interviewees who placed their experience and time at my disposal.

I would like to thank the organisations that have supported my work either by participating in the financing or allowing experts to participate in the interviews and meetings of my research. These organisations are, in addition to VTT; the Ministry of Transport and Communications, Ministry of the Environment, Ministry of Social Affairs and Health, the Finnish Road Administration, the Finnish Rail Administration, the Finnish Metropolitan Area Council, the Finnish National Institute for

Health and Welfare, and the Association of Finnish Local and Regional Authorities.

I am grateful for the scholarships I have received from the Finnish Cultural Foundation, the Finnish Foundation for Technology Promotion and Wihuri Foundations. I would like to thank Arto Seppovaara for his support and my current employer the National Audit Office for the time I was allowed to use on finalisation of my thesis.

Warm thanks go to my mother Päivikki and my spouse Ari for their practical help and kind support.

Hyvinkää, 24 August 2015

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Author’s contributions

Katja Estlander is the sole responsible author of the monograph ‘Assessment of welfare impacts in transport system planning’. She has planned and conducted the study, as well as carried out the related analysis and reporting.

Saara Pekkarinen supported Estlander throughout the study, in the form of review and discussions. Virpi Britschgi and Juha Heltimo had minor roles in conducting the study.

Contents

List of abbreviations

AHP	Analytic Hierarchy Process
AST	Appraisal summary table
B/C	Benefit-cost ratio
CBA	Cost-benefit analysis
CEA	Cost-effectiveness analysis
EIA	Environmental impact analysis
GOMMS	Guidance on the methodology for multi-modal studies
HIA	Health impact assessment
HuIA	Human impact assessment
IRR	Internal rate of return
MACBETH	Measuring Attractiveness by a Categorical Based Evaluation Technique
MAMCA	Multi-actor multi-criteria analysis
MAUT	Multi-attribute utility theory
MCA	Multi-criteria analysis
MCDA	Multi-criteria decision analysis
MCDM	Multi-criteria decision making
NATA	New approach to appraisal
NPV	Net present value
QOL	Quality of life
SCBA	Social cost-benefit analysis

SEA	Strategic environmental assessment
SIA	Social impact analysis
SMART	Simple Multi-Attribute Rating Technique
SoE	State of the environment
YHTALI	Finnish framework for appraisal of transport projects

1. Introduction

1.1 Overview of the introductory section

The background of the study is introduced in Chapter 1.2. The key concepts are first presented in Chapter 1.2.1. These concepts are welfare, sustainability and well-being. Secondly, features of the context of the study, transport system planning and especially the assessment of transport plans, are introduced in Chapter 1.2.2. In Chapter 1.2.3, a summary of the above-mentioned information is presented and the motivation of the study is discussed.

The research problem of the study is presented and the research questions defined in Chapter 1.3. Finally, in Chapter 1.4, the contents of this thesis are described.

1.2 Background for the study

1.2.1 Welfare, well-being and sustainability

When the transport system is modified, changes occur in many areas of society. These changes have an impact on the everyday life of people and on the condition of the environment. In the context of the transport system, this thesis concentrates on identifying and assessing such impacts and impact groups which are here referred to as **welfare impacts**. These impacts include impacts on the level of service of the transport system that affect the daily mobility of people, as well as impacts on traffic safety, health, social conditions and viability of nature or economic conditions.

In this chapter, the definition of the key concept, **welfare**, is discussed**.** Two concepts that are closely related to the definition of welfare are **sustainability** and **well-being**. The relations between welfare, well-being and sustainability are briefly introduced here. There are various definitions of the multidimensional concepts of sustainability and well-being. Some of the definitions are overlapping, some even competing. Public and policy-level interest in the concept of well-being has grown

recently, while interest in sustainability issues has somewhat declined. (Rinne et al. 2013.)

Concepts of sustainability and welfare, differ from each other in their time frames. Welfare is more related to the present time and short-term future, whereas sustainability strongly emphasizes the living conditions of the following generations. The different aspects of welfare can be defined as *human*, *environmental* and *economic* welfare. *Human welfare* cannot be summed up in one definition or an indicator. Welfare consists of a number of factors. Human welfare refers to what makes up people's "basic essentials of life". Human welfare includes factors like health, income, housing, a clean environment, safety, personal fulfilment and human affection (The Ministry of Social Affairs and Health 2007). Three areas are looked at; physical, mental and social well-being (Laitinen, 2009).

Human w*ell-being* includes both objectively measurable things and subjective personal values and feelings. In general, it can be argued that the needs of well-to-do humans are satisfied, when they have strength and opportunities for recreation, rest, self-fulfilment and spending time with people who are close to them. (The Ministry of Social Affairs and Health, 2007).

A recent definition of *well-being* describes well-being as the balance point between individuals' resources and the challenges faced by them. Stable well-being occurs when individuals possess the psychological, social and physical resources that they need to meet particular psychological, social or physical challenges (Dodge et al. 2012).

Environmental welfare is close to ecological or biological integrity. Environmental welfare involves being aware of the limits of the earth's natural resources, and understanding the impact of one´s actions on the environment. Environmentally healthy environment supports the whole range of species or ecosystem processes of natural habitat in that region, and is capable of recovering from normal stress situations. An 'unwell' environment is presented as degraded, or impoverished. (Neller and Neller 2009, UI Wellness Center 2013).

Environmental well-being involves being aware of the limits of the earth's natural resources, and understanding the impact of your actions on the environment (UI Wellness Center 2013).

According to the above-mentioned definitions, impacts on nature and the environment have an effect on environmental well-being, while impacts of environmental changes on people result in changes in human well-being. *Economic welfare* is the economists' general term for the prosperity and living standards of an individual or group. Economic welfare is a means for being able to achieve and maintain sustainability (The Sustainable Society Foundation 2013).Van Praag and Frijters (1999) define economic welfare as utility of income, or income satisfaction. However, they separate welfare from *well-being*. According to Van Praag and Frijters, well-being also includes factors unconnected to income or purchasing power. One distinction made by the economists between welfare and well-being is that welfare is assigned to the contribution to well-being from the goods and services that can be bought with money (Van Praag and Frijters 1999). According to this definition, well-being is rather similar to life satisfaction and happiness.

Human, environmental and economic welfare are not equal or independent. Human welfare and environmental welfare are goals to be achieved. Economic welfare is a means for achieving sustainability and maintaining it over time. All the three concepts are interdependent and there are large trade-offs between them. (The Sustainable Society Foundation 2013.)

The concept of welfare can also be divided into three dimensions: health, material and perceived welfare and quality of life (The Finnish National Institute for Health and Welfare, 2013)

The social-scientific approaches to welfare can be roughly divided into needs-based or resource-based perspectives. The difference between the needs-based and resources-based approaches is whether the state of welfare is assessed subjectively (needs-based) as people's own impression, or objectively (resource-based), which means analysing the resources that enable the satisfaction of various human needs. (Marski 1995.)

As regards the needs-based aspect, welfare is considered as a state that already exists, and as regards the resource-based aspect, welfare is a state that is possible to reach. All in all, welfare can be seen as an entity that consists of different interconnected and interdependent needs, possibilities and resources. (Marski 1995).

The economists define an often used optimum situation for welfare; the so-called Pareto optimum. A Pareto optimum is reached when nobody can increase their welfare, unless someone else's welfare decreases. An often cited alternative comes from Hicks and Kaldor. They discuss a potential Pareto improvement, where a method of redistribution is possible. They state that the winners should be somehow able to redistribute the gains to the losers. (Van Wee 2011.)

Tapaninen et al. (2002) point out that welfare is shaped in the interactive process of people's needs and the resources available. Although the requirements of different individuals vary, they always depend on the surrounding society and its culture. A crucial question is whether the decision-makers, authorities, different actors and residents reach a common opinion on the desired living environment and on the ways to achieve this (Tapaninen et al. 2002).

Dimensions of *community-level well-being* include living conditions, employment and working conditions and income. *Well-being of the individual* consists of social relationships, self-fulfilment, happiness and social capital. (The Finnish National Institute for Health and Welfare, 2013.) One definition of human well-being is how good and successful people consider their lives to be, or what their "basic essentials of life" are like. Often, three areas are looked at; physical, mental and social well-being (Laitinen 2009). According to O'Riordan (2013), well-being is a culture-based concept that consists of feelings and functions.

According to Delbosc (2012), the social and *well-being impacts* of transport are beginning to be addressed in the sustainability framework. Likewise, O'Riordan (2013) recommends that promotion of sustainability that is focused on well-being, should take place in the planning processes. Delbosc (2012) suggests that improved well-being should be the primary social policy goal in transport, instead of only improved accessibility or mobility. However, Delbosc (2012) also points out

that potential impacts of transport on well-being have not been studied much empirically. She also reminds transport planners and policy-makers that they must not ignore the importance of transport in facilitating well-being.

The fundamental definition of *sustainable development* is the one of the World Commission on Environment and Development, also known as 'the Brundtland Commission' (WCED 1987). The commission introduces sustainable development as "development that meets the needs of the current generation without undermining the ability of future generations to meet their own needs". The so-called Brundtland report (WCED 1987) also discusses limits and limitations in the following way:

"The concept of sustainable development does imply limits – not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology and social organization can be both managed and improved to make way for a new era of economic growth."

Burgess and Barbier (2001) point out that both weak and strong *sustainability* exist. The weak sustainability view includes no inherent difference between natural and other forms of capital, and hence the same optimal depletion rules apply to both natural and other forms of capital. The strong sustainability view argues that physical or human capital does not substitute for all the environmental resources. These resources comprise, for example, the natural capital stock, or all the ecological services performed by nature. (Burgess & Barbier 2001.)

According to the Finnish National Commission of Sustainable Development, FNCSD (2003), sustainable development, or sustainability is a continuous, guided process of societal change at the global, regional and local levels. The process is aimed at providing every opportunity to present and future generations to lead a good life. The basic preconditions for ecologically sustainable development are preservation of biodiversity and adjustment of mankind's economic and other material activities to our global resources and the carrying capacity of the nature. The FNCSD defines the three operational dimensions of sustainability as follows: an ecological dimension (including and closely integrated with economic sustainability), a social dimension and a cultural dimension. The Finnish national strategy for sustainable development claims that well-being needs to be assured within the limits of the carrying capacity of nature, both nationally and globally. The realisation of the strategy requires the balancing of ecological, economic, social and cultural viewpoints. (Finnish National Commission on Sustainable Development 2008.)

The OECD (2001) defines sustainability to consist of three dimensions; economic, social and environmental objectives. The intention to sustainability entails integration of these objectives of the society, where possible, and making trade-offs between the objectives where integration is not possible.

Munda (2005) defines sustainable development as a multidimensional concept that includes socio-economic, ecological, technical and ethical perspectives. He brings into question that, when sustainability policies are being made operational, the essential questions are 1) sustainability of what and, 2) sustainability of whom. Munda (2005) also points out that a high degree of conflicts is involved in sustainability issues.

The following, evolved definition of sustainability has been introduced in a monitoring report of the EU Sustainable Development Strategy (European Commission 2011): *"The overall aim is to achieve a continuous improvement in the quality of life of citizens through sustainable communities that manage and use resources efficiently and tap the ecological and social innovation potential of the economy, so as to ensure prosperity, environmental protection and social cohesion."*

According to Steg and Gifford (2005), there is no common definition of sustainable transport. They define that generally accepted sustainable transport implies balancing current and future economic, social and environmental qualities. Tzay and Liu (2013) and ECMT (2004) outline the following basic characteristics of transport sustainability:

- The basic access and development needs of individuals are met safely, and in a manner that is consistent with human and ecosystem health.
- Sustainable transport system operates fairly and efficiently, offers a choice of transport mode and supports a competitive economy, as well as balanced regional development.
- The emissions and waste are limited within the planet's ability to absorb them. Renewable resources or non-renewable resources below the rates of development of renewable substitutes are used, while minimizing the impact on the use of land and the generation of noise.

1.2.2 Features of transport planning and assessment of transport system plans

Transport system planning is one type of public planning process. Bots and Lootsma (2000) recognise the following four characteristics of such a process:

- Decisions 'happen' as a result of complex interactions, for example between national, regional and local administrations, trade unions, pressure groups etc.
- Decisions often involve many different interests in a society. Aggregation into such notions as 'general welfare' only hides conflict.
- There is a wide range of evaluation criteria, with a wide variety of both qualitative and quantitative criteria. The values of these criteria, for example quality of life or safety are difficult to establish and aggregate.
- The planning horizon extends to several decades, for example in decisions on infrastructure.

Political decision-making concerning transport infrastructure investments routinely rely on a detailed quantitative project appraisal, both on the national as well as on local level. Transport policy decisions on transport infrastructure investments often require knowledge of welfare effects of using these infrastructures on a detailed regional level. (Bröcker et al. 2010.)

Sayers et al. (2003) have presented a general diagram about the decision-making process in the British strategic planning of transport system (Figure 1). They address the problem that there is lack of knowledge about what should go into the 'black box' in what is otherwise a rather well-defined process. This way of thinking can be applied to the Finnish case of transport system planning, too. Sayers et al. note that there are conflicting requirements for consistency and flexibility, with respect both to the criteria that are used in the evaluation and the selection of the best method for ranking the options.

For example Leskinen (1994) and Valli (1998) have carried out research in the areas of strategic planning, impact assessment and decision-making related to transport systems in Finland. Valli (1998) analysed environmental impact assessment in the Finnish transport policy, using soft systems methodology (see Checkland 1981). Valli's approach emphasised system-oriented assessment, instead of the traditional approach in which the focus is on separate sectors related to transport. The key issue in her approach was to recognize the underlying values and objectives, while considering the complicated interactions. The role of impact assessment as a crucial part of every stage of the planning process was pointed out by Valli.

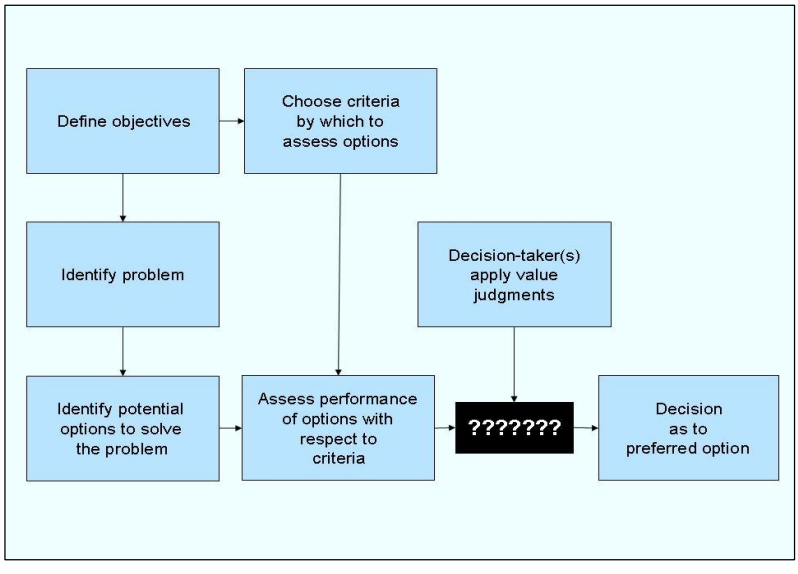

Figure 1. A simplified presentation about the decision-making process in transport system planning (edited according to Sayers et al. 2003, Figure 1.)

Midgley and Reynolds (2001) have also discussed the relationship between the systems approach and environmental planning. They have presented three general similarities between operational research and environmental management. These similarities are 1) complexity and uncertainty, 2) multiple and often conflicting values and 3) political effects on those not involved in the planning processes. Another similarity between the transport system and operations research is stated by Maani and Cavana (2003): a system is the product of the interactions of its parts that function as a whole. They agree with Kauffmann (1980) who defines a regional transport system as an example of a social-economic system.

Valli (1998) recommends an interdisciplinary approach and examination of the transport system as a set of interactions. Also Midgley and Reynolds (2004) have pointed out a common interest in purposeful interdisciplinarity within physical planning.

The European Conference of Ministers of Transport (ECMT 2004) comment on the promotion of sustainability. They note that the advancement of sustainability is often impaired by a traditional tendency to view the environment as a constraint and legal obligation. They also request for interdisciplinary approaches to planning and policy making. A clear and urgent need exists to integrate all forms of assessment into the whole process of planning, both for projects and for more strategic initiatives (ECMT 2004).

Both Valli (1998) and Hildén et al. (2004) point out that the view of planning has a great effect on the methods used and on the interpretation of the results of impact assessment.

Munda et al. (1994) state that environmental management is primary conflict analysis that includes technical, socio-economic, environmental and political value judgments. Thomopoulos et al. (2009) stress that this is the case with transport evaluation, too. Consequently Hildén et al. (2004) describe transport planning as a social struggle over problem definitions and future choices. Keeney (1992, 1996) emphasises that values are fundamentally important in any decision situation. Keeney refers to a traditional problem solving approach as alternative-focused thinking, and criticises that focusing on the alternatives instead of values is a limited and reactive way to think. Value-focused thinking leads to identification of desirable decision opportunities whereas alternative-focused thinking is designed to solve decision problems. This means identification of the fundamental objectives of planning and values of the actors and decision-makers, as well as discussion thereon.

The context of this study is Finnish regional transport system planning. The Finnish regional transport system plans present the wide framework for regional and local transport planning. These plans are the means of applying the national high-level objectives regionally. The plans are usually created interactively with regional land use planning. Prediction and appraisal of the potential impacts of the different options are an important part of the planning process. The plans concern all transport modes and usually involve several municipalities. Environmental impact assessment and small-scale public participation are generally included in the planning process. As an example of the above-mentioned interaction, Hok-

kanen et al. (1998) define five criteria in determining the implementation order of a regional general plan. These criteria are the effects on the surrounding environment, urban planning economics, land ownership, community structure, as well as human health and living conditions.

The impact assessment practice within the Finnish transport sector has traditionally been divergent, and there is need for a more integrated approach (Rusila 2004b). The assessments have been carried out separately e.g. concerning changes in the transport system and its effectiveness, economic impacts, environmental impacts or human impacts.

However, growing emphasis on sustainability, and on the other hand, scarcity of the economic resources available for transport planning have adduced ever increasing interest in the actual influence that transport system planning has on the everyday lives of people and well-being of the nature. In my licentiate study (Rusila 2004b), I studied the vague research subject of "indirect impacts and impact chains that happen due to changes in the transport system and that affect the welfare of individuals and communities". As a result, certain welfare impacts that were identified according to their objects of influence were introduced (Appendix A). The study was conducted in close co-operation with the Finnish national and regional transport authorities, who expressed their need for further information about the subject that could be used in the regional transport system planning.

Assessment of transport policies, projects and plans in Europe relies on quantitative methods. Two common methods are cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA). The importance of qualitative elements within the evaluation and decision-making of transport projects has however increased over the last ten years. In connection, the use of multi-criteria decision aid (MCDA) methods for transport project appraisal has increased. Substantive reasons for this increase are the complexity of issues evaluated and the experienced inadequacies of traditional tools such as cost-benefit analysis or cost-effectiveness analysis that may not capture the diversity of the impacts of the project, plan or policy under evaluation. Research on methods that are based on multi-criteria decision aid has evolved rapidly in the past years. (Macharis and Bernardini 2015.)

Tools that are based on multi-criteria analysis (MCA) are practical for comparison of for example different policy options. These tools can be effectively used to integrate a diversity of multidimensional criteria, and both qualitative and quantitative data. For example, Munda (2005) states that a multi-criteria framework is a very efficient tool in implementing a multi or interdisciplinary approach. Also Ribeiro et al. (2013) note that an application of multi-criteria decision analysis is most suitable in assessing a case in which economic, social and environmental criteria are explicitly indicated.

Methods based on multi-criteria analysis are extensively used in evaluating sustainability (Munda 2005). There is wide potential in the MCA methods to support an emerging and heterogenous area of sustainability assessment. However, information has to be gathered to facilitate the selection of a multi-criteria method in connection with different approaches and evaluations (Cinelli et al. 2014).

As a result of a study in which evaluation techniques for transport policies were compared, it was recommended that a cost-benefit analysis or cost-effectiveness analysis should be complemented with a complete environmental and socio-economic impact assessment, in terms of multi-criteria decision analysis (Browne and Ryan 2011). It was highlighted that multi-criteria decision analysis allows for participatory analysis and qualitative assessment. However, subjectivity and value-laden judgments were identified as potential problem areas of the method.

Transport evaluation contains technical, socio-economic, environmental and political value judgments that are often competing. This has generated the need for a flexible approach to the contradictory aspects of transport evaluation. The multi-criteria analysis has been used to provide a flexible means of assessing the multidimensional effects of transport projects, though to a limited extent so far. (Thomopoulos et al. 2009.)

1.2.3 Motivation of the study

The grounds for this study were the need to integrate and effectively utilise the information about the wide range of impacts related to the welfare of people and the environment within the Finnish transport system planning, and the growing importance of regional transport plans. At present, several methods exist that can be used to evaluate the above-mentioned impacts separately. A common framework is still needed to enable decision-makers and planners to understand what the individual impacts mean, and how these could be compared with each other. EMCT, the European Conference of Ministers of Transport (2004), requests for interdisciplinary approaches to planning and policy making. They call for integration of all forms of assessment into the whole process of planning, both for projects and for more strategic initiatives (ECMT 2004). In Finland, the impact assessment practice has traditionally been divergent, and there is need for a more integrated approach (Rusila 2004b).

In a review of European transport project appraisal practices that was carried out in the year 2000, it was confirmed that there is strong tradition in the use of cost-benefit analysis for the appraisal of public sector transport projects in Europe (Bristow and Nellthorp 2000). It was detected that there is a high level of consensus on the direct impacts that should be included in a CBA, but the values diverge largely when it comes to impacts for which no market values are available. These types of impacts are for example time and accident costs. Respectively, consensus on which environmental impacts should be included existed, but less agreement was shown on the appropriateness of monetary valuation thereof. No agreement was found on how the indirect socio-economic impacts of policy relevance should be included in the appraisal. Also, it was not clear under what circumstances these impacts are supplementary to the direct impacts. The emerging use of multi-modal approaches and multi-criteria analysis was seen as development in the right direction.

Numerous benefits are brought to the society by transport networks. The benefits result from for example goods delivery, access to services and personal mobility of people. However, significant environmental, economic and social costs i.e. 'negative externalities' are caused by transport. These externalities are often under-priced or not internalised in the prices of transport. The users are generally not aware of the marginal external costs of their activities. Hence, the above-mentioned externalities rarely affect the purchasing patterns or behaviour of the users of the transport networks (Browne and Ryan 2011).

The concepts of sustainability and welfare, and the human, environmental and economic aspects of those were introduced in Chapter 1.2.1. Sustainability is a commonly applied concept that is rather similar to welfare. The assessment of sustainability impacts of physical planning is usually carried out according to division into three aspects (for example Hayashi et al. 2014, Souza Santos and Kahn Ribeiro 2013, Wang 2014). These aspects are the economic, social and environmental points of view. These are presented in several definitions of sustainability (for example OECD 2001, Finnish National Commission on Sustainable Development 2008).

According to Steg and Gifford (2005), several methods for the assessment of economic, social and environmental impacts of transport exist, but only few social or sustainability indicators are actually used. Steg and Gifford state that the reasons for this deficiency are lack of knowledge and lack of valid methods.

In several countries, it has become an essential task to develop an indicator system for measuring and monitoring transport sustainability (Shiau and Liu, 2013). Although general indices for human and environmental welfare have been defined (e.g. Prescott-Allen 2001), impacts of transport system planning on the welfare of people, communities and the environment have not been generally assessed.

Transport appraisals are mainly quantitative in many countries, both on the national as well as on local level. However, policy decisions on transport investments would often require knowledge of welfare effects of using these infrastructures on a detailed regional level (Bröcker et al. 2010). For example, the Finnish framework for appraisal of transport projects (The Finnish Transport Agency 2011) mainly relies on assessment of economic feasibility. However, the framework has recently been supplemented with assessment of non-monetary impacts and feasibility. There are no actual requirements about the methods to be used in these assessments.

The decision-making process of transport projects is almost inevitably a complex situation. In addition to consideration of several quantitative or qualitative effects, for example economic, environmental, technical, spatial and social impacts, several possible alternatives or solutions to a proposed question are to be compared. In addition, several stakeholders can be involved in the decision-making process. Multi-criteria decision analysis-aid (MCDA) enables evaluation of alternative projects or variants against multiple qualitative and quantitative criteria (Macharis and Bernardini 2015).

There is a great risk that the evaluation procedure of transport options is experienced as a 'black box' (as shown in Figure 1), where the link between the preferences of the decision-maker and the results of the evaluation is lost, which should not happen. Macharis and Bernardini (2015) demonstrate that the properly designed use of a correctly selected MCDA technique can tackle this problem.

As a result of a study in which evaluation techniques for transport policies were compared, it was stated the there is no simple solution to the comprehensive evaluation of transport policy measures (Browne and Ryan 2011). Both qualitative and quantitative assessments, where possible, were recommended for transport policy appraisal. More research was required in valuing the non-tangible impacts of transport policy, to ensure that cost-benefit analysis and multi-criteria analysis are used properly. It was also underlined that future studies should examine how tools like cost-benefit analysis, cost-effectiveness analysis and multi-criteria analysis could be used in assessing the strategic environmental impacts or sustainability of transport projects, policies and programmes. The importance of the need for experience in how health impact assessments could be incorporated into these types of tools was also stressed.

A widely used MCDA technique is the Analytic Hierarchy Process (AHP). The AHP and its derivatives are widely used in connection with transport project appraisal (Macharis and Bernardini 2015). The AHP can be used for example for ranking of different criteria based on pairwise comparison. In turn, a MCDA technique called MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique) enables demonstration of how the values of an individual or a group of people can affect the priority order of for example policy alternatives.There are advanced computer programs available for this. MACBETH has been used for example in the context of urban planning, prioritization of policy objectives or in conflict resolution (see for example Figueira et al. 2005, Dodgson et al. 2000, Saaty and Vargas 1994 and Olson 1996). However, MACBETH is not a common method within assessment of transport system.

The two above-mentioned methods have generally not been combined in the assessment of physical planning or comparison of policy objectives.

Academic literature about the use of multi-criteria analysis within Finnish transport system planning is difficult to find, although some literature is available on the use of multi-criteria methods in, for example, environmental planning, land use and urban planning or the energy sector (e.g. Ekholm et al. 2014, Neste and Karjalainen 2013, Saarikoski et al. 2013, Sorvari 2010).

The assessment of welfare impacts requires consideration of a wide range of criteria, both qualitative and quantitative. Due to several participants, there may be conflicts in the assessment process. Interaction with the decision-makers, and their possibility to give feedback during the process is essential.

Finland is one of the Nordic Countries in Europe. The Finnish living conditions and transport system differ radically from those of Southern and Central Europe. For example, Finland is sparcely populated, there are vast distances between locations and there can be severe hindrance caused by snow and low temperatures in the wintertime. These conditions and the characteristics of people have an

impact on the values of the people concerning changes in the transport system. There is lack of integrated information about the welfare impacts of changes in the transport system in the Nordic setting.

In this Section 1, the different aspects related to the assessment of welfare impacts and the assessment methods have been discussed. It is highlighted that multi-criteria decision-making methods are becoming more common, and there is need for innovative approaches in the selection and combination of the MCDA techniques. This is the case especially within planning of the transport system in Finland. It is demonstrated that there are few interdisciplinary approaches for complementing the prevailing practice of quantitative impact analysis. Especially approaches that would incorporate both quantitative and qualitative information and take the values of the different actors and interest groups into consideration are rare. It is also stated that there is little information about the welfare impacts of the changes in the transport system, especially in the Nordic context.

1.3 Objectives

My research problem is '**How to recognise welfare impacts and to assess those in a transport planning assessment process in a way that reflects the effect of the stakeholders' values on the outcome of the assessment?'**

The consequent research questions are as follows:

1. What kind of innovative combination of multi-criteria approaches would be applicable for assessment of welfare impacts of a transport plan, programme or policy and would allow the valuations of stakeholders to be taken into consideration?
2. What kind of impacts can modifications in transport systems have on the welfare of individuals, communities and the environment in Finland, and what criteria can be formulated to assess the impacts?
3. Is it possible to use the evaluation criteria in practice and get representative and sufficient information about the welfare impacts of a transport plan, programme or policy?

This thesis concentrates on changes that take place in the preconditions for welfare of people and the environment when the transport system is modified. I have

examined welfare impacts through prerequisites for human and environmental welfare (see e.g. Prescott-Allen 2001 for Human Welfare and Environmental Welfare Indices, Rosenström & Palosaari 2000, and Heltimo 2003).

The results of this thesis are aimed to be used in evaluations that are required by recent legislation on environmental impact assessment of plans, programmes and policies (Act on the Assessment of the Impacts of the Authorities' Plans, Programmes and Policies on the Environment 200/2005, 347/2005). There is also a growing interest in multi-criteria assessment in the transport sector and there exists a need to test and develop such methods for the assessment of transport policies, plans and projects.

It is not possible to consider the different aspects of welfare separately and independently of each other, however. It is often crucial to be able to decide about actions that are simultaneously ecologically sustainable, socially acceptable and technically and economically realistic and feasible. This means that the conceptions of welfare need to be brought together under the same framework of analysis in order to reconcile the diverse aspects of the different views. Another dimension of the analysis is the operational environment of the society; consisting of e.g. commerce and business opportunities, economical structure, urban structure and the built environment.

Increasingly interactive planning and open decision-making processes are desirable trends for the future (e.g. Valve 1999). Multi-criteria analysis can be used to create a transparent procedure that would help to illustrate the decision-making process and provide a means for participation. Applications of multi-criteria decision aid can be used for processing both quantitative and qualitative data. This is an essential feature for the assessment of welfare impacts, since the data that is available for the assessment of welfare impacts is very diverse.

Multi-criteria appraisal techniques provide a flexible way of dealing with qualitative multidimensional effects of decisions (Munda et al. 1994). Strategic transport planning includes decisions that merge several, often conflicting opinions. The decisions usually involve long-term processes with numerous interest groups and considerable uncertainty. This study builds on the theory and applications of multi-criteria decision analysis (MCDA), in order to provide tools for making strategic decisions about the regional transport system. The MCDA provides means of identifying the objectives, analysing the options and making choices based on several criteria (Dodgson et al. 2000).

1.4 Contents of the thesis

The background for the study is provided in Chapter 1.2, and the research questions are presented in Chapter 1.3.

The findings of the literature study concerning the research context and selection of research methods are presented in Chapter 2. In Chapter 2.2, an overview of the traditional appraisal processes of transport plans, programmes and policies in selected European countries is given. Chapter 2.3 presents a variety of ap-

proaches relating to the assessment of impacts on welfare and quality of life. Different criteria for assessment of sustainability impacts are presented in Chapter 2.4. Chapter 2.5 describes two frameworks for transport appraisal, in Finland and the UK. In addition, two methods of analysis, the CBA and MCDA are introduced in chapter 2.6.

The research materials and methods used in the study are described in Chapter 3.

The findings of the study are introduced in Chapter 4, which presents the results of the selection and pre-testing of the criteria for welfare impacts, results from the post-testing of these criteria and creation of a MCDA procedure to support the assessment of welfare impacts. The main contribution of this thesis, the list of criteria for assessment of welfare impacts, is introduced in Chapter 4.9.

To conclude, the results and methods used, as well as potential future needs for research, are discussed in Chapter 5.

2. Overview of the research context and methods

2.1 Introduction

The research context and background information for selection of two applications of multi-criteria analysis as research methods is described in this section, based on a literature overview. The overview of literature included four objectives. The first objective was to find out what kind of research results exist about the assessment of welfare impacts of transport system planning or sustainability impacts related to the subject, and thus clarify the need for the information provided by this study. The second aim was to gain data that could be used as background material in identification of possible welfare impacts of transport system planning. The third objective was to form a picture about the context of assessment of transport plans, programmes and policies. Finally, the fourth purpose was to gather information about potential research methods and thereby facilitate the selection of the methods used.

This chapter brings into question issues related to the subject, assessment of welfare impacts of transport system planning, and on the other hand, discusses the most relevant potential methods that could be used in the study.

The literature overview focuses on European practice in assessment and appraisal of transport plans, programmes and policies, with special emphasis on the impacts on sustainability, welfare and quality of life and the evaluation methods used commonly within transport system planning. The status of European assessment and appraisal practices was examined by studying existing guidelines, as well as theoretical journal articles and practical evaluation reports of transport plans, programs and policies. The literature that was studied had been published between the years 1990 and 2014. The main emphasis is on European literature, because European practices are considered the most similar to Finnish environment of assessment. However, interesting examples of transport assessment or sustainability criteria, as well as development of research methods are included in the study of literature.

The journal articles were searched for in international academic databases. The data searches concerned mainly transport assessment and appraisal, sustainability assessment and criteria, theory and use of multi-criteria analysis, theory and use of cost-benefit analysis, and welfare impacts as well as assessments of human, health, quality of life and social impacts in physical planning. The information about practical applications of multi-criteria and cost-benefit analysis was mainly sought for within assessments concerning transport planning. The transport evaluation reports were search for e.g. from the EU and OECD databases, as well as from the internet interfaces of Finnish and other European authorities in transport, environment and social and health sectors.

The guidelines for transport assessment were at first sought from all European countries, but then a decision was made to focus the review on Finland and the UK. This choice was made because the study was carried out in Finland and the context of Finnish transport planning formed the framework for this study, and because there exist wide-ranging guidelines for transport appraisal in the UK.

Initially, selected features of assessment of transport plans, programmes and policies are briefly introduced in Chapter 2.2. Assessment of different types of impacts that can be considered as sustainability impacts is discussed in Chapter 2.3. The welfare impacts as understood in this study were not detected in the literature. Therefore the identification of potential welfare impacts was focused on a review of sustainability impacts and the assessment of those. As discussed in 1.2.1, welfare and sustainability are concepts that are very close to each other in their meaning. Assessment of impacts related to sustainability is described in Chapter 2.3. Examples of sustainability criteria that were used as the starting point for the identification of welfare impacts are presented in Chapter 2.4.

The assessment and appraisal practices in Finland and in the UK are briefly described in Chapter 2.5. Finland was selected because this study is carried out in Finland, and aims at contributing to the appraisal of transport plans, programmes and policies in Finland. Another example is presented from the UK, where there exist advanced guidelines for the assessment of transport plans, programmes and policies. Also, guidance for and experience in the use of multi-criteria methods is available in the UK.

As well as Finnish guidelines and regulations, principles of selected European guides for transport project appraisal are adopted in the present study (see for example: the Department of the Environment, Transport and the Regions 2004, OECD 2001, European Commission 2002, 2003a, 2003b). In addition, research results about and guidelines for economic evaluation of transport or urban planning projects, plans and policies are included (e.g. the Finnish Road Administration 2001, Kulmala et al. 2002, The Finnish Rail Administration 2004, OEEI 2000, European Commission 1998 & 2002, Center for International Forestry Research 1999, Sudgen 2003, Saelensminde 2004, the Finnish Transport Agency 2011, and the Ministry of Transport and Communications 2003b).

Information on the use of multi-criteria analysis in the Finnish transport sector was sought for. The use of multi-criteria analysis and its derivative techniques has been quite limited in Finland, compared to several European countries. In the

search for literature (Chapter 2.1), it was found out that academic literature about the use of multi-criteria analysis in Finland was available for example in environmental planning, land use and urban planning as well as in energy sector (e.g. Ekholm et al. 2014, Neste and Karjalainen 2013, Saarikoski et al. 2013, Sorvari 2010). However, no academic literature on the use of multi-criteria methods in the transport sector could be detected.

The two most commonly used methods in the appraisal of transport plans, programmes and policies are introduced and compared in Chapter 2.6. These methods are cost-benefit analysis and multi-criteria analysis. In addition, general information about multi-criteria decision aid techniques is presented and two multi-criteria methods are introduced in Chapter 2.6.4. These two methods, the Analytic Hierarchy Process (AHP) and Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) were selected as research methods of the current study.

2.2 Assessment of transport plans, programmes and policies

The transport system is an aggregate system that is comprised of transport infrastructure, transport operations and maintenance of the system. Examples of transport infrastructure are traffic networks, terminals and systems for traffic control and management. Different vehicles and organisations are involved in transport operations. Several regulations exist to guide the operations of the transport system. The planning of transport system works in close interaction with the planning of land use and community structure. (Sirkiä et al. 2000.)

Different terms for the assessment of transport projects that are based on EC and UK government practices (see e.g. European Commission 2003b) are presented in Table 1. The major share of transport impact assessment is ex-ante assessment of the impacts.

Table 1. Different types of assessment of transport projects, plans and policies (European Commission 2003b).

Type of assessment	Stage of the project, plan or policy
Appraisal	Before implementation (a priori, ex ante)
Monitoring	During implementation
Evaluation	Reflective, after implementation (ex post)

The dimensions of the above-mentioned appraisal of transport plans, programmes or policies are discussed by Mackie and Nellthorp (2003). They present three questions that the decision-makers need to consider in connection with appraisal of improvements in the transport system. These questions are as follows: 1) Is a

project or policy acceptable to the public? 2) Is it economically acceptable? 3) Is it politically acceptable?

Mackie and Nellthorp also point out that good-quality decision-making comprises the ability to understand, incorporate and balance-off social, economic and political considerations. They do not, however, point out environmental considerations, which can play a major role in connection with transport system planning.

The appraisal processes in transport planning are generally seen as a tool to assist the process by providing relevant information to decision-makers, but decisions are not made in the appraisal. This decision support usually includes support in choosing between alternative solutions, deciding whether or not the projects represent good social value for money, and support in choosing the optimal time(s) at which to carry out an investment. (Bristow and Nellthorp 2000.)

According to Bristow and Nellthorp (2000), the most common transport appraisal methods within the EU have been cost-benefit analysis and multi-criteria analysis. They recognise that the appraisal of direct impacts is usually incorporated in a cost-benefit analysis, by placing a money value on for example construction costs, vehicle operating costs, time savings and safety. However, the variety of environmental impacts varies across countries. For example, noise and local air pollution are not always included. The least agreement is shown in the appraisal of the coverage of socio-economic impacts. In some countries, a wide range of socio-economic impacts is included, whereas some countries exclude these types of impacts from the calculations. There is also uncertainty about whether these impacts are additional to the direct costs and benefits of the project. The treatment of equity issues is usually not comprehensive in the European transport appraisals.

Jones and Lucas (2000) state that it is necessary to develop and use appraisal frameworks that enable comparison of how the different project proposals would contribute to the full range of public policy objectives.

As mentioned earlier, the transport appraisal process includes the consideration of many interactions. Many different stakeholders who have an important role in the appraisal process are involved. Weiss (1998) points out that the stakeholders of an evaluation all have their own interests and ideas, own questions and concerns, and a unique selection of opportunities to put the evaluation results to use.

For example the following stakeholders are often involved in projects, plans or policies within the transport sector:

1. the funding organisation; government or private foundation
2. national or local agencies
3. program designers
4. directors of the specific project
5. clients and prospective clients of the project
6. program consultants, often academics, who consult for and advise decision-makers

7. directors and managers of programs with similar purposes elsewhere
8. scholars in the disciplines and professions who build knowledge and teach oncoming generations.
9. the public, which, in the form of public opinion, sets the general direction of, and limits to, policy and programming.

Because transport system planning involves several stakeholders, for example the ones mentioned above, conflicts can often emerge. Hokkanen et al. (1998) identify the following three common types of conflict that can take place in the planning process. The conflicts can be based on

1. misunderstanding; in order to remove these, all important factors for the interest groups can be listed and the impacts analysed against the factors,
2. different interests; the winners and losers can be listed, but always someone benefits and someone suffers,
3. different valuations of the factors; this requires a transparent method, sensitivity analysis and documentation of the weights and values used.

The assessment of welfare impacts can especially include conflicts of type three, although all the three types of conflicts can arise. This is due to the several actors who represent different disciplines and different views of planning.

2.3 Assessment of impacts related to the aspects of sustainability

Sairinen (2004) claims that the social dimension of urban planning has become a topical issue in the Finnish urban policy since the late 1990's. This is due to e.g. changes in legislation, structural changes in urban development and economic and social spatial differentiation. New fields of thinking about the social sustainability of cities have emerged from the debate on urban politics. According to Sairinen, social consistency of urban development has been seen as a precondition for the competitiveness of cities. He argues that environmental and social impact assessment procedures (EIA and SIA) and participatory planning practices are important policy tools and methods. These methods have been developed in order to satisfy the legitimacy qualifications concerning the environmental and social questions of planning.

The environmental impact assessment (EIA) is assessment of the possible positive or negative impacts that a proposed plan could have on the environment. These impacts may include environmental, social and economic aspects. The purpose of the assessment is to ensure that decision-makers consider the potential environmental impacts in deciding whether or not to proceed with a project. Correspondingly, the social impact assessment (SIA) includes analysing, monitor-

ing and managing the intended and unintended social consequences of planned policies, programmes, plans or projects and any social change processes invoked by those interventions. The primary purpose is to bring about a more sustainable and equitable environment.

The Human Impact Assessment (HuIA) is used to generate advance information on the impacts of a project, plan, programme or decision on human health and well-being. The HuIA is a relatively new concept. The HuIA is an integrated process that includes both the Health Impact Assessment (HIA) and the Social Impact Assessment (SIA). The HuIA provides information for decision-making and helps to deal with conflicts. The HuIA draws attention to, for example, welfare and health aspects. The process supports participation and commitment and offers opportunities to discuss values and goals. (National Research and Development Centre for Welfare and Health 2007, WHO 2013, Kauppinen and Nelimarkka 2004.)

Valve (1999) states that a meaningful environmental impact assessment process must give an input to the policy outcomes. She emphasises that the environmental assessment of plans, programmes and policies should make planning more interactive and decision-making more open. This entails that the environmental impact assessment process should be carried out for the different policy options that are compared in the planning process. Valve's opinion is that new ways of thinking and acting can be found in an assessment process that is characterised by social learning. This means that authorities may become better equipped to respond to the demanding environmental policy challenges. One way of disseminating environmental information is the so-called State of the Environment (SoE) report (Lyytimäki 2004). Such reports are a means to combine the different types of data that describe the state of the environment, as well as manage possibly opposing opinions and varying interpretations about value positions.

Valve (1999) and Lyytimäki (2004) have highlighted the interaction between planning and decision-making that is crucial to the success of policy outcomes.

