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# Knowledge production for transport policies in the information society

Anu Tuominen

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**Keywords** transport policy, knowledge production, information society, transport system

## Abstract

This dissertation explores and analyses the challenges and needs that developments in the information society are bringing to knowledge production supporting policy development and strategic decision making in the field of transport. Currently, the context of transport policies is about to shift from a transport infrastructure network design towards the development of a large socio-technical system, depending largely on ICT technology and applications. Dynamic decision making clusters or networks, consisting of different actors and having a variety of goals, are growing around policy items or transport system innovations, and they need information and knowledge as the basis for their mutual decisions. This development will change the roles of the different actors within the system as well as the nature of strategies and measures.

My key argument is that in this new context the traditional, analytical knowledge production approaches (such as “planning” and “impact assessment”, referring to infrastructure investments and project appraisals) are alone not sufficient in providing the knowledge needed to understand the socio-technical nature of the transport system or the dynamics between the different actors, as a basis for transport policy development. The knowledge provided to make informed transport decisions needs to include, in addition to the traditional issues, also new forms to serve the needs of a wider variety of societal actors. Based on the field of science and technology studies (STS), which aims to illuminate the relationship between knowledge and political power as well as investigating the place of science and technology in society, I have identified five emerging forms that I consider relevant to transport policy knowledge production in the future. These are knowledge production through system-based foresight, knowledge production through system-based evaluation, knowledge production in networks, knowledge production as processes of social learning and argumentation, and knowledge production as a source of renewal. Further, I have identified the basic characteristics of these forms. I believe that the presented forms can shed light

on the relationships between knowledge production, policy making and the society, which may lead to the implementation of new, socially embedded ways of developing transport systems and policies. The dissertation also presents implications of these emerging knowledge production forms for transport policy and business development (in Finland) and related future research needs. The thesis is an article dissertation including four scientific papers (Papers I–IV) and this summary chapter, bringing together and elaborating further on the ideas of the individual papers.

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**Avainsanat** transport policy, knowledge production, information society, transport system

## Tiivistelmä

Väitöskirja tarkastelee tietoyhteiskuntakehityksen mukanaan tuomia muutostarpeita, jotka koskevat liikennepolitiikkaa, liikennejärjestelmien kehittämistä ja näihin liittyvää strategista päätöksentekoa palvelevaa tiedontuotantoa. Liikennejärjestelmä on murroksessa – se on muuttumassa vähitellen kohti kommunikoivaa systeemiä. Kommunikaatiota ja tiedonsiirtoa tulee tapahtumaan liikennejärjestelmän eri osien, käyttäjien (ihmisten ja yritysten), kulkuneuvojen ja infrastruktuurin, välillä kaikkiin suuntiin. Myös julkisten ja yksityisten toimijoiden roolit liikennejärjestelmän kehittämisessä muuttuvat ja sekoittuvat. Liikennepolitiikan valmistelun ja strategisen päätöksenteon apuvälineiksi tarvitaan perinteisten vaikutusarviointien lisäksi uudenlaisia toimintamalleja ja käytännön työkaluja, jotka pystyvät ottamaan huomioon entistä paremmin liikennejärjestelmän sosiaalisen luonteen ja muuttuneen toimijakentän.

Väitöskirjan teoreettinen viitekehys koostuu pääosin tieteen ja teknologian tutkimuksen esille nostamista uusista tiedontuotannon käytännöistä ja teorioista, jotka pyrkivät ilmentämään tieteen, teknologian ja poliittisen vallan välisiä suhteita yhteiskunnallisessa päätöksenteossa. Työssä sivutaan myös perinteisiä liikenteen vaikutusarvioinnin ja politiikka-analyysin tieteenalvoja. Väitöskirja esittää viisi tietoyhteiskunnan liikennejärjestelmää palvelevaa tiedontuotannon muotoa ja näitä kuvaavat keskeiset piirteet, jotka on tunnistettu relevanteiksi tiedontuotannon ulottuvuuksiksi teoreettisten viitekehysten ja neljän tapaustutkimuksen avulla. Nämä viisi muotoa ovat tiedontuotanto järjestelmätason ennakointitoiminnan avulla, tiedontuotanto järjestelmätason arviointitoiminnan avulla, tiedontuotanto verkostoissa, tiedontuotanto oppimis- ja argumentointiprosessina sekä tiedontuotanto järjestelmän uudistajana. Väitöskirjassa esitetään lisäksi päätelmiä tunnistettujen tiedontuotannon muotojen politiikkaseuraamuksista ja jatkotutkimustarpeista. Väitöskirja on tyypiltään artikkeliväitöskirja, jossa neljä julkaistua tieteellistä artikkelia sidotaan yhteen erillisen, artikkelien kontribuutioita täydentävän ja kokoavan johdantoluvun avulla.

## Preface

Writing this doctoral dissertation has taken me on a learning journey of triumphs, failures and near misses over many years. Now, as the journey nears its end, I feel very fortunate. I believe that along the way, I have learnt a lot about what it means to be a scientist, and that to be one is a goal worth striving for. There is a large group of people, whom I would like to thank warmly for guiding me through this journey.

First of all, I would like to thank my supervisors, professors Janne Hukkinen and Tapio Luttinen for their guidance and advice in academic research and writing. The Doctoral Seminar of the Laboratory of Environmental Protection at the Helsinki University of Technology has offered me an invaluable source for learning the secrets of academic writing. I would like to thank Henrik Bruun, Katri Huutoniemi, Maria Höyssä, Nina Janasik, Aino Kilpiö, Richard Langlais, Mikko Rask, Olli Salmi and Martti Timonen for their valuable comments and fruitful discussions over the past decade.

I would like to express my particular gratitude to Veli Himanen, who was responsible for introducing me to the fascinating world of transport policy research in the late 1990s. Since then I have had the privilege of co-operating with him on several very interesting projects. In the field of future studies, I appreciate Sirkka Heinonen for her guidance of the same kind.

I would like to thank my colleagues and co-authors of the included papers – Toni Ahlqvist, Tuuli Järvi, Jukka Räsänen and Ari Sirkiä at VTT Technical Research Centre of Finland and Jaques Leonardi and Christophe Rizet at INRETS, France – for the many good discussions, their support and words of encouragement during the period of writing. Without their contribution, this dissertation would not be as it is now. My pre-examiners, Docent Petri Tapio and Professor Bert van Wee, I appreciate for their valuable views and guidance in finalising the dissertation.



For the past ten years, I have been fortunate to work at VTT, Technical Research Centre of Finland, which has offered me a special vantage point on European transport research. I am indebted to all my colleagues at VTT for their time and encouragement whenever needed. In particular, I would like to thank Heikki Kanner and Juha Luoma for their support and words of advice in problematic situations, be it theoretical or practical. For innovative discussions and moments of laughter through many hard working days, I warmly remember Marja Rosenberg and Raija Sahlstedt. Thank you for those enjoyable moments, which have helped me discover new perspectives in my work.

The Finnish Foundation for Technology Promotion and VTT Technical Research Centre of Finland have supported this dissertation financially, for which I am very grateful. I would also like to thank Adelaide Lönnberg for correcting the English language.

I am deeply indebted to my parents for their love and encouragement throughout the writing process. From a practical point of view, their help with childcare over the past ten years has been invaluable. The same applies to my in-laws, Anneli and Timo. Thank you all so much. My oldest and dearest friend Merja I appreciate for her invincible belief in my ability to finalise the doctoral studies.

Finally, I would like to thank my wonderful family – my husband Jukka and our children Lauri, Akseli and Anna for their love and support during this process. You make it easy to remember what the really important things in life are.

Otaniemi, October 2009

Anu Tuominen

# Contents

Abstract .....	3
Tiivistelmä .....	5
Preface .....	6
Publications .....	10
Contributions of the author .....	11
List of key concepts.....	12
1. Introduction .....	15
2. An evolving transport system poses challenges for policy-relevant knowledge production .....	19
3. Theoretical considerations .....	24
3.1 Knowledge production to support transport policies .....	24
3.2 Transport planning – the traditional knowledge production approaches to support transport policies.....	25
3.3 Policy analysis .....	29
3.4 Systemic planning.....	31
3.5 Emerging knowledge production practices .....	32
3.5.1 Background .....	32
3.5.2 Integrated assessment.....	33
3.5.3 Co-production and mode 2 knowledge production.....	35
3.6 Research questions .....	38
4. The approach .....	40
5. Emerging forms of knowledge production .....	45
5.1 Contribution of the papers.....	45
5.2 The transport system context.....	46
5.3 Knowledge production through system-based foresight.....	47
5.4 Knowledge production through system-based evaluation .....	48

5.5	Knowledge production in networks .....	49
5.6	Knowledge production as processes of social learning and argumentation .....	51
5.7	Knowledge production as a source of renewal – forming new identities and institutions .	52
6.	Discussion and conclusions.....	55
6.1	Scientific and practical implications .....	55
6.2	Future research needs.....	59
	References.....	62
Appendices		
Papers I-IV		

## Publications

The dissertation consists of the summary chapter and the following papers:

- I Tuominen, A. & Ahlqvist, T. Is the transport system becoming ubiquitous? Socio-technical roadmapping as a tool for integrating transport policies and intelligent transport systems and services (ITS) in Finland. *Technological Forecasting & Social Change* 77 (2010), pp. 120–134.
- II Tuominen, A., Järvi, T., Räsänen, J., Sirkiä, A. & Himanen, V. Common preferences of different user segments as basis for intelligent transport system: case study – Finland. *IET Intelligent Transport Systems*, 2007, 1, (2), pp. 59–68.
- III Tuominen, A. & Himanen, V. Assessing the interaction between transport policy targets and policy implementation – A Finnish Case Study. *Transport Policy*, Volume 14 (2007), pp. 388–398.
- IV Tuominen, A., Leonardi, J. & Rizet, C. Assessing the Fitness-For-Purpose of strategic transport research in support of European transport policy. *European Journal of Transport and Infrastructure Research*, Issue 8(3), September 2008, pp. 183–200.

## **Contributions of the author**

Anu Tuominen has been the initiator and responsible author of each of the papers. In Paper I, both authors contributed to the theoretical as well as the empirical sections. Anu Tuominen answered for the transport system and policy analysis and Toni Ahlqvist for the roadmapping approach. In Papers II–IV, Anu Tuominen was responsible for the theoretical sections concerning the fields of Large Technological Systems (Paper II), decision-making processes (Paper III) and policy networking (Paper IV). In the empirical section of Paper II, Tuuli Järvi was responsible for the calculations regarding passenger transport segmentation, Ari Sirkiä was the initiator of the logistics concept, and Anu Tuominen, Jukka Räsänen and Veli Himanen contributed to the overall methodological development and conclusions. Anu Tuominen and Veli Himanen wrote the empirical section of Paper III jointly. Anu Tuominen answered for the main conclusions. In Paper IV, Anu Tuominen, Jacques Leonardi and Christophe Rizet were jointly responsible for the empirical section. Anu Tuominen wrote the discussion and concluding remarks.

## List of key concepts

### **Foresight**

The term foresight was introduced in scholarly journals in the late 1980s. Foresight is neither prophecy nor prediction. It does not aim to predict the future – to unveil it as if it were predetermined – but to help in building it. It invites to consider the future as something that we can create or shape, rather than as something already decided. Four characteristics distinguish foresight from other kinds of future studies such as forecasting and modelling. Foresight is action-oriented, open to alternative futures, participatory and multidisciplinary. Foresight can be envisaged as a triangle combining “Thinking the Future”, “Debating the Future” and “Shaping the Future”.

### **Information society**

Information society is a society in which the creation, distribution, diffusion, uses, integration and manipulation of information is a significant economic, political, and cultural activity. Information society has also been referred to as knowledge society, network society, post modern society, post industrial society, etc. These concepts show that it is an important question in which society we live and which role technologies and information play in contemporary society.

### **Knowledge production**

Knowledge production refers here to various kinds of practices, approaches, methods and tools, which can provide assistance in policy design or decision making. Knowledge production for policies presents how information is used and given meaning within policy design.

### **Knowledge society**

Knowledge society refers to the use a certain society gives to information: it is a deepened and intensified version of the information society. A knowledge society creates, shares and uses knowledge for the prosperity and well-being of its people. A knowledge society is one in which knowledge becomes a major creative force. Current technology offers much greater possibilities for sharing, archiving and retrieving knowledge.

### **Policy**

Policy is a highly flexible concept that is used in different ways on different occasions. For the purpose of this dissertation, the following definition was selected. Policy is a specific decision or set of decisions, with a common long-term purpose(s). Policy is selected by a government, institution, group (public or private) or individual from among alternatives and it includes the related actions designed to implement the policy.

### **Policy process** (also referred to as policy development)

Policy process is a tool used for analysis of the development of a policy item. Classical decision making models distinguish between four to eight process phases, the most typical of which are: (1) problem identification, (2) agenda setting, (3) policy formulation, (4) decision making, (5) policy implementation and (6) policy evaluation (continue or terminate).

### **Roadmap**

Roadmaps aim to provide an extended view of the future of a chosen field of inquiry. They also make inventories of different possibilities, communicate visions, stimulate investigations and monitor progress. In other words, roadmaps are composed of the collective knowledge and the imagination drivers of change in a particular field. The technology roadmapping approach provides a structured (and often graphical) means for exploring and communicating the relationships between evolving markets, products and technologies and processes over time. Socio-technical roadmaps provide a wider, more societal view of the future of a chosen field.

### **Socio-technical system**

Socio-technical system is a mixture of people and technology. Socio-technical systems include hardware, software, physical surroundings, people, procedures,

laws and regulations, data and structures. Socio-technical system often refers to the interaction between society's complex infrastructures and human behaviour. In this sense, society itself, and most of its sub-structures, are complex socio-technical systems.

### **Technological system**

Technological systems are open systems in which social, economic, political and scientific factors are interrelated. Technological systems contain messy, complex, problem solving components. They are both socially constructed and society shaping. Among the components in technological systems are physical artefacts, organisations, scientific and legislative components, and natural resources. According to T. P. Huges (1987), the evolution or expansion of Large Technological Systems (LTS) can be presented in the following phases: invention, development, innovation, transfer, growth, competition and consolidation.

### **Ubiquitous (network) society**

Ubiquitous society refers to the vision of a world, in which information can be accessed from anywhere, at anytime, by anyone and anything. It is hoped that new and exciting technologies will make this vision a reality. Early forms of such technologies can be seen in mobile phones, and to some extent in the broadband internet. In the future, however, it is hoped that ubiquitous networks will extend beyond person-to-person and person-to-object connectivity, uniting everyday things in one huge, ubiquitous communications network.

### **Vision**

Vision refers to great perception of future developments or the ability to see or plan into the future. A vision can be political, religious, environmental, social, or technological in nature. A visionary can be a person with a clear, distinctive and specific vision of the future, usually connected with advances in technology or social/political arrangements. Visionaries simply imagine what does not yet exist, but might some day, as some forms of visioning provide a glimpse into the possible future.



# 1. Introduction

In Finland as in many other European countries, knowledge production to support transport policy development and decision making have traditionally focused on project appraisals regarding the costs, benefits, and social and environmental impacts of infrastructure investments. Recently, due to the important role the Information and Communication Technologies (ICT) have gained in our societies, similar assessments have become common in relation to ICT application projects in the field of transport as well. It can be argued that these practices have over the years developed into a field of science that could be described as a policy-driven applied science, placing scientific results in the service of society. Due to the dominance of infrastructure project investments in transport system-level planning, classical decision-making models stemming from political science or other methods with a wider social perspective have not been traditional frameworks in the field of transport.

The researchers of ICT-related social change (e.g. Anderson et al. 2007, Oudshoorn and Pinch 2003) perceive that we might currently be on the cusp of a major social and economic transition. As a consequence, the context of transport policies could also be about to shift from designing road, railway or waterway lines or networks towards the development of a complex technological system largely depending on IC technology and ICT applications (such as traveller information services, traffic management services, navigation and autonomous vehicle systems). Intelligent technologies and services are considered to have great potential, but concerns over e.g. privacy, security or public-private role divisions are one challenge out of many posed by contemporary transport. Energy and global warming issues, globalising markets, regional and urban structure developments, ageing population as well as lifestyle, consumer habit and time management changes of individuals have been named as the other major challenges (e.g. CEC 2006, MinTC 2007a, Stead 2006, Tuominen et al. 2007). One dimen-

sion in the above mentioned shift is that policy makers and other societal actors worldwide need to understand the kinds of changes that are occurring in society, although these are not necessarily visible through official statistics, for the basis of their decisions. Further, the evolving transport system includes also commercial stakeholders who need to gain an understanding of the same processes as well (e.g. Anderson et al. 2007, Rämä et al. 2004 and Tuominen et al. 2007).

In the emerging phase of the information society – the ubiquitous society – the functioning of the transport system will be based increasingly on different mobile, flexible and personalised ICT services. The new technology brought into the transport system will change the roles of the different actors within the system and the nature of strategies and measures. This development will have some impact on the ways in which people move and goods are delivered. As the transport system and the needs and preferences of its end-users evolve, policy developments supporting knowledge production should respond accordingly.

This dissertation explores and analyses the challenges and needs that developments in the information society are bringing to knowledge production supporting policy development and strategic decision making in the field of transport. My basic argument is that there is a need to broaden the understanding of the dynamics of knowledge production supporting transport policies of the information society. The conventional transport planning approaches, like cost-benefit analysis and impact assessments that apply to infrastructure projects, are by themselves inadequate for addressing the systemic challenges of future transport policy. I argue that new forms of knowledge production having a broader societal perspective are of major importance in this new context.

My particular interest concerns the challenges that knowledge production relevant to transport policy face within the context of information society development. Consequently, my general aim in this dissertation is to identify the forms of knowledge production that can serve the needs of policy development in the changing transport system context. I have chosen to refer to these practices as “knowledge production for transport policies in the information society” as distinct from the traditional transport planning presented in detail in section 3.2. I am also interested in the methods of knowledge production that transport system actors need in order to adopt these forms. The theoretical and practical implications of emerging knowledge production forms for designing better transport policies form the main conclusions of my dissertation.

My contribution to the above issues is based on four case studies (Papers I–IV), in which I have illustrated new knowledge production approaches to support

transport policies. The papers provide four different views on understanding the dynamics between the socio-technical transport system, its actors, networks, policy relevant knowledge production and decision making.

In Paper I, Toni Ahlqvist and I examine the challenges of designing transport policies on a technological frontier that is moving very quickly. Our main argument is that in order to understand the systemic and socio-technical nature of the transport system, the views of the system itself as well as the supporting knowledge production should be re-thought. We propose socio-technical road mapping as one potential method to widen the perspective of knowledge production for transport policy design.

In Paper II, together with co-authors Tuuli Järvi, Jukka Räsänen, Ari Sirkiä and Veli Himanen we highlight the importance of the preferences, needs and emergent characteristics of the different transport system end-users as a knowledge base for transport policy design. Since it is not possible to survey the preferences of each individual, we illustrate a method to categorise users of the transport system into homogeneous groups based on their differences in daily mobility and transportation of goods. These groups can provide a starting point towards end-user-oriented policy design and also initiate a more detailed analysis of end-user preferences and needs.

In Paper III, Veli Himanen and I explore the knowledge production or knowledge flow between the two important but often too distant phases of transport policy development, namely policy targets and policy implementation. In order to strengthen the often overly weak link between those two phases, as well as increase the success of policy implementation, we introduce a method called target analysis.

In Paper IV, together with co-authors, Jacques Leonardi and Christophe Rizet we discuss the fitness-for-purpose of strategic transport research conducted in the European Framework Programs. We argue that there is a need to bridge the gap between the European transport research and policy agendas. Consequently, we propose a fitness-for-purpose assessment method to provide the knowledge required for the bridge building.

However, knowledge production in support of transport policy formulation consists of multidimensional processes that cannot be extensively covered by a set of scientific papers. Hence, in this summarising section of the dissertation, my aim is to take a more comprehensive look at knowledge production in the transport domain. The structure of this dissertation is as follows: Section 2 describes the challenges that knowledge production faces in the transport policy environ-

## 1. Introduction

ment of the future. Section 3 presents the theoretical premises and discussions related to knowledge production in support of transport policy, and outlines potential new approaches to knowledge production. The research questions are detailed at the end of Section 3. An overview of the methodological principles adopted in the papers is provided in section 4. Section 5, based on the main results of the included papers and the theoretical section, explores the forms of “knowledge production for transport policies in the information society”, related methods, actors and their linkages. Finally, section 6 discusses the implications of the identified forms for the future of transport policy development and suggests some future research needs.

## **2. An evolving transport system poses challenges for policy-relevant knowledge production**

In Finland, neither the notion of transport policy itself nor knowledge production supporting transport policy have traditionally been issues of wide public debate. If anything, transport policy has been perceived through its objectives, targets or policy measures identified for the achievement of the objectives. Among the Finnish transport sector stakeholders, transport policy has often been understood as meaning the construction of infrastructure, i.e. roads, railways, waterways, airports and related terminals, but in today's society also the information and communications infrastructure for transport. Another interpretation has been to see transport policy as an issue relating to the mode share of intermodal transport where the public sector has the main decision making power (Ruostetsaari 1995, Valli 1998, MinTC 2007b).

In both interpretations, transport policy has been perceived as actions of the public sector within a distinct arena of the society, i.e. transport sector, not within a wider societal (e.g. social or economic) context. The adopted perspective can be seen as a fairly natural, path-dependent way of perceiving Finnish transport policy. This is because the main duty of the administrative branch of the transport sector (namely the Ministry of Transport and Public Works, established in 1917), from the 1920s to the 1960s, was the construction of the main road network for Finland. From the 1960s towards the early 1990s, the focus shifted to increasing transport capacity (i.e. economic efficiency and fluency) of goods as well as passenger transport (MinTC 2007b, Trafiikki 2007).

A rapid increase in road traffic since the 1950s has resulted in accidents and environmental problems forming key issues for Finnish transport policy from the mid-20th century onward. Since Finland joined the European Union in 1995, also sustainability concerns of European transport policy (CEC 2001, CEC 2006) have

## 2. An evolving transport system poses challenges for policy-relevant knowledge production

steered the national transport policy design. Currently, energy and global warming issues, globalising markets, regional and urban structure developments, ageing population, consumer habits, and time management and lifestyle changes are seen as the great challenges for the development of future transport systems in Finland and Europe (CEC 2006, MinTC 2007a, Prime Minister's Office Finland 2007, Stead 2006).

The efficiency objectives of the transport and logistic systems are still on the agenda, albeit framed into a new form. According to the Finnish Government<sup>1</sup> and the European Commission<sup>2</sup>, Intelligent Transport Systems and Services (ITS)<sup>3</sup>, also called transport telematics, will – whether they already exist or are due on the market in the near future – gradually provide new services to citizens and allow improved real-time management of traffic movements and capacity use. It is hoped that the new systems will offer benefits to transport operators and end-users, but also provide public administration with rapid and detailed information on infrastructure and maintenance needs. In addition to enhanced travelling and transportation comfort, it is argued that they will also help both increase transport safety and security and tackle wasteful transport patterns in the interests of environmental sustainability. The Working Group on ICT for Clean and Efficient Mobility (2008) believes that there is substantial untapped potential for a new generation of Green ITS technologies, applications and services (such as eco-traffic management, eco-information and guidance, eco-demand and access management, eco-freight and logistics management) whose primary purpose is to reduce environmental impacts or increase the energy efficiency of road transport.

The above suggests that the context of transport policy development is about to shift from a path-dependent network design towards development of a complex technological system, largely depending on ICT technology and applications. The challenge is how to recognise the changes in the system and its environment as the basis for the system and policy developments.

Richard Bolan (2007), for example, suggests that information workers (20 percent of the workforce in year 2000) have a particularly strong influence on transport systems because they tend to be clustered in terms of where they work but

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<sup>1</sup> Prime Minister's Office Finland 2007

<sup>2</sup> CEC 2006, CEC 2008

<sup>3</sup> Information and Communication Technology (ICT) applications for transport

## 2. An evolving transport system poses challenges for policy-relevant knowledge production

not where they live, and also tend to commute longer distances from home to work. Bolan has noticed that information workers spread out in a very controlled way, like Route 128 near Boston or in the Silicon Valley, in the U.S. He sees information workers as the future's "city shapers" by claiming that where policy leaders place highways can shape how the economy of a region takes form.

Another example relating to the former one is to recognise new, emerging forms of utilising existing transport networks. One of these is to turn commuter trips into office hours with the help of company buses. The Internet company Google, for example, ferries in about 1,200 employees, nearly one-fourth of its local work force, to and from Google daily in Silicon Valley. The service includes around 32 free shuttle buses equipped with comfortable leather seats and wireless Internet access. Riders can sign up to receive alerts on their computers and cell phones when buses run late. The employees also promote environmental sustainability, not just for ditching their cars, but because all Google shuttles run on biodiesel (Helft 2007).

In Finland, ITS development relates to Finland being a paradigmatic information society due to the fast rise of the Finnish ICT sector during the 1990s (Castells & Himanen 2002). Generally speaking, public policies on ICT in Finland have been based on two main foundations: the selective technology policy where ICT, together with biotechnology, have been the key targets of public funding, and the liberalisation and market orientation of telecommunications (Häyrinen-Alestalo et al. 2004, Pelkonen 2003). In the vision of the Finnish information society, the role of information technology and data networks is to bring forth efficiency, organisational renewal and new forms of collaboration as well as promote the network economy by opening up the development of new services and industries (Ministry of Finance 1995).

One of my principal claims (Papers I and II) is that in the context of the information society's transport system, it is too seldom emphasised that a transport system is not just physical networks or about physical networks. A transport system, whether international, national or local, is a large technological system that contains messy and complex components. It is a socio-technical network. The state of the transport system is a result of the measures and actions carried out by the producers, operators and users of the system, who in turn shape the system by their own behaviour and actions. The system is thus both socially constructed and society shaping (cf. Hughes 1987). The challenges of the strong ICT push and its social implications have been examined e.g. by Anderson et al. (2007) and Oudshoorn & Pinch (2003).

## 2. An evolving transport system poses challenges for policy-relevant knowledge production

In Finland, the role of citizens has so far been rather limited, as the public has not been seen as a contributor to policy making but rather as the object of policy – besides having the role as consumers and users of end products. The shift toward market governance in ICT and consequently in ITS has, however, resulted in increasing interest in consumer needs and preferences as a basis of transport technology design (Paper II). Early signs of a similar interest in placing end-user needs as the first priority have also been emerging within the context of Finnish policy design (Jalasto et al. 2007, MinTC 2007a).

On the other hand, it seems that the world is becoming an increasingly turbulent information society, and too fast – faster than the structures of private and public organisations or even private lives are able to become resilient (Papers I and III). In the transport context, this means that while there are no general restrictions for developing and supplying Intelligent Transport Technologies and Services from a technological point of view, users are still quite slow or even reluctant to accept new intelligent products and services (Paper II). This relates also to the dilemma between ITS and sustainable development. The pace and scale of these focal areas of contemporary transport policies often seem to be very different.

OECD governments and the media today remind us at almost every turn that knowledge production has an enormous, foundational role in our lives in the information society or, further, in the knowledge society. Based on Paper I, in which I and my co-author have identified the features of current and future societies in the context of transport policy, I argue that the main socio-technical principles of the transport system are likely to evolve as follows.

In the contemporary information society, the physical transportation principle is increasingly concentrated on the flow of bits in cables. However, also traditional transport flows are still increasing due to globalisation and growing networks of companies and individuals. In the following societal phase – the knowledge society, as we propose in Paper I – the produced information will be put to use. The knowledge society will share and use knowledge for the prosperity and well-being of its people. Here knowledge becomes a major creative force. During this phase, an immaterial transportation will become a true option. The transport system will be governed increasingly by ICT-based management solutions. To support the development and functioning of the system, also new forms of knowledge production will be needed.

Based on our view of societal transformation in Paper I, in the next – ubiquitous – phase of society, one will start to highlight transparency as the key socio-technical principle. The transport system will become a truly global system, a grid



## 2. An evolving transport system poses challenges for policy-relevant knowledge production

that functions and constantly communicates at every level – man-to-man, man-to-machine and machine-to-machine. During this phase, the transportation principles will change and we can start to speak of a new, transparent operation mode or “technology services”. Technology services can be defined as combinations of technologies and services enabled by interlinking the static transport system and the information infrastructures, information gathering, processing and delivering, as well as its mobile stakeholders like people, goods and vehicles. Technology services will be the products of a society utilising ICT as its basic infrastructure and service platforms. They will be tailored for different kinds of purposes based on the continuous communication between actors in the transport system.

The emergence of new intelligent technologies and services will bring new challenges to decision makers, researchers, businesses, and other societal actors. Intelligent technologies and services will also affect the nature of schemes, strategies and measures as well as the roles of the different actors within the transport system. The roles of public and private parties in the transport system will intermingle in different ways, with new operational practices, and new policy and business models will arise. This development will have some impacts on the ways people move and work and how goods are delivered. The accelerated pace of information society life and business styles will affect also the daily time budgets for travelling. The existence of fixed daily travel time budgets, for example, is an ongoing subject of scholarly debate (e.g. Metz 2004, Höjer & Mattsson 2000, Schafer 2000).

I argue that these are the main challenges we need to face in designing contemporary and future transport policies on, as it seems, a rapidly advancing technological frontier. One of the most problematic questions is how to combine broader societal needs and the dominance of market governance in developing transport policies of the future. Further, what are the particular implications of these socio-technical challenges for knowledge production supporting transport policy formulation?

In the following section, I take a closer look at these questions by first examining the theoretical premises of current knowledge production supporting transport policies. Second, I present some emerging knowledge production approaches from other disciplines that I see as having potential also in the transport sector.

## **3. Theoretical considerations**

### **3.1 Knowledge production to support transport policies**

Science and technology studies (STS) is a field that has aimed to illuminate the relationship between scientific knowledge and political power, as well as investigating the place of science and technology in society over the past few decades (Jasanoff 2004). In the discourse of STS a distinction is often made between basic science, driven by curiosity and the desire to expand knowledge for its own sake, and applied science that places scientific results in the service of society (Jasanoff 1990, Lövbrand 2007). In my view, knowledge production to support transport system developments and decision making cannot be categorised into either of these branches, but into a third one which has interested science and technology scholars since the 1970s. This third branch of science is closely related to applied science, but is more policy driven and has been referred to as “trans-science” (Weinberg 1972), “regulatory science” (Jasanoff 1990) or “fiducial science” (Hunt & Shackely 1999). Recently, this branch has been closely studied and elaborated further, for example in relation to environmental regulation (e.g. Jasanoff 2004, Lemos & Morehouse 2005, Lövbrand 2007).

To my understanding, within this third branch of science, knowledge production to support transport policies and decision making have traditionally focused on project appraisals regarding the costs, benefits and environmental impacts of physical transport project (e.g. infrastructure) investments. I have chosen to refer to these as “traditional transport planning”.

With that background, in subsequent sections I first present the theoretical backgrounds of traditional knowledge production used for policy support in the transport domain, “traditional transport planning”. After discussing their deficiencies in information society contexts, I review some other knowledge production

approaches, which provide a wider, more societal approach for policy support and which seem to hold some promise also for the transport domain. These approaches include policy analysis, systemic planning, integrated assessment, mode 2 knowledge production and the concept of co-production. I formulate my specific research questions in the final section of this chapter.

### **3.2 Transport planning – the traditional knowledge production approaches to support transport policies**

The rational approach as a knowledge production practice for the transport domain evolved in the early 1960s and has ever since, with minor variations, served as the main purpose and methodology for transport planning and decision making. The rational transport planning process begins with an articulation of policy or community goals, leading to an identification of transport system problems. Once these problems are identified, alternative solutions are identified and assessed, and a set of actions recommended based on which alternatives return the most benefit for the costs incurred (Meyer & Miller 2001, Pearman et al. 2001 and 2003, TRANS-TALK 2001).

Within the traditional transport policy and project planning approaches there exists a wide range of different assessment methods or tools for data collection, analysis and formal assessments. Typical methods used for data collection are surveys, before-and-after studies, use of secondary data, existing databases, case studies, expert opinions, program documents and literature reviews. Statistical analysis, transport models (based on micro- and/or macro-economic models), transport forecasts, expert panels and benchmarking are examples of current data analysis methods. As regards formal assessment techniques, cost-benefit analysis (CBA) is very well established in transport as a means of aggregating the impacts of competing transport (infrastructure) proposals so as to get an overall ranking in terms of contribution to social well-being. Generally, CBA is used when the objective of evaluation is to compare the costs and benefits of a project using a common denominator (usually money) in order to decide on whether costs outweigh benefits or vice-versa (e.g. Layard & Glaister 1994, Pearce & Nash 1981, Sugden & Williams 1978).

Multi-criteria analysis (MCA) is often presented as an alternative to CBA in cases where the majority of important effects cannot be monetised or CBA is not seen as sufficient to ensure the multifaceted understanding of a plan or policy that is increasingly required (Dodgson et al. 2000). In addition, Environmental Impact

### 3. Theoretical considerations

Assessment (EIA), Social Impact Assessment (SIA), Strategic Environmental Assessment (SEA) and Socio-Economic Cost-Benefit Analysis (SCBA) have been commonly used in transport project assessments. Due to the development of ITS and interest in and use of Human-Machine Interface (HMI) design, user requirements and specific field tests have increased. This applies also to ex-ante and ex-post assessments of technical applications as well as larger systems. Sometimes also, Delphi and Beneficiary surveys and SWOT analysis have been used in obtaining data and observing changes in the transport field.

