Making planning support systems matter: improving the use of planning support systems for integrated land use and transport strategy-making

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MAKING PLANNING SUPPORT SYSTEMS MATTER

Improving the use of Planning Support Systems for integrated land use and transport strategy-making

Marco te Brömmelstroet
Making Planning Support Systems Matter

Improving the use of Planning Support Systems for integrated land use and transport strategy-making

ACADEMISCH PROEFSCHRIFT

Ter verkrijging van de graad van doctor aan de Universiteit van Amsterdam op gezag van de Rector Magnificus prof.dr. D.C. van den Boom ten overstaan van een door het college voor promoties ingestelde commissie, in het openbaar te verdedigen in de Agnietenkapel der Universiteit op dinsdag 9 maart 2010, te 10:00 uur

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Preface

THERE IS NO SUCH THING AS COINCIDENCE
In October 2005, just after I received my Master’s Degree in Environment and Infrastructure Planning at the University of Groningen, I was accepted as an intern at the European branch of Shell: a position that is much desired and difficult to obtain. Within days after the acceptance, I attended a small good bye party for my Indonesian classmates, where I first heard about the PhD position at the University of Amsterdam. The profile (a combination of land use planning, infrastructure planning and geographical Information) seemed to fit seamlessly. It took one phone call and a short conversation with Frank le Clercq and Luca Bertolini to convince me that this PhD project was well suited to both my skills and my interests. I was so convinced that I started travelling to Amsterdam from our house north of Groningen (a long commute of over 4 hours, twice to three times a week minimum!).

Four years later it is great to see the research finished, the goals met and the job accomplished. In these four years, I have learned a lot, I accomplished much and developed many (non-) academic skills. I found it especially striking that so many of the skills I developed during my active engagement in endurance sports were particularly useful during the research period. Below, I will draw some parallels from three of the sports that I practiced during the past four years: running, cycling and swimming. Then I will say something about the skills of the people who were fundamental for my success and thank those who positively influenced my research, my academic pursuits and my private life.

RESEARCHING AS AN ENDURANCE SPORT
In the first two years of the research I was training to run a marathon, with the ambitious goal of finishing within three hours. Reaching such a goal required running three to four times a week, at least one hour per day. In the beginning one feels a clear progression, but over time the progression slows down and it feels like just clocking in countless hours in order to accomplish a very long term goal: to run a marathon. Such a long term goal requires significant short term investments. To keep the momentum, I created mid-term goals: 10 kilometres under 40 minutes, 15 kilometres in one hour, and a half marathon under 1 hour and 20 minutes. I used a similar strategy in my research. That is one of the reasons why this dissertation is based on articles. Instead of working towards a book in four years, I started with conference papers (with acceptance for conference as a goal), which slowly turned into articles (peer review acceptance as a goal). This strategy provided positive feedback (reaching goals), focus and spread out the work- and energy load. Finally, this process primed me for achieving the ultimate goal: approval by the PhD commission.

In the third year of my PhD research, I bought a racing bike and started to ride long tours, such as the classics Waalse Pijl, Liege-Bastogne-Liege and the Tour de IJsselmeer. Such tours cover 250 kilometres or more (10 hours non-stop biking). One rapidly learns how to take good care of the body and mental health: to start eating
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when you are not hungry, to get ample rest and to manage one’s energy (do not burn it all up in the first hours). Again, lessons that proved easily transferable to the four years of PhD research. I started out with a lot of ambition in the first year, with work weeks stretching over 60 hours now and then. My intention was to finish many articles early on, in order to have a lighter fourth year. In practice, the requirement to put in adequate energy and time never seemed to decrease. Organising three experiential case studies demands a lot of energy, especially because one has to actively search and convince partners in planning practice. Also, the teaching load increased over the years. Also, articles that need revision kept coming back as fast I had sent them, even now that the book is finally finished! This meant that I had to learn to take ample rest along the way. To keep my head fresh, I took a lot of non-related work on board (not always to the likings of my professor). However, making movies, writing non-related articles, organising cycle tours or talking to Chinese delegations kept me from getting too bored with my subject.

In the final months, I started to take lessons to improve my long distance swimming skills. A sport that is completely different from running and cycling. Swimming is a technical sport with a very steep learning curve. Learning the technique and improving ones endurance have to go hand in hand, which makes it an exhausting learning process. An important element that increases the exhaustion is the fact that there are other swimmers that cause turbulence and waves (which seemed to coincide with my breathing rhythm). When I mastered the technique, these waves did not seem to bother me anymore. I saw this as a metaphor for the turbulence and waves caused by colleagues, peers, managers, and others. They came up with new ideas, organised all kinds of (fun and less fun) meetings, they asked me to consider all the other relevant academic fields that can be included in the argumentation, they asked me to move offices at least once per year. All these influences could potentially overwhelm one’s own work, but I managed to find my own rhythm, which enabled me to deal with outside disturbances.

HAVING A SUPERPROMOTER

The quality of a product, especially a book, is related to the skills of the author, but also to the quality of his/her direct working environment. During the long PhD research period, it is very helpful if one has good colleagues with whom to share the problems, challenges and euphoric moments in- and outside the professional environment. It is even better, when they are able to offer additional stimulus through their own work and provide constructive comments. I would like to continue by extending my sincere gratitude to all the colleagues who provided this crucial support during the past years.

It is even better when somebody in your environment is also able to connect emotionally and intellectually to the product and process of your PhD research. Such a person can provide crucial encouragement when the research seems stuck or challenged (“is somebody else doing the exact same research already?”) and can explore new lines of reasoning. Although sometimes tunnel vision is a danger in such situations, it can be crucial in moving the research forward to the next level.
The last four years I was lucky enough to be supervised by somebody who could provide such crucial and through support, first as daily supervisor and later as my professor: Luca Bertolini. Only recently I found the right term for him, an increasingly popular marketing concept: that of the Superpromoter.1 A Superpromoter is defined as the personification of the power of enthusiasm. He/she is a sincere enthusiast who can influence others by sharing his/her enthusiasm. The Superpromoter is a problem-solver, an optimist by nature, constructive-critical, has a social personality and an open and transparent agenda. Having a Superpromoter as a customer can help to expand a company exponentially, by creating new Superpromoters for the product (his/her enthusiasm is contagious). Having a Superpromoter working within a company benefits the working atmosphere. But having a Superpromoter as a boss or professor is really the optimum! Luca’s motivation helped me to give my maximum, inspired me with new ideas and concepts, re-energised my when I was facing problems and helped me to think outside of the box. He was a key contributor to the shaping of the content and the pleasant working atmosphere of the last four years. Looking around in the PhD landscape (inter)nationally, such professors are rare and truly exceptional; therefore, I would like to express my sincere gratitude to Luca.

THE MANY PEOPLE WHO MADE IT POSSIBLE (FROM ABSTRACT TO CONCRETE)
Although they no longer exist as an autonomous research institute, I would like to thank the Amsterdam Institute for Metropolitan and International Development Studies (AMIDSt) and the University of Amsterdam for providing a pleasant and fruitful working environment. Also, thanks go out to the people who kept the interface between the bureaucracy and the employees workable, most notably Barbara Lawa, Gert van der Meer and Marianne van Heelsbergen. I would like to thank Transumo (Transition to Sustainable Transport) for their organisation of all those interesting discussion and knowledge exchange events, and primarily for making out research financially possible (including all exotic conferences).

One of the most pleasant experiences of the last four years was the company of the many stimulating individuals in my life. They made it possible to regularly share enjoyable lunches, have discussion events, drinks, annual soccer tournaments, cycle tours, etc. I cannot name them all, but within this group I extend my appreciation to Bas Hissink Muller, Nadav Haran, Sebastian Dembski, Thomas Straatemeier, Perry Hoetjes, Wendy Tan, Wouter van Gent, and Els Beukers. Also a special thank you to Nikola Stalevski for editing all of the articles (twice, or even three times) and dramatically improving their English language (even these very words). I learned a lot from him.

I also would like to extend not only special thanks, but also sincere gratitude to Frank le Clercq, who sadly passed away within one year after the start of my research. He was in many ways a founder of the research approach and the line of reasoning that flows throughout this book. He was a co-author of the first research proposal, a

scholar with a long term interest in the relationship between knowledge and planning, and a central person in one of the predecessor initiatives of this research -- the VervoersPrestatie Regionaal (VPR). He was a model developer, who took a constructive critical approach to the role these models play in planning practice.

The biggest gratitude I extend to Iris Rüssel; she managed to provide added motivation and encouragement, while at the same time working on her own PhD research at the Free University. It is no coincidence that her research subject is the heart. With her energy we managed to even keep our ‘normal’ life running smoothly, which made the last four years even more special.

I close this foreword with a quote that both fits my lifestyle and the general research approach described in this dissertation:

“Until we try, how will we know?
How will we know until we try?
So let’s say we give it a go
To find the world we’re looking for”

_Pennywise_, Wouldn’t it be Nice (2005)

Marco te Brömmelstroet, January 19th 2010
Chapter 1

Introduction
1.1 SPATIAL STRATEGY-MAKING

The essence of spatial strategy-making is the link that it establishes between knowledge about the urban context and intervening actions, plans and strategies (Friedmann, 1987; Healey, 2007). At first sight this seems fairly straightforward; however, as those involved in spatial strategy-making practices or research know very well, this is almost never the case. Spatial strategy-making is often a chaotic (and complex) process without a clear start or end, one void of central control. Couclelis’ recent definition of land use planning clearly describes this characteristic of urban strategy-making:

It involves actions taken by some to affect the use of land controlled by others, following decisions taken by third parties based on values not shared by all concerned, regarding issues no one fully comprehends, in an attempt to guide events and processes that very likely will not unfold in the time, place, and manner anticipated. (Couclelis, 2005, p. 1355)

All these elements influence the before mentioned link between knowledge and spatial strategies. The link becomes even more problematic when different parties with differing values and goals are involved. This point is well illustrated in Christensen’s seminal scheme on prototype planning responses (Figure 1.1):

![Figure 1.1 Christensen’s four styles of planning (Christensen, 1985, p. 66)](image)

When the actors involved in a spatial strategy-making process agree on the planning goal (i.e. solving congestion) and know how to reach that goal (i.e. by building new road infrastructure), planning can follow a linear rational programming approach. In such an approach, where often one key planning actor is in full control, knowledge has a very clear role to support the reduction (or even elimination) of uncertainty. The planning issue is objectively analysed by experts and the knowledge is transferred to the strategy-making actor.
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The programming approach lost much of its applicability and validity in the 1970s and 1980s, when the number of actors in spatial strategy-making – and consequently the number of disagreements about strategic goals – increased. Also, the failure of the universally accepted solutions at the time to resolve the growing problems (i.e. building roads to solve congestion) created more uncertainties on the technological dimension of Christensen’s schema (Forester, 1989). One can therefore state that since then most spatial strategy-making processes take place in the bottom-right quadrant of Figure 1.1. As already stated by Rittel and Weber (Rittel and Webber, 1984), discovering order in what they coined as ‘wicked’ problems is far from unproblematic and clear-cut.

1.1.1 Linking knowledge to urban strategy-making

The specifics (the how) of linking knowledge and action in current spatial strategy-making processes has been the object of much academic debate (Healey, 2007, chapter 8). Both in theory and practice, debates revolve around what constitutes right, relevant or rigorous knowledge and who has the power to make this distinction. Up to the early 1970s, planning was generally believed to be a discipline of technical-rational thinking with professional/systematised/expert knowledge at its centre. In the 1980s and 1990s, the theoretical, political and practical flaws of the technical-rational model critically undermined this positivist epistemology (Owens et al., 2004). In transport planning practice however, it still seems dominant (Willson, 2001).

There is an increasing awareness that this traditional view of what constitutes right, relevant and rigorous knowledge is incomplete at best. This awareness has been one of the driving forces of the growing emphasis in planning research on various communicative and collaborative planning approaches which aim to include other, more contextualised and personal types of knowledge of all the involved actors. Despite important differences, most of these approaches share the idea that planning should be first and foremost a social process of ‘reasoning together’, based on communicative rationality (Friedmann, 1987; Habermas, 1984; Healey, 1997). In terms of knowledge, the decision-making processes should incorporate different types of knowledge, from different (types of) stakeholders. Several authors (e.g. Friedmann, 1987; Gibbons et al., 1994; Habermas, 1984; Healey, 1997; Innes, 1998; Khakee et al., 2000; Scharmer and Kaufer, 2000) have pointed out that knowledge is a social construct and that urban strategy-making is a knowledge construction site (Healey, 2007). Local and experiential knowledge (as opposed to systematised expert knowledge) can play an important role in spatial strategy-making and their contribution should be duly recognised in planning processes (see Albrechts, 2004). Bringing together different types of actors and different types of knowledge serves two general purposes: it enriches the knowledge used for designing actions and it allows for more inclusive, democratic and transparent planning processes. Usually stakeholders and citizens provide this local and experiential knowledge. However, as it is also the case that professional planners can make this contribution, my research will focus on the knowledge of different types of planners in the spatial strategy-making process.
Research in communicative practices emphasises whether and how to organise inclusive planning processes. For practitioners this can be especially problematic, as it overshadows the need for professional, systematised knowledge. Many planning practitioners feel that it is still important to address the complexity of urban planning problems with systematised knowledge. If this is neglected, there is a higher risk of strategy-making becoming an ‘intellectually empty processes’ (Couclelis, 2005; Vigar and Porter, 2005). More importantly, the literature on communicative planning does not educate practitioners how to integrate local and experiential types of knowledge with the more traditional, professional types of knowledge. This is one of the main reasons why the ‘communicative paradigm’ is considered as a chiefly theoretical construct (Huxley and Yiftachel, 2000; Tewdwr-Jones and Allmendinger, 1998). Without knowing how to reconcile different types of knowledge in planning processes, chances of collective action are reduced or alternatively such action is based on limited knowledge.