Mobility and participation in different activities are an important part of people's everyday life. The transport system creates prerequisites for the comfortable and smooth organisation of these activities. The transport system thus generates welfare by helping people satisfy the needs connected to mobility and activity. On the other hand, traffic and travel also generate harmful and unhealthy side effects, and this makes it necessary to also assess the negative welfare impacts of the transport system. For assessing the various impacts connected to the various interactions, planners and decision-makers need to recognise the connections between the transport system and welfare conditions. It is necessary to consider how the changes in e.g. traffic volume, choice of means of transport, modal share, other mobility choices, travel costs, traffic emissions etc. change human welfare and its conditions. It is also important to consider how these conditions and impacts are allocated between different demographic groups, for example children, women versus men, old people, disabled or handicapped, people living in urban versus rural areas, car-owners versus people without cars etc. (Maslow 1943,

Kajanoja 1999, Marski 1995, Heltimo 2003, Doyal and Gough 1991, Allardt 1976, Litman 2001, Estlander et al. 2005.)

Human welfare also includes impacts on human health. For example, Lercher (2003) states that the methodological requirements for assessing health outcomes of physical planning exist, but there is lack of information about the selection of the outcomes. Lercher suggests that the prerequisite for a rational choice in planning is an adequate Quality of Life (QOL) model, which unifies the needs of both the environmental and health area. This would also enable avoidance of later confusion in interpretation.

Steg and Gifford (2005) state that transport policies will be less acceptable, less feasible and less effective if they show significant negative impacts on the quality of life of people. Steg and Gifford draw attention to the current status within the transport sector. They point out that several methods for the assessment of economic, social and environmental consequences of transport plans exist, but only few social or sustainability indicators are actually being considered, because of lack of knowledge and valid methods thereto. Steg and Gifford also present an essential question about whether the more sustainable transport systems are acceptable to the public, as the transition to sustainability may conflict with short-term individual interests.

Ness et al. (2007) point out the importance of the so-called intergenerational component in the assessment of sustainability. In their analysis of methods for sustainability assessment, they recognise the following six areas of integrated assessment methods: 1) conceptual modelling and systems dynamics, 2) multi-criteria analysis, 3) risk analysis and uncertainty analysis, 4) vulnerability analysis, 5) cost-benefit analysis and 6) impact assessment. However, they point out that a key aspect in the assessment process is the way that sustainability is defined. They also stress that there is a contradiction within the future development of sustainability assessment tools. There is a simultaneous need for very specific and broad approaches. Another challenge is the need for standardised tools that give transparent results.

Graymore et al. (2008) present five methods for the assessment of sustainability. The 'ecological footprint method' provides a single sustainability indicator that determines the amount of land required to support a nation. The per capita 'Ecological footprint' describes whether a nation is exceeding its ecological carrying capacity. 'Wellbeing assessment' takes a holistic systems approach to sustainability assessment. Several performance criteria are aggregated, and wellbeing indices for both ecosystem and human sub-system health are defined. An assessment approach called 'quality of life' is based on measuring how well certain targets are met over ten-year periods. This assessment is carried out by defining indicators that describe the different aspects of quality of life and measuring conditions and trends of these indicators against the specified targets. Generalisations about quality of life are based on the information about how many indicators either met the target or were improving. 'Ecosystem health assessment' is similar to that of quality of life assessment. In this approach, sustainability requires the human system to be within the limits of the ecosystems they live in to prevent a decline in

ecosystem health. The approach of 'natural resource availability' is based on a comparison of a region's resource availability and consumption rates. The resource carrying capacity describes how many people the natural resources within a region can sustainably support.

According to Graymore et al. (2008), the most effective of the above-mentioned five methods was the wellbeing assessment method. This was the only method that met the requirements set for not losing information during the aggregation process, transparency, simplifying of the complexity of sustainability and facilitation for communication. Graymore et al. state that a sustainability assessment method can only be useful in guiding well-informed policy development and decision-making if it provides information about the following issues: 1) the whole system's progress towards sustainability, 2) what pressures exist on supporting systems (social, economic and environmental), 3) the conditions of these supporting systems, and 4) inter- and intra-generational equity.

Kumar et al. (2013) point out that the assessment of sustainability involves integration of social, environmental and economic considerations and often requires trade-offs between multiple stakeholders. But they note that sustainability appraisal is often compartmented by the boundaries of different disciplines. It can facilitate discussion, but frequently many important aspects of sustainability remain abstract and disconnected. They therefore recognise the need to improve the methods to assess the sustainability of policies, plans and legislation.

Koo et al. (2009) emphasise that assessment methods need to be developed and created continuously in considering the complexity and variety of sustainability aspects. They created a sustainability assessment model for infrastructure projects. This model included 47 sustainability indicators and involved six assessment methods. Consequently, the multi-criteria decision making (MCDM) approaches were used to combine several estimates into a single comparable and integrated result.

Steg and Gifford (2005) point out that sustainability indicators are needed for examining to what extent the future transport plans affect sustainable development. They consider that special attention should be paid to development of social indicators.

Rorarius (2007) discusses different aspects of sustainability assessment and potential ways to improve the assessment of sustainability in Finland. He defines sustainability indicators as simple measures that represent a state of economic, environmental and/or social development in a specific region. These indicators can be aggregated to specific indices. Becker (1997) emphasises that the selection of the indicators must be based on scientific quality, ecosystem relevance, data management and sustainability paradigm.

Rorarius (2007) states that the Strategic Environmental Assessment (SEA) is a process similar to the Environmental Impact Assessment (EIA), thus being a tool for evaluating the potential impacts of strategic decisions. He mentions that the EIA is normally carried out in more specific cases, such as particular projects. According to Fischer (2004), the SEA is a systematic and participative instrument that aims at ensuring that environmental aspects are taken into consideration in

decision-making of policies, plans or programmes. He states that actors are more likely to use the results of the SEA process if they reflect their own values and policy objectives. Fischer suggests that the SEA influences decision-making process in the following three ways: 1) through providing information, 2) through participation and involvement in structured processes, and 3) through changing routines and rationalization of the pluralist democracy.

Hildén et al. (2004) present issues they consider important and missing from the environmental impact assessment processes. These include 1) climate change (CO2), 2) energy consumption, 3) modal split, 4) biodiversity (difficult to assess quantitatively), 5) transport demand, 6) health effects and 7) transboundary effects.

One suggestion for an integrated appraisal has been made by Jones and Lucas (2000). They emphasise that in order to achieve effective integrated policy formulation and implementation, it will be necessary to develop appraisal frameworks that can set out the contribution of different alternative projects clearly and comprehensively. Jones and Lucas present the following list of sustainability indicators: 1) traffic flows, 2) modal splits, 3) modal choice, 4) environment/pollution, 5) environment/ resource use, 6) health, 7) education, 8) accessibility and 9) social progress/inclusion. There is no reference to any type of economic indicators, although common definitions of sustainability also include the economic aspect (for example WCED 1987, Shiaua & Liu 2013).

Several methods for the assessment of sustainability impacts were introduced in this Chapter. Also two approaches to the Quality of Life models were discussed (Carse 2011, Lercher 2003). It was stated that the assessment methods need to be developed continuously (Koo et al. 2009). Especially the Environmental Impact Assessment and Human Impact Assessment are potential sources for input data for the assessment of welfare impacts.

2.4 Examples of sustainability criteria for transport and urban planning

The Ministry of Transport and Communications in Finland has defined a desired level of service for the Finnish road network, as well as detailed descriptions for four areas of indicators to be controlled. The areas of indicators include the 1) daily mobility of people, 2) needs of industry and commerce, 3) regional development and 4) societal conditions. (The Ministry of Transport and Communications 2003b.)

Jones and Lucas (2000) discuss eight sustainability criteria and 28 sub-criteria that have been presented in the UK for transport appraisal (Table 2). Häkkinen et al. (2006) suggest 26 criteria for the assessment of sustainability in connection with target setting in development of urban area (Table 3).

Table 2. Sustainability criteria in the UK by Jones and Lucas (2000, Table 2).

Criteria	Sub-criteria
Traffic flows	Heavy goods mileage intensity
	Road traffic
	Traffic congestion
Modal splits	Passenger travel by mode
	Leisure trips by mode of transport
	Freight transport by mode
Modal choice	Average journey length by purpose
Environment / pollution	Local environmental quality (noise and pollution from traffic)
	Concentrations and emissions of selected air pollutants
	Sulphur dioxide and nitrogen oxide emissions
	Acidification in the UK
	Emissions of greenhouse gases
	Carbon dioxide emissions by end user
	International emissions of carbon dioxide per capita
	Implementation of multilateral environmental agreements
Environment	Depletion of fossil fuels
/ resource use	Ozone depletion
	Energy efficiency of road passenger travel
	Average fuel consumption of new cars
Health	Environmental factors affecting health (respira-tory illness)
Education	How children get to school
Accessibility	Access to rural services
	Access for the disabled
	Access to the countryside
Social	Major factors leading to health inequalities
progess / inclusion	Distance travelled relative to income
	Real changes in the cost of transport
	People finding access to services difficult

Table 3. Sustainable Urban Design Criteria (Häkkinen et al. 2006, Table 16b)

Criteria
Use of existing networks and services
Density
Efficiency of networks
Transfer of soil
The value of the area under development in terms of nature conservation
Risks for threatened and near threatened species
Access to green areas and other open areas
Conservation of valuable or significant natural pieces like valuable individual trees and rock formations
District heat, use of renewable energy resources, making use of solar energy
Microclimate
Accessibility of public transport services
Bicycle and pedestrian routes
Effects on motor traffic
Access to car park
Diversity of functions
Correspondence of types and floor area distribution of dwelling stock with demand
Accessibility of public services
Active and lively service centres
Air quality in the vicinity of residential buildings, schools and kindergartens and in outdoor recreation areas
Noise conditions in the vicinity of residential buildings and houses, schools, kindergartens and outdoor recreation areas
Barrier-free access
Maintenance of cultural heritage
The quality of buildings with reference to townscape
Attractiveness of public open spaces
Flexibility of local or regional structure with respect to possible changes in use and users
Participation

In a study that concerned the definition of sustainability indicators for Cape Town in South Africa, Kane (2010) suggested eight so-called key performance indicators for assessment of sustainability (Table 4). Kane (2010) also mentions the need for integrated assessment procedures. She points out that engineers consider material and technological complexity, planners focus on social complexity and environmental planners with bio-physical complexity. Kane suggests that the SEA work should be able to straddle boundaries, sectors and scales.

Table 4. Key performance indicators for sustainable transport, adopted in Cape Town, South Africa (Kane 2010).

Energy use
Emissions
Full modal split
Public transport use
– Public transport coverage
– Public transport service quality
– Public transport security
Congestion on major freight routes
Congestion on peak hour commuter routes
Loss of life and livelihood
Urban quality

Korkiala-Tanttu et al. (2006) suggest a criteria hierarchy for the assessment of environmental impacts of infrastructure construction (Table 5). They also build an assessment framework, where the different impacts were weighted based on a MCA technique called SMART (simple multi-attribute rating technique). Korkiala-Tanttu et al. found the following restricting factors in the process:

- availability of necessary baseline data
- the presented weights being rough estimates
- the weights could not be assessed and set on a case-by-case basis; the environmental impact categories and indicators included should have been assessed separately in each case
- some impacts lacked relevant measurable indicators.

Table 5. Environmental impact categories suggested for infrastructure construction in a Finnish study (Korkiala-Tanttu et al. 2006).

Global impacts	Climate change
	Depletion of natural resources
Regional impacts	Formation of tropospheric ozone
	Acidification
	Decrease of biological diversity
	Impacts on health
	Impacts on ground water quality
Local impacts	Eco-toxicity
	Physical and mechanical impacts
	Damage on landscape and cultural environment
	Impacts on recreation and comfort

Carse (2011) suggests an additional 'transport quality of life' framework (Figure 2) that could be used to add new relevant points of view to the prevailing transport appraisal practices. This framework concentrates mainly on the experience encountered by passengers when they travel by public transport.

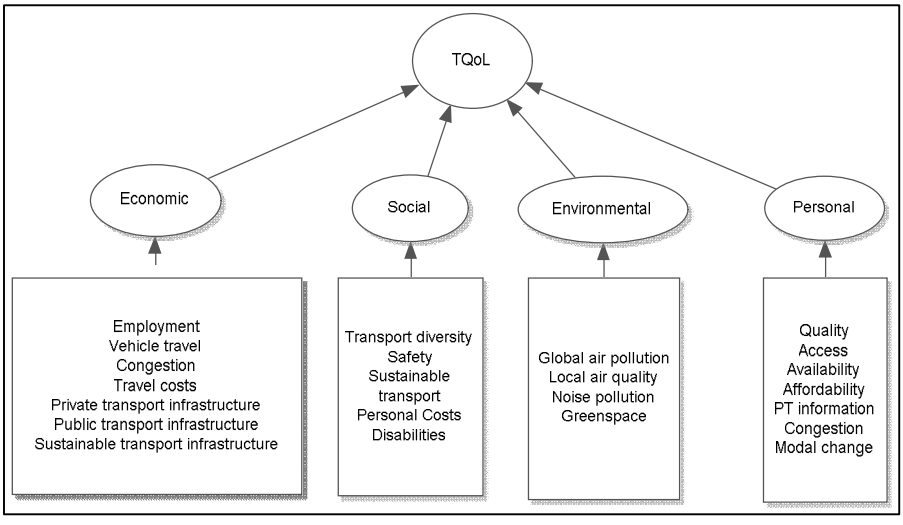

Figure 2. Conceptual model for assessment of transport quality of life (Carse 2011, Figure 1, p. 1038).

Of the sustainability criteria presented in this Chapter, two were rather similar (Tables 2&3). The others (Tables 4&5) that were meant for transport and infrastructure construction were more limited. The contents of the above-mentioned tables were input data for the formation of the first version of the welfare criteria.

In recent research, it has been common to define a set of sustainability indicators using the division into three key aspects of sustainable development. These key aspects, goals or categories are 1) environmental, 2) social and 3) economic development. The Melbourne transport sustainability index (Reisi et al. 2014) or sustainability indicators for urban passenger transport in Rio de Janeiro (Souza Santos and Kahn Ribeiro 2013) are examples of this division.

A slightly different division has been made by Shiau and Liu (2013), who have defined transport sustainability indicators for local governments in Taiwan. The criteria are used for the comparison of transport policy strategies in Taipei. The value judgements, or weights of the indicators were facilitated using the Analytic Hierarchy Process, AHP. The key indicators were selected based on the relative weights of the indicators. The indicators were divided into four sub-groups. These groups are 1) economy, 2) environment, 3) society and 4) energy. The number of

indicators in these groups varies from two to ten. Shiau and Lung-Shan recognise that interdependency between different transport sustainability indicators is common. In defining these indicators, there had been active interaction with a committee that comprised of seventeen government officials. However, other stakeholders had not been involved in the process. These results apply to a large, densely populated metropolitan area, but probably not to a narrower context, unless revised.

2.5 Transport appraisal in Finland and the UK

2.5.1 Transport appraisal in Finland

The appraisal practices of road and rail transport in Finland are based on the general national transport appraisal framework (Figure 2). This so-called YHTALI-framework has been restructured in 2011, but the old framework is introduced here, since I have used the previous version of YHTALI in my study that took place prior to 2011. This framework is intended to standardise the appraisal of major transport infrastructure projects. The needs of the Ministry of Transport and Communications and the Finnish Transport Agency are hereby met in comparing the suggested plans for major infrastructure projects. The framework defines the main principles for carrying out socio-economic calculations. However, the results are not quite comparable yet, because the assessment of non-monetary impacts needs to be improved. (The Ministry of Transport and Communications 2003a, The Finnish Transport Agency 2011.)

In the current YHTALI-framework (The Finnish Transport Agency 2011), the list of potential impacts is rather wide; including impact areas Accessibility, Safety, Environment, Human impacts, Community structure, Development of areas and Economy. The new YHTALI also includes calculation of effectiveness. In calculating project effectiveness, impacts that are not included in the cost-benefit calculations can be amended in the assessment results.

The Finnish legislation on the assessment of the impacts of the authorities' plans, programmes and policies on the environment is based on EC directives. (Act on Environmental Impact Assessment Procedure 468/1994, Act on the Assessment of the Impacts of the Authorities' Plans, Programmes and Policies on the Environment 200/2005, Decree on the Environmental Assessment Procedure 268/1999, Council Directive 2001/42/EC, Council Directive 85/337/EEC, Council Directive 97/11/EC, Council Directive 2003/35/EC of the European Parliament and of the Council.)

The above-mentioned legislation defines that if a significant environmental impact can be expected from a plan, programme or policy, an environmental impact assessment has to take place. This assessment takes into account a broader range of impacts than the traditional environmental impact assessment of a project. For example Valve (1999) states that the environmental assessment of plans,

programs and policies ought to serve as an open forum where mutual learning among participants takes place. However, this may be difficult in real-life planning, where the temporal and monetary resources are limited.

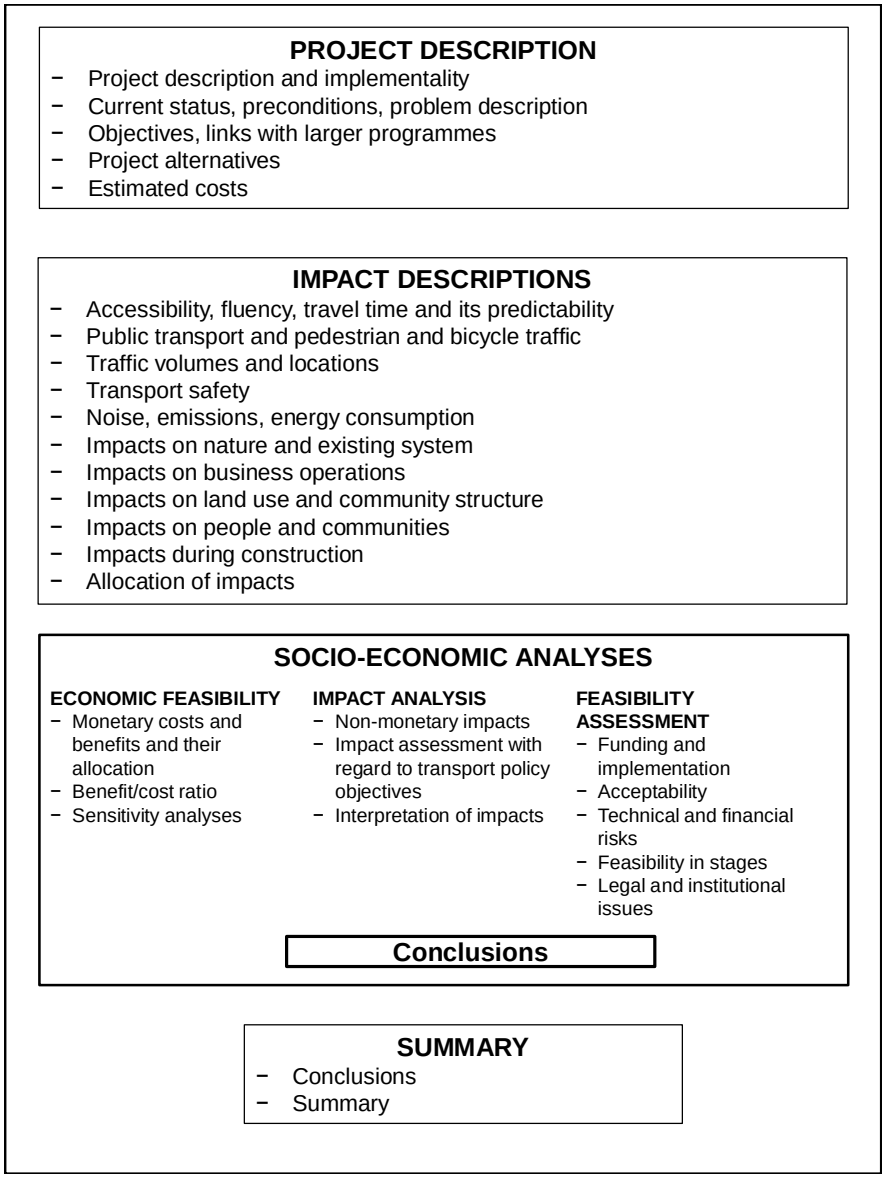

Figure 3. The Finnish framework for appraisal of transport projects, the so-called YHTALI-framework (The Finnish Transport Agency 2011).

The context of this thesis is transport system planning in Finland. The following legislation and guidelines address the official requirements for creating transport plans, programmes and policies. The appraisal of transport projects, plans and policies in Finland is regulated by the national legislation and mode-specific guidelines. The guidance for the appraisal of road, rail and maritime transport schemes is derived from the general national guidelines (see the following guidelines: the Ministry of Transport and Communications 2003c, 2003b & 2004, the Finnish Maritime Administration 2005, the Finnish Road Administration 2004, the Finnish Rail Administration 2004, Kulmala et al. 2002, The Finnish Transport Agency 2011).

The Finnish legislation on environmental impact assessment defines the requirements for two types of planning. Firstly, it is required that the assessment procedure is carried out in connection with all projects that may cause considerable negative environmental impacts. Secondly, environmental impact assessment is required when a plan, programme or policy is expected to have significant environmental impacts. (Act on Environmental Impact Assessment Procedure 1994, Act on the Assessment of the Impacts of the Authorities' Plans, Programmes and Policies on the Environment 2005, Decree on the Environmental Assessment Procedure 1999, the Ministry of the Environment 1999.)

Finnish national guidelines for the Human Impact Assessments (HuIA) are implemented nationally, regionally and locally (Kauppinen and Tähtinen 2003, Kauppinen 2006). Furthermore, research results and guidelines concerning social, health and environmental impact assessment have been applied in this thesis (see e.g. Department of the Environment, Transport and the Regions 1999, the Ministry of Transport and Communications 2003a, 2004, Sudgen 2003, Barrow 2002, Faiz 2000, Hine 2003, Hodgson and Turner 2003, Lyons 2003, Sairinen 2004, Schönfelder and Axhausen 2003).

In addition, the legislation for land use and building has a significant role in urban planning, and therefore contributes to transport system planning, too (see The National Building Code of Finland 2000, Decree on Land Use and Building 1999, Act on Land Use and Building 1999).

2.5.2 Transport appraisal in the UK

The broad guidelines for appraisal of plans, programmes and policies in the UK are defined in the so-called Green Book (HM Treasury 2003). This so-called New Approach to Appraisal (NATA) was updated in April 2009. The NATA approach was introduced for 1) choosing between different options for solving a transport problem, 2) prioritising between proposals, and 3) assessing value for money (Department for Transport 2011a, 2011b).

Sayers et al. (2003) criticised the previous UK system of transport project appraisal (NATA) for the lack of guidance to decision-makers as to how the multi-criteria information about alternative projects should be used to identify the preferred option. According to Sayers et al., this could, despite the care taken to assess all the various impacts, lead to lack of clarity, consistency and accountability in a crucial part of the decision-making process. Tomlinson (2001) presents needs for enhancement in the evaluation that was brought out by the NATA and Guid-

ance on the Methodology for Multi-Modal Studies (GOMMS) (Department of the Environment, Transport and the Regions 2000) approach. Tomlinson states the following four needs for improvements in the transport appraisal in the UK:

- assessment of social exclusion and the distribution of the consequences of investment in transport,
- consideration of health, social, economic and environmental issues on a consistent basis,
- trying to get wider involvement of all stakeholders, with clear definition of the objectives
- enhancing the transparency of the appraisal and reporting.

The NATA Approach includes the identification and assessment of transport problems, the identification of implementation options, and the assessment of those options (Department for Transport 2011b).

The NATA Approach is based on the following five transport objectives (Department for Transport 2004, 2011b):

1. to protect the built and natural environment
2. to improve safety
3. to support sustainable economic activity and get good value for money
4. to improve access to facilities for those without a car and to reduce severance
5. to ensure that all decisions are taken in the context of the Government's integrated transport policy.

An essential part of the results of the appraisal is the Appraisal Summary Table (AST). The AST (Table 6) is a one-page summary of the impacts of a transport solution on the Government's transport objectives, and it includes both qualitative and quantitative data, with the results of cost-benefit analysis (Department of the Environment, Transport and the Regions 1998 & 2000, Department for Transport 2011b). The objective areas in the AST are the above-mentioned ones; Environment, Safety, Economy, Accessibility and Integration.

In the NATA Approach, there are three so-called supporting analyses that do not easily fit in the AST, but are however relevant to the choice of a strategy or a plan (Department for Transport 2011b). These supporting analyses are concerned with 1) distribution and equity, 2) affordability and financial sustainability, and 3) practicality and public acceptability.

In the Transport Analysis Guidelines, individual guidance exists for undertaking distribution and equity analysis (Department for Transport 2011c). The main contribution of this guidance is the definition of potential datasets and distribution of target populations according to different social groups. The assessment of distribution and equity impacts leads to a matrix that includes qualitative statements about the key impacts that are 1) user benefits, 2) noise, 3) air quality, 4) accidents, 5) security, 6) severance, 7) accessibility and 7) affordability. The key findings of the above-mentioned matrix are reported in the Assessment Summary Table (Table 6).

Table 6. Appraisal Summary Table (Department for Transport, UK 2012). The result of the assessment can be presented either in money values or with a pre-defined score.

Option		Description	Problems	Present Value of Costs to Public Accounts, £
OBJECTIVE	**SUB-OBJECTIVE**	**QUALITATIVE IMPACTS**	**QUANTITATIVE ASSESSMENT**	**ASSESSMENT**
ENVIRONMENT	**Noise**			
	Local Air Quality			
	Greenhouse Gases			
	Landscape			
	Townscape			
	Heritage of Historic Resources			
	Biodiversity			
	Water Environment			
	Physical Fitness			
	Journey Ambience			
SAFETY	**Accidents**			
	Security			
ECONOMY	**Public Accounts**			
	Transport Economic Efficiency: Business Users & Transport Providers			
	Transport Economic Efficiency: Consumers			
	Reliability			
	Wider Economic Impacts			
ACCESSIBILITY	**Option values**			
	Severance			
	Access to the Transport System			
INTEGRATION	**Transport Interchange**			
	Land-Use Policy			
	Other Government Policies			

The Green Book emphasises that the appraisal process should provide an assessment of whether a proposal is worthwhile, and present the conclusions and recommendations in a clear way. Option appraisal, whereby government intervention is validated, objectives are set, and options are created and reviewed, is required. The essential contribution of the appraisal is to analyse the costs and benefits of the options. A cost-benefit analysis is recommended, with supplementary techniques to be used for weighing up those costs and benefits that remain unvalued. The main supplementary technique recommended is weighting and scoring. Guidelines for the use of multi-criteria appraisal in the government have been published (e.g. Dodgson et al. 2000).

In 2007, Mackie and Kelly summarised the following findings within the NATA approach:

- there were significant regional differences in the approach and practice of transport appraisal
- the appraisal frameworks used for roads were clearly more developed that those for rail, air, inland waterways and sea transport
- there was lack of consensus about which elements were to be included within appraisals, especially about environmental effects
- there was a significant range of values used, especially for safety.

The NATA approach was compared with the recommendations of a European project to harmonise project guidance on the EU level (HEATCO 2005, 2006). The main findings related to my research problem concerned the so-called supporting analyses about equity issues and treatment of indirect socio-economic impacts (Table 7).

Table 7. Differences in the two appraisal concepts between HEATCO and UK (Mackie & Kelly 2007)

	HEATCO	**UK**
Equity issues (intergenerational)	Winners and losers table at minimum, distributional matrices as a more sophisticated approach.	Disaggregation of impacts between stakeholder's categories and mode to identify winners and losers.
Treatment of indirect socio-economic effects	Qualitative assessment at a minimum. Use of spatially computable general equilibrium models where possible.	Framework approach to appraisal based around the 5 core objectives: environment, safety, economy, integration and accessibility.

PIARC, the World Road Association is an association that aims at fostering and facilitating global discussion and knowledge sharing on roads and road transport.

PIARC has 120 government members worldwide. The association retains consultative status to the Economic and Social Council of the United Nations. (PIARC 2015.)

Mackie and Kelly suggest that the PIARC member countries should continue to refine and develop CBA and MCA methodologies and co-operate in developing monetary values for environmental and social impacts and methods for their inclusion in project evaluation. They also state that very few countries included other environmental effects than noise, local or regional air pollution and climate change. Another finding was that very few countries included indirect socio-economic effects, such as agglomeration benefits, community severance and access to the transport system in their project evaluation guidance.

Carse (2011) states that although the NATA approach has been recently updated, it still fails to fully evaluate the individuals' experiences of transport. According to Carse, the improvements mainly include appraisal of cycling and walking quality and modifications to the intervention techniques.

2.6 Cost-benefit analysis and multi-criteria decision aid

2.6.1 Cost-benefit analysis (CBA)

The cost-benefit analysis (CBA) is one of the most frequently used assessment methods for transport investments. It is a widely used and well developed tool for evaluation of suggested transport projects (Mackie et al. 2014).

Economic theory has been founded on the notion of a rational individual, making decisions on the basis of a comparison of benefits and costs. The cost-benefit analysis (CBA) is a systematic approach to assessing the viability of an action by calculating and comparing its costs and benefits. The social cost-benefit analysis (SCBA), extends this to the area of government decision-making by replacing private benefits and costs with social benefits and costs. The cost-benefit analysis seeks to value the expected impacts of an option in monetary terms. The main evaluation criteria are net present value (NPV), benefit/cost ratio (B/C) and internal rate of return (IRR) (Brent 1996).

The CBA considers the gains and losses to all members of the society and has therefore great attraction as a tool for guiding public policy. Also, with the single measurement scale, money can in principle be used to show that implementing an option is worthwhile relative to doing nothing. The monetary values used can be subject to criticism. Procedures such as stated preference or hedonic pricing provide ways to establish monetary values of some non-marketed impacts. However, for others the use of monetary values is not immediately practicable. The relevant data may not be available or it may be too expensive to collect. It may not be possible to present some impacts in terms in which people are able to make reliable trade-offs against money. In addition, there may be impacts which cannot be quantified and set against a scale of monetary values. The CBA is also sometimes

criticised for the limitation that it does not generally account for the interactions between different types of impacts. (Dodgson et al. 2000.)

Van Wee (2011) presents examples of criticism that has been made towards the CBA method. He divides the criticism towards CBA to 'real critics' and 'opportunistic critics'. The group labelled 'opportunistic critics' includes people criticising the method only because they do not like the outcomes of the CBA process. In such cases people criticise the method, because the outcomes of the decision-making do not favour their preferred alternative. However it seems that if the result of the assessment favoured their preferred alternative, the people would have no objections to the actual cost-benefit analysis. With 'real critics' van Wee refers to both a) content-related and b) process-related criticism. Van Wee defines content-related critics as criticism towards the CBA framework itself, and towards the inputs for CBA. Respectively, as process-related critics he comprises criticism of the position of the CBA in decision-making, of the process of developing a CBA and, criticism of communications issues. (van Wee 2011.)

Hanley and Barbier (2009) discuss the strengths and weaknesses of environmental CBA. They outline three challenges to individual parts of CBA, and four challenges to the overall approach of CBA.

The first challenge to the individual parts of environmental CBA is the problem of environmental valuation. The revealed preference approaches that are widely used to estimate the value of non-market goods in the context of environmental policy and management are challenged by producing values for hypotethical changes. It can be doubted whether people would actually pay the amounts that they say they would be willing to pay. Another important issue is the question about whether the summing up of individual values would provide a reliable estimate for the value of the entirety. Also, it is not unambiguouos that people know enough about their own willingness to pay, especially when it comes to issues they are unfamiliar with. In addition, the willingness to pay of people is not always the same as their willingness to accept the changes. Respectively, the revealed preference methods are criticised for not being able to value non-use commodities. The second challenge is the difference between the subjective risk assessments of people, and the scientific risk assessments. The third challenge to individual parts of CBA is the choice of discount rate. Although there exist recommendations for specific discount rates and for selecting declining discount rates, the actual choice of the discount rate is still demanding. (Hanley and Barbier 2009.)

First one of the callenges to the overall approach of CBA is the objection to the Kaldor-Hicks test. This test shows that an option is profitable if its added benefits are greater than the added costs, and thus the costs can be compensated by the benefits. One objection to the Kaldor-Hicks test is that, it is not always possible to compensate some of the losses. Other questions are the way the compensation is paid, and the way the benefits and losses are calculated. The second challenge is formed by the objections to adding up gains and losses as a way of determining the overall impacts. The main points are the questions about benefits and costs that range over generations, and whether the environmental gains and losses are commensurable with each other. The third challenge is the morality of calculating

benefits and costs in decisions about for example human rights, environmental protection or health and safety. The fourth challenge is that to what extent the application of CBA can be relied on to guarantee the ecosystem functioning and global life support services. (Hanley and Barbier 2009.)

Also, a controversial issue is how to make interpersonal comparisons of well-being. The diminishing marginal utility of income suggests that while the individual income increases, individuals gain a correspondingly smaller increase in satisfaction and happiness from a constant increase in consumption. Well-being can however be seen as the satisfaction of preferences. This way the interpersonal utility comparison can be seen as a comparison of how well satisfied the preferences of the individuals are, and not as a comparison of how much satisfaction they feel. (Hausman and McPherson 2006.)

One view is that the CBA can provide insights into the decision problem, but not necessary the final answer to it. This view underlines that the CBA should not be the only piece of information available to the decision-makers about a policy choice or environmental management decision. Without modifications to the discounting method of CBA, qualitative aspects such as social viewpoints, safety issues or welfare questions cannot be processed with CBA. Therefore evaluation of for example environmental impacts over a long period of time may not be practicable using CBA alone. The CBA provides a substantial piece of information, but awareness of for example distributional impacts and political expediency is also important. (Hanley and Barbier 2009, Kolosz and Grant-Muller 2015.)

The role of CBA in the appraisal processes of spatial-infrastructure projects was studied in the Netherlands (Mouter et al. 2013). According to the key actors in the Dutch Cost-Benefit Analysis, CBA must be included in the appraisal processes of spatial-infrastrucutre projects. However, economists believed that not enough value has been put on CBA in the decision-making processes, whereas spatial planners thought that too much value had been assigned to the CBA.

2.6.2 Multi-criteria analysis (MCA) and multi-criteria decision aid (MCDA)

The multi-criteria analysis (MCA) is a group of methods that can be used in situations where one needs to determine overall preferences amongst alternative or competing options, and thus to identify the most optimal policy (Ness et al. 2007). The MCA procedure generally aims to recognise certain objectives or goals and find out the trade-offs between them. Due to incorporating both quantitative and qualitative data, methods based on multi-criteria analysis allow decision-makers to consider for example a wide range of economic, social and technical criteria at the same time.

The multi-criteria analysis techniques cover a wide range of approaches, in contrast to cost-benefit analysis, which is a more unified body of techniques. However, all the MCA methods require judgement. The formal MCA techniques usually provide an explicit relative weighting system for the different criteria. The tech-

niques differ in how they combine the data. The main purpose of the MCA techniques is to cope with the difficulties that decision-makers have in handling large amounts of information in a consistent way. The MCA techniques can be used to identify a single most preferred option, to rank options, to short-list a limited number of options for subsequent detailed appraisal, or simply to distinguish acceptable from unacceptable possibilities. (Dodgson et al. 2000.)

The multi-criteria decision analysis (MCDA) is a MCA approach that is being used in many applications, in both public and private sectors. The goal of the MCDA is to support the decision-making by providing an overall ordering of the options in question; from the most preferred to the least preferred option (Department for Communities and Local Government 2009).

The MCDA is both a specific perspective to deal with decision problems and a set of techniques. All the actors in the decision process play more or less defined roles which give priority to their objectives and values. The purpose of the MCDA is to serve as an aid to thinking and decision-making. The MCDA is a way of looking at complex problems with monetary and non-monetary objectives. The problem is broken into more manageable pieces to allow data and judgements to be brought to bear on the pieces, and then of reassembling the pieces to present a coherent overall picture to decision-makers. The MCDA provides different ways of disaggregating a complex problem, of measuring the extent to which options achieve objectives, of weighting the objectives, and of reassembling the pieces. The most common MCDA techniques are based on mathematically explicit aggregation procedures. A successful implementation of the MCDA depends crucially on the way of structuring and conducting the appraisal. The MCDA can be used either retrospectively to evaluate things to which resources have already been allocated, or prospectively to appraise plans that have been proposed but not yet implemented. (Roy 2005, Dodgson et al. 2000.)

Keeney and Raiffa (1993) gave the first complete exposition of the MCDA in 1976. By extending decision theory to accommodate multi-attributed consequences, Keeney and Raiffa provided a theoretically sound integration of the uncertainty associated with future consequences and the multiple objectives those consequences realise. The MCDA is applied to help decision-makers develop coherent preferences. The approach helps individuals and groups to achieve reasonably coherent preferences within the frame of the problem at hand. Once coherent preferences are established, decisions can be taken with more confidence. However, the theoretical Keeney and Raiffa approach cannot be directly implemented in real-world practical problems. (Keeney and Raiffa 1993, Dodgson et al. 2000.)

For example López and Monzón (2010) hold that a commonly accepted assessment model that would integrate the sustainability paradigm in strategic transportation planning is still lacking. They have built a multi-criteria model that covers the economic, social and environmental dimensions. They suggest that the MCA can be used to take account the wide variety of strategic aspects in a flexible and transparent way.

2.6.3 Comparison of CBA and MCA

Some differences between the above-mentioned appraisal methods are pointed out in the following:

Cost-benefit analysis (CBA) indicates how the common resources of the society could be used, or have been used for alternative needs. On the other hand, multi-criteria analysis provides methods for discovering the key advantages and disadvantages of an option, and the most significant differences from the other options.

The CBA is a method that measures economic efficiency, choosing the alternatives that provide the highest net gain. It does not measure other objectives, however. A wide range of impacts and multiple objectives can be examined with the MCA, but the MCA does not indicate whether an individual measure improves welfare or not, or show whether an individual measure is cost-effective.

In the CBA, the comparisons are based on monetary values, whereas in the MCA quantitative and qualitative information can be combined. The monetary valuation of the impacts can sometimes be problematic and there is a risk of excluding those impacts that cannot be valued in money.

Even though there has recently been significant progress in calculating monetary values for effects like social or environmental impacts that are not traded in real markets, it is still difficult to determine reliable estimates or even acceptable approximations for many important effects (De Brucker et al. 2013). Such effects are for example value of a unique landscape or biodiversity.

The CBA analysis is based on explicit performance indicators (NPV, B/C), whereas in MCA there are no explicit rules for the selection of indicators. The selection of the CBA indicators is carried out based on scientific rules, and in the MCA it is case-specific expert work to select the criteria. However, the information used in the CBA calculations can be 'hidden' behind the key ratios. In the MCA, ordering of the qualitative criteria and the scoring of the overall impacts can be arbitrary. There is a risk of double-counting the impacts both in the CBA and in MCA.

Both methods can be applied in different phases of an assessment or decision-making process. Also, sensitivity analyses are possible in both the CBA and MCA. Both methods can be combined with other assessment methods. With the MCA, also strongly conflicting views can be examined, which the mechanical frameworks of the CBA may not allow.

Phillips and Stock (2003) state that the MCDA and CBA are not necessarily competitive methods, but they can be used to complement each other. For example, the CBA calculations can provide input to the MCDA process. However, Phillips and Stock also point out that different use of terminology in the CBA and MCDA can cause confusion. In addition, they argue that the MCDA that is based on group modelling can provide different results from the CBA that is based on expert calculations. They also point out that human judgment is needed to establish the weights for the criteria, and that proper scaling techniques are required in the MCDA. (Phillips and Stock 2003).

Multiple purposes can be considered in planning with the MCDA, which also allows construction of win-win scenarios. The MCDA, in particular, can provide more flexibility than the CBA, and the techniques are more comprehensive in their coverage. (Dodgson et al. 2000, Midgley and Reynolds 2004.)

The CBA is carried out as expert estimation, and therefore there is a risk for excluding interaction and public participation. In the MCA process, several decision-makers, stakeholders and experts can be involved. That is why the method can provide a new way of communicating between the decision-makers and rest of society. In addition, the decision-maker can receive feedback during the analysis. (Dodgson et al. 2000, Brent 1996, Hanley and Spash 1993, Phillips and Stock 2003.)

Van Wee et al. (2013) have compared the social cost-benefit (SCBA) analysis with the multi-criteria analysis (MCA). They summarise that both methods include systematic comparison of alternatives and explicit formulation of weights and trade-offs. However, in SCBA the weights have been set by the consumers, whereas in the MCA the formulation of weights is done by politicians. In both methods, there is possibility for manipulation. In the SCBA, the policy makers can manipulate the inputs and in the MCA, they can manipulate either the inputs or the weights. In the SCBA, every undesirable attribute can in principle be compensated by a favourable outcome for another attribute. In the MCA, various degrees of compensation enable the incorporation of minimum requirements. The risk of double counting is bigger in the MCA than in the SCBA.

The SCBA and CBA can also be used in combination; the result of the CBA can be used as an input to the MCA (Van Wee et al. 2013).

2.6.4 MCDA techniques

This Chapter first presents general information about the MCDA techniques, and then introduces two examples of these methods. The examples are the AHP and MACBETH. The first one is a known and widely used application, while the other one is a rather new, promising application. MACBETH has proven to be a useful method in supporting interactive learning about the subject of evaluation and working out of recommendations for prioritising and selecting between alternative options. It is suitable for both individual and group decision-making. (Bana e Costa et al. 2004, Bana e Costa and Chagas 2004.)

The need to consider multiple and conflicting objectives has increased as the society has grown more complex. The MCDA methods can e.g. be classified into two groups that are called the American and the French schools in multi-criteria decision analysis. In the French school methods, subjective human judgment is modelled via partial systems of binary outranking relations between the alternatives and via a global system of outranking relations. Correspondingly, the methods of the American school build partial utility functions on a set of alternatives as well as an aggregated value function. (Lootsma 1993a, Roy and Vanderpooten 1996, Geldermann and Rentz 2000, Olson 1996.)

An important initial consideration in the choice of the MCA technique is that of the number of alternatives to be appraised. Some problems, especially in design and engineering, are concerned with outcomes that are infinitely variable. However, most policy decisions are usually about choices between discrete options, for example, between alternative investment projects, or between alternative types of tax system. The conflicting objectives can be for example growth, employment or general welfare. (Olson 1996, Dodgson et al. 2000.)

Where the number of options is finite, it does not matter whether this number is small or large. However, each option that has to be considered has to be appraised to determine how well it performs on each of its criteria. Gathering and processing this data will consume resources, the more so if a large number of criteria have been identified. This should be considered when choosing whether to implement one of the simpler or one of the more detailed MCA decision support procedures. (Dodgson et al. 2000.)

In the MCA, problems with a finite number of options, each of which is assessed in terms of a given number of criteria, the initial frame of reference is essentially the performance matrix. The matrix includes basic information about how the options perform against each criterion. The MCA procedures are distinguished from each other principally based on how they process the basic information about the alternatives. (Dodgson et al. 2000.)