Basically, the objective of these approaches has been to break down the planned transport project into thematic components (e.g. environmental, economic and social) and give those components numerical values, on the basis of which analytical assessment and comparison of different solutions have been conducted to find the optimal one. The intention has been to provide premises for rational societal decision making. These formal techniques have a strong technological basis and, partly as a consequence, a strong institutional basis as well. In most European countries, mandatory assessments such as Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) regarding new transport infrastructure projects are examples of that field. The approaches have been mostly inter-urban, only rarely responsive to interactions outside the transport sector and hence not consciously oriented towards wider societal, e.g. sustainability concerns (e.g. ECMT 2004, Nijkamp & Blaas 1994, Pearman et al. 2001 and 2003, TRANS-TALK 2001).

The above implies that in the field of transport, the terms "planning" and "(impact) assessment" referring to infrastructure investments and project appraisals have formed the policy support frameworks for decades (Giorgi et al. 2002, de Rus & Nash 1997). Consequently, knowledge production serving transport policy has focused on "checking plans for public expenditures" (de Rus & Nash 1997), for estimating time savings, for investigating mainly at the macro economic level the relation between infrastructure investment and urban or regional development (Banister & Lichfield 1995), or for assessing social and environmental impacts (Hoon Oum et al. 1997). The development and use of policy level approaches (such as policy analysis) is still a new, emerging field in the transport context, even though it has been on the agenda for a long time.

Juri Pill (1978), for example, argued already in the late 1970s that transport planning needs more detailed, comprehensive and objective observation and less theorising. He presented also the main planning paradox: striking the balance between rigorousness and usefulness. If the transport planner wants to influence the

decisions, he or she must sometimes set aside the comprehensiveness of the analysis and deal with the issues as they occur. If he or she chooses the more rigorous, academically correct course, the advice will arrive too late. In the 1980s e.g. Alexander (1984) Christensen (1985) and Himanen (1987) criticized the traditional rational models for policy design and decision making, based on the best available information, and stage-based proceeding as being unrealistic in tackling the problems of goal consensus, information processing and the nature of information itself within the changing environment.

The multiplicity of methods complemented with the complexity of the transport environment has been seen to pose severe problems for knowledge production relevant to transport policy. The complexity involves at least the dimensions of scope and timing. With regard to geographical scope, one has to distinguish at least between international, national, regional and local levels. The time dimension is considered important in two ways:

First, the timing with regard to the phase of project or policy development. In transport assessment or evaluation literature (e.g. Giorgi & Tandon 2000, Giorgi et al. 2002, JEGTE 2003, Layard & Glaister 1994, Minken et al. 2003, Pearce & Hett 1999, Pearman et al. 2003, Sugden & Williams 1978, TRANS-TALK 2001, Turro 1999), one refers alternatively to *ex-ante assessment or appraisal* to describe assessment carried out during the planning or policy formulation phase. The primary function of appraisals is to deliver insights into the expected outputs, results or outcomes of the project or policy. Assessment carried out during implementation or the decision-making phases – often referred to as *mid-term assessment or monitoring* – has the function of observing developments to deliver the preliminary assessment of the project's or policy's effects or of the extent to which it is proceeding according to original plans. The third assessment type carried out once the project or policy implementation has been completed is often given the name *ex-post assessment or evaluation*. Its function is to supply policy makers with information about the results and outcomes of the projects or policies. Second, and in addition to the above categorisation, the time dimension is considered relevant in presenting the time horizon for which project or policy effects are to be observed or forecast.

Currently, according to the European Thematic Network: 'Policy and Project Evaluation Methodologies in Transport' TRANS-TALK (2001), Giorgi & Tandon (2000), Giorgi et al. (2002) and Pearman et al. (2001 and 2003), there are two views about what role knowledge production (especially assessments) to support transport policies should have. One is simple: they are tools to assess value for money. An al-

### 3. Theoretical considerations

ternative view is that they are tools to help in the negotiation and deliberation process, through which socially desirable transport actions are identified.

Meyer & Miller (2001) support the latter view and argue that the decision-oriented transport planning approach, for which different methods provide information, should address a much wider range of issues. These include: establishing the future context; responding to the different scales of analysis; expanding the problem definition; maintaining flexibility in analysis; providing feedback and continuity over time; relating to the programming and budgeting process; and finally providing opportunities for public involvement. Also Short & Kopp (2005) present a critique of current (mega) project appraisals. They observe that project appraisal is inconsistent and weak, strategic appraisal is in its infancy, ex-ante appraisal is often biased and ex-post analysis rarely takes place. They suggest (as do some other contributors in Priemus et al. (2008)) that research into planning and decision-making processes could, given their ever-increasing complexity and duration, be of great value to society.

The above arguments are complemented and elaborated e.g. by Tuomi (2001, 2003), who has defined the three research domains of knowledge society that are linked to core developments in the ongoing transformation or change. These domains are Institutions & Culture, Everyday Life, and Systems of Production. The transport system lies in the intersection of these domains, which naturally puts pressure on the transport sector to stay as sensitive to changes in society as the other domains. This requires the introduction of wider, multidisciplinary approaches also to support all phases of transport policy development (e.g. ECMT 2004, Giorgi et al. 2002, TRANS-TALK 2001, Tuominen et al. 2007).

My basic argument in this dissertation is that traditional transport planning is no longer sufficient to provide the knowledge needed to understand the socio-technical nature of the transport system – and the dynamics between the different actors within – as a basis for transport policy development. For example, in the information society's transport system the roles and networks of stakeholders will be pluralised. The transport system will be increasingly composed of public parties, private parties, contributing end-users and their complex networks. In Paper I we suggest that in the future, all actors within the transport system will equally produce and use the produced knowledge as the basis of their actions, business, and policy development. This requires re-thinking also of the knowledge production approaches.

Frameworks for bounded rationality and experiential incrementalism, referred to in Paper III, and also Valovirta & Hjelt (2005) complement my view by ob-

serving that traditional formal knowledge production techniques are often based on assumptions which may not be accurate; e.g. the policy maker is assumed to be a rationally acting individual, and choices are clearly demarcated or decisions non-recurrent. My view is that very seldom are formal assessment techniques capable of producing comprehensive answers to practical questions. To serve the transport policy development of the future, knowledge production will need to take into account also the socially constructed and systemic nature of the transport system. This requires further shifting of the decision making from the actual decision-making situation to the future (foresight) on the one hand and the past (evaluation and monitoring) on the other. To my understanding, assessing the long-term and broad scale policy outcomes as well as the effectiveness of the proposed policies is of great importance here. Knowledge production does not need to provide a solid basis for decision making as a result, but act more as a process of social argumentation. The new knowledge can be seen as a fuel feeding the already ongoing processes, and individuals or organisations will gain added value by participating in the processes.

### **3.3 Policy analysis**

The academic field of policy analysis is an old, traditional way of policy-relevant knowledge production. Understood in its widest sense, policy analysis is as old as civilization itself. It emerged at a point in the evolution of human societies where practical knowledge was consciously cultivated, thereby prompting an explicit and self-reflective examination of links between knowledge and action (Dunn 2004). One of the earliest recorded efforts to consciously cultivate policy-relevant knowledge occurred in Mesopotamia, in the twenty-first century B.C. The early Mesopotamian legal codes were a response to growing complexity of fixed urban settlements, where policies were needed to regulate the distribution of commodities and services, keeping records and maintaining security and defence.

Basically, as defined in political science, policy analysis is a term used to cover all methods or approaches that can be used to make any form of judgement on public policy (Birkland 2001, Dunn 2004). In other words, it can be described as a multidisciplinary, problem-solving process designed to create, critically assess, and communicate information that is useful in understanding and improving policies. Policy analysis may regard economics, environment issues, decision-making processes, organisational aspects, etc., and it has been applied in many fields of society such as health, education, housing and work.

### 3. Theoretical considerations

In political science the policy cycle or policy process is a tool used for analysing the development of a policy item. Classical decision making models (e.g. Birkland 2001, Dunn 2004, Dye 1976, deLeon 1999, Lasswell 1956, Palumbo 1987, Parsons 1995) distinguish between four to eight process phases, the most typical of which are: (1) problem identification, (2) agenda setting, (3) policy formulation, (4) decision making, (5) policy implementation and 6) policy evaluation (continue or terminate).

Traditionally, the main purpose of policy analysis has been to improve the policy making process by producing knowledge for the different phases of the policy processes. According to Dunn (2004), policy analysis aims to produce five types of policy-relevant information. These types represent information about policy problems, policy performance, expected policy outcomes, preferred policies and observed policy outcomes. These five types are interrelated. Five policy analysis procedures produce and transform the information: *problem structuring* produces information about what problem to solve, *forecasting* about expected outcomes of policies, *evaluation* produces information about the value or worth of expected and observed outcomes, *monitoring* produces information about observed outcomes of policies and *recommendations* about preferred policies.

Furthermore, in policy analysis literature, one may distinguish between different forms of analysis. As in the context of transport planning (discussed in section 3.2), prospective (*ex-ante*) policy analysis involves information production *before* policy actions are taken and retrospective (*ex-post*) analysis involves information production *after* policies have been implemented. Other forms identified for policy analysis are descriptive or normative, problem-finding or problem-solving and segmented or integrated analysis.

Some scientists and practitioners in the field of transport observe that policy analysis could be successfully applied also to the transport sector (e.g. Giorgi et al. 2002, TRANS-TALK 2001). However, when looking at the knowledge production needs of the transport systems of the future, my claim is, that despite providing a wider perspective than traditional transport project assessments, policy analysis would by itself fall short in taking into account the many different actors and emerging actor clusters that produce and need knowledge within the information society's policy processes. The original aim of the policy analysis has been, however, to serve "traditional" institutionalised policy making, which justifies this kind of reflection.

There are also other features, which my co-authors and I have identified as important for future knowledge production in transport policy, but are missing from



the approaches presented in the previous sections. The first one is the ability to see transport systems as common pool resources developed by various clusters of actors and end-users. Papers II and III take two different perspectives on this issue, namely needs and preferences of different end-user segments as well as policy target analysis and elaboration. The second one, a consequence of the former, is the lack of interest and forums for co-operation in building common future visions for transport sector developments within the wider societal context. The issue is highlighted especially in Paper IV.

### 3.4 Systemic planning

Systemic planning (SP) by Steen Leleur (2008) is an approach developed for planning under complicated and difficult circumstances. The basic ideas of SP stem from the third wave of systems science (from the 1990s to the present) and draws on the theoretical work primarily done by Luhmann (1995), Morin (1992), Dreyfus & Dreyfus (1988) and Stacey et al. (2000). The third wave of systemic science is characterised by uncertainty, chaos and complexity. SP is basically built on the last complexity orientation. Systemic planning refers to the emerging new type of 21<sup>st</sup> century society as the hyper-complex society.

The systemic planning approach emphasises that reorientation from conventional, analytical stage-based planning (see section 3.2) to a wider, systemic, communication-based, decentred social systems thinking is needed under complex conditions. Seeing planning as a non-linear process and contingency as its main condition are the basic ideas behind the SP approach.

Building awareness of the complex conditions, as well as creatively building processes for the systemic approach, are the key tasks in systemic planning. SP consists of an exploration and learning cycle that in an ongoing, self-organising process establishes a “sub world” around the planning problem (Leleur 2008). The key notion, and what creates the sub-world is the successive recasting of systemic perceptions. The various insights identified and the way these insights are confronted, interpreted and combined determines the achievement of the systemic perception of the problem, the “difference” from the previous one.

Furthermore, Leleur presents four SP planning concerns, which can assist the planning processes as follows: (1) adequacy, which illustrates the feasibility of the action, (2) dependency, representing context feasibility, (3) suitability, representing action acceptance and (4) adaptability, representing context acceptance. Both hard and soft operations research methods can be used in testing the above concerns. The

### 3. Theoretical considerations

approach has been applied to and examined in the context of transport infrastructure planning (The Øresund Fixed Link 2005), but the methodology seems to be generally applicable to other sectors of society with a need for systemic decision support due to uncertainty and complexity (Leleur & Holvad 2004).

Even though SP presents a new, wider, systemic approach to transport planning, the focus is still on transport infrastructure project planning, not on developing the socially constructed and society-shaping transport system. This, I consider to be one of the main issues in producing knowledge in the information society context. It allows me to propose the forms for knowledge production that I present in this dissertation as complements to the SP approach.

## **3.5 Emerging knowledge production practices**

### **3.5.1 Background**

In the previous sections, I presented the traditional and emerging approaches to support transport planning and policies. In addition, I discussed their potential and deficiencies in serving the knowledge needs of the emerging socio-technical transport systems. In the following sections, I review some emerging knowledge production practices from the field of Science and Technology Studies (STS) that I see as relevant also for the transport sector, namely: integrated assessment; co-production and mode 2 knowledge production. The reason for choosing these approaches lies in their nature and ambition to explore how knowledge production is incorporated into practices of policy making or of governance more broadly and, conversely, how practices of governance influence the making and use of knowledge (Jasanoff 2004). I consider this a very important but missing perspective in current knowledge production in the transport domain.

As discussed in section 2, traditional institutionalised knowledge production and mechanisms in the field of transport are no longer – and will be even less in the future – sufficient in serving policy development processes, which are themselves also evolving. As Jasanoff (2004) puts it, deeper understanding between the transport domain and others such as STS, politics, environmental protection, economics, sociology etc. about the links between knowledge, power and culture are needed and could be enormously fruitful. I see that understanding these links could clarify also the roles and relationships of different transport system actors in the information society's transport domain, not as such but as part of a wider socio-technical system.

### 3.5.2 Integrated assessment

An emerging assessment approach, complementary to the traditional policy analysis and claimed to have potential also within the transport sector, is the concept of Integrated Assessment. When first introduced in the mid-1990s (e.g. Gough et al. 1997, ICIS 1999, Rotmans 1998, Rotmans & Dowlatabadi 1998), Integrated Assessment (IA) was referred to as “the new fashion in scientific research for policy making purposes”. IA suggests that since the world around us is becoming increasingly integrated in its commercial, financial and social activities, the consequent complexity forces us to think and act in a more integrative manner.

Hence, IA has been delineated as a structured process of dealing with complex issues, using knowledge from various scientific disciplines and/or stakeholders, such that integrated insights are made available to decision makers. It tries to shed light on complex issues by illuminating different aspects of the issue under concern: from causes to impacts, and from options to strategies. IA partly overlaps with the existing research areas, especially technology assessment, risk analysis and policy analysis. However, these research areas also address some kind of complex problem from a specific point of view. The essential difference is that IA aims to integrate knowledge from an *a priori* integrated point of view (Rotmans 2006 and 1998).

Further, IA has been described as an iterative, continuing process, where integrated insights from the scientific and stakeholder community are communicated to the decision making community, and experiences and learning effects from decision makers form one input for scientific and social assessment (Rotmans 1998). The IA toolkit includes both analytical tools/methods (such as scenarios, models, risk analysis) and participatory methods (such as focus groups, policy exercises and dialogue methods). IA methods have been developed by e.g. Rotmans (1998); Rotmans & Dowlatabadi (1998); Toth & Hizsnyik (1998) and Toth (2003). They have been successfully applied especially in the field of Climate Change.

Currently, the IA theorists (e.g. ICIS 1999, Rotmans 2006) see that the first generation of IA tools described above were quite technocratic and deterministic by nature, with a high level of engineering and often considered as “truth machines”. The next generation tools should focus on their exploratory rather than predictive value. Also, they should be considered more as aids to gain more insight into and achieve better understanding of the persistent problem in question and should be built by networks and collaborations between different institutions.

### 3. Theoretical considerations

Sustainable development as an overarching policy target is seen as a major initiator for these needs. The key requests of also the systemic planning approach (in section 3.4) – building awareness about the complex conditions and creatively building processes for a systemic approach – relate closely to the needs of IA, strengthening the demand.

There are at least four complementary approaches, which have been suggested to alleviate the demand (Rotmans 2006, ICIS 1999). The first is interlinking and improving existing tools. The main issues identified here are interlinking the different existing assessment tools to enable estimation of how policies contribute to specified objectives and targets, using tools in conjunction with relevant indicators and scenarios, improving the presentation (visualisation) and documentation of the tools and the communication of disciplinary researchers and gaining more experience with participatory methods.

Our focus in Paper III relates closely to the issue of estimating how policies or policy measures contribute to specific targets. We see that the method we have developed for target analysis in the transport context could contribute also to other fields, especially IA since the transport system is a socially constructed and widely integrated large technological system. Also, in Paper IV there are similarities with the above requested issues, namely using assessment tools with relevant indicators and scenarios. We found that in the context of the European Commission's transport research projects there has been a definite lack of linkages between developed indicators and different assessment tools.

The second approach is developing new tools and instruments. Here it is seen that the new tools should handle multiple scales, especially to link micro and macro scales and deal with the dynamic behaviour of stakeholders. The tools should be rooted in complex systems theory, evolutionary economics, multi-level governance and multi-agent modelling. They should also integrate science better and be more explorative than predictive. Our approach in Paper II is to illustrate how categorisation of transport system's end-users, based on their differences in daily mobility and transportation of goods, could be used as a basis for end-user-oriented transport policy design. In addition, we discuss the possibility to use the categorisation as a starting point also for identifying end-user's preferences for new technology in the transport system. This approach can be seen to answer especially the micro-scale dynamics requests of the next generation of IA tools.

The third suggested approach is to match better the demand and supply of IA studies. At present, most IA research is supply-driven and analytical and participatory IA tools are not used in a complementary way. The major challenge here is

seen as letting non-scientists or stakeholders co-develop analytical tools in a well-led participatory learning process. This could increase the credibility, trust and also use of these methods. My contribution to this issue is in Paper I, in which I and my co-author develop and test a participatory foresight method, socio-technical roadmapping, and identify the future knowledge needs for the transport system and policy development.

The fourth approach is developing quality criteria for IA studies. Analytical, methodological and usability criteria are the three distinguished quality criteria types. In Paper IV we consider and contribute especially to the usability criteria by developing and testing a fitness-for-purpose method for transport research projects in policy support.

The field of transport has often been mentioned, mostly because of its societal nature, as a potential field for integrated assessment. Despite this, the use of IA within the transport sector and the contribution of transport research to IA have thus far been modest.

### **3.5.3 Co-production and mode 2 knowledge production**

In the following, I briefly review two other emerging approaches of knowledge production, namely co-production and mode 2 knowledge production, and discuss their implications for the transport domain.

The concept of *co-production* has been introduced in the field of STS, labelling a research arena where, in contrast to both basic and applied science, the primary audience are policy makers and regulators rather than scientific peers. Jasanoff (2004) defines the aim of co-production as making available resources for thinking systematically about the processes of sense-making through which human beings come to grips with worlds in which science and technology have become permanent fixtures. The aim is not to provide deterministic causal explanations or rigid methodological templates for future research.

Some (e.g. Hunt & Shackley 1999, Lemos & Morehouse 2005) have used the co-production concept to refer to the institutionalised practices by which "usable science" is co-produced in the context of everyday interaction between scientists, policy makers and the public. Further, Lemos and Morehouse (2005) propose a concept of iterativity as a model for co-production of science and policy through integrative science. According to the model, substantial commitment to the three identified components is required. The components are: interdisciplinarity, stakeholder participation, and production of knowledge that is demonstrably usable.

### 3. Theoretical considerations

The usability request relates closely to the usability criteria demand of the IA studies. In addition, resource availability, flexibility, and the level of fit between science and stakeholder needs and expectations interact with the three components to either facilitate or limit the scope of co-production in different situations. My co-authors and I discuss the production of usable science in the context of European transport research projects in Paper IV, by using the term fitness-for-purpose.

Others have referred to co-production as the dynamic process by which science and society continually shape, constitute and validate one another (e.g. Jasanoff 2004, Jasanoff & Wynne 1998, Latour 1987). Bruno Latour (1998) suggests the notion of “collective experiment”, meaning that the old culture of certainty associated with pure science has been replaced by a culture of research in which science and society search for solutions collectively. Latour sees that what has changed most is the way science enters a society. It no longer enters it to bring order or simplify its composition; it enters to add new, uncertain ingredients to all the other ingredients to the collective process, to make “collective experiments”.

Jasanoff (2004) identifies the following four pathways or instruments by which co-production most often occurs and operates at the nexus of natural and social order. Making identities refers to the importance of forming and maintaining of identities. What roles do knowledge and its production play in shaping and sustaining the social roles (e.g. researcher, expert or civil servant) or giving them power and meaning? In Paper I, we touch the issue by identifying the roles of different transport system stakeholders within a road mapping exercise in the context of technology services. Forming identities is referred to also in Paper II, although in a very different form. Paper illustrates the identification of the main end-user groups of the Finnish transport system for the basis of policy development, based on differences in daily mobility patterns.

According to Jasanoff (2004), making institutions emphasises that when contexts and knowledge change, new institutions emerge to provide the web of social and normative understanding within which new characterisations can be recognised and given political effect. Making discourses proposes that solving problems frequently takes the form of producing new languages or modifying old ones to find words for new phenomena, persuade a sceptical audience, link knowledge to practice or action, give account to experiments, etc. Finally, making representations refers to the fact that much work has been done on the means by which scientific representations are produced and made intelligible in diverse communities of practice, but the connections between this work and political and social representa-

tions have not always been apparent. In Paper IV, building researcher-civil servant networks around European transport research project assessments and dissemination of results is presented as a one possible solution to alleviate the problem.

Currently, one of the new knowledge production practices possibly most widely referred to and closely related to co-production is the so-called *mode 2 knowledge production*. In the discussion about mode 1 and 2 knowledge productions by Gibbons et al. (1994) and Nowotny et al. (2001), a number of attributes have been identified which suggest that the way in which knowledge is currently being produced is beginning to change. Mode 1 is presented as more or less synonymous with what has traditionally been called science. Within mode 1, knowledge is produced primarily under highly institutionalised conditions, e.g. universities, colleges, research institutes, protecting scientists from external demands. The emphasis is on differentiation, making distinctions between research fields and drawing boundaries between disciplines.

Mode 2 instead puts great emphasis on the significance of “social” in the practice constitution of science. By this it implicates that science can no longer be regarded as an autonomous space clearly demarcated from the “others” of society, culture and economy (Nowotny et al. 2001). Attributes in mode 2 knowledge production include transdisciplinarity, heterogeneity and organisational diversity, social accountability and reflexivity, quality control and, last but not least, knowledge produced in the context of applications. By application I do not mean the traditional product development and the processes. In mode 2, knowledge is always produced in a complex context, is shaped by diverse sources of supply and demand, and is not produced unless and until the interests of various stakeholders are included. These processes specify what is meant by the context of application. In Paper I, we have highlighted the issue by illustrating what kind of technologies, services, actors and related policy relevant knowledge is needed in transport system and policy developments of the ubiquitous society of the future.

The second attribute of mode 2 knowledge production is transdisciplinarity, which means that the final solutions will normally be found beyond any single discipline. The third attribute, homogeneity and organisational diversity, means that knowledge production is heterogeneous in terms of the skills and experience people bring to it. The composition of a problem-solving team changes over time; teams are not firmly institutionalised. People come together in temporary work teams and networks (arenas), which dissolve when a problem is solved (Gibbons et al. 1994).

### 3. Theoretical considerations

Social accountability and reflexivity mean increased sensitivity of scientist and technologist to the broader implications of what they are doing. In other words, it refers to a growing awareness about the variety of ways in which advances in science and technology can affect the public interest. Due to this, different individuals and groups that have traditionally been seen outside the scientific and technological system become active agents in the definition and solution of problems and in the evaluation of performance. The transport system end-user groups illustrated in Paper II are examples of such new groups that may turn out to be very important information providers in the future. Finally, and endorsing the IA and co-production approaches, the criteria used to assess the quality of the work and the teams that carry it out are much broader in mode 2 than in mode 1 knowledge production.

### 3.6 Research questions

The discussion in previous sections has revealed some of the problems, questions and development needs, but also possibilities regarding knowledge production supporting transport policies in an information society.

On the one hand, traditional transport planning seems no longer to be sufficient in providing the knowledge needed to understand the socio-technical nature of the transport system and the dynamics between the different actors within, as a basis for transport policy development. On the other hand, new emerging knowledge production approaches are highlighting issues such as dynamic behaviour of actors, social accountability, handling multiple scales, exploring the future, linking participatory and analytical methods, developing quality criteria, etc. Therefore, there seem to be both practical and theoretical reasons to explore what kind of forms knowledge production supporting transport policies of an information society should have, and how these differ from those of traditional transport planning. For this purpose, I formulate my research questions as follows:

1. What kind of challenges and opportunities does the changing transport system pose to knowledge production approaches and contributing actors supporting transport policy development and decision-making?
2. What are the emerging forms of knowledge production that can serve the needs of policy development and decision making in the changing transport system context?



3. What are the theoretical and practical implications of the new knowledge production forms and their characteristics for different transport system and policy stakeholders?

Understanding the dynamics of knowledge production within the information society's transport system, and finding ways to fit the produced knowledge for the purposes of the development of contemporary and future transport policy, form the motivation for the research questions.

## 4. The approach

A variety of knowledge production methods or practices relevant to transport policy have been developed in the papers of this dissertation. The methods themselves constitute the main results of the papers. Even if the backgrounds of the papers are quite different, each paper stems fundamentally from the lack of wider, communication-based knowledge production methods to support policy development of a complex, socio-technical transport system.

In each paper, the basic approach is based on empirical material that has been used to test the potential of the developed method. In addition, a specific theoretical framework has been applied in the papers to enrich empirical analysis as well as to contribute to methodological development in the field of knowledge production for transport policy. The approaches aim to respond to both practical and theoretical needs of the information society's transport system and policy developments presented in sections 2 and 3. The papers present illustrations of the emerging forms and new characteristics, contributing actors and networks for knowledge production supporting transport policies of the future. In the following sections, I briefly present the approaches and the material of the papers included in this dissertation. Further, I discuss their contribution to the research questions.

In Paper I, we developed a foresight method – labelled visionary socio-technical roadmaps – to study the changing transport system and knowledge production needed to support transport policy development. In general terms, roadmaps aim to provide an extended view on the future of a chosen field of inquiry. They also make inventories of different possibilities, communicate visions, stimulate investigations and monitor progress. In other words, roadmaps are composed of the collective knowledge and the imagination drivers of change in a particular field (e.g. Kostoff & Schaller 2001, Phaal et al. 2004, Probert & Radnor 2003, and Rinne 2004). Visionary socio-technical roadmaps developed in Paper I aim for these basic roadmapping objectives with a wider view by (1) emphasising the

application visions that are embedded in the roadmap structure and (2) combining different layers of society and technology (Ahlqvist et al. 2007). The presented roadmapping process comprises three phases: (1) background study, i.e. review of existing documentary material, (2) two participatory workshops of researchers, civil servants and technology developers and (3) reporting and presentation of final results. As a result, three complementary, visionary roadmaps within a time frame up to the year 2025 have been produced. The roadmaps consist of five layers: user needs, markets, actors, technologies and assessment knowledge.

The approach in Paper I contributes mainly to the research questions 1 and 2 by illustrating the future developments of the transport system technology services through user needs, markets, participating actors, technologies and the required policy relevant knowledge. Traditionally, roadmaps have been described as links between concepts such as product, technology and science. However, in a wider societal framework or in the field of knowledge production for policy processes, which is my main field of interest, the roadmapping method has not been commonly applied. Based on Paper I, with the Finnish case study, I argue that visionary socio-technical roadmapping can provide a tool for a better understanding of the socio-technical and systemic nature of the transport system as well as bringing transport system actors together to discuss future transport visions, policies, technologies, services and their interdependencies in a collaborative manner.

Paper II contributes to the methodological development of end-user-oriented transport policy-relevant knowledge production. Since it is not possible to survey the mobility needs and preferences of each individual transport system user as a basis for end-user-oriented policy design, the paper illustrates, through a Finnish example, the possibility to categorise users of the transport system into homogeneous groups based on their differences in daily mobility and transportation of goods. In addition, the potential to deepen this segmentation to illustrate the acceptance by different user groups for new transport technology or policy is discussed. The theoretical background of the paper stems from the framework of the LTS (Large Technological Systems) theory developed by Thomas P. Hughes (1987 and 1983) which is complemented by the Social Construction Of Technology (SCOT) approach of Pinch & Bijker (1987).

The empirical data for passenger transport categorisation stems from Finnish national household surveys and demographics. The aim of the approach is to classify the whole population into a minimum number of person groups by their demographics, using differences in daily mobility as the criteria. The motivation behind the exercise was to find homogenous groups, whose mobility needs could

#### 4. The approach

be investigated further, e.g. with a survey or interviews, as the basis for policy developments. The analysis was started with around 100 person groups, which through various mergers were reduced to 11. Furthermore, the potential to deepen this segmentation to describe the needs of – but later in the policy process also social acceptance by – different user groups for new transport technology or policy was examined. The strength of this classification method can be seen in its extensive but also simple nature. First, the extensive data and large number of groups at the beginning help the analyst to identify the most descriptive criteria for clustering. Second, as the method proceeds by merging groups into major groups that still have sufficiently similar daily mobility characteristics, both the number of criteria and mobility groups are gradually reduced, resulting in a limited number of segments as well as criteria. Earlier methods developed for this kind of clustering have been much more complex and not as easy to carry out. Due to the demographic data, the categorisation can be forecasted also to a point of time in the future.

In the case of freight transport, we used an approach called “generic logistics concept”. This comprises three vertical business activities or levels: management, operations and instruments. The aim of the logistics concept was primarily to help in identifying different transport chains or operational models within a certain geographical area. Secondly, it considered different actors and their needs and preferences for the transport system and logistics services within the transport chains’ three levels presented above. As a result, from six to eleven user segments were identified. National transport as well as goods transport statistics were used here as the empirical material.

The approach in Paper II contributes mainly to research question 2 by suggesting that in developing policies or technologies, the end-user preferences are critical from the points of view of policy implementation and technology acceptance and usability. The findings of paper II illustrate that a basic, system-based framework for identifying user preferences as a basis for end-user-oriented transport system and policy design could be initiated by the segmentation approach.

In Paper III, the potential of a target analysis method in acting as a link between policy objectives, targets, measures and their implementation in order to improve the policy process was illustrated. The empirical data stems from Finnish policy documents and from discussions with civil servants within the transport sector. The policy process frameworks for bounded rationality and experiential incrementalism (Birkland 2001, Talvitie 2006, Khisty and Arslan 2005) have been used as a basis for exploration and complemented with the new target analysis. The analysis has the following five steps: First, relevant policy targets and meas-

ures to meet them are screened from the policy documents. Second, a framework assessing the forms and types of interactions between targets according to six characteristics is presented. Third, the dependence of the targets is defined. Fourth, the acceptability of the policy measures presented for meeting the targets is assessed by approaching potential stakeholders about their views on the policy measures and their implementation. Finally, the expected outcomes of the policy measures are assessed against the targets identified in the first step of the analysis.

The importance of linking policy targets to implementation highlighted in Paper III relates to the general question of relating facts to values, which has been identified as one of the most important and long-standing discussions in the modern social sciences. Massive amounts of empirical data have been collected, but systematic methods for exploring the normative frameworks that give these data meaning are lacking. Marsden & Bonsall (2006), for example, refer to the issue in the transport sector by arguing that transport policy targets often do not reflect the totality of the issues. Much data has been collected on e.g. the indicators of a sustainable transport system, but frameworks on how to use these data to measure the development of transport systems in a more sustainable direction are missing. Accelerated changes in our living and working environments, with overwhelming amounts of information, are unfortunately not alleviating the process.

The approach in Paper III contributes to research questions 2 and 3 by suggesting that it is possible to appraise the potential success of transport policy implementation by studying synergies and conflicts as well as other dependencies between the targets presented in policy statements. In addition, in order to meet the targets, examination is needed of possible support for or opposition to the policy measures to reach the targets by main stakeholder groups. The target analysis method helps improve policy processes by covering all five categories of the bounded rationality concept, and consequently incorporating new knowledge into it regarding the problems, causes, consequences, stakeholders, etc. that are emerging and changing within the transport system.

Finally, Paper IV presents a generic fitness-for-purpose assessment (FFPA) method for research projects in support of transport policy. The approach aims to illustrate how to systematically analyse the usability of the information produced in research projects concerning impact and policy assessments, as well as how to build interacting networks around the assessments to support the use of policy-relevant research knowledge in practice. In addition, the paper presents recommendations on how to promote the use of the new research knowledge in the development of transport policy.

#### 4. The approach

Paper IV highlights the ideas of policy networking which have gained strength recently both in European policy science and governance (e.g. Kickert et al. 1997, Marsh 1998, Peterson 2003). Also, the literature from theoretical fields of FFPA and Policy and Impact assessment has been used as a starting point for methodological development. The FFPA method was developed and applied within the framework of the Transforum Coordination Action -project within the European 6th Research Framework Programme (FP). Transforum facilitated networking and dialogue among researchers, policy makers and stakeholders by establishing an innovative knowledge Forum, which acted as an assessor of the usability of results in the fields of transport indicators, transport modelling and transport policy assessment of strategic transport research. The developed method is comprised of three parts: (1) The Project Screening Process, which describes the data collection and selection concerning relevant transport policy support projects, (2) The FFP Analysis of research projects, consisting of four assessment phases and (3) The transport researcher-civil servant network building through European-wide meetings (forums).