Both the importance and difficulties of linking systematised knowledge to spatial strategy-making are recognised in the academic literature on communicative planning. Literature on Planning Support Systems (PSS are the instruments explicitly designed with this goal in mind) shows that these systems are hardly used in planning practice, despite the fact that there is both great progress in scientific insights and computer techniques as well as great need to provide improved support to planning professionals (Lee, 1973; Lee, 1994; Vonk, 2006). However, planners see current Planning Support Systems as far too generic, complex, technology oriented (rather than problem oriented), narrowly focused on strict technical rationality and incompatible with the unpredictable/flexible nature of most planning tasks and information needs (see e.g. Batty, 2003; Bishop, 1998; Couclelis, 1989; Geertman and Stillwell, 2003; Harris and Batty, 1993; Innes and Simpson, 1993; Klosterman and Landis, 1988; Sheppard et al., 1999; Sieber, 2000; Uran and Janssen, 2003; Vonk, 2006). The fundamental problem of these instruments is their overwhelming focus on (computer) technological tools for producing systematised, scientifically rigorous knowledge. Far too little attention is paid to embedding the output in the planning context and connecting it with local and experiential knowledge. First, this technology biased focus fails to consider the different meanings that each planning actor attaches to the technical facts and outcomes (Innes and Booher, 2000). Second, it fails to take into account the rapidly changing context in which spatial strategy-making takes place. Currently most Western countries do not have a single dominant planning authority; often a variety of actors is involved in the process. Each brings with them their own set of responsibilities, values and experiences, which further influence the planning process and reinforce the need to link systematised and local and experiential knowledge.

As Healey (2007) and Innes (1998) pointed out, a holistic view of knowledge and its use in strategy-making is very important for understanding and overcoming the above mentioned problems. Spatial strategy-making involves many types of knowledge, both experiential and systematised. Often it is the result of an intangible combination of many forms of knowledge shared by various actors, such as: anecdotes, intuition, expert judgment, beliefs, maps, experiences, values, model
outcomes and other. The discussion should not focus on ranking the importance of particular types of knowledge; rather it should look for fruitful ways to combine the different types of knowledge and to produce improved planning strategies. In particular, Healey stressed the importance of combining different types of knowledge for richer and shared common knowledge. According to her, this is a necessary condition for increasing the strategic capacity of a group of actors and for enabling them to improve their strategies and planning action (Healey, 2007).

1.1.2 Use of knowledge  
In the planning literature, as well as in academic contributions about Planning Support Systems, the *use of knowledge* to support strategy-making is central. However, is often the exact meaning of use of knowledge is not clear (Gudmundsson, 2009). As discussed above, up to the 1970s, the application of knowledge was seen under the rational instrumental model: experts provide neutral quantitative knowledge is provided to strategy-makers and decision-makers (Parson, 2002). Although, recent research has rejected this classical model of knowledge use (Sager, 1999; Sager, 2003), it still underlies much analysis and development (e.g. in Planning Support Systems literature).

Empirical studies developed more sophisticated notions about the use of knowledge to support activities such as strategy-making (Amara et al., 2004; Weiss, 1979). Gudmundsson referred to a frequently used typology of types of knowledge use. This typology came out an analysis of research utilisation by Amara et al. (2004, p. 77):

- **Instrumental use** involves applying research results in specific, direct ways;
- **Symbolic use** involves using research results to legitimise and sustain predetermined positions;
- **Conceptual use** involves using research results for general enlightenment, whereby the results influence actions, but more indirectly and less specifically than in instrumental use.

When I speak of using different types of knowledge in support spatial strategy-making, I am referring to the conceptual use definition. This is an important addition to the PSS literature, which usually focuses on the more strict instrumental use (e.g. Uran and Janssen, 2003; Vonk, 2006).

1.2 INTEGRATED LAND USE AND TRANSPORT PLANNING  
Within spatial strategy-making, one of the central challenges is to integrate different planning domains that are strongly interrelated but that often have developed strict sectoral pillars of legislation, financial arrangements, institutions and education. Especially domains that have developed a strong technical engineering character with a well established sectoral planning framework (such as water management, transportation and to a lesser extent environmental planning) are difficult to link with each other and especially with domains that are less technical and more visionary by character, such as land use planning. The professional sectoral languages developed throughout their careers, equip the professionals with different the types of indicators and different modes of thinking, which makes shared spatial strategy-making difficult and sometimes even conflict prone.
This dissertation will focus on the integration of two specific planning domains in the strategy-making phase of planning. It is a widely held notion that better integration of the land use and transport planning domains is a crucial prerequisite for designing sustainable spatial strategies. Such a sustainable strategy would foster opportunities for the inhabitants and businesses to take part in relevant social and economic activities which require mobility, while at the same time reducing the negative effects of this mobility (Bertolini, 2009; Bertolini et al., 2008). The transport planning field is changing, from a closed engineering view towards a more holistic view of transport problems and solutions (Banister, 2002; Bertolini, 2009; Dimitriou, 1992; Gifford, 2003; Meyer and Miller, 2001; Straatemeier, 2008). This new, emerging paradigm is the result of the increased recognition of the fundamental problems of the classic transport paradigms. Both the ‘predict and provide’ paradigm, where growing mobility demand was seen as a given and sufficient (road) infrastructure had to be constructed to foster this growth, and the ‘predict and prevent’ paradigm, with the goal of reducing mobility demand, proved to be insufficient to tackle the growing transportation problems. These paradigms do not sufficiently take into account either the importance of mobility for the functioning of individuals and businesses (and thus society) or its negative side effects. Integration of land use and transport planning is widely seen as a new promising direction for addressing this dilemma by planning professionals, by governments, and even in the business world (Banister, 2005; Cervero, 1998; ECMT, 2002; European Commission, 2004; Meyer and Miller, 2001; MinV&W, 2005; TRB, 2004; WBCSD, 2001, 2004).

The underlying belief is that reciprocally supportive land use and transport systems improve mobility (i.e. improved access to activities and jobs, a higher standard of living etc. (WBCSD, 2004, p. 13)), while, at the same time, reducing the negative impacts (i.e. pollution, risk, congestion etc. (Banister, 2005; WBCSD, 2001, 2004])). Several empirical studies that showed a strong interaction between both systems support this belief (overviews in: Banister, 2005; Hanson and Giuliano, 2004; Meurs, 2002; Meyer and Miller, 2001; Wegener and Fürst, 1999). It also reflects a long-standing body of theory on the relationship between land use and transport (Giuliano, 2004; Manheim, 1974; Meyer and Miller, 2001; Mitchell and Rapkin, 1954; Wegener and Fürst, 1999). Although both the existence of this direct relationship and its perceived importance are still academically contested (see e.g. Schwanen et al., 2004; Susilo and Maat, 2007), there seems to be little debate about the added value of integrated land use and transport strategy-making.

1.2.1 Differences in land use and transport knowledge

The integration aspect of such strategy-making adds even more complexity to the link between knowledge and strategy-making. They are not only different types of knowledge (systematised vs. local/experiential), but there are also differences within these types of knowledge (different sorts of systematised and local/experiential knowledge). Land use and transport planners not only use different indicators and models, but also perceive differently the urban environment, its problems, and strategy-making.
CHAPTER 1: INTRODUCTION

Notwithstanding the increasing attention paid to communicative approaches (see for example Banister, 2008), scientific instrumental rationality still seems to be the predominant paradigm in the field of transport planning (Willson, 2001). Therefore, transport planners tend to use more quantitative information concerning for transport flows, levels of service and costs. They focus more on general theories and computer models and usually have an engineering background (Willson, 2001, p. 2). In general, transport planners focus on solving problems (i.e. congestion) and optimising the transport system, without paying much attention to achieving wider (social, economic) goals. In other words, the focus is on finding the means (e.g. congestion charge or highway extension) for achieving a given goal (e.g. efficient functioning of the transport network). Also, transport planners often use predictive forecasting methods to deal with uncertainty in the future (Jones and Lucas, 2005; van der Bijl and Witsen, 2000; Wachs, 1985; Zapatha and Hopkins, 2007).

On the other hand, land use planners tend to use more qualitative spatial information about places and functions, work in more communicative settings and often have a background in design or the social sciences. Today’s predominant land use planning mode is (at least theoretically) based on communicative, deliberative rationality. It includes multiple stakeholders (e.g. Forester, 1999; Healey, 1997; Innes, 1995) and focuses on confronting and bringing together in inclusive strategies multiple goals from multiple disciplines. They deal with uncertainty in the future in many different ways (planning, scenarios and visioning) (van der Bijl and Witsen, 2000; Zapatha and Hopkins, 2007).

1.2.2 Knowledge support for integrated land use transport strategy-making

There have been significant academic and professional efforts to develop concepts, tools and instruments to support the integration of land use and transport planning processes. The common goal of these efforts was to generate a type of knowledge that could support planning processes, and the outcomes included a host of integral indicators (i.e. potential accessibility measures (see e.g. Bertolini et al., 2005; Geurs and Van Wee, 2004)), tools and instruments (i.e. Land Use Transport Interaction tools such as MARS (Emberger and Ibesich, 2006) and UrbanSim (Waddell, 2002)), and Planning Support Systems that link process with content elements (Straatemeier and Bertolini, 2008). However, recent studies show that this information and these ‘state of the art’ instruments are hardly used to support LUT integration in planning practice (NICHES, 2007). Especially in the early phases of planning there is still a significant deficiency of relevant integral information and tools (see Hull, 2005; Jones and Lucas, 2005; Straatemeier, 2008). The tools that do find their way into planning practice are in most cases developed to support the analysis of trends, the evaluation of alternatives or the assessment of projects. Not many of them are able – let alone are used – to support integrated strategy-making. If they are used (such as described in Kelly et al. [2008]), it is for simple instrumental use.
1.3 CENTRAL RESEARCH QUESTION

The importance of integrated land use and transport strategy-making and the cumbersome relationship between knowledge and action in such processes is synthesised in the following central research question:

How to improve the use of Planning Support Systems that aim to support integrated land use and transport strategy-making?

Planning Support Systems (PSS) are the most recent member in the family of computer-aided planning programmes, which includes Large Scale urban Models and (Spatial) Decision Support Systems. There are many definitions of PSS, ranging from very broad (any computer-aided technique that can be used for planning tasks) to very narrow definitions. Extending on Klosterman (1997), I will define PSS as an infrastructure that systematically introduces relevant (spatial) systematised knowledge to a specific process of related planning actions. This often, but not always, includes computer software (in the case of land use and transport strategy-making: often Transportation - or Land Use Transport Interaction models).

Strategy-making is also a widely debated concept that has many definitions. Following among others the relational perspective of Healey (2007) and the work of Friedman (1987), I will define it as a virtual construction site where planning actors actively link different types of knowledge to make sense of the complexity of (urban) problems and develop possible long-term actions for improvement.

Improved use of PSS will be defined here as the fruitful combination of the systematised knowledge of the PSS with the local and experiential knowledge of land use and transport planners. This combination influences (enlightens) their integrated strategy-making processes (i.e. conceptual use as defined by Amara et al. (2004)).

1.4 EPISTEMOLOGICAL CHOICES

1.4.1 Explanatory versus design oriented research

The central research question is not simply describing, explaining, understanding or predicting a part of social reality for the sake of knowledge generation. It implies a change oriented development or design process that will explore the possible solutions to real existing problems in planning practice. Therefore, as this type of research should actively engage planning practice in developing and testing solutions, it is structured along a pragmatic design oriented approach.

In order to distinguish it from the ‘explanatory science’ type of research, which is the key comparative reference for all types of research, Van Aken (2004, 2005) names the change oriented type of research ‘design science’ (inspired by Schön, 1983; 2004).

2 This paragraph is a pre-print of: Straatemeier, T., Bertolini, L., Te Brömmelstroet, M., and Hoetjes, P. (2009). "An experiential approach to research in planning." Environment and Planning B: Planning and Design (accepted for publication). It is slightly edited to fit the format of this publication.
Simon, 1969). What design sciences have in common is the awareness that “understanding a problem is only halfway to solving it. The second step is to develop and test (alternative) solutions” (Van Aken, 2004, p. 220). In other words, explanatory and design sciences have different missions. The core mission of explanatory sciences is to describe, explain and possibly predict observable phenomena within their field (natural or social). An *explanandum*, or ‘something to explain’, is their object (as in the questions ‘How did different species come to be?’ and ‘Why is there poverty?’). *Descriptions, explanations, and/or predictions* are the typical products. Depending on the object of study (natural or social), they will be more or less value and context free (as for instance extensively discussed in Flyvbjerg, 2001) and will have some type of *causal model* as their central concern.

Design sciences have a different core mission. Their focus is not primarily to develop a causal model, but rather to develop knowledge for the design and realisation of artefacts (for instance in engineering or architecture), or for improving the performance of existing entities (for instance in medicine or management). A *mutandum* or ‘something to change’ is their object (as in the questions ‘How to cure AIDS?’ or ‘How to improve the performance of a governmental organisation?’). The typical products of design sciences are *prescriptions* (‘If you want to achieve Y in situation Z, then something like action X will help’). They are prescriptions that are *tested* in practice and *grounded* in scientific knowledge. Central design science research questions are ‘What works?’, and ‘Why does it work?’, or more precisely: ‘Through which *mechanism* does a certain *intervention* impact on a certain *context* to determine a certain *outcome?’ (Pawson and Tilley, 1997; referred to in Van Aken, 2004).