The simplest form of the MCDA is a direct analysis of the performance matrix. This approach provides fairly limited amount of information about the relative merits of the options. An initial step can be to check if any of the options are dominated by others. Dominance occurs when one option performs better than the other on at least one criterion, and as well as another on all the criteria. Once any dominance analysis has been concluded, the next stage is for the decision-making team to determine whether trade-offs between different criteria are acceptable. This means that good performance on one criterion can in principle compensate for weaker performance on another. Most public decisions admit such trade-offs. However, in some circumstances, perhaps where ethical issues are central, trade-offs of this type are not acceptable. If the trade-offs between criteria are not allowed, there are a limited number of non-compensatory MCA techniques available. (Dodgson et al. 2000.)

The linear additive model is applicable when it can be proved or assumed that the criteria are preferentially independent of each other, and uncertainty is not formally built into the MCA model. The linear model shows how an option's values on the many criteria can be synthesized into one overall value. This is done by multiplying the value score on each criterion by the weight of that criterion, and then adding all those weighted scores together. However, this is only appropriate if the criteria are mutually preference independent. Most MCA approaches, for example the multi-attribute utility theory (MAUT), the Simple Multi-Attribute Rating Technique (SMART), Measuring Attractiveness by a Categorical-Based Evaluation Technique (MACBETH) and the Analytic Hierarchy Process (AHP) use this additive model. Models of this type have provided robust and effective support to decision-makers. (Roy 2005, Dodgson et al. 2000.)

The foundation of multi-attribute utility theory (MAUT) lies on the work of Keeney and Raiffa, who in 1976 developed a set of procedures, consistent with the earlier normative foundations, which would allow decision-makers to evaluate multi-criteria options in practice (Keeney and Raiffa 1993). The principle of utility theory is that coherent decisions will result if alternative performances on concrete, measurable attributes are compared in a rational, unbiased manner (Olson 1996).

The steps of the procedures are as follows: 1) selection of goals and criteria that are independent from each other, 2) identification of relative utilities U(x) for each of the measures, to express the decision-maker's overall valuation of an option in terms of the value of its performance on each of the separate criteria, 3) identification of the relative contribution to value the goals and criteria, 4) comparison of the alternatives, verifying that the assessments and trade-offs obtained from the decision-makers are consistent. Several approaches to multi-criteria analysis can be considered as special cases or approximations to multi-attribute preference models. (Olson 1996, Dyer 2005, Dodgson et al. 2000.)

Outranking methods depend upon the concept of outranking. The methods use outranking to eliminate alternatives that are specifically dominated. Dominance within the outranking frame of reference is defined using weights to give some criteria more influence than others. The most complex task is the assignment of criteria weights by decision-makers as initial inputs. Outranking methods downgrade options that perform badly on any one criterion. The methods can be effective tools for exploring how preferences between options come to be formed. (Olson 1996, Dodgson et al. 2000.)

Procedures that use qualitative data inputs provide tools for decision situations where the information in the performance matrix, or about preference weights, consists of qualitative judgments. Verbal decision analysis attempts to structure a decision problem by using the language used by a decision-maker and others involved in the decision-making process. In verbal decision analysis, scales with verbal descriptions of criteria levels for unstructured problems are used. However, it can be argued that the less precise the data inputs to any decision support procedure are, the less precise and reliable will be the outputs that it generates. The techniques may involve significant amounts of data processing and usually require some extra assumptions. (Moshkovich and Mechitov 2005, Dodgson et al. 2000.)

The MCA methods based on fuzzy sets apply the idea that our natural language in discussing issues is not precise. Fuzzy arithmetic attempts to capture the assessments using the idea of a membership function. An option would belong to the set of, say, 'attractive' options with a given degree of membership, lying between 0 and 1. The fuzzy MCA models develop procedures for aggregating fuzzy performance levels using weights that are sometimes also represented as fuzzy quantities (Dodgson et al. 2000). Triantaphyllou (2000) argues that the fuzzy revised AHP is better than the other MCA methods that are based on fuzzy sets.

The extent of stakeholder involvement is a significant issue in the evaluation of transport options (Macharis and Bernardini 2015). In a recent study (De Brucker et al. 2013) it was demonstrated that diverse dilemmas related to sustainable devel-

opment can be addressed with stakeholder-oriented multi-criteria analysis. The method is especially applicable in connection with complex project evaluations that involve multiple objectives and multiple stakeholder groups. In such cases it is generally desirable to simultaneously satisfy private economic goals, broader social objectives and environmental targets.

Consequently, an extension of the traditional multi-criteria analysis is the Multi-Actor Multi-Criteria Analysis (MAMCA). This methodology is used for evaluation of alternatives, such as policy measures, scenarios or technologies from the perspective of the different actors, the so-called stakeholders who are involved (e.g. Macharis et al. 2012, Macharis et al. 2010, Macharis and Nijkamp 2013). The MAMCA methodology explicitly includes the objectives of the different stakeholders (Macharis and Nijkamp 2013).

The seven steps of MAMCA are 1) definition of the problem and the alternatives, 2) stakeholder analysis, 3) definition of the criteria and weights, 4) operationalising of the criteria, construction of indicators and identification of measurement methods, 5) overall analysis and ranking, 6) providing results and carrying out sensitivity analysis, and 7) implementation (Macharis et al. 2012). In MAMCA, separate sets of criteria are used for the different stakeholder groups. Macharis et al. (2012) stress that the purpose of the MAMCA is more to provide insight into what is important for the differen stakeholders, than to sum up the views of the stakeholders and to come up with one final decision. An example of the use of MAMCA within the transport sector, is the creation of a framework for comparison of alternative solutions for urban and inter-urban freight transport (Macharis et al. 2014). This framework allowed the comparison of alternative solutions from the perspectives of multiple stakeholders within the city distribution context.

Triantaphyllou (2000) states that for the successful use of MCDA methods, one needs both deep understanding of the pure numerical properties of the method in question, as well as of the cognitive and behavioural aspects of the decision-making process.

Two MCA applications are introduced here. These techniques are the Analytic Hierarchy Process (AHP) and Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH). The AHP is described because it is a commonly used method for ranking of decision criteria. MACBETH is introduced because it is a promising method for demonstration of how the values of an individual or a group of people can affect the priority order of for example policy alternatives. The objectives of the current study (Chapter 1.3) include both the abovementioned purposes, in connection with the aspiration of constructing an innovative combination of multi-criteria approaches.

AHP; The Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) also develops a linear additive model. However, in its standard format, the AHP uses procedures for deriving the weights and scores achieved by alternatives which are based, respectively, on pairwise

comparisons between criteria and between options. Thus, for example, in assessing weights, the decision-maker is asked a series of questions, each of which examines how important one particular criterion is relative to another for the issue being addressed. The AHP provides a means to improve consistency in the judgments, but it also allows for inconsistency if necessary. (Dodgson et al. 2000, Saaty and Vargas 1994.)

Accoring to Macharis and Bernardini (2015), the AHP (or one of its derivates) is the most used MCDA method within transport project appraisal.

In its general form, the AHP is a nonlinear framework for carrying out both deductive and inductive thinking. The strengths and weaknesses of the AHP have been the subject of substantial debate among specialists in the MCA. Users generally find the pairwise comparison form of data input straightforward and convenient. On the other hand, doubts have been raised about the theoretical foundations of the AHP and about some of its properties (Lootsma 1993b). In particular, the rank reversal phenomenon has caused concern. This is the possibility that, simply by adding another option to the list of options being evaluated, the ranking of two other options, not related in any way to the new one, can be reversed. This is seen by many as inconsistent with rational evaluation of options and thus questions the underlying theoretical basis of the AHP. (Dodgson et al. 2000, Saaty & Vargas 1994.)

The AHP is a means of developing measures for comparison of alternatives when physical or statistical measures are unavailable. The AHP provides one way of converting subjective assessments into relative values. The AHP is a multicriteria evaluation method that is based on developing a linear additive model, using weights that are derived with pairwise comparisons between criteria and between options. The AHP is theory for measurement of intangible criteria (Saaty 2005).

The AHP is often used to decompose a complicated decision problem into its constituent parts which are structured hierarchically. Multiple or even conflicting goals can be taken into consideration. As a result, the AHP provides a ranking of options and criteria which facilitates the selection on the decision problem, for example the selection of a policy option. The judgments that are used in the AHP are based on the opinions of knowledgeable and expert people, who may have existing statistics or other data available during the AHP process (Saaty 2005).

The AHP is based on the following axioms:

1. reciprocal judgments (the necessary condition for combining individual judgments is the calculation of geometric mean)
2. homogeneous elements
3. hierarchic or feedback dependent structure
4. rank order expectations.

The following main principles are applied in the AHP (Olson 1996):

1. problems are decomposed by identifying the important factors that are parts of the problem

2. comparative judgments are made on the decomposed elements of the problem (so-called branches)
3. measures of relative importance are obtained through pairwise comparisons by experts or decision-makers
4. the measures of relative importance are recombined into an overall rating of available choices.

The AHP analysis consists of five main steps, namely; 1) structuring of the objective and hierarchy development, 2) subjective pairwise comparisons, 3) calculation on implied weights, 4) definition of the consistency measure and 5) synthesis (Olson 1996, Kasperczyk and Knickel 2004). In the AHP, a fundamental scale of 1 to 9 is used for comparison of the alternatives. These paired comparisons lead to definition of a scale of relative values, which belongs to an absolute scale that is invariant under the identity transformation like the real values. The steps of the AHP are described in the following:

1) Structuring a decision goal or objective, selection of criteria, and developing a hierarchy over the selected criteria

The factors that are important parts of the different aspects of a goal or an objective are organized into a hierarchy (Figure 4). At the top of the hierarchy is the goal or the objective. The criteria under the goal identify the different aspects that contribute to attaining the goal. It is suggested that the number of criteria under any one node is limited to seven. This is because it is difficult for humans to concentrate on more than seven things at one time. (Olson 1996, Kasperczyk and Knickel 2004.) In constructing a hierarchy, it is essential to identify all the parties associated with the problem.

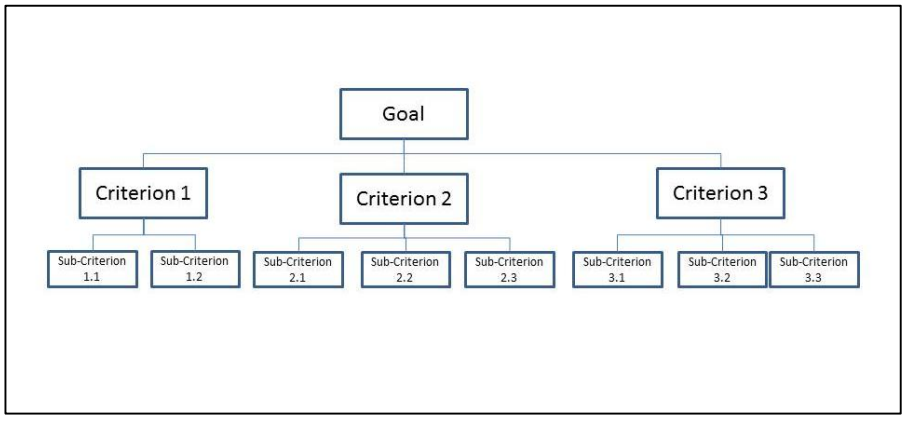

Figure 4. An example of a tree of hierarchy (e.g. in Saaty 2005).

2) Priority setting by subjective pairwise comparisons (weighting)

When the hierarchy has been constructed, the next step is to obtain the relative importance of the factors within each hierarchical level of each criterion. All the elements in each level of the hierarchy are compared pairwise. One pairwise comparison is required for the definition of the overall utility. The comparisons are expressed with the scale of 1 to 9 (Table 8). With this scale, the weights for each criterion are defined. The expert or decision-maker is asked a question such as: "How important is criterion A relative to criterion B?".

Table 8. The AHP scale for comparison of the factors (Saaty 2005, Table 9.1. p. 356).

Difference between the factors compared	**Definition**	**Explanation**
1	Equal importance	Two factors contribute equally to the objective
2	Weak	Experience and judgment slightly
3	Moderate importance	favour one factor over another
4	Moderate plus	Experience and judgment strongly
5	Strong importance	favour one factor over another
6	Strong plus	One factor is favoured very strong-
7	Very strong or demonstrated importance	ly over another; its dominance demonstrated in practice
8	Very, very strong	The evidence favouring one factor
9	Extreme importance	over another is of the highest possible order of affirmation

3) Calculation of implied weights (scoring)

There are several alternative ways to calculate the relative scores of weights. The relative score can be obtained by normalising any column, averaging the given values or calculating geometric mean of the values. The eigenvector method also provides a means of assessing the relative consistency of a matrix.

4) Consistency measure

A consistency index is a factor that demonstrates the consistency between the individual valuations. The maximum eigenvalue of the elements is used as the measure of consistency index. Olson (1996) notes that a value of 0.10 is proposed for this cut-off limit. If the consistency between the answers is below this limit, the expert or decision-maker is asked to reconsider his answer.

5) Synthesis

A synthesis of the analysis implies multiplying down the hierarchy and adding the products for each alternative. The sum of weights of all alternatives will add to one.

With careful consideration, some less important criteria can be left out of further inspection, because of their relatively small impact on the overall objective. The priorities can then be recalculated, either with or without changing the judgments. The remaining criteria are then evaluated based on their weights, which can be assumed to represent how well the individual criteria satisfy the expressed objective or goal.

The AHP has been successful in situations where the acceptance of practitioners is included in the process. However, the process takes a lot of time and manpower. (Kasperczyk and Knickel 2004).

MACBETH; Measuring Attractiveness by a Categorical Based Evaluation Technique

MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique) is an MCDA approach that enables an individual or a group of people (further referred to as a decision-maker) to compare and illustrate the effect of their expressed values on the relative attractiveness of different options or ways of action. MACBETH utilises qualitative judgments. It is an interactive approach that uses semantic judgments to build a model and thus presents the results in a way which helps the decision-makers to understand how their preferences contribute to differences in overall attractiveness of different alternatives or for example policy options. (Bana e Costa et al. 2004, Bana e Costa and Chagas 2004.)

MACBETH finds its roots in multi-attribute value theory and difference value measurement. The approach is based on an additive value model. MACBETH can be used to support interactive learning about the subject of evaluation and elaboration of recommendations for prioritising and selecting between the options. As mentioned earlier, MACBETH is suitable for both individual and group decision-making processes. (Bana e Costa et al. 2004, Bana e Costa and Chagas 2004.)

The structuring phase of the multi-criteria decision aid model provides the actors involved with a common language for debating and arguing about their preferences. In addition to providing the common language, the structuring phase facilitates identification of decision opportunities and construction of new alternatives. The phases of structuring are 1) problem-definition, 2) model-structuring and 3) assessment and analysis of impacts. (Bana e Costa et al. 2003, Bana e Costa 2005, Bana e Costa et al. 2005, Bana e Costa and Beinat 2005, Bana e Costa 2001.) These phases are introduced below (Figure 5).

1) Structuring

The first phase includes identifying the criteria and structuring the values of concern, and defining the alternatives to be evaluated. Also, a table of performance is created that describes the performance of the alternatives or policy options with respect to the criteria. The structuring phase of the multi-criteria decision aid model provides the actors, namely the facilitator and the decision-maker(s), with a common language for debating and arguing about their preferences. In addition to providing the common language, the structuring phase facilitates identification of decision opportunities and construction of new alternatives.

The criteria are composed to represent the key aspects that contribute to the attractiveness of the alternative or policy option. The criteria are presented in the so-called value tree.

2) Evaluating and weighting

The evaluation process includes definition of each option's attractiveness with respect to each criterion, and weighting of the criteria. The facilitator presents the decision-maker two criteria at a time, and asks him or her to tell which one s/he considers to be more important than the other. Also a judgment of whether the difference in importance is "very weak", "weak", "moderate", "strong", "very strong" or "extreme" is asked for. By comparing the criteria pairwise, a matrix of qualitative judgments is filled in. The decision-maker can either define that there is a fixed distance between the criteria; e.g. that there is the same difference in importance between "very weak" and moderate than between "strong" and "very strong". Another possibility is to define the distances between the statements of importance. For example, the decision-maker can consider that "moderate" is twice as far from "strong" than "strong is from "very strong".

The MACBETH numerical scale of preference information is defined based on the above-mentioned qualitative matrix. In this process, the consistency of the judgments is also tested. The facilitator discusses the scale with the decision-maker that has given the judgments, and the evaluation can be refined until the decision-maker agrees that the outcome reflects his or her valuations.

The MACBETH scale is presented in two ways; in a table and the so-called thermometer that show the differences in the overall attractiveness of the different alternatives.

After the initial judgments described above, the overall attractiveness of the alternatives or policy options can be analysed by weighting the criteria and calculating an overall score for each of the alternatives or policy options that are being compared.

In the weighting process, the decision-maker is asked how large s/he considers the differences in the values of criteria to be. This is done by asking questions like: "How much more attractive is the swing from neutral to good in a specified criterion than in another criterion?" This way a weighting matrix is created. When the

matrix is filled, the facilitator asks the decision-maker to consider whether the matrix represents his or her valuations, and it can be changed if necessary.

When the weighting is completed, the overall scores for each of the alternatives of policy options are calculated. In this calculation, the MACBETH software uses the weighted criteria and the data describing the performance of the alternatives or policy options respective to the criteria that were judged.

3) Recommending

Based on the previous phase, the MACBETH software provides both numerical information and graphics about how the different alternatives or policy options relate to each other considering the valuations that have been expressed by the judgments. These results are carefully discussed with the decision-maker(s), before a recommendation of the preferred action is presented.

Analysing the sensitivity and robustness of the model's results in light of data uncertainty are an important part of the process.

Which of the above-mentioned steps are performed and what is the order of the consequent steps depends on the decision context. (Bana e Costa et al. 2003, Bana e Costa and Chagas 2004, Bana e Costa et al. 2005a, Bana e Costa and Beinat 2005b, Bana e Costa 2001.)

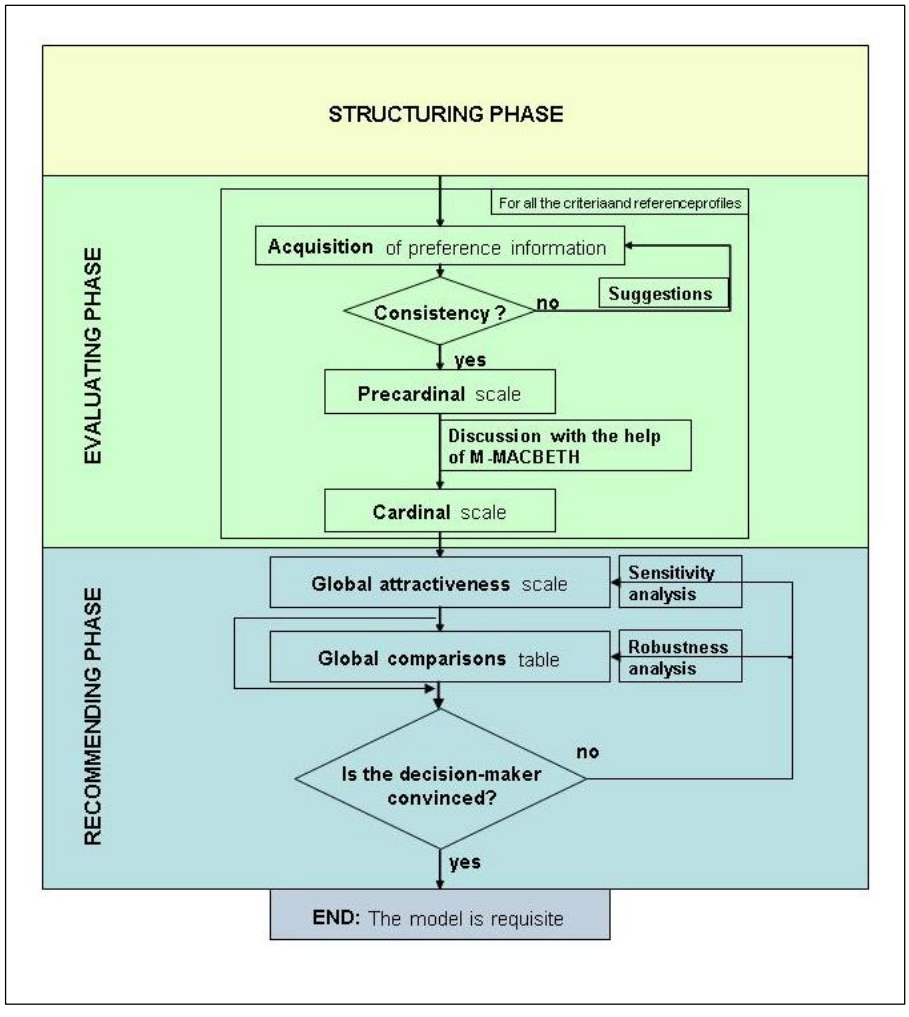

Figure 5. The steps in the MACBETH procedure (edited according to Bana e Costa et al. 2003).

2.7 Summary of the overview

In Chapter 2.2 it was stated that appraisal of transport plans, programmes or policies involves questions of public, economic and political acceptability. Important issues were traffic flows, modal splits and modal choice, as well as health, educa-

tion and biodiversity. (Mackie and Nellthorp 2003, Jones and Lucas 2000, Hildén et al. 2004.)

The transport appraisal guidelines often emphasise quantifiable impacts and assessment of economic efficiency at the level of society, using cost-benefit analysis. On the contrary, the legislation and guidelines for environmental impact, or strategic impact assessment encourage study of a broad range of impacts, and reporting the findings in extensive, usually qualitative reports.

In Chapter 2.3 methods that are commonly used for assessing the so-called sustainability impacts were presented. The most relevant of such methods were, for example, the Human Impact Assessment, (Strategic) Environmental Impact Assessment and Sustainability Assessment, as well as Transport quality of life and, appraisal methods the Cost-Benefit analysis and Multi-Criteria Analysis (Ness et. al 2007, Graymore et al. 2008, Rorarius 2007 & Carse 2011). The literature overview confirmed that there is need for research that combines the views of the different sectors involved in transport system planning. Also, the need for standardised tools that give transparent results was expressed (Ness et al. 2007, Koo et al. 2009).

Several lists of sustainability criteria were presented in Chapter 2.4. The combination of the different lists of criteria and their classifications provided a good starting point for making the list of criteria for assessment of welfare impacts.

The Finnish YHTALI-framework (The Ministry of Transport and Communications 2003a, The Finnish Transport Agency 2011) for transport appraisal was compared with the UK appraisal procedure NATA (HM Treasury 2003). The NATA approach provided a useful list of appraisal objectives and sub-objectives in the so-called Appraisal Summary Table (Department for transport, UK 2012). Guidance on the evaluation of transport projects was somewhat similar to each other in both appraisal procedures. The Finnish framework emphasised feasibility assessment better than the UK. However, the UK approach included assessment of more impacts that are close to the idea of welfare impacts. In both evaluation frameworks, certain methods were suggested, but the actual selection of the methods to be used was to be made by the evaluators themselves.

In Chapter 2.6, two common methods used in the assessment of transport projects, multi-criteria analysis (MCA) and cost-benefit analysis (CBA) were introduced. Also, two applications of the MCA were identified. These methods were the AHP and MACBETH (Saaty 2005, Bana e Costa et al. 2004, Bana e Costa and Chagas 2004). The literature overview confirmed that the MCA methods would be suitable for the research problem that involved several stakeholders, both quantitative and qualitative data, and inclusion of the stakeholders' valuations.

The main results of the literature study were the combination of criteria lists and identification of the AHP and MACBETH.

3. Materials and methods

3.1 Overview

In this overview chapter, the research process and methods are briefly introduced. The results of each work phase are introduced in Chapter 4. However, the findings of the first work phase, the literature survey, have already been presented in Chapter 2.

The literature overview focused on European practice in the appraisal and assessment of transport plans, programmes and policies, especially emphasising impacts on welfare and quality of life and the theory of common evaluation methods. Two approaches were identified in the literature review; the needs-based or resource-based approach. The resource-based approach is applied in this work. The society provides the preconditions for welfare that can be realised by changes in the transport system. The people then decide whether to make use of the modified transport system and the preconditions for welfare that it provides.

The process of creating the criteria and AssessmentAid included two main phases; **selection and pre-testing the criteria for assessment of welfare impacts,** and **creating and testing AssessmentAid with post-testing of the criteria** (Figure 6).

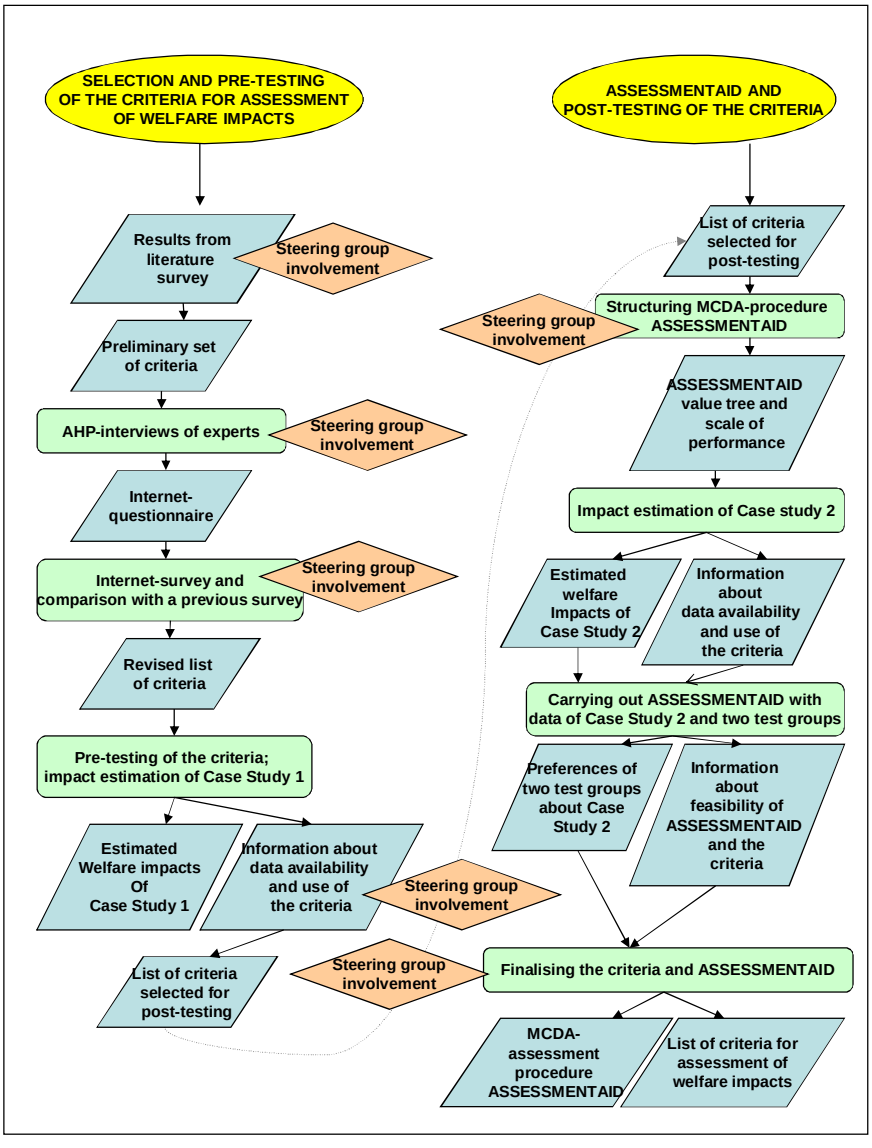

Figure 6. The process of creating the criteria and AssessmentAid.

Selection and pre-testing of the criteria was carried out in order to create a suggested list of criteria for assessment of welfare impacts that could be used and refined in a multi-criteria model. The work phase involved interviews and analysis thereof with the MCDA-technique AHP (Chapter 1.6, Expert Choice 2015) and an internet-questionnaire survey. The selection of the criteria was to be carried out in

short time through interviews of several decision-makers and experts. Consequently, the AHP was selected as the technique for the ordering task. The AHP software used for analysing the interviews about the criteria was Expert Choice (Expert Choice 2015). The usability of the preliminary set of criteria and availability of data were tested in a case study. This first of the two case studies was a development plan of a railway corridor between Central and Northern Finland (SOul 2005b) (see Chapter 3.2). The selection and pre-testing process is introduced in Chapter 3.3.

In order to have good basis for the criteria, several tasks were included in this phase. The steering group involvement was essential, as the criteria were to be based on expert opinions. However, the AHP was used as a means for discussion, and no final results were gained before discussions with the steering group. With the Internet survey, opinions of several experts in Oulu and Helsinki were collected, and a basis for comparison was a previous similar postal survey (Rusila 2004b). The pre-testing phase was targeted to tell whether there was data available for the criteria and how it could be measured. Also, an example of defining potential welfare impacts of a transport plan was carried out, in order to show the outcomes of the estimation and provide information to the participants from Oulu.

Creating and testing the MCDA-procedure AssessmentAid and post-testing of the criteria comprised of applying the MCDA-technique MACBETH (Chapter 2.6.4) with the data of a case study. The output of this work phase were the final list of criteria for assessment of welfare impacts and the AssessmentAid framework.

MACBETH is an MCDA application that has been used in similar situations, and experiences have been positive. MACBETH was selected because the plan was to compare alternatives, as well as include impact assessment data and expert valuations in the model. Also, good software existed. The second case study, the Transport Plan of the Helsinki Metropolitan Area 2007 (The Helsinki Metropolitan Area Council 2007) is described in Chapter 3.2. This work phase is introduced in Chapter 3.4. The reason for MACBETH process was to create and test an assessment procedure that can be used with the criteria created. The impact estimation of the second case study provided information both about the usability of the criteria, availability of data and about the Helsinki Metropolitan Area Transport Plan.

The variety of different stakeholders of a transport plan, and the importance of involving them in the assessment process was addressed in Chapters 2.2, 2.5 and 2.6. In the current study, the stakeholders of transport system planning were involved in the steering group of the study and as interviewees in the surveys and AHP analysis.

The work was exposed to expert judgment in the form of meetings of **a steering group**. These meetings provided important views of Finnish transport authorities and helped to focus the research work to also account for the practical needs of planners and decision-makers. The work phases where the steering group was involved in the study are presented in Figure 6. These steering group participation

points had been planned in the beginning of the study, to have their input in certain points of defining the criteria and creating AssessmentAid.

The steering group of the study included the two main ministries that design the strategic overall objectives of transport system planning in Finland, as well as two transport authorities that participated in the planning and realisation of transport system plans. The regional authorities were represented by two organisations. Also, the national authorities for welfare, health and social issues were involved in the steering group. This group of experts and authorities participated in the work by initiating discussion about the specific topics of their own operational environment. The steering group included representatives from the following Finnish organisations:

1 the Ministry of Transport and Communications,
2 the Ministry of Environment,
3 the Finnish National Road Administration,
4 the Finnish Rail Administration,
5 the Helsinki Metropolitan Area Council,
6 the Finnish Federation of Municipalities.
7 the Ministry of Social Affairs and Health, and
8 the Finnish National Research Centre for Welfare and Health.

The main contribution of the steering group was to discuss the main concepts about welfare impacts and to participate in the interviews in order to compile the first, tentative list of impacts. In addition, the group took part in the testing of the multi-criteria application created in the study, and commented on the different phases and outputs of the study. Also, data for the case studies was provided by the Finnish Rail Administration and the Helsinki Metropolitan Area Council. The steering group provided important opinions for discussion. These opinions of the Finnish transport authorities were provided at the points were choices about the criteria and the AssessmentAid model were made.

In addition to the project steering group, the other interviewees of the **internet-questionnaire survey** represented regional authorities, planners and service providers of transport and land use, local business, social and health sector, schools, environmental protection, the media and local organisations of citizens, both in the Helsinki Metropolitan Area and the Oulu region. The internet-questionnaire was sent to a total of 251 people in the Helsinki Metropolitan Area and the Oulu region. Total of 93 responses were received.

The AHP interviews in the selection of the criteria were carried out with the individual members of the organisations represented in the steering group, because the opinion of the authorities and experts was sought for.

The data about welfare impacts of the case studies was collected from the impact assessment documents of the case plans, and some missing or partial data was amended as expert work by a transport consultant. This consisted of analysis of qualitative planning material, by combining the different data that had been produced in the planning processes.

3.2 The case study transport plans

The study included two case studies. The first case study was a development plan of a railway corridor between Central and Northern Finland and the second case study was the regional transport system plan in the Helsinki Metropolitan Area in Southern Finland (Estlander et al. 2007). Helsinki is the largest municipality in Finland, with 613 000 inhabitants and Oulu is the fifth largest city, with 194 000 inhabitants (Statistics Finland 2014b).

Impact assessment data was needed in order to find out how the criteria for assessment of welfare impacts could be applied in practise and to find out whether useable data for this purpose existed. Experience was sought for about the applicability of AssessmentAid in a real-world assessment situation. Also, there was a need to study what kind of impacts the differences in valuations of the stakeholders had on the outcomes of the assessment process. These were the reasons for applying case studies.

Two case studies were selected because the testing of the criteria was to be carried out in two phases, and reference information about the availability and useability of different types of data was needed. Also, experience was sought for from different geographical locations, because the transport conditions are very different in the Southern and Northern parts of Finland. Also other Finnish regional transport system plans were considered as case studies, but the timing and the extent of impact assessments of the selected two proved to be the most suitable for the purpose. Regional transport system plans were created during the years 2006 and 2007 in for example Western parts of Southern Finland and in the area of Kokkola in Northern Finland.

The initial pre-testing of the criteria with the data from Seinäjoki–Oulu railway connection is explained in Chapter 3.3, and the post-testing with the data from the Helsinki Metropolitan Area Transport Plan is described in Chapter 3.4.

At the time when the case studies were selected, the enhancement of the railway connection between the cities of Seinäjoki and Oulu had recently been started, and the Ministry of Transport urgently needed information on its potential impacts. Also, there had been a great amount of innovative studies and development projects in the Oulu area, and therefore it was thought that there would be interest in the idea of assessment of new types of impacts, and enthusiasm to participate in the survey and interviews.

The Helsinki Metropolitan Area Transport Plan was selected as a case study, because its impact assessments were the most advanced in Finland at that time when it comes to assessment of human and social impacts. Therefore it was assumed that useful data would exist. Also, the transport system of Helsinki Metropolitan Area is the largest and busiest of all cities in Finland. Since the transport volumes are high, significant impacts on welfare were expected to be seen as a result of modifying the transport system.

Case study 1: Enhancement strategy of the railway connection Seinäjoki–Oulu

The railway corridor between the cities of Seinäjoki and Oulu (Figure 7) is a highly occupied connection for both passenger and freight traffic.

Oulu is a city of 190 000 inhabitants in Northern Finland, on the coast of Gulf of Bothnia. The transport system of Oulu is well-known for example for having an extensive and busy bicycle lane network, despite of the cold climate. (City of Oulu 2015.)

Seinäjoki is one of the fastest growing urban areas in Finland which is located south from Oulu. The population of the city of Seinäjoki is 60 000. However, the urban area of Seinäjoki that is formed by nine municipalities, has a population of 150 000. (City of Seinäjoki 2015.)

The railway corridor between the cities of Seinäjoki and Oulu belongs to the European TEN network. The railway line is one of the busiest single-track railway sections in Finland. The length of the railway section is 335 km. The railway project Seinäjoki-Oulu includes both repairing old and constructing new infrastructure. The construction work started in 2007 and the work will be completed in 2017. (The Finnish Transport Agency 2012.)

The aim of the development work was to cut travel times by increasing the speed level of passenger trains up to 200 km/h. The level of service of freight transport would be improved by raising the axel loads to 25 tons. Double tracks would increase the capacity of the railway connection. The removal of railway level crossings would improve the safety on the railway connection. The development strategy of the railway connection Seinäjoki–Oulu addresses ways to increase the use of railway transport and offer concrete suggestions about the responsibilities of all the involved parties (SOul 2005b).

This case study was based on the development strategy of the connection and the impact assessment within the strategy, not yet on the implementation plan.

The impact assessment material was mainly qualitative, with indications of the significance of the impacts. Therefore, the assessment was kept on a rather general level. The material was structured according to the list of criteria that had been drafted by that stage of the study (Figure 6). The impacts were estimated with the following judgments:

- clearly negative impacts on this criterion
- somewhat negative impacts on this criterion
- neutral or not significant impacts on this criterion
- somewhat positive impacts on this criterion
- clearly positive impacts on this criterion.

Also, the availability of already existing data about the different types of impacts was assessed.

The impact assessment was based on the documents that report the different options and potential impacts of the railway connection between Seinäjoki and Oulu. The following reports were used: the transport plan 2020 of the Oulu region, strategy – priority tasks – intention agreement (City of Oulu 2003), the intermediate report of the railway 2020 -program, appraisal of the development options (The

Finnish Rail Administration 2000), the Finnish guidelines for appraisal of rail transport investments (The Finnish Rail Administration 2004), a report on a basis for the social impact assessment – the city code of Oulu (Kinnunen et al. 2001), a report on the enhancement of Seinäjoki–Oulu railway connection, analysis of the current state of the transport system (SOul 2003), the 2005 environmental impact assessment report of the improvement of the level of service of Seinäjoki–Oulu railway connection (SOul 2005a), a report describing the enhancement strategy of the railway connection Seinäjoki–Oulu, Soul (SOul 2005b), the statement of the contact authority on the environmental impact programme of the improvement of the level of service of the Seinäjoki–Oulu railway connection (SOul 2005c), the 2006 environmental impact assessment report of the improvement of the level of service of the railway connection Seinäjoki–Oulu (SOul 2006), and a memorandum discussing the suitability of the criteria in the assessment of welfare impacts in the case Seinäjoki–Oulu railway connection (Heltimo 2006).

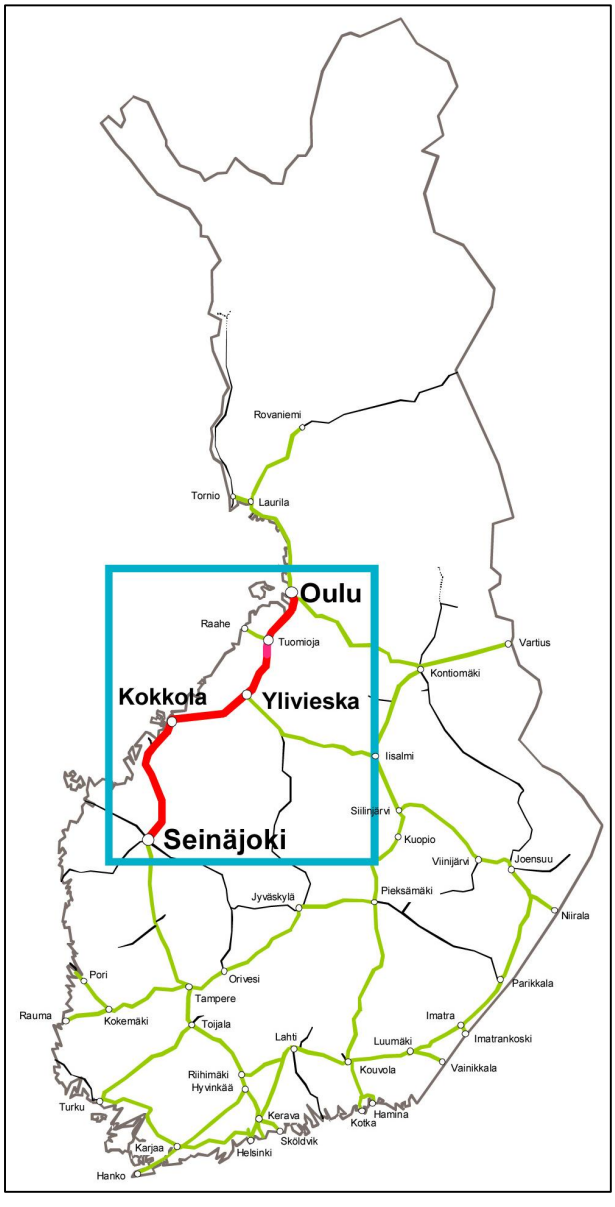

Figure 7. The first case study, the enhancement of the railway connection between the Finnish cities of Seinäjoki and Oulu (the image obtained from the Finnish Transport Agency, July 2015).

Case study 2: Transport Plan of the Helsinki Metropolitan Area 2007

The Helsinki Metropolitan Area Transport System Plan is a strategic transport plan, where the transport system is taken into consideration as a whole. Helsinki is the capital of Finland, located on the Baltic Sea Coast. In 2006, the Helsinki Metropolitan Area offered employment to roughly 600 000 people and had roughly one million inhabitants, while the greater Helsinki region (14 local governments)

was home to about 1 275 000 people. (Helsinki Metropolitan Area Council 2007.) The share of public transport is 43%, which is the highest in Finland (HSL 2013).

A vision for the transport system of the Helsinki Metropolitan Area (Figure 8) has been created by the lead of the Helsinki Metropolitan Area Council. The Helsinki Metropolitan Area Transport System Plan 2007 has been produced on the basis of a vision for the long-term target state of the transport system. The transport system envisioned should offer generous transport opportunities for everyone and guarantee comfortable living conditions and transport reliability, thus promoting regional competitiveness. (Helsinki Metropolitan Area Council 2007).

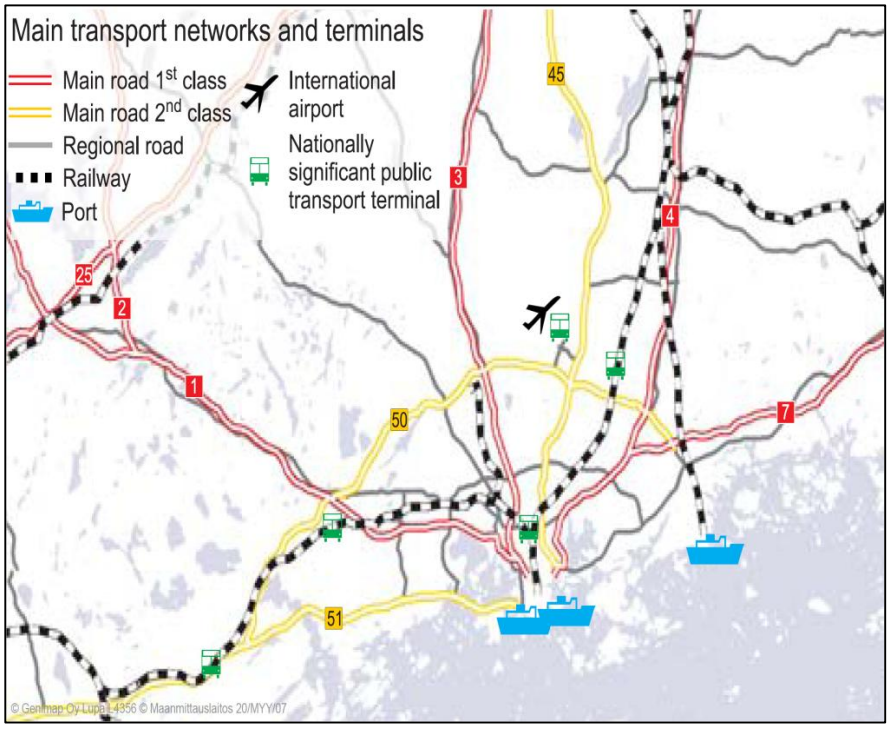

Figure 8. The main transport networks and terminals in the Helsinki Metropolitan Area (Helsinki Metropolitan Area Council 2007).