The general challenge taken up in the approach of Paper IV was to illustrate that linking a systematic analysis of transport research projects to researcher-civil servant network building could provide tools for the FFPA of EU research projects in support of policies, and consequently bring transport research closer to policy processes. Hence, the main contribution of the approach is to research questions 2 and 3, in showing that this kind of process is relevant for and can be accepted by both the research and policy making communities.

## **5. Emerging forms of knowledge production**

### **5.1 Contribution of the papers**

In the following sections I explore and identify, based on the empirical research of the papers and the theoretical part of this introduction, the emerging forms of knowledge production that can serve the needs of policy development in the changing transport system context. Further, I give examples of the methods, contributing actors and networks necessary for useful knowledge production. Finally, in section 6, I present the theoretical and practical implications of the new knowledge production forms, and outline future research needs.

Based on papers I–IV, I propose that approaches broadening the perspectives of knowledge production for traditional transport planning towards forms of e.g. foresight, networking and learning, may serve well the knowledge needs of the information society’s transport policies. In the information society’s transport system, the emergence of new technologies and services will bring new challenges to decision makers, researchers, businesses, and other societal actors. There will be a large variety of parallel development or innovation processes going on within a larger societal context. Consequently, the roles of public and private parties in the transport system will intermingle in different ways, and new operational practices and business models will arise. There no longer exists a small group of (public) organisations (such as the ministries, modal administrations, municipalities, i.e. “the producers”) solely responsible for the decision-making. Instead, a number of dynamic decision making networks, consisting of different actors having a variety of goals, are growing up around the policy items or transport system innovations needing information and knowledge for the basis of their mutual decisions.

This means that the knowledge provided to make informed transport decisions needs to include, in addition to the traditional issues, also new forms to serve the

new needs of a wider variety of societal actors. The end-users of the knowledge will be multi-actor processes where a policy item is affected at all stages of policy making and where heuristic rules and routines have a strong influence on the behaviour of different actors (see Paper IV). Clarification of the relationship between scientific knowledge, political power and different transport system stakeholders proposed by the emerging knowledge production approaches in section 3 is extremely relevant here.

The following sections present and characterise my basic arguments regarding the emerging forms of knowledge production for transport policies in the information society. The forms are an outcome of the results of the included papers as well as the practical and theoretical considerations presented in previous sections of this summary chapter. I have named the five forms as follows: Knowledge production through system-based foresight; Knowledge production through system-based evaluation; Knowledge production in networks; Knowledge production as processes of social learning and argumentation; Knowledge production as a source of renewal. The forms are evident in each of the papers and can hence be considered as their overarching elements.

### **5.2 The transport system context**

Traditionally, transport policy and transport system development has focused largely on transport networks (roads, railways, waterways), making the policy processes very path-dependent in nature. However, as emphasised in Papers I and II, a transport system is no longer simply physical networks or just about them. A transport system, whether international, national or local, is a large technological system containing messy and complex components. It is a socio-technical network. The state of the transport system is the result of the measures and actions carried out by the producers, operators and users of the system. Basically, the ultimate purpose of the transport system is to serve the needs and expectations of the end-users, who in turn shape the system by their own behaviour and actions. The system is thus both socially constructed and society shaping.

Producing relevant knowledge that supports the development of successful transport policies within such a system thus requires constantly evolving mapping of the system's future as well as learning from its past developments, all conducted from different societal perspectives. In the complex and networked information society, various forms of foresight and evaluation knowledge, used as



complements to each other, can provide potential approaches to support the transport system and its policy developments (Papers I and IV).

### **5.3 Knowledge production through system-based foresight**

Foresight and visioning as approaches to anticipate future developments within a wider societal context, and using this foresight knowledge as the basis for transport policy development, has not been a traditional approach for the transport sector. Anticipating the future has focused largely on analysing past trends and been based on them, forecasting the future trends of e.g. transport volumes. The emerging knowledge production approaches reviewed in section 3 emphasise, however, seeing contingency as the main societal condition and dynamic processes by which science and society continually shape, constitute and validate one another within (Jasanoff 2004, Latour 2004, Leleur 2008). In addition, the exploratory rather than predictive value of knowledge production is seen as important.

The included papers have revealed that there is a lack of visionary thinking in the transport sector – to be more precise, a lack of innovation in using different knowledge production approaches for developing new visions for the future. In the information society's complex transport system, decisions on future development cannot be based solely on analysis of the past; also wider mapping of different futures is required. Mapping the future is essential in order to stay resilient to the rapid changes in the system as well as different societal demands of the diverse transport system users and producers.

System-based foresight as a form of knowledge production is based on characteristics relating to the use of social constructions of the transport system as the basic knowledge for policy as well as technological developments. The essential issue in this context is to gain knowledge and understanding on the dynamics of end-user acceptance as the basis for technology, service or policy developments. Socio-technical foresight methods (e.g. roadmapping) can provide good premises for coping with the systemic challenges of transport policy development. In the roadmapping approach, which we present in Paper I, different transport system and service developments are explored on different levels, e.g. user needs, markets, actors, technologies and knowledge production. In addition, short, medium and long term developments are considered.

Another example is developing methods and tools for identifying the preferences and needs of the transport system end-users as the basis for policy devel-

opment. My argument here is that by developing methods for large-scale end-user segmentation (illustrated in Paper II), which lean on theories like the Large Technological Systems Theory by Hughes (1987) or the Social Construction Of Technology (SCOT) approach of Pinch & Bijker (1987), the impact of policy measures on transport system's future could be assessed in a wider context than before. In addition, the methods might be expanded further to assess also the end-user acceptance for new technologies or policies (e.g. the system level acceptance of ICT applications).

### **5.4 Knowledge production through system-based evaluation**

In addition to foresight knowledge, successful development of policies for the transport system of the future also requires evaluation of current and past system performance, at least from the point of view of their quality, efficiency, effectiveness, and robustness as a basis for future developments. In addition, the usability of the produced knowledge from the point of view of its end-users is of high importance. These form the basic characteristics of system-based evaluation.

One very important perspective in assessing the quality of knowledge production that has received too little consideration in the past is the evaluation of the impacts and usefulness of transport research on policy making. My argument here, based on Paper IV, is that to be able to utilise the knowledge produced with different transport policy analysis methods, and learn from them, new practices are required also in the knowledge transfer processes. Examples of these are e.g. producing the right information in the right form to fit the purposes of the policy process and its different actors, and furthermore promoting learning within the policy process. These practices are currently very poor in many Finnish and European cases. Based on Paper IV, the effectiveness of transport research projects on policy development could be enhanced e.g. in the following ways: building common transport visions from the systems perspective, increasing the effectiveness of stakeholder participation within the transport research projects, presenting research outputs of policy support projects in a form that is simple and clearly communicated, mixing theoretical and practical knowledge and people within research projects to advance the output implementation and finally establishing innovation networks of researchers and civil servants.

Another example of the possibilities raised by the characteristics of system-based evaluation regards effectiveness. In traditional transport planning, the dif-

ferent phases of policy process – namely policy objectives, targets, measures and their implementation – are often integrated very loosely, particularly targets and policy implementation. One of the problems here is that specific policy targets have relationships, which may have effects on the selection of policy measures, reaching agreement on measures between different stakeholders, and further on the success of implementation of the policy measure. Currently, there seems to be a lack of methods and tools, which could evaluate the effectiveness of the complete policy process from the perspective of the transport system (including all modes and different actors). The target analysis method presented in Paper III provides an example of such a method.

### **5.5 Knowledge production in networks**

Referring to Gibbons et al. (1994) and Nowotny et al. (2001), I can argue that within the information society's transport system, we are experiencing the emergence of socially distributed knowledge production. It means that knowledge is both supplied and distributed to individuals and groups across the social spectrum. Here numerous different networks are emerging, and communications within and between the networks are crucial. Consequently, the knowledge will need to be produced beyond any single discipline or organisation. Here persons or organisations having the ability to work as knowledge integrators between different sources of information are highly valued. Also the co-production theorists (e.g. Hunt & Shackley 1999, Lemos & Morehouse 2005) see that "usable science" is co-produced iteratively in the context of everyday interaction between scientists, policy makers and the public.

The case studies in the included papers contribute to the above arguments and have revealed that in the information society's transport system, the methodological development regarding the emergence and evolution of new policy-relevant knowledge-production networks is of great importance. There are numerous and altering possibilities of how the networks might be built up. Here, it is important to note that the end-users of the transport system itself and the end-users of policy-relevant knowledge are often different (groups of) individuals and organisations. In some cases, individuals may even have several roles, because almost everybody can be considered a transport system end-user. The fast pace of transport-related technological development will further intensify this differentiation. It will also require building many new stakeholder and policy networks around new technology or service concepts. Different actor clusters or networks naturally

## 5. Emerging forms of knowledge production

need different kinds of knowledge as the basis for their decisions. Some of it they may be able to produce themselves, some of it not.

Based on the above discussion, I propose that knowledge production in networks includes at least the following two characteristics: (1) multiple forms and levels of networks, (2) the ability to serve other forms of knowledge production, e.g. future mapping, determining quality or effectiveness and mutual learning. In the following section, I present some examples of the characteristics based on the results of the included papers.

One example is a network built around future evolution of the transport system and visioning relating to e.g. technical development (i.e. transport system technology services within a wider societal context, Paper I). In such cases, once the new (information) technologies – such as flexible mobile interfaces, sensor technologies and real-time monitoring systems – become the basis of the transport system, the views of system itself, its actors and networks between public and private stakeholders should be re-thought. Consequently, the networks and other forms of knowledge production supporting system design and transport policy should evolve accordingly.

In the development of transport policy, particularly given the information society's complexity, networks of policy process stakeholders with different views are essential in order to gain their acceptance of policy targets and, even more importantly, of policy measures proposed for meeting the targets. Mutual agreement of the network is important since policy objectives and targets can usually be agreed upon, whereas concrete measures put the future into specific terms and create differences in opinion (Paper III). Ideally, of course, the potential of policy measures should be assessed against the needs of the end-users of the system in question. As discussed before, in the transport system, end-user issues are complex because almost everybody can be considered a user. However, not all feel directly involved with all parts of the system; there are some that they do not use or are unaffected by. Since the needs and preferences of the transport system end-users (individuals and companies) are seen as an increasingly important basis for future policy design, also here networks are needed. The networks producing knowledge can consist here (as illustrated in Paper II) of different end-user groups having similar mobility needs and preferences at a certain moment, but evolving over the course of time. The user groups provide an example of “socially distributed expertise” introduced by Gibbons et al. (1994).

A further example of the different knowledge production networks, mentioned briefly in the previous section, concerns policy networks. The network model of

Kickert et al. (1997) sees policy development as interaction processes in which actors exchange information about problems, preferences and means, and trade off goals and resources. Stakeholders in networks are interdependent because they cannot attain their goals by themselves but need the resources of other actors in order to do so. In Paper IV, such an asset is the experiential research knowledge produced in EC research projects for policy support. Here researcher-civil servant networks are an essential element in evaluating the usability of previous transport research – as well as accepting, elaborating on and disseminating the produced research results so they can be applied in policy processes.

### **5.6 Knowledge production as processes of social learning and argumentation**

The role of traditional, analytical transport policy-relevant knowledge production described in section 3.2 has basically been to support the managerial “top-down” decision making and actions of the public authorities. Instructions and commands have been the outcomes of a decision-making process as opposed to emergence and autonomy. Within the information society, however, the concepts and rules of different stakeholders strongly influence each other’s behaviour and hence their learning abilities. This is due to the network building discussed above, whereby stakeholders in networks are interdependent because they cannot attain their goals by themselves but need the resources of other actors in order to do so.

The emerging knowledge production approaches reviewed in section 3.5 propose that future practice should focus on their exploratory rather than predictive value. In addition, we should consider them more as aids to gaining better insight into and better understanding of problems in different stages of the policy process. Further, as Valovirta & Hjelt (2004) suggest, knowledge production can be seen as social argumentation, consisting of different discussions, comments and addresses. Here, the claims relating to the facts, values and strategies can be joined together into arguments, which again raise counter-arguments, persuasion, possible defence and critics. Consequently, the results will be communicated in the course of the participation, not through institutional channels.

Currently, there seem to be growing signs of understanding transport policy-relevant knowledge production (e.g. assessment, evaluation and foresight practices) in terms of social interaction processes. Such processes can be characterised as means in e.g. building co-operation relationships, future visions or trust between transport system actors in a wider societal context. Here, the processes

themselves can be seen as policy instruments. In the transport domain, new players and emerging knowledge production networks need to develop a common language to discuss emerging issues such as human-machine interfaces, user acceptance, business models, public-private partnerships, etc. within the transport system, traditionally developed only by the public sector.

Again, the papers included in this dissertation provide examples of knowledge production as processes of social learning and argumentation. Paper I illustrates the visioning of socio-technical development, here namely “technology services”, as a mediator and possibly also intensifier of existing societal processes relating to e.g. economic, legal, privacy and security issues. Different actors within the transport system are invited to argue and learn through workshop discussions about the role of end-users, markets, technology and service developers and providers and other stakeholders, as well as knowledge required in the development of future transport system technology services.

My second example and argument, based on Paper III, considers the traditional, path-dependent, staged policy development processes, always starting from the “root”. In order to be successful and effective, these processes need to be complemented, or in some cases even replaced, by approaches which can explore the successes and failures and can learn from the other phases as well as from various actors within the policy process and hence adjust.

My third example on the learning and argumentation processes regards the actual use of the produced knowledge. Currently, massive amounts of transport-related empirical data are collected and research results produced, but there is a lack of normative frameworks that give the data meaning, as well as practices and arenas (forums) for the acceptance and uptake of this information and knowledge in policy processes. Within such arenas (e.g. researcher-civil servant networks proposed in Paper IV), information on the latest results or best practices on selected themes could be shared and assessed, and collaborative learning could take place.

### **5.7 Knowledge production as a source of renewal – forming new identities and institutions**

Within the information society’s transport policy development, one of the greatest challenges will be to adjust policy developments on the one hand and end-user needs, preferences and acceptance on the other, on the rapidly advancing technological frontier. Policy makers, civil servants, commercial actors and other socie-

tal stakeholders worldwide will need to understand the kinds of changes that are occurring in society as the basis of their decisions. These changes may occur very fast and will not necessarily be visible through official statistics. This will consequently influence the required concepts of knowledge production and competencies. In order to be useful, knowledge production and competencies need to be resilient to constant change in the transport system and the surrounding society.

In the above context, by “knowledge production for transport policy as a source of renewal” I mean the need to understand the pathways by which transport policy-relevant knowledge production occurs, operates and renews the society. By further elaborating on the co-production concept by Jasanoff (2004), I have identified the following two characteristics for this form of knowledge production.

*Making identities* refers to the importance of understanding different roles knowledge and its production play in developing, shaping, sustaining and giving meaning to new transport policies, technologies, services or concepts and related social roles (e.g. experts, civil servants, policy makers, technology developers, transport system end-users). As technologies and services change and renew, different transport system actors, their needs, roles and behaviour, and the forms and contents of the produced knowledge need to change accordingly. In the development process, it is important to highlight the contest between the old forms and structures of knowledge production and the new ones, since building new forms without discharging the old is almost impossible. Markets, various policies and the level of co-ordination, at the very least, constitute the dimensions, which shape the mechanisms of forming new transport identities and institutions.

Currently, there is very limited amount of information available on these mechanisms in the transport context. Due to the development of the information society, the roles of different actors within knowledge production in the transport domain are currently under transition. Hence, the topic of making identities is extremely relevant. Who will be the future producers and users of knowledge relevant to transport policy: public actors, private actors, individuals or new networks or consortiums developing around transport technologies and services?

An example of making identities can be found e.g. in identifying key concepts for the future development of the transport system. In Paper I, networking technologies, real-time based interactive systems and service packaging were identified as such “technology service” concepts. Here, making identities means understanding of how to integrate different transport technologies into these service concepts, what kind of roles different transport system actors can have and what kind of knowledge they need within the development process of such technology

## 5. Emerging forms of knowledge production

services. It also means discussing and identifying the different meanings technology services can bring to policy development and the different transport system stakeholders.

In Paper II, we illustrate that new identities, “personas”, important for the future transport policy design could be found by categorising the transport system end-users into homogeneous segments. The needs and preferences of the “personas” could be further investigated by e.g. surveys or interviews. The adaptations and acceptance of different user segments regarding the new transport technologies and services will be of great importance in the future design processes, be it policies, technologies or services.

The other characteristic, *making institutions*, is an outgrowth of the former one and emphasises that when contexts and knowledge change, new institutions will emerge to provide a web of social and normative understanding within which new identities can be recognised and given effect. In the transport sector, where the traditional requirements for institutions have been e.g. to make laws, standardise measures and methods, ratify new identities and interpret evidence, there is currently a need to advance the understanding of the linkages between intelligent transport systems and services and society as integral to the traditional functions of institutions.

Paper IV provides an example of making institutions. In the paper, we describe fitness-for-purpose assessment of transport research projects as a source of renewal for the European research agenda, as well as for building research-policy networks. Here the network illustrates one possible new form of institutions and governance.



## **6. Discussion and conclusions**

### **6.1 Scientific and practical implications**

The traditional view of knowledge production supporting transport policy and planning has been very reductionist. In general, the approaches of knowledge production have aimed to reduce transport system complexity to components and elements, or even to a single number (e.g. CBA). In the information society, however, the complex, networked and adaptive nature of the transport system and policy processes is in evidence everywhere. Thus, simplifications by themselves are no longer adequate, but need wider, societal approaches as their complements. The traditional project level approaches do still have importance, especially as a part of project assessments. However, for understanding the social constructions of the transport system as the basis for knowledge production and for understanding the relationships between knowledge production, policy formulation and decision making, additional new forms are required. This concerns knowledge production for transport at all levels: local, regional, national and international.

The purpose of this dissertation is to broaden the understanding of the dynamics of knowledge production supporting transport policies of the information society. Further, the ambition is to identify what forms knowledge production supporting transport policies of the information society should have. Keeping that in mind, the first research question seeks answers to what kind of challenges and opportunities the changing transport system poses to knowledge production and contributing actors supporting transport policy development. Essentially, section 2 of this dissertation presents several answers to research question 1. In the most concise form, the answer is as follows: First, the pace of development as regards intelligent transport systems and services (ITS) and transport policies is quite dif-

ferent. The challenge is how to integrate the design of traditionally very slow transport policies and a technological frontier that is moving very quickly.

Second, mostly due to recent socio-technical developments, the number of actors within the transport system development has pluralised. Hence, the system and policy developments are shifting towards a more societal process including many, old and new, public and private actors, such as service providers, technology developers, private individuals, advertisers, lobbying organisations, legislators etc. Managing the production, processing and use of the knowledge within this context is a demanding task.

Third, relating to the second point, the information society's knowledge production is no longer serving a single public policy process. Instead, there are several different public-private development or innovation processes ongoing throughout the transport system. The end-users of the transport system can also be part of these processes as information providers and integrators. The needs and preferences of end-users as the basis for the system and policy developments are of great importance here. The challenge is how to identify and integrate the information needs of these processes as the basis for "usable" knowledge production to serve transport policies and decisions. In this context, the exploratory rather than predictive value of knowledge production is important, as well as understanding the dynamic processes by which knowledge and the transport system continually shape, constitute and validate one another.

The second research question aims to identify what are the emerging/new forms of knowledge production that can serve the needs of policy development in the changing transport system context. Table 1 below gives the most concise answer to the question. Section 5 of this dissertation looks in detail at the contents and motivation of the various forms and their characteristics.

Table 1. Emerging forms and specifying characteristics of knowledge production for transport policies in the information society.

<b>Form</b>	<b>Characteristic</b>	<b>Derived from Paper</b>
Knowledge production through system-based foresight	Social constructions of the transport system as the basis for policy and technology developments	I, II
Knowledge production through system-based evaluation	Quality, efficiency, effectiveness and robustness of system performance as the evaluation criteria Usability of the produced knowledge	III, IV
Knowledge production in networks	Multiple forms and levels of networks Ability of networks to serve other forms of knowledge production	I, II, III, IV
Knowledge production as a process of social learning and argumentation	Building co-operation relationships, future visions or trust between transport system actors in a wider societal context Processes as policy instruments	I, III, IV
Knowledge production as a source of renewal	Making identities Making institutions	I, II, III, IV

The five forms of knowledge production, along with the examples in the included papers provide an inroad to understanding the emerging perspectives I consider important for designing transport policies in the information society. The forms are complementary, which means that they will strengthen one another when appearing simultaneously.

The third research question explores what are the scientific and practical implications of the emerging knowledge production forms. The scientific implications of the dissertation are twofold: First, the dissertation aims to open up the discussion on new forms of knowledge needed to support transport policy development in the information society. As discussed in section 3, traditional transport planning methods have strong technological and institutional bases and hence wider, more societal approaches are lacking. The emerging forms of knowledge production identified in this dissertation, based on emerging knowledge production practices in the field of STS, provide a starting point to wider discussions and methodological development in the systemic, socio-technical transport context.

Second, the knowledge production methods developed in the included papers widen the methodological base of knowledge production in support of transport policies. The methods illustrate new, communicative tools to support policy development of a complex socio-technical transport system. They do not aim to replace traditional transport planning methods but to complement them. For example, Papers I and II highlight the need to find tools or methodologies revealing interactions between technology and end-user needs and acceptance i.e. to move on from developing technologies to understanding the meanings of the results to the end-users. They also emphasise the need to understand different kinds of uses for different kinds of technologies and services.

The main practical implication of the dissertation is the development of new, concrete tools (in the included articles) for the use of transport policy design and decision-making processes. The tools are suitable for use by various kinds of stakeholders within the policy and research and technology development processes. In addition, the emerging forms aim to structure knowledge production in any systemic, strategic decision-making process – public, private, or a combination of both. Hence, the new forms support the often technical and institutionalised knowledge production relating to the substance (transport infrastructure) issues. For example, fitness-for-purpose assessment, presented in Paper IV, enables formulation of the recommendations and best practices based on the mutually agreed results, as well as shaping the future policy agendas collectively by all participating parties. This kind of process improves the usefulness of the produced results, strengthens the commitment to apply the recommendations in future activities, and urges different parties to work together in future policy activities. Currently, in the transport policy – ITS context, the problem is that still too few forums exist for networking, interaction and knowledge dissemination.

Knowledge production for transport policies is a topic the relevance of which, both in scientific and practical terms (see sections 1 and 2), has been questioned in Finland for decades. At the European level, the issue has been considered more important, at least in the context of the European Commission's Framework Program research projects. In both of the above contexts, rational transport planning as a form of knowledge production has received sporadic criticism since the 1950s (e.g. Leleur 2008, Pill 1978, Paper III). One may therefore ask what the ITS development brings to the discussion that is new. To my understanding, the challenges presented as the main results in answer to research question 1 at the beginning of this section provide the answer to the question. The systemic nature and complexity of the transport system and its different actors do propose new re-

quirements for knowledge production. Consequently, I consider the identification of emerging forms of knowledge production and the concrete methods supporting the framework, developed in the included papers, as the main scientific contributions of this work. Further, returning to the co-production approach (see section 3); the dissertation contributes to the usability of the produced knowledge. The identified forms together with the methods in the included papers strengthen the scientific base of knowledge production for transport policies and provide practical guidelines on how knowledge can be gathered and used within the development of transport policy in the information society.

The identified forms are generic in their nature. This means that they can be applied to different levels of the transport system and policy development. In addition, they can be transferred to other fields of society where policy, technology and services need to be developed in collaboration.

## 6.2 Future research needs

Based on the theoretical part of this dissertation and the included papers, the most important future research needs regarding knowledge production for transport policies in the information society are as follows.

I propose that in the future, development of the transport system and policies needs to be based more on continuous systemic foresight as well as ex-ante and ex-post assessments regarding system performance. It is important that indicators presenting the results of such assessment could focus on the quality (based on end-user views), efficiency, effectiveness, and robustness of the system, not its individual parts. Development of approaches identifying the impacts of transport strategies and policies on the quality of people's daily mobility and companies' transportation of goods are very relevant here. Examples of such approaches are user-centric design in general and societal impact assessments and indicators. From the technology side, new demand analyses of technology services, market foresight and public-private business model development are important fields of research. Large enough national research and development programmes, as well as technology service pilots financed by both the public and private parties could serve as a possible means for developing knowledge production in the above themes.

Second, there is a need to develop tools to gain understanding of the different forms that knowledge and its production can take in shaping and sustaining the social roles of different transport system actors or giving them power. For exam-

ple, the meaningful use of new transport technology services is grounded in social groups within which technological change appears. In order to assess the influence of new technologies on the transport system, both the public and private stakeholders in the development process need first to identify the different user groups, within which the change could appear. Only then do they have the possibility to continue further, into identification of their preferences and acceptance for intelligent technologies.

Third, network management is the key research need in the information society's transport system. Networks are often quite easy to build but very hard to manage. This holds true especially for lasting public-private partnership networks in technology service development and maintenance. There is a need to develop strategic level policy processes as interaction processes in which actors exchange information about problems, preferences and means, and trade off goals and resources. Referring to Klijn (1997), actors in policy networks are interdependent because they cannot attain their goals by themselves, but need the resources of other actors to do so. Another important research need regarding the networks is how they can learn to gain societal influence that is crucial for the legitimacy or implementation of policies.

Fourth, focusing on the usability of the produced knowledge from the point of view of its end-users (policy, business, research or individuals) is essential in an information society where the creation, distribution, diffusion, uses, integration and manipulation of information is a significant economic, political, and cultural activity. The main research needs in this field relate to the identification of emergent characteristics and the development of processes of communicating knowledge, both scientific and practical, in the course of the participation, not through institutional channels. For example, to be accepted and effectively applied by practitioners and decision-makers, the capabilities of the developed scientific research knowledge need to be checked against factors like transparency, inclusiveness, but first against acceptability and appropriateness in terms of the needs of the final users in policy and business. Currently, the processes for facilitating this check and meanwhile communicating the knowledge to the wider audience of transport system practitioners are missing.

Fifth, when contexts and knowledge change, future research is needed to help in understanding how and what kind of new institutions will emerge to provide the web of understanding within which the new knowledge can be recognised and given influence. In many European countries, including Finland, there currently exist open forums (e.g. ITS Finland) for the cooperation of companies, public

administrations and telematics developers to promote the deployment of concrete ITS services for private and corporate users. The role of these emerging institutions has been strong in pushing the new transport technologies and services onto the market in short term, but the role in advancing the understanding of the linkages between technology and society has been modest. That is e.g. in understanding how to build long-lasting public/private business models for transport technology services or how technology changes the behaviour of the transport system's end-users. Future research is needed to probe the institutional developments regarding these fundamental issues.

Finally, the ideas of the emerging knowledge production forms identified in this dissertation for transport policies in the information society have to be further elaborated and put into more concrete terms from the points of view of different transport system and policy stakeholders. The list of forms is in no sense exhaustive. To my understanding, it will evolve constantly, and keeping up with its changes is challenging. I hope, however, that the forms can speak to the realities of civil servants and policy makers, business managers, researchers and the public within the information society's transport domain at both national and international levels. I believe that they can shed light on the relationships between knowledge production, policy making, and society by e.g. facilitating network discussions and mutual learning. Such discussions and learning can create new options for the future, experimenting with different solutions to problems, and implementing new, socially embedded ways of developing transport systems and policies.

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Paper I

**Is the transport system becoming ubiquitous? Socio-technical road-mapping as a tool for integrating the development of transports policies and intelligent transport systems and services in Finland**

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# Is the transport system becoming ubiquitous? Socio-technical roadmapping as a tool for integrating the development of transport policies and intelligent transport systems and services in Finland

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## ABSTRACT

This paper examines the main development characteristics within the transport system as we are approaching the ubiquitous phase of the information society. Particularly the challenges in designing transport policies on a rapidly evolving technological frontier are emphasised. The theoretical background of the paper stems from policy assessment as well as futures studies, especially from technology roadmapping. The paper presents a socio-technical roadmapping method as a tool to integrate the technology developments better with societal developments and transport policy design. The method is tested with a Finnish case study, which provides three thematic, complementary roadmaps of the potential transport system technology services of the future. The roadmaps illustrate what kind of technologies, services, actors and related policy relevant knowledge is needed in satisfying the demands of transport policy development in the future's ubiquitous society. The case study reveals several changes in the transport system: pluralised number of actor roles and actor networks in the system, emergence of a new kind of business and service layer because of the new dynamic interlinkages between the actors, and further, possibility to capture the service layer with the concept of “technology service”. The changes require also re-conceptualisation of knowledge production to support transport policies. In conclusion, the socio-technical roadmapping holds great potentials as a tool for aligning technology development with transport policy development.

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## 1. Introduction

In the field of transport, the concepts of planning and impact assessment, referring to infrastructural investments and project appraisals, have formed the frameworks and strategic lenses for transport policy development for decades [1–3]. However, due to the important role information and communication technologies (ICTs) have gained in our societies, the context of transport system and policy development has started to shift from designing road, railway or waterway lines or networks towards the development of a complex technological system largely depending on ICTs and applications (e.g. traveller information services,

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traffic management services, navigation, autonomous vehicle systems). Intelligent technologies and services are considered to have great potential, but on the other hand, e.g. due to reasons of privacy, security or public–private role divisions, they also pose great challenges to the transport system [4–7].

For example the Finnish Government [8] and the European Commission [4] see that Intelligent Transport System and Services (ITS), i.e. ICT applications for transport, also called transport telematics, hold a great potential in the future. According to these strategies [4,8], ITS will gradually provide new services for citizens and allow improved real time management of traffic movements and capacity use. New ICT-based systems are hoped to provide new benefits for transport operators and end users, and also endow public administration with rapid and detailed information on infrastructure and maintenance needs. In addition to the enhanced services for travelling and transportation needs, it is argued that ITS will also help in increasing transport safety and security and tackling with the wasteful transport patterns in the interest of environmental sustainability.

In this paper we trace the evolution of transport system in different phases of information society. Our view on the main transport related characteristics of these phases is presented in Section 2.1. These developments will have some impact on the ways in which people move and goods are delivered. As the environment and the needs and preferences of the transport system end users are changing, the knowledge production supporting system and policy developments should be responsive to these changes accordingly. We argue that conventional transport planning approaches, like cost-benefit analysis and impact assessments, are alone inadequate for addressing the systemic challenges of future transport systems. We further claim that mapping of emerging technological developments within a broader societal context is of crucial importance in the changing transport system.

Our perspective in this paper can be stated through following questions:

- (1) What are the main development characteristics within the transport system as the society is moving, as we propose, towards the ubiquitous phase of information society?
- (2) What kinds of tools and approaches are needed to integrate emerging technology developments with transport policies?
- (3) What kind of tool is socio-technical roadmapping in this context?

The article is structured as follows: Firstly, we describe societal transformations on the way towards a ubiquitous transport policy environment as well as challenges in designing transport policies on a rapidly evolving technological frontier. Secondly, we present the theoretical background of our work, which stems from policy assessment as well as futures studies, especially from technology roadmapping.

In the subsequent results section we will show, based on our Finnish case study with three socio-technical roadmaps, what kind of technologies, services, actors and related policy relevant knowledge is needed in satisfying the demands of transport policy development in the ubiquitous information society. We conclude with a discussion on the both theoretical and practical implications of our method.

## 2. Towards a ubiquitous transport system

### 2.1. Transport system and the technological evolution of society

As many theorists have formulated, through different terms and varying concepts [e.g. 9–13], the societal development in advanced industrial countries has moved towards an information society, where the major driving forces are the development and rapidly increasing use of information and communication technologies (ICTs) and the growth of the knowledge-based service sector. ICTs and the related knowledge have been simultaneously rising in importance as production factors and as products [14]. In the information society, the ICTs are developing towards an infrastructure that will enable new kinds of practices also affecting the transport system, like teleworking and integration of ICTs in vehicles. Fig. 1 presents a generic societal framework for the emergence of technologies and services, which can also be applied for transport systems and policies.

The emerging phase of the information society can be called the ubiquitous information society. In the ubiquitous society of the future, we argue, the functioning of the transport system will increasingly be based on different mobile, flexible and personalized ICT services. The new technology brought into the transport system will change the nature of strategies and measures as well as the roles of the different actors within the system. In ubiquitous information society, ICTs will become a standard layer of infrastructure. This means that societal operations, such as mobility of people and transportation of goods, will widely be controlled and channelled through this infrastructure. Also the static components of the transport system, like roads, rails and bridges, will be monitored by ICTs. These static components communicate with mobile components of the system, like cars, trains and other vehicles, through sensors and other devices. Furthermore, the mobile components will constantly and automatically communicate with each other. The result will be a ubiquitous, networked transport system that can be characterized by an intensive layer of multi-directional and multi-actor communication. The fields of transport policy and management will expand from a macro-scale infrastructural level towards the micro-scale end-user level.

Table 1 reflects our view on the societal transformation from an agrarian to a ubiquitous mode. It also presents our vision on the role of transport in the ubiquitous society. The key idea in Table 1 is formed by the connections between socio-technical principles and logistic/transport principles that frame the views of the transport system and, thus, also the transport policy.