As a change oriented disciplines, planning research should also be expected to follow this mode of ‘design sciences’. However, and certainly as far as academic planning research is concerned, it mostly seems to follow the mode of ‘explanatory sciences’. It might still ask questions such as ‘What works?’ and ‘Why does it work?’, but it does not submit its findings through the full cycle of actually implementing interventions and reflecting on their outcomes.³

³ A review of articles recently published in some of the most practice oriented academic planning journals seems to confirm this pattern. Four journals were scanned for contributions featuring (de facto) grounded and tested technological prescriptions: the *Journal of the American Planning Association*, *Planning Practice & Research*, *Planning Theory and Practice*, and the *Journal of Planning Education and Research*. These journals have the explicit aim to publish research that is relevant for practitioners, and to bring together practice and academia. The scan of recent issues of these journals shows that that tested and grounded prescriptions are an exception. The majority of contributions (over 85% of the scanned articles) consist of explanatory analyses of physical and social phenomena, policy analyses, or theoretical contributions. Most of these contributions result in recommendations for policy or further research. This type of research merges into a category of articles featuring prescriptions that are grounded in theory, but which have not been tested in practice. In the end, there was arguably only one article, out of the 99 articles scanned, that engaged in the full experiential reflective cycle, resulting in a grounded prescription that was actually used and tested in a practical case [Cervero R, 2006, "Alternative approaches to modeling the Travel-Demand impacts of Smart Growth" *Journal of the American Planning Association* 72 285-295].
To a large extent the idea of engaging with practice is already well known as ‘action research’. Indeed, action research has some essential similarities with design sciences, as demonstrated by Argyris and Schön (1989). Both design sciences and action research are focused on finding solutions in close cooperation with practitioners, and both types of research take place through iterative action-reflection cycles. Like design science, ‘good’ action research requires not only practical results in the specific cases of intervention, but a certain degree of generalisation as well (Eden and Huxham, 1996). However, at least partly due to the origins of action research as a method of facilitating social change and empowering ‘the client’, often it emphasises more the ‘action’ than the ‘research’. Hence, there is poor transfer of the knowledge obtained from action research to other contexts (Argyris and Schön, 1989; Baskerville and Wood-Harper, 1996; Eden and Huxham, 1996; Stringer, 1999; Van Aken, 2004). The design science approach on the other hand, is explicitly intended to generate grounded and tested prescriptions, which can be used in other contexts.

1.4.2 Pragmatic Research Notions

The relationship between research and experience was a core concern of American pragmatism. Central to American pragmatism in general and to the work of John Dewey in particular is the notion that practical knowledge can only be generated within actual experience. According to Dewey (1960, 1964), human practices are based on more dimensions of ‘knowing’ than the merely cognitive sort of knowledge that experts typically contribute. He highlighted dimensions such as ‘reflection’, ‘values’, ‘experience’, and ‘emotions’. Dewey further ascertained that human knowledge is always incomplete and imperfect, even in its richest forms. The knowledge of acting subjects is thus, and by definition far less complex than the practices they are engaged in. As a result, one cannot cope with the complexities of practice from the position of an outsider/spectator; the real meaning and value of knowledge can only be learned by trying and probing it in action.

This key pragmatist notion has been further articulated and made operational in the field of education by Kolb and Fry (1975), through their theories and methods of ‘experiential learning’. Experiential learning unfolds through an iterative sequence of interlinked activities, with a continuous shift between reflection and action, whereby one nurtures the other. In this learning cycle, the observation of and reflection on concrete experience leads to the forming of abstract concepts, which are then tested in new situations, eventually resulting in the adaptation of existing practices (that is, concrete experience) in a continuous flow (Figure 1.2).

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4 This paragraph is a slightly edited pre-print of Straatemeier, T., Bertolini, L., Te Brömmelstroet, M., and Hoetjes, P. (2009). "An experiential approach to research in planning," Environment and Planning B: Planning and Design (accepted for publication).
The experiential learning cycle can also provide a useful framework for analysing planning research, planning practice and their (potential) relationship. These four activities are, of course, already present in current planning research and practice, although fairly limited so in research on Planning Support Systems. However, and this is the core of my argument, they are often not linked, at least not systematically and directly. I propose that a more direct and systematic link between these different activities (and the people and organisations behind them) would greatly improve learning processes and thus knowledge development in planning research and practice. This would require some changes on both sides. Researchers need to engage more in practice (in ‘concrete experience’) and practitioners need to engage more in research (in ‘forming abstract concepts’). As in our highly specialised world it is difficult to expect an individual or even a single organisation to be equally proficient in all these activities, the answer is for practitioners and researchers (and their respective organisations) to engage more with each other: the former providing ‘food for thought’ the latter ‘thought for food’.

1.5 RESEARCH APPROACH AND OUTLINE OF DISSERTATION
The central research question will be answered through five research steps, each focusing on a particular aspect of the wider scope of the dissertation. In this final section of Chapter One I will introduce the research steps, the main research methods and the outline of this dissertation.

The main structure of the research (see Figure 3.1) is based on the experiential learning cycle introduced above.
1.5.1 *Understanding the implementation gap*

The first research step will be to explore the current implementation gap of PSS that aim to support integrated land use and transport strategy-making (Figure 1.2: ‘observation and reflection’). This gap will be explored in the Netherlands with three supplementary research methods. First, an international literature review will reveal the more general problems with PSS development and implementation. Second, the resulting insights will be used to analyse the supply side of the implementation gap through semi-structured interviews. Finally, the demand side of the implementation gap will be mapped. Here, insights from the first two methods will help structure a web-based survey, in which land use and transport planning practitioners will have the opportunity to share their views on and experiences with existing PSS and to offer some directions for improvement. The results will be discussed in Chapter Two, which is a preprint of the article: Te Brömmelstroet, M. (2010a). "Equip the warrior instead of manning the equipment: state of practice of land use and transport planning support in the Netherlands." *Journal of Transport and Land Use* (forthcoming).

1.5.2 *Grounding solution directions for PSS implementation*

The second step will be to develop concepts that could support the improvement of the implementation problems (Figure 1.2: ‘Forming abstract concepts’). For this, an international literature review will be conducted examining not only the general PSS literature but also the adjacent fields of knowledge management, process management, cognitive sciences, system analysis. The main directions for improvement of these fields will be combined in an approach that can improve the implementation of PSS in planning practice: Mediated Planning Support (MPS). These results will be presented and further discussed in Chapter Three. This chapter is a reprint of the article: Te Brömmelstroet, M., and Schrijnen, P. M. (2010). "From Planning Support Systems to Mediated Planning Support: A structured dialogue to overcome the implementation gap." *Environment and Planning B: Planning and Design* (forthcoming).

1.5.3 *Understanding its implications in planning practice*

In the third step the research will shift from generating and grounding knowledge (regarding the PSS implementation challenges and solution direction) towards testing and improving these insights in planning practice (Figure 1.2: ‘Testing in new situations’). The MPS approach will be used to structure a PSS development process aimed at supporting integrated land use and transport strategy-making in the
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Amsterdam Metropolitan Area. To improve the usefulness of such research, a pragmatic research methodology will be presented and applied. The added value of using this approach instead of the classical PSS research approach is discussed in the intermezzo, which was published as: Te Brömmelstroet, M. (2009). "Commentary: The Relevance of Research in Planning Support Systems." Environment and Planning B: Planning and Design, 36(1), 4-7.

The research methods will include participatory observation during the workshops in which MPS will be utilized used and questionnaires where the participants will have the opportunity to share their views and experiences. Together, this will be discussed in Chapter Four, which was previously published as Te Brömmelstroet, M., and Bertolini, L. (2008). "Developing Land use and Transport PSS: Meaningful information through a dialogue between modellers and planners." Transport Policy, 15(4), 251-259.

1.5.4 Testing solution directions for PSS implementation
The fourth step will close the circle of Figure 1.2 with a reflection on the use of the MPS approach in two cases of integrated land use and transport strategy-making in the Netherlands: the Amsterdam Metropolitan Area and Breda. These applications will serve to observe, reflect and re-define abstract concepts of the solution directions for PSS implementation. Based on the findings from the participatory observation and questionnaires, I will analyse the importance of the different elements of MPS in improving the usability of the PSS and the corresponding results will be discussed in Chapter Five. This chapter was previously published as: Te Brömmelstroet, M., and Bertolini, L. (2009). "Integrating land use and transport knowledge in strategy-making." Transportation, DOI: 10.1007/s11116-009-9221-0.

1.5.5 Towards a technological rule
The final step will be to analyse the original hypotheses, developed in step two and refined in step four of the research. These hypotheses were grounded in both international literature and applied to Dutch integrated land use and transport strategy-making. To develop a technological rule, these hypotheses have to be rigorously tested, which will be conducted through the MPS approach in three cases (Amsterdam Metropolitan Area, Breda and Eindhoven). The participants (both from PSS development and planning practice) answered a short questionnaire about the general workings of the MPS approach and the results. This partly quantitative, partly qualitative analysis will be discussed in Chapter Six, which is submitted as: Te Brömmelstroet, M. (2010b). "Transparency, flexibility, simplicity: From buzzwords towards strategies for real PSS improvement." Computers, Environment and Urban Studies (submitted).

The final chapter of the dissertation will summarise the findings of the five research steps, combine them into an answer to the central research question, discuss implications for PSS development and planning practice, and explore future directions for research.
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Chapter 2

Equip the Warrior instead of Manning the Equipment: Land Use and Transport Planning Support in the Netherlands
This chapter assesses the embedding of land use and transport instruments (Planning Support Systems (PSS), models and tools) in Dutch planning practice, in order to shed light on how planning practitioners perceive these instruments and the reasons and manner of their (lack of) utilisation. These insights provide much needed input to improve support instruments for integrated land use and transport planning, in particular during early planning phases and on the regional level. The research adds to the emerging literature on PSS. It builds on general insights in bottlenecks that block the use of PSS in practice, and uses a user oriented approach to gain more insight in 1) how users perceive these bottlenecks and 2) how they relate to the specific land use and transport PSS. Much of the existing research geared at improving these instruments has a technical focus on adjusting the intrinsic workings of the instruments themselves. However, the way in which they are embedded in planning practice has remained largely ignored and poorly understood.

Using a web-based survey, administered among land use and transport practitioners in the spring of 2007, this chapter describes how LUT instruments are embedded in planning practice and how they are perceived by the planning actors in land use and transport planning. The findings suggest that a technical focus is insufficient for improving the implementation of these instruments. The key bottlenecks, identified by the survey, actually are centred on “softer issues”, like lack of transparency and poor connections with the planning process. The closing analysis and discussion offers some potential remedies for these shortcomings.

(This chapter is a preprint of the article Te Brömmelstroet, M. (2010), Equip the warrior instead of manning the equipment: state of practice of land use and transport planning support in the Netherlands. Journal of Transport and Land Use, accepted for publication © 2009 Journal of Transport and Land Use. It is slightly edited to fit the format of this dissertation.)
2.1 INTEGRATING LAND USE AND TRANSPORT PLANNING

Better integration of transport and land use planning is deemed crucial for achieving more sustainable mobility patterns in urban areas, as strongly supported by academics (e.g. Banister, 2005; Cervero, 1998; Meyer and Miller, 2001), professionals (e.g. TRB, 2004), governments (e.g. ECMT, 2002) and business (e.g. WBCSD, 2001, 2004). In the Netherlands this is mirrored in recent Dutch national policy documents stressing the need for integration, ex. the ‘Nota Ruimte’ (MinVROM et al., 2004) and the ‘Nota Mobiliteit’ (MinV&W, 2005).

Nevertheless, effectively integrated land use and transport (LUT) planning processes are often absent in planning practice (Banister, 2005; Stead et al., 2004; TRB, 2004), which in turn produces sub-optimal or even conflicting plans, ideas and concepts. Although there are some positive signs, real LUT integration in the Netherlands is still far away (Expertcommissie Netwerkanalyses, 2006; Heerema and Linssen, 2006). Both reports put emphasis on the importance (and the current lack) of integration in the early phases of the planning process and on addressing issues on the regional level.

Several barriers seem to explain this lack of integration, roughly divided in institutional/procedural discrepancies (i.e. separate planning institutions, formal processes, financial arrangements, etc.) and substantive differences (i.e. different planning objects, information etc.) (e.g. Curtis and James, 2004; Hull and Tricker, 2006; Lautso et al., 2004; Vleugel, 2000; Webster et al., 1988). As far as substantive barriers are concerned, general insights and suggestions for improvement have produced a host of indicators and instruments which attempt to provide expert LUT knowledge aimed at bridging the divide between the two planning domains (often based on transportation models) (Emberger et al., 2006; Geurs and Van Wee, 2004; Schoemakers and van der Hoorn, 2004; Waddell, 2002; Wegener and Fürst, 1999).

However, not many of these instruments are used to support integral LUT planning in daily planning practice. Some LUT instruments are successfully implemented to identify and extrapolate trends, assess strategies and prioritise land use and/or transport projects; however, they do not address early planning phases, which are more open and ‘wicked’ (Rittel and Webber, 1984). These phases (ex. visioning, generating strategies and developing strategies) are very dynamic because there is a wide range of options still open for discussion and a wide range of potential participants. The resulting unstructured and diverging information needs greatly complicate the potential role of supporting instruments. Yet, these planning phases are crucial for effective LUT integration; framing common problems and solution spaces in a particular way limits the potential options available later in the process (see Schön, 1983).