If the growth of road traffic continues as strongly as anticipated, the traffic problems cannot be solved solely by developing transport networks and traffic services. For example, interaction between land use and the transport system strongly affects the development of road traffic. The development strategy of the Helsinki Metropolitan Area Transport System Plan 2007 utilises a wide range of measures.

The development strategy illustrates the overall traffic policy for the Helsinki Metropolitan Area. The sub-strategies of the development strategy are

1. Managing mobility demand and modes of transport
2. Development of public transport services
3. Increasing transport system efficiency by means of mobility management and information
4. Theme programmes and projects for the development of the transport system
5. Infrastructure development projects. (Helsinki Metropolitan Area Council 2007)

The Transport Plan of the Helsinki Metropolitan Area was chosen for the testing of the AssessmentAid, because it is a major transport plan that comprises a more extensive impact evaluation process than other Finnish transport system plans. Also, there was up-to-date material available, as the environmental impact assessment was completed at the same time with the planned case study.

Three strategic implementation alternatives and a 0+ -alternative of the Helsinki Metropolitan Area Transport Plan were examined (Helsinki Metropolitan Area Council 2007). The alternatives are described as follows:

- **0+:** The current transport policy will be followed, but no new transport infrastructure will be constructed or the current infrastructure improved
- **A1**: Land use is favourable for transport; community structure supports the functioning of the transport system
- **A2**: Controlled mobility; the demand is managed in a way that safeguards the environment and the transport system capacity
- **A3**: Control of demand for passenger car traffic; balancing of the demand and supply of transport, by the means of transport pricing.

The impact assessment material of the Helsinki Metropolitan Area Transport Plan comprised assessment of eight types of impacts and four additional assessments. The above-mentioned nine groups were impacts on 1) mobility and freight transport, 2) community structure, 3) cultural heritage, built environment, cityscape and landscape, 4) traffic emissions and air quality, 5) greenhouse emissions, 6) nature and biodiversity, 7) health, living conditions and comfort, 8) preconditions for operations of industry and commerce. The following issues were also examined: 9) spatial concentration of the impacts, 10) impacts on the regional competitiveness, 11) the realisation of the vision on the transport system and 12) possible uncertainty in the impact assessments (Helsinki Metropolitan Area Council 2007). This data was examined according to the list of criteria that had been selected for post-testing (Figure 6), to find out what the potential impacts of the plan were, and what type of data were available.

The impact assessment material was mainly qualitative, with indications of the significance of the impacts. Therefore, the assessment was kept on a rather general level. The material was structured according to the above-mentioned list of criteria. The following estimates were used in the assessment:

- - = negative impacts on this criterion
- 0 = neutral, no significant impacts on this criterion
- + = positive impacts of this criterion
- +/- = mixed impacts on this criterion; both positive and negative significant impacts
- ? = no relevant data was available for assessment of these types of impacts.

The impact assessment data was gathered from the following publications: a report on the strategic environmental Impact assessment of the Helsinki Metropolitan Area transport system (Helsinki Metropolitan Area Council, YTV 1998), the report of the impact assessment of the Helsinki Metropolitan Area transport aystem plan (Helsinki Metropolitan Area Council YTV 2002a), Information booklet about the Helsinki Metropolitan Area transport system plan (Helsinki Metropolitan Area Council, YTV 2002b), documentation of cross-town public transport; vision 2030 and development plan for the years 2005–2020 (Helsinki Metropolitan Area Council, YTV 2004), the report on impact assessment of the transport system plan 2007 of the Helsinki Metropolitan Area (Helsinki Metropolitan Area Council, YTV 2006), and reporting of a study on environmental assessment's role in the Transport System Planning; a case study from Helsinki Metropolitan Area (Kaljonen 2000).

3.3 Selection and pre-testing of the criteria for assessment of welfare impacts

The objective of the selection process was to provide clear, easy-to-use criteria for the assessment of preconditions for welfare that result from changes in the transport system. These criteria are to be used as practical framework by planners and decision-makers of transport systems.

Representative criteria for the assessment of welfare impacts were selected through a gradual process that involved several transport authorities, experts and ordinary individuals. The main methods in the revision of the assessment criteria were 18 **interviews with the Analytic Hierarchy Process (AHP)** and a **questionnaire survey** on the internet in 2005, as well as testing the criteria with impact estimation data of a **case study.** The results of the internet survey were also compared with a survey that was carried out in the Oulu region in 1999 (Rusila 2004b). The purpose of the comparison with the older results was mainly to comprehend potential changes in the attitudes that may have taken place since 1999.

Interviews of the steering group and AHP-analysis of the interview data

At first, a preliminary list of criteria was written as expert work, based on a literature survey. The list was combined using the lists or assessment criteria that had been provided by earlier research and guidelines. These criteria lists were introduced in Chapters 2.4 and 2.5. This list was used as starting point for the interviews of the project steering group. This group of people was selected as interviewees, because they represented the key authorities and decision-makers within the Finnish transport and environmental sectors, and experts of the health sector were also involved.

The data was collected by interviewing individual steering group members with six other experts that represented the organisations represented in the steering group. The additional experts were suggested by the steering group members. The interviews were carried out according to the input format of the Analytic Hierarchy Process (AHP) application Expert Choice (Expert Choice 2015). The significance of the criteria was examined by pairwise comparisons. The interviewees were asked to indicate the relative significance of two criteria at a time, using a scale from -9 to 9. This scale can be interpreted in the same way as the one from 1 to 9. The negative numbers only indicate the direction of the difference in the significance.

The interview data was analysed using the AHP (see for example Saaty and Vargas 1994). As a result of these interviews, relative priorities for each of the criteria were calculated, separately for each interview. The priorities of individual interviewees were aggregated by calculating geometric means for all the criteria (for group decision-making with AHP, see for example Bryson and Joseph 2000). All the responses were considered to be of equal importance in the analysis, no weight was put on any of the interviews. The results of the AHP process were used only as a starting point of discussion, not as final results of the selection. (Estlander et al. 2005.)

However, the priorities were calculated only for the individual criteria, not for their group headings. This was because the group headings that had been defined together with the steering group were taken as given, and the priorities were used for organising the potential criteria under these group headings.

The Internet questionnaire survey

An Internet questionnaire was formed according to the results of the AHP analyses and group discussions (the questionnaire is presented in appendix B). In addition to complementing the selection and ordering of the criteria, the questionnaire survey focused on studying the values and preferences of several groups of people, in order to enhance the representativeness of the criteria. The interviewees were asked to state their opinion about the significance of 77 potential welfare impacts, using a scale from 0 to 8.

An introductory e-mail message was sent to 108 people in Oulu and 143 people in the Helsinki Metropolitan Area, with a link to the questionnaire in the Internet.

The main objectives of the research project, reasoning of the questionnaire and the structure of the questionnaire, as well as advice on how it should be filled in were explained in the above-mentioned message. Another message, reminding the participants about the survey, was sent three weeks later.

The structure of employment varies a little between Oulu and the Helsinki Metropolitan Area, but no major differences exist. In Oulu, business and industry represent 32% of all jobs, human health and social work activities almost 20%, wholesale and retail trade 11%, education 9%, public administration and defence 7%, transportation and storage sector 5%, and agriculture and fishing 2% (Statistics Finland 2014a). In turn in 2007, in the Helsinki Metropolitan Area, business and industry represented 39% of all jobs, wholesale and retail trade 19%, transportation and storage 9%, human health and social work activities 4.6%, education 2%, public administration and defence 1.3% and agriculture and fishing 0.2% (Helsinki Metropolitan Area Council 2007).

The distribution of the recipients of the questionnaire differed from that of the entire populations of Helsinki Metropolitan Area and Oulu. The rather low number of recipients (37 per cent) was due to the fact that filling out the questionnaire required a lot of work and understanding of transport planning and its potential impacts.

Because the filling in of the questionnaire required some kind of background knowledge about the subject, a higher percentage of the questionnaires was sent to professionals within the transport and environmental sector, or to decision-makers who have been involved in the decision-making concerning the transport sector than to other citizens. Therefore, half of the questionnaires were sent to decision-makers and experts in regional planning, transport and environment. At this stage the different types of experts were not identified in detail, and therefore not all possible types of experts, for example transport logistics providers were included in the survey. Of the messages sent, 49% were directed to decision-makers or actors in regional and transport system planning and environmental protection. Business, industry and trade involve a large share of jobs both in Oulu and Helsinki Metropolitan Area, and therefore 16% of the questionnaires were sent to this sector. There was quite a large difference between the proportion of all jobs of health and social sector between Oulu and Helsinki Metropolitan Area. The health and social sector was, however, considered to have important experience in human and social impacts of planning, and the sector hence represented 16% of the people who received the questionnaire. 19% of the questionnaires were sent to other groups of people, such as the media, representatives of schools and education, and civic organisations that have expressed their opinions about transport system planning. Representatives of the media were selected because they follow and publicly comment on transport planning processes and outcomes. Children are one important group of people that are affected by transport planning, but their opinions would have been difficult to obtain by the questionnaire. Therefore the representatives of schools and education were selected as respondents. The civic organisations were considered as important group of stakeholders, because they generally involve people who are affected by the plans. They were

seen to represent the opinions of ordinary residents, and to have great motivation to express their views.

The above-mentioned tentative classification of the respondents was defined more closely in the analysis of responses. The new classification was based on a question that asked in which target group the respondent belonged, according to a division into 14 groups of people (see Table 9). When the differences in the divisions of the questionnaires sent were compared with the responses received, it was noticed that in several cases the primary target group defined by the respondent most probably was not the same as our preliminary definition was. Related to this, there were respondents who had stated that they belonged to more than one target group.

Total of 93 responses were received (Table 9); 31 in the Oulu region and 62 in the Helsinki Metropolitan area. The corresponding response rates were 29% in Oulu and 43% in the Helsinki Metropolitan area. In the Oulu region, 39% of the respondents and in the Helsinki Metropolitan Area, 56% of the respondents had experience in developing a transport system plan.

More than half of the respondents were between years 50–64 of age. In Oulu, there were 11 female and 20 male respondents, while in Helsinki Metropolitan Area number of female respondents was 27 and male 35.

The analysis of the survey data began by examining percentage distributions and statistical characteristics, such as mean, standard deviation, mode and median. Then the extreme opinions concerning all criteria were compared, and the differences between the groups of respondents were examined using a statistical t-test.

The main purpose of the analyses was to identify the criteria that were generally considered the most significant ones. The other aim was to find out about the differences in opinions between the different actor groups that had answered the survey. An additional aim was to find out how the opinions had changed since 1999, when a survey of similar type was conducted (Rusila 2004b). All the groups of respondents had equal weights in the analysis. The comparisons were made between the following groups:

- Oulu region, all responses vs. Helsinki Metropolitan Area, all responses
- Oulu region, actors in planning (22 people) vs. other respondents (9 people)
- Helsinki Metropolitan Area, actors in planning (35 people) vs. other respondents (27 people)
- Oulu region, actors in planning vs. Helsinki Metropolitan Area, actors in planning
- Oulu region, other respondents vs. Helsinki Metropolitan Area, other respondents
- Oulu region, all responses vs. Oulu region in 1999, all responses.

Table 9. The respondents of the internet survey in 2005, presented by the actor group. One person can belong to one or more groups.

Actor group	**Helsinki Metropolitan Area**	**Oulu**
Decision-makers	14	2
The task force for the regional structure of the Oulu region	-	6
Representatives from the neighbouring districts (Oulu or Helsinki Metropolitan Area)	-	9
Transport and land use planners	14	4
Transport services providers	2	-
Other experts in transport and community planning	10	8
Representatives of business sector	3	3
Employees in industry and trade	1	-
Health and social sector	13	3
Schools and education	4	2
Environmental protection	1	3
The media	1	2
Civic organizations	13	5
Others	5	-
Number of respondents	**62**	**31**

Because the numbers of people were very small in some groups of respondents, for example one person represented environmental protection, and 1 person the media (Table 9), the responses were divided into two groups for further analysis. These groups were the responses of 1) the 57 actors in transport system planning, and 2) 36 non-actors in transport system planning. The group of actors consisted of active participants of transport system planning. These were the decision-makers (in transport planning), the task force for the regional structure of the Oulu region, representatives from the neighbouring districts (Oulu or Helsinki Metropolitan Area), transport and land use planners and transport services providers, as well as other experts in transport and community planning. The non-actors consisted of representatives of business sector, employees in industry and trade, health and social sector, schools and education, environmental protection, the media, civic organizations and the group of other respondents than the above-mentioned.

Intermediate output: Revised list of criteria

The priorities generated with the AHP and the results of the Internet survey were used as guidelines for selection of the criteria. In this process, the most relevant criteria were selected, some new criteria were formulated and the least significant ones were completely left out of the list. This selection was based on the relative priorities, and standard deviation of the individual judgments. Based on the above-mentioned work and discussions with the steering group, a *revised version of the criteria list* was formulated. The points of discussions with the steering group had already been defined before starting the process. The meaning of these group discussions was to take the valuations of the stakeholders as thoroughly into consideration as possible. There was still a possibility for example to change one's mind after seeing the results of the analysis, and to discuss the ways in which individual respondents had understood the criteria. This resulted in some changes in the criteria list.

Case Study 1: Railway connection Seinäjoki - Oulu

The revised list of criteria was tested in the first case-study, an inter-urban railway connection between the Finnish cities of Seinäjoki and Oulu (Soul 2005b). This initial testing consisted of impact analysis of the development strategy of the railway connection.

The data was collected from the strategy and environmental assessment documents of the railway project (see Chapters 3.2 and 3.3). Some additional data about the impacts that were difficult to assess based on the existing material, was collected as expert work by a transport consultant.

In the pre-testing process, both the potential impacts and the availability of information were assessed. The data was organised according to the revised list of criteria. After these modifications, the coverage of the different types of criteria in the existing assessments was studied. The areas where there is little or no data available were also identified.

Result of this work phase: Selected list of criteria

The results of the case study, with the results of the AHP process and Internet survey were taken to the steering group for discussion, and thereafter the list of *selected criteria* was formulated.

3.4 AssessmentAid and post-testing

The two objectives of this phase of the study were 1) to propose a procedure that would facilitate the assessment of welfare impacts and thus take the values of the

planning participants into consideration, and 2) to fine-tune and finalise the suggested list of criteria for assessment of welfare impacts.

The selected list of criteria (the selection is explained in Chapter 3.3) was taken as input for the creation of the assessment procedure. This suggested procedure for combining and comparing the diverse set of welfare impacts was named as AssessmentAid. It was composed with an MCDA application called MACBETH (Measuring Attractiveness by a Categorical-based Evaluation Technique). The MACBETH approach was introduced in Chapter 2.6.4.

The criteria were yet tested with the impact assessment data from the Helsinki Metropolitan Area (see Chapter 3.2) (Transport Plan of The Helsinki Metropolitan Area; the Helsinki Metropolitan Area Council 2007a & 2007b).

This second case study (Chapter 3.2) was especially targeted to test the usability of the criteria, and the availability of relevant data. Another purpose was to test the AssessmentAid procedure, and to give recommendations about its future need for improvement. The way the resources are used or the economic efficiency of the transport options was not calculated.

The steps of the MACBETH procedure that were introduced in Chapter 2.6.4 were carried out in the following way, when AssessmentAid was created:

Structuring phase: The criteria to be used in AssessmentAid had been selected and pre-tested as described in Chapter 3.3.

Impact estimation phase: The potential welfare impacts of the second case study, the Helsinki Metropolitan Area Transport Plan 2007 were assessed against the criteria that had been defined during the structuring phase. Some missing data was amended as expert work by a transport consultant (Heltimo 2006).

The usability of the criteria was tested in the AssessmentAid application. The draft list of criteria was used in a MACBETH model.

The objectives of this phase were

1) to test the availability of impact evaluation material that could be used for assessing the welfare impacts, according to the evaluation criteria introduced in this study,
2) to estimate what kind of welfare impacts are typical for the major transport system plan,
3) to learn about the potential welfare impacts of the Helsinki Metropolitan Area Transport Plan 2007,
4) to test the validity and representativeness of the criteria; to test if there are relevant impacts that cannot be expressed by means of the list of criteria, or if there are criteria in the list that seem not be valid for assessing welfare impacts,
5) to define the amount of work required for the assessment process
6) to find out whether the AssessmentAid procedure can be carried out in a smooth and comprehensive way, and
7) to provide data for the finalisation phase about the valuations of the two different groups of people.

The AssessmentAid procedure was tested with valuations of two groups of people. As described in Chapter 3.3, the actual test group consisted of national and regional transport authorities (the so-called Helsinki test group). The reference test group contained students from the Oulu region (the Oulu test group). The purpose was to involve two groups that were in many ways different from each other. The reason was to ensure that the valuations of the groups would not be similar to each other. However, it was only tested what kind of effect the different valuations have on the outcomes of the assessment process. The impacts of the individual differencies were not analysed, and therefore it was possible to have two groups that included several differencies.

The Helsinki test group comprised of members of the project steering group and the reference group, the Oulu test group was formed by students of environmental economics in the University of Oulu. Altogether, these people represented several groups of stakeholders of transport planning, such as decision-makers, regional authorities, planning experts and the citizens affected by the planning were involved in the process.

The members of the steering group participated in the process because of their role as the key target group of the study. Also, they represented the main authorities and significant experts of Finnish transport system planning. The Oulu test group was purposefully combined by people who were anticipated to show valuations very different from those of the steering group, in order to demonstrate how different valuations can affect the outcomes of the assessment.

The above-mentioned two groups of people were different in age, experience and geographical location. However, in order to take part in the AssessmentAid process, the participants were expected to have at least basic knowledge about assessment in physical planning and the impacts of the planned solutions on humans, the environment and economy. This selection was made because the process involved complicated concepts and coping with interactions of the potential impacts.

The twelve members of the steering group were highly experienced, mainly middle-aged people living in Southern Finland. Only five members of the Helsinki test group were able to participate in the AssessmentAid session. The Oulu test group consisted of twenty graduate or postgraduate students of the total of fifty students who attended the lessons on environmental economics. The students were between 20–30 years of age, having little experience in working on the subject. However, they had experience in studies of environmental sciences and environmental economics, and represented future experts in the area. The members of the student group lived in Northern Finland. The AssessmentAid session was carried out as a lesson and an exercise as part of the course in environmental impact assessment that the students were participating in.

The AssessmentAid process was run through with both the test groups. All the participants first wrote down their own opinions about the differences in significance of the different pairs of criteria. After this, each pair of criteria was discussed in the group and a common opinion was negotiated. In this process the test group members were encouraged to express their opinions and possible disagreements.

All the opinions of the members in the test groups had equal weight in the process, no participant was considered to be more important than another. When a consensus was reached, the uniform opinion of the group about the pairwise comparisons of the different criteria was entered in the AssessmentAid model.

Finalisation phase: The results of the impact estimation phase, the potential welfare impacts of the Helsinki Metropolitan Area Transport Plan 2007, and the differences in the relative preference order of the alternatives within the plan according to the valuations of the groups were presented to the test groups, as well as to the steering group as a whole. No additional weight was put on either of the group results. Also, a sensitivity analysis was carried out. This way it could be demonstrated how the different valuations have an effect on the final outcomes of the assessment procedure. In the sensitivity analysis, the changes of the criteria weights were examined. This was done by changing the weight of one criterion at a time, and studying how it affected the total scores and the relative order of the strategy alternatives studied.

4. Research findings

4.1 Grouping for the presentation of the research findings

In Section 4, the findings of the research are presented in eight sub-chapters. These sub-chapters were formed according to the different phases of the research (Figure 6).

The pre-testing of the tentative list of criteria (Chapter 4.2) that was created based on the results of the literature survey led to selection of a variety of assessment criteria for further testing. Chapter 4.3 introduces the initial results of the pre-testing process; an AHP analysis of opinions of the steering group. The results of an Internet survey about opinions of different groups of people are presented in Chapter 4.4. The results of the above-mentioned analysis are compared with another survey that was carried out in Oulu in the year 1999 (Chapter 4.5). The list of criteria that were selected for the next step in the pre-testing process is presented in Chapter 4.6. The results of the second step of pre-testing; estimated welfare impacts of the Seinäjoki–Oulu railway connection, are described in Chapter 4.7.

Chapter 4.8 introduces the structure of the MCDA assessment tool that was formed according to the pre-testing process, as well as the findings of the post-testing process of the initial assessment criteria. The post-testing was carried out by estimating the potential welfare impacts of the 2007 Transport Plan of the Helsinki Metropolitan Area.

Finally, the main outcome of the study; the final list of criteria for the assessment of welfare impacts within transport system planning, is defined in Chapter 4.9.

4.2 The preliminary list of criteria for assessment of welfare impacts

A preliminary list of criteria (Table 10) for the assessment of welfare impacts of modifications in the transport system was created based on the literature overview (Chapter 2, Appendix 1). This version was used as a starting point for the AHP-interviews (Chapter 3.3).

The five headings of the UK Appraisal Summary Table (Table 6) were the starting point for defining the categories of welfare criteria, as well as the headings in Table 4. Tables 3, 4 and 5 were used for comparison with the results of the study.

The seven main objectives that were formulated based on the literature were '*accessibility, alternatives and options*', *'hindrance in the transport system*', '*health, safety and attractive living environment*', '*opportunities for participation and decision-making*', '*quality of life, lifestyles*', '*the nature and built environment*' and '*economic conditions*'.

The first main objective 'Accessibility, alternatives and options' refers to the external conditions and the features in the transport system that can have an effect on the ease of reaching destinations using the transport system. This objective was divided into the following five groups of criteria: external conditions for mobility, transport connections, opportunities for choosing mode of travel or transport, functionality, as well as fluency and convenience of connections.

'Hindrance in the transport system' refers for example to the existence of physical barriers that can be met in the transport system or economic usage conditions that can cause barriers for an individual to use the transport system. Within these economic hindrance criteria, the costs of purchase and operation of a vehicle were grouped in one criterion, and all other costs of travel of an individual or a group of people, or costs of freight transport were presented by 'travel costs' and 'freight transport costs'. However, the distinction between costs of operation of a means of transport and other travel or freight transport costs was not made. Therefore these criteria are somewhat overlapping and perhaps confusing. Also the level of availability, comprehensibility and reliability of information concerning the use of the transport system can make it easier or more difficult for an individual to use the transport system. In addition, the way people feel about their possibilities to use the transport system can cause psychic barriers and make it more difficult to travel or transport goods.

The third objective 'health, safety and attractive living environment' refers to impacts of transport that can either support health or be harmful for health, in addition to issues relating both to the external risk of traffic accidents and the feeling of safety, and impacts of transport that have an effect on how attractive the living environment is.

The fourth objective 'opportunities for participation and decision-making' refers to the possibilities of different groups of people to participate in the planning and decision-making concerning the transport system.

The fifth objective 'quality of life, lifestyles' refers to quality of life issues that can be affected by transport planning. In this group, there are two criteria that in further analysis were identified as overlapping ones. These are 'social interaction and networks' and 'interaction' that both mean the impact on the possibilities and ways in which people or groups of people can be in contact with each other.

The sixth objective 'the nature and built environment' refers to changes in the environment that are induced by transport. Also the impacts on the fragmentation of communities and density of housing are included in this group. A clear distinction was however not made between 'attractive living environment' in 'health,

safety and attractive living environment' and 'community structure' in 'the nature and built environment' with a result that these criteria may be overlapping and confusing.

The last of the objectives, 'economic conditions' refers to the economic preconditions of households, business sector and public sector. These preconditions change interactively with the changes in transport system, and have an effect on its planning and usage.

Table 10. The preliminary version of the criteria for welfare impacts of modifications in the transport system.

ACCESSIBILITY, ALTERNATIVES AND OPTIONS
External conditions for mobility
Regional and urban structure
Amount and quality of activities (services, housing, employment, leisure activities)
Location of activities (services, housing, employment, leisure activities)
Population size and structure
Community structure that supports public, pedestrian and bicycle transport
Land use efficiency
Opportunities for industry and commerce location (e.g. site supply)
Car dependency within communities
Transport connections
Connections to basic public and private services (shopping facilities, health services, post offices etc.)
Connections to other shops and personal business
Connections to leisure, recreation and outdoor activities
Possibilities to combine modes of transport
Connections to workplaces, schools, children's day care etc.
Business connections
Business trip connections
Transport connections to industrial locations
Goods delivery connections
Logistic chains
Connections at different times of day
Connections at different times of week
Connections at different times of year
Opportunities for choosing mode of travel or transport
Connections of bicycle and pedestrian transport
Passenger car connections
Freight transport connections (ground, water, air)
Air transport connections
Waterway connections

Public transport supply connections

Functionality, fluency and convenience of connections

Predictability and accuracy

Predictability of travel times

Functionality and fluency of trip and transport chains

Certainty of successful trip or transport

Fluency of connections

Condition of connections and maintenance

Predictability of traffic circumstances

HINDRANCE IN THE TRANSPORT SYSTEM, USABILITY OF TRANSPORT SYSTEM

Physical

Unhindered means of transport

Unhindered transport infrastructure

Obstacles caused by transport infrastructure

Unhindered construction

Quality of construction

Physical condition of transport network

Economic

Travel costs (price of the trip, parking costs, etc.)

Freight transport costs

Purchase and operation costs of means of transport

Informative

Availability of information and guidance

Comprehensibility of information and guidance

Up-to-date information and guidance

Reliability of information and guidance

Psychic

Perceived health

Experienced safety

Experienced security

HEALTH, SAFETY AND ATTRACTIVE LIVING ENVIRONMENT

Harmful to health

Traffic noise

Traffic emissions

Case specific criteria (e.g. vibration, smell)

Risk of contamination of surface and ground water

Risk of contamination of soil

Quality and cleanliness of food products

Health supporting

Possibilities for walking and cycling (everyday exercise and movement, recreation)

Perceived health impacts

Safety

Risk of accident or injury
Experienced safety *(traffic safety and general feeling of safety)*

Attractive living environment
Land use characteristics (density, fragmentation)
Satisfaction with the residential environment
Vitality of villages and population centres
Regional identity
Aesthetic quality of residential environment
Landscape, urban landscape

OPPORTUNITIES FOR PARTICIPATION AND DECISION-MAKING

Opportunities for participation in transport system planning
Opportunities for participation in transport system decision-making
Opportunities for involvement and decision-making for 'quiet' or 'weak' groups

QUALITY OF LIFE, LIFESTYLES

Attitudes, values
Relations between community members
Satisfaction with living conditions
Every day ways of living and mobility
Social interaction and networks
Interaction
Healthy way of living
Traffic behaviour

NATURE AND BUILT ENVIRONMENT

Air and climate
Emissions of greenhouse gases
Ozone depletion
Acidification
Ground and surface water
Risk of contamination of groundwater/quality of groundwater
Risk of contamination of surface water/quality of surface water
Plants and living organisms
Quantity and quality of wild regions
Territories and living conditions of plants
Territories and living conditions of animals/ecological corridors
Interaction between animals and plants
Natural diversity, biodiversity
Quantity of animal and plant species
Position of endangered species
Viability of nature
Natural resources
Exploitation of natural resources (especially non-renewable natural resources)

Energy consumption of traffic
Community structure
Fragmentation, density
ECONOMIC CONDITIONS
Households
Land price
Value of real estates
Renting expenses
Building costs
Level and structure of wealth/property
Income level and structure
Business sector
Profitability
Competition
Public sector
Market area
Logistics costs
Land price
Value of real estates
Renting expenses
Building costs

The above preliminary list of criteria was the starting point for the analysis on the criteria. This preliminary list is a summary of several lists of criteria. Similar criteria may be shown under more than one heading. This may be seen as an inconsistency in the list, but the reason was that some of the criteria did not unambiguously belong to one group. Therefore the choice of their particular location was left to be defined by the further analyses. Similarly, some criteria that were very close to each other, were left in this version of the list. For example, criteria like 'predictability and accuracy' and 'predictability of travel times' which actually do not differ much from each other are both included in 'functionality, fluency and convenience of connections'.

Travel costs, for example, or freight transport costs are put under the heading 'Economic hindrance'. Another grouping could have been that travel costs were shown in the group of criteria that represents the economic conditions of households, and freight transport costs as economic conditions of the business sector. The division in Table 10 was made because changes in economic hindrance or economic usability were considered as economic changes within the transport system, while economic conditions of households were interpreted as economic changes in the surrounding world that have an effect on the different characteristics of the transport system.

It was assumed that further analysis would show which interpretation of such criteria is the most significant. In creating this preliminary list, the main idea was that as many potential impacts as possible were included for the further selection

of the significant ones and definition of a better classification. However this list is not as comprehensive as it was meant to be. For example an important factor, the actual travel time is not represented at all, as the list includes only 'predictability of travel' time in the group 'functionality, fluency and convenience of connections'.

4.3 Selection and initial pre-testing of the criteria; Opinions of the stakeholders of the research project

The AHP was used as an instrument for structuring the preliminary list of criteria. The AHP was considered more as a tool to facilitate discussion than a method to produce final numbers. The results of the AHP process were used as a basis for discussion. The final decision on which criteria to include for the continuation of the analyses was made after discussions about the valuations of the project steering group. The AHP-process confirmed that the initial long list of criteria needed to be considerably reduced.

For all the criteria, the mean scores are presented as geometric means of the individual priorities. The individual priorities were generated with the AHP for each of the interviews separately (Table 11). The sum of the individual priorities of different criteria summed up to one within each of the seven main groups. In the following summary tables (Tables 14–20), the sum may remain a little below one, due to the use of geometric mean in defining the mean values of the individual interviews (about use of geometric mean with AHP results, see for example Saaty 2008).

The tentative rule was that a criterion was selected for further analysis if its priority was ≥0.05, and rejected if the priority was less than 0.05. However, when the first results were presented to the steering group, they did not agree on the proposed way to include or reject certain criteria, even though the analysis was based on their own expressed valuations in the AHP interviews. Therefore lively discussion was carried out about the criteria that the steering group did not agree on with the results of the preliminary analysis. At this stage, three rules were formed for including and possibly reformulating certain criteria that were not significant according to the AHP analysis (priority ≥0.05) or rejecting certain criteria despite their high priority numbers. The rules for further modifications were the following:

1) A criterion with a priority equal to or greater than 0.5 was rejected, if another similar criterion with higher priority already existed.
2) A criterion with a priority equal to or greater than 0.5 was rejected, if all the members of the steering group considered that the priority number was too high and the criterion was actually insignificant. If only a part of the group expressed this, the criterion was yet selected for further analysis.
3) A new criterion was formulated by combining 1–3 more detailed criteria.

4) A criterion with a priority less than 0.5 was selected if all the members of the steering group considered the criterion to be significant.

A total of 70 criteria were selected for further analysis in the above-mentioned process and 56 criteria were rejected. Four criteria were rejected according to the first rule, one criterion was rejected according to the second rule and six criteria according to the third rule. In addition, six criteria were selected for further testing by the fourth rule. Four new criteria were formulated during the process.

An example of the AHP-analysis for one group of criteria, 'Quality of life, life-styles' is presented in Tables 11–13.

Table 11. Pairwise comparison matrix for ‘Quality of life, lifestyles’. An example of an individual interview with pairwise comparisons between each of the criteria. The priorities were defined with the AHP-software Expert Choice (ExpertChoice 2015). (An example for reading the table; on the row ‘attitudes, values’ the column value for ‘interaction’ is 6. This means that ‘attitudes, values’ is valued strongly over ‘interaction’. Were the column value 1/6, it would show that the valuation of the row criterion is one sixth of the column criterion).

	Attitudes, values	**Interaction**	**Healthy way of living**	**Relations between community members**	**Traffic behaviour**	**Satisfaction with living conditions**	**Every day ways of living and mobility**	**Social interaction and networks**	**Calculated priorities**
Attitudes, values	1	6	6	6	5	5	3	3	0.322
Interaction	1/6	1	3	1/5	1/6	1/5	1/5	1/5	0.028
Healthy way of living	1/6	1/3	1	2	1/5	1/5	1/6	1/5	0.029
Relations between community members	1/6	5	1/2	1	2	1/6	1/5	1/3	0.046
Traffic behaviour	1/5	6	5	1/2	1	1/6	1/5	1/5	0.054
Satisfaction with living conditions	1/5	5	5	6	6	1	6	5	0.261
Every day ways of living and mobility	1/3	5	6	5	5	1/6	1	6	0.166
Social interaction and networks	1/3	5	5	3	5	1/5	1/6	1	0.095

Inconsistency = 0.23

Table 12. Geometric means of the individual priorities indicated in all the interviews for “Quality of life, lifestyles”. These values represent the comparative priority of each of the criteria.

	Priority
Attitudes, values	0.18
Interaction	0.07
Healthy way of living	0.04
Relations between community members	0.07
Traffic behaviour	0.03
Satisfaction of living conditions	0.36
Every day ways of living and mobility	0.05
Social interaction and networks	0.14

The following criteria (Table 13) were selected or rejected for ‘*Quality of life, lifestyles*’. ‘Interaction’ was rejected because there was already a strong, similar criterion ‘social interaction and networks’. These criteria were considered as overlapping ones and therefore the less significant criterion was rejected, even though its priority exceeded 0.05.

Table 13. The selected and rejected criteria for ‘Quality of life, lifestyles’.

Potential criteria	Rejected criteria
Attitudes, values *(0.18)*	Interaction *(0.07)*
Relations between community members *(0.07)*	Healthy way of living *(0.03)*
Satisfaction of living conditions *(0.36)*	Traffic behaviour *(0.03)*
Every day ways of living and mobility *(0.05)*	
Social interaction and networks *(0.14)*	

The following Tables (14–20) present which criteria were selected for further examination, and which were rejected at this stage.

The first group of criteria describing changes in ‘*accessibility, alternatives and options’* consists of four sub-groups describing the functionality and conditions of the overall transport system and mobility opportunities. The results of the analysis of this group of criteria are presented in Table 14.

The first sub-group ‘*external conditions of mobility*’ consists of factors of the external structure of society, e.g. location as well as amount and quality of different activities indicating the need and preconditions of travel. The most important condition (mean score 0.27 in Table 14) describes how the community structure supports public, pedestrian and bicycle transport.

The second sub-group ‘*transport connections*’ includes options to use transport services to reach activities, indicating how well different mobility and logistics needs can be fulfilled. From seven criteria the connections to work places, schools

and children's day care as well as to basic public and private services were found the most important with the mean scores around 0.20. Transport connections to leisure and other outdoor activities and possibility to build intermodal travel chain got very low importance around 0.05.

The third sub-group '*opportunities for choosing mode of travel (transport)*' reflects the freedom of travel choice considering different modes. The highest mean score (importance) resulted for connections of bicycle and pedestrian transport. The criteria describing connections at different times and freight transport were inserted after the AHP analysis. These new criteria were combined from three more detailed ones, which were insignificant, but it was agreed that these issues had to be included in the criteria on a more general level.

The fourth sub-group '*functionality, fluency and convenience of connections*' indicates how predictable and accurate travelling in general is. The rate of success of an individual trip or transport task is the most important criteria (0.38) in this sub-group.

Table 14. The criteria for assessment of changes in accessibility, alternatives and options for mobility. The numbers in parentheses indicate the comparative priorities generated with AHP.

ACCESSIBILITY, ALTERNATIVES AND OPTIONS	
External conditions for mobility	
Potential criteria	**Rejected criteria**
Regional and urban structure *(0.15)*	Land use efficiency *(0.04)*
Amount and quality of activities (services, housing, employment, leisure activities) *(0.14)*	Opportunities for industry and commerce location (e.g. site supply) *(0.05)*
Location of activities (services, housing, employment, leisure activities) *(0.16)*	Car dependency within communities *(0.04)*
Population size and structure (0.08)	
Community structure that supports public, pedestrian and bicycle transport *(0.27)*	
Transport connections	
Potential criteria	**Rejected criteria**
Connections to basic public and private services (shopping facilities, health services, post offices etc.) *(0.17)*	Business connections *(0.04)*
Connections to other shops and personal business *(0.11)*	Business trip connections *(0.04)*
Freight transport connections *(a new criterion, derived from three more detailed ones[1)] after the AHP)*	[1)] Transport connections to industrial locations *(0.04)*
	[1)] Goods delivery connections *(0.04)*
	[1)] Logistic chains *(0.05)*
Connections at different times of day, week and year (a new criterion, derived from three more de-	[2)] Connections at different times of day (0.04)

tailed ones [2] after the AHP analysis) Connections to leisure, recreation and outdoor activities (0.05) Possibilities to combine modes of transport (0.04) Connections to workplaces, schools, children's day care etc. (0.20)	[2] Connections at different times of week (0.04) [2] Connections at different times of year (0.05)
Opportunities for choosing mode of travel or transport	
Potential criteria	**Rejected criteria**
Connections of bicycle and pedestrian transport (0.31) Passenger car connections (0.07) Freight transport connections (ground, water, air) (0.11)	Air transport connections (0.04) Waterway connections (0.06) [3] Public transport supply connections(0.28)
Connections and supply of local public transport (a new criterion, derived to replace the rejected one according to the interviewees' comments [3] after the AHP analysis) Connections of long-distance transport (bus, rail, flight, water) (a new criterion, derived to replace the rejected one according to the interviewees' comments [3] after the AHP analysis)	
Functionality, fluency and convenience of connections	
Potential criteria	**Rejected criteria**
Predictability and accuracy (0.11) Predictability of travel times (0.15) Functionality and fluency of trip and transport chains (0.16) Certainty of successful trip or transport (0.38)	Fluency of connections (0.05) Condition of connections and maintenance (0.04) Predictability of traffic circumstances (0.07)

In the second group, *'hindrance in the transport system or the usability of the transport system*' is measured by four aspects; physical opportunity or easiness to travel, the costs of transport, information and subjective health or subjective feeling of capability to travel. The results of the analysis are given in Table 15.

For this group, it is difficult to find any powerful criterion over all the others. It is possible that there are too many criteria reflecting the same aspects of freedom to use the transport system.

There remained a possible overlap in the criteria about 'perceived health'. This criterion was included in the list for further testing in both the groups 'hindrance in the transport system, usability of the transport system' (Table 15) and 'health, safety and attractive living environment' (Table 16). However, such a distinction can be made that in the first group the criterion signifies the feeling of health of an individual and in the second group the impacts that could affect this feeling.

The criteria ‘experienced safety’ and ‘experienced security’ were removed from this group despite of their high priorities because of an overlap with another group. This aspect is represented as the criterion ‘experienced safety (traffic safety and general feeling of safety)‘, in the group ‘health, safety and attractive living environment’ (Table 16). The unanimous opinion of the steering group was to include ‘experienced safety’ in the group ‘health, safety and attractive living environment’, in order to include all safety issues under the same heading.

The criterion ‘perceived health’ is, however, included in ‘hindrance in the transport system, usability of transport system’ (Table 15) because it was considered a possible psychic hindrance experienced by an individual, and the external aspects that support the feeling of health in the transport system were identified in the group ‘health, safety and attractive living environment’ (Table 16).

Table 15. The criteria for assessment of changes in hindrances and usability of transport system. The numbers in parentheses indicate the comparative priorities generated with AHP.

HINDRANCE IN THE TRANSPORT SYSTEM, USABILITY OF TRANSPORT SYSTEM	
Physical	
Potential criteria	**Rejected criteria**
Unhindered means of transport *(0.04)*	Unhindered construction *(0.05)*
Unhindered transport infrastructure *(0.04)*	Quality of construction *(0.04)*
Obstacles caused by transport infrastructure *(0.04)*	Physical condition of transport network *(0.05)*
Economic	
Potential criteria	**Rejected criteria**
Travel costs (price of the trip, parking costs, etc.) *(0.05)*	-
Freight transport costs *(0.06)*	-
Purchase and operation costs of means of transport *(0.05)*	-
Informative	
Potential criteria	**Rejected criteria**
Availability and quality of information and guidance *(New criterion, combined from three more detailed ones[4] after the AHP analysis)*	[4]Availability of information and guidance *(0.02)* [4]Comprehensibility of information and guidance *(0.02)* [4]Up-to-date information and guidance *(0.03)* [4]Reliability of information and guidance *(0.04)*

Psychic	
Potential criteria	**Rejected criteria**
Perceived health *(0.13)*	Experienced safety *(0.14)* Experienced security *(0.11)*

The criteria that define how the living environment contributes to the '*health, safety and attractiveness of the living environment*' fall into four sub-groups (Table 16). However, none of the criteria that were either supporting of harmful to health, or indicated the attractiveness of the living environment proved to be important. The most important criterion in this group was experienced safety.

Table 16. The criteria for assessment of changes in health, safety and attractive living environment. The numbers in parentheses indicate the comparative priorities generated with AHP.

HEALTH, SAFETY AND ATTRACTIVE LIVING ENVIRONMENT	
Harmful to health	
Potential criteria	**Rejected criteria**
Traffic noise *(0.09)* Traffic emissions *(0.04)* Case specific criteria (e.g. vibration *(0.01),* smell *(0.03),* other unhealthy) Risk of contamination of surface and ground water *(0.05)*	Risk of contamination of soil *(0.02)* Quality and cleanliness of food products *(0.03)*
Health supporting	
Potential criteria	**Rejected criteria**
Possibilities for walking and cycling (everyday exercise and movement, recreation) *(0.07)*	-
Perceived health impacts *(0.05)*	-
Safety	
Potential criteria	**Rejected criteria**
Risk of accident or injury *(0.04)* Experienced safety *(traffic safety and general feeling of safety) (*0.10)	- -
Attractive living environment	
Potential criteria	**Rejected criteria**
Land use characteristics (density, fragmentation) (0.08) Satisfaction with residential environment (0.09)	Aesthetic quality of residential environment (0.03) Landscape, urban landscape (0.03)

Vitality of villages and population centres (0.08) Regional identity (0.04)	

Involvement in planning and opportunity to participate in the decision-making of the transport system are often seen as significant aspects of sustainability (Table 17). Two potential criteria were selected in this group; 'opportunity to participate in planning' and 'opportunity to participate in decision-making', which were seen as equally important.