In the agrarian phase, the socio-technical principle was the combination of feudal communities utilizing local agricultural technologies. The utilization of and mobilization through natural channels such as rivers and the seas was the basic principle for transportation of goods and people. In the industrial phase, urbanization developed simultaneously with the emerging

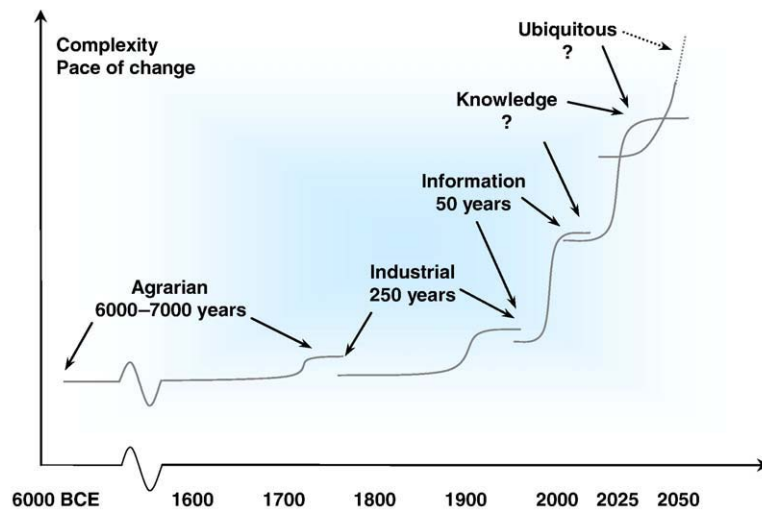


Fig. 1. Societal framework for the emergence of technologies and services.

technologies of mass production. This also led to a more systematic development of the basic transport infrastructure, e.g. roads, striving to fill the needs of the urbanized industrial nodes.

In the information society, the socio-technical principle highlights the information economy with its regional agglomerations and mega cities. The physical transportation principle is increasingly concentrated on the flow of bits in cables. However, the physical transportation principles of the earlier phases are also intensified. There are more traffic on the roads, more traffic on the rails and the seas. Furthermore, air transportation is steadily increasing as the transportation system becomes globalised and interconnected. The information society emphasises the combinations of electronic and physical transport as its logistic principle.

The following phase, the knowledge society, is actually a deepened and intensified version of the information society. In this phase, the information technology becomes the key enabling technology of the transport system. It functions as the basic tool in controlling the system and also as the key infrastructure. The transport system is more and more governed by ICT-based management solutions. To support the development and functioning of the system, new forms of knowledge production are also needed.

In the ubiquitous phase, transparency becomes the key socio-technical principle in the society. Transport system is a global system, a grid that functions and constantly communicates at every level—man-to-man, man-to-machine and machine-to-machine. During this phase, the transportation principles change and we can start to speak of a new, transparent operation mode that combines technologies and services.

It is through this societal frame, highlighting the transparent and ubiquitous functioning of technologies, that we discuss the notion of technology services and the related assessment knowledge in this paper. We define technology services as the combinations of technologies and services that are enabled by interlinking the static transport system and the information infrastructures, gathering, processing and delivering information, and its mobile actors, e.g. people, goods and vehicles. We propose that technology services are the products of a society utilizing ICT as its basic infrastructure and service platform. Technology services are also products of transparency: the services are based on the continuous communication between actors in the transport system and they can be tailored for different kinds of purposes.

Our definition of technology services come quite close to the concept of “innovative product-related services” proposed by Lenfle and Midler [15]. Their starting point is the every-day confusion with concepts of product and service that are sometimes interlinked and might have quite osmotic boundaries. Lenfle and Midler [15] argue that the introduction of service component

**Table 1**

Societal framework for the emergence of technology services.

Societal phase	Socio-technical principles	Logistic/transport principle(s)
Agrarian	Feudal communities; local agricultural technologies	Utilization of natural channels
Industrial	Urbanization; technologies of mass production	Development of basic transport infrastructure
Information (physical infrastructures)	Information economy, regional agglomerations; megacities; Information technology	Combinations of electronic and physical transport
Knowledge (economic sphere)	Global information economy, regional agglomerations, megacities; Information technology as enabling tool and infrastructure in itself	ICT-based management of transport and logistic services
Ubiquitous (realtime and transparent information/knowledge)	Global system (grid), regional polarization; ubiquitous technologies	Ubiquitous, transparent and tailored technology services

“does not mean that physical goods disappear from our universe but that they are more and more associated with complex services”. The idea is that technological devices and systems are increasingly utilized as parts of advanced service concepts formed by companies and public organizations, sometimes even by private persons. In the next two sections, we turn to challenges of transport planning that tries to cope with the changes described above.

## 2.2. Transport planning – the traditional approach for transport system and policy developments

The rational transport planning approach as a knowledge production practice for transport domain evolved in early 1960s, and with minor variations has ever since served as the main methodology for transport planning. The rational transport planning process begins with an articulation of policy or community goals, leading to an identification of transport system problems. Once these problems are identified, alternative solutions are identified and assessed, and a set of actions recommended based on which alternatives return the most benefit for the costs incurred [1,2,16].

Within the traditional transport policy and project planning approaches, there exists a wide range of different assessment methods or tools for data collection, analysis as well as for formal assessments. As regards formal assessment techniques, cost-benefit analysis (CBA) is very well established in transport as a means of aggregating the impacts of competing transport (infrastructure) proposals so as to get an overall ranking in terms of contribution to social well-being. Generally CBA is used when the objective of evaluation is to compare the costs and benefits of a project using a common denominator (usually money) in order to decide on whether costs outweigh benefits or vice-versa [e.g. [17–21]].

Multi-criteria analysis (MCA) is often presented as an alternative to CBA in cases where the majority of important effects cannot be monetised or CBA is not seen sufficient to ensure the multi faceted understanding of a plan or policy that is increasingly required [22]. In addition, Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), Strategic Environmental Assessment (SEA) and Socio-Economic Cost-Benefit Analysis (SCBA) have been commonly used in transport project assessments. Mostly due to the ITS development, the interest to and use of Human–Machine Interface (HMI) design, user requirements and specific field tests has increased to supplement the traditional approaches.

The existing frameworks have typically been used for infrastructure assessments at a project level, for ex ante assessments (i.e. appraisals), and for prioritizing purposes. They have focused primarily on economic efficiency. Distributional questions have only been considered to a limited extent. Assessments have mostly been inter-urban and only rarely responsive to interactions outside the transport sector. Hence the assessments have not been consciously oriented towards wider societal concerns [e.g. [1,2,20] and [21]]. Further, the role of citizens in transport policy design has so far been rather limited. This is because citizens have not been seen as contributors to policy making, but rather as objects of policy – in addition to having the role as consumers and users of end products. However, the shift toward market governance in ICT policies, and consequently in ITS developments, has resulted in the increasing interest in consumer needs and preferences as a basis for transport technology design, e.g. in the studies of human-technology interfaces and design.

In the ubiquitous transport system, which we presented in Section 2.1, the traditional rational planning paradigm is no longer sufficient in providing the knowledge needed to understand the socio-technical nature of the transport system and the dynamics between the different actors. For example, the roles and the networks of actors in transport system will be pluralised. Transport system will be more and more composed of complex networks that consist of public parties, private parties and contributing end-users. We suggest that in the future, most of the actors within the transport system will equally use and produce knowledge via ICT devices as the basis of their actions. This requires re-thinking also of the knowledge production for transport policies and decision making.

New kinds of systemic knowledge structures are thus emerging in the transport system. Tuomi [23], for example, has defined three research domains of knowledge society that are interlinked in the ongoing societal transformation. These domains are: institutions & culture, everyday life, and systems of production. The transport system lies in the intersection of these domains, which naturally puts pressure on the transport sector to stay as sensitive to changes in society as the other domains. This requires wider, multidisciplinary approaches to be introduced also into the transport policy making process (e.g. [1,3,20], and [24]).

The Science and Technology Policy Council of Finland [25], based on Valovirta and Hjelt [26], presents another view for identifying policy-relevant information for strategic decision making in the future. The monitoring of the socio-economic development (i.e. how economy, society and technology have changed) and the evaluation of policy actions form the policy-relevant information about the past. Expected future socio-economic developments mapped with different kinds of foresight exercises (e.g. roadmaps, mega trends, and weak signals), *ex ante* impact and technology assessments as well as policy analysis regarding the policy options available and their expected impacts, provide tools for producing policy relevant future information.

## 2.3. Challenges in designing transport policies for a ubiquitous society

Some theorists of ICT-related social change [e.g. [27,28]] see that there is a possibility that we are on the cusp of a major social and economic transition. One dimension of this transition is that policy makers and other societal actors throughout the world need to understand the systemic nature of changes occurring in society. These changes are not necessarily visible through official statistics. Also commercial actors will need to understand the same processes. This approach lends itself well for the transport sector, too [e.g. [27,29,30]].

The growing emphasis on new technology industries and services and the consequent market governance will also change the concepts of knowledge production and competencies. As the policy environment for transport design and the needs and

preferences of the transport system users' are changing, the assessment and analysis practices concerning the transportation system should also reflect on these changes. The conventional assessment methods, like cost-benefit analyses and impact assessments, are not adequate for addressing contemporary systemic challenges of transport policies. Consequently, the needs for transport assessments are evolving from project assessments to broader analyses of transport system in its societal context.

There are, however, great challenges related to these kinds of systemic socio-technical perspectives in transport planning. Geels and Smith [31], for example, have identified seven key pitfalls in exploring the future technological developments in transport. In one way or another, all of these pitfalls relate to the socially constructed nature of transport system. The authors argue that the images of the future are often based on too simplistic conceptualisations of technological development and its impact on society, ignoring especially the dynamic co-evolution of technology and society. The concept of technological frames, introduced by Olikowski and Gash [32], emphasises the same issue. Technological frames build on a wide range of previous studies about the perceptions and values of designers and users (the social aspects) in constructing information technologies. Olikowski and Gash [32] argue that an understanding of peoples' interpretations of a technology is critical when trying to understand their interaction with it. Currently, the pace of development as regard to transport technologies is quite different from that of the technological frames for transport systems, which poses problems, especially in acceptance and use of new transport technologies.

As Rycroft [33] and Rejenski [34] highlight, current policy practices are not capable of dealing with fast-paced technological innovations. According to Rejenski [34], main characteristics of new, complex technologies, like adaptation, co-evolution and agility, are difficult concepts to be grasped by current public policy agendas. Rejenski argues that new technological environment requires us to rethink the linkages between the temporal dimension of technological innovation and public policy. The policy formulation should be re-invented and made more sensitive to complex technological issues. Things are made even more complex by the idea of technology services, i.e. combinations of technologies and service concepts.

van Zuylen and Weber [35] argue, technological transport innovations are only beneficial if they are integrated into services or transport concepts. This development towards technology-based services calls for organizational changes, because in new environment the role of governments will potentially also change.

### 3. The method and the Finnish case study

#### 3.1. The setting

Finland is often seen as one paradigmatic information society due to the fast rise of the Finnish ICT sector during the 1990s [36]. Generally speaking, public policies on ICT in Finland have been based on two main foundations: the selective technology policy where ICT, together with biotechnology, have been the key targets of public funding, and the liberalisation and market orientation of telecommunications [37,38]. In the vision of the Finnish information society, the role of information technology and data networks is to bring forth efficiency, organizational renewal and new forms of collaboration as well as promote the network economy by opening up the development of new services and industries [39].

It is not commonly acknowledged that a transport system is not just about physical networks. A transport system – be it international, national or local – is a large technological system, which contains messy and complex components. It is a socio-technical network. The state of the transport system results from the measures and actions carried out by the producers, operators and users of the system, who affect and shape the system by their behaviour and actions. The system is thus both socially constructed and society shaping [40].

In our case study we dealt with the above mentioned issue of societal context by carrying out a socio-technical roadmapping process that included different actors and perspectives, e.g. decision makers, technology developers and end users, to support both ITS and transport policy developments in Finland. Following the interpretation of Ragin and Becker [41] to see cases as theoretical constructs ("cases are conventions") we consider Finland's ITS development as an appropriate case for our study.

#### 3.2. Socio-technical roadmapping as a case study method

Roadmapping is a methodology that has been applied in several industrial organizations in order to facilitate and communicate technology strategy and planning. Roadmapping approach provides a structured and often graphical means for exploring and communicating the relationships between evolving markets, products and technologies over time. Roadmaps can take a variety of specific forms depending on the roadmap type, e.g. technologies, products, capabilities and resources, and on the particular organizational context.

Basically, roadmaps aim to provide an extended view on the future of a chosen field of inquiry, as the now classical formulation states [see [42]]. They also make inventories of different possibilities, communicate visions, stimulate investigations and monitor progress. In other words, roadmaps are composed of the collective knowledge and the imagination drivers of change in a particular field [e.g. [42–45]]. According to a classic text by Kostoff and Schaller [42], roadmaps can be categorized broadly into four categories: 1) S&T roadmaps, 2) industry technology roadmaps, 3) corporate or product-technology roadmaps, and 4) product/portfolio management roadmaps. New approach to roadmapping is to use them to map potential technology disruptions [46]. Particularly useful crystallizations of the roadmaps is to approach them as strategic lenses [47], or more widely, as strategy roadmaps that visualize and describe the core issues of a strategy e.g. for an organization [48].

In the fields of transport infrastructures, mobility and transportation of goods, vehicles and transport policies, foresight and assessment approaches have been utilized for a wide range of topics already for quite sometime. Methodologically, the foresights and assessments have applied different variations of Delphi [49], cross-impact analyses [49], scenarios [50] or combination of both [51]. Also, a new kind of integrative foresight approaches have been applied in the field of transport. One interesting example is adaptive foresight [52] that combines foresight approach with adaptive strategic planning and innovation process approaches. Furthermore, the targets of the analyses have accentuated e.g. European level strategic innovation policy approaches [35] and technological alternatives to advance sustainability in transportation system at national levels [53]. One important emerging topic has been the overall energy efficiency of transportation system and utilization of alternative technologies that could ease our dependency on fossil fuels. In this field, foresight studies have touched upon topics such as trends in energy usage and emissions passenger vehicles [54], development of alternative technology paths for transport fuels [55] and new kind of energy distribution technologies, like vehicle-to-grid systems [56]. Also, overall sustainability of transport and life cycle issues have been important new topics [e.g. [57]].

Roadmapping is still a relatively new foresight method in the field of transport and transport infrastructure. However, some examples can be found in the areas of transport technologies [e.g. [58–60]], energy [e.g. [61,62]] and from related infrastructures, such as waste management [e.g. [63]] and water coordination [e.g. [64]]. Roadmaps have also been constructed on topics such as the future of cars and vehicles [e.g. [65,66]]. Fuel and energy systems for cars and transportation in general have been central emerging topic in the foresight and assessment studies [e.g. [67]].

The aims of the above-mentioned roadmaps are more or less technological, i.e. they primarily seek to identify crucial technological developments that could be realized by setting technological targets and forming action recommendations. In our case study, we have applied roadmapping method to study the emergence of a new kind of ICT based knowledge and service layer on top of traditional transportation infrastructure. We call the layer "technology services". We put emphasis on technologies in specific contexts, i.e. we have tried to identify meaningful technological developments and their connections to the evolving networks of actors. In this sense, our approach comes quite close to strategy roadmapping described above [48]. Furthermore, we have also mapped the changing forms of information needed to grasp these developing technologies and actor contexts. Therefore, we utilize a special brand of roadmapping—labelled visionary socio-technical roadmaps—to study the changing transport system and related policy design [68].

Visionary socio-technical roadmaps aim for the basic roadmapping objectives defined above, by (1) emphasising the application visions that are embedded in the roadmap structure and (2) by combining different layers of society and technology. Our transport system roadmaps consist of five layers: user needs, markets, actors, technologies and assessment knowledge. It is crucial to note that the roadmaps are application-oriented and visionary, i.e. they do not try to depict all the possible development trajectories relevant to the sector under scrutiny. Instead, the roadmaps produce partial glimpses of the elements and development paths surrounding a certain application. Roadmaps have typically been described as links between concepts such as product, technology and science. However, in a wider societal framework or in the field of knowledge production for policy processes, which is our main field of interest, the roadmapping method has not been commonly applied, even though a demand for it seems to exist [e.g. [68–70]].

In the following, we present the results of a socio-technical roadmapping process completed in Finnish context. We claim that this approach and other related approaches are important tools to gain better understanding of the socio-technical and systemic nature of the transport system among both policy designers and technology developers, and furthermore to encourage the use of a systems perspective as a basis for transport policy development.

### 3.3. Characterization of the case study

Our case study, named "Research directions for future transport service assessments" [29], was targeted towards the following vision: "The Finnish transport system and its technology services are developed on the basis of the best possible knowledge about the impacts of the development measures on the effectiveness and functionality of the system, the activities of different transport system users as well as on the environment." In this study, we produced visionary socio-technical roadmaps of the potential future trajectories in Finnish transport system. Roadmaps included examples of technology services and evaluations of related

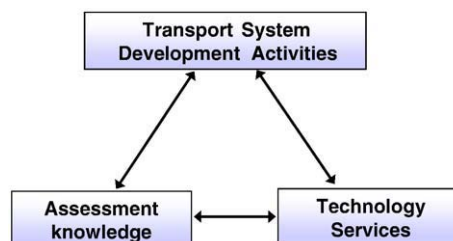


Fig. 2. Three knowledge elements of the case study.



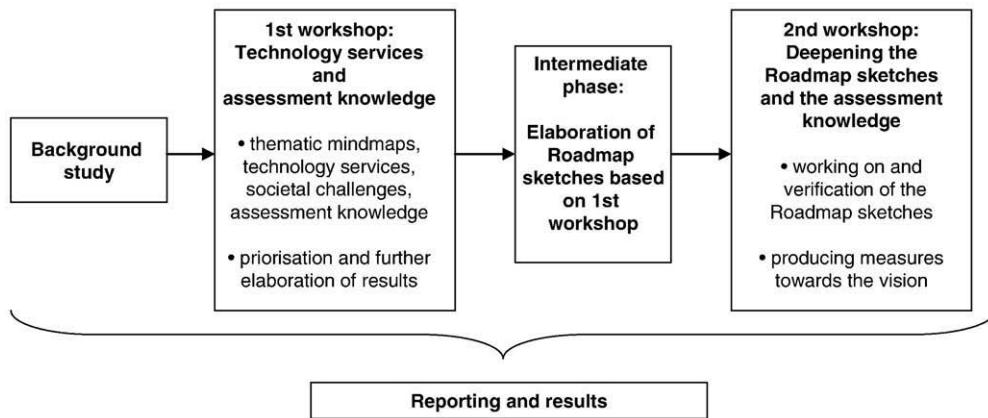


Fig. 3. Roadmapping process.

assessment knowledge needed in their development. The timeframe of the study was to the year 2025. Fig. 2 presents the basic knowledge elements of the roadmaps: transport system development activities, technology services within these activities and related assessment knowledge.

The actual roadmapping process comprised of three phases: (1) background study, (2) workshops and their intermediate phase, and (3) reporting and presentation of final results (Fig. 3).

The first phase started with definition of objectives, vision and corresponding research questions. In order to validate the chosen objectives and the vision, the phase continued with the collection and analysis of relevant publicly available material. The material comprised mainly of policies, strategies, foresight and research reports in the field of transport, or in closely related fields, such as land use or safety and security at the Finnish national and European levels.

The second phase consisted of two workshops and an intermediate desktop study phase. In the first workshop, the participants were divided into three thematic groups, namely: (1) transport infrastructure; (2) transport services; and (3) transport policy design and implementation. Each of the groups provided two outputs: (a) a thematic mind map, and (b) prioritization of elements in the mind map that were chosen for the further elaboration. In our study, mind maps applied the basic ideas of futures wheel (for more information see: [71]) in the following way: The theme of the group constituted a core element of the mind map. The task of the groups was to construct three circled topic areas representing (1) the future challenges for transport system development; (2) the transport technologies or services answering those challenges; and (3) the assessment knowledge relating to the technologies or services (Fig. 4).

Each group identified elements that in the future could affect the transport system and produced a description of their linkages with other elements. The elements were then prioritized by giving votes to second and third level elements. Top three elements were chosen for further elaboration. Between the two workshops, the results of the first workshop were analysed and constructed into roadmap templates. Roadmap templates had the following generic structure: user needs, markets, actors, enabling technologies, and assessment knowledge (Fig. 5). Second workshop focused on the elaboration of roadmap templates, especially on enabling technologies and assessment knowledge. Also, in the second workshop the participants produced visionary application examples that could enable the realization of the vision.

The third phase of the roadmapping process comprised of finalising the three roadmaps and reporting the process. It is important to note that the roadmaps were compiled to reflect the themes found particularly important by the workshop

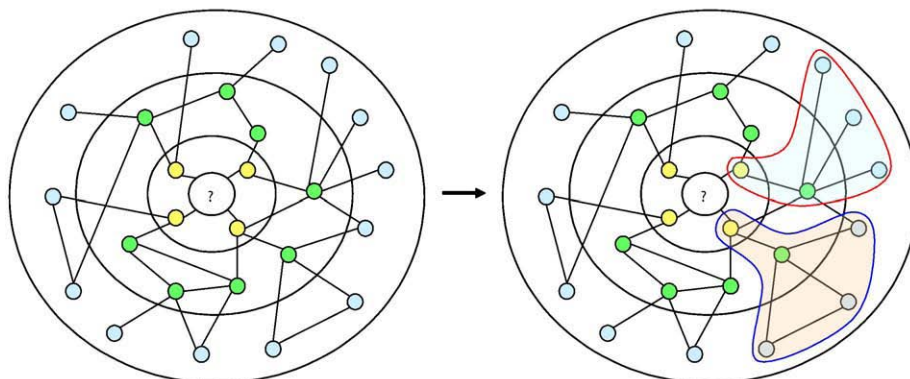


Fig. 4. Example of thematic mind map and presentation of technology/service elements and their linkages.

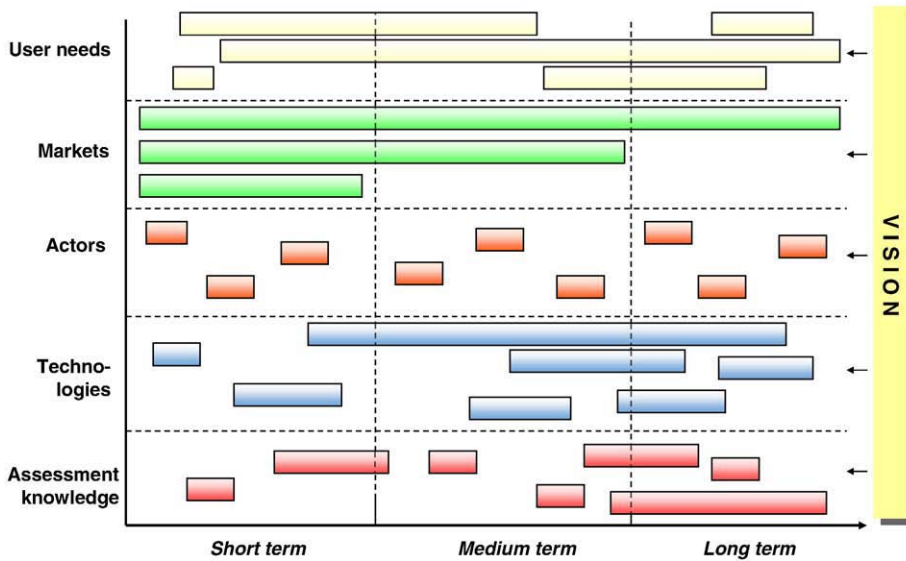


Fig. 5. Generic roadmap structure.

participants from the Ministry of Transport and Communications Finland, the Finnish Road Administration, the Finnish Motor Insurers' Centre, the Confederation of Finnish Industries and VTT Technical Research Centre of Finland.

**4. Roadmaps of technology services in the changing transport system**

The roadmapping process indicated that in the ubiquitous society of the future, a concept here called “technology service” could become an important idea for understanding the dynamics of technologies, applications and actors in transport system. In the roadmapping process we defined technology service as a flexible and tailored combination of technologies and services which takes into consideration the travel or transportation preferences, needs and expectations of the different transport system end-users (see also Section 2.1). The emergence of tailored technology services brings new challenges to decision makers, private actors, and other societal actors. Consequently, the roles of public and private parties in the transport system will intermingle in different ways, and new business models and operational practices will arise. In the following, we present the results of our exercise in the form of three roadmaps (Fig. 6).

The thematic roadmaps provide three different, but complementary, perspectives into the development of transport system technology services. We consider each perspective as equally important in the creation of well balanced technology services that are accepted and utilized by actors in transport system. Networking technologies create the settings for general service development. Real time information based interactive systems offer information in a custom-built format for the end-users. Service packaging helps in implementing user friendly technology services (Figs. 7–9).

*4.1. Roadmap 1: networking technologies*

The first roadmap, Networking technologies, presents applications and co-operation concepts that could make assessment knowledge accessible to different actors in the transport system. The vision for the roadmap is: “The information flow between public and private producers and end-users, e.g. companies, citizens, regarding transport system design, assessment as well as

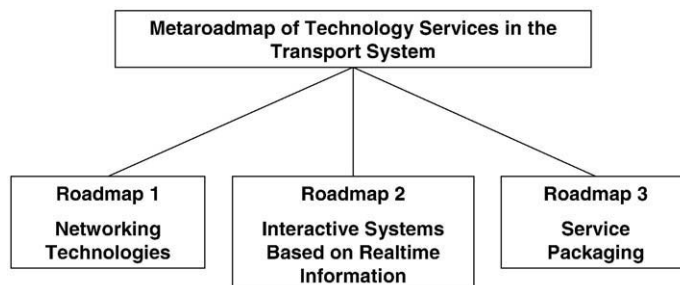


Fig. 6. The four roadmaps produced.

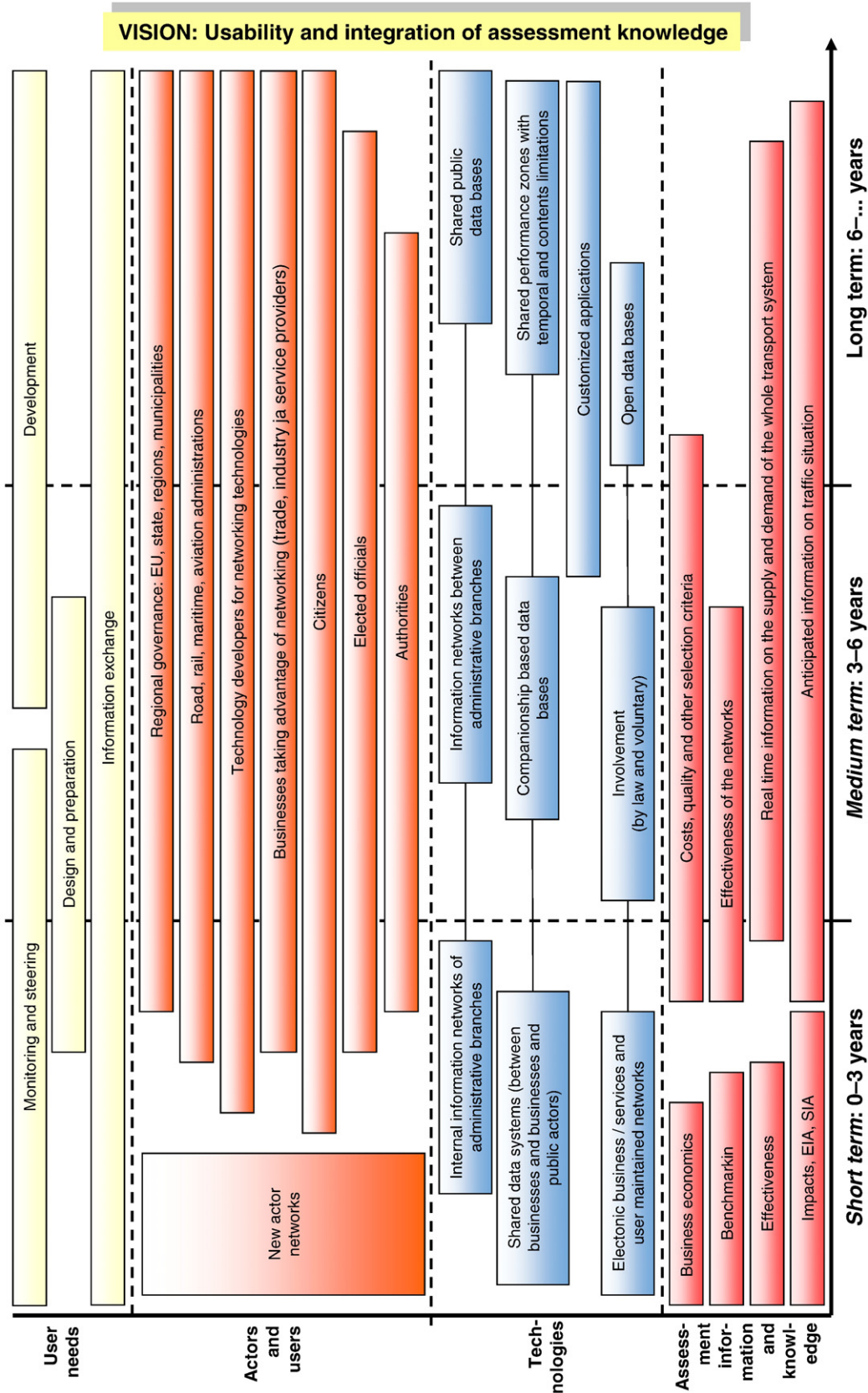


Fig. 7. Roadmap 1: networking technologies.

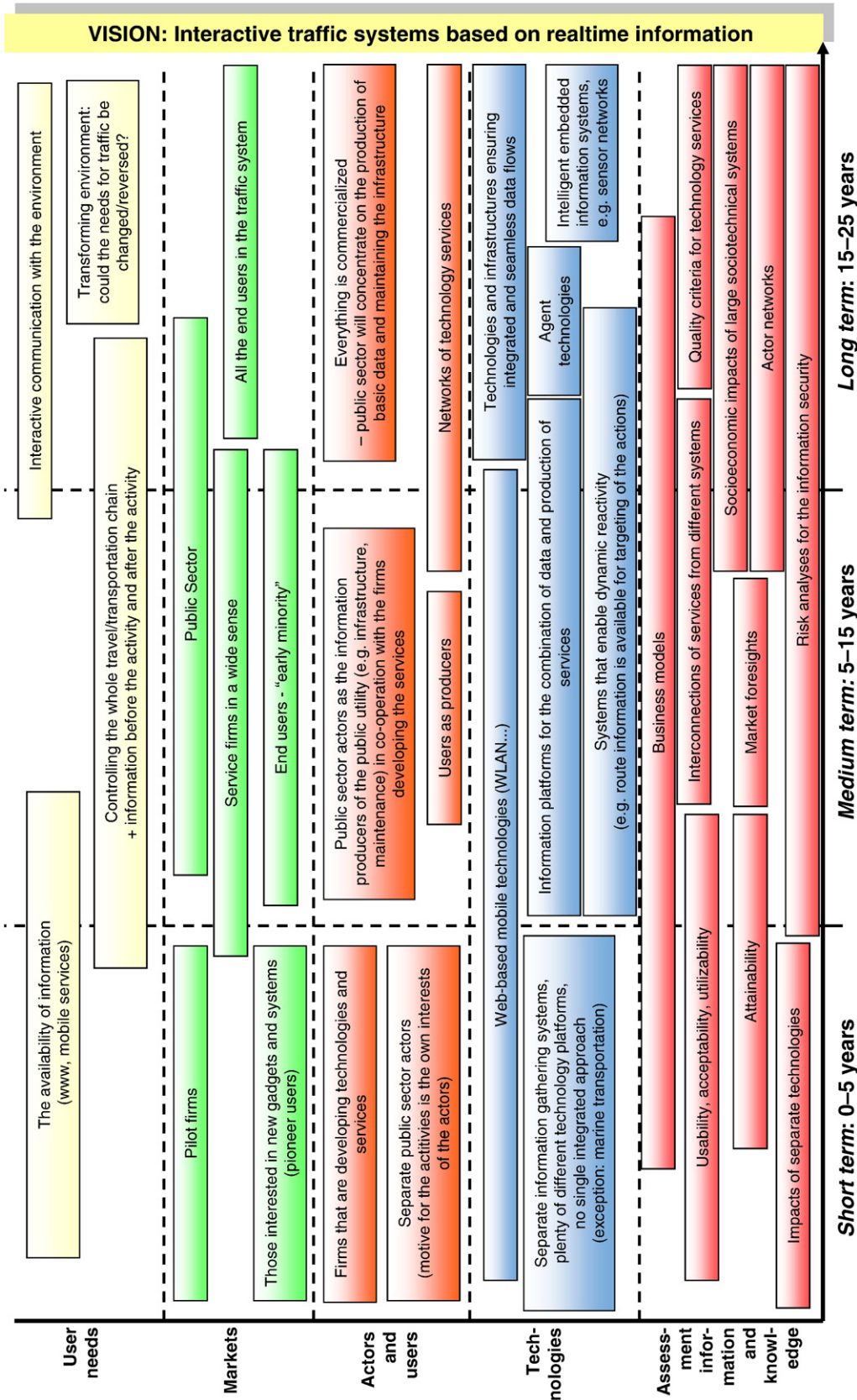


Fig. 8. Roadmap 2: interactive systems based on real-time information.