The lack of effective LUT instruments for these crucial planning phases produces several key questions: why are existing instruments not used/usable in these planning phases; what context specific demands for information support are important and how can the fit of (existing) land use and transport instruments with
current planning practices be improved? This chapter will discuss the outcomes of an exploratory research into the embedding of existing LUT instruments in daily planning in the Netherlands.

This research builds upon the existing research which examines the infrequent and week utilisation of Planning Support Systems (PSS) (Batty, 2003; Bishop, 1998; Couclelis, 1989; Geertman and Stillwell, 2003; Harris and Batty, 1993b; Innes and Simpson, 1993; Klosterman and Landis, 1988; Sheppard et al., 1999; Sieber, 2000; Uran and Janssen, 2003; Vonk et al., 2005). It identifies specific bottlenecks for LUT instruments, through a web-based survey of planning practitioners (the end users). The aim is to deepen our understanding of a specific branch of PSS, with a focus on embedding them in planning practice and exploring more directly directions for improvement. Also, this analysis started from a more PSS user oriented perspective than most of the abovementioned publications, with two groups of potential users (land use and transport planners) as starting point. Therefore, this chapter offers more in-depth knowledge than the recent mainstream PSS literature. I will first briefly outline the general academic debate on the ‘implementation gap’ of PSS, which provided the background for the survey developed for this chapter. After presenting the survey method and the characteristics of the respondents, the outcomes of the survey will be covered in greater detail. Finally, I will close with conclusions and suggested directions for improving PSS support for integrated LUT planning processes.

2.2 THE IMPLEMENTATION GAP OF GENERAL PLANNING SUPPORT INSTRUMENTS

2.2.1 Computer aided planning: high and low tides

Since the first serious attempts at using computers to aid planning processes in the 1950s (Harris, 1960), the academic field of computer aided planning has seen several waves alternating between enthusiastic optimism about its potentials and depressive critique (mainly due to the low implementation rates of the instruments).

In the 1960s, there was a growing effort to develop metropolitan land use models and transportation models, applying insights from several adjacent scientific fields (i.e. economics and regional science). Planning was then seen as a technical-rational process; the planning expert started from a set of policy goals and systematically evaluated all policy alternatives on their merits and consequences. It was believed that this process produced the optimal plan, which could be subsequently monitored and (if necessary) adapted (Allmendinger, 2002, p. 55). Computers were seen as very useful support tools aiding the planner in their daunting task of assessing all possible alternatives from a wide range of indicators. The computer also offered the opportunity to include more scientific knowledge into the planning process (Batty, 1994; Klosterman, 1997). During this period, some planners even saw computer aided planning as “a revolutionary new potential that may impact or redefine the process of planning” (Harris, 1968, p. 223).

Yet the many large-scale urban models (LSUM) developed at the time (often with significant public funding) failed to be implemented into planning practice, bringing
heavy criticism of the instrument developing community (Brewer, 1973; Danziger, 1977; Greenberger et al., 1976; Lee, 1973). In his seminal paper, Lee identified seven sins that seemed to cause the lack of implementation of the LSUMS, mostly concerning (lack of) data and calculation restrictions (Lee, 1973, pp. 163-168). Many see his paper as heralding the start of the ‘dark ages’ of the computer aided planning field, when most of the funding for instrument developing programs was cancelled (Wegener, 1994).

In the 1980s there was a paradigm shift, due to the recognition that the technical-rational view of planning was no longer feasible in practice. First of all, this approach often resulted in planning disasters (Hall, 1981); while also current planning practice changed and was marked by increased complexity and uncertainty. Thus, planning became more focused on communicative and deliberative activities among all relevant stakeholders. At first sight, this tremendously decreased the potential for computer instruments; however, the advances in computer technology (introduction of the desktop PC) rekindled the interest in the role of computers in planning (Openshaw, 1986). Instead of presenting objective scientific data, it was suggested that computer instruments should primarily support the communication between all the stakeholders and support the process of making collective decisions (Sprague and Carlson, 1982). This view was further strengthened in the 1990s with the introduction of Geographical Information Systems (GIS), a set of instruments geared to support the collection, analysis and visualisation of all kinds of geographical phenomena (Burrough and McDonnel, 1998; Stillwell et al., 1999). Such instruments could enhance the flow of information and knowledge between stakeholders in an open spatial planning process. Some scholars saw this renewed enthusiasm for computer aided planning as a new revolution in planning processes, because now “virtually anything a planner does can be done with a GIS” (Juhl, 1994).

However, “this always imminent revolution has yet to occur” (Klosterman, 1997). Although GIS instruments are used to increase efficiency and facilitate routine planning tasks (i.e. information gathering, processing and visualising), they are hardly used to support the more complex tasks unique to planning (i.e. forecasting, analysis, evaluation and communication) (Couclelis, 2005; Klosterman, 2007; Lee, 1994). Klosterman argues that the “soft side of technology” partially explains this shortcoming; the search for the appropriate role of technology in planning should not begin from a particular technology, but with a conception of a particular planning problem (Klosterman, 1997, p. 46).

The most recent developments in the field of computer aided planning are the so-called Planning Support Systems (PSS). As a relatively new concept, the term PSS has several interpretations in the literature, ranging from very narrow computer centred definitions to much broader concepts related to information and planning. Here I use it broadly to refer to any kind of infrastructure which systematically introduces relevant (spatial) information to a specific process of related planning actions. In this view PSS has both a process and a substantive component; the latter is sometimes (but not always) supported by computer technologies. Furthermore, PSS should accomplish several specific tasks: 1) to facilitate interaction among planners; 2) to
CHAPTER 2: EQUIP THE WARRIOR

contain structured and accessible information; 3) to facilitate social interaction, interpersonal communication and debate (to address common concerns); and 4) to support a continuous and interactive process of constantly integrating new information (generated as analytical results) and thus redefining design issues ((Klosterman, 1997). Such PSS would contribute greatly to improving contemporary planning practice.

However, recent research shows that (yet again) these new planning support instruments have difficulties to find their way into daily planning practice (Coulcelis, 2005; Geertman, 2006; Uran and Janssen, 2003; Vonk et al., 2005). Some of the reasons for this ‘implementation gap’ are grounded in the planners’ negative perception of current PSS as: inadequate, far too generic, complex, technology oriented (rather than problem oriented), too narrowly focused on strict technical rationality and incompatible with the unpredictable/flexible nature of most planning tasks and information needs (Batty, 2003; Bishop, 1998; Coulcelis, 1989; Geertman and Stillwell, 2003; Harris and Batty, 1993a; Innes and Simpson, 1993; Klosterman and Landis, 1988; Sheppard et al., 1999; Sieber, 2000; Uran and Janssen, 2003; Vonk, 2006) In 1994, Douglas Lee argued in retrospect that his 1973 critique of LSUM’s was still valid, as model developers had not changed their approach and were still striving for comprehensiveness and fighting to include as much complexity as possible. As a result they failed to respond to the needs of the practitioners, who would rather have “redundant approximations then detailed models” (Lee, 1994).

Recent scientific progress in land use transport interaction models (Waddell, 2002; Wegener and Fürst, 1999), activity based mobility modelling (Ettema and Timmermans, 1997) and the modelling of agents (Macy and Willer, 2002) confirms that there is still vibrant interest in model development. However, the utilisation of these tools in supporting LUT integration in daily planning practice remains rather limited.

2.2.2 Specific challenges for LUT PSS

The general lack of use of PSS has been extensively covered in recent studies. We have reasons to believe that supporting LUT integration in the early phases of the planning process presents some unique opportunities and threats. First of all, LUT planning is adding complexity: two separate systems (land use and, transport) have to be addressed, each with its own unique input variables, dynamics and uncountable interrelations (not all of which are well understood). Consequently, as LUT PSS have to model all relevant interrelations, it is difficult for planners to interpret modelling outcomes and understand the cause-effect relationships. Also, relationships are sometimes designated as relevant at random and the resulting uncertainties about these relationships increase the complexity of the LUT PSS. Secondly, although there are generic LUT problems, most of the challenges are unique for a specific geographical and temporal context (especially in dynamic urban regions). Finally, the information has to be meaningful for planning actors from both separate planning domains; they come from two very different planning traditions with different education, skills and planning paradigms. LUT PSS and their outputs have to be able to accommodate two highly different mindsets, each with its own set
of explicit and tacit knowledge (further elaborated in Straatemeier and Bertolini, 2008; Te Brömmelstroet and Schrijnen, 2010; Willson, 2001).

2.3 EXPLORING LUT PLANNING SUPPORT IN PRACTICE: METHODOLOGY

2.3.1 Data collection

The primary goal was to gain insight in the embedding of PSS in processes of LUT integration in planning practice. With this aim, a web survey was developed based on lessons from the PSS literature, experiences from planning practice and interviews with planners and PSS developers\(^5\). In March 2007, a large number of Dutch land use and transport planning practitioners were contacted to assess their experience with LUT PSS in integrating land use and transport planning and their willingness to participate. In total, 450 people were approached directly via electronic mailing lists (provided by relevant consultants and knowledge networks) and calls for participation were posted on several appropriate websites and newsletters\(^6\).

Although the survey was anonymous, the respondents had to provide their primary domain of work (transport or land use) and their position (end user or developer). The next part of the survey consisted of eleven general statements, referring to the current state of LUT PSS. For each statement, respondents could distinguish between: ‘strongly agree’, ‘agree’, ‘neutral’, ‘disagree’ and ‘strongly disagree’. The third part of the survey listed twelve possible bottlenecks, selected from existing PSS literature, as possible explanations for the low implementation of existing LUT PSS. For each bottleneck, the respondent had to judge its degree of importance by distinguishing between: ‘very big problem’, ‘big problem’, ‘neutral’, ‘no problem’ and ‘no problem at all’. Also additional bottlenecks could be suggested by the respondent in an open format. The fourth part of the survey consisted of 21 open and closed questions; it focused on harnessing in-depth insight regarding implementation challenges and potential improvements.

2.3.2 Data interpretation methods

For the general statements, the level of agreement was analysed by calculating the average of the responses, where ‘strongly agree’ was coded as ‘2’, ‘agree’ coded as ‘1’ and so forth, finally with ‘strongly disagree’ coded as ‘-2’. Generating this average level of agreement for each group of respondents (based on their primary domain of work) allowed me to check for varied patterns. Also, the consistency of the outcomes within the groups was assessed by comparing frequency scores.

For each group of respondents, the perceived importance of the bottlenecks was analysed by combining the frequency scores of the categories ‘very big problem’ and ‘big problem’.

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\(^5\) The web survey is available at [http://www.transport-planning.eu/websurvey.html](http://www.transport-planning.eu/websurvey.html) and [http://www.transport-planning.eu/websurvey2.html](http://www.transport-planning.eu/websurvey2.html) (both in Dutch).

\(^6\) [http://www.verkeerskunde.nl](http://www.verkeerskunde.nl) (site for transport planners); [http://www.ruimte-mobiel.nl](http://www.ruimte-mobiel.nl) (knowledge network for LUT integration); [IKCRO newsletter](http://www.ikcro.nl) (newsletter for land use planners).
The open questions were mainly used to interpret the other results and to provide in-depth justification of problems and possible solutions.

2.3.3 Exploration of survey participants
A total of 124 people responded and filled in the first three parts of the survey (a response ratio of 28%): 62 from land use planning, 60 from transport planning and 2 who did not specify their primary work domain. The vast majority (over three-quarters) were LUT PSS users, while the developers made a smaller part (31 respondents). Twenty-four of the respondents (primarily PSS developers) specifically declared that their activities fitted in multiple boxes.

A total of 107 respondents filled in the fourth part (open questions); the twelve which declared to have no prior LUT integration experience were excluded from further analysis. Of the remaining 95, four had LUT experience from a PSS development perspective, 25 had experience from a land use planning perspective and 66 were involved in LUT integration from a transport perspective. The employment of these respondents (mostly civil servants on the sub-national level) is shown in the left-hand pie chart in Figure 2.1. The role they played in LUT integration is visualised in the right hand pie-chart (multiple answers were possible). Project leaders (38 %) form the most prominent group, followed by project members (30%). The respondents represent all (geographical and organisational) layers of land use and transport planning, with different levels of experience in LUT integration processes.

![Figure 2.1](image) Work organization of respondents (N=95) of fourth part of survey (left pie chart) and their role in LUTR integration (right pie-chart)

2.3.4 Validity of outcomes
Because there is little insight in the embedding of LUT PSS, the main aim of the survey was to identify directions and patterns of bottlenecks and solutions, not to scientifically assess the implementation blocking mechanism. Listing the twelve bottlenecks provided a useful format for the respondents to select common problems, and stimulated them in thinking and adding additional ones. Only a very limited number of additional bottlenecks were proposed, leading me to conclude that the original twelve cover the most pertinent barriers.
2.4 HOW ARE LUT PSS PERCEIVED IN PLANNING PRACTICE?

2.4.1 General statements concerning LUT PSS
The three categories of general statements included: 1) implementation of LUT in the planning process; 2) phases of LUT planning that are insufficiently supported with PSS; and 3) general statements. Figure 2.2 illustrates the level of agreement with the statements. In order to verify if there is agreement or conflict of opinion between the two domains, it maps separately the overall average (black), the land use respondents (orange) and the transport respondents (green) outcomes.