Basically, three criteria were included into the interviews and two criteria, 'planning of transport system or residential environment" and 'involvement in decision-making' were subtracted. These two criteria were omitted from the list already before the AHP interviews, as they were already included in the two other criteria within this group. Also, 'opportunities for involvement and decision-making for 'quiet' or 'weak' groups' was rejected after the AHP analysis despite of its high priority, because it was actually already included in 'opportunities for participation in transport system planning' and 'opportunities for participation in transport-system decision-making' (of all groups of people).

Table 17. The criteria for assessment of changes in opportunities for involvement and decision-making. The numbers in parentheses indicate the comparative priorities generated with AHP.

OPPORTUNITIES FOR PARTICIPATION AND DECISION-MAKING	
Potential criteria	**Rejected criteria**
Opportunities for participation in transport system planning (0.25)	Planning of transport system or residential environment *(Rejected unanimously by the steering group before AHP analysis)*
Opportunities for participation in transport system decision-making (0.26)	Involvement in decision-making *(Rejected unanimously by the steering group before AHP analysis)*
	Opportunities for involvement and decision-making for 'quiet' or 'weak' groups (0.22)

As was shown in the example in Tables 12 and 13, the fifth group '*quality of life and lifestyles'* consists of five criteria reflecting the aspects of individual satisfaction of living conditions (Table 18). The individual 'satisfaction of living conditions' was expressed as the most important criterion by the interviewees (0.36).

Other accepted criteria were 'changes in attitudes and values', and 'social relations between community members and within networks'. 'Interaction' was rejected, although its priority exceeded 0.05, because the same criterion was already included as 'social interaction and networks'.

Table 18. The criteria for assessment of changes in the quality of life and life-styles. The numbers in parentheses indicate the comparative priorities generated with AHP.

QUALITY OF LIFE, LIFESTYLES	
Potential criteria	**Rejected criteria**
Attitudes, values *(0.18)*	Interaction *(0.07)*
Relations between community members *(0.07)*	Healthy way of living *(0.03)*
Satisfaction with living conditions *(0.36)*	Traffic behaviour *(0.03)*
Every day ways of living and mobility *(0.05)*	
Social interaction and networks *(0.14)*	

The group '*nature and built environment*' includes criteria generally used in practice for evaluating the environmental impacts of transport projects and policies (Table 19). The indicators for some criteria may be difficult to quantify or even describe for minor-scale projects, e.g. emissions or greenhouse gases. Within this group, the use of a large number of criteria forced all mean scores low, and this makes it somewhat difficult to assess the relative significance of the criteria. The highest score was given for 'viability of nature'. 'Territories and living conditions of plants' was not selected as a potential criterion, because it was seen as a part of 'quality and quantity of wild regions'.

Energy consumption of traffic was rejected as environmental criterion. However two criteria that concern the same issue on environmental viewpoint were left in the list. These criteria were 'exploitation of (non-renewable) resources' and 'emissions of greenhouse gases'. However, no criterion that would include the economic perspective point of view of energy consumption was left in the list.

Table 19. The criteria for assessment of changes in nature and built environment. The numbers in parentheses indicate the comparative priorities generated with AHP.

NATURE AND BUILT ENVIRONMENT	
Air and climate	
Potential criteria	**Rejected criteria**
Emissions of greenhouse gases *(0.07)*	Ozone depletion *(0.04)*
	Acidification *(0.04)*
Ground and surface water	
Potential criteria	**Rejected criteria**
Risk of contamination of groundwater/quality of groundwater *(0.10)*	Risk of contamination of surface water/quality of surface water *(0.04)*
Plants and living organisms	
Potential criteria	**Rejected criteria**
Quantity and quality of wild regions *(0.06)*	Territories and living conditions of plants

	(0.05) Territories and living conditions of animals/ecological corridors *(0.04)* Interaction between animals and plants *(0.04)*
Natural diversity, biodiversity	
Potential criteria	**Rejected criteria**
Quantity of animal and plant species *(0.06)*	-
Position of endangered species *(0.03)*	-
Viability of nature *(0.14)*	-
Natural resources	
Potential criteria	**Rejected criteria**
Exploitation of natural resources (especially non-renewable natural resources) *(0.05)*	Energy consumption of traffic *(0.02)*
Community structure	
Potential criteria	**Rejected criteria**
-	Fragmentation, density *(0.03)*
-	Buildings, landscape, urban landscape, cultural heritage *(Rejected unanimously by the steering group before AHP analysis)*

The group '*economic conditions'* reflects more the general premises of welfare than any direct monetary consequences of the transport projects (Table 20). However, these criteria can be used in assessing how economically realistic and feasible the transport system is. In this evaluation, the indirect impacts of changes in the transport system on the indicators measuring the economic well-being of citizens, enterprises and public organisations need to be taken into account.

No criteria were left in 'economic preconditions' that would describe community structure, but these are present as external conditions for mobility in 'accessibility, alternatives and options'.

Table 20. The criteria for assessment of changes in economic conditions. The numbers in parentheses indicate the comparative priorities generated with AHP.

ECONOMIC CONDITIONS	
Households	
Potential criteria	**Rejected criteria**
Land price *(0.07)*	-
Value of real estates *(0.09)*	-
Renting expenses *(0.11)*	-
Building costs *(0.07)*	-
Level and structure of wealth/property *(0.18)*	-
Income level and structure *(0.19)*	-

Business sector	
Potential criteria	**Rejected criteria**
Profitability *(0.07)*	Market area *(0.02)*
Competition *(0.04)*	Logistics costs *(0.02)*
Public sector	
(*Most of these criteria were generated only after the AHP analysis, as the interview and AHP process showed that there is need to include public sector economic criteria in the list, but the initially suggested ones turned out as insignificant)*	
Potential criteria	**Rejected criteria**
Public transport expenditures *(New)*	Other investment needs *(New)*
Capital value of transport system *(New)*	General economic growth (output, tax incomes) *(New)*
Operational preconditions for new business *(New)*	Labour supply *(New)*
Locational advantages of region, community or city (concering housing, industries, trade, tourism) *(New)*	Tax revenues *(New)*
	Productivity in other sectors in economy *(New)*
	Land price *(0.02)*
	Value of real estates *(0.02)*
	Renting expences *(0.01)*
	Building costs *(0.02)*

The interviewees considered all criteria related to individuals (household sector) more important than those related to business and public sector. Within criteria reflecting the individual economic welfare, income and wealth have a higher score than the other ones. After the AHP analysis, eight new and more representative criteria were generated to describe the economic conditions of the public sector, and four of these were selected.

4.4 Opinions of actors and non-actors in transport planning within Oulu region and Helsinki Metropolitan Area

An overview of the results of the Internet survey (see Appendices B&C for more)

A total of 93 responses were received from the Internet survey. In the Helsinki Metropolitan Area, 62 people responded to the survey and the corresponding figure in the Oulu region was 31 people.

The first analysis of the Internet survey was to study the basic statistical figures of the responses (Table 21). This was done separately for the Oulu region and the Helsinki Metropolitan Area. The respondents seemed to consider most of the criteria quite significant. On the scale of 0 to 8, the mean values of the individual criteria mainly exceeded 5.

In the Oulu region, the most diverse opinions concerned the importance of 'social interaction and networks' and the following criteria that describe the economic conditions of private sector economics: 'value of real estates', 'building costs', 'level and structure of wealth/property', as well as 'income level and structure'. Correspondingly, the largest deviation in the stated importance in the Helsinki Metropolitan Area occurred for 'perceived health' and the following criteria that describe the economic conditions of private sector economics: 'land price', 'renting expenses' and 'level and structure of wealth/property'.

The opinions of the respondents in the Oulu region were closest to each other on the importance of the criteria 'connections to workplaces, schools, children's day-care', 'connections of bicycle and pedestrian transport', and 'functionality and fluency or trip and transport'. In the Helsinki Metropolitan Area, the smallest variation was shown for the criteria 'regional and urban structure' and 'operational preconditions for new business'.

An analysis was carried out to obtain an idea on whether the criteria were thought to be very significant or rather insignificant. The more detailed results of this analysis are presented in Appendix C.

Table 21. Mean values and standard deviations of the responses to the internet survey in the Oulu region and Helsinki Metropolitan Area.

	Oulu region		Helsinki Metropolitan Area	
Criterion	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Accessibility Regional and urban structure	7.0	1.4	7.3	0.9
Amount and quality of activities (services, housing, employment, leisure activities)	6.9	1.0	6.9	1.1
Location of activities (services, housing, employment, leisure activities)	6.9	1.3	7.0	1.0
Population size and structure	6.7	1.4	6.6	1.3
Community structure that supports public, pedestrian and bicycle transport)	7.1	1.2	7.1	1.0
Connections to basic public and private services (shopping facilities, health services, post offices etc.)	6.9	1.0	7.1	1.0
Connections to other shops and personal business	6.1	1.3	6.0	1.5
Connections to workplaces, schools, children's day-care etc.	6.9	0.9	6.8	1.1
Connections to leisure activities	5.2	1.5	5.6	1.4
Possibilities to combine modes of transport	5.8	1.4	6.2	1.3
Freight transport connections	5.6	1.6	5.2	1.5
Connections at different times of day, week and year	5.5	1.2	6.1	1.2
Connections and supply of local public transport	6.9	1.0	6.8	1.0
Connections of long-distance transport	5.8	1.4	5.5	1.4
Connections of bicycle and pedestrian transport	7.1	0.8	6.7	1.1
Passenger car connections	6.6	1.3	6.0	1.4
Air, waterways and surface transport connections	6.0	1.3	5.6	1.3
Predictability and accuracy	6.2	1.4	6.4	1.2

	Oulu region		Helsinki Metropolitan Area	
Criterion	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Predictability of travel times	5.9	1.3	6.0	1.5
Functionality and fluency of trip and transport chains	6.4	0.9	6.3	1.3
Certainty of successful trip or transport	6.4	1.4	6.3	1.3
Hindrance in the transport system, usability of transport system				
Unhindered means of transport	6.2	1.4	6.6	1.1
Unhindered transport infrastructure	6.1	1.4	6.3	1.4
Obstacles caused by transport infra-structure	6.4	1.3	6.2	1.5
Condition of connections and maintenance	6.4	1.5	6.3	1.2
Travel costs	6.7	1.4	6.4	1.4
Freight transport costs	6.6	1.1	5.7	1.4
Purchase and operation costs of the means of transport	5.4	1.7	5.4	1.7
Availability and quality of information and guidance	5.9	1.5	5.9	1.5
Perceived health	6.0	1.6	6.0	1.8
Health, safety and attractive living environment	6.5	1.2	6.7	1.1
Traffic noise				
Traffic emissions	6.6	1.3	6.7	1.2
Case specific criteria (e.g. vibration, smell, other unhealthy)	6.0	1.3	5.8	1.4
Risk of contamination of surface and ground water	6.7	1.5	6.9	1.2
Possibilities for walking and cycling	7.0	1.0	6.9	1.1
Perceived health impacts	6.2	1.4	6.2	1.7
Risk of accident or injury	7.0	1.3	7.0	1.1
Experienced safety	6.7	1.1	6.6	1.1
Land use characteristics (density, fragmentation)	6.5	1.3	6.0	1.6
Satisfaction with residential environ-ment	6.6	1.3	6.4	1.6
Vitality of villages and population centres	6.7	1.1	6.5	1.3

	Oulu region		Helsinki Metropolitan Area	
Criterion	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Regional identity	6.2	1.7	6.1	1.4
Opportunities for participation and decision-making				
Opportunities for participation in transport system planning	5.7	1.5	5.9	1.5
Opportunities for participation in transport system decision-making	5.4	1.9	5.6	1.6
Quality of life, lifestyles Attitudes, values	5.6	1.9	6.2	1.3
Relations between community members	5.1	1.8	5.8	1.3
Satisfaction with living conditions	5.2	1.8	6.0	1.6
Every day ways of living and mobility	6.6	1.0	6.7	1.1
Social interaction and networks	5.5	2.0	5.8	1.4
The nature and built environment				
Emissions og greenhouse gases	5.7	1.8	6.2	1.5
Risk of contamination of groundwater /quality of groundwater	7.0	1.4	6.9	1.0
Quantity and quality of wild regions	5.8	1.5	6.2	1.2
Quantity of animal and plant species	5.5	2.0	5.7	1.6
Viability of nature	6.0	1.9	6.3	1.2
Exploitation of natural resources (especially non-renewable natural resources)	5.9	1.9	6.5	1.4
Economic conditions				
Public transport expenditures	6.5	1.2	6.7	1.3
Public sector; capital value of the transport system	6.5	1.2	6.8	1.2
Public sector; other investment needs	6.1	1.4	6.2	1.2
Productivity in other sectors in the economy	5.8	1.5	5.9	1.3
General economic growth (output, tax incomes)	5.8	1.7	6.1	1.3
Labour supply	5.4	1.8	5.9	1.5
Operational preconditions for new business	6.2	1.5	6.3	0.9
Locational advantages of a region,	6.4	1.3	6.4	1.1

Criterion	Oulu region		Helsinki Metropolitan Area	
	Mean	Standard deviation	Mean	Standard deviation
community or city (concerning housing, industries, trade, tourism)				
Private sector; land price	5.9	1.7	5.9	1.9
Private sector; value of real estates	5.6	2.0	6.1	1.7
Private sector; renting expenses	5.4	1.9	5.7	1.8
Private sector; building costs	5.3	2.0	5.9	1.7
Private sector; level and structure of wealth/property	4.9	2.0	5.4	1.8
Private sector; income level and structure	4.8	2.0	5.5	1.7
Business sector; profitability	6.1	1.6	5.9	1.6
Business sector; competition	6.0	1.6	5.9	1.5

Comparison geographically and between different actor groups

After the tentative analysis by sub-groups, the average significances and ranges of variation of each criterion were studied. According to the analysis of the mean values, the smallest differences (difference in mean less than 0.05) between the Oulu region and the Helsinki Metropolitan Area were in the following criteria:

- 'amount and quality of activities (services, housing, employment, leisure activities)'
- 'community structure that supports public, pedestrian and bicycle transport'
- 'connections to other shops and personal business'
- 'availability and quality of information and guidance'
- 'perceived health'
- 'traffic emissions'
- 'perceived health impacts'
- 'risk of accident or injury'
- 'risk of contamination of ground water / quality of ground water'
- 'locational advantages of a region, community or city (concerning housing, industries, trade, tourism)'.

Similarities and differences between the respondent groups

The similarities and differences between the groups of actors and the two geographical locations were studied using two-tailed t-test. This test indicated the probability of uniform responses between the groups in question. The purpose of this analysis was to find out whether there exists unanimity or conflicting views either geographically or between the actors and non-actors in transport planning. A summary table of the analyses is presented in Appendix C. The following three different groupings were used:

– actors in transport planning / non-actors in transport planning

– all Oulu respondents / all Helsinki Metropolitan Area respondents
– actors in transport planning, Oulu / actors in transport planning, Helsinki Metropolitan Area.

According to the analysis of the uniformity of the responses, there were a total of 21 criteria out of 52, about which no disagreement was shown. There were 15 criteria, of which all respondents in Oulu and all respondents in Helsinki agreed on. However, the analysis showed that conflicts occurred actually for a total of 31 criteria. Even 19 criteria showed conflicts geographically, either between all respondents in Oulu and all respondents in Helsinki or between the actors in transport planning in Oulu and the actors in Helsinki. There was contradiction between the actors in transport planning and the non-actors about 17 criteria.

The analysis of differences between the respondent groups (see Appendix C) showed that the criteria about which the respondents agreed in the Helsinki MA were 'external conditions for mobility' and in the Oulu region 'opportunities for choosing mode of travel or transport'.

As shown in Figure 9, the individual criteria that all the respondents agreed on are 'Connections to other shops and personal business (mean 6)' and 'Private sector; land price (mean 6)'. Completely conflicting views were expressed about 'Satisfaction of living conditions (mean 5)' and 'Private sector; building costs (mean 5)'.

The actors in transport planning had similar opinions with the non-actors about the following three criteria: 'Functionality and fluency of trip and transport chains (mean 6)', ' Unhindered transport infrastructure' (mean 6) and 'Traffic noise (mean 7)'. In the opinions between the actors and non-actors that differed the most contradictions were expressed for the following criteria: 'Freight transport connections (mean 5)', 'Air, waterways and surface transport connections (mean 6)', 'Satisfaction of living conditions (mean 6)' and 'Public transport expenditures (mean 7)'.

As a result of the analysis of uniformity between the respondent groups, it could be concluded that there are major differences both geographically and between the actors and non-actors in transport planning. This supports the view that actually more than one list of criteria for different geographical locations would be applicable. However this change would have required additional resources and collection of supplementary data, which was not feasible at this stage of study. Therefore only one general list of criteria is defined in this study, and an idea of refinement of it is suggested for future research.

The differences between the actors in transport planning and the non-actors in transport planning emphasise the need to involve all potential stakeholders in the assessment process. The results about the differences in opinions were presented to and thoroughly discussed with the steering group, so that both the criteria that were highlighted in this analysis, and the idea of differences between the different groups of respondents could be taken into account in the process of selecting the list of criteria for future testing.

	Actors in transport planning, Oulu / Actors in transport planning, Helsinki MA	All Oulu respondents / All Helsinki MA respondents	Actors in transport planning / Non-actors in transport planning
Private sector; land price			
Connections to other shops and personal business			
Risk of contamination of ground water / quality of ground water			
Purchase and operation costs of the means of transport			
Availability and quality of information and guidance			
Functionality and fluency of trip and transport chains			
Perceived health			
Regional identity			
Population size and structure			
Case specific criteria (e.g. vibration, smell, other unhealthy)			
Opportunities for participation in transport system planning			
Amoint and quality of activities (services, housing, employment, leisure activities)			
Perceived health impacts			
Risk of accident or injury			
Opportunities for participation in transport system decision-making			
Traffic emissions			
Connections to workplaces, schools, children's daycare			
Operational preconditions for new business			
Daily ways of living and mobility			
Transport noise			
Barriers in transport infrastructure			
Locational advantages of a region, community or city (housing, industries, trade, tourism)			
Condition of connections and maintenance			
Productivity of other sectors in the economy			
Connections and supply of local public transport			
Obstacles caused by transport infrastructure			
Experienced safety			
Business sector; competition			
Community structure that supports public, pedestrian and bicycle transport			
Possibilities to combine modes of transport			
Private sector; building costs			
Satisfaction with living conditions			
Private sector; income level and structure			
Connections at different types of day, week and year			
Social interaction and networks			
Labour supply			
Connections of bicycle and pedestrian transport			
Land use characteristics (density, fragmentation)			
Exploitation of natural resources (especially non-renewable natural resources)			
Unhindered means of transport			
Transport costs			
Passenger car connections			
Attitudes and values			
Freight transport connections			
Air, waterways and surface transport connections			
Viability of nature			
Green house effect			
Quantity and quality of wild regions			
Certainty of successfull trip or transport			
Public sector; capital value of the transport system and transport expenditures			
Public transport expenditures			
Quantity of animal and plant species			
		Similar opinions about significance	
		Conflicting opinions	

Figure 9. Comparison of the uniformity of the responses of the different respondent groups. The empty cells express that the opinions somewhat varied, but were not yet conflicting. (Values derived with t-test, indicating the probability of agreement in the significance of the criteria. Similar opinions, ($p \leq 0.25$), conflicting options, $p \geq 0.75$).

4.5 A brief comparison with a previous survey

The results of the Internet survey were compared with a previous survey that was carried out in the Oulu region in 1999. The survey was part of my licentiate thesis, in which I defined the first ideas for the approach to assess the welfare impacts within strategic transport system planning (Rusila 2004a, b). This postal survey included similar groups of actors and questions to the current Internet survey (see Rusila et al. 2003). The objective of this brief comparison was to find out whether there had been changes in the opinions during the past six years, and to study whether the results of the previous study supported the findings of the more recent Internet survey. The total number of responses was 79. Some respondents were the same as before, but there were also new ones answering the survey.

The criteria of both the studies were put side by side where applicable. Some of the criteria had to be left out, as there were no corresponding criteria in the two datasets. Also, some of the criteria were slightly modified, mainly in the 1999 data.

Both mean and mode numbers were calculated from the data. The mean is the average of the numbers, calculated by adding up all the responses concerning one criterion, and dividing this sum by the number of responses. The mode was defined by selecting the number that occurred most often in the responses. In general, the values given in the 2005 survey were higher than the ones in 1999 (Table 22). The mean of all the mean values was 6 in 2005 and 5 in 1999. The mean of all the mode values was 7 in 2005 and 6 in 1999.

Table 22. Criteria that were the most significant in the 1999 postal survey and 2005 Internet survey (mean value 6, 7 or 8).

	Internet survey in 2005 (93 responses)			Postal survey in 1999 (79 responses)		
	% of responses with value over 6	Mean	Mode	% of responses with value over 6	Mean	Mode
Connections to basic private and public services	100	7	8	95	6	7
Connections to other shops and personal business	73	6	6	95	6	7
Connections to workplaces, schools, children's day-care etc.	100	7	7	95	6	7
Connections and supply of local public transport	100	7	8	95	6	7
Bicycle and pedestrian connections	100	7	8	95	6	7
Passenger car connections	89	7	6	95	6	7
Air, waterways and surface transport connections	72	6	6	95	6	7
Traffic noise	90	7	7	91	6	7
Possibilities for walking and cycling	100	7	7	95	6	7
Risk of accident or injury	100	7	8	90	6	8
Satisfaction of residential environment	90	7	8	81	6	6
Public sector, transport expenditures	90	7	7	96	6	8
Public sector, capital value of the transport system and needs for investments in it	97	6	6	96	6	8

4.6 The criteria that were selected for further testing

The analyses of the basic statistical figures, extreme opinions and opinions of the respondent groups were used to select the most important criteria. It was supposed that the criteria that different groups of respondents thought to be important represent the preconditions for welfare. However, regional differences had to be considered, and some criteria that were very important in some areas only were taken into the list for future considerations.

More than half of the significant criteria in the 1999 and 2005 surveys represented different aspects of accessibility. This justified the decision to include the accessibility criteria in the 2005 survey in more detail than in the 1999 survey. Other criteria significant in both the surveys were 'traffic noise', 'risk of accident or injury', 'satisfaction of residential environment' and 'freight transport costs'. In general, the expressed values of importance were higher in the 2005 than in the 1999 survey.

The approach of the study seemed successful in revealing the opinions of the interviewed experts and decision-makers about the importance of the large number of welfare criteria related to the evaluation of the impacts of the changes in the transport system. The active involvement of the project steering group was significant at every stage of the process. This involvement both provided ideas and extensive expertise on the contents of the list of criteria, and ensured a user-oriented approach as well as consideration of the end-users' needs in the creation of the assessment tool.

Even after the AHP-process, the list of evaluation criteria still had some overlaps. In addition, some of the criteria were difficult to evaluate or even verbally describe. Also, this version of the list of criteria was too long and quite complex. The challenge left for the next phases of the work was therefore to modify the list to include the most relevant criteria, and to define indicators that can be measured with reasonable resources.

It could be assumed that the geographical location of Oulu, long distances and the more diverse community structure than in the Helsinki MA have on effect on the expressed significance of the assessment criteria. Passenger car connections and transport costs as well as quality of land use are thought to have an effect on the preconditions for welfare, whereas in the Helsinki MA the most significant criteria are connected to living conditions and relations between community members. The economic preconditions are valued higher in the Helsinki MA than in the Oulu region, as well as use of natural resources and connections at different times of day, week and year. These differences can be explained by that there is plenty of nature and space for everybody in the Oulu region, and people may take those for granted. In the Helsinki Metropolitan Area, the above-mentioned resources are scarcer, which may result in higher values of importance.

Based on the Internet survey and the AHP interviews of the stakeholders, the list of assessment criteria was modified in the following way:

- *for further testing were selected (Table 23):* the criteria that were
  - according to the Internet survey; important either in Helsinki MA or Oulu region
  - significant in the AHP analysis
- *removed from the list were (Table 24):* the criteria that were of little importance in both the AHP analysis and the Internet survey.

Table 23. The most important criteria according to the Internet survey and AHP-analysis, agreed both by the respondents in Oulu and in Helsinki Metropolitan area. These criteria were selected for further testing.

Sub-group of criteria	Criterion
1. Accessibility, alternatives and options	
	Certainty of successful trip or transport
	Connections to basic public and private services (shoping facilities, health services, post offices etc.)
	Regional and urban structure
	Location of activities (services, housing, employment, leisure activities)
	Connections to workplaces, schools, children's day care etc.
	Conditions of connections, level of maintenance
	Local public transport connections and supply
	Connections of bicycle and pedestrian transport
	Amount and quality of activities (services, housing, employment, leisure)
	Community structure that supports public, pedestrian and bicycle transport
	Population size and structure
	Functionality and fluency of trip and transport chains
2 Physical, informative, economic or mental barriers	
	Travel costs (price of the trip, parking costs, etc.)
	Barriers in the transport infrastructure
3 Quality of life, lifestyles	
	Every day ways of living and mobility
	Satisfaction with living conditions
5. Health, safety and satisfaction with living environment	
	Perceived health impacts
	Vitality of town centres, villages and other population centres
	Perceived safety
	Traffic noise
	Traffic emissions
	Risk of accident or injury
6. Environment and build environment	
	Risk of contamination of groundwater / Quality of groundwater
	Risk of contamination of surface- or groundwater
7. Economic preconditions	
	Public sector; other investment needs (than transport)
	Capital value of transport system, investments on the transport system
	Locational advantages of region, community or city (concerning housing, industries, trade, tourism)
	Public expenditure (special groups of people, health sector, school transport)

A total of 17 criteria were removed from the list of assessment criteria (Table 24). Even five of these removed criteria represented private sector economy, and four were about different types of transport connections.

'Accessibility, alternatives and options' remained the largest group of criteria. No criteria that would represent freight transport or long distance transport were left in this group. In the sixth sub-group 'environment and build environment', only two criteria were included, both describing the risk of contamination of water resources. However two environmental criteria were included in 'health'; 'traffic noise and 'traffic emissions'. Also two criteria that describe safety were included in 'health'. No criteria that represented opportunities to participate in planning and social interaction were included in the list. After the changes no criteria that would describe the economic preconditions of the private sector were left in the list of selected criteria.

Table 24. The assessment criteria that were not significant in the AHP analysis or in the Internet survey.

	Criteria removed from the list of criteria
1.	Private sector; building costs
2.	Private sector; value of real estates
3.	Labour supply
4.	Social interaction and networks
5.	Emissions of greenhouse gases
6.	Private sector; renting expenses
7.	Opportunities for participation in transport system planning
8.	Quantity of animal and plant species
9.	Private sector; income level and structure
10.	Case specific criteria (e.g. vibration, smell, other unhealthy)
11.	Private sector; level and structure of wealth / property
12.	Opportunities for participation in transport system decision-making
13.	Purchase and operation costs of the means of transport
14.	Air, waterways and surface transport connections
15.	Connections to leisure activities
16.	Connections of long-distance transport
17.	Freight transport connections

4.7 Estimated welfare impacts of the Seinäjoki–Oulu railway connection

The list of criteria was pre-tested with the impact assessment data of the development strategy of the Seinäjoki-Oulu railway connection, as described in Chapters 3.2 and 3.3. The purposes of the practical testing of the criteria were to

1) find out whether the list of criteria includes necessary elements for assessing the welfare impacts of changes in the transport system
2) test the validity and representativeness of the criteria
3) discover the availability of data for the assessment of welfare impacts
4) outline the possible grouping of the criteria, for example according to geographical location or different groups of people.

In general, the welfare impacts of the project appeared to be positive (Figures 10, 11 & 12). Traffic noise and health impacts were evidently the most negative impacts of modifications in the transport system. Unfortunately, the data did not allow estimation of how the prerequisites for welfare would be realised for different groups of people. The impacts on for example attitudes, feelings of safety and attractiveness of the living environment could have been examined, had there been a possibility to carry out interviews or focus group discussions. However, public participation had been ensured throughout the planning process, which was taken into account in the strategy documents.

The welfare impacts that were somehow derived from the changes in traffic behaviour or direct changes in the transport system were the easiest ones to assess. Such impacts included 'accessibility', 'physical, informative, economic or mental barriers' and 'environment'. The easiest data available concerned impacts on accessibility, different types of barriers for mobility and the environment (Figures 10, 11 & 12). Also, some new criteria emerged in the testing process. The ways to measure the impacts are presented in Appendix D.

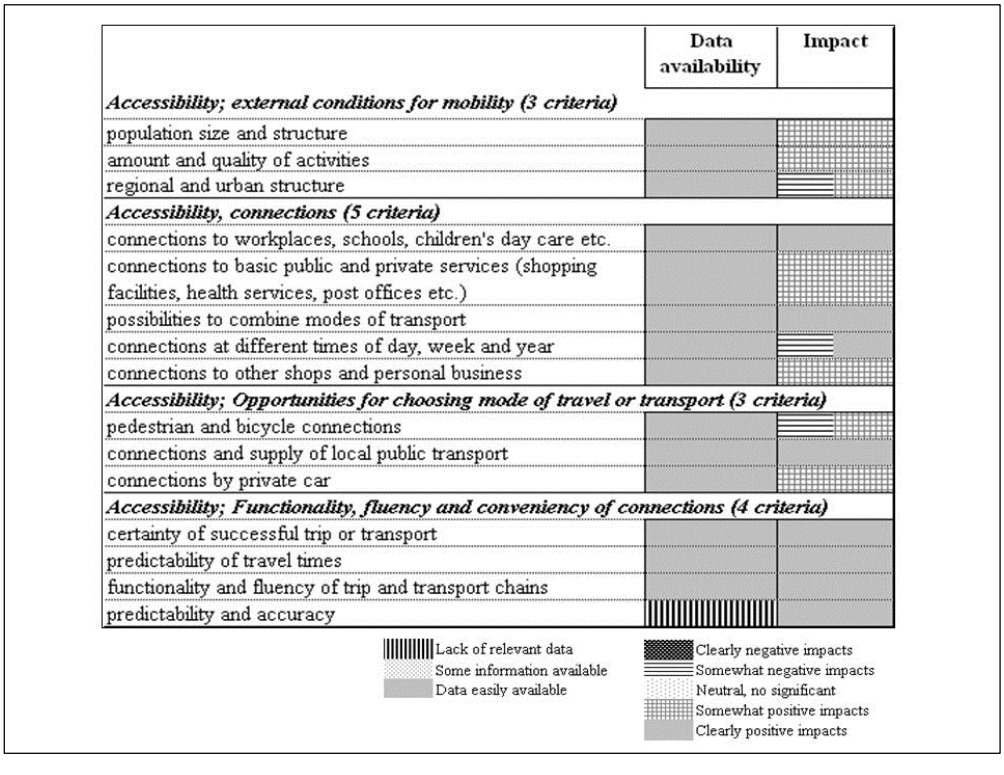

Figure 10. Data availability of the improvements in the Seinäjoki–Oulu railway connection and the estimated general impacts on accessibility.

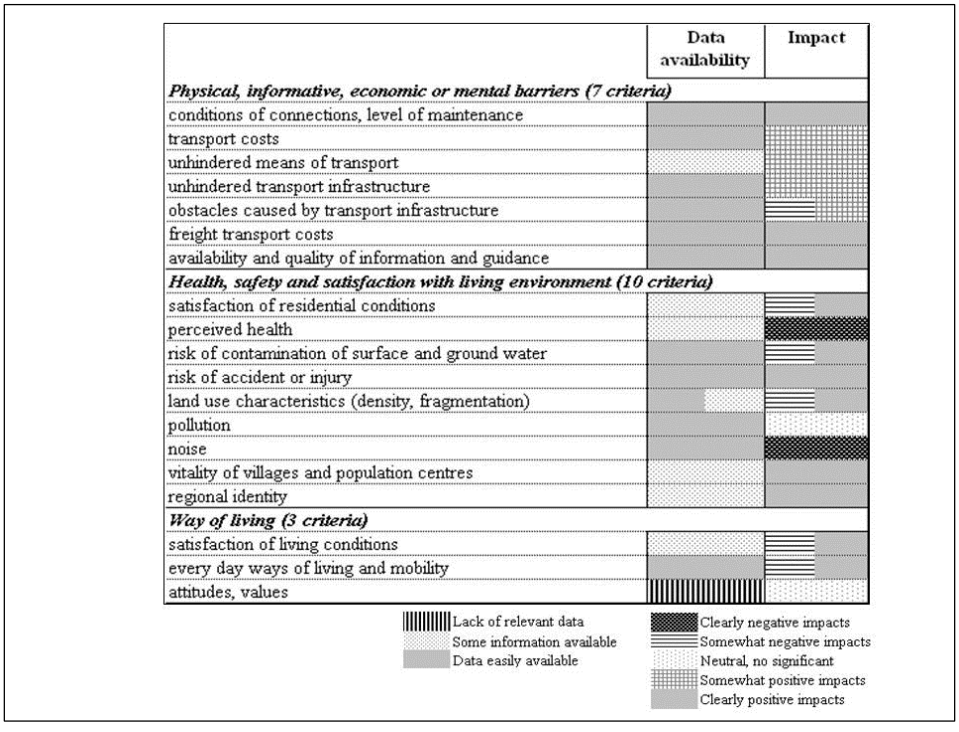

Figure 11. Data availability of the improvements in the Seinäjoki–Oulu railway connection and the estimated general impacts on barriers, health, safety and satisfaction on the living environment, as well as impacts on the way of living.

The analyses presented above provided the following input for the four purposes that were posed in the beginning of this chapter:

- According to the study, the list included necessary elements for assessing the welfare impacts of changes in the transport system.
- The impacts could be assessed in other ways, but there was lack of data concerning attitudes and values, as well as competition in the business sector and other investment needs in the public sector.
- The estimation of how the prerequisites for welfare would be realised for different groups of people was not possible, due to data restrictions. The resulting classification was to divide the criteria under six sub-groups; 'Accessibility', 'Health', Safety and security', Quality of life', 'Environment' and 'Economic conditions' (see Chapter 4.6 for the tentative grouping of the criteria).
- In addition, the tentative indicators used for the impact estimation were defined (Appendix D).

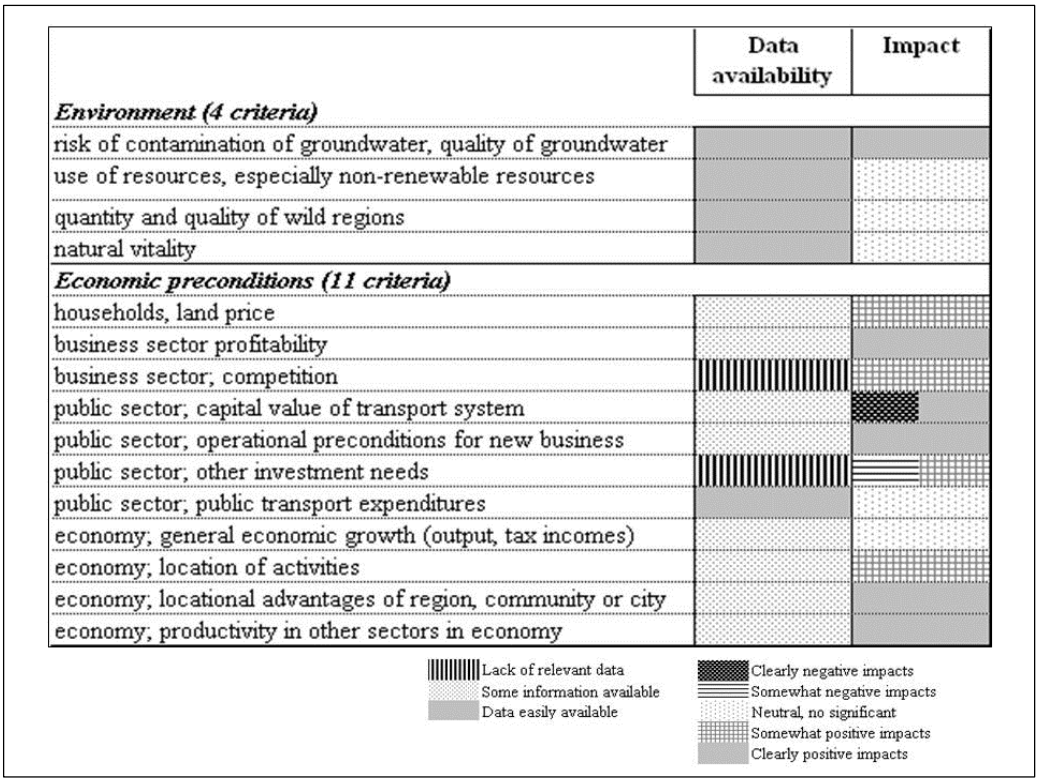

Figure 12. Data availability of the improvements in the Seinäjoki–Oulu railway connection and the estimated general impacts on the environment and economic preconditions.

4.8 AssessmentAid and post-testing of the criteria

4.8.1 Structure and process of AssessmentAid

The findings of the pre-testing of the assessment criteria (described in Chapters 4.2 to 4.7) were used for structuring the assessment tool (modified from Table 23) that will be further called AssessmentAid. AssessmentAid is a MCDA analysis process conducted using the MCDA application MACBETH (Chapter 2.6.4).

AssessmentAid consists of fifteen assessment criteria that are structured by six sub-objectives under the general objective of promoting the preconditions for welfare (Figure 13). The final criteria under the fine-tuned sub-groups are introduced in Table 28. The structure of AssessmentAid is based on the results of the AHP analysis (Chapter 4.3), Internet survey (Chapter 4.4 and 4.5) and several discussions with the stakeholders.

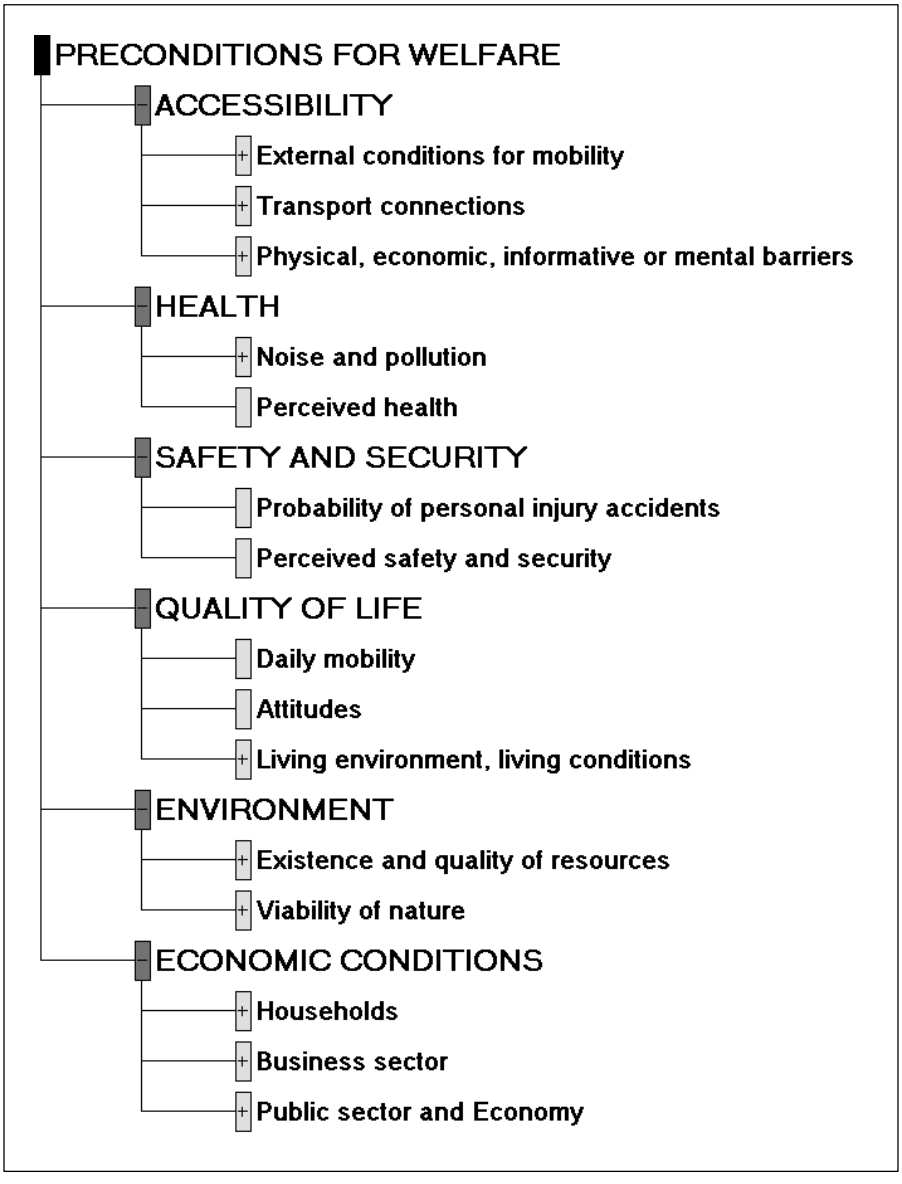

Figure 13. The structure (value tree) of AssessmentAid.

The AssessmentAid process contains the following steps:

1) collect a representative group of experts or stakeholders
2) select the alternatives for comparison; transport plans or projects
3) introduce the AssessmentAid structure (Figure 13) to the experts and stakeholders
4) collect impact estimation data about the alternatives, using the criteria for assessment of welfare impacts
5) run the MACBETH procedure with the experts and stakeholders
6) discuss the outcomes with the experts and stakeholders.

4.8.2 Estimated welfare impacts of the 2007 Transport Plan of the Helsinki Metropolitan Area

The welfare impacts of the 2007 Transport Plan of the Helsinki Metropolitan Area were estimated by assessing the influence of the Plan on accessibility, health, safety and security, quality of life, environment and economic conditions in the area. The impacts on these components of welfare were examined with the above-mentioned 15 assessment criteria (see Figure 13). The data for this estimation was gained from the different types of planning documents of the Transport Plan, provided by the Helsinki Metropolitan Area Council.

In the post-testing of the criteria, four implementation strategies of the 2007 Transport Plan of the Helsinki Metropolitan Area were examined. Potential welfare impacts were estimated for the following strategies (as in Chapter 3.2):

- **0+:** The current transport policy will be followed, but no new transport infrastructure will be constructed or the current infrastructure improved
- **A1**: Land use is favourable for transport; community structure supports the functioning of the transport system
- **A2**: Controlled mobility; the demand is managed in a way to save the environment and the transport system capacity
- **A3**: Control of demand for passenger car traffic; balancing of the demand and supply of transport, by the means of transport pricing.

The estimated welfare impacts of the Helsinki Metropolitan Area Transport Plan are shown in Figure 14. The clearly *positive* welfare impacts of the strategy alternatives of the Helsinki Metropolitan Area Transport Plan were

- Alternative 2 (Controlled mobility); impacts on the *external conditions for mobility*
- Alternative 3 (Demand control, transport pricing); impacts on *transport connections, probability of personal injury accidents and business sector economy*.