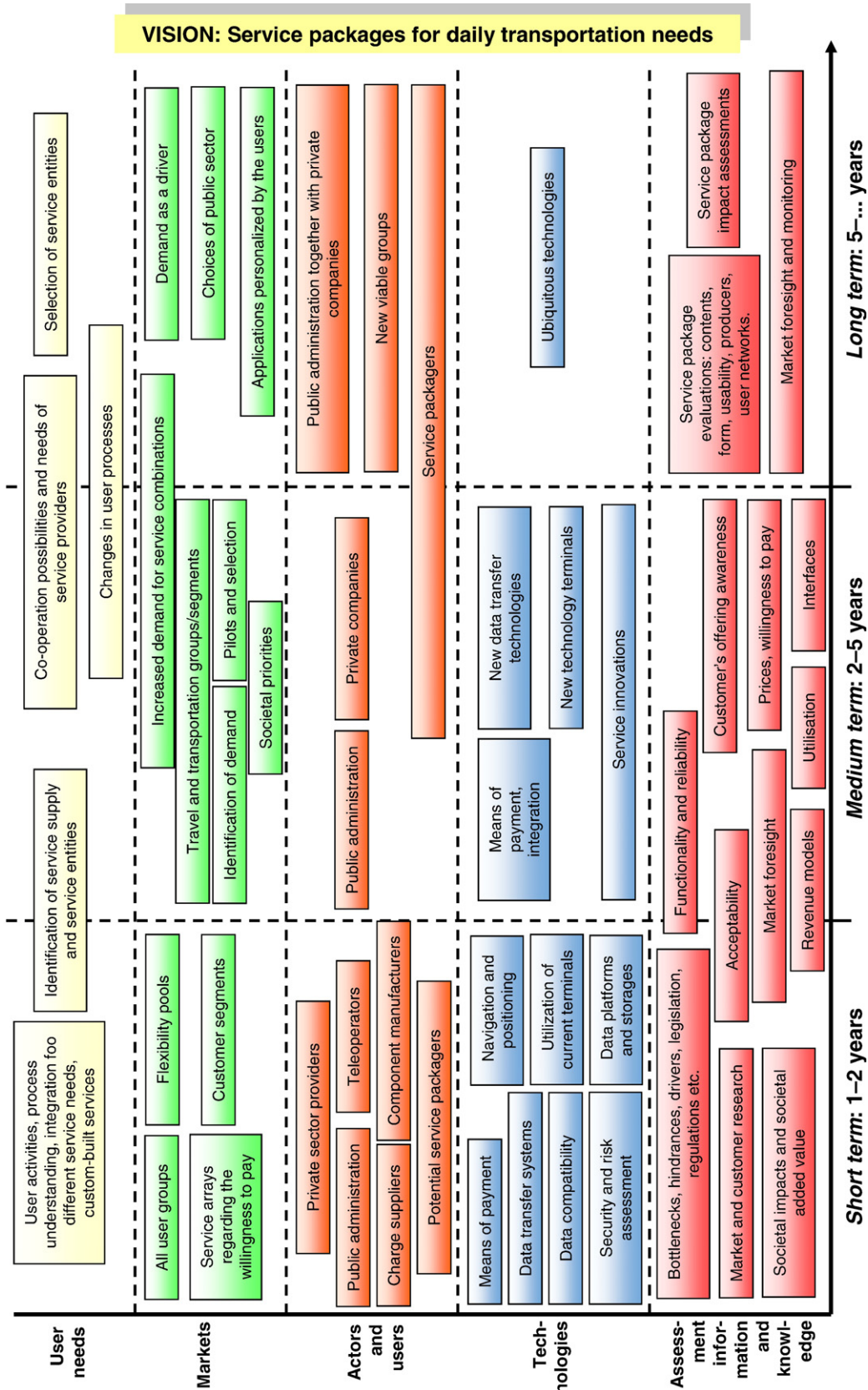


Fig. 9. Roadmap 3: service packaging.

implementation, is systematically organized. New knowledge relevant for transport policy is produced within commonly constructed and accepted policy networks.”

#### 4.1.1. Roadmap description

In the short term (0–3 years), the user needs will focus on information exchange relating to transport system monitoring and control. The main emphasis will be on the fields of easy access to and comparability of the produced information, as well as finding descriptive indicators for the system development. The technological base for the networking technologies stems from ICTs, combining e.g. information exchange optimisation, mobile social media and geographical information systems (GIS). In the public sector, networking in the short term is limited to internal information systems in different administrative bodies and institutions. Impact assessment based on cost-efficiency is the primary mode of required assessment knowledge.

In the medium term (3–6 years), internal information networks of the public administration sectors will emerge. Even inter-sectoral networks may become possible, allowing the utilization of information from other sectors as a basis for transport system design. On the private sector, the emerging partnership networks will serve the needs for information/knowledge of both passenger and freight transport. These networks could also integrate public and private actors e.g. in infrastructure design, construction and monitoring. Public participation in the design of transport systems will increase due to electronic communication. As a result, the role of transport system user networks as critical system designers is enhanced in the medium term. The assessment knowledge needs in medium term will focus on quality, costs and some specific selection criteria for networking technologies. Also, real-time transport information, forecasts based on real-time information, as well as assessments of the transport system demand and supply will be of high importance.

In the long term (6– ... years), the transport system development objectives will focus on utilization of open information and databases. Integrated databases will alleviate the use of assessment and monitoring information in transport system research, design, citizen participation and implementation. There will be two different types of information within the transport system management: 1) freely available public information critical for transport system functionality and safety; and 2) “non-free” information with commercial value. The line of demarcation between publicly available and commercial information will not be easy to draw, because commercial information may be produced also by tailoring, packaging, revising and personifying publicly available information.

#### 4.2. Roadmap 2: interactive systems based on real-time information

The second roadmap, Interactive systems based on real-time information, presents technological complexes that give transport system end-users a constant access – through vehicles or mobile devices – to real-time information on travelling/transport possibilities in the system. The vision of the second roadmap states: “Interactive, mobile information systems will support travelling and the transportation of goods before, in the course of and after the journey. Infrastructure, vehicles, and transport service providers will exchange information, which will enhance the fluency, safety, and eco-efficiency of the transport system.”

##### 4.2.1. Roadmap description

In the short term (0–5 years), the needs of the transport system user will focus on easy access to travel and transport information concerning different transport modes. Mobile interfaces will be the primary channel in information distribution. The potential market segments for the new applications will include pioneer companies in need of real-time logistic information and technology oriented individuals, early adopters. Information systems will be provided by different private service providers and public sector branches. Enabling technologies will consist of many separate, i.e. mode-specific, data gathering systems. No common platform for the production, processing or use of information will be available in short term. The assessment knowledge needed in developing the above mentioned services relate to the analysis of individual data systems from the perspectives of e.g. interface design, implementation, acceptance and security. Foresight knowledge regarding business model development and market developments will also be essential.

In the medium term (5–15 years), the integration of different information modes in the transport system will increase, targeting towards one systemic network. Users of the system will be able to plan their trips in advance and use saved information during the journey in an interactive manner. Different sensors within the infrastructure and the vehicles will continuously gather transport information for the use of both public and private sector actors. The main challenge will be finding an appropriate provider for the whole information system. The service providers will combine transport information from different sources into new services, which will be used by even wider pool of end-users. The needed assessment knowledge to realize this will include business model development, analysis and market foresight for system wide services, provided in collaboration with private and public parties. In addition, assessments regarding the utilization of older and smaller systems as parts of the new integrated system are of pivotal importance.

In the long term (15–25 years), transport services are based on interactive real-time information systems. Service environment will develop towards end-user oriented consumer markets. Mobile ICTs will enable the communication and information flow between vehicles and infrastructures, but on the other hand, it will require development of a common data/knowledge platform for different service providers. Many different sources, e.g. individual persons and vehicles, will be used to gather critical information regarding the state of the transport system. Technology producers and service providers will operate in the service networks striving for increased service efficiency and quality. Public sector will have an important role as network builder and provider of basic knowledge.

### 4.3. Roadmap 3: service packaging

The third roadmap, Service packaging, answers to the daily transportation needs of individual people and firms. Service packaging helps transport system users to create a selection of individual technology services assisting in travelling or transportation. However, service packaging is also important e.g. in business where logistics are crucial part in the overall service. According to the roadmap vision: “Service packaging enables the customers to define their individual selection of transport technology services. Service packages are easy to acquire and use and their costs are on a reasonable level.”

#### 4.3.1. Roadmap description

In the short term (0–2 years), the focus will be on understanding the current actions, processes and preferences of the end-users. Markets for service packages will be formed among all user groups both in passenger and goods transport. Service packages may assist in managing the large logistic processes of large companies as well as the small tasks in people’s everyday lives. Here, finding the right target groups for the packages as well as their accurate pricing is essential. Also the development of commonly accepted terminal devices and payment systems will be important. Databanks, data transmission and processing systems will constitute the foundations of the services. Data security, data consistency and risk management will be the main challenges for service packaging in the short term. The most important assessment knowledge needs include market and customer studies, societal impact assessments of the service packages and identification of the legal bottlenecks for new service packages.

In the medium term (2–5 years), more wide ranging service concepts will emerge. The co-operation possibilities, needs and preferences of different service providers as well as the roles of public and private parties within the service packaging will become clearer. Technological development will focus on further development of data transmission, payment systems and terminal devices. The assessment knowledge needs include assessments of the functionality and reliability of service packages, service package interface design and market foresight for new services.

In the long term (5–... years), service packages that have the highest response among the transport system end-users will survive. Public sector may be able to steer the development with its own choices e.g. by subsidies. New, viable clusters of service providers will dominate the markets and ubiquitous technologies will form the basis of technological development. Also, user-driven transport-related social media services are in use. Market foresight concerning the new service packages will, furthermore, be one of the key forms of assessment knowledge. Assessments regarding the functionality and impacts of wide service areas will also be important from the viewpoint of business development.

## 5. Discussion

Based on our case study, we argue that societal development leads to at least three kinds of changes in the future transport system. Firstly, the actor roles and the actor networks in the system will be pluralised. The transport system will increasingly be composed of public parties, private parties, contributing end-users and complex networks formed of these actors. Secondly, a new kind of business and service layer will be formed in the system because of new dynamic inter-linkages between the actors. This emerging service layer will give possibilities to new kinds of public–private relationships and end-user perspectives. Thirdly, we propose that this service layer could be captured with the concept of “technology service”. In the paper we defined technology service as flexible and tailored combination of technologies and services that takes into consideration the travel or transportation preferences, needs and expectations of the different end-users in the transport system.

Our roadmapping process revealed that – to be able to develop working and practical technology services in the future and integrate the developments with policy developments – there are at least three complementary perspectives to consider. These perspectives were the themes of our roadmaps, namely networking technologies, interactive systems based on real time information and service packaging. Examples of approaches needed to integrate the technology developments into transport policy developments are societal impact assessments, user-centred design and different future oriented assessments regarding e.g. service demand, emerging market needs and new business models.

Based on our case study, we argue that in the short and medium term (1–10 years), the approaches supporting transport system technology services should emphasise following topics: market foresight, technology assessment, business model assessment and evaluation of integrated data systems, societal impacts and effectiveness of the technology services in public–private production environment. From end-users’ point of view, essential assessment knowledge relates to the users’ activities and acceptance of new devices and applications, as well as to the co-operative interface design. In addition, it is important to identify legal and organizational obstacles relating to new technology services. In the long term (10–25 years), the needed approaches in the transport system emphasise interfacing possibilities, joint implementation of different interactive systems, security and privacy, business models, criteria for data transmission and societal impacts.

The case study summarised above supports our argument that moving up the ladder of information society, towards ubiquitous knowledge society, poses unique challenges to the development of transport systems and transport policies. In order to grasp the networks dynamism in the system, a rethinking and reconceptualisation of knowledge needs is required. To cope with this increasing systemic complexity, traditional transport planning approaches should be complemented with societal and actor-oriented, proactive approaches. We claim that foresight methods, like visionary socio-technical roadmapping, can provide good premises for the implementation of this wider societal perspective.

To conclude, the socio-technical roadmapping method tested with a Finnish case study proved to be useful in producing transport policy relevant knowledge from at least five different perspectives (roadmap levels). It also provided an interactive foresight platform that brought researchers and policy actors together and stimulated future oriented discussion on transport visions, policies, technologies, services and their interdependencies in a collaborative manner. We find that method holds potentials not just as tool of technology foresight, but also as a tool for new agenda identification and network building in complex societal-technological systems, like transport system is.

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Paper II

**Common preferences of different  
user segments as basis for intelligent  
transport system:  
case study – Finland**

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# Common preferences of different user segments as basis for intelligent transport system: case study – Finland

A. Tuominen, T. Järvi, J. Räsänen, A. Sirkiä and V. Himanen

**Abstract:** The ultimate purpose of the transport system is to serve the needs and expectations of the end users, who in turn shape the system by their own behaviour, actions and investments. This work examines, within the framework of the Large Technological Systems theory the possibility to categorise users of the transport system into homogeneous segments on the basis of their differences in daily mobility and transportation of goods. Furthermore, the potential to deepen this segmentation to describe the needs of, but later in the policy process also the social acceptance by, different user groups for new transport technology or policy, is examined.

## 1 Introduction

A transport system, international, national or local, relates closely to the definition of large technological systems: ‘Technological systems contain messy, complex, problem-solving components. They are both socially constructed and society shaping’ [1]. The state of the transport system is a result of the measures and actions carried out by the producers, operators and users of the system. Producers and operators are organisations or companies, which can be categorised according to their main duties, such as: policy formulation, infrastructure construction and maintenance, production and operation of services for the transport system, and production of transport-related services (e.g. vehicle manufacturing and fuels). Individual people, actually the whole population, are the users of the passenger transport system. In freight transport, users are companies and organisations in the fields of industry, transport and commerce. Basically, the ultimate purpose of the transport system is to serve the needs and expectations of the end users, who in turn shape the system by their own behaviour and actions. The system is thus both socially constructed and society shaping (Fig. 1). Producers gather information on the state of the transport system and also receive feedback from customers, that is, the users of the transport system. They make plans on the grounds of expert knowledge (design principles), and decisions based on generic or special decision-making principles. Within the process, information about the system gathered by the producers is, or at least should be, transformed into policy measures, aiming to lead the transport system into an intelligent as well as sustainable future (e.g. [2–5]). By the intelligence of the transport systems and policy measures we refer here mainly to the transport and traffic information services offered and transmitted via information and communication

technology (ICT), usually labelled as telematics or ICT-based mobility information services [6].

As we are rapidly approaching the capacity limits of transport systems in many parts of the world, especially in urban areas, different information services for transport users are offered as one solution to the problem. The general assumption is that the use of infrastructures can be optimised by improved information for transport system users [6]. On the other hand, however, it seems that the world is becoming more and more turbulent, and the information-based ‘knowledge society’ too fast – faster than the structures of private and public organisations or even private lives are becoming resilient. In transport this means that while there are no general restrictions to the supplying of traffic information services from a technological point of view, users are still quite reluctant to accept these services (e.g. [6–8]).

Recently, interest in and understanding of the systemic nature of transport has increased (e.g. [4, 5, 9–11]). Consequently, this development has highlighted the importance of the user-centric approach, especially in ICT-related transport technology development (e.g. [12–15]), but also in the transport policy process in general. New technology or policy brought into a transport system requires, in addition to operational functioning, acceptance and a motive for itself among the different users facing it according to their individual preferences. In some recent studies on mobility information services [6, 16], a technological application is defined as useful if: (i) the potential user can profitably use the functions of a service for the tasks in his (everyday) life context and (ii) the configuration of the system fulfils the requirements of the user in terms of both operability and functionality.

As it is not possible to survey the needs of and acceptance by each individual transport system user, this paper examines the possibility to categorise users of the transport system into homogeneous segments based on the differences in their daily mobility. Furthermore, the potential to deepen this segmentation to embody the different user segments’ common mobility needs and preferences on one hand, and the acceptance of new technologies and services on the other is discussed. The theoretical background of our work stems from the framework of the LTS (Large Technological Systems) theory developed by Thomas P. Huges [1, 17], which is complemented by the

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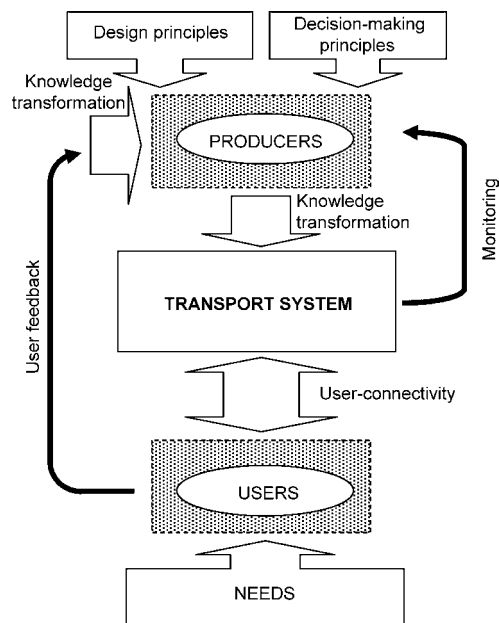
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**Fig. 1** Producers, users and interactions within the transport system

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Social Construction Of Technology (SCOT) approach of Pinch *et al.* [18]. As a case study, we use Finnish national demographic statistics and passenger transport survey data [19] for passenger transport, and annual goods transport statistics in the context of a general logistics concept, developed by VTT Technical Research Centre of Finland, for freight transport.

In the following sections we first summarise the literature on LTS and SCOT in relation to user preferences and user-oriented research carried out within the transport sector. We go on to explain how user segments can be identified with the help of household surveys, demographic and goods transport statistics, and the logistic concept. Moving on to the results, we show that in Finland, users of the passenger transport system can be initially clustered into 11 segments and users of the freight transport system into 6–11 segments based on the differences in daily mobility and transportation of goods. We conclude with a set of recommendations on how to use and elaborate the segments identified in order to uncover deeper preferences as well as acceptance of intelligent technologies and services for the basis of transport policy development.

## 2 Previous work

In recent years, there has been too little attempt to bring together such work as studies concerning technological innovation and sociological studies of new knowledge (e.g. [18]), although they could benefit from each other. This argument also holds true within the transport sector, especially in the case of intelligent transport system (ITS) applications or artefacts with new types of contexts and interfaces to be faced by the end user. In transport, the main problem seems to be the linking of the acceptance of intelligent transport services, travel behaviour and use of ICT [6].

How do objects, artefacts and technological processes come to be stabilised? And why do they take the forms that they do? The LTS approach developed by T.P. Huges [1, 17] and applied in our study understands technological innovation and stabilisation in terms of systems metaphor. The argument is that those who build artefacts do not concern themselves with (technological) artefacts alone,

but must also consider the way in which the artefacts relate to social, economic, political and scientific factors. That is to say, technological systems are open systems and all these factors are interrelated. Technological systems are thus both socially constructed and society shaping. Among the components in technological systems are physical artefacts, organisations, scientific and legislative components, and natural resources. According to T.P. Huges [1], the evolvment or expansion of LTS can be presented in the following phases: invention, development, innovation, transfer, growth, competition and consolidation. LTS theory also presents other useful concepts, such as technological momentum (which systems acquire as they mature), technological style, and reverse salient, that can help in discovering or understanding new aspects in technological development. In this paper our particular interest lies in the consolidation phase of LTS evolvment, as we see the identification of homogeneous user segments for a transport system and their common pattern of preferences as a novel attempt to describe the needs, but later in the policy process also the social acceptance, for new technology or policy brought into the transport system.

A complementary approach to the LTS theory is presented by Pinch *et al.* [18] and called the SCOT. In this constructivist approach to the study of technology, the ‘closure’ concept is presented as follows: ‘When the social groups involved in designing and using technology decide that a problem is solved, they stabilise or consolidate the technology. The result is closure. Various groups will, however, decide differently not only about the definition of the problem but also about the achievement of closure and stabilisation’.

Both of these approaches suggest that technological stabilisation can be understood only if the technology in question is seen as being interrelated with a wide range of non-technological and specifically social factors [20]. The recent research on adopting new technology in the transport sector has, however, paid fairly little attention to the importance of the varying opinions of different users in introducing and stabilising new technology, that is, in identifying the ‘closure’. As Tuomi [21] argues, new types of ICT are implemented in all spheres of modern society, in everyday life, in production systems, in institutions and in culture. Consequently, research on the usability and functioning of new technology should include as wide a range of social factors and end users as possible. Also in the context of ITS there seems to be a strong discrepancy between knowing about the applications and using them, for example, mobility information [16]. A wider social discussion on gaining legitimacy (Legitimacy can be defined as a generalised perception or assumption that the actions of an entirety are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs and definitions [22, 23].) as well as designing strategies for intelligent transport technologies and services thus needs to be carried out. We leave that discussion, however, to the agenda of future research.

The main focus in the transport sector has been on the quite narrow field of Human-Technology Interaction (HTI) research, shaped by rapidly developing ICT and its applications in new types of user interfaces (e.g. [13, 14, 24]). The central aim of HTI research has been to improve the implementation of information technologies in solutions that are more functional, usable and meaningful for people. Research on new technology’s implications for society at large has been quite modest. A couple of attempts to cluster transport system users into homogeneous segments on the basis of their common expectations and needs can, however, be identified (e.g. [11, 25–27]). Yet,

the approaches cover only a small fragment of transport system users (e.g. public transport users), not the system as a whole. Concepts like the travel behaviour and journey quality of certain user segments as a basis for transport policy formulation have also been examined only lightly (e.g. [6, 16, 28–31]). These studies indicate that the importance of user needs in the study of the ‘closure’ of technological and service innovations as well as in the design and development of the whole system has been identified also within the transport sector.

### 3 Research gaps revealed

The formulation of a transport policy (ICT-related or other), and especially the implementation of one, is a process of successive compromises. Although the environmental, economical, social and equity objectives are all well known by researchers and often referred to by politicians, other decision-makers and civil servants, actual decisions are too often based on the needs of the majority, whether real or presumed.

We argue that the emerging user-centric design within the ICT-related transport sector has focused on too narrow a field of users at a time (e.g. the working population, public transport users and the elderly). The LTS evolution perspective with phases from invention to consolidation has had too little attention. We claim that policy planning too often serves a ‘middle-class male car user’, which causes conflicts between policy goals, decisions and implementation. Conflicts might be alleviated if the policy formulation would be carried out with a wider range of users in mind. On the other hand, the too large a number of heterogeneous user groups involved within the transport sector is presented as one factor hindering the user-oriented approach to policy development (e.g. [11, 12]). In the transport sector the field of users and other stakeholders is quite complicated because almost everybody may be considered a user of the transport system, but at the same time a vast majority do not feel directly involved with some parts of the system, that is, those that they do not use or are not affected by.

Generally, ICT-related transport technologies or services are considered as an attempt to optimise travelling. They aim to improve a user’s information level to ease his or her decisions about adaptive behaviour, concerning, for example, the choice of transport modes or routes. However, in an everyday context, people often act as they did before in the same or similar situations. They reconsider the way they act only if situations are completely new or unknown so that previous behavioural patterns do not fit. The actions taken also depend very much on the potential user groups, because general requests for mobility information exist throughout diverse social classes [6, 16].

To start a wider discussion on the acceptance of transport-related ICT technologies, we present in the following chapters a tentative method to generally categorise all transport system users into a limited number of segments, based on their differences in daily mobility and transportation of goods. In addition, we argue that these segments can be used as a starting point and elaborated upon further to uncover the mutual needs, expectations and acceptance of these user segments for the development of transport-related innovations as well the transport system as a whole.

### 4 Method

The empirical data used in this study stems from a national research project financed by the Ministry of Transport and Communications, Finland. The project introduced a novel

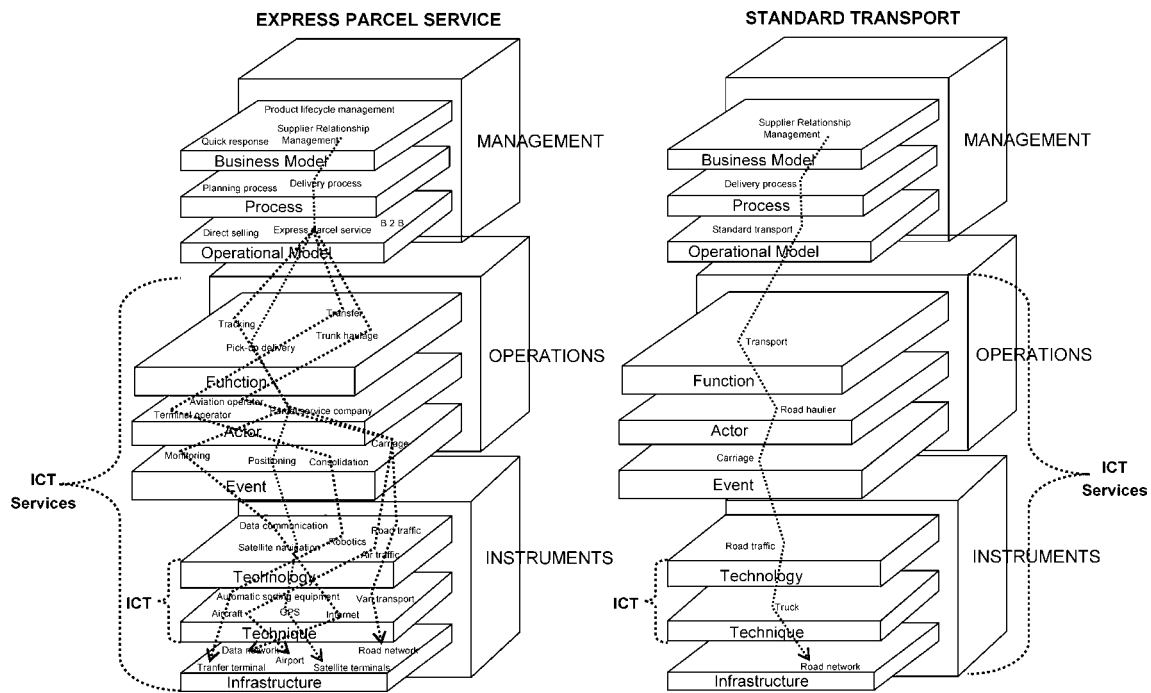
approach to classify users of the transport system into a limited number of homogeneous segments and identify their mobility needs.

#### 4.1 Passenger transport

In Finland, passenger transport surveys are conducted every 6 years, the latest in 2004–2005. The data in this paper stems, however, from an older survey, carried out in 1998–1999 [19]. The survey method used is a preinformed computer-aided telephone interview (CATI). Although the survey is directed at a single person in the household a lot of information is gathered on the household as well. Regarding trips, a full-day travel diary and a separate record of long trips during the past 4 weeks is obtained. The survey covers the whole year and altogether nearly 12,000 persons over the age of six. The sample basis as well as the demographics to assess the fitness for purpose of the sample and to enlarge it to represent the whole population, has been obtained from Statistics Finland.

For the purpose of the study the data was analysed as follows: the aim was to classify the entire population into a minimum number of person groups by their demographics using differences in daily mobility as the criteria. Daily mobility was defined as the number of trips, the distance travelled and the time used in travelling; the mode of transport was not used in this phase. People were characterised according to gender, age group, activity, location and type of residential area and also the household’s car ownership. The analysis was started using an initial detailed classification of around 100 person groups. The starting position was based on the basic survey analysis and reporting as well as previous research on the daily mobility of Finnish people (e.g. [26]). In addition, the aim was that the groups could be predictable in the future and thus could serve as a basis for the development of new ICT services. In the first phase, groups with fairly similar daily mobility patterns were merged, and groups with very few representatives were merged with the major groups. This brought us to 30 person groups, the characteristics of which were identified as the most descriptive criteria for clustering: living environment having three subgroups ((i) six biggest cities, (ii) other densely populated areas, (iii) rural areas); age having three subgroups ((i) 6–17 years, (ii) 18–64 years, (iii) over 64 years of age), activity having two subgroups ((i) active people: working people, schoolchildren and students; (ii) others) and household car ownership ((i) yes, (ii) no) having two subgroups.

The second phase of the analysis was to reduce the number of groups further on the same basis of similar travel behaviour but now focusing also on the daily needs for similar ICT services, both for public transport and travel by car and for familiar and unfamiliar trips. This new criteria set out new constraints for the formation of the groups. People groups with access to car could not be merged with groups without a car, large cities were to be kept separated from other areas as the transport system, and especially the supply of public transport differs significantly. The differences in the freedom of travel choices, particularly in timing, between active people (working, schoolchildren and students) and non-active groups are relevant for the ICT services required. For instance, the routine trips of active people are familiar and thus do not need any assistance in beforehand planning but real-time information and guidance during the journey is needed instead. In the second phase, the age and activity groups were at first merged into three subgroups ((i) 6–17 years of age, (ii) working people and students 18–64



**Fig. 2** Two different operational models identified by the logistics concept: (i) express parcel service with a complicated structure and a large number of actors; (ii) standard transport with a more simple structure and only a few actors

years, (iii) others 18–64 years of age or over 64 years) and second, where appropriate, smaller cities were combined with rural areas. The number of person segments was reduced to 11, which gives the possibility to obtain the size of each group from standard population forecasts in the future. The modal share distributions of the different person groups defined in each phase were used as check criteria for the success of the classification.

The strength of this classification method is in its extensive but on the other hand simple nature. First, the extensive data and the large number of groups in the beginning helps the analysts to identify the most descriptive criteria for clustering. Second, as the method proceeds by merging groups into major groups which still have sufficiently similar daily mobility characteristics, both the number of criteria and mobility groups are gradually reduced resulting to a limited number of segments as well as criteria. The former methods developed for this kind of clustering (see also Sect. 2) have been much more complicated and not so easy to carry out.

#### 4.2 Freight transport

There are two traditional approaches by which the public sector has for long tried to enhance the logistics system. The first one is the enhancement of infrastructure (mainly investing in transport networks), nowadays backed up widely with ICT applications. This approach tries to influence the operational level of organisations in need of logistic services from the bottom–up, offering different kind of (new) technologies and techniques aiming to enhance the fluency of goods transportation. This approach lacks, however, the system perspective. The second one is a top–down approach, where the use of policy instruments (regulation, economic instruments and information provision) is directed towards the different businesses of trade, industry and transport. This approach can be seen to be more systemic and effective, as it affects all levels or activities of the logistic processes. It lends itself especially to situations when either the infrastructure is basically in adequate condition or when

it cannot be extended further because of financial, spatial, environmental or political limitations.

Basing on one of these approaches, the users of the freight transport system have traditionally been approached horizontally through individual or mode-specific transport operations. However, the main decisions concerning the different activities (including logistics) of, for example, an industrial corporation are made at a high managerial level. Consequently, if the public sector desires to affect the system, it has to gain knowledge about the fundamental needs the industry has as an end-user for the transport or logistic system. This leads to the need to better understand the business and operational models of different industrial sectors as a basis for the transport or logistic system development. In order to gain a deeper understanding of the needs of the different actors within the logistic system, we suggest here to use a generic logistics concept, developed by VTT (see Fig. 2). The concept comprises of three vertical business activities or levels: management, operations and instruments. The aim of the logistic concept is first to help in identifying different transport chains or operational models within a certain geographical area. Second, different actors and their needs and preferences for the transport system within the transport chains are considered. The analysis is carried out by defining how many times the different levels of the logistic concept, including different actors, functions, processes and so on need to be passed to get the goods delivered. By opening up the structure of the logistic system, the logistic concept assists in identifying user or actor segments, with similar needs, within existing as well as new operational models for goods transport. Consequently, it also allows the recognition of problems for various actors within the transport chains.

The examples in Fig. 2 illustrate, that in the contemporary information society ICT is one, very important instrument, which public sector can use to develop the freight transport system, but that there are also lots of other aspects to consider. ICT is embedded in many different technological applications, techniques and infrastructure components within the instruments level of the logistic concept. ICT



services instead, need a wider field of operation and are hence established and used by various actors within different events occurring both in operations and instruments levels.

The logistic concept is by no means a completed method yet, it still needs further development. The results in the next section show, however, that it has potential which should be utilised in the future. The goods transport statistics (Statistics Finland) as well as transport statistics from the Finnish Road, Rail and Maritime Administrations have been used as basic data for the identification of transport chains and freight user segments.

## 5 Results

The following sections present the results of the study, that is, the usability of the method for identifying user segments. The results are discussed through a Finnish case study.

### 5.1 Passenger transport

On the basis of the empirical data, the Finnish population over the age of six was clustered, after several group mergers, into 11 transport system user segments. The user segments, their current travel behaviour and possible future trends are presented in detail in Appendix 1. The future appraisals are based on the demographics trends by the Statistics Finland and Knowledge Society Programme statements by the Finnish government complemented with the own deliberations of the authors. Some former studies have shown [6, 16] that the main objectives for individuals to use new transport technologies (e.g. mobility information services) are to optimise their travel behaviour not to change it. This phenomenon exists throughout diverse social classes. Especially, there does not exist much willingness to shift to other modes of transport, particularly not from car to public transport. Therefore the diffusion of new transport technologies will not necessarily lead to a better or smoother use of the transport system. However, a tendency to follow recommendations and guidance resulting in changes in initial 'decisions' with respect to routing of trips, for both public transport and car use, has been identified. Especially for trips to work this might have influence (e.g. [6, 11, 16, 28]). These aspects need further research, but allow us to assume that our three main criteria for clustering, that is, access to car, living environment and

activity/age are relevant in the context of new technologies for transport as the needs for new ICT services are quite different for each of the segments. The age of the person, that is, transport system user, his/her daily activity, type of residential area and the transport system available, and last but not least accessibility to a car are the main elements for the mobility behaviour but also for the needs of ICT services.