![Figure 2.2](image_url) Average level of agreement on statements about implementation of LUT PSS, phases of the planning process and general use: from -2 (strongly disagree) to +2 (strongly agree)

As Figure 2.2 shows, the respondents found that LUT PSS are implemented too late rather than too early in the planning process. However, both statements showed a relatively low score (-0.27 and +0.14) indicating a lack of consensus within each group. There was a stronger positive score for the statements that LUT PSS are “implemented too far removed from the political process” and that “they do not fit the LUT planning process”. Transport respondents had stronger opinions about both statements.

The responses to the four statements about the support of the different typical phases of the LUT planning process show that LUT PSS do not sufficiently support the generation of new strategies; on the other hand, both planning domains agree that it does adequately support the evaluation of strategies. Also, but with a lower level of agreement, the evaluation of LUT projects seems insufficiently supported.

The bottom three general statements show a relatively high level of agreement in both planning domains. This confirms the widely held view of LUT PSS weaknesses, as: developed too far from planning practice, not providing enough insight in crucial LUT relationships and in the words of one respondent being used as “weapons in fact-fighting-battles instead of for joint-fact-finding”.

Overall, there are no large discrepancies between land use and transport respondents or PSS users and developers. In general, the results show that the respondents are dissatisfied with the current PSS and how they are used (and
This widely held view is succinctly summarised in the words of one land use respondent who would rather see “a provisional instrument that is simple to use and shows useful images than the current sophisticated black boxes”.

### 2.4.2 Bottlenecks blocking implementation

In order to gauge the importance of each bottleneck, the respondents were asked to select the most pertinent blockages for LUT PSS, as presented in Figure 2.3.

![Figure 2.3](image.png)

**Figure 2.3** Potential bottlenecks for LUTR instruments and their perceived importance (percentage of respondents who consider it a big problem)

Again, a remarkable consensus among professionals from both domains emerged. Four bottlenecks were seen as blocking the use of LUT PSS by over half of the respondents. However, additional analysis showed that PSS developers saw the top four as far less problematic, but graded the bottleneck “instruments are not known” as most important (with 52 percent).

Almost two-thirds of the respondents (and an even higher three-quarter of transport respondents) found the lack of transparency to be a big PSS implementation problem. Apparently, the LUT PSS do not clearly define assumptions and calculation methods, echoing one of the fundamental problems of computer aided planning, already recognised in Douglas Lee’s *Requiem* (Lee, 1973). Land use respondents ranked the low communication value (i.e. LUT PSS which are not understandable for planners, stakeholders and politicians) as the biggest problem, with this bottleneck scoring almost equally to ‘lack of transparency’. All four of these key problems can be described as soft problems, clearly indicating that the biggest problem of LUT PSS lies in the fact that they are very difficult to use by non PSS developers.

Apparently, the technical issues are not considered a major hindrance for implementing LUT PSS. The ‘too comprehensive’ and ‘too specific’ bottlenecks scored low, as did the price and the calculation time. However, these problems are not negligible; half of the land use respondents saw them as a bottleneck and the lowest ranking bottleneck was seen as a problem by almost 22 percent of all respondents.
respondents. As previously identified by Vonk (2006), these findings confirm the importance of the instrument quality category of bottlenecks. However, it is not so much the technological qualities, but rather the adaptation of the tool to the planners’ demands (user friendliness, transparency, flexibility) that seems important for LUT PSS. This holds especially true in combination with the lack of PSS support during the phase of generating strategies. In other phases (e.g. evaluating strategies) more technical issues might be considered more important.

2.4.3 Understanding the embedding of LUT PSS in planning practice
The above results support the findings of the academic PSS literature that the planning actors are not satisfied with the current PSS offered. Further in line with the academic literature, the reasons given in this survey highlight the “soft” elements of PSS instead of its technological characteristics. To better understand this perception of LUT PSS and to find concrete directions for improvement, the last part of the survey contained mainly (semi-)open questions.

This last part of the survey was completed by 95 respondents, who had prior experience with PSS in LUT integration projects. Almost half of them (42 percent) consider their integration project a success: “it was the first time that there was genuine interaction between the two domains”; “there was readiness to listen to each other”; “it was possible to dispute sacred cows”; and “it led to more acceptable solutions” than separated planning. Yet, the respondents who consider it unsuccessful (30 percent) often mention the PSS as one of the main reasons: “the assumptions in land use and transport models did not match” and “too rigid [PSS] to easily calculate alternatives”.

Conflicting interests between the land use and transport actors are the main barrier to successful LUT integration, with ‘lack of a common language’ in second place and ‘lack of political commitment’ as third. Although these findings suggest that there is a severe institutional barrier, they also confirm the potential importance of and need for the development of useful LUT PSS.

The second set of questions concerned the use of PSS outputs. Respondents state that the outputs of LUT PSS often are used as input at the start of LUT workshops, to evaluate existing and new strategies or to provide background information for discussions. Although three-quarters of the respondents state that it created new insights, only 26 percent find that it creates a common language. The weak points deemed responsible for this lack of performance were the one-sided transport orientation and the complexity of the PSS output (which made it is difficult to use for generating strategies).

The respondents were asked how the phases of generating new strategies and developing strategies should be better supported with the output of LUT PSS (Figure 2.4). About 85 percent of the land use respondents suggested that LUT information should be used to ‘create new insights’ and almost 70 percent that the information should be ‘easy to play with’. The most frequent uses of LUT PSS, visualising the
current situation and providing background information, were rated at the bottom of the list of important characteristics, especially by transport respondents.

![Figure 2.4](image)

**Figure 2.4** How LUTR information should be used to improve support (percentage of respondents)

The last part of the survey addressed the use of LUT PSS. Only 12 percent of the respondents reported that PSS were used during workshops and an even lower percentage shared that the participants used them hands-on. Mostly, the consultants used the LUT PSS, often as back office applications. Yet, 60 percent confirmed that the PSS did play a supportive role in the project, providing new insights: in each others’ choices, in coherent LUT relationships, and in the effects of the strategies selected.

Although both groups agreed on the phases needed to improve PSS usage, land use respondents additionally emphasised the need for improving it in all phases of implementation. Figure 2.5 shows the suggestions given by participants for the desired characteristics of a useful LUT PSS.
The PSS should be able to evaluate the participants’ existing ideas and to allow the actors to play with strategies and thus learn about their effects. In other words, the LUT PSS should form a theoretical laboratory to experiment and learn-by-doing, which can be effectively achieved only with a transparent LUT PSS. Characteristics such as detail, objectiveness and speed are considered to be less important; therefore, it is apparent that the soft aspects of LUT PSS should be the focus of future improvement efforts.

2.5 CONCLUSIONS AND DISCUSSION

2.5.1 Patterns and directions
This chapter reiterated the widespread consensus on the need to improve the integration of land use and transport planning (especially during early planning phases). However, despite this long apparent need, a common LUT language is still lacking and this forms a substantive barrier. The implementation of recently developed PSS, aimed at overcoming this barrier, is either weak or nonexistent in daily planning. The results of the web-based survey presented in this chapter provide more insight in the challenge of using these specific LUT instruments in planning practice and discern clear patterns of user demands. This research builds upon the existing body of academic literature which deals with the unsatisfactory application of PSS. It seeks to 1) deepen the understanding of specific PSS which successfully supported integrated LUT planning processes; 2) provide more user oriented insights in attitudes towards PSS and 3) explore more directly avenues for improvement.

In conclusion, it can be stated that current LUT PSS seem well suited for some planning tasks, such as calculating the effects of new/existing strategies and providing background information for discussions. However, PSS do have serious shortcomings as they do not provide enough new LUT insights, for example: they are
used to justify positions that are already taken (i.e. ‘fact-fighting’), do not fit the
planning process and are not well linked to planning practice. Land use respondents
feel stronger about this sentiment than their transport counterparts. Moreover, the
output is often too transport oriented and fails to provide a common LUT language
to support the generation of strategies. In one word, the fundamental disconnect
between PSS developers and their users is confirmed (already addressed in Lee, 1973)

The findings highlight the LUT strategy generating stage (where land use and
transport planners are in dire need for good support) as the weakest link, due to: a
lack of transparency, low communication value, lack of user friendliness and the
incapability to experiment with the PSS. This supports the identified findings of
bottlenecks for general PSS and unveils that the PSS developers’ recent efforts to
address these problems have not yet yielded results. The respondents’ minute
concerns for the technical challenges flies in the face of current efforts and funding:
which remains geared towards improving these technical aspects of LUT PSS (i.e.
improving calculation time or credibility of outcomes by introducing new
complicated modelling techniques).

LUT PSS seem too complex and too opaque to be useful in early phases of planning.
The respondents see a need to support the development of strategies and programs
with improved information and LUT PSS support. PSS should function as laboratories
where planners can collectively experiment and take part in group learning about
LUT relationships. Building on this experience, they can subsequently generate
grounded and tested LUT strategies. In order to provide this support, the PSS should
be easy ‘to play with’ and transparent on its assumptions. The researchers’ current
focus on precision, detail and objectiveness is not very beneficial when planners
generate strategies (although probably they are useful in other planning phases).

2.6 DISCUSSION: FROM ‘DEVELOPING FOR’ TO ‘DEVELOPING WITH’
These results seem to necessitate a fundamental shift in thinking for both PSS
developers and LUT planners. In order to increase the implementation success of PSS
(with the aim of developing a common LUT language) the developers should not only
focus on scientific rigor, PSS outcomes, detail and comprehensiveness. Instead, they
should try to find a balance between rigor and relevance. When developing their
ultimate LUT PSS, the developers still seem to follow a technology and supply focus.
They should not (only) develop scientifically state-of-the-art PSS, but (also) PSS which
embody context-specific user demands for support (state-of-practice). These
demands differ over time, per group of planners, per geographical area and scale
(geographical and temporal). Again, Douglas Lee’s requiem offers useful guiding
principles for such a fundamental shift (Figure 2.6). LUT PSS developers should not
aim to follow (only) the dashed line, even though academic incentives support this
focus. If PSS aim to support real planning practice, the top of the black line should be
the goal, with a rigor-relevance balance to be found somewhere in-between. In my
view, this should take place in close cooperation between PSS developer and
potential user.
One promising strategy is to create a structural dialogue between PSS developers and potential users. It would be centred on existing planning problems in daily planning practice and would correspondingly produce a ‘learning by doing’ dynamic. Around the planning problem, the PSS users and developers can cooperatively construct and use a PSS throughout the entire cycle (not only at the start and the end of a PSS development process), conceptualising and testing it in iterative cycles. Such dialogues would allow PSS developers to understand that a generic PSS does not exist and appreciate the fact that the dialogue with the users should be an integral part of developing and using their PSS. Potential users would understand that these PSS are not always perfectly transparent and flexible to use; however, debate can increase the common understanding and build a useful common language (a notion also supported in Vonk and Geertman, 2008). For LUT PSS such a dialogue is described in (Te Brömmelstroet and Bertolini, 2008).

The shift in approach from a ‘developing for’ towards ‘developing with’ will increase mutual understanding between PSS developers and potential users. This shift does not infer a simple ‘going through the motions’ of a prototype run with the users, upon which the developers would subsequently develop a LUT PSS in isolation based on these identified requirements. It implies a structural, continuous dialogue throughout the relevant steps during the planning process, with the PSS developers participating in all planning projects from the early phases of planning. This seems a promising way to create mutual understanding and thus useful, transparent, flexible and appropriate planning support instruments. Finally this would result in progress from the current situation where they are simply ‘manning their equipment’ towards a desirable conditions where they ‘equip the warriors’.
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Chapter 3

From PSS to MPS: A Structured Dialogue to Overcome the Implementation Gap
Planning Support Systems (PSS) are intended to facilitate relevant steps in planning processes; however, the academic evaluation of PSS reveals many bottlenecks precluding a widespread use of these systems. A central weakness is the lack of communication between PSS developers (focussing on technical issues) and potential PSS users.

Other academic fields like knowledge management and technological innovation have recognised similar bottlenecks years ago. Based on methods proposed in these fields, a new process architecture for the development of a PSS is proposed. Based on a dialogue in which PSS developers and potential users discuss and use the PSS, existing tools, instruments and models are refined and improved to be more useful for their potential users. The focus shifts away from the development of a technically more sophisticated support system, towards a process of PSS development which is intertwined with the planning process itself. This process architecture is called Mediated Planning Support (MPS).

The chapter explores what can be learned from other academic domains and enquires about the applicability of these findings to PSS development. The case of Amsterdam, where the Department of Transport wanted to transform their transportation model into a land use and transport PSS, illustrates how such a process architecture can link PSS developers and users in planning practice. This chapter discusses the concepts behind MPS and uses the case of Amsterdam to visualise its workings, lastly offering hypotheses on the method and suggestions for further research.

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3.1 INTRODUCTION

“Most learning takes place in the process of building the model, rather than after the model is finished”
(Vennix et al., 1997)

Urban and regional planning is becoming an increasingly complex task. First of all, growing numbers of stakeholders and participants are closely involved in the process. Secondly (and deriving from this increase) varying and conflicting goals and agendas have to be addressed during the planning process. Thirdly, planning challenges are growing in scale (e.g. from local problems to regional challenges). As Couclelis summarises: “[land use planning] involves actions taken by some to affect the use of land controlled by others, following decisions taken by third parties based on values not shared by all concerned, regarding issues no one fully comprehends, in an attempt to guide events and processes that very likely will not unfold in the time, place, and manner anticipated” (Couclelis, 2005, p. 1355).

As Couclelis concludes, planners should embrace all available help and there is a wide variety of academic fields which can offer help in the form of theories and guidelines. Faludi (1973, chapter 1), distinguishes a procedural dimension (i.e. insights from political or management sciences which define and justify methods of decision making and planning) and a substantive dimension (i.e. theories from geography, economics or natural sciences which provide knowledge about the planning object).