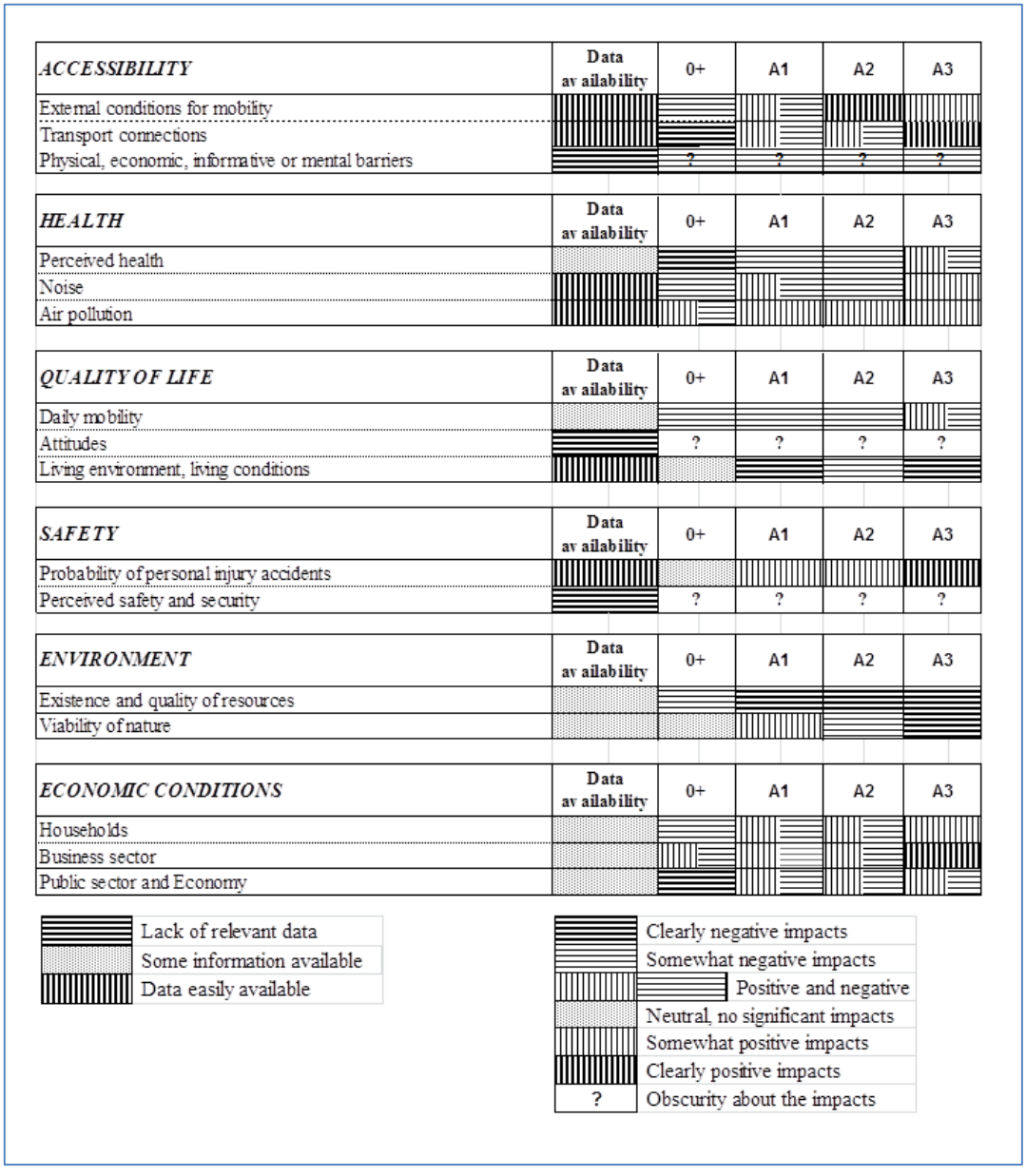

Figure 14. Data availability and the estimated welfare impacts of the 2007 Transport Plan of the Helsinki Metropolitan Area.

The main *negative* welfare impacts of the strategy alternatives were

- 0+ (Current policy, no new infrastructure), impacts on tr*ansport connections* and *perceived health*, as well as *economy* and *public sector economy*
-
- Alternative 1 (Favourable land use and community structure), impacts on *living environment* as well as *use and quality of natural resources*
- Alternative 2 (Controlled mobility), impacts on *quality and use of natural resources*
- Alternative 3 (Demand control, transport pricing), impacts on *living environment, quality and use of natural resources, viability of nature and biodiversity*.

Table 25 presents the table of performance of the 2007 Transport Plan of the Helsinki Metropolitan Area. The table of performance demonstrates, with the 15 assessment criteria (Figure 12), what the welfare impacts of the three strategy alternatives (see Chapter 3.2) of the 2007 Helsinki Metropolitan Area Transport Plan are. The strategy alternatives are presented according to their estimated impacts on the fifteen criteria for assessment of welfare impacts. The columns describe the impacts on the individual assessment criteria and the rows represent the impacts of the different strategy alternatives of the plan. In the columns, there are values that have been derived from the impact assessment data of the 2007 Transport Plan of the Helsinki Metropolitan Area. The symbols in the columns mean the following:

- - = negative impacts on this criterion
- 0 = neutral, no significant impacts on this criterion
- + = positive impacts of this criterion
- +/- = mixed impacts on this criterion; both positive and negative significant impacts
- ? = no relevant data was available for assessment of these types of impacts.

The most extensive material was available for the assessment of impacts on external conditions for mobility, transport connections, noise and air pollution, living environment and the probability of transport injure accidents.

Due to data unavailability, three criteria had to be omitted from the testing exercise. These criteria were ‘physical, informative or mental barriers’, ‘perceived safety and security’ and ‘attitudes’. Appendix D presents the Indicators with which the impacts were evaluated. However this list is not a very detailed one, and especially Indicators for some of the impacts that were assessed qualitatively should be defined for a more consistent use of the assessment criteria.

4.8.3 Comparison of alternatives with two test groups

As described earlier, AssessmentAid was tested with the impact assessment data of the 2007 Transport Plan of the Helsinki Metropolitan Area. Two test groups were involved in the post-testing process.

The first test group comprised of authorities within the Helsinki Metropolitan Area, located in Southern Finland. The second test group included students and environmental specialists in the University of Oulu, located in northern Finland. The purpose of having these very different test groups was to demonstrate whether potentially different valuations show different end results of the analysis with the same impact assessment data. The same MACBETH steps (see 2.4) were carried out for both groups.

The opinions about the differences of importance of the criteria that were stated by the Oulu group are presented in Table 26.

Table 25. Table of performance for the 2007 Transport Plan of the Helsinki Metropolitan Area, demonstrating the impacts of the strategy alternatives with 15 assessment criteria.

	External conditions for mobility	Transport connections	Barriers	Noise and pollution	Perceived health	Probability of personal injury accidents	Perceived safety and security	Daily mobility	Attitudes	Living environment, living conditions	Existence and quality of resources	Viability of nature	Economic conditions, households	Economic conditions. business sector	Economic conditions, public sector and economy
0+	-	-	?	+/-	-	0	?	-	?	0	-	0	-	+/-	-
Alternative 1	+/-	+/-	?	+/-	-	+	?	-	?	-	-	+	+/-	+	+/-
Alternative 2	+	+/-	?	+/-	-	+	?	-	?	-	-	-	+/-	+/-	+/-
Alternative 3	+	+	?	+	-	+	?	+/-	?	-	-	-	+	+	+/-

Table 26. Results of MACBETH group interviews of the second test group in the University of Oulu, concerning the importance of the assessment criteria. The criteria were scored and ordered according to their stated importance. The words in the columns indicate how strong the difference between the importance of two criteria is; positive means that there is a difference, but the magnitude of it was not clear.

	Transport connection	**Probability of personal injury accidents**	**Economic conditions for public sector and economy**	**Noise and pollution**	**Daily mobility**	**Viability of nature**	**External conditions for mobility**	**Economic conditions for business sector**	**Barriers**	**Economic conditions for households**	**Living environment and conditions**	**Attitudes**	**Perceived safety and security**	**Perceived health**	**Existence and quality of resources**
Transport connections		very weak	very weak	positive	positive	positive	very weak	moderate	positive	positive	positive	positive	positive	positive	positive
Probability of personal injury accidents			positive	positive	positive	positive	positive	positive	positive	positive	positive	positive	positive	positive	very strong
Economic conditions for public sector and economy				positive	positive	positive	positive	positive	positive	positive	positive	positive	positive	positive	very strong
Noise and pollution					very weak	positive	positive	positive	positive	positive	positive	positive	positive	positive	very strong
Daily mobility						positive	positive	positive	positive	positive	positive	positive	positive	positive	positive
Viability of nature							positive	positive	positive	positive	positive	positive	positive	positive	positive
External conditions for mobility								positive	positive	positive	positive	positive	positive	positive	positive
Economic conditions for business sector									positive	positive	positive	positive	positive	positive	positive
Barriers										positive	positive	positive	positive	positive	positive
Economic conditions for households											positive	positive	positive	positive	positive
Living environment and conditions												positive	positive	positive	positive

	Transport connection	Probability of personal injury accidents	Economic conditions for public sector and economy	Noise and pollution	Daily mobility	Viability of nature	External conditions for mobility	Economic conditions for business sector	Barriers	Economic conditions for households	Living environment and conditions	Attitudes	Perceived safety and security	Perceived health	Existence and quality of resources
Perceived safety and security													positive	positive	positive
Attitudes														weak	strong
Perceived health															weak
Existence and quality of resources															

Weighting scales were defined to introduce the reference scores of all the criteria (Table 27). The first group (Helsinki MA) accepted that there are fixed distances between the reference values of all the criteria, whereas the second test group (Oulu) defined the distances between the reference values of the individual criteria. The MACBETH weighting scale (Table 27, Bana e Costa et al. 2005) was created for both valuations of the Helsinki MA transport officials and students in Oulu. The scaling constants present the relative importance of the twelve evaluation criteria about which data were available.

Table 27. The MACBETH weighting scale.

Criterion	Helsinki MA	Oulu
ACCESSIBILITY		
External conditions for mobility	10.25	6.41
Transport connections	14.10	10.25
HEALTH		
Noise and pollution	6.41	7.69
Perceived health	3.85	14.10
SAFETY		
Probability of personal injury accidents	15.38	8.97
QUALITY OF LIFE		
Daily mobility	11.54	5.13
Living environment, living conditions	8.97	15.38
ENVIRONMENT		
Existence and quality of resources	12.82	12.82
Viability of nature	7.69	11.54
ECONOMIC CONDITIONS		
Economic conditions; households	1.29	3.85
Economic conditions; business sector	2.57	1.29
Economic conditions; public sector and Economy	5.13	2.57
Total	100.00	100.00

As results of the analysis with AssessmentAid, the relative order of the strategy alternatives (overall thermometers, Figure 15) and differences in preferences for the strategy alternatives by the sub-objectives (xy-maps, Appendix E) are presented for both the test groups.

There were visible differences in the priorities between the Helsinki MA test group and the Oulu test group. The Helsinki MA test group preferred Alternative 3 (*demand control, transport pricing*), whereas the Oulu group preferred Alternative 1 (*favourable land use and community structure*).

The interviewees were asked to rank the criteria according to attractiveness (or importance). When asked to rank the criteria according to significance, the four most attractive criteria for the Helsinki MA group were “probability of personal injury accidents”, “transport connections”, “viability of nature” and “daily mobility” while the Oulu group preferred “living conditions”, “noise and pollution”, “viability of nature” and “quality and amount of natural resources”. The four least attractive criteria in the Helsinki MA were “private sector economy”, “business sector economy”, “noise and pollution” and “economy and public sector economy”. The corresponding criteria in Oulu were “business sector economy”, “economy and public sector economy”, “private sector economy” and “daily mobility”.

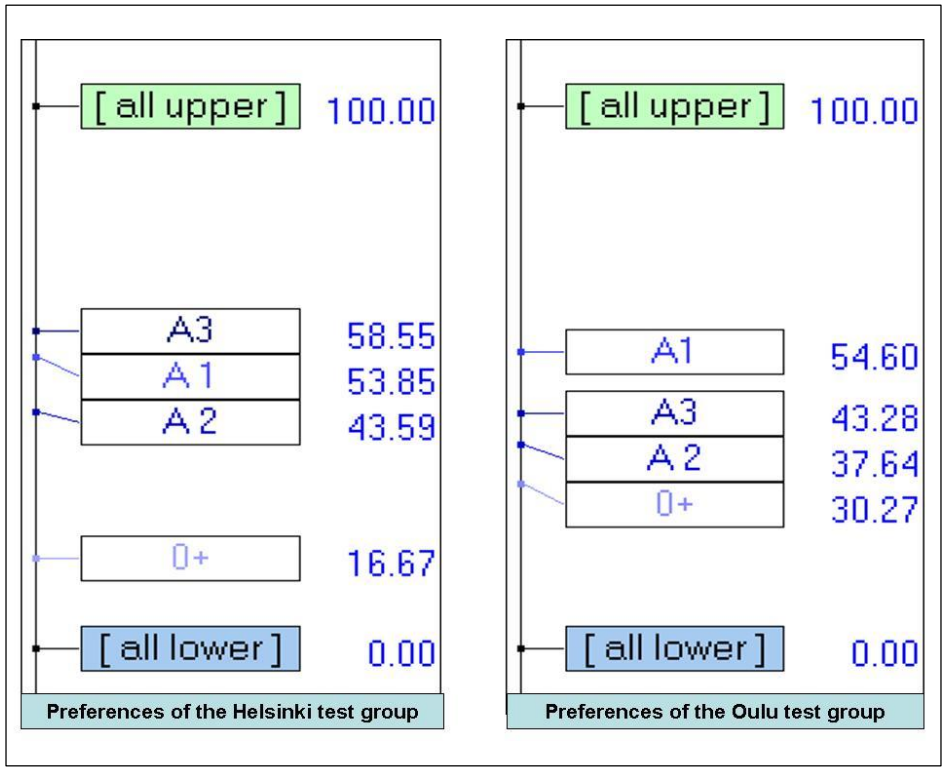

Figure 15. The overall thermometer; the preferences of the two test groups, concerning the 2007 Transport Plan of the Helsinki Metropolitan Area and its strategy alternatives

The 0+ situation was clearly the least wanted alternative for the Helsinki Metropolitan Area test group, while the Oulu test group considered this difference to be notably narrower (Figure 15). Also, the difference between Alternatives 1 and 2 was broader in Oulu, while the other group considered the attractiveness of these alternatives to be very close to each other. According to the valuations of the test

groups and the impact assessment data, the most significant welfare impacts of all the alternatives can be found to be accessibility and safety.

The sensitivity analysis on the weight of the criteria was carried out for the impact assessment data of the Helsinki Metropolitan Area Transport System Plan 2007, and for the valuations of the project steering group, as well as for the valuations of university students from Oulu.

This sensitivity analysis demonstrated that for the Helsinki test group, the relative order of the strategy alternatives changed if there were significant changes in the weight of 'external conditions for mobility', 'daily mobility', 'living environment' or 'viability of nature'. Even if the weight of other criteria was changed one criterion at a time, the relative order of the alternatives remained the same. For the Oulu test group, the relative order of the strategy alternatives changed if there were changes in the weight of 'external conditions for mobility', 'living environment, living conditions' or 'viability of nature'.

4.9 The final list of criteria for assessment of welfare impacts

After the fine-tuning of the criteria based in connection with the post-testing, the main output of this thesis, the list of criteria for assessment of welfare impacts was finalised.

In the resulting list, the primary objective, contributing to the prerequisites for well-being, is described using its six sub-groups and their 15 constituent evaluation criteria.

The sub-groups are 'Accessibility', 'Health', 'Traffic safety and perceived safety', 'Quality of life', 'Environment', and 'Economic boundary conditions' (Table 28). Also, additional sub-criteria were defined for the criteria in the sub-group 'Accessibility". For other groups, no relevant sub-criteria were found.

Compared to the preliminary list of criteria (Chapter 4.2), the number of groups has been reduced from seven to six. However, two group headings were deleted and one new was created. The aspects concerning hindrances in the transport system were classified as physical, economic and informative barriers in 'accessibility, alternatives and options'. Health and safety impacts were defined as two separate groups, and 'attractive living environment' was moved under the heading 'quality of life'. The locations of the criteria 'perceived health' and 'perceived safety' that were discussed in 4.2, were solved by including all health issues in 'health' and all safety issues in 'safety and security'. The group 'opportunities for participation and decision-making' was removed from the list. Several criteria have been removed from the list and some new ones, for example 'daily mobility' have been created.

There are no criteria included in the final list that directly concern two rather important aspects of economic welfare. Freight transport and logistics operations or the economic perspective of the environment and resources were not left in the final list. However, there were no representatives of business and industry,

transport and logistics sector or environmental economists in the steering group that made the final choice.

Table 28. The finalised criteria for assessment of welfare impacts in transport system planning. Either the criteria or the sub-criteria can be used, depending on the level of detail of the assessment. If no sub-criteria exist, the single criterion is to be used.

Sub-group	Criterion
1. ACCESSIBILITY, ALTERNATIVES AND OPTIONS	
	External conditions for mobility
	- Population size and structure of different types
	- Regional and urban structure
	- Amount and quality of activities (services, housing, employment, leisure activities)
	Transport connections
	- Connection possibilities
	- Opportunities for choosing mode of travel or transport
	- Functionality, fluency and conveniency of connections
	Physical, economic and informative barriers
	- Physical
	- Economic
	- Informative
2.HEALTH	
	Noise and pollution
	Perceived health
3. SAFETY AND SECURITY	
	Probability of personal injury accidents
	Perceived safety and security
4. QUALITY OF LIFE	
	Daily mobility
	Living environment, living conditions
	Attitudes
5. ENVIRONMENT	
	Existence and quality of resources
	Viability of nature
6. ECONOMIC CONDITIONS	
	Households
	Business sector
	Public sector and Economy

5. Summary and discussion

5.1 The research framework

The research problem that was posed in Chapter 1.3, was 'How to recognise welfare impacts and to assess those in a transport planning assessment process in a way that reflects the effect of the stakeholders' values on the outcomes of the assessment?' This research problem was approached with three research questions.

The first research question was 'What kind of innovative combination of multicriteria approaches would be applicable for assessment of welfare impacts of a transport plan, programme or policy and would allow the valuations of decision-makers to be taken into consideration?' This question was answered by combining multicriteria approaches AHP and MACBETH in the study. AHP was a useful technique in the process of creating the criteria for assessment of welfare impacts. The AssessmentAid framework was created with MACBETH. The use of these techniques allowed the valuations of stakeholders to be taken into consideration.

The second research question was 'What kind of impacts can modifications in transport systems have on the welfare of individuals, communities and the environment in Finland, and what criteria can be formulated to assess the impacts?' This question was answered by providing a list of assessment criteria and by estimating the welfare impacts of two Finnish case studies.

The third research question was 'Is it possible to use the evaluation criteria in practice and get representative and sufficient information about the welfare impacts of a transport plan, programme or policy?' The evaluation criteria were tested in two case studies. It was proven that the criteria can be used in practice in an assessment process. However, it turned out that there is still room for improvement in the availability of appropriate data and in formulating indicators for the criteria.

5.2 The criteria for assessment of welfare impacts

In this thesis, a set of criteria for assessment of welfare impacts of modifications in the transport system (Chapter 4.9) has been introduced. With welfare impacts, I

refer to changes in the preconditions for welfare of individuals, communities, society and the environment.

A total of fifteen assessment criteria were defined. These criteria represent the different elements of the primary objective, contributing to the welfare of the above-mentioned groups. The criteria are structured by the following six objectives: '*accessibility, alternatives and options*', '*health*', '*safety and security*', ' *quality of life*', ' *the environment*' and '*economic conditions*'.

In the preliminary list of criteria, the individual criteria could have been defined more unambiguously, to avoid different interpretations by the respondents of the survey and the AHP interviews. For example, the difference between 'travel costs', 'freight transport costs' and 'purchase & operation costs of means of transport' was not clear. Also, these criteria were somewhat overlapping. These criteria were however combined and rephrased in the later phases of the process of creating the criteria.

To avoid misunderstandings, for example the criterion 'traffic emissions' in 'health, safety and attractive living environment' could have been named more clearly as 'emissions of carbon dioxide, particles, nitrogen oxides, compounds of hydrocarbon or carbon monoxide from traffic'. The criterion 'perceived health' is mentioned under two objectives, 'hindrance in the transport system, usability of transport system' and 'health, safety and attractive living environment', as well as 'experienced' or 'perceived safety'. A logical solution could have been to consider all health and safety issues only in 'health, safety and attractive living environment'.

Another way would have been to remove those criteria from 'health, safety and attractive living environment' and to include those only under 'hindrance in the transport system' that includes issues that can be experienced as barriers for travel or transport. This would, however, have altered the definition of the group. Also a duplicate criterion 'satisfaction with the residential environment' could have been left out of 'health, safety and attractive environment' and included only as 'satisfaction with living conditions' in 'quality of life, lifestyles'. This way 'health, safety and attractive living environment' would have represented external conditions that have an effect on health, safety and attractiveness of living environment, while 'quality of life, lifestyles' includes issues that people experience as components of their quality of life.

Also, the criterion 'predictability and accuracy' may be difficult to grasp, as it could have been named as 'predictability and accuracy of traffic'.

The differences in opinions between different groups of people from different locations may indicate that the 21 criteria about which no conflicting opinions were expressed can be better generalised than the 31 criteria about which conflicting opinions were expressed. However this comparison was carried out only for two geographical locations and two different groups of people. A more comprehensive view of the transferability of the criteria could be formed by carrying out the survey in several geographical locations.

In the version of the criteria list that was used in the AHP analysis, some criteria were included under more than one group heading. This, however, offered the

respondents the opportunity to examine the criteria from more than one point of view in several ways. Finally, in the process of modifying the criteria, these were combined and placed in the groups that were proven as most appropriate.

The criterion 'perceived health' is included in 'hindrance in the transport system, usability of transport system' (Table 15) because it was considered a possible psychic hindrance experienced by an individual, and the external aspects that support the feeling of health in the transport system were identified in the group 'health, safety and attractive living environment' (Table 16). It did not come up in the discussion that the decision to separate experienced health and the external factors that affect health in different groups may not be in line with including both perceived safety and external risk of injury together in the same group of criteria.

The criterion 'perceived health' is mentioned under two objectives, 'hindrance in the transport system, usability of transport system' and 'health, safety and attractive living environment', as well as 'experienced' or 'perceived safety'. A logical solution could have been to remove those criteria from 'health, safety and attractive living environment' and to include them only under 'hindrance in the transport system' that includes issues that can be experienced as barriers for travel or transport. Also a duplicate criterion 'satisfaction with the residential environment' could have been left out of 'health, safety and attractive environment' and included only as 'satisfaction with living conditions' in 'quality of life, lifestyles'. This way 'health, safety and attractive living environment' would have represented external conditions that have an effect on health, safety and attractiveness of living environment, while 'quality of life, lifestyles' would include issues that people experience as components of their quality of life.

The AHP process is a type of a learning process. Therefore, the results might have changed if the process had been repeated.

I have compared my list of assessment criteria with other assessment frameworks that were introduced in Chapter 2. Two of these included the same type of characteristics as the criteria that were created in this study, namely 1) AST; Assessment Summary Table (Department for Transport, UK 2012) and 2) Sustainable Urban Design Criteria (Häkkinen et al. 2006). Particularly the AST in the UK is intended to be used in the assessment of transport planning, while the second list serves the wider concept of urban planning.

In the AST, there are several rather similar criteria to my list. For example the following: 'population and urban structure' – 'land-Use Policy (AST)', 'transport connections' – 'transport interchange (AST)', 'barriers' – 'accessibility (AST)', 'health' – included in 'environment' in the AST. The criteria that outline 'safety and security' are quite similar in both lists, as well as 'economy'. There is no correspondence in the AST with 'quality of life' or 'attitudes'. However, I have not included 'heritage of historic resources' in the list of criteria for assessment of welfare impacts, due to the results of the discussions with decision-makers and practitioners. In general, the list that I have introduced in this thesis contains a larger number of and more detailed criteria than the AST. This could be anticipated, too, because the AST is a general framework for assessing the common impacts of

transport planning, while my criteria are targeted to assess the welfare impacts in a rather detailed manner.

The Sustainable Urban Design Criteria (Häkkinen et al. 2006) contain for example following criteria that are not included in my framework:

- density of urban structure
- risks for threatened and near threatened species
- individual trees and rock formations
- microclimate
- correspondence of types and floor area distribution of dwelling stock with demand
- maintenance of cultural heritage.

The criteria introduced in this thesis include for example the following criteria that cannot be found in the Sustainable Urban Design Criteria:

- listing of different types of transport connections and connection opportunities
- population size and structure
- physical, economic and informative barriers
- safety and security
- attitudes
- economic conditions.

Because the two lists of criteria are created for different purposes, it is perhaps no wonder that there are so many differences. However, some of the criteria mentioned in the Sustainable Urban Design Criteria could also be useful for the assessment of welfare impacts of transport system planning.

During the design of the criteria, pairwise comparisons using the Analytic Hierarchy Process (AHP) were found to be a good way to determine the preferences, despite the time and effort needed in carrying out the individual interviews (Chapter 3). The most important parts were discussions with and participation of the officials and experts. Another advantage was to gain the national and regional authorities' commitment for the study. This will hopefully promote the use of the final results. The AHP proved to be a useful method for the selection of the potential criteria. However, the method was used only as consultative tool to collect and process the opinions of the interviewees. A major point of success was that the opinions of the decision-makers and experts were collected through a co-operative and conversational multi-step process that included meetings, workgroup discussions and personal interviews. Without this participation of the stakeholders, the list of criteria would have been rather different. There would probably be more criteria than now, but also some that overlap and some that would not be useful in the assessment process.

The use of the criteria list leaves room for consideration in an assessment process. If there is a specific plan under assessment, some of the rejected criteria may be relevant in that situation, for example, in an area that consists of historical surroundings. It was also found out that geographical location has on effect on

what is being considered as an important assessment criterion. Also, the contents of the list are naturally affected by the groups of people who have been involved in the definition process.

For example, the criterion ‘freight transport connections’ was left out of the final list of criteria. Had freight transport operators been involved in the selection of the criteria, the result could have been completely different. Also criteria that would describe the economic aspect of the environment, for example energy consumption are not included in the final list of criteria. In addition to freight transport operators, representatives of for example environmental economy, agriculture, forestry and fishing were not comprehensively included in the study. The AHP-process and the final selection of the relevant criteria were carried out with participation of the steering group of the study. This group consisted of key authorities and decision-makers within the Finnish transport and environmental sectors and experts of the health sector, but for example business and commercial sectors were not represented. In the Internet survey and the post-testing of the criteria, a wider variety of stakeholders was however included. Still, this sample could have been more comprehensive and included for example freight transport or logistics operators and actors within environmental economics, forestry, agriculture and fishing, as well as representatives of business and commerce.

The exact meaning and contents of the individual criteria and group headings in the selection process could have been defined and expressed more unambiguously. There was potential for misunderstandings and different interpretations thereof in the study. However the meaning of the names of the criteria and the contents of the group headings were lively discussed in the meetings of the steering group.

The list of assessment criteria was grouped into the sub-groups in an early stage of the study, and these groups were not compared with each other. Better information about the relative importance of the different criteria groups would have been gained by comparing the sub-group level in the Internet survey and AHP-process, too.

Also, tentative assessments of welfare impacts of two case studies were provided using the criteria.

The estimation of the welfare impacts of the case studies was based on already existing impact evaluation material. This led to difficulties to evaluate all the welfare impacts that were represented by the preliminary list of criteria. Three criteria had to be left out of the impact assessment of the Helsinki Metropolitan Area Transport System Plan because no precise data was available to describe these impacts. The above-mentioned criteria were ‘physical, informative or mental barriers’, ‘perceived safety and security’ and ‘attitudes’. A large share of the welfare impacts were estimated qualitatively. It was noticed that a more comprehensive and detailed variety of indicators than those used in this study needs to be defined (Appendix D). A special challenge is to find indicators and to define the background data for the three criteria that were eliminated from the impact assessment due to unavailability of data.

5.3 AssessmentAid

In addition to defining the criteria, a procedure for the assessment of the welfare impacts in the context of transport system planning, the so-called AssessmentAid (Chapter 4.8), has been suggested. This procedure is an application of a multi-criteria decision aid (MCDA) technique called MACBETH (Chapter 2.6.4). The AssessmentAid is an interactive procedure that takes the objectives and valuations of the planning participants into consideration. It can be used to illustrate the values of the decision-makers and other stakeholders, for example in comparing different alternatives of suggested transport plans.

In my opinion, the approach called value-focused thinking (Chapter 1.2.2) was essential in order to include the opinions and values of the stakeholders in the assessment of welfare impacts. Value-focused thinking is the basis for using the MCDA procedures.

The AssessmentAid process is quite complicated and time-consuming. It would therefore be tempting to reduce the amount of steps and comparisons in the process. However, this would entail the risk of losing important information.

The multi-criteria analysis technique MACBETH proved out to be useful in evaluating welfare impacts, the evaluation of which is based on diverse qualitative and quantitative data. MACBETH has been used in some rather similar processes in Europe by its creators, but not with the same type of research questions and data as was used in this study. In Finland the use of MACBETH is very limited. Even though the focus of the current national YHTALI-framework for transport assessment has been widened to include some qualitative data, no MCA technique is proposed. Therefore the AssessmentAid process with data of welfare impacts and MCDA process is a completely new approach in the transport sector.

Despite the time-consuming process, MACBETH well facilitated interaction between the decision-makers or other stakeholders and the experts that carry out the evaluation, as well as interpretation of the valuations of the planning participants.

However, when using MACBETH as an impact assessment technique, a skilled and acquainted expert is required in the process, and the decision-makers need to be well informed about the process and interpretation of its results. Also the steering group of the study held that an easier-to-use tool would be welcome for the assessment work in practice. But overall, the steering group was content with the study and its results, and highly appreciated the criteria and AssessmentAid that were introduced as the final results of my study. The active participation of the steering group members was absolutely necessary for the usability and effectiveness of my results. Their questions and suggestions, as well as their constructive critique helped me to pay attention to the essential subjects and to link the scientific methods and background information to the practice of everyday transport planning and impact assessment work.

The national transport, environment and social sector authorities were actively involved in the development of AssessmentAid and the criteria, and were thus

committed to promote the use of the results. However, I failed to enhance public participation in the assessment process.

With the MACBETH-procedure and the tentative impact assessments it was demonstrated that the values of the decision-makers can have great effect on the outcomes of the impact evaluation. This may weaken the generalisability of the list of criteria and the structure of AssessmentAid, as there should probably have been more representatives of for example transport operators as well as representatives of business and commerce.

The weighting of different stakeholder groups would not have been necessary in the process of defining the criteria. However in the AssessmentAid process, weighting of the stakeholder groups could have been useful, especially if there were a possibility of over- or under representativeness of a group.

5.4 Applicability and transferability of the results

The use of multi-criteria analysis and its derivative techniques has been quite limited in Finland, compared to several European countries. In the search for literature (Section 2), it was found out that academic literature about the use of multi-criteria analysis in Finland was available for example in environmental planning, land use and urban planning as well as in the energy sector (e.g. Ekholm et al. 2014, Neste and Karjalainen 2013, Saarikoski et al. 2013, Sorvari 2010). However no academic literature about the use of multi-criteria methods in the transport sector was detected. The outcome of the study present a new perspective and a new type of methodological development work in Finland. In my opinion, this thesis presents a good starting point for contributing to efficient evaluation of the impacts that transport system modifications can have on the well-being of individuals, communities and the environment.

The results presented in this thesis can be directly applied in regional transport system planning, but also in assessing the welfare impacts of an individual infrastructure project in Finland. In such a case, the assessment of welfare impacts would be a complementary analysis to for example cost-benefit analysis. As was indicated in Chapter 2.6, cost-benefit analysis is an important and useful method, but it should not be the only piece of information available to the decision-makers about a policy choice or environmental management decision.

For international use, it would be useful to refine the list of impacts first for its representativeness. The assessment of welfare impacts can take place either as ex-ante assessment, for example in comparison of alternative solutions, or as ex-post assessment, giving information about the impacts of a plan or project that has taken place in practice.

The method that was created is directed to address such impacts that may not be shown in the traditional socio-economic calculations of transport plans. It provides a supplementary point of view that can be used in addition to for example cost-benefit analysis. The method does not provide information about the econom-

ic efficiency of a transport plan. In Finland, the assessment criteria and AssessmentAid could be used to provide information about the additional impacts in calculating the feasibility of a transport strategy, plan or project according to the YHTALI framework for transport appraisal (The Finnish Transport Agency 2011).

If the suggested process of assessing welfare impacts of modifications in the transport system were applied in addition to cost-benefit analysis, it would be important to specify which aspects (for example accessibility, safety or environmental impacts) are included in both the processes. Existence of same types of impacts would not necessarily mean double-counting, because the effects would be considered from different points of view and could this way complement each other. This would however constitute a challenge to the interpretation of the results of the assessment.

I realise that the AssessmentAid procedure takes so much time and resources that it may not be possible for it to be directly included in all assessment processes. It can still be applied in connection with certain planning projects, where there are enough resources for impact assessment, and where significant welfare impacts are expected or decision-makers strongly disagree about the planning alternatives. My suggestion is that the list of criteria for the assessment of welfare impacts could be taken into consideration when the Finnish national guidelines for human and social impact assessments of transport plans are being improved. Also, I hope that I have been able to demonstrate some aspects about the importance of qualitative information and consideration of the values of the stakeholders, to amend the traditional cost-effectiveness and cost-benefit analyses of transport plans.

5.5 Suggestions for further research

The list of criteria and the AssessmentAid procedure were created in connection with two large Finnish transport plans. The relevance of the results could be tested by assessing the welfare impacts of different types of strategies, plans or projects than purely transport. Challenging testing environments would be for example the topical innovative assessments of the combined transport and land use planning, including the points of view of services as well as the business and industry. Also applying the results within assessment of welfare impacts of transport strategies, plans or projects in other European countries than in Finland would enhance the generalisability of the criteria for assessment of welfare impacts and AssessmentAid.

It was detected in the study that there are major differences in opinions of stakeholders from different geographical locations. Taking this into consideration, a similar analysis but with a more extensive sample and definition of parallel lists of criteria would improve the accuracy and applicability of the results obtained by now. In this process, also the importance of the three assessment criteria that could not be assessed in the current study could be reconsidered. These criteria

were ‘physical, economic and informative barriers’, ‘perceived safety and security’ and ‘attitudes’.

In the study, the criteria were defined according to the opinions of potential stakeholders. It might however be interesting to test whether similar criteria were selected if the respondents included also other groups of people. For this purpose, the existing internet questionnaire ought to be modified in a way to better visualize the chains of impacts in question.

For better applicability and transferability of the criteria, it would be useful to carry out an exercise of defining a more detailed set of indicators for the criteria. The best way would be to use the list in Appendix D as a starting point, and to test and improve it in connection within an ongoing impact assessment of transport plans from different geographical locations. It would be necessary to participate in an assessment process in such a phase that the assessment of welfare impacts could be taken into consideration in the collection of impact estimation data. This would allow a more accurate evaluation of impacts about which it was difficult to find data in the current study.

Although the authorities and decision-makers who participated in this study regarded AssessmentAid as a feasible and illustrative tool, they brought out that the contents of the process were difficult to follow in some phases. One challenge would be to develop the AssessmentAid so that it would become easier to approach and understand by the decision-makers and other stakeholders. Another challenge would be to fine-tune the way the outcomes of AssessmentAid are presented, in order to connect the results with the outcomes of a cost-benefit analysis and thus help the decision-makers form an overall picture of the different types of assessment.

The importance of the presence and participation of the stakeholders in the assessment process was highlighted in several stages of the current study. Therefore, one suggestion for further research would be to carry out an assessment of welfare impacts using the criteria that were introduced in this thesis, and to focus on stakeholder representativeness in the different phases of the assessment process. In the identification of the stakeholders, for example such groups of actors who have their specific needs for transport system but were not sufficiently represented in the current study should be involved. Such groups include environmental economists or actors in social sector, agriculture, forestry and fishing, as well as freight transport or logistics operators.

For example multi-actor multi-criteria decision aid (MAMCA) and group decision support methods could be applied in the assessment that is based on significant participation of different stakeholders (e.g. Macharis and Nijkamp 2013, Macharis et al. 2012). In case of involving a large amount of stakeholders, it would be feasible to consider the importance of the different groups of participants. This could be implemented by adding weights to the opinions of different stakeholders, according to their agreed importance in the assessment process.

References

Act on the Assessment of the Impacts of the Authorities' Plans, Programmes and Policies on the Environment. (2005), (Laki viranomaisten suunnitelmien ja ohjelmien ympäristövaikutusten arvioinnista 200/2005). Finland.

Act on Environmental Impact Assessment Procedure (1994), including amendments to the Act. (In Finnish: Laki ympäristövaikutusten arviointimenettelystä 468/1994; Laki ympäristövaikutusten arviointimenettelystä annetun lain muuttamisesta 267/1999.) Finland.

Act on Land Use and Building. (1999), (In Finnish: Maankäyttö- ja rakennuslaki 132/1999.) Finland.

Allardt, E. (1976), Dimensions of Welfare. (In Finnish: Hyvinvoinnin ulottuvuuksia). Porvoo: WSOY. 359 p. Finland.

Bana e Costa, C.A. (2001), The Use of Multi-Criteria Analysis to Support the Search for Less Conflicting Policy Options in a Multi-Actor Context. Case Study. Journal of Multi-Criteria Decision Analysis 10, 111–125.

Bana e Costa, C. A. (2005), On the mathematical foundations of Macbeth. In: Multiple Criteria Decision Analysis, State of the Art Surveys, edited by Figueira, J., Greco, S. & Ehrgott, M. Pp. 409–442.

Bana e Costa, C.A. & Beinat, E. (2005), Model-structuring in public decision-aiding. Working Paper LSEOR 05.79. The London School of Economics and Political Science.

Bana e Costa, C. A. & Chagas, M. P. (2004), A career choice problem: An example of how to use MACBETH to build a quantitative value model based on qualitative value judgments. European Journal of Operational Research 153 (2004), pp. 323–331.

Bana e Costa, C. A., De Corte, J.-M. & Vansnick, J.-C. (2003), MACBETH. (Overview of MACBETH multicriteria decision analysis approach). LSE OR Working Paper 03.56. The London School of Economics and Political Science.

Bana e Costa, C.A., De Corte, J-M. & Vansnick, J-C. (2004), On the mathematical foundations of MACBETH. LSEOR Working Paper 04.61. The London School of Economics and Political Science.

Bana e Costa, C. A., Fernandes, T. G. & Correia, P.V.D. (2005), Prioritisation of public investments in social infra-structures using multicriteria value analysis and decision conferencing: A case-study. Working Paper LSEOR 05.78. The London School of Economics and Political Science.

Barrow, C. J. (2002), Evaluating the social impacts of environmental change and the environmental impacts of social change: an introductory review of social impact assessment. Environmental Studies, 2002, vol. 59(2), pp. 185–195.

Becker, B. (1997), Sustainability Assessment: A Review of Values, Concepts, and Methodological Approaches. Issues in Agriculture 10. Consultative group on international agriculture research.

Bots, P.W.G. & Lootsma, F.A. (2000), Decision Support in the Public Sector, Journal of Multi-Criteria Decision Analysis 9: 1–6 (2000).

Brent, R. J. (1996), Applied Cost-Benefit Analysis. Cheltenham, UK: Edward Elgar.

Burgess, L. & Barbier E.B. (2001), Sustainable Transportation. In: International Encyclopedia of the Social and Behavioral Sciences. Elsevier Science. Pp. 15329−15335.

Bristow, A.L. & Nellthorp, J. (2000), Transport project appraisal in the European Union, Transport Policy 7 (2000). Pp. 51–60.

Bröcker, J., Korzhenevych, A. & Schürmann, C. (2010), Assessing spatial equity and efficiency impacts of transport infrastructure projects. Transportation Research Part B, 44 (2010) 795−811.

Browne, D. & Ryan, L. (2011), Comparative analysis of evaluation techniques for transport policies. Environmental Impact Assessment Review 31 (2011), Pp. 226–233.

Bryson, N. K.-M. & Joseph, A. (2000), Generating Consensus Priority Interval Vectors for Group Decision-making in the AHP. Journal of Multi-Criteria Decision Analysis 9, 127–137 (2000).

Burgess, L. & Barbier, E.B. (2001), Sustainable Transportation. In: International Encyclopedia of the Social and Behavioral Sciences. Elsevier Science. Pp. 15329−15335.

Carse, A. (2011), Assessment of transport quality of life as an alternative transport appraisal technique. Journal of Transport Geography 19 (2011) 1037–1045.

Center for International Forestry Research, CIFOR. (1999), Guidelines for Applying Multi-Criteria Analysis to Assessment of Criteria and Indicators. 9, The Criteria and Indicators Toolbox Series, Center for International Forestry Research, Indonesia.

Checkland, P. (1981), Systems thinking, systems practice. Hicester, New York, Brisbane, Toronto: John Wiley & Sons.

Cinelli, M., Coles, S.R. & Kirwan, K. (2014), Analysis of the potentials of multi criteria decision analysis methods to conduct sustainability assessment. Acological Indicators 46 (2014), 138–148.

City of Oulu (2003), Transport plan 2020 of the Oulu region, Strategy – priority tasks – intention agreement. (In Finnish: Oulun seudun liikenne 2020. Strategia-kärkitehtävät-aiesopimus.) Oulu.

City of Oulu (2015), Oulu. <http://www.ouka.fi/oulu/english/environment-and-nature>. Accessed 8th February, 2015.

City of Seinäjoki (2015), About Seinäjoki. <https://www.seinajoki.fi/en/index/cityofseinajoki/aboutseinajoki.html>. Accessed 8th February, 2015.

Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects. Brussels: European Commission.

Council Directive 97/11/EC amending Directive 85/337/EC on the assessment of the effects of certain public and private projects on the environment. Brussels: European Commission.

Council Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment. Brussels: European Commission.

Council Directive 2003/35/EC of the European Parliament and of the Council, providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC. Brussels: European Commission.

De Brucker, K.D., Macharis, C. & Verbeke, A. (2013), Multi-criteria analysis and the resolution of sustainable development dilemmas: A stakeholder management approach. European Journal of Operational Research 224 (2013), 122–131.

Decree on the Environmental Assessment Procedure (1999), (In Finnish: Asetus ympäristövaikutusten arviointimenettelystä 268/1999). Finland.