The results of our mobility pattern case study indicate that Finland has become motorised: over 80% of the population live in households having at least one passenger car, and nowadays over 90% of young people, both men and women, obtain a driving licence. Among the singles, the group composed mainly of the elderly and population in the large cities, living without a car is most common. The adults in households with a car use it for the majority of their daily trips. They also chauffeur their children as well as members of households without a car, who otherwise mostly walk or cycle. In the largest cities, especially in the Helsinki region, public transport is used by all person groups (see Appendix 1), but in smaller cities, public transport is mainly used by members of households without a car and to some extent also by children from families having a car.

An average member of a Finnish household with at least one car makes on average three trips per day, spending around 70 minutes in the car and travelling approximately 45 km. In households without a car, the members make on the average 2.3 trips per day, on which they travel 22 km and spend 67 min in travelling. Comparing households with respect to car ownership we notice that the trip rate and time used in travelling is only somewhat higher for households with a car. The significant difference is seen in the daily distance travelled, as the members of non-car-households reach exactly half the distance those of car-households do. In addition, the differences both in the average number of daily trips and the travel time are actually mainly caused by persons with 'other activity' and the elderly who travel much less if they do not have a car. For the other person groups the only significant difference is the speed of the car, which takes the car-owning household further.

For households with a car all three types of residential locations can be distinguished, but for households without a car only the large cities differ from the other areas as they can offer a real alternative for the car, an effective public transport system. The 11 different user segments identified and their modal share distributions are presented in Fig. 3.

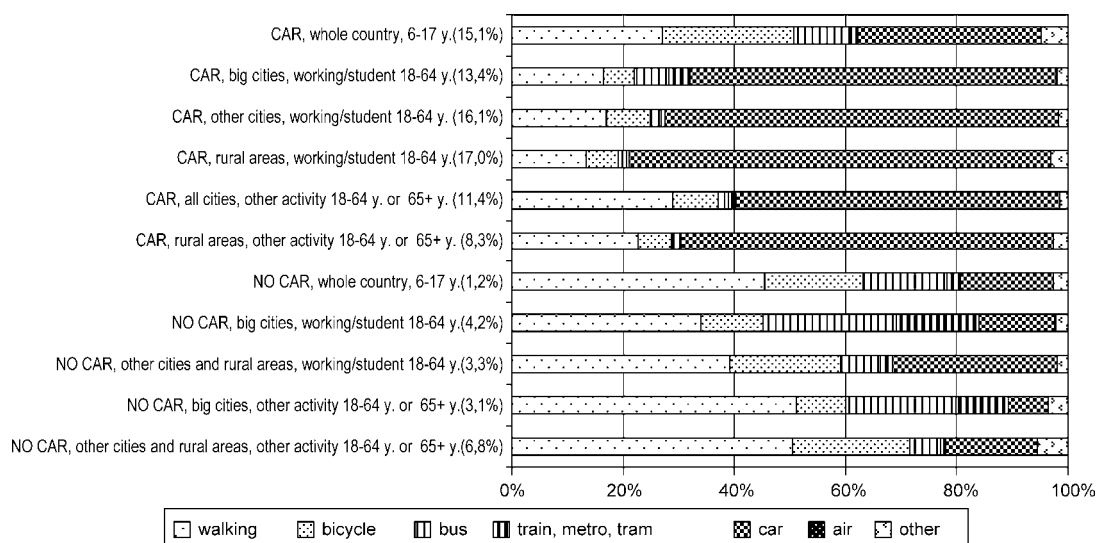


Fig. 3 Transport system user segments in Finland and their modal share distribution

## 5.2 Freight transport

A wide range of different transportation chains can be identified within Finland's goods transport system with the aid of the logistics concept. Most of them can, however, be represented through the following operational models or freight transport chains, which may include several modes of transport: (i) import and delivery of daily consumer goods, (ii) export of unutilised freight, (iii) long-distance haulage, (iv) regional business delivery, (v) import of raw materials, (vi) export of bulk cargo, (vii) air cargo transport (value goods) and (viii) transit transport across the country. These chains are illustrated in Fig. 4.

There are basically two different possibilities to segment the users of the freight transport system in the contexts of these transport chains identified by the logistic model (see Fig. 2). In case the development of transport networks is seen as essential, the operators of the freight transport system may be considered end users and categorised into segments, for example, as follows: (i) lorry operators, (ii) van transport companies, (iii) railway operators, (iv) shipping companies, (v) airline companies, (vi) railway terminal operators, (vii) port operators, (viii) airport operators, (ix) border-crossing terminal operators, (x) other store, depot and similar terminal operators, (xi) forwarding agents. By considering terminal operators to be end user groups of the freight transport system, the intermodal feature of freight transport is emphasised here.

Another perspective is to use different branches of industry as user segments for the freight transport system. This is a more traditional approach and might be used as the basis for wide strategic considerations but also for regional transport planning. The following segments are based here on the different transportation needs of different branches of industry and commerce in Finland: (i) forest industry, (ii) other basic industries, (iii) building trade, (iv) agriculture, (v) food industry, (vi) high-tech industry, electronics and so on.

In the event that the user segments of the freight transport system are used as a basis for the development of

transport-related technological innovations or the system as a whole, it is important to keep in mind both of these dimensions for categorisation, in order not to exclude any essential segment.

## 6 Discussion

The LTS and SCOT theories presented earlier suggest that the evolution and development of large technological systems and technological artefacts can proceed successfully only if the users' perceptions towards and reception of a problem, policy or new technological application can be identified. As Huges argued [1], even the problems are seen differently by different social groups.

This study was designed to test whether the users of a transport system could be clustered into a limited number of homogeneous user segments on the basis of their differences in daily mobility and transportation of goods. Furthermore, the study was to test whether these segments could be used as a starting point and elaborated further to describe the needs and preferences of, but later in the policy process also the social acceptance by, different user groups (i.e. consolidation, closure or legitimacy) for new technology or policy introduced into the transport system.

The method we presented and tested with Finland as a case study proved to be useful in the context of transport system user segmentation. The findings suggest that a basic, system-based framework for identifying the users' needs for the development of transport-related technological innovations, as well as the system itself, can be initiated by the segmentation approach. In our case study, users of the passenger transport system may be initially divided into 11 segments, and users of the freight transport system into 6–11 segments (depending on the purpose). The approach is currently being adopted by the authorities in the Ministry of Transport and Communications as well as the Road and Rail Administrations in Finland. Travelling is not a direct need for man, but a consequence of satisfying needs in different places. The similarities and differences in mobility

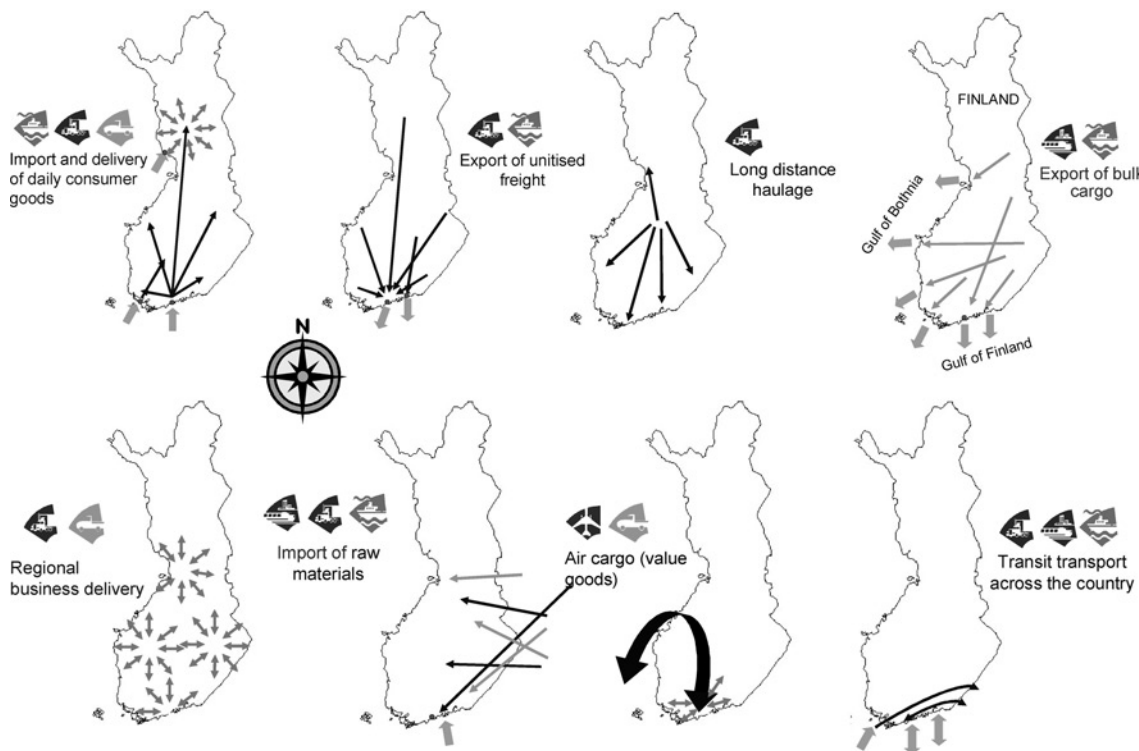


Fig. 4 Most typical Finnish freight transport chains (including different transport modes) identified in the study

and transport patterns cannot hence be seen as reflecting the ultimate needs and preferences of different user groups for the transport system. We can, however, expect them to be consequences of satisfying similar needs and hence we argue that the user segments can be used as a preliminary form of segments describing also the common preferences of and acceptance by the users for the development of transport-related technological innovations or even the system as a whole.

## 7 Conclusions

Transport system users use ICT services to improve their travel process. All transport system users should be able to make information-based decisions on the choice of transport modes and routes, which would hopefully lead to optimal travel behaviour. By offering ICT-based services tailored to the special needs of the end user groups, the best acceptance rate and benefits can be achieved. For instance, unnecessary car use can be reduced and use of public transport promoted by introducing new information services specially aimed at car users in big and medium-sized cities (around a third of the Finnish population) whose public transport use is presently less than 10%. In rural areas the stress should be on all initiatives to share car rides and also demand responsive systems, as there is no potential for frequent public transport. The continually increasing group of elderly people without a car in rural areas (presently around 7%) with all their special needs is a real challenge for the present society. Other examples of ICT-based services, where user segmentation could be applied, are, for example, identification and acceptance of routing services and electronic ticketing. Future research (e.g. in-depth interviews of different user segments and methodological development) is still, however, needed to specify the user segments more adequately, as well as to clarify the chain from needs to usage and behaviour.

In conclusion, the construction of new technology (which in the transport sector has become more and more ICT-based) also requires revealing the need and furthermore the meaning for the new technology among different user segments. As Tuomi argues [21], like Pinch and Bijker [18] and Huges [1] before him, new technologies and innovations are fundamentally about social change; they become articulated only when they are taken into meaningful use in social practice. In other words, meaningful use is grounded in social groups, here namely different user segments, within which technological change appears. Currently, the main objective for individuals throughout diverse social classes to utilise new transport technologies is to optimise their travel behaviour not to change it (e.g. shift to other modes of transport). To expand the influence of new technologies also to the travelling behaviour of different kind of transport system users, we need first to identify their mobility needs, expectations and also acceptance for intelligent technologies. The method we have presented for the user segmentation provides good premises for that.

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## Passenger transport system user segments and their travel behaviour

No	Passenger segment	Number of Persons	Description of current travel behaviour	Future
1	CAR, whole country, 6–17 years	720 796 (15.1%)	Children and teenagers of families with at least one car either walk or bike half of their trips. One-third of the trips are made as car passengers. They are clearly distinguished from the adult population in their active use of both bicycles and public transport. The total distance travelled as well as the average travel speed stay fairly low compared with other person groups because of the dominant use of slow modes.	No major changes in the mobility needs of children are expected. The safety and security aspects of using public transport as well as slow modes will affect people's choices and may lead to an increase in chauffeuring by car. In rural areas travelling on one's own will become even more difficult as the potential for conventional public transport decreases.
2	CAR, big cities, working/student 18–64 years	636 218 (13.4%)	In the big cities the working population with cars spend more time travelling than any other person group. Public transport is used more than in other cities or rural areas, in around 10% of trips, but two-thirds of all trips are still made by car. The daily travel distance as well as the average travel speed stays lower than for people living elsewhere because of the slowness of city traffic.	Because of increasing congestion, the potential demand for public transport is likely to increase among the working population in large cities. The high price of fuel also has an effect on people's choices. On the other hand, in accordance with the present trend, car dependency will increase as well. On shorter trips the use of slow modes may increase. Because of urban sprawl, travel times will get longer.
3	CAR, other cities, working/student 18–64 years	768 311 (16.1%)	In smaller cities a quarter of the trips of the working population with cars are made by walking or cycling, whereas the share of public transport trips is less than 3%. The use of bicycles is more common than in bigger cities. The average travel speed is higher and thus the daily distance is longer in spite of the somewhat shorter daily travel time.	In smaller cities congestion will not be a major problem. Car dependency is likely to increase, but the high price of fuel will also have an effect on people's choices. On shorter trips the use of slow modes may increase. Because of urban sprawl, travel times will get longer.
4	CAR, rural areas, working/student 18–64 years	808 068 (17.0%)	The working population with cars living in rural areas make nearly 80% of their trips by car. Slow modes are used less than in cities and public transport even less, actually not at all. The average travel speed is the highest, causing also the longest distance travelled despite the still shorter daily travel time compared with the population in the cities.	The car dependency of the working population in rural areas will continue to increase. The potential for conventional public transport will break down as the number of users will decrease. No major changes in travel times are expected.

## Appendix 1 Continued

No	Passenger segment	Number of Persons	Description of current travel behaviour	Future
5	CAR, all cities, other activity 18–64 years or 65+ years	544 474 (11.4%)	Compared with the working population, the remaining adult population with cars (retired, devoted to housekeeping, unemployed and so on) make fewer trips and walk much. Also, the time used for travelling is shorter, which causes the daily distance travelled to remain clearly less than other people's.	For this non-active-working-life group congestion will not be such a problem that it would affect people's choice of transport mode, except in the Helsinki area. The number of retired, healthy people will increase as will their growing dependency on cars. In general, travel times will get longer.
6	CAR, rural areas, other activity 18–64 years or 65+ years	394 329 (8.3%)	In rural areas the non-working adult persons with cars, including the elderly, make fewer trips and spend less time travelling than persons living in cities. The share of car trips is greater and, because of the higher speed of cars, the daily mileage is also greater than for persons in the cities, in spite of the shorter time used.	No major changes are expected. However, the number of retired, healthy people will increase, as will most probably their dependency on cars.
7	NO CAR, whole country, 6–17 years	56 955 (1.2%)	Children and teenagers of families without a car or bike make half of their trips by walking. The three other modes, cycling, public transport and being a car passenger, share the other half evenly. Compared with young people in families with a car, walking is more dominant, as is the use of public transport, and thus the average travel speed and distance are lower. The majority of this small group lives in cities. In rural areas nearly all families with children have at least one car.	No major changes are expected. The safety and security aspects of using public transport as well as slow modes will be essential in maintaining the present modal share.
8	NO CAR, big cities, working/ student 18–64 years.	201 883 (4.2%)	In big cities the working population without cars use more time travelling than any other person group. Public transport is used for nearly 40% of trips. Also, the share of walking and cycle trips is double that of car owners (segment 2). They make fewer trips than persons with cars and the daily travel distance remains far below the car owners'.	According to present trends, there is potential for the size of this group to grow. However, no major changes in daily mobility are expected. Walking and cycling are likely to gain more success. The safety and security aspects will affect people's choice of transport mode, and may lead to an increase in chauffeuring by car.

(Appendix continued)

## Appendix 1 Continued

No	Passenger segment	Number of Persons	Description of current travel behaviour	Future
9	NO CAR, other cities and rural areas, working/student 18-64 years.	157 376 (3.3%)	The working population without cars living in smaller cities or rural areas make nearly 60% of their trips by walking or biking, of which biking is responsible for a third. The share of public transport is less than 10%, whereas the share of car trips is nearly a third in spite of not owning a car. The average daily travel time is the same as for persons with cars but shorter than in big cities. Because of the slightly higher speed, the distance travelled is the same as in the big cities, that is, around a half of that of car owners.	This group is likely to decrease. As the use of cars generally increases it will reduce the potential for more effective public transport. This group will be dependent on car-owning people in fulfilling their mobility needs. Travel times will become longer.
10	NO CAR, big cities, other activity 18-64 years. or 65+ years.	149 020 (3.1%)	Compared with the car-owning group in big cities (segment 5), the daily mobility of this adult person group with other activity than work or studying and without cars is clearly lower. The daily distance travelled is less than half of that of the car owners' and they make fewer trips as well. A half of the trips are made by walking, a third by public transport and the rest by bicycle and car.	The number of retired, healthy people will increase and their mobility needs are expected to increase as well. The safety and security aspects of the use of both public transport and slow modes are of great concern to this group and may affect people's choices concerning daily mobility. Travel times will get longer.
11	NO CAR, other cities and rural areas, other activity 18-64 years. or 65+ years.	325 990 (6.8%)	This fairly large person group is the least active mobility group in all respects. The number of trips, the daily distance and especially the time used in travelling stays far below that of those living in big cities and of persons with cars. A half of the trips are made by walking, nearly no trips by public transport and the rest by bicycle or car.	The number of retired, healthy people increases and their mobility needs are expected to increase as well. However, if the public transport services decrease this group will be more and more dependent on the car-owning population and their chauffeuring.

Paper III

**Assessing the interaction between  
transport policy targets and policy  
implementation – A Finnish case study**

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# Assessing the interaction between transport policy targets and policy implementation—A Finnish case study

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## Abstract

This article explores the potential of a target analysis method in acting as a link between policy objectives, targets, measures and their implementation in order to intensify the policy process. The context is the information-abundant policy environment where feasibility conditions keep constantly changing. The policy process frameworks for bounded rationality and experiential incrementalism are used as a basis for exploration and complemented with our target analysis, which is tested with a case of Finnish transport policy targets. We argue that by studying synergies and conflicts as well as other dependencies between the targets presented in policy statements and also by examining the possible support or opposition of main stakeholder groups for the policy measures to meet the targets, we can appraise the potential success of the transport policy implementation. Our case study, the Finnish transport policy, presented targets with quite a clear direction, with a lot of weak synergies and only a few serious conflicts. The implementation of the policy measures, presented to meet these targets will, however, be demanding because of several reasons related to the challenges to governance that are emerging from the complex and continually changing linkages between and among transport (policy) problems, targets and their consequences. The method we presented and tested proved to be useful in bringing transport policy targets closer to policy implementation by considering policy measures to meet the targets and their acceptance as a part of the target or objective analysis process. The findings suggest that linking these often detached parts of the policy process together the co-ordination will be improved and the process hence intensified. The target analysis presented could act as an originator for a more open, interactive and particularly systematic process in transport policy formulation, leading through social learning into a more successful implementation of policies.

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*Keywords:* Transport policy; Policy targets; Policy implementation; Policy assessment; Framework; Interaction

## 1. Introduction

### 1.1. Background

The striking features of contemporary policy making, business and essentially our whole society are change and complexity. Changes may be physical, organisational, psychological, or they may be manifested in financial, biological, political or other forms. They appear in regulation, political conditions, customers, technology, competitors, collaborators, and so on, making our living and working environments more and more complex. Digital information technology and its inexorable march

through global communication networks, its current ubiquitous nature, can be seen as the main enabler for the emergence of change and complexity (e.g. Hagel and Brown, 2005; Himanen and Castells, 2002; Tuomi, 2001, 2003). It seems that the world is becoming a turbulent, information based “knowledge society”, faster than the structures of private and public organisations or even private lives are becoming resilient (e.g. Brown and Eisenhardt, 1998; Blickstein and Hanson, 2001; Hamel and Välikangas, 2003; Meadows et al., 2005; Åkerman and Höjer, 2006). However, when remembering the two world wars, we can see that the failure of governing is not a new phenomenon.

Changes and complexity are setting new kind of pressures to policy processes as well, in particular to policy formulation in diverse domains. Tuomi (2001, 2003) for

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example, has defined the three research domains of “knowledge society” that are linked to core developments in the ongoing transformation or change. These domains are: institutions and culture, everyday life and systems of production. The transport system lies in the intersection of those domains, which naturally puts pressure on the transport sector to stay as sensitive to changes in society as the other domains. Knowing the public role of the transport sector, the flexibility for change in policy formulation, as well as in organisational structures has not, however, been one of its typical features.

Within the development of the “knowledge society”, the use of targets to assess the performance of, and report on, different aspects of government has become increasingly widespread within the public sector (NAO, 2001). At the same time, also the concept of sustainable mobility and defining objectives and targets for it within different societal contexts has become one of the essential tasks both for the present and the future. It seems, however, that targets and related indicators are often too loosely linked to concurrently introduced policy measures and their implementation. Too often targets describe only the good (economic) performance of different bodies involved within the policy process. The achievement of the sustainability of the system itself, introduced in the targets, gets quite little attention (see e.g. Zografos et al., 2004; Hidas and Black, 2002), especially from the perspective of the end users. Massive amounts of empirical data are collected (e.g. sustainability indicators), but systematic methods for exploring the normative frameworks which give these data meaning are lacking.

In the changing knowledge society traditional rational methods for target formulation do not fit for purpose because of the constant changes and information overflow. Preferences and proper decisions change over time and it is necessary to evolve the policy and implementation with these changes (Pressman and Wildavsky, 1984). That is to say, deeper understanding is needed of the behaviours that targets induce in the public sector. Also, the relation between the targets and the key outcomes that need to be achieved through policy implementation (cp. Himanen, 2002; Marsden and Bonsall, 2006) needs closer examination. New integrated frameworks or activities are required to act as mediators between policy targets, measures and their implementation in order to intensify the policy process. Dodgson et al. (2005) for example, have presented a following framework which we find fitting within transport context as well. The authors distinguish between three generic technologies in the future: Information and Communication Technology (ICT) will be the enabling technology for innovations, Operations and manufacturing technologies and processes (OMT) will enable the implementation of innovations or making them operational, a new kind of a technology called Innovation technology (IvT), including simulation, modelling and assessment tools, virtual reality, etc., will provide the means by which people are technologically assisted in their innovation

tasks. Changes associated with the introduction and linkages of these technologies will lead to the intensification of innovation processes.

In this article, we aim to test the potential of a target analysis method in acting as a link between policy objectives, targets, measures and their implementation in order to intensify the policy process in an information abundant policy environment where feasibility conditions constantly keep changing. The policy process frameworks for bounded rationality and experiential incrementalism (Birkland, 2001; Talvitie, 2006; Khisty and Arslan, 2005) are used as a basis for exploration and complemented with our target analysis, which is tested with a case of Finnish transport policy targets. Furthermore, we examine how to incorporate the new knowledge of the problems, causes, consequences, and stakeholders revealed by this interaction into the design process of a sustainable transport policy.

The article is structured as follows: We start by summarising the relevant literature on models for policy process focusing on the link between policy targets and implementation, in relation to research done in the area of transport policy design. Then we present the case study and the framework for target analysis. Moving on to the results, we show that interactions between policy targets together with the acceptance of policy measures to meet the targets can be used as an indicator reflecting the potential success of policy implementation. We conclude with a discussion of the relevance of our findings in relation to the current transport policy design process.

## 1.2. Previous work

A policy is a statement by a government of what it intends to do or not to do. At an early stage in the policy design process, decision makers must explicitly consider five elements of policy design, namely (Birkland, 2001): (1) The objectives or goals of the policy, (2) the causal model, (3) the tools of the policy, (4) the targets of the policy and (5) the implementation of the policy. Given the difficulties caused by ambiguous terminology in the field of policy studies, we first define the terminology adopted in this paper (see Table 1).

Traditional rational models for policy design and decision making, based on the best available information, and stage-based proceeding have, however, for decades been seen as unrealistic in tackling the problems of goal consensus, information processing and the nature of information itself within the changing environment (e.g. Alexander, 1984; Alexander and Beimborn, 1987; Christensen, 1985; Himanen, 1987; Hukkinen, 1999; Birkland, 2001; Talvitie, 2006). Especially the separation of the two final stages, policy targets from implementation, has been considered problematic. As early as in 1971, Pressman and Wildavsky pointed out that implementation should not be divorced from policy, because there is no point having good ideas if they cannot be carried out. The authors recognised a need to view policy implementation as more

Table 1  
The terminology used in policy issues

Term	Definition
Policy area	Very wide and can be stable over a very long period of time (e.g. education, transport, health)
Policy theme	Several policy themes can be found within one policy area. Themes can emerge and evolve over long periods of time (years/decades) (e.g. sustainability, competitiveness of freight transport)
Policy issue	A more specific, concrete, immediate “problem”; in each policy theme, there will be several policy issues, which may emerge or change over a short time (a few years or even months). The line between “theme” and “issue” can sometimes be difficult to draw.
Policy objective/ goal	What the policy is trying to achieve, the overall goal; often quite abstract and qualitative.
Policy target	More specific and quantitative than an objective or goal (e.g. 10% less emissions of air pollutants within 5 years). The target points out a clear sense of direction for policy measures.
Causal model	What causes a policy problem and how would particular responses alleviate the problem? Do we know that model? If we do not know, how can we find it?
Policy tools/ measures/ instruments	The means/methods that are chosen to meet the targets and objectives
Policy implementation	The process by which the policies enacted by government are put into effect by the relevant agencies.

of an evolution than revolution. Furthermore, they pointed out that the policy process is not solely about getting what you once wanted, but rather about getting what you have learned to prefer.

The traditional planning model recognises that the implementation may fail because the original plan was infeasible. Many constraints, however, can be hidden in the planning stage and discovered only during the implementation (Pressman and Wildavsky, 1984). The traditional model with fixed stages is not able to use the new information as a basis for policy design, since first, the ends are isolated, and then the means to achieve them are sought out. Furthermore, feasibility conditions keep changing over time: old constraints disappear or are overcome, while new ones emerge. The solution space undergoes continuous transformations, shrinking in one direction, expanding in another. Consequently the designer's left hand should constantly be probing the feasibility boundary, while his/her right hand tries to assemble the various programme or policy process components (Birkland, 2001; Pressman and Wildavsky, 1984). This sort of approach is a far cry from the traditional procedures suggested by the traditional planning model.

An approach to tackle the above problems is presented by March and Simon (1958), applied by Lindblom (1959) and called bounded rationality (incremental decision making). To be boundedly rational means that one behaves

as rationally as one can within certain bounds or limits, including limited time, limited information, and our limited human ability to recognise every feature and pattern of every problem (Birkland, 2001). In addition, Lindblom argues that people make decisions in relatively small increments, rather than in big leaps. As opposed to the rational method for decision making, which is always starting from the “root” and using the approach of means-ends analysis, incremental decision making uses and builds on what is already known, without reanalysing what is currently being done. The typical features for incremental decision making can be summarised in the five points presented in the second column of Table 2.

In the transport sector, Talvitie (2006, 1997) and Khisty and Arslan (2005) have introduced approaches based on the concept of bounded rationality, to develop the transport policy process. Talvitie presents the concept of experiential incrementalism, which alleviates the shortcomings of the rational policy model with nine propositions. Talvitie extends his approach to also cover the aspect of organisational learning, thus linking it closer to implementation. Khisty and Arslan (2005) propose five interlinked strategies for steering the process of transportation planning in the face of bounded rationality and unbounded uncertainty. All three approaches seem to reflect quite similar issues which can be presented under five categories (first column in Table 2). None of the approaches, however, presents a systematic method to complement and operationalise the approaches.

### 1.3. Research gaps revealed

The importance of linking policy targets to implementation relates to the general question of relating facts to values, which has been identified as one of the most important and long-standing discussions in the modern social sciences. Massive amounts of empirical data are collected, but systematic methods for exploring the normative frameworks which give these data meaning are lacking. This problem has been documented by countless examples, especially during periods of rapid and turbulent change (e.g. Fisher, 1997; Vedung, 2000). Marsden and Bonsall (2006) refer to the same issue in the transport sector by arguing that transport policy targets often do not reflect the totality of the issues. A lot of data have been collected, e.g. about indicators for or measures towards a sustainable transport system, but frameworks for how to use these data and link targets to measure their implementation, in favour of sustainable policy development, are missing. Accelerated changes in our living and working environments, with overwhelming amounts of information are unfortunately not alleviating the process.

In the following chapters, we present a method for target analysis, which complements the bounded rationality approaches (see Chapter 1.2) and highlights the link between transport policy targets and implementation. Our approach aims to act as a link between policy

Table 2  
The approaches of bounded rationality

Category	Incremental decision making	Experiential incrementalism	Bounded rationality and unbounded uncertainty
1. Big picture	<ul style="list-style-type: none"> <li>● Objectives, values and empirical analysis are closely intertwined</li> <li>● Means-ends analysis limited</li> </ul>	<ul style="list-style-type: none"> <li>● Look for the big problem</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the concept of systemicity</li> <li>● Expand the current planning paradigm</li> </ul>
2. Stakeholder participation	<ul style="list-style-type: none"> <li>● “Good” policy = direct agreement on policy by the stakeholders and the analysts</li> </ul>	<ul style="list-style-type: none"> <li>● See planning as an experiment, involve people from start to finish</li> <li>● Explore successes and failures and adjust</li> </ul>	<ul style="list-style-type: none"> <li>● Introduce soft systems thinking</li> </ul>
3. Simplifying	<ul style="list-style-type: none"> <li>● Limited analysis of outcomes, alternative policies, affected values</li> </ul>	<ul style="list-style-type: none"> <li>● Do not focus on results and outcomes</li> </ul>	<ul style="list-style-type: none"> <li>● Reduce the complexity</li> </ul>
4. Mixing	<ul style="list-style-type: none"> <li>● Reliance on theory is low</li> </ul>	<ul style="list-style-type: none"> <li>● Change is caused by emotional communication, rarely by “scientific” facts</li> <li>● Behind everything (paradoxically) there must be a scientific explanation</li> </ul>	<ul style="list-style-type: none"> <li>● Use abductive inferencing</li> </ul>
5. Learning		<ul style="list-style-type: none"> <li>● Help develop a competent planning organisation</li> <li>● Help the organisation to learn about itself and others</li> <li>● Explore successes and failures and adjust</li> </ul>	

objectives, targets, measures and their implementation in order to intensify the policy process. We argue that by studying synergies and conflicts as well as other dependencies between the targets presented in the policy statements and also by examining the possible support or opposition of main stakeholder groups for the policy measures to meet the targets, we can appraise the potential success of the transport policy implementation. Furthermore, we can simultaneously intensify the process by incorporating new knowledge into it about the problems, causes, consequences, stakeholders, etc., emerging and changing, within the transport system. After the policy measures have been implemented, the evaluation of impacts naturally provides another important source of information for the policy process, but here, it is left for the agenda of further research. As a case study, to test our method, we use documents for a long-term transport policy in Finland.

## 2. The research context

### 2.1. The setting

The role of the Ministry of Transport and Communications in Finland (MinTC) is to formulate and implement a transport and communications policy (MinTC, 2000, 2005; The Finnish Government, 2003) based on targets accepted by all stakeholders. It also monitors the functionality of the transport and communications system and promotes their balanced development. In policy formulation, the ministry co-operates with other ministries (e.g., Finance, Environment, Labour and Interior), modal transport

administrations and other stakeholders in the transport sector. Within the ministry, the policy preparation and implementation is dispersed between the minister, the Permanent Secretary and the three departments (General Affairs, Transport Policy and Communications). In transport policy target setting and policy formulation, the role of the Transport Policy Department is essential.

### 2.2. The vision of intelligent and sustainable transport

The empirical data used in this paper stem from two national research projects financed by the Ministry of Transport and Communications, Finland and VTT Technical Research Centre of Finland in 2004 and 2005. The projects aimed to improve the transport policy formulation process within the Ministry of Transport and Communications. The data about transport policy targets and measures are derived from a long-term Finnish transport policy document titled: “Towards Intelligent and Sustainable Transport 2025” (MinTC, 2000). The document presents a vision for a sustainable transport system 2025, its objectives, targets and also policy measures to meet the objectives.

The aim of Finland’s transport policy is “An intelligent and sustainable transportation system that properly addresses all the economic, ecological, social and cultural considerations” (MinTC, 2000, 2005; The Finnish Government, 2003). A reliable, high-quality transport infrastructure is seen as essential for ensuring that the society can operate on a basis that is efficient, regionally and socially equitable and internationally competitive. The policy aims

to ensure that the long-term maintenance and development needs of the country's transport infrastructure are met. Other transport policy objectives and targets are to improve the operating conditions for public transport and the service it provides, to promote traffic safety, to safeguard the standard of service provided by merchant shipping, and to safeguard the competitiveness of merchant shipping in comparison to Finland's main competitor countries. In implementing the transport policy, the Ministry of Transport and Communications aims to enhance the well being of the public at large and to improve the operating environment for businesses by ensuring access to high-quality transport facilities and maintaining well-functioning transport markets in a way that balances the needs of the country's different regions and population groups.

### 3. Target analysis

The method for the target analysis applied in this paper and presented below, was first developed in the project called: Strategic Assessment Methodology for the Interaction of CTP-Instruments (SAMI), funded by the European Commission under the Transport RTD programme of the fourth Framework Programme (see Himanen et al., 2000). The method's fitness-for-purpose as a tool supporting the real policy process was not, however, tested.