One way of offering substantive support is to provide planners with information technologies to model certain phenomena, applying theories from other academic fields. Applying gravity theory to model competition between cities and using market theories to model land use changes are two well known examples.

Since the 1950s, the field of Computer Aided Planning has been developing such technologies, resulting in many families of instruments, such as Large Scale Urban Models (LSUM) and Spatial Decision Support Systems. The most recent of these technologies is known as Planning Support Systems (PSS). There are many different definitions of PSS, ranging from very broad (any computer-aided technique that can be used for planning tasks) to very narrow definitions. Here, we define PSS as an infrastructure that systematically introduces relevant (spatial) information to a specific process of related planning actions (based on Klosterman, 1997). As the origins and development of PSS are already concisely covered elsewhere (Geertman, 2006; Klosterman, 2001), here it is important to highlight that PSSs differ from (group) Decision Support Systems, optimisation techniques and computer models in that they are not highly structured. Instead, they are loosely coupled assemblages of (often computer-based) techniques, which aid planning actors to manage and overcome their planning problems (Batty, 2003, p. v). For specific planning actions a planning department can utilise: a transportation model, cost benefit analyses software, qualitative tools and a GIS. A PSS can offer all these types of techniques and can be linked to specific planning actions in specific planning domains. A PSS typically has a process component (related to the planning actions) and an
CHAPTER 3: From PSS to MPS

information component. Under the flag of PSS several packages have been developed which offer such an assemblage of techniques for a specific range of planning actions (What IF™ for collaborative planning actions (Klosterman, 1999), LEAM for spatial modelling (Deal, 2001), UrbanSim for transport and land use integration (Waddell, 2002), for more see (Brail, 2005; Brail, 2008; Geertman and Stillwell, 2003, 2009)).

Numerous studies show that the implementation of these families of instruments in daily planning practice has been lagging and continues to lag behind expectations, especially in actions unique to early phases of planning (such as visioning, storytelling, sketching and developing strategies). These planning actions are increasingly gaining importance in planning and managing cities and regions (see e.g. Healey, 2007). They can be characterised as highly complex both in terms of the planning process (many actors with different goals, means and understanding) and in terms of content. Especially in this phase the sorely needed PPS support (see Couclelis above) is often lacking (see e.g. Couclelis, 2005; Klosterman, 1997; Klosterman, 2007; Vonk et al., 2005). Studies show that planners find serious drawbacks in using PSS; deeming these tools as: too generic, too complex, inflexible, incompatible with the ‘wicked’ nature of most planning tasks, oriented towards technology rather than problems, incompatible with less formal and unstructured information needs, and too focused on strict technical rationality (see Bishop, 1998; Couclelis, 2005; Geertman, 2006; Klosterman, 2001; Ottens, 1990; Scholten and Stillwell, 1990; Vonk, 2006).

This apparent mismatch between supply and demand is often referred to as the ‘implementation gap’ of PSS (Vonk, 2006). The consistency of this gap over time and over different planning domains poses serious questions regarding the possibility for applying PSS effectively. Are there more fundamental problems between the realms of PSS development and the realm of planning (the Janus relationship of planners looking forward in time with modellers looking backward as suggested by Couclelis (2005, pp. 1355-1360)? Could solutions from related domains, such as (Group) Decision Support Systems or software development, provide answers and how could they be applied to the field of PSS?

Our core argument is that, in order to bridge the gap between PSS and the early phases of planning, PSS developers should focus away from solving technical challenges and towards improving the social process of developing their tools (within the complexity of real planning practice) staying firmly centred on the end user. This does not imply that a separate PSS has to be developed for each unique user. PSS should be sufficiently flexible/adaptable and developed in dialogue with the end user in the context of real planning problems. In this chapter, we will present how such a dialogue could be structured and how this could support the refinement, improvement and application of PSS. First, we will explore suggestions for improvements found in existing PSS literature, to further connect them to innovations found in knowledge management literature. Then, we will introduce concepts from academic literature in two related fields which specifically deal with establishing the link between explicit knowledge and tacit knowledge. These concepts are used as starting points for a PSS development framework (found in
section 6), which is illustrated with a recent application in Amsterdam. In the final portions, the proposed hypotheses are reviewed and followed by some closing remarks.

3.2 PSS: SUGGESTED DIRECTIONS FOR IMPROVEMENT
From its conception in the 1950s the field of Computer Aided Planning can be characterised as a continuous tidal movement (for extensive overviews see: Geertman, 2006; Guhathakurta, 1999; Klosterman, 1997). Periods dominated by high confidence in the potential of applying IT technology in urban planning processes, (partly related to increases in IT capacities) were followed by periods of deep criticism, primarily as it did not fulfil the envisioned goal of changing or supporting planning practices. During these periods of criticism, authors suggested several improvements for connecting IT tools and planning practice, with some fundamental directions repeatedly gaining attention.

The seven sins of modelling, recognised by Douglas Lee in his 1973 seminal paper on the failure of Large Scale Urban Models (LSUM) to support planning practice, are still regularly used by PSS developers (often to state that these sins have been overcome). However, in the often overlooked remainder of his paper, Lee suggested four more fundamental (behavioural) changes, necessary for making LSUM more relevant for planning practice. Namely, modellers should: improve the transparency of their assumptions, improve the contact with the policy (or planning) problem, focus less on theory and objectivity, and retreat from using too complex and unnecessarily comprehensive tools (Lee, 1973, p. 178). In 1994, Lee repeated most of his argument, recognising that (despite the vast changes in computer hardware and software) the attitudes of the model developers have largely remained the same during the 20 years in between. The new tools were still not widely used in daily planning practice (Lee, 1994, pp. 38-40).

Recognizing instrumental, diffusion and acceptance bottlenecks, more recently Vonk (2006) suggested that system developers and specialists should improve communication with practitioners, in order to actively analyse the tasks which a PSS could support. He recommends enhancing the instrumental quality, acceptance and diffusion of PSS through an interactive learning process among the relevant actors of the innovation network. Another key recommendation is for developers to increase their communication with planning practitioners, government research agencies and consultants (Vonk, 2006, p. 96). Klosterman emphasised similar directions. He argued that the search for the appropriate role of technology in planning should not begin from a particular technology, but with a conceptualisation of a particular planning problem (Klosterman, 1997, p. 46).

Focussing on the fundamental characteristics of model developers, Meadows and Robinson (2002) concluded that the modelling community is aware of most of these avenues of improvement and often pays lip service to simplicity, transparency and user orientation. Yet, practice doesn’t show major improvements. They concluded that bottlenecks underlying the implementation gap are embedded firmly in the habits and culture of the modellers, who are rewarded for increasing academic
robustness (e.g. R-square focus) with publications, invitations for key notes speeches and status from their peers. Applying their tools in practice often is often only a secondary goal: “they really prefer to have technical conversations with each other” (Meadows and Robinsons, 2002, p. 289).

3.3 SIMILAR INSIGHTS IN KNOWLEDGE MANAGEMENT

The above mentioned bottlenecks and ways of addressing them mirror insights found in knowledge management literature. PSSs can be understood as tools, feeding planning processes with (often) hard and scientific knowledge (e.g. algorithms, general rules, rules of thumb, etc). As such, they have to be linked to the softer experience based knowledge of the planning actors (e.g. experience of earlier similar projects, education, etc). In recent decades, key discussions in knowledge management have explored the possible avenues for connecting these two kinds of knowledge (respectively called explicit and tacit knowledge (Friedmann, 1973; Polanyi, 1967))

Explicit types of knowledge are formal (such as data, formulae and general/universal theories), making them easy to codify and allegedly giving them a broad validity. Tacit knowledge is more difficult to codify, because it is context-specific, informal and acquired through experience. As Nonaka and Konno state: “tacit knowledge is deeply rooted in an individual’s actions and experience as well as in the ideas, values, or emotions he or she embraces” (1998, p. 42). It is this connection and continuous interaction between both types of knowledge that generates learning and new knowledge. Nonaka and Takeuchi distinguish four modes of interaction in this social process (figure 3.1):

- **Socialisation** (tacit with tacit): to share experiences and to create new tacit knowledge, to observe other participants, to brainstorm without criticism;
- **Externalisation** (tacit with explicit): to articulate tacit knowledge explicitly by writing it down and by creating metaphors, indicators and models;
- **Combination** (explicit with explicit): to manipulate explicit knowledge by sorting, adding, combining and looking to best practices;
- **Internalisation** (explicit with tacit): to learn by doing, to develop shared mental models, goal based training (Nonaka and Takeuchi, 1995).

Each of these types of knowledge creation has a value in the process of creating new knowledge. Ideally they have to be executed in continuous iteration.
Following these insights, a PSS which also aims to generate new knowledge has to be able to effectively interact with the tacit knowledge of the planning actors. That interaction will enable it to connect with the subjective insights, intuitions, values and experiences of the potential users, thus increasing the chances of being accepted and successfully implemented. Moreover, if this interaction occurs during the development of the PSS, it will also improve its substantive quality, as the planners will be able to introduce context or area specific knowledge early on in the process.

3.4 LEARNING PROCESSES AND STRATEGIES
Recent insights in cognitive psychology illustrate the ways of cultivating learning processes. Learning theories have shifted decidedly away from the behaviourist perspective towards a constructivist perspective. Where behaviourism views knowledge as an entity external to the learner (Gredler, 2001), constructivism sees the learner not as an empty vessel to be filled with knowledge, but rather as an individual with specific personal experiences which he/she brings into interactions with others. Learners create (construct) their own knowledge in their attempts to understand their experiences (Driscoll, 2000; Gergen, 1985). According to this view, the subjective experience of each individual has to be the point of departure for learning (see Donovan et al., 2000; Simons et al., 2000; Stepich and Newby, 1988). This approach emphasises the importance of linking tacit knowledge and PSS. Most of the recognised bottlenecks of PSS implementation can be related to PSS developers following a behaviourist perspective: offering objective knowledge to the planner. Constructivism argues that without taking the specific personal experiences into account, this is an ineffective strategy.

Constructivism stresses that learners need forms of metacognition, i.e. knowledge regarding the mechanism of organising ones’ own thinking and memory. Such knowledge allows them to acknowledge their individual values and perceptions.
CHAPTER 3: From PSS to MPS

Accepting this subjectivity, constructivists also presume the existence of a multitude of truths and realities. The outcomes of learning processes are therefore essentially open.

Recently, constructivist learning theories extended their focus from the individual to the wider context. Social constructivist theory assumes that the behaviour and the learning processes of individuals are dependent of the context which gives meaning to their lives and work (Siemens, 2006). This insight stimulates new learning strategies which combine the individual learning process with the learning process of their team or community. Some examples include: situational learning or communities of practice (Lave and Wenger, 1991; Stein et al., 1998), action learning or learning-on-the-job (Ramirez, 1983), organisational learning (Argyris and Schön, 1978) and double-loop learning (Argyris, 2005). Another line is the development of specific learning strategies emphasising a specific context, e.g. the integration of spatial planning and transport engineering (Schrijnen, 2005).

There is no set format for structuring learning; however, as a general guideline, Kolb (1984) found that a complete learning process combines four stages of perceiving and processing information: (1) concrete experience, (2) reflective observation, (3) abstract conceptualisation, and (4) active experimentation.

Most people have a personal preference for one style; however, a group seeking to acknowledge the various possible learning types in the team should follow the entire cycle. Traditionally PSS developers (especially the larger LSUM) tended to start with abstract conceptualisations, whereas most potential PSS users start with concrete experiences. According to Kolb’s learning theory, developing a meaningful or useful PSS requires the combination of these learning styles, ideally including all four. In this way the potential users, which have different preferred styles of learning, can all learn what the PSS can and cannot do. Such learning-by-doing combines explicit and tacit knowledge in different ways, creating the conditions for fruitful learning.

3.5 METHODS FOR INTERACTIVE KNOWLEDGE CREATION

Before translating the insights from knowledge management and cognitive psychology to PSS development, this section identifies methods in related domains that have used such insights to improve development of software and models, with specific focus on the link between explicit knowledge and tacit knowledge. These development methods and their underlying principles served as inspiration for the PSS development approach presented in section 3.6.

3.5.1 DSDM

Dynamic System Development Method (DSDM) is developed in interaction between information technology (IT) professionals, consultants and project managers. Their goal was to improve IT implementation through the study of best practices. The philosophy behind DSDM is that development must iteratively combine the users’ knowledge of the requirements with the technical skills of professionals (figure 3.2). This is translated into a set of main principles: close user involvement, an
empowered project team able to make decisions, frequent delivery of products and a focused effort on critical functionality (Stapleton and Constable, 1997).

Building on the learning cycle of Kolb (especially learning by experimenting), DSDM offered a more flexible approach than conventional approaches (Hansen, 2006; Stapleton and Constable, 1997). This flexibility is based on the techniques of Rapid Application Development (Martin, 1991), distinguished by several characteristics: application development should be iterative and incremental; changes made during development should be reversible; the scope and requirements should be base-lined before the project starts; and testing is experiential and carried out throughout the project life-cycle (Stapleton and Constable, 1997). This approach offers strategic benefits: users are more likely to take ownership of the developed product; the risks of developing inappropriate instruments are reduced; it is more likely that the products meets businesses’ requirements; users are better trained in using the product; and system implementation runs more smoothly (Stapleton, 2003, pp. XXIV-XXV).