Decree on Land Use and Building (1999), (In Finnish: Maankäyttö- ja rakennusasetus 895/1999). Finland.

Delbosc, A. (2012), The role of well-being in transport policy. Transport Policy 23 (2012) 25−33.

Department for Communities and Local Government: London (2009). Multi-criteria analysis: a manual. January 2009. <http://eprints.lse.ac.uk/12761/Multi_Criteria_Analysis.pdf>. Accessed December 2nd, 2012.

Department of the Environment, Transport and the Regions (1998), Understanding the new Approach to Appraisal. DETR, London. <http://www.dft.gov.uk/pgr/economics/rdg/anintroductionto transportana3042>. Accessed April 11th, 2012.

Department of the Environment, Transport and the Regions. (1999), Review of Technical Guidance on Environmental Appraisal. <http://www.defra.gov.uk/environment/economics/rtgea/index.htm>. Accessed 6 May 2005.

Department of the Environment, Transport and the Regions, DETR. (2000), Guidance on the methodology for multi-modal studies (Vol 2). DETR, London. <http://www.dft.gov.uk/stellent/groups/dft_transstrat/documents/pdf/dft_transstrat_pdf_503874.pdf>. Accessed August 3rd, 2004.

Department of the Environment, Transport and the Regions, DETR (2004), Transport Analysis Guidance. Appraisal Summary Table TAG Unit. 2.7.2. and Cost-Benefit Analysis TAG Unit 3.5.4, <www.webtag.org.uk>. Accessed in 2006.

Department for Transport (2004), Transport Analysis Guidance (TAG), Appraisal, TAG Unit 2.5. February 2004 UK. <www.dft.gov.uk/webtag>. Accessed April 11th, 2012.

Department for Transport (2011a), An Introduction to Transport Analysis. <http://www.dft.gov.uk/pgr/economics/rdg/anintroductiontotransportana3042>. Accessed 16 March, 2011.

Department for Transport (2011b), Transport Analysis Guidance (TAG). The Appraisal Process. TAG Unit 2.5. April 2011. UK. <www.dft.gov.uk/webtag>. Accessed April 11th, 2012.

Department for Transport (2011c), Transport Analysis Guidance (TAG). Detailed Guidance on Social and Distributional Impacts of Transport Interventions. TAG Unit 2.5. April 2011. UK. <www.dft.gov.uk/webtag>. Accessed April 11th, 2012.

Department for Transport, UK (2012), Appraisal Summary Table. UK. <http://www.dft.gov.uk/webtag/documents/worksheets.php>. Accessed March 27th, 2012.

Dodge, R., Daly, A.P., Huyton, J. & Sanders, L.D. (2012), The challenge of defining wellbeing. Journal of Wellbeing, 2(3), 2012, 222–235.

Dodgson, J., Spackman, M. et al. (2000), Multi-Criteria Analysis: a Manual. Department of the Environment, Transport and the Regions, London. Also available from the World Wide Web: <http://www.odpm.gov.uk /stellent/groups/odpm_about/documents/page /odpm_about_608524-01.hcsp> [Accessed 6th May 2005].

Doyal, L. & Gough, I. (1991), A Theory of Human Need. London: Macmillan Press Ltd. 365 p.

Dyer, J. (2005), MAUT – Multiattribute utility theory. In: Figueira, J., Greco, S. and Ehrgott, M. (eds.) (2005) Multiple criteria decision analysis, State of the art surveys. International series in operations research and management science. Springer science + business media Inc.

ECMT, European Conference of Ministers of Transport (2004), Assessment & decision-making for Sustainability. OECD Publications 2. France.

Ekholm, T., Karvosenoja, N., Tissari, J., Sokka, L., Kupiainen, K., Sippula, O., Savolahti, M., Jokiniemi, J. & Savolainen, I. (2014), A multi-criteria analysis of climate, health and acidification impacts due to greenhouse gases and air pollution – The case of household-level heating technologies. Energy Policy (74) 2014, 499–509.

Estlander, K., Britschgi, V., Pekkarinen, S & Heltimo, J. (2005), Criteria for assessment of welfare impacts within regional planning of transport systems.

ERSA2005, 45th Congress of the European Regional Science Association, 23–27 August 2005, Vrije Universiteit Amsterdam, Land Use and Water Management in a Sustainable Network Society, CD-rom. European Regional Science Association.

Estlander, K., Pekkarinen, S., Britschgi, V. & Heltimo, J. (2007), Assessment of the welfare impacts of transport system modifications. (In Finnish: Liikennejärjestelmän kehittämisen hyvinvointivaikutusten arviointi.) The Ministry of Transport and Communications, Finalnd, Publications 1/2007. <http://www.mintc.fi/oliver/upl564-LVM%201_2007.pdf>, Accessed in February, 2007.

European Commission, EC (1998), Economic Evaluation of Environmental Policies and Legislation. Final Report Sep. 1998. European Commission. DG III Industrial Affairs. London, Norfolk: Risks & Policy Analysts Ltd. (Project title: J236/CBA/CEA).
<http://ec.europa.eu/environment/enveco/others/pdf/policies_and_legislation.pdf>, Accessed 6 May, 2005.

European Commission, EC (2002), Guide to cost-benefit analysis of investment projects. Structural Fund-ERDF, Cohesion and ISPA. Evaluation Unit DG Regional Policy. Brussels: European Commission.

European Commission, EC (2003a), A Decision makers' Guidebook, Deliverable No 15, Project PROSPECTS (Procedures for Recommending Optimal Sustainable Planning of European City Transport Systems). 52 p.

European Commission, EC (2003b), A Methodological Guidebook. Deliverable 14, Project PROSPECTS (Procedures for Recommending Optimal Sustainable Planning of European City Transport Systems).

European Commission, EC (2011), Monitoring report of the EU sustainable development strategy. Sustainable development in the European Union. Luxembourg: Eurostat statistical books.

Expert Choice (2015). AHP: Science and math of better decision-making. <http://expertchoice.com/about-us/our-decision-making-methodology/>. Accessed 18th June, 2015.

Faiz, A. (2000), Sustainable transport for the Developing World: The Social and Environmental Nexus. Conference Proceeding Paper 2000/09/18. Transportation Planning and Air Quality IV: Persistent Problems and Promising Solutions. American Society of Civil Engineers.

Figueira, J., Greco, S. & Ehrgott, M. (eds.) (2005), Multiple Criteria Decision Analysis. State of the Art Surveys. Springer's International Series. USA.

The Finnish Maritime Administration (2005), Guidelines for the assessment of Investments on Waterways. Helsinki, Finland.

The Ministry of the Environment (1999), Guidelines for the environmental assessment of plans, programmes and policies in Finland. Helsinki, Finland: Edita Ltd.

The Ministry of Transport and Communications (2003a), Guidelines for the assessment of transport infrastructure projects. (In Finnish: Liikenneväylähankkeiden arvioinnin yleisohje.) Publications Liikenne- ja viestintäministeriön julkaisuja 34/2003. Helsinki, Finland.

The Ministry of Transport and Communications (2003b), Primary level of service on the road and rail network. (In Finnish: Liikkumisen ja kuljetusten peruspalvelutaso tie- ja rataverkolla.) Publication: Liikenne- ja viestintäministeriön julkaisuja 3/2003. Helsinki, Finland.

The Ministry of Transport and Communications (2003c), (In Finnish. Liikennepäästökustannusten päivitys ja yhteenveto). Publication: Liikenne- ja viestintäministeriön mietintöjä ja muistioita B29/2003. Helsinki, Finland.

The Ministry of Transport and Communications (2004), In Finnish. Kevyen liikenteen vaikutusten arvioinnin yleisohje. JALOIN-ohjelma. Liikenne- ja viestintäministeriön julkaisuja 32/2004. Helsinki, Finland.

The Finnish National Commission on Sustainable Development (2008), 'Towards a globally and nationally sustainable Finland'.
<http://www.ym.fi/download/noname/%7B608235CB-78AC-4475-8C6A-AEEE5595D790%7D/58472.> Accessed in March, 2012.

The Finnish National Institute for Health and Welfare (2013), Reducing Inequalities in Health and Wellbeing <http://www.thl.fi/en_US/web/kaventaja-en/health-inequalities-in-finland/life-expectancy>. Accessed 25th November, 2013. Finland.

The Finnish Rail Administration, RHK (2000), Intermediate report of the railway 2020 -program, Appraisal of the development options. ('Rataverkko 2020 -ohjelman väliraportti, Kehittämisvaihtoehtojen vaikutustarkastelut.) Publication: Ratahallintokeskuksen julkaisuja 1/2000.

The Finnish Rail Administration. (2004), Guidelines for appraisal of rail transport investments (In Finnish: Ratainvestointien hankearviointiohje.) Publications B12. Helsinki, Finland.

The Finnish Road Administration, Tiehallinto (2001), The calculation of road traffic costs. (In Finnish: Tieliikenteen ajokustannukset.) Tiehallinto. Helsinki: Edita Oyj.

The Finnish Road Administration, Tiehallinto (2004), Guide to assessment of road infrastructure project. (In Finnish: Tiehankkeiden arviointiohje.) Tiehallinto. Helsinki: Edita Prima.

The Finnish Transport Agency (2011), Guide to assessment of transport infrastructure projects. (In Finnish: Liikenneväylien hankearvioinnin yleisohje.) Publication: Liikenneviraston ohjeita 14/2011. Helsinki, Finland.

The Finnish Transport Agency (2012), Improved service level, Railway project Seinäjoki-Oulu.
<http://portal.liikennevirasto.fi/portal/e/projects/under_construction/seinajoki_oulu/Seinajoki-Oulu_90x210_ENG_120312.pdf>. Accessed January 2nd, 2013.

Fischer, T. B. (2004), Having an impact? – the influence of non-technical factors on the effectiveness of SEA in transport decision-making. Expert paper prepared for the BEACON Network Building Environmental Assessment CONsensus on the transeuropean transport network. May 21st, 2004.

FNCSD, The Finnish National Commission on Sustainable Development (2003), Defining sustainable development in Finland. The Ministry of the Environment,

Finland. <http://www.vyh.fi/ eng/environ/sustdev/tmkeng.htm>. Accessed in September, 2003.

Geldermann, J. & Rentz, O. (2000), Bridging the gap between American and European MADM Approaches? Paper presented at the 51st Meeting of the European Working Group Multicriteria Aid for Decisions, 30–31.03.2000. <http://www-dfiu.wiwi.uni-karlsruhe.de/forschung/technik_html/veroeffentlichungen/04_T/TGel2000d.pdf>. Accessed 15th May, 2006.

Graymore, M. L. M., Sipe, N. G. & Rickson, R. E. (2008), Regional sustainability: How useful are current tools of sustainability assessment at the regional scale? Ecological Economics 67 (2008) 362–372.

Häkkinen, T., Rauhala, K. & Huovila, P. (2006), Rakennetun ympäristön kestävän kehityksen kriteerit ja indikaattorit (Sustainable development criteria and indicators for urban design). VTT Tiedotteita – Research Notes 2325. Espoo, Finland: VTT.

Hanley, N. & Barbier, E.B. (2009), Pricing nature. Cost-benefit analysis and environmental policy. Aldershot, UK: Edward Elgar Publishing Limited.

Hanley, N. & Spash, C. L. (1993), Cost-benefit Analysis and the Environment. Aldershot, UK: Edward Elgar Publ. Ltd.

Hausman, D.M. & McPherson, M.S. (2006), Economic Analysis, Moral Philosophy, and Public Policy. Second edition. Cambridge University Press.

Hayashi, T., van Ierland, E.C. & Zhu, X. (2014), A holistic sustainability assessment tool for bioenergy using the Global Bioenergy Patnership (GBEP) sustainability indicators. Biomass and bioenergy 66 (2014) 70–80.

HEATCO (2005), Current practice in project appraisals in Europe. Analysis of Country Reports. Deliverable 1. Available in the world wide web: <http://heatco.ier.uni-stuttgart.de/deliverables.html>. Accessed April 10th, 2012.

HEATCO (2006), Proposal for Harmonised Guidelines. Deliverable 5. <http://heatco.ier.uni-stuttgart.de/deliverables.html>. Accessed April 10th, 2012.

Helsinki Metropolitan Area Council, YTV (1998), Strategic Environmental Impact Assessment of the Helsinki Metropolitan Area Transport System. Publication B 1998:4. In Finnish with English abstract. (Pääkaupunkiseudun liikennejärjestelmän strategisen tason ympäristövaikutusten arviointi. Pääkaupunkiseudun julkaisusarja B 1998:4.)

Helsinki Metropolitan Area Council, YTV (2002a), Impact Assessment of the Helsinki Metropolitan Area Transport System Plan. (In Finnish with English abstract: Pääkaupunkiseudun liikennejärjestelmäsuunnitelman vaikutusten arviointi.) Publication: Pääkaupunkiseudun julkaisusarja B 2002:10. Helsinki.

Helsinki Metropolitan Area Council, YTV (2002b), Information booklet about the Transport System Plan. (In Finnish: PLJ-tiedote 7, syyskuu 2002.)

Helsinki Metropolitan Area Council, YTV (2004), Cross-town Public Transport: Vision 2030 and Development Plan for the years 2005–2020. Publication B 2004:14. In Finnish with English abstract. (Poikittaisen joukkoliikenteen visio 2030 ja kehittämissuunnitelma vuosille 2005–2010. Pääkaupunkiseudun julkaisusarja B 2004:14.)

Helsinki Metropolitan Area Council, YTV (2006), Impact Assessment of the Transport System Plan 2007 of the Helsinki Metropolitan Area. (In Finnish with English abstract: PLJ 2007 vaikutusten arviointi.) Publication: Pääkaupunkiseudun julkaisusarja B 2006:20. Helsinki.

Helsinki Metropolitan Area Council, YTV (2007), Business review of the Helsinki Metropolitan Area, facilities 2007 (In Finnish: Pääkaupunkiseudun yrityskatsaus 2007).

Heltimo, J. (2003), Social Sustainability in Strategic Transportation Impact Assessment. (In Finnish: Sosiaalinen kestävyys liikenteen ohjelmatason arvioinneissa.) Publications of the Ministry of Transport and Communications, 31/2003. Helsinki. 139 p.

Heltimo, J. (2006), The suitability of the criteria in the assessment of welfare impacts, Case Seinäjoki-Oulu railway connection. Memorandum. (In Finnish: Hyvinvointivaikutusten arviointikriteeristön soveltuvuus hyvinvointivaikutusten arviointiin, Case Seinäjoki–Oulu-ratahanke.)

Hildén, M., Furman, E. & Kaljonen, M. (2004), Views on planning and expectations on SEA: the case of transport planning. Environmental Impact Assessment Review 24 (2004) 519–536.

Hine, J. (2003), Social exclusion and transport systems. Transport Policy. Volume 10, Issue 4. P. 263.

HM Treasury (2003), Green Book, Appraisal and Evaluation in Central Government. Available from the world wide web: http://greenbook.treasury.gov.uk/. Accessed July 2007.

Hodgson, F.C. & Turner, J. (2003), 'Participation not consumption: the need for new participatory practices to address transport and social exclusion'. Transport Policy. Volume 10, Issue 4. Pp. 265–272.

Hokkanen, J., Lahdelma, R. et al. (1998), Determining the implementation order of a general plan by using a multicriteria method. Journal of multi-criteria decision analysis 7: 273–284 (1998).

HSL (2013), The popularity of public transport in the Helsinki region is growing faster than car traffic (In Finnish: Joukkoliikenteen suosio Helsingin seudulla kasvaa nopeammin kuin henkilöautoilu). <https://www.hsl.fi/uutiset/2013/joukkoliikenteen-suosio-helsingin-seudulla-kasvaa-nopeammin-kuin-henkiloautoilu-2133>. Accessed 8th February, 2015.

Jones, P. & Lucas, K. (2000), Integrating transport into 'joined-up' policy appraisal. Transport Policy 7 (2000) 185–193.

Kajanoja J. (1999), Theoretical Foundations for the Indicators of Welfare and Sustainable Development. (In Finnish: Hyvinvoinnin ja kestävän kehityksen indikaattoreiden teoreettisia lähtökohtia.) Unpublished report of a seminar on indica-

tors of welfare organized by VATT (Government Institute for Economic Research), August 17th 1999.

Kaljonen, M. (2000), Environmental Assessment's Role in the Transport System Planning. A case study from Helsinki Metropolitan Area. Finnish Environmental Institute. In Finnish with English abstract. (Vaikutusten arviointi liikennejärjestelmäsuunnittelun tukena. Suomen ympäristö, ympäristöpolitiikka 410. Helsinki, Finland: Suomen ympäristökeskus.)

Kane, L. (2010), Sustainable transport indicators for Cape Town, South Africa: Advocacy, negotiation and partnership in transport planning practice. Natural Resources Forum 34 (2010) 289–302.

Kasperczyk, N. & Knickel, K. (2004), The Analytic Hierarchy Process (AHP). <http://www.ivm.vu.nl/en/Images/MCA3_tcm53-161529.pdf>. Accessed 22nd May, 2012.

Kauffmann, D.L. Jr. (1980), Systems 1: An Introduction to Systems Thinking. (Innovative Learning Series.)

Kauppinen, T. (2006), Human Impact Assessment in Finland. Paper for the Human Impact Assessment seminar. 25.1.2006. Kellokoski, Finland.

Kauppinen, T. & Nelimarkka, K. (2004), Human Impact Assessment (HuIA) as a tool of welfare management. Training material. September 15, 2004. <http://www.thl.fi/thl-client/pdfs/9d6392cb-e995-4c04-8855-73fcf31392c4>. Accessed November 25th, 2013.

Kauppinen, T. & Tähtinen, V. (2003), (Human Impact Assessment, a Guidebook). In Finnish. Ihmisiin kohdistuvien vaikutusten arviointi -käsikirja). Stakes, aiheita 8/2003. Tilausnumero A308. Helsinki: Stakes. 43 p.

Keeney, R. L. (1992), Value-focused thinking: a path to creative decision-making. London: Harvard University Press.

Keeney, R.L. (1996), Value-focused thinking: Identifying decision opportunities and creating alternatives. European Journal of Operational Research (1996) 537–549.

Keeney, R.L. & Raiffa, H. (1993), Decisions with Multiple Objectives: preferences and Value Tradeoffs. Cambridge University Press. 569 p.

Keeney, R.L., De Corte J.-M. & Vansnick, J-C. (2005), On the mathematical foundations of MACBETH. In: Figueira, J., Greco, S. & Ehrgott, M. (editors) (2005). Multiple Criteria Decision Analysis. Pp. 409–442. Springer's International Series.

Kinnunen, P., Kortelainen, J., Pakarinen, T. & Rusanen, J. (2001), Basis for the social impact assessment – The city code of Oulu. (In Finnish: Sosiaalisten vaikutusten arvioinnin lähtökohtia – Oulun kaupungin yleiskaava 2020.) Oulu.

Kolosz, B. & Grant-Muller, S. (2015), Extending cost-benefit analysis for the sustainability impact of inter-urban intelligent Transport Systems. Environmental Impact Assessment Review 50 (2015) 167–177.

Koo, D.-H., Ariaratnam, S. & Kavazanjian, E. Jr. (2009), Development of a sustainability assessment model for underground infrastructure projects. Canadian Journal of Civil Engineering 36 (2009) 765–776.

Korkiala-Tanttu, L., Tenhunen, J., Eskola, P., Häkkinen, T., Hiltunen M.-R. & Tuominen, A. (2006), Environmental Values and Ecoindicators of the Infra Construction (In Finnish with English abstract: Väylärakentamisen ympäristövaikutukset ja ekoindikaattorit; Ehdotus arviointijärjestelmiksi.) Publication: Tiehallinnon selvityksiä 22/2006. Helsinki: The Finnish Road Administration.

Kulmala, R., Luoma, J. et al. (2002), FITS 2002, Guidelines for the evaluation of ITS projects. FITS-publications 4/2002. Liikennetelematiikkahankkeiden arviointiohjeet. FITS-julkaisuja 3/2002. Helsinki, Finland: The Ministry of Transport and Communications, liikenne- ja viestintäministeriö. 83 p.

Kumar, V., Rouquette, J.R. & Lerner, D.N. (2013), Integrated modelling for Sustainability Appraisal of urban river corridors: Going beyond compartmentalised thinking. Water Research 47 (2013) 7221–7234.

Laitinen, A. (2009), Joseph Raz ja hyvinvoinnin ulottuvuudet. In: Niemi, P. & Kotiranta, T. (editors). Sosiaalialan normatiivinen perusta (In Finnish). Pp. 34–69. Helsinki, Finland: Gaudeamus Oy.

Lercher, P. (2003), Which health outcomes should be measured in health related environmental quality of life studies? Landscape and urban planning 65 (2003) 63–72.

Leskinen, A. (1994), Environmental Planning as Learning: The Principles of Negotiation, the Disaggregative Method and Parallel Organization in developing the Road Administration. Helsinki: University of Helsinki, Department of Economics and Management. (Publications No. 5, Land Use Economics.)

Litman T. (2001), You can get there from here. Evaluating transportation choice. Victoria Transport Policy Institute. Also available from the World Wide Web: http://www.vtpi.org/choice. [Accessed 04 August 2006].

Lootsma, F.A. (1993a), The French and American School in multicriteria decision analysis. Operations Research 24: 263–285.

Lootsma, F.A. (1993b), Scale sensitivity in the multiplicative AHP and SMART. Journal of Multi-Criteria Decision Analysis 2: 87–110.

López, E. & Monzón, A. (2010), Integration of sustainability issues in Strategic Transportation planning: A Multi-Criteria Model for the Assessment of Transport Infrastructure Plans. Computer-Aided Civil and Infrastructure Engineering 25 (2010) 440–451.

Lyons, G. (2003), The introduction of social exclusion into the field of travel behaviour. Transport Policy. Volume 10, Issue 4. Pp. 339–342.

Lyytimäki, J. (2004), Producing Multidisciplinary State of the Environment Reports: Two Tales from Finland. The Journal of Transdisciplinary Environmental Studies, Vol. 3, No. 2, 2004.

Maani, K. E. & Cavana, R. Y. (2003), Systems Thinking and Modelling. Understanding Change and Complexity. Prentice Hall. Pearson Educ. New Zealand Ltd.

Macharis, C. & Bernardini, A. (2015), Reviewing the use of Multi-Criteria Decision Analysis for the evaluation of transport projects: Time for a multi-actor approach. Transport Policy 37 (2015) 177–186.

Macharis, C. & Nijkamp, P. (2013), Multi-actor and multi-criteria analysis in evaluating mega-projects. In: Priemus, H. & van Wee, B. (Eds.) (2013), International Handbook on Mega-Projects. Edgar Elgar Publishing Limited.

Macharis, C., De Witte, A. & Turcksin, L. (2010), The Multi-Actor Multi-Criteria Analysis (MAMCA) application in the Flemish long-term decision making process on mobility and logistics. Transport Policy 17 (2010), 303–311.

Macharis, C., Turcksin, L. & Ledeau, K. (2012), Multi actor multi criteria analysis (MCMA) as a tool to support sustainable decisions: State of use. Decision Support Systems 54 (2012) 610–620.

Macharis, C., Milan, L. & Verlinde, S. (2014), A stakeholder-based multicriteria evaluation framework for city distribution. Research in Transportation Business & Management 11 (2014) 75–84.

Mackie, P. & Kelly, C. (2007), Transport Appraisal in other countries: lessons for the NATA Refresh. A Report to the Department of Transport. Institute for Transport Studies, University of Leeds.

Mackie, P. & Nellthorp, J. (2003), Transport Appraisal in a Policy Context. In: Pearman, A., Mackie, P. and Nellthorp, J. (eds.) (2003). Transport projects, programmes and policies. Evaluation needs and capabilities. Contemporary Trends in European Social Sciences. Ashgate Publishing.

Mackie, P., Worsley, T. & Eliasson, T. (2014), Transport appraisal revisited. Research in Transportation Economics (2014), http://dx.doi.org/10.1016/j.retrec.2014.09.013.

Marski, J. (1995), Dimensions of Welfare 1995: Risks, Opportunities and New Challenges. In Finnish: Hyvinvoinnin ulottuvuuksia 1995: uhat, mahdollisuudet ja uudet haasteet. The Social Insurance Institution of Finland. Studies in social security and health 15/1995. Helsinki. 124 p.

Maslow, A.H. (1943), A Theory of Human Motivation. Psychological Review 1943.

Midgley, G. & Reynolds, M. (2001), Operational research and environmental management: towards a new agenda. Birmingham, UK: The Operational Research Society.

Midgley, G. & Reynolds, M. (2004), Systems/Operational Research and sustainable development: towards a new agenda. Sustainable Development 12, 56–64 (2004). John Wiley & Sons, Ltd and ERP Environment.

The Ministry of Social Affairs and Health (2007), Welfare 2015 programme. Long-term objectives for social services. 2007:3 Publications of the Ministry of Social Affairs and Health, Finland.

Moshkovich, H. & Mechitov, A. (2005), Verbal decision analysis. In: Figueira, J., Greco, S. and Ehrgott, M. (eds.) (2005), Multiple criteria decision analysis, State of the art surveys. International series in operations research and management science. Springer science + business media Inc.

Mouter, D., Annema, J.A. & van Wee, B. (2013), Attitudes towards the role of Cost-Benefit Analysis in the decision-making process for spatial-infrastructure projects. Transportation Research Part A 58 (2013) 1–14.

Munda, G. (2005), Multiple Criteria Decision Analysis and Sustainable Development. In: Multiple Criteria Decision Analysis, State of the Art Surveys. Springer's International Series. Chapter 23, pp. 953−986.

Munda, G., Nijkamp, P. & Rietveld, P. (1994), Qualitative multicriteria evaluation for environmental management. Ecological Economics 10, 97–112.

The National Building Code of Finland. (2000), www.environment.fi. Helsinki.

National Research and Development Centre for Welfare and Health, Finland, (2007), Human impact assessment. Ideacard 06/7. Helsinki, Finland.

Neller, A.H. & Neller, R.J. (2009), Environmental Well-being and Human Well-being. In: Institutional issues involving ethics and justice – Vol. 2 – Encyclopedia of Life Support Systems (EOLSS). Oxford, UK.

Ness, B., Urbel-Piirsalu, E., Anderberg, S. & Olsson, L. (2007), Categorising tools for sustainability assessment. Ecological Economics 60 (2007) 498–508.

Neste, J. & Karjalainen, T.P. (2013), A literature review – The use of multi-criteria decision analysis in Environmental Impact Assessment. Report on the use of MCDA in EIA and SEA. IMPERIA EU LIFE11 ENV/FI/905. Inception report. Annex 7.2.5.

OECD, Organisation for Economic Cooperation and Development. (2001), The DAC Guidelines. Strategies for Sustainable Development, Guidance for Development Co-operation. < http://www.oecd.org/dac/environment-development/2669958.pdf>. Accessed in September, 2003. OECD Publications Service. Paris. 76 p.

OEEI, Research Programme on the Economic Impacts of Infrastructure. (2000), Evaluation of infrastructural projects; Guide for Cost-benefit analysis. Section I: Main Report. Research Programme on the economic effects of Infrastructure. CPB Netherlands Bureau for Economic Policy Analysis. Netherlands Economic Institute NEI.

Olson, D.L. (1996), Decision Aids for Selection Problems. Springer Series in Operations Research. New York Inc., USA: Springer-Verlag.

O'Riordan, T. (2013), Sustainability for wellbeing. Environmental Innovation and Societal Transitions 6 (2013) 24−34.

Phillips, L. & Stock, A. (2003), Use of Multi-Criteria Analysis in Air Quality Policy. A report prepared for the Department for Environment, Food and Rural Affairs. <http://www.defra.gov.uk/environment/airquality/mcda/mcda-report.pdf>. Accessed 4 January 2006.

PIARC (2015). Exchange knowledge and techniques on roads and road transportation. <http://www.piarc.org/en/>. Accessed 18th June, 2015.

Prescott-Allen, R. (2001), The Wellbeing of Nations: A Country-By-Country Index of Quality of Life and the Environment. Co-published by Island Press, Washington D.C.. In cooperation with International Development Research Centre, IUCN-The World Conservation Union, International Institute for Environment and Development, Food and Agriculture Organization of the United Nations, Map Maker Ltd., UNEP World Conservation Monitoring Centre.

Reisi, M., Aye, L., Rajabifard, A. & Ngo, T. (2014), Transport sustainability index: Melbourne case study Renewable. Ecological Indicators 43 (2014) 288–296.

Ribeiro, F., Ferreira, P. & Araújo, M. (2013), Evaluating future scenarios for the power generation sector using a Multi-Criteria Decision Analysis (MCDA) tool: The Portuguese case. Energy 52 (2013) 126−136.

Rinne, J., Lyytimäki, J. & Kautto, P. (2013), From sustainability to well-being: Lessons learned from the use of sustainable development indicators at national and EU level. Ecological Indicators 35 (20013) 35−42.

Rorarius, J. (2007), Existing Assessment Tools and Indicators: Building up Sustainability Assessment (Some Perspectives and Future Applications for Finland). The Ministry of the Environment. August 24th, 2007. Helsinki, Finland.

Rosenström, U. & Palosaari, M. (2000), Kestävyyden mitta: Suomen kestävän kehityksen indikaattorit 2000. Helsinki: Ympäristöministeriö.

Roy, B. (2005), Paradigms and challenges. In: Figueira, J., Greco, S. and Ehrgott, M. (eds.) (2005), Multiple criteria decision analysis, State of the art surveys. International series in operations research and management science. Springer science + business media Inc.

Roy, B. & Vanderpooten, D. (1996), The European School of MCDA: Emergence, Basic Features and Current Works. Journal of multi-criteria decision analysis, Vol. 5, 22–38.

Rusila, K. (2004a), An approach to holistic evaluation of welfare impacts in strategic transport system planning. ECTRI-FERSI Young Researchers Seminar, December 2003. Paper revised in January 2004.

Rusila, K. (2004b), Evaluation of welfare impacts in Finnish regional system planning until the year 2000. (In Finnish.) Hyvinvointivaikutusten arviointi Suomen liikennejärjestelmäsuunnittelussa vuoteen 2000. Licentiate thesis. Helsinki University of Technology.

Rusila, K., Pekkarinen, S. & Britschgi, V. (2003), Finnish experience of ecological, social, economic and health-related welfare impacts in strategic planning of urban transport system. – Selected Proceedings of the 9th World Congress on Transport Research (WCTR), 22–27 July 2001, Seoul Korea, CD-rom. Elsevier Science Ltd.

Saarikoski, H., Mustajoki, J. & Marttunen, M. (2013), Participatory multi-criteria assessment as 'opening up' vs. 'closing down' of policy discourses: A case of old-growth forest conflict in Finnish Upper Lapland. Land Use Policy 32 (2013) 329–336.

Saaty, T. L. (2005), The Analytic Hierarchy and Analytic Network Processes for the measurement of intangible criteria and for decision-making. In: Multiple Criteria Decision Analysis; State of the Art Surveys (eds. Figueira, J., Greco, S. and Ehrgott, M), (2005). Pp. 345–407.

Saaty, T. L. & Vargas, L. G. (1994), Decision making in Economic, Political, Social and Technological Environments. The Analytic Hierarchy Process Series Vol. VII. Pittsburgh, USA: University of Pittsburgh.

Saelensminde, K. (2004), Cost-benefit analyses of walking and cycling track networks taking into account insecurity, health effects and external costs of motorized traffic. Transportation Research Part A 38, 593–606.

Sairinen, R. (2004), Social impact assessment in urban planning. Advances in architecture series, Volume 18, page 423. ISSN 1368-1435.

Sayers, T. M., Jessop, A. T. & Hills, P. J. (2003), Multi-criteria evaluation of transport options – flexible, transparent and user-friendly? Transport Policy, Volume 10, Issue 2, April 2003. Pages 95–105.

Schönfelder, S. & Axhausen, K. W. (2003), Activity spaces: measures of social exclusion? Transport Policy. Volume 10, Issue 4. Pp. 273–286.

Shiau, T.-A. & Liu, J.-S. (2013), Developing an indicator system for local governments to evaluate transport sustainability strategies. Ecological Indicators 34 (2013) 361−371.

Sirkiä, A., Markkanen, A. & Metsäranta, H. (2000), The present passenger traffic infrastructure and its change factors. Henkilöliikenteen infrastruktuurin nykytila ja muutostekijät. In Finnish. The Ministry of Transport and Communications. Liikenneministeriön julkaisuja 21/2000. Helsinki.

Sorvari, J. (2010), Application of Risk Assessment and Multi-Criteria Analysis in Contaminated Land Management in Finland. Monographs of the Boreal Environment Research. Monograph No. 37.

SOul (2003), The enhancement of Seinäjoki–Oulu railway connection, analysis of the current state of the transport system. (In Finnish: Seinäjoki–Oulu ratakäytävän kehittämissuunnitelma, liikennejärjestelmän nykytilan analyysi, luonnos 29.9.2003.)

SOul (2005a), Seinäjoki–Oulu tasonnosto, Ympäristövaikutusten arviointimenettely, Ympäristövaikutusten arviointiohjelma 2005 (The improvement of the level of service of Seinäjoki–Oulu railway connection, Environmental impact assessment, Environmental impact assessment programme 2005).

SOul (2005b), The enhancement strategy of the railway connection Seinäjoki–Oulu, Soul. (In Finnish: Seinäjoki–Oulu-(SOul) ratakäytävän kehittämisstrategia.) Oulu, Finland: Liidea Ltd.

SOul (2005c), The statement of the contact authority on the environmental impact programme of the improvement of the level of service of the Seinäjoki–Oulu railway connection. (Yhteysviranomaisen lausunto ympäristövaikutusten arviointiohjelmasta koskien Seinäjoki–Oulu-rataosan palvelutason parantamishanketta.) Vaasa.

SOul (2006), The improvement of the level of service of the railway connection Seinäjoki–Oulu, Environmental impact assessment, Environmental impact assessment report. (In Finnish: Seinäjoki–Oulu-radan palvelutason parantaminen, Ympäristövaikutusten arviointimenettely, Ympäristövaikutusten arviointiselostus.)

Souza Santos, A. & Kahn Ribeiro, S. (2013), Current Opinion in Environmental Sustainability 2013, 5, 251–260.

Statistics Finland (2014a), BusinessOulu – Industries. <http://tilastokeskus.fi/tup/seutunet/businessoulu_toimialat_en.html>. Accessed December 3rd, 2014.

Statistics Finland (2014b), Finland in Figures. <https://www.tilastokeskus.fi/tup/suoluk/index_en.html>. Accessed December 3rd, 2014.

Steg, L. & Gifford, R. (2005), Sustainable transportation and quality of life. Journal of Transport Geography 13, 59–69.

Sudgen, R. (2003), Conceptual Foundations of Cost-benefit Analysis: A Minimalist Account. In: Pearman, A., Mackie, P. & Nellthorp, J. (eds.) Transport Projects, Programmes and Policies. Evaluation Needs and Capabilities. Aldershot: Ashgate.

The Sustainable Society Foundation – SSF (2013), Notes and Definitions. <http://www.ssfindex.com/sustainability/notes-and-definitions/>. Netherlands. Accessed November 25th, 2013.

Tapaninen, A., Kauppinen T. et al. (2002), Ympäristö ja hyvinvointi (The Environment and welfare). STAKES. In Finnish. Porvoo, Finland: WSOY.

Thomopoulos, N., Grant-Muller, S. & Tight, M.R. (2009), Incorporating equity considerations in transport infrastructure evaluation: Current practice and a proposed methodology. Evaluation and Program Planning 32 (2009) 351–359.

Tomlinson, P. (2001), Transport Planning: Influence of Strategic environmental assessment / Integrated assessment on decision-making. In: Furman, E. & Hildén, M. (eds.) (2001), The Finnish Environment 534. Final Report of a Workshop. Helsinki. 82 p.

Triantaphyllou, E. (2000), Multi-criteria decision making methods: A comparative study. Dordrecht, NL: Kluwer Academic Publishers.

Tzay-An Shiaua, T.-A. & Liu, J.-S. (2013), Developing an indicator system for local governments to evaluate transport sustainability strategies. Ecological Indicators 34 (2013) 361– 371.

UI Wellness Center (2013), Environmental Wellness. <http://www.campusrec.illinois.edu/wellnesscenter/dimensions/environmental.html>. USA. Accessed November 25th, 2013.

Valli, R. (1998), (Environmental) assessment in transport policy planning. (Ympäristö)vaikutusten arviointi liikennepoliittisessa suunnittelussa. Doctoral thesis. Helsinki: University of Helsinki, Department of Limnology and Environmental Protection.

Valve, H. (1999), Frame conflicts and the formulation of alternatives: environmental assessment of an infrastructure plan. Environmental Impact Assessment Review 1999;19:125–142.

Van Praag, B.M.S. & Frijters, P. (1999), The measurement of welfare and well-being. The Leyden approach. In: Diener, E., Schwartz, D. & Frijters, P. (Eds.) (1999), Well-being: the foundations of hedonic psychology. Russel Sage Foundation.

Van Wee, B. (2011), Transport and Ethics, Ethics and Evaluation of Transport policies and Projects. Transport Economics, Management and Policy. Edward Elgar Publishing.

Van Wee, B., Annema, J.A. & Banister, D. (2013), The transport system and transport policy. Edward Elgar Publishing.

Wang, L. (2014), Framework for Evaluating Sustainability of Transport System in Megalopolis and its Application. IERI Procedia 9 (2014) 110–116.

WCED, the World Commission on Environment and Development (1987), Our Common Future. Report of the World Commission on Environment and Development. <http://www.un-documents.net/our-common-future.pdf>. Accessed February 24th, 2014.

Weiss, C. H. (1998), Evaluation. Methods for Studying Programs and Policies. 2nd ed. Upple Saddle River, New Jersey: Prentice Hall.

WHO, World Health Organization (2013), Human Impact Assessment. <http://www.who.int/hia/tools/toolkit/whohia033/en/>. Accessed November 25th, 2013.

Appendix A: A general list of potential welfare impacts of changes in the transport system

Table 29. Potential welfare impacts of changes in the transport system (Rusila, 2004a, 2004b).

Direct and indirect impacts that influence the nature - Well-being, living conditions and interdependency of flora and fauna - Conditions of endangered species - Amount and quality of area in natural state	**Chains of impacts that contribute to business environment** - Business fluency - Safety, comfort and easiness of travel (employees and customers) - Use of terminals - Use of premises
Direct and indirect impacts that have an effect on human health, safety or social conditions - Quality of life and life-style - Living conditions - Satisfaction with the milieu - Attitudes towards the nature - Population; number and structure - Effects on special groups of people, e.g. children, the elderly or handicapped - Status and interrelations of population groups - Social relationships - Behaviour, manners - Attitudes, conflicts - Values, norms - Structure of public and private services - Accessibility of services - Employment, unemployment - Income level and structure - Wealth and properties - Costs of living - Participation in decision-making concerning the milieu - Opportunities to affect local decision-making - Communication links, information - Accident risk - Exposure to air pollutants	**Chains of impacts that influence the economy of households, communities of enterprises** *Economy of households;* - Travel costs - Health care costs - Living costs - Leisure costs - Social costs, e.g. services for the elderly or prevention of crime *Economy of communities:* - Construction costs - Maintenance costs - Transport costs - Land rent - Property values - Changes in land use (from leisure use to industrial) and its effectiveness - Changes in accessibility - Changes in social status (for example changes in property values due to changes in social status) - Costs to maintain biodiversity and vitality of the environment *Economy of enterprises:* - Changes in cost-effectiveness

- Exposure to noise - Quality of water supplies - Quality of food supplies - Exposure to radiation	- Changes in market area - Changes in business situation

Appendix B: The questionnaire of the Internet survey (translation of the original Finnish questionnaire)

Table 30. A translation from Finnish, of the Internet survey questionnaire.

What are the impacts of modifications in the transport system on the welfare of people, the environment and the society?
An internet-questionnaire survey about the welfare impacts of transport system planning

A. Background information
This is background information only, no individual respondents will be identified or studied.

Gender	
Female	
Male	

Age	
< 18	
18-19	
20-29	
30-39	
40-49	
50-64	
65-74	
> 75	

Reference group; Indicate which group of people you belong to (if necessary, you can choose several alternatives):	
☐	Decision-makers in Helsinki Metropolitan Area
☐	The task force for the regional structure of the Oulu region
☐	Decision-makers in Oulu region
☐	Representatives from the neighbouring districts
☐	Transport and land use planners

☐	Transport services providers
☐	Other experts in transport and community planning
☐	Representatives of business sector
☐	Employees in industry and trade
☐	Health and social sector
☐	Schools and education
☐	Environment protection
☐	The media
☐	Civic organizations
☐	Others

Have you ever participated in transport system planning?
○ No, I haven't
○ Yes, I have
If yes, what was your role/task in the process?