The target analysis has the following five steps: First, relevant policy targets and measures to meet them (see definitions in Table 1) are screened from the policy documents. A distinction is made between two types of targets: (a) expansive targets, where the aim is for an ever increasing level of availability of something considered good and (b) defensive targets, where the goal is to reach or maintain the current position with respect to some variable in a range considered satisfactory. In most cases, stakeholders will be more open to accept compromise over expansive targets (e.g. short delays in action, reductions in the speed of progress, etc.) than over defensive targets, where the present positions are considered entitlements and any movement might be perceived as withdrawal. This is why identification and assessment of the position of each stakeholder group, i.e. social groups who would support or oppose those transport policies or policy measures, is important (see also step four in the target analysis).

Second, a framework is presented for the assessment of interactions between transport policy targets. The frame-

work considers the forms and types of interactions according to six characteristics presented in Table 3.

The basic form of interaction between policy targets is determined by three characteristics: direction, intensity and precedence. The direction tells whether the interaction is synergetic, i.e. pursuing one target will be helpful for the improvement of the other or in the case of a conflict pursuing one target would make the situation worse with respect to the other. The intensity describes the power of the interaction. If there is no intensity, there is no interaction between the targets. The precedence implies which one of the targets generates a reaction in the other. This is necessary information because in many cases interactions between targets are not symmetrical, even though symmetrical cases do exist, i.e. either target can generate a reaction on the other.

In addition to form, also the type of interaction, characterised by structural, circumstantial and instrumental dimensions, is important. Structural interaction is considered permanent, independent of the current positions and point of view, as well as of the orientations adopted for action in pursuit of those targets. One of the major factors contributing to structural interaction is a strong commonality of the stakeholders engaged (positively or negatively) in the two targets (being) considered. Circumstantial interaction refers to the situation where a change of position in one of the targets would lead to changes in the direction and intensity of the interaction. Instrumental interaction means that the interaction between targets is likely to depend on the instruments or policy orientations adopted for their pursuit.

Third, the dependence of the targets is defined based on the number of precedence arrows identified in the second step of the analysis. In case the analysis shows that a target is not dependent on others (i.e. the number of precedence arrows is low), it is naturally easier to meet. That does not, however, necessarily mean that the target is more important, only that it is less dependent on actions aimed at other targets. This also means that the policy measures aimed towards less depending targets are, in principle, easier to accomplish.

Fourth, the acceptability of the policy measures presented to meet the targets is assessed by approaching potential stakeholders about their views on the policy measures and their implementation (see also step one in the target analysis). Finally, the expected outcomes of the

Table 3  
Forms and types of interactions between the transport policy targets

Form of interaction			Type of interaction		
Direction	Intensity	Precedence	Structural	Circumstantial	Instrumental
synergy (+); conflict (-)	weak (+) or (-); strong (++) or (--)	>, < or <>	Permanent (S)	Depends on actual circumstances (C)	Depends on the selected instruments (I)

policy measures are assessed against the targets identified in the first step of the analysis.

#### 4. Results

In the following sections we present the results of our assessment, i.e. the potential of our target analysis method in linking policy objectives, targets, measures and their acceptance in order to intensify the policy process as a whole. The results are discussed through a Finnish case study.

##### 4.1. Screening of relevant transport policy targets

The policy document “Towards Intelligent and Sustainable Transport 2025” by the MinTC presents a wide and somewhat confusing mixture of policy themes, objectives, targets and measures. We have drawn three different tiers of targets from it and compressed them into three groups with a total of 10 targets. Furthermore, we have identified five main policy measures to meet the targets.

The first tier in the policy document includes five policy themes, each with two to six policy objectives, a total of 18 objectives (see Table 4). These objectives are all, with one exception, expansive and have a general character. They describe a vision of an adequate Finnish transport system for the year 2025. Whether the situation is better or worse compared to the current state of transport system, is not considered. That is to say, no clear direction for policy measures is pointed out. Consequently, these objectives cannot be recognised targets in a sense presented in Table 1. The exception is objective 2 from the health and safety policy theme: “Nobody should have to die or suffer serious injuries in traffic”. This objective also gives the policy measures a direction, since nearly 400 people die and even more get injured in traffic in Finland every year. So, by the year 2025, the situation should change substantially. This objective is extremely demanding, because it presents a clear, quantitative and very ambitious claim.

The second tier addresses nine policy issues, namely: (1) Passenger transport, (2) Freight transport, (3) Level of service in transport networks, (4) Finland’s links with the outside world, (5) Environment, (6) Traffic safety, (7) Regional development, (8) Transport economics, and (9) Social equity. These issues are not linked to the above policy objectives. Instead, two to five policy objectives, targets or measures are presented under each of the policy issues. In some of them, the desired direction for development is also identified, which allows us to consider them as targets in a sense presented in Table 1.

The third tier also addresses the nine policy issues above by proposing a number (1–19) of policy objectives and measures addressed to organisations under the purview of MinTC. These are not directly linked to the policy themes or objectives presented in Table 4, either, rather, they form a new, third entity. The presented policy objectives and

Table 4  
Objectives for intelligent and sustainable transport

Policy themes	Objective
Service level and costs of the transport system	<ul style="list-style-type: none"> <li>• The movement of people and goods should be safe, moderately priced and of high quality</li> <li>• All regions should enjoy the same basic level of mobility. Both domestic and international passenger and freight services should be reliable and smooth</li> <li>• The transport information should be reliable, easy-to-use and up-to-date</li> <li>• The transport system should be developed and maintained in a cost-effective manner</li> <li>• The passenger and freight transport markets should be efficient and open to competition</li> <li>• The Finnish transport sector should be competitive both on the domestic and international markets</li> </ul>
Health and safety	<ul style="list-style-type: none"> <li>• The transport system as a whole should support improvements in peoples’ health</li> <li>• Nobody should have to die or suffer serious injuries in traffic</li> </ul>
Social sustainability	<ul style="list-style-type: none"> <li>• The benefits and negative impacts of transport should be fairly distributed amongst different population groups</li> <li>• Special consideration should be given to the needs of vulnerable groups</li> <li>• Individual citizens should be able to participate in and influence the traffic planning process</li> </ul>
Regional and urban development	<ul style="list-style-type: none"> <li>• Regional land use targets set at the national level and the regions own development strategies should be supported by the transport system</li> <li>• The targets concerning urban structure and cityscape should be supported by the transport system</li> <li>• The transport planning and land use planning processes should be compatible and consistent with each other</li> <li>• The traffic environments should be pleasant and safe</li> <li>• The cityscape and the cultural and historic landscape should not be altered unless there are strong reasons to do so</li> </ul>
Negative impacts on the natural environment	<ul style="list-style-type: none"> <li>• Both global and local negative impacts on the natural environment should be minimized</li> <li>• The use of natural resources (such as energy, soil materials and land) should be minimized</li> </ul>

measures basically describe the current duties and good practices within the purview of MinTC.

From the above mixture of policy themes, issues, objectives and targets, we have identified 10 policy targets, which we see to give the transport policy a clear sense of direction. These targets and related policy measures are identified to solve three general transport policy problems, namely: (1) accessibility and mobility in general, (2) local environmental and safety problems due to traffic, (3) global environmental problems. Table 5 presents the 10 identified targets grouped under the three policy problems.

Table 5  
Policy problems and targets

Policy problem	Policy target
Accessibility and mobility in general	<ol style="list-style-type: none"> <li>1. The most serious bottlenecks of the public road network will be eliminated</li> <li>2. Problems caused by frost damage on the low intensity road network will be minimised</li> <li>3. A basic level of public transport will be provided for people in rural areas</li> <li>4. The modal share of public transport in inter-city services will be increased by improving the rail network to introduce high-speed trains</li> <li>5. The modal shares of walking and cycling will be increased by expanding the network of cycle and pedestrian routes and continuing their effective maintenance</li> <li>6. The freight transport will be intensified by upgrading the rail network to take more trains with a 25-tonne axle load</li> <li>7. The freight transport will be intensified by opening rail traffic to competition</li> </ol>
Local environmental and safety problems due to traffic	<ol style="list-style-type: none"> <li>8. The number of fatalities on the road network will be reduced in the long run, to no more than 100 a year</li> <li>9. There will be no accidents involving passengers on railways, in commercial air traffic, nor in merchant shipping</li> </ol>
Global environmental problems	<ol style="list-style-type: none"> <li>10. Greenhouse gas emissions from transport in 2010 will not exceed the level of the year 1990</li> </ol>

#### 4.2. Analysis of interaction and the structure of transport policy targets

We started by cross tabulating the transport policy targets identified into Table 6. Secondly, we analysed the interactions of each of the targets with all of the other targets through the framework described in Chapter 3 (see also Table 3). We found a total of 45 interactions between them. Each analysis (interaction) result was placed into a cell in Table 6 indicating the intersection of the two targets under analysis. One must, however, keep in mind that interactions may be identified differently by different actors. Consequently, the identification should preferably be carried out collaboratively by a group of stakeholders with different backgrounds and expertise.

- In 21 cases, we found the interaction synergetic. 10 of those were structural or permanent (+S), 10 circumstantial (+C), and one dependent (+I) on the instruments adopted.
- In 17 cases, we could not identify any interaction (0).
- In five cases, we identified conflicts between targets. One of them was structural or permanent (−S) and four circumstantial (−/−C).
- In two cases, we found the interaction either synergetic or conflicting depending on the external circumstances.

The analysis indicated that most of the targets complement each other, i.e. there is synergy between them. On the other hand, the interaction between targets is often weak, i.e. also the synergy is weak. Only three of the interactions are strong. Two of them describe conflicts between sub-targets for rail transport, and one the synergy between eliminating the serious bottlenecks and reducing the number of fatalities on the public road network. The targets with the most synergies are: (i) to eliminate the most serious bottlenecks on the public road network, (ii) to reduce the number of fatalities on the road network, and (iii) to limit greenhouse gas emissions from transport to the level of year 1990. Achieving these three targets is, however, dependent on the achievement of several other (5–7) targets, which will complicate the selection and implementation of policy measures to reach them. Only in the first case, the interactions are structural (permanent), pointing out a large potential to reach the target.

#### 4.3. Dependence of transport policy targets

When analysing the interactions between the targets, we noticed that there exists a hierarchy between targets. We defined this dependence or hierarchy of the targets (see the last column of Table 6) with the help of precedence arrows introduced in Table 3. For example, in the row of target 6 in Table 6, the one arrow pointing left indicates that target 6 depends on target 7. Equally, on column 6, there is an arrow pointing right, indicating that target 6 also depends on target 4, although negatively. The arrows also indicate that problems caused by frost damage on a low-intensity road network (target 2) can be prevented independently from other targets. One should, however, keep in mind that most of the interactions here were recognised as weak, which suggests that also the dependences are weak. For example, the “elimination of most serious bottlenecks on the public road network” is supported by many other targets, but their summarised influence remains weak.

#### 4.4. Transport policy measures to meet the targets and their acceptance

Firstly, we discuss the possibility of the above 10 policy targets to get accepted by various stakeholders. The examination is applied here on policy measures presented to meet the targets, since policy objectives and targets can usually be agreed on, but only the measures put the future into specific terms, creating differences in opinions. In our screening, we found five policy measures that can be used to achieve the policy targets (Table 6) from the Finnish policy document:

1. Slight increases in investments in the road network (main and low intensity road networks).
2. Increased subventions in public transport on rural areas.

Table 6  
The forms and types of target interaction and the dependence of targets

No	Transport policy targets	2	3	4	5	6	7	8	9	10	Number of depending targets
1	The most serious bottlenecks of the public road network will be eliminated	0	+S <	+S <	+S <	+S <	+S <	++I >	+S >	+–C >	5
2	Problems caused by frost damage on the low-intensity road network will be minimised	x	+C >	0	0	0	0	+C >	0	+C >	0
3	A basic level of public transport will be provided for people in rural areas		x	+S >	–C >	0	0	+C >	0	+C >	1
4	The modal share of public transport in inter-city services will be increased by improving the rail network to introduce high-speed trains			x	0 >	––C >	––C >	+C >	–C >	+C >	1
5	The modal shares of walking and cycling will be increased by expanding the network of cycle and pedestrian routes and continuing their effective maintenance				x	0	0	+–C >	0	+S >	1
6	The freight transport will be intensified by upgrading the rail network to take more trains with a 25-tonne axle load					x	+C <	+S >	0	+C >	2
7	The freight transport will be intensified by opening rail traffic to competition						x	+C >	–S >	+S >	1
8	The number of fatalities on the road network in the long run will be reduced to no more than 100 a year							x	0	0	7
9	There will be no accidents involving passengers on railways, in commercial air traffic, nor in merchant shipping								x	0	4
10	The greenhouse gas emissions from transport in 2010 will not exceed the level of the year 1990									x	7

Symbols: +(weak) ++ (strong) synergy, –(weak) ––(strong) conflict, > < precedence (which one of the targets generates a reaction), S structural interaction, C circumstantial interaction, I interaction depends on selected instrument, 0 no interaction.

- Investments in the main rail lines to introduce high-speed trains.
- Investments to upgrade the rail network to take more trains with a 25-tonne axle load.
- Investments to eliminate level crossings from major railway lines carrying passengers and/or dangerous goods.

Basically, the potential of the policy measures should be assessed against the needs of the end users of the system in question. In the transport system things become more complicated because almost everybody may be considered a user, but at the same time they do not

feel directly involved with some parts of the system, i.e. those that they do not use or are affected by. We tackled that problem by next identifying the most potential stakeholders in relation to our policy measures presented to meet the targets (Table 7). Their positions towards proposed policy measures should be included in Table 7. Our case does not, however, present a real policy formulation case with opinions from various stakeholders. Consequently, we have not included any symbols indicating support or resistance by the stakeholders into Table 7. The table is, however, included as an illustrative example of our method.



Table 7  
Stakeholders and their positions towards proposed policy measures

Policy measures/stakeholders	1. Investments in the road network	2. Subventions in public transport in rural areas	3. Investments in main rail lines/high-speed trains	4. Investments to upgrade the rail network/ 25-tonne axle load	5. Investments to eliminate rail level crossings
Vehicle manufacturing, fuels, components, etc.					
Construction industry					
Bus transport operators					
Lorry and van operators					
Rail transport operators					
Private car drivers					
Public transport passengers					
Industry					
Environmental groups					

Strong support (+ +), moderate support (+), indifference (0), moderate rejection (–), strong rejection (––).

Thirdly, in order to demonstrate our approach, we have made advanced guesses on the possible support and resistance that above five policy measures could get:

1. Large investments in the main road network may face strong resistance from environmental but also other organised groups, strongly in favour of rail transport. Upgrading the low-intensity road network will probably not raise such an opposition.
2. Subventions for public transport could have strong support and raise little resistance. On the other hand, the supporters are not that well organised.
3. Investing in the main rail lines to introduce high-speed trains may get wide support, but bus (and air) transport operators as well as the industry using rail transportation (but not high-speed trains) may show resistance. Objectors are, however, not well clustered behind their case.
4. Investments to upgrade the rail network to take more trains with a 25-tonne axle load could probably get wide support; only road transport operators might be opposed to them, but not actively.
5. Investments to eliminate the level crossings from the major railway lines, similarly to road safety measures without any traffic restrictions, could possibly have the widest support.

## 5. Discussion

Our analysis revealed that the transport policy of MinTC Finland presents the continuum for a policy introduced as early as in 1960s, highlighting the development of public, non-motorised and especially railway transport and restraining the growth of the road transport. Traditionally, taxes directed towards the purchase of cars and fuels as well as car use have been the main instruments to encumber car traffic in Finland. Public funds have been used to support passenger transport by rail as well as coach transport in rural areas. Municipal taxes have been the

instrument to maintain the public transport in cities and partly also in rural areas.

Policy measures presented in the policy paper and summarised in Chapter 4.4 all, more or less, contribute to meet not one, but several policy targets at a time, which is a natural consequence of the wide synergic interactions of the targets. The policy measures could have wide support from potential stakeholders and the measures could be executed in case there were resources available. If not (as is often the case) the measures will need to be prioritised. Subventions in/of public transport in rural areas, as well as increases in investments in the low-intensity road network require fewer resources compared to the development of the main road network and the railway network, and therefore the discussion is focused here on the latter measures and their possibilities as means to meet the targets.

The potential of the transport policy measures is next assessed against the three generic transport policy problems under which the targets are categorised in Chapter 4.1.

- (1) *Accessibility and mobility in general:* Due to the investments in the upgrading of the main road network, the congestion will not exceed the current situation. Directing car taxes relatively more towards car use rejuvenates the car fleet and consequently, improves the comfort of driving. The government will not subsidize the public transport of the biggest cities in the future either, and therefore the quality and wideness of public transport will still depend on the allocation of municipal tax revenues. High-speed trains will decrease the travel time for long-distance passengers.
- (2) *Local environmental and safety problems related to transport:* Directing car taxes relatively more towards car use will rejuvenate the car fleet and consequently decrease the amount of exhaust gas emissions from road traffic. Newer cars will contribute to the decrease of deaths and serious injuries on the roads thanks to technical improvements, e.g. in brakes and coachworks.

So far (in the 5 years since the publication of the policy paper), the taxation for new cars has not eased off significantly, but the taxation for imported used cars has been lightened. Measures towards this particular policy target have, thus, not been implemented. Of the policy measures presented, only the upgrading of the main road network has a considerable impact on the road traffic accidents, even though not all measures can be seen to increase (the) safety. Due to limited resources the upgrading cannot, however, reach the extent which could bring the number of accidents even close to the presented target. In rail transport, higher speeds and open competition will require new methods for risk management, but on the other hand, eliminating level crossings will reduce risks.

- (3) *Global environmental problems*: CO<sub>2</sub> targets set by the MinTC cannot possibly be reached with the policy measures presented. In general, the transport policy measures available for Finland are in many respects already in use and quite limited, if Finland continues to keep/stay together with the other countries of the European Union. In addition, one has to remember that the global environmental problems cannot be solved with measures inside the transport sector, since they are based on or are consequences of more fundamental issues like population growth and changes in consumption patterns and mobility.

The Finnish transport policy presents targets with a quite clear direction, with a lot of weak synergies and only a few serious conflicts. The implementation of the policy measures presented to meet these targets will, however, be demanding, because of at least the following reasons: (i) some of the targets are too ambitious to be reached; (ii) some of the targets are conflicting and consequently, measures to meet them cannot easily get agreed upon by various stakeholders; (iii) the possibility to meet the targets depends in several cases on other targets and policy measures selected, which complicates the implementation context; (iv) there are not resources available for the implementation of all the measures and consequently, prioritisation is needed, which again puts pressure finding consensus among stakeholders.

## 6. Conclusions

The bounded rationality approaches presented in Section 1 suggest considering policy implementation in the changing environment as more of evolution than revolution. Leaning on that thought, this study examined the potential of our target analysis method to act as a mediator between policy targets, measures and their implementation in order to intensify the policy process in a complex knowledge-based environment. The method we presented and tested with a Finnish case study proved to be useful in bringing transport policy targets closer to policy implementation by considering policy measures to meet the

Table 8  
Target analysis within the context of bounded rationality

Bounded rationality category	Target analysis
1. Big picture	The big picture is acquired by assessing the interactions between the targets as well as the potential of policy measures as means to meet the targets.
2. Stakeholder participation	The acceptance of the stakeholders towards the policy measures is included into the process from the beginning.
3. Simplifying	Simplicity is attained by identifying the “relevant” policy targets and measures in the beginning of the analysis.
4. Mixing	Theory and practice is mixed in the detailed analysis of policy targets and measures in cooperation with various stakeholders.
5. Learning	Knowledge of the interaction between policy targets and the implementation of policy measures presented to meet these targets is gained and circulated among stakeholders during the assessment process.

targets and their acceptance as a part of the target or objective analysis process. The findings suggest that linking those often detached parts of the policy process together the co-ordination will be improved and the process hence intensified. Simultaneously new knowledge is incorporated into the transport policy process. The method covers all five categories of the concept of bounded rationality (Table 8, see also Table 2).

At all levels, from local to global, governments are currently faced with the need to set sustainable transport policy targets, to be sensitive to changes in the surrounding society and also to anticipate the indirect and long-term effects of their actions. The target analysis presented could act as an originator for a more open, interactive and particularly systematic process in transport policy formulation, leading through social learning into a more successful implementation of policies.

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Paper IV

**Assessing the Fitness-For-Purpose of  
strategic transport research in support  
of European transport policy**

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## Assessing the Fitness-For-Purpose of strategic transport research in support of European transport policy

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The transport policy environment is changing, because of increasing mobility of people and goods, world wide use of ICT, a rising importance of the knowledge economy, etc. Future methods for transport policy assessments will have to integrate these emerging trends, but above all, the new research knowledge produced needs to be taken better into use within the policy processes. To tackle the problem, the paper presents a generic fitness-for-purpose (FFP) Assessment method for research projects in support of transport policy. Based on the results of a case study, the paper argues that by linking a systematic FFP Analysis of transport research projects with researcher-civil servant network building, a method for accepting, elaborating and applying the produced European transport research knowledge can be provided. By doing this, the paper contributes to a more systematic and integrative assessment of transport research in policy support, and hopefully enhances the integration of transport research and policy making while at the same time, initiating a better based policy process. We see that FFP Assessments could offer an essential element for the policy relevant transport research knowledge production in the future.

*Keywords:* fitness-for-purpose assessment; strategic transport research; policy networking; knowledge production; policy assessment tools

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## 1. Introduction

### 1.1 Background

Since the Transport White Paper, published in 2001 (Commission of the European Communities, 2001a), and somewhat even by its predecessor, the objective of a European Union (EU) sustainable transport policy has been that the transport systems in Europe should meet the economic, social and environmental needs of society. Effective transportation systems are seen as essential to Europe's prosperity, with significant impacts on economic growth, social development and the environment. The mobility of goods and persons is considered to be an essential component of the competitiveness of European industry and services (Commission of the European Communities, 2005a). Even if the policy objectives have remained valid for a long time, the policy environment for transport seems to be changing. The White Paper mid term review (Commission of the European Communities, 2006b) identifies notable changes at least in the fields of: The Spatial Dimension of the EU, mostly due to the enlargement; European Governance practices in general; Transport Industry, as it seems that transport is fast becoming a high-tech industry; and in many International Contexts, especially in Environmental Commitments. In addition, the review indicates something of a change in direction and focus in the European transport policy, e.g. referring to the 'need to re-adjust' policy measures and the need for 'a broader, more flexible transport policy toolbox' (Stead, 2006).

In order to support better based and informed transport planning/policy processes, extensive research has been conducted in the past Framework Programmes (FP) of the European Commission (EC) and also at national levels to develop appropriate assessment tools for practitioners and policy makers, and to help them reach the objectives of sustainable mobility (see European Commission, 2006). With the assessment tools we mean here methodologies and tools developed under the research themes of: Policy Instruments and Packages, Impact Assessment Methods, and Policy Appraisal Methods. Past and current research has developed such policy support and assessment methods and tools for the National and the European Transport Policies (e.g. Wolthuis, 2006; Extra project, 2001a; 2001b), and they will be further refined in future research, particularly on the research agenda of the EU FP7. Unfortunately, the actual use of these innovative methods and tools has, thus far, been rather limited.

Currently, the policy environment for transport is changing. A Ubiquitous Information Society is emerging, where people's ways of life and work are based on ICT services that are available at all times and in all places. This brings challenges to decision-makers in society, to businesses, and to individuals. Consequently, the roles of public and private parties within the design and production of transport system technologies and services are evolving, many new actors are emerging and new business and operating models will be needed to satisfy the new demands. This creates a demand for new arenas for transport policy design and assessments, as well. Furthermore, the development leads to the conclusion that arrangements supporting the interactions in and between the public and private sectors will become more significant in the future. Managing transport policy supporting knowledge production is one important part of these interactions. Hence, we see that there is a need to establish processes for the uptake of the policy relevant research knowledge produced, in order to best contribute to as well as improve the transport policy processes.

To be more precise, we find that to be effectively applied by practitioners and decision-makers, the capabilities of the developed tools need to be checked against factors like scientific consistency, transparency and inclusiveness, but also against acceptability and appropriateness in terms of the needs of the final users in policy development and policy making. Therefore, the



“fitness-for-purpose (FFP<sup>4</sup>)” of the tools needs to be assessed in order to enhance governance practices. A knowledge gap in establishing systematic recommendations as well as processes for their uptake alongside with the above tool developments has been identified also by the European Commission (Commission of the European Communities, 2001b; 2005a; 2005b; 2006a; 2006b). Policy Network thinking, which has grown strong both in European policy science and governance (e.g. Kickert et al., 1997; Marsh, 1998; Peterson, 2003), is one example of such developments, and the growing number of European research programmes in support of policies is another. Within the transport domain, the research on such processes has, thus far, been quite modest (e.g. Rietveld and Stough, 2002; Geerlings and Stead, 2003).

In this paper, we aim to tackle the problem of research results not being put to use in practice, e.g. in policy processes. Based on the results of our case study, we show that by linking a systematic FFP Analysis of transport research projects with researcher-civil servant network building we can provide a method for the “fitness-for-purpose assessment (FFPA)” of EU research projects. We claim that the method can alleviate the above problem by contributing to a more systematic and integrative assessment of transport research in policy support. We see that the method has the potential to enhance the transport research result uptake as well as integration with policy making practices while at the same time initiating better based policy process. The theoretical background of our work stems from the frameworks of Fitness-For-Purpose Assessment, Research Project Evaluation as well as Policy Networking brought into the context of Transport Policy and Impact Assessments research.

The article is structured as follows: Section 2 discusses problems with the traditional way of producing policy relevant transport research knowledge. Section 3 explains the theoretical starting points of the paper in more detail, and discusses their suitability in our case study. Section 4 describes the case-study: the process for FFPA developed within the Transforum project. Next, section 5 shows the FFPA results through a project analysis and network building cases. Finally, section 6 discusses the potential of our method of FFP Assessment and presents the fields where more efforts are needed to fit the produced European transport research knowledge better for the purposes of policy processes. Section 7 concludes with final remarks on the importance of policy relevant knowledge production in the transport sector.

## 2. Formulation of the problem

The aim of transport research supporting policies is to produce knowledge for the use of policy processes, to help the policy process actors to make informed decisions. The conventional approach (“The Rational Central Rule Model”) to the processes of public policy making (e.g. Dunn, 2004; Meyer and Miller, 2001) focuses on the behaviour of a (rational) actor who would reach a decision within a situation of being fully informed and of complete and clear preference ranking (Braybrooke and Lindblom, 1963). The model originated from the economics. In the policy formulation phase of the policy process (for more information about public policy processes see e.g. Dunn, 2004; Birkland, 2001; deLeon, 1999; Parsons, 1995; Palumbo, 1987; Dye, 1976; Lasswell, 1956) consensus between the acting parties is reached regarding the problem formulation and scientific knowledge is used to design policy measures and an implementation programme. The critics of the conventional model (e.g. Van Gunsteren, 1976; Hanf and Toonen, 1985) see that the model fails in presupposing that the central steering agent has at his disposal the necessary information about existing public problems, preferences and the available solutions, which is im-

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<sup>4</sup>FFP = Fitness For Purpose, FFPA = Fitness For Purpose Assessment (the whole process, see Figure 1), FFP Analysis = Detailed analysis of research projects

possible given the agent's limited capacity and the uncertainties involved. The model also neglects the values and interests of implementing bodies and target groups.

An alternative approach, the network model, instead considers public policy making and governance to take place in networks consisting of various actors (individuals, coalitions, bureau, and organisations), none of which possesses the power to determine the strategies of the other actors (Kickert et al., 1997). Policy processes are not viewed as the implementation of ex-ante formulated goals, but as an interaction process in which actors exchange information about problems, preferences and means, and trade of goals and resources.

As we presented in the previous section, the transport policy environment is changing, particularly because of globalisation, with increasing mobility of people and goods, world wide use of communication technologies, a rising importance of the knowledge economy, high energy prices, and the enlarged Europe. Future tools for the transport impact and policy assessments will have to integrate these (and other) emerging trends. As the EC puts it, there is a need for 'a broader, more flexible transport policy toolbox' (see also Commission of the European Communities, 2006b; Stead, 2006). But above all, the new research knowledge produced needs to be taken into use within the policy processes. Currently, the appraisals in the European transport research and policy domains use diverse methods, they are performed by different teams, and the results are produced for different purposes. The wide range of policy assessment methods and applications makes the assessment of their "Fitness-For-Purpose" challenging and also prone to over-generalisation and failure to cover all cases. Further, very few arenas for interactions between research projects and civil servants or policy makers exist.

To tackle the problem of research results not being put to use in practice (i.e. the low effectiveness of research results), we adopt the ideas of Kickert et al. (1997) about the network model as an alternative approach to policy making and in our case particularly to policy relevant knowledge production and utilisation and combine the ideas with the FFP Analysis of research project results. Our paper presents a generic FFPA method for research projects in support of transport policy. The method aims to show how to systematically analyse the usability of the information produced in research projects concerning impact and policy assessments as well as how to build interacting networks around the assessments to support the use of policy relevant research knowledge in practice. In addition, the paper presents recommendations on how to promote the use of the new research knowledge in the transport policy process. Our data stems from the Transforum Coordination Action -project within the European 6th Research Framework Programme (FP). Transforum has facilitated networking and dialog among researchers, policy makers and stakeholders by establishing an innovative knowledge Forum, which has acted as an assessor of the usability of results in the fields transport indicators, transport modelling and transport policy assessment of strategic transport research.

### **3. The theoretical background**

The following sections present briefly the three theoretical starting points for our methodological development. There is clearly some overlapping in these theories, but at the same time each of them presents a different context for producing policy relevant knowledge. In our view they can complement each other and in doing so help in developing and understanding the method for transport research FFPA.

#### *3.1 FFPA*

The question of what defines a quality product or a quality service is always difficult to answer. One vision of a good product which is "fit for its purpose" is that it meets the needs of a changing style of planning or design in the next decade(s) as well as the demands of changes in the plan-

ning environment (Crow et al., 2000). The term "Fitness-For-Purpose" (FFP) has traditionally been used to describe the quality or the performance of a technical design, construction, programme or service in the fields of Product Management, Information Technology and Environmental Impact Assessment (e.g. Carvalho et al., 2005; Jakeman et al., 2006; METEOR, 2004; Raggamby, 2006). Established methods to assess whether a proposed solution can perform a task consist of design evaluation, testing, verification and validation, checking the proving properties or looking at how the final product structurally matches the requirements from the viewpoint of the final user. In the field of Transport, the Fitness-For-Purpose Assessment (FFPA) of policies, plans, projects or methods has not been common. In the context of transport policy research projects, the objective of Fitness-For-Purpose Assessments is to enable different actors within the policy processes to assess how suitable a developed model, appraisal tool or outcome is for a particular task.

### 3.2 *Policy Networks*

The role of inter-organisational collaboration and networks has been of interest to political scientists since the late 1950's (Marsh, 1998; Kickert et al., 1997). Policy scientists started using the term 'Policy Network' in the mid-1970's as the debate on the openness of political processes recurred in Europe (Klijn, 1997). According to Klijn (1997) and Kickert et al. (1997), the Policy Network approach was an attempt to understand the "context in which policy processes take place". It illustrated the shift from understanding policy as an outcome of rational decision making proceeding in distinct stages (policy formulation, decision and implementation) to seeing it as a multi-actor process where the policy content is affected at all stages of policy making and where heuristic rules and routines have a strong influence on the behaviour of actors.

There is no generally accepted definition of the notion "Policy Network". Here, as in the German and Dutch tradition (e.g. Kickert et al., 1997), it is used to indicate patterns of relations between interdependent actors, involved in processes of public policy making. Interdependency is the key word in the network approach. Actors in networks are interdependent because they cannot attain their goals by themselves, but need the resources of other actors to do so (Klijn, 1997). In the case of public actors, such complementary assets can, for instance, be experiential knowledge of the field that is the object of policies, economic resources to implement policies, or societal influence that is crucial for the legitimacy/implementation of policies (Bruun, 2002). Furthermore, as Kickert et al. (1997) claim, Policy Networks can be understood as a new form of governance, which could successively replace top-down policy making in the form of state intervention as well as market oriented attempts to make government more businesslike ("new public management").

Our aim is to apply the network approach to the field of research projects in support of transport policy. We claim that research-policy network building around the project assessments, accepting, elaborating and applying the knowledge, is an essential supportive element in the FFPA of transport research in policy support. Furthermore, we see that FFPAs could offer an essential element for policy relevant transport research knowledge production in the future.

### 3.3 *Policy and impact assessment in the field of transport*

The analysed research projects in this paper belong to the research theme or tradition of transport policy and impact assessments. Different ex-ante (appraisal) and ex-post (evaluation) assessments have been a standard procedure for public bodies in many countries to develop their transport systems for a long time. The range of different assessment methods is wide including theoretical appraisals, modelling, simulations, empirical measurements, participatory methods, etc. However, in all cases the question being asked is: "How well does this scheme or strategy meet the objectives which have been set?"