![Figure 3.2 DSDM iterative lifecycle (adopted from Stapleton and Constable, 1997)](image)

3.5.2 Group model building

In system dynamics, an approach developed in the 1950s to study the behaviour of complex systems with dynamic visual models as a central product, client involvement is a central and recurring theme (Forrester, 1961; Roberts, 1978; Vennix and Rouwette, 2000) which generated several new techniques over the years. The term Group Model Building (GMB) can be seen as the overarching umbrella for these techniques (Vennix et al., 1997). GMB includes system dynamics insights as well as theories and findings of other academic fields. GMB focuses on group learning, seeking in turn to: integrate explicit and tacit knowledge, engage participants as active subjects, and utilise simple and transparent information (Ackermann et al., 2005; Rosenhead and Mingers, 2001). Stakeholders collaboratively develop a dynamic model of the identified problem or challenge. Through this process they learn about each others’ perspectives on the system and collectively identify possible
interventions to improve it. By increasing the stakeholders’ ability to process information and arguments, GMB attempts to change the participants’ beliefs, mental models, intentions and behaviour (Rouwette et al., 2007).

This method also uses insights from experiential learning; using system dynamic tools results in short feedback loops during the modelling phases. Ultimately, GMB attempts to tap into the situated knowledge of practitioners.

3.5.3 Mediated modelling

Mediated modelling uses the process of building computer models as a vehicle to support complex environmental policy and problem-solving management (van den Belt, 2004). It builds on theoretical insights from organisational learning (Senge, 1990; Vennix, 1996), system dynamics (Forrester, 1961), and social psychology (Hare et al., 1994). Rather than having outside experts dispensing “answers” to stakeholders, mediated modelling brings together diverse interests to jointly construct a simulation model. As a result, it elevates the level of shared understanding of the problem and fosters a broad and deep consensus. Mediation refers both to the role of a mediator (one person or a team) and to the functioning of the link between the system dynamics tools and the participants. It is much more than simple facilitation, i.e. managing the process during meetings (see Phillips and Phillips, 1993). It involves proactive interventions during negotiations, and key contributions to the content and participation in shaping the process in-between meetings (van den Belt, 2004, p. 51).

Mediated modelling is linked to GMB, but differs in two aspects. Firstly, the level of client participation is higher and the clients have complete control over the type of modelling and the content of the model. Secondly, as one of the goals is to relate and integrate existing information, participation occurs from the very beginning of the modelling (van den Belt, 2004, pp. 15-16). It does not rely on pre-existing models; instead, it provides building blocks and assistance for constructing models. The manner of arranging these blocks is decided together with the users. This process can be a first step towards a full-blown system model.

The open character of this approach challenges both the users (to make their tacit knowledge explicit) and the developers (to develop model that fit the users’ needs). It combines Kolb’s learning cycle and (implicitly) Nonaka’s SECI model.

3.5.4 SSM

Soft System Methodology (SSM) (Checkland and Scholes, 1990) is a method of dealing with ill-defined problem situations with significant social and political components (Checkland, 2001; Wilson and Morren, 1990). It originates from the understanding that thinking in “hard” systems is inadequate for large, ambiguous and complex issues. It also builds on the idea of experiential learning (Kolb, 1984). In an iterative process both developers and users engage in active learning and debate, from the starting point of defining the problem up to the final stages of taking action to improve the situation (figure 3.3). Some of these stages address the “real” world, while others address a conceptual world. The key notion is that it provides a
structure aiding the participants in their thought and deliberation process operating in messy situations. SSM stimulates both the developers and the users to reflect on, and experiment with, their (mental) models. Unlike the other methods, specific attention is focused on linking tacit and explicit knowledge.

**Figure 3.3** Soft Systems Methodology (adopted from Checkland and Scholes, 1990)

### 3.5.5 Lessons for PSS development

These development methods stem from specific research domains, often supporting different goals than the PSS. Most of these methods build upon insights from knowledge management and/or cognitive psychology. Some methods start from a preconceived notion of the desired way to model a problem (i.e. system dynamics). In (integrative) planning, such a preconception can make it hard to get all planning actors involved in PSS development, because they can hold radically different views of the planning subject or of the process preferred to address the issues (due to differences in culture, paradigm, discourse, education etc.).

SSM specifically addresses the confrontation of tacit and explicit knowledge in creating new knowledge, as proposed by Nonaka & Takeuchi (1994). The other methods only hint to this link.

Some methods actively employ the concept of double loop learning, in which subjects not only learn about consequences of an action strategy to adopt this strategy, but also about their underlying goals, values and frameworks that guide their actions (Argyris, 2005; Argyris and Schön, 1978). Most approaches use both iteration and cyclical development steps. Most methods acknowledge that neither the models, nor the underlying theoretical concepts or the outcomes of the iterations will be definitive.

In contrast to the above mentioned methods, in PSS development a shared understanding or a problem structure should not be the end goal but rather the
means to arrive at the desired planning product - shared visions, strategies and/or planning interventions. A PSS is intended to support the development of strategies, visions and plans; this should be clearly reflected in the PSS development method.

Furthermore, as discussed in the first section, a PSS consists of a process component and an information component. So, both components have to be developed and digested together with the planning actors. In order to bridge the implementation gap, it is essential to introduce the context of the actors in the interpretation or even in the development of the PSS itself.

3.6 MEDIATED PLANNING SUPPORT
Together the insights from knowledge management, cognitive psychology and the development methods described above suggest that a PSS development strategy should include the following:

- An iterative stepwise approach – providing a structure but also taking double-loop learning effects into account (Argyris, 2005; Stapleton and Constable, 1997);
- Experience, reflection, conceptualisation, and experimentation for every (sub)product (Kolb, 1984);
- Socialisation, externalisation, combination and internalisation incorporated in the entire group learning process (Nonaka, 1994; Nonaka and Konno, 1998);
- Emphasising the contextual nature of the method, from problem definition to taking action on existing planning problems, (Checkland and Scholes, 1990; Lee, 1973; Vonk, 2006);
- A close and continuous dialogue between clients and developers (Meadows and Robinsons, 2002; van den Belt, 2004; Vennix et al., 1997);
- A mediator who actively structures the dialogue between PSS developers and planning actors (also in between meetings) (Phillips and Phillips, 1993; van den Belt, 2004);
- To overcome acceptance bottlenecks, existing technologies should be used as much as possible (preferably within the users’ organisation) (Vonk et al., 2005);
- Keep it as simple as possible, but not simpler than necessary (Meadows and Robinsons, 2002; van den Belt, 2004).

We have called this approach Mediated Planning Support (MPS). Mediated refers to the process of dialogue and learning between PSS developers and planning actors. Planning Support refers to the goal of supporting planning practices. In the next sections, we will describe the core components of MPS and consequently illustrate this mechanism at work in Amsterdam.

3.7 THE MEDIATED PLANNING SUPPORT FRAMEWORK
In order to create more useful and relevant PSSs for early planning phases, the MPS framework aims to structure the dialogue between PSS developers and planning actors. Most often, the starting point is an existing model or PSS with generic features, which have to be applied to a specific planning context. MPS fulfils a supporting function, by providing an iterative learning process, during which both the PSS developers and the planning actors learn together about the specific context and the PSS characteristics. Through this learning process, both adjust to each
other’s needs and perceptions; thus the application of PSS in supporting the planning tasks at hand is greatly enhanced.

A MPS process includes five steps that build upon each other in an iteration (figure 3.4). With the guidance of a process mediator, planning actors and PSS developers go through these steps together and obtain learning effects which may call for the adaptation of earlier (sub)products. For example, by using the developed PSS for the development of planning strategies, planners learn that the proposed process steps are not as functional as originally thought. Each product is developed through the steps of Kolb’s learning cycle. This does not necessarily occur for each product at once; sometimes experiential learning occurs during the development of a later product. Working through the MPS framework delivers two concrete outputs: (1) the final PSS with a process and information component (for the developer) and (2) planning products as strategies and plans (for the planning participants).

![Figure 3.4 A Framework for Mediated Planning Support](image)

The first step in the process (the top square in figure 3.4) focuses on the specific demand for support recognised by the participating planning actors. It aims to answer the questions: why is a desired planning product difficult to develop and where should support be improved? This first step is important as it aligns the participants in the MPS process and mobilises commitment to both products (sense of ownership), as the rest of the product development takes the defined problems and demands as a starting point. Mapping individual feelings can be accomplished on an individual basis; however, it is important to discuss them in plenary in order to
build group consensus. These demands are not fixed and can change during the process.

The second step (figure 3.4: process protocol) is to design a set of planning actions for the desired planning product; answering the questions: what is the planning problem, what is the desired product and how to get there? A starting point can be a standardised framework for developing archetypical planning products (e.g. a two step scenario developing method including a diverging phase in which scenarios are developed and a converging phase of selection). In dialogue between the planning actors, this standard can be adapted to fit the specific context. This step has a strong conceptual character; through experience and testing it will be refined during consecutive meetings. In these first two steps, the PSS developers have to be present in order to learn, to create empathy for the planners’ perspectives.

In step three (figure 3.4: information protocol), the PSS developers propose how their PSS can support the process with relevant information. In a dialogue with the planning actors, a selection is made of useful and feasible knowledge sources. Through this discussion, the process protocol can already be adapted (e.g. some information is not feasible, so the process step doesn’t make sense).

Steps four and five (figure 3.4: final PSS and planning products) are connected more with iteration then the first three. Their focus lies on experimenting, experiencing and refining the concepts developed before. The process and information protocol are executed to develop the desired planning products. Through one or more iterations (this depends on the complexity of the planning issues and on the available resources) these planning products are developed and the protocols are refined to form the final PSS.

Every step constitutes one or more group meetings, during which planners and PSS developers collaboratively conceptualise, test and use the (sub)products (depending on the complexity, some steps can be combined in one meeting). In between these sessions, the mediator focuses on creating conceptualisations of the discussions in direct contact with some of the planning actors and PSS developers. Meetings start with a discussion of these conceptualisations (problems, process, information) followed by the application of the (adapted) concept and a closing plenary reflection.

### 3.8 ILLUSTRATING MPS IN AMSTERDAM

The application of MPS in Amsterdam illustrates the practical application of such a MPS process and its principles. As this is a unique context (in terms of planning actors and in terms of available PSS) it is not used to generalise claims for other contexts.

Early 2006, the University of Amsterdam and the Municipality of Amsterdam started a MPS process, in response to the planners’ need for improved support for integrative land use and transport (LUTR) strategy development. They felt that currently available models (notably the city’s own transportation model: GENMOD) did not provide sufficient support. Five MPS sessions were set up to develop and use
a PSS for land use and transport strategy development (for more details see Te Brömmelstroet and Bertolini, 2008). The participants from the municipality and the city region included transport planners, land use planners, and model developers (about 10-12 people). Two researchers from the university functioned as mediators. Each session took around 4 to 5 hours and the whole process spanned about five months.

In the first step the participants explored the areas needing improved support in the integrative land use and transport strategy development process. In two groups the existing land use and transport planning practices were conceptualised and missing links were identified. Especially when generating and testing new strategies there should be more knowledgeable integration. It highlighted the need for building a common land use – transport language. Further discussions with the modellers revealed that GENMOD focused too much on detail/objectivity and it was also deemed as slow and insufficiently transparent.

To find out how to provide a common language, in the second step a process protocol was discussed. Based on discussions in the plenary meeting and design literature, the mediator team conceptualised a four step scenario design process. The participants shared the need to improve the understanding of crucial land use and transport interdependencies. A four step design process supports such a learning process. The planners wanted to start from an integrated land use and transport program and develop a variety of scenarios based on insights in accessibility and sustainability indicators. Also, spatial constraints had to be considered. Then, the scenarios are evaluated and optimized based on their network effects. This selection step results in an overview of strategies that are interdependent of others or that work in most possible scenarios (robust). This protocol is visualized in figure 3.5.

![Figure 3.5](image-url)  
**Figure 3.5** Process protocol for land use and transport strategy development
The starting point was a land use and/or transport program which deals with 150,000 new houses and 150,000 new jobs in the region, in addition to finding solutions to the major congestions of the highway network. Combining spatial constraints and accessibility/sustainability opportunities and threats, different urbanisation scenarios were designed (covering only land use). The third step analyses these scenarios on their car/rail/bike network effects, further refining the scenarios and adding transport interventions. In the final step, the planners discussed and identified important interdependencies based on insights on the interventions and their consequences, in turn distinguishing which interventions seem robust (with stable positive effects in different scenarios). It is precisely this process of integrated strategy development that has to be supported with explicit knowledge.

In the third step relevant explicit knowledge was identified. The modellers presented several (archetypical) possibilities, based on what GENMOD and other available models can do and what has been done in recent policy documents. Through a selection process, a set of useful, relevant and comprehensible information and analyses was selected and linked to different steps of the process protocol (table 3.1). Also, important characteristics of the best method for presenting this knowledge were recognised. Similarly to the process protocol, this protocol was primarily a conceptualisation; the planners gained new insight by using it in the next steps to develop strategies. During the process, in particular the accessibility opportunity analysis was simplified (excluding congestion effects/competition elements) and made comprehensible for all involved planners.