B. Welfare Impacts

For example the following measures can be used to improve the transport system:
-constructing new infrastructure, for example on the major regional road network,
- enhancing the existing infrastructure
- modifying the level of service of the public transport system,
- modifying the conditions for walking and cycling,
- increasing or decreasing the amount parking spaces,
- modifying the pricing of public transport or car parking.
The following tables include different types of potential welfare impacts. Which of these should be assessed primarily before decisions concerning the transport system are made? Please think about the significance of these impacts for **the welfare of people, groups of people or the environment**. Some interpretations of the scale of significance are presented below.
8 = Very significant impact
4 = Rather significant impact
0 = Impact of no significance
eos = uncertain/no reply

	SIGNIFICANCE OF THE IMPACT									
1. Accessibility	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***	***eos***
Regional and urban structure	○	○	○	○	○	○	○	○	○	○
Amount and quality of activities (services, housing, employment, leisure activities)	○	○	○	○	○	○	○	○	○	○
Location of activities (services, housing, employment, leisure activities)	○	○	○	○	○	○	○	○	○	○
Population size and structure	○	○	○	○	○	○	○	○	○	○
Community structure that supports public, pedestrian and bicycle transport)	○	○	○	○	○	○	○	○	○	○
Connections to basic public and private services (shopping facilities, health services, post offices etc.)	○	○	○	○	○	○	○	○	○	○
Connections to other shops and personal business	○	○	○	○	○	○	○	○	○	○
Connections to workplaces, schools, children’s day-care etc.	○	○	○	○	○	○	○	○	○	○
Connections to leisure activities	○	○	○	○	○	○	○	○	○	○
Possibilities to combine modes of transport	○	○	○	○	○	○	○	○	○	○
Freight transport connections	○	○	○	○	○	○	○	○	○	○
Connections at different times of day, week and year	○	○	○	○	○	○	○	○	○	○
Connections and supply of local public transport	○	○	○	○	○	○	○	○	○	○
Connections of long-distance transport	○	○	○	○	○	○	○	○	○	○
Connections of bicycle and pedestrian transport	○	○	○	○	○	○	○	○	○	○
Passenger car connections	○	○	○	○	○	○	○	○	○	○
Air, waterways and flight transport connections	○	○	○	○	○	○	○	○	○	○
Predictability and accuracy	○	○	○	○	○	○	○	○	○	○
Predictability of travel times	○	○	○	○	○	○	○	○	○	○
Functionality and fluency of trip and transport chains	○	○	○	○	○	○	○	○	○	○
Certainty of successful trip or transport	○	○	○	○	○	○	○	○	○	○
Other?	○	○	○	○	○	○	○	○	○	○

	SIGNIFICANCE OF THE IMPACT									
2. Hindrance in the transport system	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***	***eos***
Unhindered means of transport	○	○	○	○	○	○	○	○	○	○
Unhindered transport infrastructure	○	○	○	○	○	○	○	○	○	○
Obstacles caused by transport infrastructure	○	○	○	○	○	○	○	○	○	○
Condition of connections and maintenance	○	○	○	○	○	○	○	○	○	○
Travel costs	○	○	○	○	○	○	○	○	○	○
Freight transport costs	○	○	○	○	○	○	○	○	○	○
Purchase and operation costs of the means of transport	○	○	○	○	○	○	○	○	○	○
Availability and quality of information and guidance	○	○	○	○	○	○	○	○	○	○
Perceived health	○	○	○	○	○	○	○	○	○	○
Other?	○	○	○	○	○	○	○	○	○	○

	SIGNIFICANCE OF THE IMPACT									
3. Health, safety and attractive living environment	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***	***eos***
Traffic noise	○	○	○	○	○	○	○	○	○	○
Traffic emissions	○	○	○	○	○	○	○	○	○	○
Case specific criteria (e.g. vibration, smell, other unhealthy)	○	○	○	○	○	○	○	○	○	○
Risk of contamination of surface and ground water	○	○	○	○	○	○	○	○	○	○
Possibilities for walking and cycling	○	○	○	○	○	○	○	○	○	○
Perceived health impacts	○	○	○	○	○	○	○	○	○	○
Risk of accident or injury	○	○	○	○	○	○	○	○	○	○
Experienced safety	○	○	○	○	○	○	○	○	○	○
Land use characteristics (density, fragmentation)	○	○	○	○	○	○	○	○	○	○
Satisfaction with residential environment	○	○	○	○	○	○	○	○	○	○
Vitality of villages and population centres	○	○	○	○	○	○	○	○	○	○
Regional identity	○	○	○	○	○	○	○	○	○	○
Other?	○	○	○	○	○	○	○	○	○	○

	SIGNIFICANCE OF THE IMPACT									
4. Opportunities for participation and decision-making	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***	***eos***
Opportunities for participation in transport system planning	○	○	○	○	○	○	○	○	○	○
Opportunities for participation in transport system decision-making	○	○	○	○	○	○	○	○	○	○
Other?	○	○	○	○	○	○	○	○	○	○
	SIGNIFICANCE OF THE IMPACT									
5. Quality of life, lifestyles	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***	***eos***
Attitudes, values	○	○	○	○	○	○	○	○	○	○
Relations between community members	○	○	○	○	○	○	○	○	○	○
Satisfaction with living conditions	○	○	○	○	○	○	○	○	○	○
Every day ways of living and mobility	○	○	○	○	○	○	○	○	○	○
Social interaction and networks	○	○	○	○	○	○	○	○	○	○
Other?	○	○	○	○	○	○	○	○	○	○
	SIGNIFICANCE OF THE IMPACT									
6. The nature and built environment	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***	***eos***
Emissions og greenhouse gases	○	○	○	○	○	○	○	○	○	○
Risk of contamination of groundwater/quality of groundwater	○	○	○	○	○	○	○	○	○	○
Quantity and quality of wild regions	○	○	○	○	○	○	○	○	○	○
Quantity of animal and plant species	○	○	○	○	○	○	○	○	○	○
Viability of nature	○	○	○	○	○	○	○	○	○	○
Exploitation of natural resources (especially non-renewable natural resources)	○	○	○	○	○	○	○	○	○	○
Other?	○	○	○	○	○	○	○	○	○	○
	SIGNIFICANCE OF THE IMPACT									
7. Economic conditions	***8***	***7***	***6***	***5***	***4***	***3***	***2***	***1***	***0***	***eos***
Public transport expenditures	○	○	○	○	○	○	○	○	○	○
Public sector; capital value of the transport system	○	○	○	○	○	○	○	○	○	○
Public sector; other investment needs	○	○	○	○	○	○	○	○	○	○
Productivity in other sectors in the economy	○	○	○	○	○	○	○	○	○	○
General economic growth (output, tax incomes)	○	○	○	○	○	○	○	○	○	○

Labour supply										
Operational preconditions for new business										
Locational advantages of a region, community or city (concerning housing, industries, trade, tourism)										
Private sector; land price										
Private sector; value of real estates										
Private sector; renting expenses										
Private sector; building costs										
Private sector; level and structure of wealth/property										
Private sector; income level and structure										
Business sector; profitability										
Business sector; competition										
Other?										

Thank You!

Submit Reset

Appendix C: Summary of the analyses of the Internet survey

Table 31. The table shows the significance of the criteria according to the mean values of the responses, the differences in opinions geographically and between the actors and non-actors of regional transport planning (derived with t-test, indicating the probability of agreement in the significance of the criteria), as well as the distributions of the opinions of the respondents in the Helsinki MA and in Oulu region.

	Significance of a criterion (average)[1]	***Differences in opinions geographically[2]***	***Differences of opinions between actors and non-actors[3]***	***The comparison of opinions: significant/ not significant geographically.[4]***	
Criterion	***S / s***	***-- / ++***	***-- / ++***	***Helsinki MA %***	***Oulu %***
Regional and urban structure	**S**			94 / 0	93 / 3
Amount and quality of activities (services, housing, employment, leisure activities)	**S**	++		92 / 0	90 / 0
Location of activities (services, housing, employment, leisure activities)	**S**			94 / 0	90 / 0
Population size and structure	**S**	++		81 / 0	84 / 3
Community structure that supports public, pedestrian and bicycle transport)	**S**	++	--	90 / 0	90 / 0
Connections to basic public and private services (shopping facilities, health services, post offices etc.)	**S**			92 / 0	94 / 0
Connections to other	**S**	++	++	66 / 2	68 / 0

[1] Significant (S); mean value of responses ≥ 6. Rather significant (s); mean value of responses ≈ 5,9**.**

[2] Respondents in Oulu and Helsinki MA: (++) agree on the significance of this criterion ($p \leq 0,25$), or (--) disagree on the significance of this criterion ($p \geq 0,75$)

[3] Actors and non-actors in transport planning: (++) agree on the significance of this criterion ($p \leq 0,25$), or (--) disagree on the significance of this criterion ($p \geq 0,75$)

[4] % of respondents say this criterion is a significant one / % of respondents think this criterion is insignificant

shops and personal business					
Connections to workplaces, schools, children's day-care etc.	**S**		++	87 / 0	94 / 0
Connections to leisure activities				56 / 2	48 / 6
Possibilities to combine modes of transport	**S**		++	79 / 2	63 / 3
Freight transport connections			--	41 / 3	55 / 6
Connections at different times of day, week and year		--		75 / 0	45 / 0
Connections and supply of local public transport	**S**		--	89 / 0	94 / 0
Connections of long-distance transport				51 / 2	65 / 0
Connections of bicycle and pedestrian transport	**S**	--		87 / 0	100 / 0
Passenger car connections	**S**	--		71 / 2	83 / 0
Air, waterways and flight transport connections			--	56 / 2	67 / 0
Predictability and accuracy	**S**			83 / 0	63 / 0
Predictability of travel times	s			69 / 3	70 / 3
Functionality and fluency of trip and transport chains	**S**		++	78 / 2	80 / 0
Certainty of successful trip or transport	**S**		--	78 / 0	73 / 0
Unhindered means of transport	**S**	--		87 / 0	74 / 0
Unhindered transport infrastructure	**S**		++	75 / 2	61 / 0
Obstacles caused by transport infrastructure	**S**		--	77 / 4	80 / 3
Condition of connections and maintenance	**S**	++	--	75 / 0	81 / 3
Travel costs	**S**		++	77 / 2	93 / 3
Freight transport costs	**S**	--		59 / 2	80 / 0
Purchase and operation costs of the means of transport		++		56 / 5	50 / 7

Availability and quality of information and guidance	s	++		63 / 2	61 / 3
Perceived health	**S**	++	++	68 / 5	64 / 4
Traffic noise	**S**		++	85 / 0	84 / 0
Traffic emissions	**S**	++		82 / 0	84 / 0
Case specific criteria (e.g. vibration, smell, other unhealthy)				63 / 3	71 / 3
Risk of contamination of surface and ground water	**S**			90 / 2	87 / 3
Possibilities for walking and cycling	**S**	++		92 / 0	93 / 0
Perceived health impacts	**S**		++	79 / 3	77 / 0
Risk of accident or injury	**S**			87 / 0	94 / 0
Experienced safety	**S**	++		84 / 0	87 / 0
Land use characteristics (density, fragmentation)	**S**	--		69 / 3	87 / 3
Satisfaction of residential environment	**S**	++		84 / 3	84 / 0
Vitality of villages and population centres	**S**			82 / 2	94 / 0
Regional identity	**S**	++	++	72 / 2	71 / 6
Opportunities for participation in transport system planning				66 / 2	68 / 6
Opportunities for participation in transport system decision-making				59 / 5	57 / 13
Attitudes, values		--		80 / 3	55 / 13
Relations between community members		--		69 / 2	52 / 13
Satisfaction of living conditions		--	--	79 / 7	61 / 13
Every day ways of living and mobility	**S**		++	89 / 0	90 / 0
Social interaction and networks			--	69 / 5	65 / 13
Emissions of greenhouse gases		--		69 / 2	61 / 10
Risk of contamination of groundwater/quality of groundwater	**S**	++		94 / 0	94 / 3
Quantity and quality of wild regions	**S**			76 / 0	71 / 6
Quantity of animal and plant species			--	65 / 2	65 / 13
Viability of nature	**S**			75 / 0	74 / 10

Exploitation of natural resources (especially non-renewable natural resources)	**S**	--		76 / 0	74 / 13
Public transport expenditures	**S**		--	86 / 0	84 / 0
Public sector; capital value of the transport system	**S**		--	88 / 0	90 / 0
Public sector; other investment needs	**S**			78 / 0	77 / 0
Productivity in other sectors in the economy	s		--	72 / 2	57 / 0
General economic growth (output, tax incomes)	**S**			69 / 0	65 / 3
Labour supply		--		72 / 2	52 / 10
Operational preconditions for new business	**S**		++	85 / 0	67 / 0
Locational advantages of a region, community or city (concerning housing, industries, trade, tourism)	**S**	++	--	85 / 0	80 / 0
Private sector; land price	s	++	++	69 / 5	74 / 10
Private sector; value of real estates				72 / 3	68 / 13
Private sector; renting expenses				67 / 7	58 / 16
Private sector; building costs		--	--	73 / 5	52 / 13
Private sector; level and structure of wealth/property				61 / 9	48 / 19
Private sector; income level and structure		--		63 / 7	48 / 19
Business sector; profitability	**S**			70 / 4	77 / 3
Business sector; competition	s		--	69 / 3	78 / 4

Appendix D: Indicators for assessing the welfare impacts of modifications in the transport system

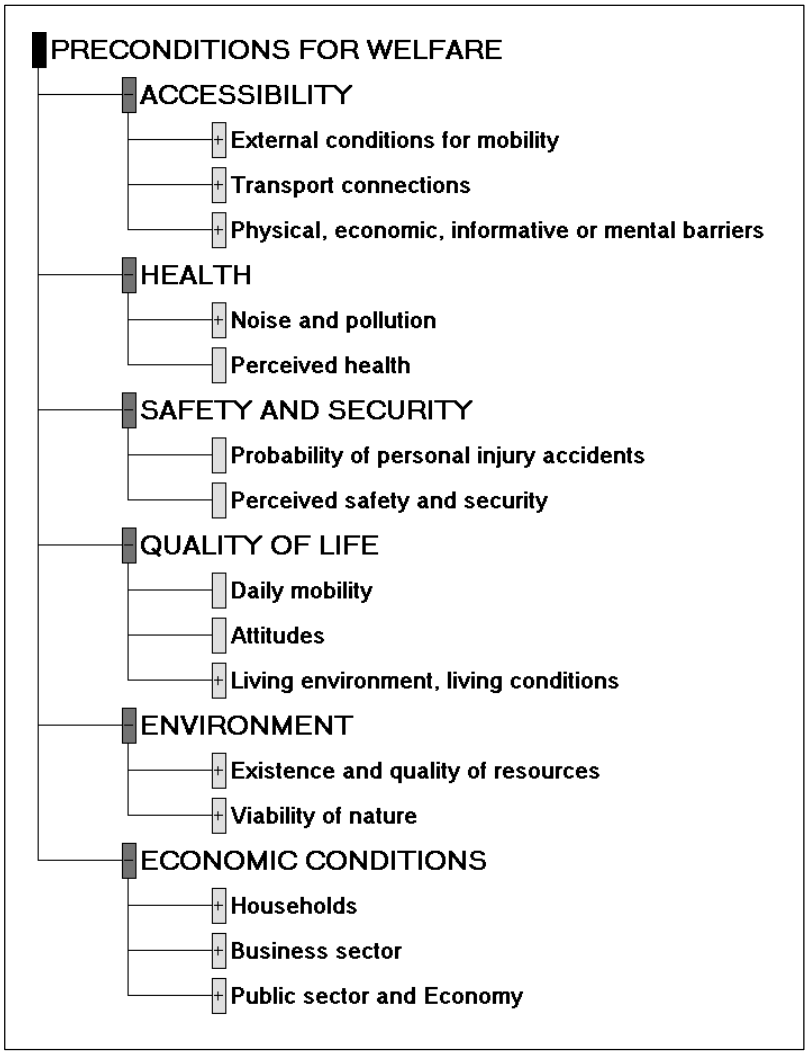

Figure 16. The value tree of AssessmentAid.

Table 32. The sub-objectives and criteria of AssessmentAid and examples of indicators to measure the impacts.

Sub-group	Criterion	Indicator(s)
1. ACCESSIBILITY, ALTERNATIVES AND OPTIONS		
	External conditions for mobility	
	Population size and structure of different types	number of inhabitants and changes in it
	Regional and urban structure	qualitative estimation
	Amount and quality of activities (services, housing, employment, leisure activities)	changes in the number of different types of activities
	Transport connections	
	Connection possibilities	coverage of transport networks
		location and number of terminals and stops
		level of service of transport network
	Opportunities for choosing mode of travel or transport	infrastructure and safety of bicycle and pedestrian transport. connections and local public transport (level of service)
		supply of passenger car connections
		connections of long-distance transport
	Functionality, fluency and conveniency of connections	certainty of successful trip or transport
		predictability of travel times
		accuracy of trip and travel times

Sub-group	Criterion	Indicator(s)
	Physical, economic and informative barriers	
	Physical	obstacles caused by transport infrastructure
		condition of connections and maintenance
		unhindered means of transport
		barriers in transport infrastructure
	Economic	freight transport costs
		travel costs
	Informative	availability and quality of information and guidance
2.HEALTH		
	Noise and pollution	estimates of changes in noise and pollution (emissions of carbon dioxide, particles, nitrogen oxides, compounds of hydrocarbon or carbon monoxide from traffic) levels, based on changes in traffic volumes
	Perceived health	qualitative assessment
3. SAFETY AND SECURITY		
	Probability of personal injury accidents	estimates based on changes in traffic volumes and types of infrastructure, statistics as background information

Sub-group	Criterion	Indicator(s)
	Perceived safety and security	qualitative assessment based on traffic volumes and and quality of infrastructure, pavements and bicycle paths, statistics as background information
4. QUALITY OF LIFE		
	Daily mobility	qualitative assessment
	Living environment, living conditions	qualitative assessment, vitality of villages and population centres
		qualitative assessment, regional identity
		qualitative assessment. satisfaction of living environment or living conditions
		qualitative assessment; city plans, land use quality
	Attitudes	qualitative assessment
5. ENVIRONMENT	**Existence and quality of resources**	quality of surface- or groundwater or risk of contamination of those
		use of natural resources, especially non-renewable resources
	Viability of nature	quantity and quality of wild regions
6. ECONOMIC CONDITIONS		
	Households	land price
		renting expenses
		value of real estates
		car ownership costs
	Business sector	competition

Sub-group	Criterion	Indicator(s)
	Public sector and Economy	profitability
		operational preconditions for new business
		public transport expenditures
		capital value of transport system, investments in the transport
		other investment needs (than transport)
		location of activities
		productivity in other sectors of the economy
		locational advantages of a region, community or a city
		general economic growth

Appendix E: XY-maps of the case Helsinki Metropolitan Area Transport System Plan 2007

These figures indicate the impact of the weight of the individual sub-objectives on the scores and preference order of the strategy alternatives of the Helsinki Metropolitan Area Transport System Plan 2007. The highest weight that could be given was 100. For example, in Figure 17 the alternative A3 dominated the comparison (58.55), with respect to the sub-objective Accessibility (100). The preferences concerning the strategy alternatives of the Helsinki Metropolitan Area Transport System Plan 2007 were studied both for the Helsinki test group and Oulu test group.

The Helsinki test group preferred Alternative 3 according to the sub-objective Accessibility, Health, Quality of life and Economic preconditions, while the Oulu test group held alternative 1 as the most preferred one according to these same sub-objectives. Either of the test groups considered Alternative 2 to be the best one for any of the sub-objectives compared.

<u>The Helsinki test group: Finnish transport authorities, the steering group of the thesis project</u>

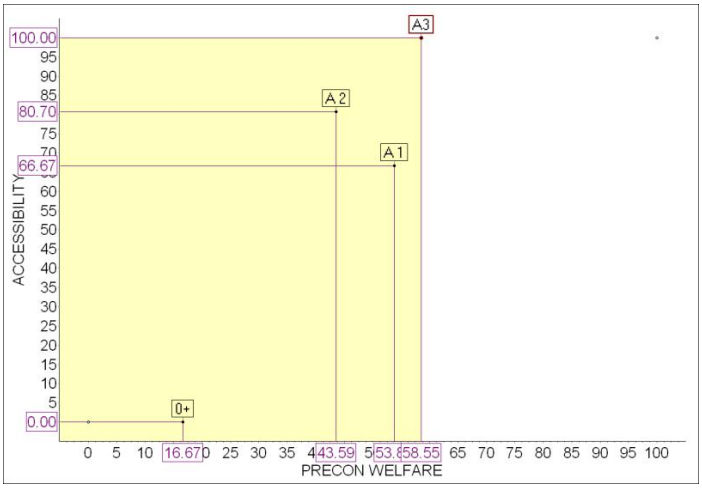

Figure 17. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the authorities towards the general objective ‘preconditions for welfare’ and sub-objective ‘accessibility’.

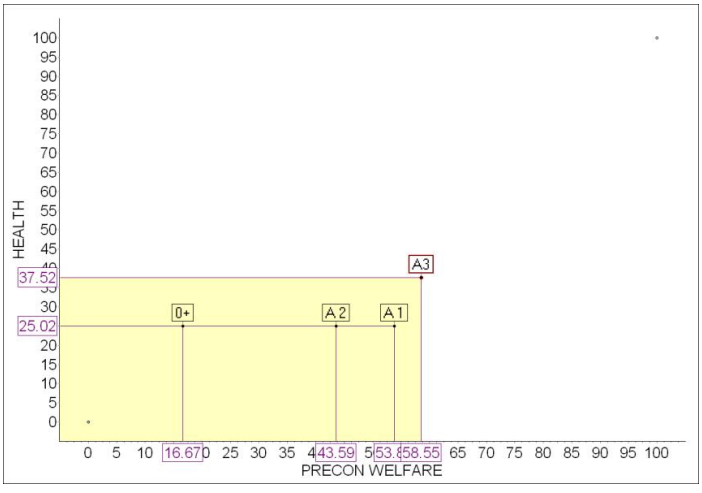

Figure 18. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the authorities towards the general objective ‘preconditions for welfare’ and sub-objective ‘health’.

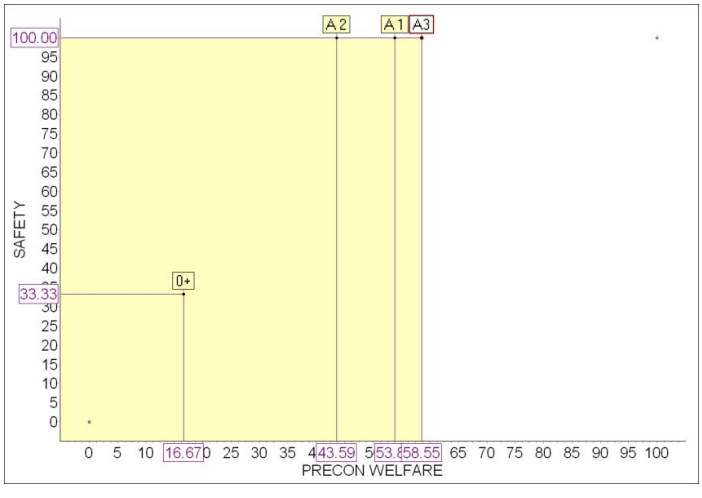

Figure 19. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the authorities towards the general objective ‘preconditions for welfare’ and sub-objective ‘safety and security’.

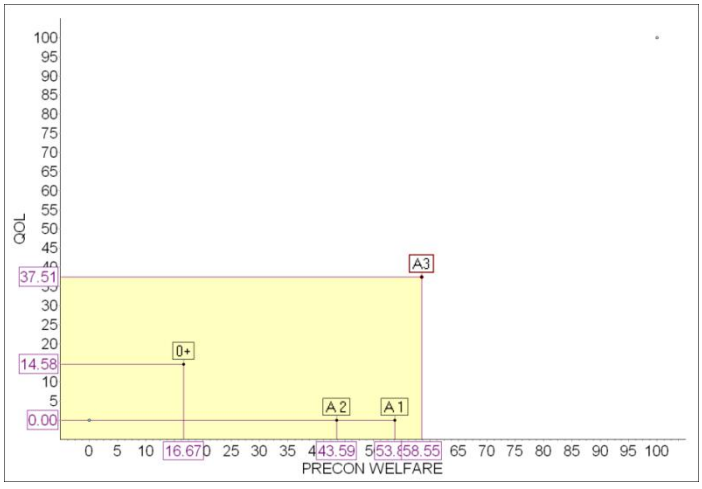

Figure 20. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the authorities towards the general objective ‘preconditions for welfare’ and sub-objective ‘quality of life’.

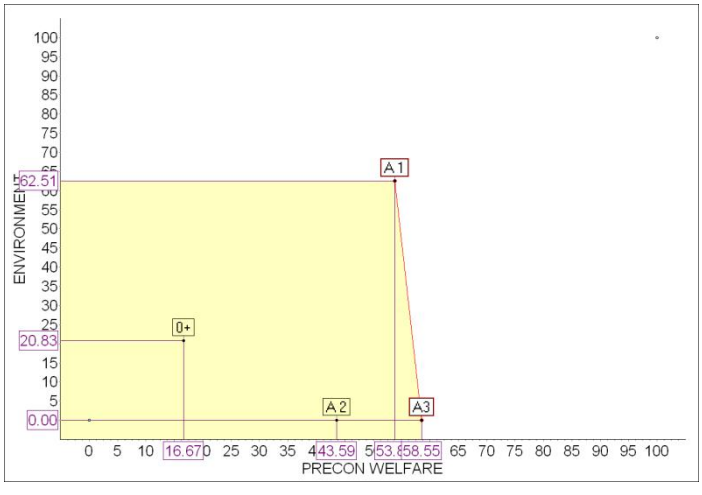

Figure 21. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the authorities towards the general objective ‘preconditions for welfare’ and sub-objective ‘environment’.

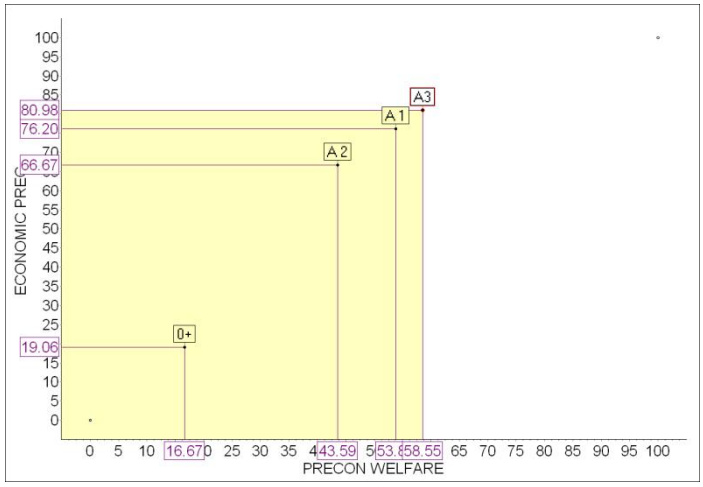

Figure 22. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the authorities towards the general objective 'preconditions for welfare' and sub-objective 'economic preconditions'.

The Oulu test group; Reference group, Students in Oulu

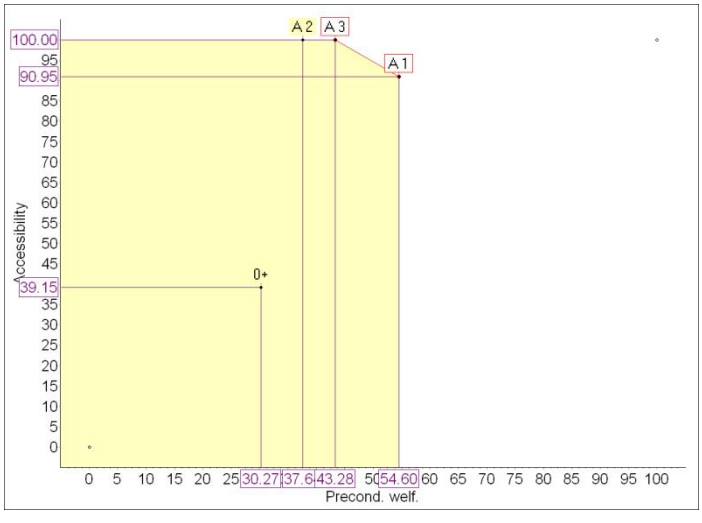

Figure 23. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the students towards the general objective 'preconditions for welfare' and sub-objective 'accessibility'.

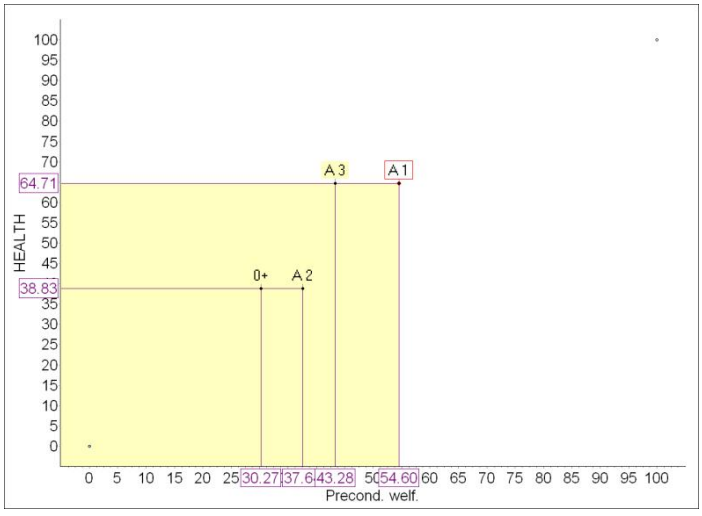

Figure 24. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the students towards the general objective ‘preconditions for welfare’ and sub-objective ‘health’.

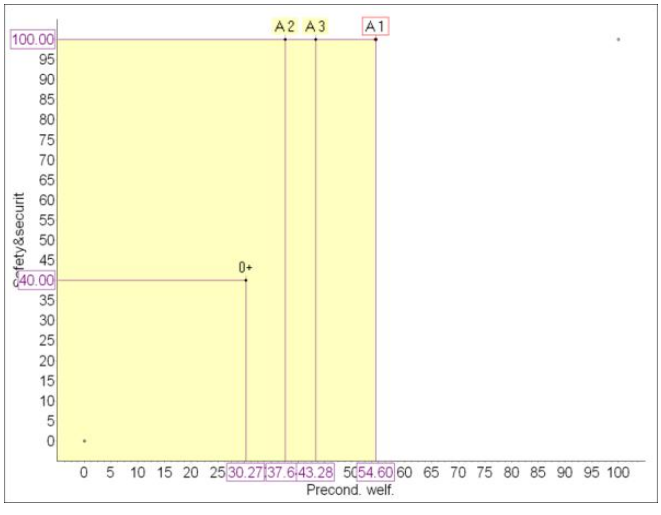

Figure 25. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the students towards the general objective ‘preconditions for welfare’ and sub-objective ‘safety and security’.

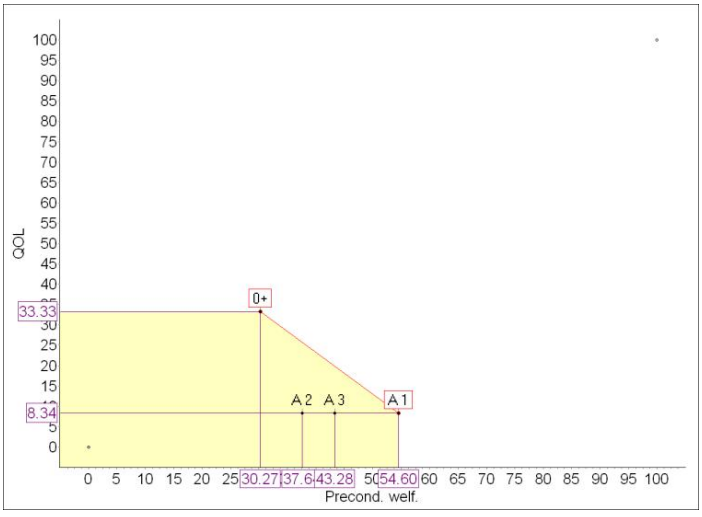

Figure 26. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the students towards the general objective ‘preconditions for welfare’ and sub-objective ‘quality of life’.

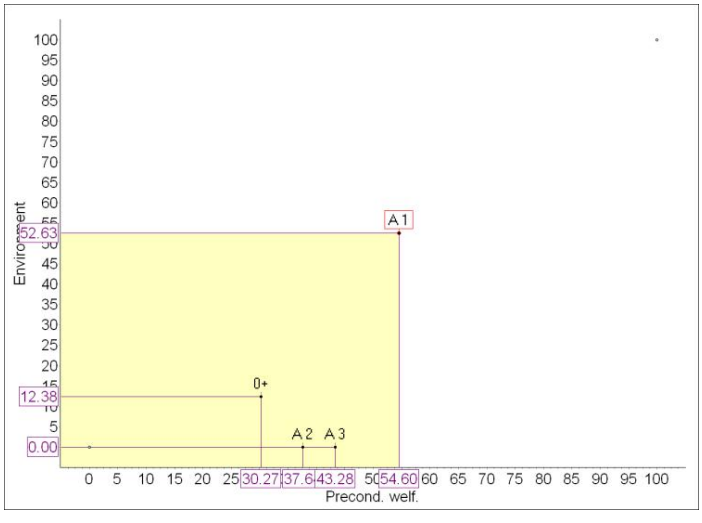

Figure 27. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the students towards the general objective ‘preconditions for welfare’ and sub-objective ‘environment’.

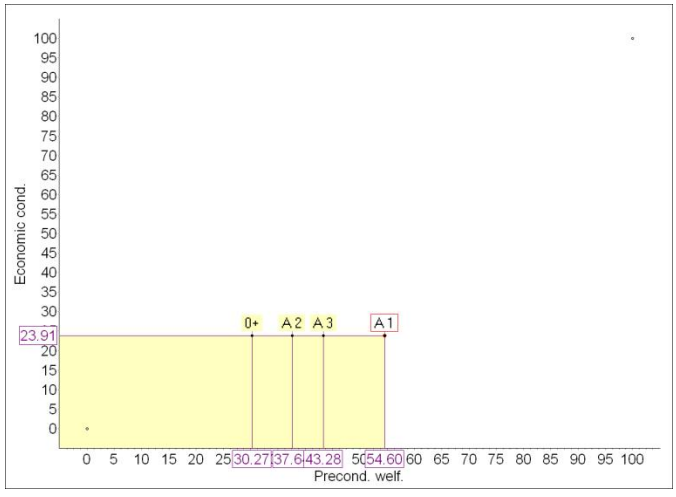

Figure 28. The scores of the policy alternatives of the Helsinki Metropolitan Area Transport Plan, reflecting the valuations of the students towards the general objective ‘preconditions for welfare’ and sub-objective ‘economic conditions’.

Series title and number

VTT Science 104

Title	**Assessment of welfare impacts in transport system planning**
Author(s)	Katja Estlander
Abstract	The goal of this thesis was to define what kind of impacts take place on the preconditions for welfare in the everyday life of people and the condition of the environment, when the transport system is being modified. Another main aim was to introduce a process for decision-makers to compare these so-called welfare impacts of different implementation schemes of transport plans, programmes and policies.The research questions were the following: 1) What kind of innovative combination of multi-criteria approaches would be applicable for assessment of welfare impacts of a transport plan, programme or policy and would allow the valuations of stakeholders to be taken into consideration? 2) What kind of impacts can modifications in transport systems have on the welfare of individuals, communities and the environment in Finland, and what criteria can be formulated to assess the impacts? and 3) Is it possible to use the evaluation criteria in practice and get representative and sufficient information about the welfare impacts of a transport plan, programme or policy? Firstly, potential welfare impacts were sought for from literature and by interviews. Then a long list of potential criteria was discussed by means of postal survey, Internet survey and group interviews. The resulting list was reconstructed by using a multi-criteria method called Analytic Hierarchy Process (AHP) and after this, by discussing the study project with the stakeholders. The two surveys, the AHP analysis and the ensuing discussions led to a new version of the list of criteria. The criteria were tested in two Finnish case studies. These case studies were the enhancement project of the Seinäjoki-–Oulu railway connection and the Helsinki Metropolitan Area Transport System Plan 2007. The welfare impacts of these two plans were evaluated by using the already existing evaluation data of the plans. After the impact assessment, another application of the multi-criteria analysis was used. This method is called Measuring Attractiveness by a Categorical-based Evaluation Technique (MACBETH). MACBETH served as a tool to imply the values of the decision-makers or stakeholders in the impact assessment and to define the comprehensive list of welfare impacts. The MACBETH analysis was carried out solely on the basis of the data from the Helsinki MA Transport System Plan, but this data was used both in Helsinki and Oulu. However, the comprehensive list was not a direct result of the MACBETH process. These results were again discussed with the project stakeholders, and the list was finished according to their valuations. The main results of the study are the list of criteria of potential welfare impacts of modifications in the transport system, and a MCDA process called AssessmentAid, for implying values of the stakeholders in the impact analysis of a transport plan or project. The list consists of six sub-groups of criteria and 15 assessment criteria thereunder. The following sub-groups were identified: 'Accessibility', 'Health', 'Safety and security', 'Quality of life', 'Environment', and 'Economic conditions'. Other results are 1) information about the welfare impacts of the two case studies, 2) information about the preference order of the plans when welfare impacts and values of the stakeholders are included in the impact analysis, and 3) information about experience in using multi-criteria methods in impact assessment within the Finnish transport sector. Also, the study contributed to the wider co-operation between the different branches of administration that are involved in the strategic transport system planning.
ISBN, ISSN	ISBN 978-951-38-8336-2 (Soft back ed.) ISBN 978-951-38-8337-9 (URL: http://www.vttresearch.com/impact/publications) ISSN-L 2242-119X ISSN 2242-119X (Print) ISSN 2242-1203 (Online)
Date	August 2015
Language	English, Finnish abstract
Pages	162 p. + app. 24 p.
Name of the project	
Commissioned by	
Keywords	Transport system, assessment of welfare impacts, evaluation criteria, multi-criteria analysis, accessibility, health, traffic safety, feeling of safety, quality of life, environment, nature, economic conditions
Publisher	VTT Technical Research Centre of Finland Ltd P.O. Box 1000, FI-02044 VTT, Finland, Tel. 020 722 111

Julkaisun sarja ja numero

VTT Science 104

Nimeke	**Liikennejärjestelmän muokkaamisen hyvinvointivaikutusten arviointi**
Tekijä(t)	Katja Estlander
Tiivistelmä	Tämän väitöskirjatyön yksi tavoite oli selvittää, millaisia vaikutuksia liikennejärjestelmän muokkaamisella on ihmisten ja luonnon hyvinvoinnin edellytyksiin. Toinen tavoite oli luoda päätöksentekijöiden käyttöön prosessi, jonka avulla voidaan vertailla liikennejärjestelmän muokkaamisen eri toteutusvaihtoehtojen hyvinvointivaikutuksia. Tutkimuskysymykset olivat seuraavat: 1) Miten monikriteerianalyysin sovelluksia innovatiivisesti yhdistelemällä voidaan arvioida liikennejärjestelmän muokkaamisen hyvinvointivaikutukset siten, että otetaan huomioon sidosryhmien arvovalinnat? 2) Millaisia vaikutuksia liikennejärjestelmän muokkaamisella voi Suomessa olla ihmisten ja luonnon hyvinvointiin sekä millaisin kriteerein näitä vaikutuksia voidaan tarkastella? ja 3) Onko edellä mainittuja kriteerejä mahdollista käyttää ja saada niiden avulla tietoa liikennehankkeen, -strategian tai -politiikan hyvinvointivaikutuksista? Mahdollisia hyvinvointivaikutuksia kartoitettiin ensin kirjallisuustutkimuksella ja haastatteluin. Näin muodostettua listaa muokattiin posti- ja internet -kyselyiden sekä ryhmäkeskusteluiden perusteella. Listan eri kriteerien välistä suhteellista merkittävyyttä tutkittiin monikriteerianalyysin sovelluksella Analytic Hierarchy Process (AHP). Kriteerilistan uusi versio muodostettiin näiden kyselyiden, AHP-analyysin ja sidosryhmäkeskusteluiden perusteella. Kriteerejä testattiin käytännössä kahden suomalaisen suunnitelman yhteydessä. Suunnitelmat olivat Seinäjoen ja Oulun välisen ratayhteyden parantamishanke sekä Pääkaupunkiseudun liikennejärjestelmä-suunnitelma (PLJ) 2007. Näiden suunnitelmien hyvinvointivaikutusten arviointiin käytettiin edellä mainittua kriteerilistaa ja suunnitelmista jo olemassa olevia vaikutusarviointiaineistoja. Vaikutusarvioinnin jälkeen käytettiin toista monikriteerianalyysin sovellusta;: Measuring Attractiveness by a Categorical-based Evaluation Technique (MACBETH). Vaikutusarviointitietoa tulkittiin MACBETH-prosessilla päätöksentekijöiden ja sidosryhmien arvostusten mukaisena. Samalla tarkasteltiin myös kriteerilistan sisältöä ja muotoa. MACBETH-prosessia seuranneen keskustelun jälkeen lista viimeisteltiin tutkimuksen sidosryhmien arvostusten mukaisena. Tutkimuksen tärkeimmät tulokset ovat liikennejärjestelmän muokkaamisen hyvinvointivaikutuksia kuvaava kriteerilista sekä MACBETH-prosessi, jota kutsutaan nimellä ArviointiApu. ArviointiApua käytetään soveltamaan päätöksentekijöiden tai sidosryhmien arvostuksia liikennehankkeiden tai -strategioiden hyvinvointivaikutusten arvioinnissa. ArviointiApu, samoin kuin valmis kriteerilista, koostuu kuudesta kriteeriryhmästä sekä niiden alaisista 15:tä kriteeristä. Kyseiset ryhmät ovat 'Saavutettavuus', 'Terveys', 'Turvallisuus', 'Elämänlaatu', 'Ympäristö' ja 'Taloudelliset edellytykset'. Tutkimuksen muut tulokset ovat 1) tieto kahden suunnitelman hyvinvointivaikutuksista, 2) tieto sidosryhmien arvostusten mukaisesta suunnitelmavaihtoehtojen keskinäisestä järjestyksestä hyvinvointivaikutusten suhteen, ja 3) kokemus monikriteerianalyysin soveltamisesta liikennejärjestelmätutkimuksessa. Lisäksi tutkimus edisti osaltaan hallinnon eri alojen yhteistyötä liikennejärjestelmän strategisen suunnittelun yhteydessä.
ISBN, ISSN	ISBN 978-951-38-8336-2 (nid.) ISBN 978-951-38-8337-9 (URL: http://www.vtt.fi/julkaisut) ISSN-L 2242-119X ISSN 2242-119X (Painettu) ISSN 2242-1203 (Verkkojulkaisu)
Julkaisuaika	Elokuu 2015
Kieli	Englanti, suomenkielinen tiivistelmä
Sivumäärä	162 s. + liitt. 24 s.
Projektin nimi	
Rahoittajat	
Avainsanat	Transport system, assessment of welfare impacts, evaluation criteria, multi-criteria analysis, accessibility, health, traffic safety, feeling of safety, quality of life, environment, nature, economic conditions
Julkaisija	Teknologian tutkimuskeskus VTT Oy PL 1000, 02044 VTT, puh. 020 722 111

Assessment of welfare impacts in transport system planning

This thesis is concentrated on assessment of the impacts that take place on the preconditions for welfare in the everyday life of people and the condition of the environment, when the transport system is being modified. Another aim is to introduce a process for decision-makers to compare these so-called welfare impacts of different implementation schemes of transport plans, programmes and policies.

Two applications of multi-criteria analysis were used in the doctoral study, namely Analytic Hierarchy Process (AHP) and Measuring Attractiveness by a Categorical-based Evaluation Technique (MACBETH). The welfare impacts of two Finnish case studies were evaluated in the study. These case studies were the enhancement project of the Seinäjoki–Oulu railway connection and the Helsinki Metropolitan Area Transport System Plan 2007.

The main results of the study are the list of criteria of potential welfare impacts of modifications in the transport system, and a MCDA process called AssessmentAid, for implying values of the stakeholders in the impact analysis of a transport plan or project.

Other results are 1) information about the welfare impacts of the two case studies, 2) information about the preference order of the plans when welfare impacts and values of the stakeholders are included in the impact analysis, and 3) information about experience in using multi-criteria methods in impact assessment within the Finnish transport sector. Also, the study contributed to the wider co-operation between the different branches of administration that are involved in the strategic transport system planning.

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