Assessments in the transport sector have a strong technological basis and partly as a consequence, a strong institutional basis also (e.g. transport project Environmental Impact Assessments). The existing frameworks have typically been used for infrastructure assessments at project level, for ex-ante assessments (i.e. appraisals), and for prioritising purposes. They have focused primarily on economic efficiency. Distributional questions have been considered to only limited extent. Assessments have been mostly inter-urban, only rarely responsive to interactions outside the transport sector and hence not consciously oriented towards wider societal, e.g. sustainability concerns (e.g. ECMT, 2004; Giorgi et al., 2002; Pearman et al., 2001; 2003; TRANS-TALK, 2001; Nijkamp and Blaas, 1994). Wider, multidisciplinary approaches like Policy Analysis as a research field are quite new in transport where the terms 'planning' and '(impact) assessment', referring to infrastructure investments and project appraisals, have formed the reference frameworks for decades (De Rus and Nash, 1997; Giorgi et al., 2002). According to the European Thematic Network: 'Policy and Project Evaluation Methodologies in Transport' TRANS-TALK (2001) as well as Pearman et al. (2001; 2003), Giorgi and Tandon (2000) and Giorgi et al. (2002), currently there exist two views about what role transport assessments should have. One is simply that they are tools to assess value for money. An alternative view is that assessments are tools to help in negotiation and deliberation processes, through which socially desirable transport actions are identified. However, analyses or assessments of the usability of the developed impact and policy assessment tools have been modest.

#### **4. The case study: applying the FFPA method**

In this section, we present a FFPA method for transport research projects. It was developed and applied in the frame of the Transforum project, in the years 2005 to 2007. The method is comprised of three parts, which are described in the following subsections: (1) The Project Screening Process, which describes the data collection and selection concerning relevant transport policy support projects; (2) The FFP Analysis of research projects, consisting of four assessment phases; and (3) The transport researcher-civil servant network building through European wide meetings (Forums). Figure 1 presents these different parts of FFPA and their interactions, i.e. the time and place when information is shared, assessed and when collaborative learning can take place.

##### *4.1 The Screening Process*

The Screening Process presents a basic scheme for identifying the right, i.e. policy relevant, projects from the extensive number of projects carried out within a certain research theme. It describes the nine general steps needed to select relevant projects for FFP Analysis. The number of projects diminishes gradually as the screening process proceeds.

In our case study, the first step was to identify all potential projects falling under the theme "Transport Policy Assessment" from the EC Database (Cordis). A list of 23 projects was identified by project partners. A Screening Report (SR) #1, focusing on: (1) projects' significance in terms of transport policy assessment; (2) value of project results; and (3) dissemination and exploitation of project results was written for each of the projects. Basing on the results, the overall relevance (from 0 to 5) of the projects to FFPA was defined on the grounds of the project team expertise. Thirteen projects out of 23 scored 4 or 5 in the relevance assessment and were selected for further assessment. In order to obtain also a "self evaluation", a questionnaire was sent to the project coordinators of the 13 projects. The questionnaire was divided into 3 parts, namely: (1) technical questions; (2) Specific questions relating to transport policy assessment tools; and (3) Impacts of the research on European transport policy decision-making. Screening Reports SR #2 summarising the results of the questionnaires and proposing 7 projects to continue into detailed FFP Analysis were written by the project partners. Finally, the third Screening Reports SR #3 of the 7

projects were written to present the results of the discussions with Commission project officers (for a detailed description of the screening process, see: Aparicio et al., 2004).

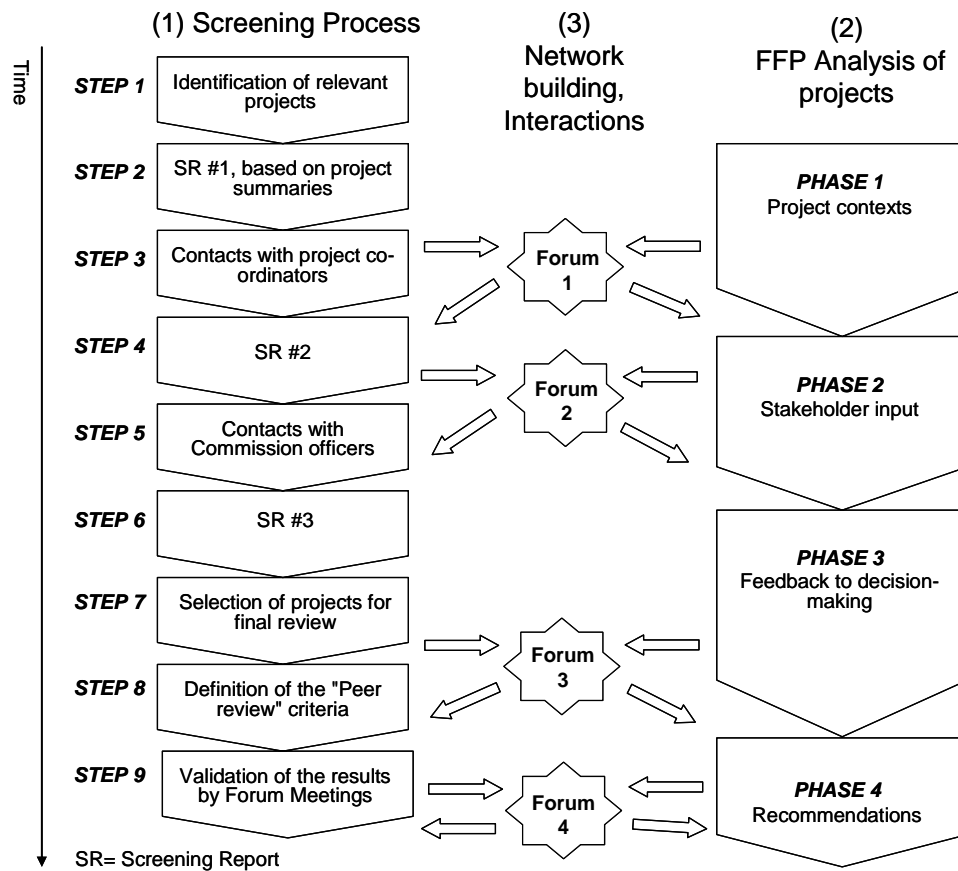


Figure 1. The FFPA method

#### 4.2 The FFP Analysis of research projects in the transport policy context

Phase 1 of the FFP Analysis, Clarification of prior circumstances, seeks to find out the kind of context the screened projects are embedded in: What kind of knowledge has been produced and has it been produced in the relevant context? In our case study, there were three research themes (Policy Instruments and Packages, Impact Assessment Methods, and Policy Appraisal Methods). The screening resulted in the 23 projects to be assessed that are listed in the first column of Appendix I. (Their research themes are shown in the second column.) FFP criteria testing the quality and comprehensiveness of the project approaches were prepared for each of the three research themes. The main contribution of phase 1 was to point out whether or not the approaches of the projects within a given theme were relevant and consistent with each other.

Phase 2, the role of stakeholders, studies the stakeholders' and end users' input into the screened research projects. In our case, the input was clarified by contacting the project co-ordinators of 13 projects (see Appendix I), either with questionnaires or by interviews, with the following questions: (1) Were the relevant stakeholders mapped out in your project?; (2) To what extent did the project include end users' priorities, needs and expertise?; (3) Were the projects results appropriately assessed during the research?; and finally (4) Did the project encourage any interactive processes of communication and learning? The main contribution of phase 2 was to find out whether the screened projects have succeeded in weaving the perspectives of various stake-

holders into a generative and coherent whole or not and consequently encouraged social learning.

*Phase 3*, the outcomes, looks at the actual feedback of the screened projects to European transport policy decision making. The aim of phase 3 is to determine the effectiveness of the screened projects in advancing understanding and co-operation between research and policy making. The overall question is: Have the projects succeeded in making the results of the projects directly usable and matching the needs of civil servants, policy makers or other end users? In our case, the methodological steps for the final seven projects (see Appendix I) included: (1) Extracting the main findings and advantages from the viewpoint of the end user were from the project reports; (2) Examining (in a peer-review manner) the Fitness-For-Purpose of the projects in terms of the FFP criteria presented in phase 1; (3) In case of the decision making support software tools, performing an additional quality check of their fitness-for-purpose; (4) Interviewing the project leader or key persons on potential weak points of the projects and how to overcome those (consolidation of the first evaluation results); and finally (5) sending the draft FFP Analysis report to the project leader for a final check and finalising the outcomes accordingly (consolidation of the outcomes).

*Phase 4*, Guidance for future projects, draws conclusions from the results of the previous assessment phases. What is even more important than determining the quality of the assessed projects is to start answering the questions: What are the needs for further improvements and how could the fitness-for-purpose of the outcomes be improved? What kind of guidance has the assessment process provided for future projects, their facilitation and the interaction between European transport policy research and policy formulation (for Project Analysis method and results see: Tuominen 2005 and 2006, Leonardi and Tuominen 2006)?

#### 4.3 *Forum meetings as means for transport researcher – civil servant network building*

Modern governance analysts frequently seek to explain policy outcomes by investigating how the networks facilitating the bargaining between stakeholders over policy design and detail are structured in a particular sector (Peterson, 2003). A theoretically ambitious policy network approach has to, first, show that policy networks do not only exist but are relevant for the policy process and the policy outcome, and second, tackle the problem of the ambiguity of policy networks, which can both enhance and reduce the efficiency and legitimacy of policy making (Börzel, 1997). Our aim is to show that stakeholder meetings, organised by a policy support project, can function as transport policy networks in terms of the above definition. Furthermore, we will attempt to confirm the usability of the network building approach as a complementary part of research project FFPAs.

In our case, the transport research-policy network building took the shape of four Forum meetings with participating stakeholders of various backgrounds. The overall objectives of the meetings were to: (i) facilitate networking and dialog among researchers, policy makers and other stakeholders, and (ii) act as an assessor of the usability of the results in the field of strategic transport research in order to gain knowledge from other parties and initiate mutual learning. Figure 1 shows the linkages between project FFP Analysis and Forum meetings. The main themes of the Forum meetings were selected to illustrate the shift from the current state of affairs in transport policy support tools through the new needs for Europe, to the new ways of integrating research and policy making in future research agendas. All four Forum meetings were organised as 1 ½ day seminars, with plenary sessions at the beginning and at the end. Three parallel sessions on the fields of: (i) indicators, (ii) transport modelling, and (iii) policy appraisal were placed in-between the plenary sessions. The plenary sessions included general presentations, key presentations on the main topic of the meetings, and conclusions. The parallel sessions included more participatory elements and discussions. Our focus in this paper is on the field and the sessions devoted to policy appraisal.

The success of the Forum meetings was analysed using an evaluation form given to all participants after each meeting. The form (questionnaire) had two parts. The first part identified the background and the experience of the participants. It also posed general questions about the usefulness, quality of the presentations and documents, organisation etc. of the Forum meetings, on a scale of 0 to 5. The second part looked for (i) potential issues that were overlooked during the Forum, (ii) the greatest success of the Forum, and (iii) recommendations to improve future Forum meetings. Participants were asked to answer these questions by stating their individual opinions in writing.

## 5. Results

In the following two subsections, we present the results of our FFPA exercise in terms of (1) the analysis of the projects, and (2) the network building.

### 5.1 Project Analysis

This first subsection presents the results of the analysis of the projects within each of the four FFPA phases.

*Phase 1* of the project analysis concentrated on project contexts and showed that contributing to sustainable mobility has been the overall objective in European transport policy appraisal research projects. Our analysis focused on 23 projects, covering the following themes: (1) Policy Instruments and Packages, (2) Impact Assessment Methods and (3) Policy Appraisal Methods. The importance of the economic efficiency dimension of sustainability was highlighted in projects fitting under the theme "Instruments and Packages". Modelling tools for environmental and safety impacts were the core issues in the "Impact Assessment" projects. Close to all "Policy Appraisal" projects developed a wider framework to help decision making in policy/ project appraisal.

Basically, all the projects produced useful tools for transport policy processes. The emphasis was on ex-ante assessments. In addition to the mainly good outputs also some problems, which complicate the use of the developed tools in practice, emerged from the project assessments and Forum meeting discussions. First, there seems to be large uncertainties around the concept 'sustainable mobility' within the EU transport policy. Different transport policy stakeholders feel uncertain which environmental, social and economic issues should be guaranteed and balanced against each other in order to support sustainable mobility. Consequently, in the course of applying the developed policy instruments and tools it remains unclear against what objectives or targets their results should be assessed. Second, the research projects in the above themes were carried out quite separately, even though they could benefit from each other. Integration of the three research themes as well as policy evaluation (ex-post analysis) was highlighted as the most important fields for future transport policy research. Third and relating to the second point, interfaces between transport research, policy processes and other transport system stakeholders were seen unclear and (possibly) as a consequence dissemination of the research project results to wider audience was very challenging.

The main contribution of phase 1 can actually be seen in the clarification of the term "fitness-for-purpose" to mean the match between the capabilities of the research results (instruments and different assessment methods) and their purpose in terms of policy and most importantly, understanding this as the main focus of the FFPA exercise.

*Phase 2* studied the stakeholders' and end users' input into the research projects. The traditional aims for involving different stakeholders in policy support research projects are basically: to ensure that the results of the projects are valid; to lend the projects the legitimacy they require to contribute to policy development; and to build support for the organisation in charge of imple-

menting the findings. However, we found out that identifying and "really" involving stakeholders at the beginning of the projects seems to be one of the main problems regarding stakeholder participation in policy support projects. It is not very clear who the end users of transport policy assessment project results are, and how their priorities, needs and expertise are incorporated into the projects. In the course of the projects, workshops, seminars and external reference groups have been used as the main instruments to involve stakeholders. However, looking at the past stakeholder practices within European FP projects neither project partners nor external stakeholders seem to have enough resources (time, money, interest, etc.) to ensure efficient stakeholder participation. Consequently, the added value of stakeholder participation in EC transport-related projects seems to be more or less missing and, thus, not fitting the purpose of serving European transport policy research and policy formulation.

*Phase 3* focused on project results as well as on feedback to the decision making. The analysis showed that most of the seven in-detail analysed projects (see Appendix I) actually were effective in interpreting their results and presenting them for civil servants or policy makers. For example, one project improved co-operation between research and policy making; another developed good assessment methods, and a third produced tools that were used years after completion. As one project officer from the European Commission stated:

"The main advantage of developed assessments for policy makers has been that they have helped in structuring the political problems that need to be tackled by the White Paper policy instruments and measures"

On the other hand, also some critique could be identified. For example: the main outcomes of the projects could have been summarised more clearly from the end user's point of view in order to better lead to practical applications; there is a lack of comparable data and criteria regarding both sustainability and competitiveness issues; and (local) equity should be considered as important criteria in assessment tools as (global) efficiency. Relating to the last point, the question: how can we define the common European interest (i.e. who pays and who gets the benefits?), created a vivid discussion.

In general, the FFP Analysis of research projects indicated that the conclusions were more useful and important to policy processes when they were more specific than generic. This is because generic conclusions, basically, concern more the framework or the methodology and less the substance of decisions. All assessed research projects produced results that are comparable with consultancy outputs like the mid-term assessment of the White Paper on transport (Commission of the European Communities, 2006b), but large differences of status and cooperation intensity with the Commission between the projects were observable. The effects of these differences on the project outputs were, however, difficult to identify.

Results from *Phase 4*, Lessons learned and recommendations are presented in sections 6 and 7 of this paper.

## 5.2 *Networking to support transport research and policy*

During our three-year case study project, four European wide Forum meetings were organised. The participants included civil servants from the national ministries, administrations and the European Commission, researchers from different institutes and universities, private transport consultants, and participants from other transport sector public and private organisations. Also, several national policy makers were able to participate. The workshop characteristics of these meetings allowed the emergence of innovative answers to the questions arising from the FFP of projects. The discussion on the screening process and on actual policy issues like sustainability, competitiveness, logistics, and Trans European Networks (TEN), led to new suggestions on potential solutions. The main strength of the performed network building approach appeared to be the exchange of ideas on different policy assessment methods and policy instruments between re-



searchers, civil servants and other participants, leading to complementing insights of the parties. From 70 to 90 participants took part in each of the Forum meetings. A Forum meeting evaluation form was distributed to all participants at the beginning of the meetings. The number of forms returned varied between 23 and 29, depending on the Forum meeting.

The following results are based on the evaluation forms. Figure 2 presents the backgrounds of the participants in the different Forum meetings. The original plan was to have a higher percentage of policy makers, civil servants and other stakeholders in the latter Forum meetings, as the actual feedback from the research projects to the decision making would start to take shape and, as we can see from Figure 2, that objective was reached.

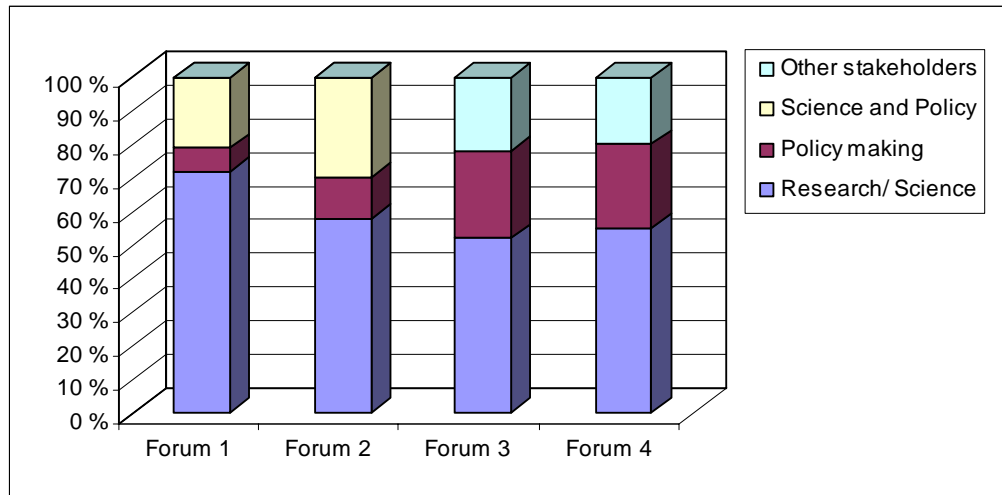


Figure 2. The backgrounds of Forum meeting participants

Figure 3 shows the participants' average degree of satisfaction with the Forum meetings, on two issues, namely: usefulness and overall impression, on a scale of 0 to 5. The participants' satisfaction can be considered very high regarding both issues. The usefulness of Forum 3 received the lowest score, 3.3.

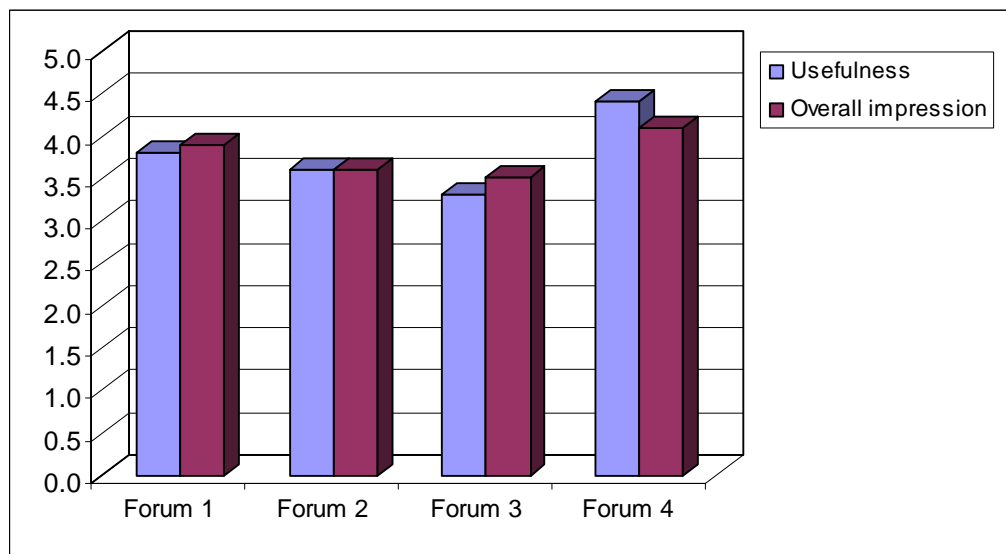


Figure 3. The participants' average degree of satisfaction.

In addition, the level of experience (new information and ideas, interaction, etc.) at the Forum meetings was regarded as extensive by 57% or more of the participants in all of the meetings. As

the participants were asked for the greatest success of the meetings, the discussions between different participants were explicitly considered as the success number one. Depending on the Forum meeting, 54% to 88% of the respondents mentioned the dialog between various partners as the greatest success.

The results show that policy networks can be built around European transport research project evaluations and they are considered important, especially the societal influence (e.g. discussions), but not too ambiguous. The research knowledge produced in the European FPs is one of the key resources to legitimate and implement policies. That is why we see it is important to include and constantly elaborate the network building as a part of the FPPA method to enhance the use of research results in policy practices now and in the future.

## 6. Discussion

In the following, we discuss the potential of our method in assessing the FFP of European transport research. The method aimed to integrate traditional transport research project evaluation with network building around project assessments, in order to help in accepting, elaborating and applying the produced research knowledge in policy processes. Furthermore, we present the implications of our case study to the European research supporting transport policies, i.e. the field of transport policy analysis.

### 6.1 *FFPA in the context of Transport Policy and Impact Assessment*

In our view, the contribution of our assessment exercise can not be found in developing the transport policy assessment methods themselves in a traditional sense, but in assessing the applicability of the produced methods in policy processes to help making informed decisions. We see that the FPPA as presented here could be seen as a simple additional quality criterion that could be performed for every new research theme, project, software or model developed by a European research consortium. This kind of fitness-for-purpose assessment delivers a much higher degree of analysis than a project's internal quality check or external expert evaluation because it is performed simultaneously for several EU policy assessment projects and includes interviews as well as an open consultation. Consequently, the method can be determined as a collective output of project analyses, expert interviews, and meetings. In addition, the conclusions of each Project Analysis give answers to specific feedbacks of the screened projects on European transport decision making, proposing both actual and potential solutions for the future. During the methodological development, objectivity, transparency and data availability were identified as potentially problematic, but not fundamental (intrinsic) methodological weaknesses of FPPA method's project analysis part. However, none of the critiques seemed to constitute a barrier that would hinder the wider use of FPPA method in the future. Basically, the method was easy to apply and led to positive results and innovative conclusions.

Applying the method revealed that at least in the following four fields more efforts are needed to fit the produced European research knowledge better for the purposes of policy processes. The first one is the understanding of the systemic nature of transport in policy and impact assessment research supporting policy processes. Basically, the ultimate purpose of the transport system is to serve the needs and expectations of its users, who in turn shape the system by their behaviour and actions. The system is, thus, both socially constructed and society shaping. This requires putting transport research and policies at the service of more general goals. Hence, the coherence of the transport system should be analysed and policy relevant knowledge produced with various goals in mind, with constant monitoring of the edges of transport projects within a larger societal context. At these edges lie the richest opportunities for transport innovations and success. In ad-

dition, there seems to be a lack of visionary thinking in the transport sector. As some experts stated in the course of the case study:

“There seem to be too few success stories on the impacts of research on policy making and a lack of innovation in using policy assessment methods for developing new visions for transport.”

The second field is the functionality of stakeholder participation and dissemination within European transport research projects. Currently, the impact of the research results on policy decisions and implementation is rather low. To increase the effectiveness, guidance is needed at least in the following areas: (1) identifying the key stakeholder/end user groups for research projects and also securing their involvement; (2) using the correct tools for efficient stakeholder participation within the projects; (3) ensuring efficient dissemination of the research results beyond the research community. In addition, reserving extra funding for project activities after the completion date (for maintaining web pages, organising policy makers' meetings/ seminars etc.), could assist the project dissemination activities with reaching beyond the research community. Also local transport authorities often play an important role in policy implementation and, therefore, best-practice knowledge transfer should be supported from the European level. Furthermore, public consultations should be conducted in most of the fields of transport research activities and at different geographical levels, with members of the research community as one of the participating stakeholder groups. Some of these consultations should consider the applicability and topicality of the FP research results for the transport policies of the EU and the member states. The public consultations are currently based on EC policy documents, like the “mid-term review”, and not on the underlying scientific assessments, which are more complex.

Third, transport policy research projects might have more impact on policy decisions if their main assessment outputs were presented to decision makers in a simple and concise form that clearly communicates the key issues. There should be no room for doubt or misinterpretation in the results. The same advice also concerns the transparency of the transport model or impact assessment tool assumptions and outputs. In most of the projects analysed in the case study, transparency was lacking. Furthermore, major efforts should be put in the future into integrating methodological developments of transport related indicators, modelling tools, as well as assessment and evaluation methods, in terms of developing these tools together.

Fourth, mixing theoretical and practical knowledge as well as people (e.g. researchers and civil servants) within the research projects may give the research results a great advantage in their implementation phase. Systematic ex-ante assessments followed by an ex-post evaluation of economic, social and environmental impacts, performed in collaboration with research and civil servant communities, should be a normal part of policy processes. However, the use of ex-post evaluation in the past transport policy has been modest. Preferably, the assessments should be transparent and publicly accessible, which would increase their validity. The diversity of assessment methods and expectations is always richness and it should be maintained as much as possible. Different methods supply policy makers with different perspectives of the same issue or problem, and help perceive the systemic nature of the transport system.

## 6.2 *Policy networking as a part of the FFPA method*

Following the network model (e.g. Kickert et al., 1997) as a new approach to transport policy relevant knowledge production, we claimed that there exists a need for building networks supporting the use of transport research results in policy processes. The networks could take the role of exchanging scientific and experiential knowledge as well as gaining mutual understanding regarding of the problems, means and the targets within the transport policy processes in order to make informed decisions. The networks could also enhance the currently poor dissemination of the research results.

Our FFPA revealed (and Forum evaluation results in particular) that research-policy network building, organised in our case in the form of Forum meetings, is relevant for both the research community and policy planning. The findings suggest that networking enables the formulation of recommendations and best practices based on the project results, as well as shaping of future research and policy agendas collectively by all participating parties. This kind of process strengthens the commitment to apply the recommendations in future activities, and hopefully urges different parties to work together in future policy planning activities. As we have claimed earlier in this paper, the roles of public and private parties within design and production of contemporary information or knowledge society's transport technologies and services are evolving very fast. We see that in this complex context, exploitation of knowledge requires participation in its generation, which means that communication and networking are crucial elements and organisation of this distributed knowledge production becomes the essential factor. The FFPA method we have presented and tested in this paper provides good premises for the further elaboration of such organisation.

## 7. Concluding remarks

OECD governments and the media today remind us at almost every turn that we live in "the knowledge society", and that the conduct of science (research) has an enormous, foundational role in that enterprise. Given the nature of the claims presented in this paper, we deem it appropriate to consider the "fitness-for-purpose" as an important characteristic of the knowledge produced to support policies. The general challenge taken up in this paper was to show that linking a systematic analysis of transport research projects with researcher-civil servant network building can provide tools for the "fitness-for-purpose assessment (FFPA)" of EU research projects in support of policies, and consequently bring transport research closer to policy processes.

The presented method, we hope, provides an inroad into understanding the importance of fitting transport policy research for its purpose and speaks to the realities of researchers as well as civil servants and policy makers. We see that policy makers and civil servants can benefit from this method by learning how the new practices might be diffused more deeply and broadly in the public sector. All the participants in the research-policy networks, in collaboration with other actors involved in the emerging transport policy environment, can benefit from discussions and mutual learning, which can lead to creating new options for the future, playing with different solutions to problems, and implementing new ways of doing things, faster, cheaper, and more effectively than in the past.

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## Appendix I

Phase I projects		Phase II projects	Phase III projects
Project	Theme	Stakeholder Input	In-detail FFP Analysis
CANTIQUÉ	Policy Instruments	X	X
CODE-TEN	Impact Assessment	X	
COMMUTE	Impact Assessment	X	
FANTASIE	Impact Assessment		
INTERNAT	Impact Assessment		
MAESTRO	Policy Assessment	X	
MEET	Impact Assessment		
MINIMISE	Policy Instruments	X	
	Impact Assessment		
RECONNECT	Policy Instruments	X	
SAMI	All	X	X
SORT-IT	Policy Instruments		
SUMMA	All	X	X
TRANSINPOL	Policy Instruments		
ARTEMIS	Impact Assessment		
FORESIGHT	Policy Instruments		
	Impact Assessment		
POET	Policy Instruments		
	Impact Assessment		
RECORD IT	Policy Instruments		
	Impact Assessment		
ROSEBUD	Impact Assessment	X	X
SPECTRUM	Policy Instruments	X	X
SPRITE	Policy Instruments	X	
	Impact Assessment		
TIPP	Policy Assessment	X	X
TRANS-TALK	Policy Assessment	X	X
TRANS VISION	Policy Assessment		
Total	23	13	7





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Author(s) Anu Tuominen		
Title <b>Knowledge production for transport policies in the information society</b>		
Abstract The dissertation explores and analyses the challenges and needs that developments in the information society are bringing to knowledge production supporting policy development and strategic decision making in the field of transport. Currently, the context of transport policies is about to shift from a transport infrastructure network design towards the development of a large socio-technical system, depending largely on ICT technology and applications. In this new context the traditional, analytical knowledge production approaches relating to infrastructure investments and project appraisals are alone not sufficient in providing the knowledge needed to understand the socio-technical nature of the transport system. The knowledge provided to make informed transport decisions needs to include also new forms to serve the needs of a wider variety of societal actors. Based on the fields of science and technology studies (STS) and policy and impact analysis the dissertation presents five emerging forms relevant to transport policy knowledge production in the future. These are knowledge production through system-based foresight, knowledge production through system-based evaluation, knowledge production in networks, knowledge production as processes of social learning and argumentation, and knowledge production as a source of renewal. Further, the basic characteristics of these forms have been identified. The dissertation proposes that the presented forms can shed light on the relationships between knowledge production, policy making and the society, which may lead to the implementation of new, socially embedded ways of developing transport systems and policies. Also implications of these emerging knowledge production forms for transport policy and business development and related future research needs are presented.		
ISBN 978-951-38-7361-5 (soft back ed.) 978-951-38-7362-2 (URL: <a href="http://www.vtt.fi/publications/index.jsp">http://www.vtt.fi/publications/index.jsp</a> )		
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Tekijä(t) Anu Tuominen		
Nimeke <b>Tietoyhteiskunnan tiedontuotannon käytännöt liikennepolitiikan valmistelussa ja strategisessa päätöksenteossa</b>		
Tiivistelmä Väitöskirja tarkastelee tietoyhteiskuntakehityksen mukanaan tuomia muutostarpeita, jotka koskevat liikennepolitiikkaa, liikennejärjestelmien kehittämistä ja näihin liittyvää strategista päätöksentekoa palvelevaa tiedontuotantoa. Liikennejärjestelmä on murroksessa – se on muuttumassa vähitellen kohti kommunikoivaa systeemiä. Kommunikaatiota ja tiedonsiirtoa tulee tapahtumaan liikennejärjestelmän eri osien, käyttäjien (ihmisten ja yritysten), kulkuneuvojen ja infrastruktuurin, välillä kaikkiin suuntiin. Myös julkisten ja yksityisten toimijoiden roolit liikennejärjestelmän kehittämisessä muuttuvat ja sekoittuvat. Liikennepolitiikan valmistelun ja strategisen päätöksenteon apuvälineiksi tarvitaan perinteisten vaikutusarviointien lisäksi uudenlaisia toimintamalleja ja käytännön työkaluja, jotka pystyvät ottamaan huomioon entistä paremmin liikennejärjestelmän sosioteknisen luonteen ja muuttuneen toimijakentän. Väitöskirjan teoreettinen viitekehys koostuu pääosin tieteen ja teknologian tutkimuksen esille nostamista uusista tiedontuotannon käytännöistä ja teorioista, jotka pyrkivät ilmentämään tieteen, teknologian ja poliittisen vallan välisiä suhteita yhteiskunnallisessa päätöksenteossa. Työssä sivutaan myös perinteisiä liikenteen vaikutusarvioinnin ja politiikka-analyysin tieteenaloja. Väitöskirja esittää viisi tietoyhteiskunnan liikennejärjestelmää palvelevaa tiedontuotannon muotoa ja näitä kuvaavat keskeiset piirteet, jotka on tunnistettu relevanteiksi tiedontuotannon ulottuvuuksiksi teoreettisten viitekehysten ja neljän tapaustutkimuksen avulla. Nämä viisi muotoa ovat tiedontuotanto järjestelmätason ennakoititoiminnan avulla, tiedontuotanto järjestelmätason arviointitoiminnan avulla, tiedontuotanto verkostoissa, tiedontuotanto oppimis- ja argumentointiprosessina sekä tiedontuotanto järjestelmän uudistajana. Väitöskirjassa esitetään lisäksi päätelmiä tunnistettujen tiedontuotannon muotojen politiikkaseuraamuksista ja jatkotutkimustarpeista.		
ISBN 978-951-38-7361-5 (nid.) 978-951-38-7362-2 (URL: <a href="http://www.vtt.fi/publications/index.jsp">http://www.vtt.fi/publications/index.jsp</a> )		
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The dissertation explores and analyses the challenges and needs that developments in the information society are bringing to knowledge production supporting policy development and strategic decision making in the field of transport. Based on the fields of science and technology studies (STS) and policy and impact analysis, the dissertation presents five emerging forms relevant to transport policy knowledge production in the future. These are knowledge production through system-based foresight, knowledge production through system-based evaluation, knowledge production in networks, knowledge production as processes of social learning and argumentation, and knowledge production as a source of renewal. Further, the basic characteristics of these forms have been identified and their implications for transport policy and business development and related future research needs are presented.