<table>
<thead>
<tr>
<th>What: Spatial constraints</th>
<th>When: Second design phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>How: Showing a global overview of spatial constraints from different domains (airport, nature, etc.). Show how stringent the constraints are.</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>What: Accessibility opportunities</th>
<th>When: Second design phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>How: An analysis of how many jobs/inhabitants can be reached within a given travel time by public transport and car, use high/middle/low categories and show order of magnitude. It is the same for sustainability except that the Euclidean distance is used as proxy.</td>
<td></td>
</tr>
</tbody>
</table>

56
In the fourth step, the final PSS for integrated land use and transport strategy development was constructed as a combination of both protocols, applying the lessons learned during its use. Experimenting with the PSS and experiencing how it works, the planners redefined their initial observation-based conceptualisation. This double-loop learning process resulted in simplified analyses and additional information about network effects. On the other hand, information about desired travel behaviour was deleted from the final PSS as its consequences were incomprehensible for most participants. This PSS was documented in a municipal report, which presented the process steps, the information and underpinning analyses. It also contained a special section on the manner of structuring dialogue between planners and modellers for subsequent processes. This report is now used to support a similar exercise to develop strategies for a regional public transit system.
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The primary goal of MPS is not the PSS itself, rather supporting the planning process. Developing planning products is the fifth step which spans several meetings, depending on the process protocol. This step is iteratively linked to the fourth step, revising the PSS based on experience. In Amsterdam, the participants were divided in two mixed land use and transport groups, with the task of developing and revising urban strategies. During this process, the modellers were present to explain the output and to understand the input of the PSS. The models supported the creation of a common language, resulting in improved communication and more integrated scenarios between the two planning domains. In an individual questionnaire one planner stated that: “with this [set of information] we can connect goals of the two planning domains”. In the fourth design step, the two groups joined again to interpret the connection between land use and transport interventions; also their accompanying effects were further examined. This resulted in a shared list of robust interventions and important interdependencies, which could be communicated to policy makers or other municipalities in the region. Several land use and transport strategies for the 150.000 houses and jobs were articulated, i.e.: to situate large housing developments in existing corridors in combination with a regional public transit network; to concentrate around satellite public transit stations; and to cancel major urban extensions in Almere if there is no new public transit link.

In questionnaires and interviews, most planning participants stated that this MPS process did support the link between land use and transport strategy development. The strategies were not all new; the positive innovation was to share them between the domains and back them up with explicit knowledge, grounded in a common language. The planners also learned about their own and each others’ manner of working. This shows deeper understanding of the planning process and the potential role of externalisation of tacit knowledge in enhancing it.

The modellers noted that they got more insight in the balance between rigour and relevance of their models in such processes. They also recognised the importance of selecting and discussing the necessary information together with the planners. They acknowledged the benefit of meeting in person to explain their assumptions behind the analyses. MPS provided them with guidelines on how to structure a dialogue with planners. Their land use and transport PSS is formed by the situation and (even though the central elements are more or less stable) this PSS is not fixed and has to be open for dialogue in subsequent planning processes (with different planning actors and a different context).

3.9 DISCUSSION AND CONCLUSION

This chapter seeks to highlight the potential contribution of PSS and to address the fundamental problems which block its successful implementation in daily planning practice. Insights and lessons from the academic fields of knowledge management and cognitive psychology offer useful methods and techniques to overcome some of these problems. Based on those techniques, the Mediated Planning Support (MPS) approach is presented as a potential answer to these challenges. The MPS approach focuses on situations where existing tools, instruments or PSS need modification to be more useful for planners who are willing to use them. The development of
complete new PSS is a different matter. While this chapter has a theoretical perspective, we used an application in Amsterdam, where a transport model needed refinement to be useful for the support of integrated strategy-making, to illustrate how such an approach might work in planning practice (in this case supporting integrated land use and transport strategy development). Planning actors and modellers in Amsterdam case did appreciate the MPS process. The specific context provided fertile ground to test the approach, as this group of participants often collaborates in other planning projects. Also, the fact that the municipality already had its own fully functional transportation model was a unique advantage. Therefore, it is not appropriate to issue general conclusions based on this one experiment.

Further research is necessary to test the approach in different planning contexts. Such research should radically diverge from existing PSS research routines (a notion further elaborated in Te Brömmelstroet, 2009). It has to be performed in planning practice with real modellers and planning actors and (next to) real planning situations. Only then could the potential of the mechanisms and principles of the approach be adequately tested and grounded. And only then could a deeper understanding of the effective ways of bridging the implementation gap evolve (as also asserted by, Schöen, 1983; Van Aken, 2005).

The MPS approach addresses some of the fundamental bottlenecks recognised in the PSS literature (section 3.1). The transparency of the output and the assumptions of the (computer) models that are part of the PSS are improved through discussions and continuous explanations by the modellers. The PSS becomes more flexible and attuned to the particular characteristics of specific planning process, increasing their compatibility with the existing planning tasks. Also, planning participants can gain a shared ownership of the process and improved information choices. PSS developers can learn how their model and output is used in ‘wicked’ planning processes and how this unpredictability can influence the usefulness of their products.

Refining, modifying and using a PSS for a real planning problem results in a user oriented support system, in which the PSS developer and the planning participants together decide on the appropriate complexity and flexibility of the tools and outputs. In dialogue they find the balance between ‘as simple as possible, but not simpler than necessary’. The planner becomes more aware that a successful PSS cannot simply be taken ‘off the shelf’, that he/she has to go through an extended process of learning, modifying and improving the model. The PSS developer becomes more aware that if they want their models to be useful in practice, they should be designed to facilitate an explicit process of modification and learning when they are implemented.

The four steps of the SECI model, designed to create interaction between explicit model results and tacit planning knowledge, are crucial for MPS. Providing planners with the much needed planning support requires internalisation of relevant information. Externalising and socialising the knowledge of the planners themselves is a key component to facilitate this. An important notion is that such steps should not occur only once (at the start of PSS development) but also have to take double-
loop learning into account. Experiential learning supports such a process, as it takes into account Kolb’s four learning styles.

Importantly, MPS is a situated method - its core steps need to be reiterated in every new context and for every new planning problem. The method is not a 'one time only' exercise producing a user friendly PSS for all cases. Creating a structured dialogue between planning actors and PSS developers yields many useful lessons. A promising application of this can be seen in the concept of 'modelling in the public eye' as used for the LEAM model (Deal and Pallathucheril, 2008).

The theoretical discussion and the illustrative case show that the MPS method can be a valuable concept for addressing several bottlenecks which block the widespread implementation of PSS. However, more understanding of its workings is needed in order to grasp the exact relationship between the context, mechanism and outcomes. Several key research questions for future efforts emerge. Which context variables are the necessary conditions for a MPS to be successful? What is the role and influence of the initiator of this process? How do power issues play a part in the outcome? How can general lessons from earlier applications be transferred to new initiatives? Currently, MPS is applied in several different contexts to find answers to these questions. Taking the step away from the syntactic program of most PSS research and towards a more pragmatic and design oriented research design seems to be crucial in gaining insight on these points.

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Intermezzo

The Relevance of Research in Planning Support Systems
[This intermezzo has previously been published as: Te Brömmelstroet M. (2009), "Commentary: The Relevance of Research in Planning Support Systems" Environment and Planning B: Planning and Design 36. pp.4-7. © 2009 Pion Ltd.]
Writing in volume 35 of *Environment and Planning B: Planning and Design*, Janssen et al. (2008) present a paper which explores the usability of a specifically developed Spatial Decision Support System (SDSS) for the support of land-use planning problems. In their words, this paper is a planning oriented follow up to a more technical one that deals with the heuristic algorithm and numerical experiences. This paper aims at issues linked to implementation and application” (Janssen et al., 2008, p. 741). We will use this paper as an illustration to argue that, although it has legitimate claims and interesting outcomes, this type of research that is currently employed in the fields of SDSS and other planning supporting instruments is not helping to bridge the wide gap between developed instruments and daily planning practice.

Such a goal seems to follow recommendations made in a growing body of academic articles and edited books that deal with the so-called implementation gap of computer aided planning support instruments (see e.g. Brail, 2008; Brail and Klosterman, 2001; Geertman, 2006; Geertman and Stillwell, 2003; Vonk et al., 2005). These instruments (commonly referred to as Planning Support Systems (PSS)) have been developed in a large variety of planning domains and contexts by consultants and universities. Including the latest technological opportunities and academic insights, these PSS are expected to support planners in their increasingly complex endeavour to plan and manage regions, cities and neighbourhoods. However, they are hardly used in daily planning practice. Studies into the reasons for this found that the gap between the modelling- and planning community is too large, PSS are technology rather than planning oriented and these instruments do not fit the complex dynamics of real world planning contexts. If PSS, and SDSS as a sub domain, wants to close this gap, the focus should shift from developing rigorous instruments that include all the latest insights to the relevance of their creations in daily planning practice.

The introduction to the article by Janssen et al. seems to follow these recommendations in exploring the implementation and application potentials of their SDSS. However, if one reads further, one can question if this self stated goal is really met. First of all, the authors begin with four requirements for the SDSS to be useful to planners. These requirements are defined by themselves (whether based on their own experience or on the literature remains unclear). After introducing the algorithm of the SDSS, the article continues with the formulation of an experimental planning problem to which it can be applied. An interesting area in the northwest of the Netherlands is selected and described, again by the authors themselves, without referring to clear reasons for it; is it an area with typical land-use problems which serves as an example or is it a very specific area where the authors think to find specific conditions for their SDSS? The description of the area is translated into mathematical assumptions and parameters for the SDSS. In the fourth section, a design interface is constructed and a (typical) design session simulated. The design process of the land use planners apparently follow a strict protocol of translating plans into the model and use the output to adjust their plans: “It is assumed that the planner sharpens his or her priorities in response to the plans presented” (Janssen et al., 2008, p. 749). These rounds are simulated and their possible output (maps and
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tables) are presented. From this, the article concludes that the interactive establishment of priorities, the inclusion of different kinds of objectives and response time of the SDSS are all positive factors in supporting planners. In short, the SDSS has a potential for the support of land-use problems especially in first rounds of policy design as long as maps are used as an interface. However, computational problems hinder realistic detail in the representations.

In the entire article and the research that lies behind it, planners or other planning actors have not been consulted on their view on the usability of the SDSS. Their working processes in designing solutions for land use problems are assumed to follow a generic protocol and their need for support in this by an SDSS is also assumed to be in the form of certain maps with “high realistic detail” still “hindered by computational problems” (Janssen et al., 2008, p. 740). In the complex processes of designing and visioning planning problems, such assumptions are not very likely. It is not realistic that this holds for the daily work of a planner, let alone for an ever changing team of actors with different backgrounds, skills and ways of looking at reality. The promised focus on implementation and application of the SDSS seems to be lost in the process of assuming and simulating planning practice. Why are real planning actors not included in the experiment to really tell us something about how the SDSS is used and how planners react to it? Why is there a simulated, and thus not a real, link with planning practice? We would argue that there seems to be fundamental problems with this way of doing research in the domain of PSS and SDSS that hampers this crucial step of including planning practitioners in our development projects. Below we will present our view of the fundamental problems with this type of research and briefly outline a research approach that can overcome this.

Research follows an explanatory program, a general style of thinking about questions of explanation. Without aiming at a definitive classification of methods, Abbott (Abbott, 2004, pp. 27-28) distinguishes three different programs: the syntactic program tries to explain reality by more and more abstract modelling of particular actions and their interrelationships; the semantic program uses patterns to which social particulars are assimilated; and the pragmatic program aims at separating the effects of different potential interventions or causes from one another. These three programs have different levels of research based on their abstraction (see figure i.1). Our main argument is that most researchers in the field of PSS and SDSS development seem, as expected, to be situated in a syntactic research program. Often they come from fields that develop computer models (the most abstract method of syntactic research) and thus they are educated modellers. When confronted with implementation problems, they revert to well known syntactic research methods and use them to make statements about the implementation and application of their instruments. This results in highly general arguments based on making reality more abstract, as the article by Janssen et al. demonstrates. Also research into general guidelines for the improvement of PSS implementation follows this syntactic explanatory program (Geertman, 2006; Vonk, 2006). These claims and guidelines try to abstract reality and are thereby simplified formal representations. This simplicity, although admirable in its intellectual elegance, does not help in
deepening the understanding of why PSS and SDSS are so seldom used and how this can be overcome.

Planning practice, and especially strategy-making, is a complex endeavour that is different in every context depending on complex relations between path dependency of planning institutions and local particularities ((Healey, 2007, pp. 174-176). Syntactic research is almost by definition not capable of recognizing this. Therefore we argue that applying semantic and pragmatic research methods are crucial in understanding (and also closing) the PSS implementation gap. The semantic program focuses on single (one-time) analyses of the social world, describing it in categories and patterns. By describing the state of affairs at a certain moment in time in deep case descriptions, it can add to our understanding about the implementation of PSS in certain contexts. Such deep case descriptions of PSS use are hardly found in academic literature. The pragmatic program uses causal analysis to generate claims about practical experiments. Research focuses on one or more variables and analyses interaction effects with other variables by changing the context (as in laboratories). It can tell us about the comparative size of pragmatic effects on the implementation chances of PSS by creating quasi-experimental situations in real planning practice. Because it is difficult (if not impossible) to create such controlled situations in daily practice, the pragmatic program could adopt a more active research method. Instead of explaining the role of variables by observing, PSS researchers can actively change variables as they work with planning actors and modellers in bridging the implementation gap (theoretically explored in e.g. Van Aken, 2005). Describing these cases in detail in academic literature can then result in recipes for the implementation of certain PSS in certain contexts (as done in

Figure i.1  Explanatory research programmes (Abbott, 2004, p. 24)
I have argued, partly based on a recent contribution in Environment and Planning B that – following academic insights in the implementation gap – PSS and SDSS developers aim to focus more on implementation issues of their instruments. I have argued that their methodological background in the syntactic program seems not sufficient for this and we propose how semantic and pragmatic methods can help in overcoming these shortcomings. It is up to the PSS developing community if they stay focussed on the substantive improvement of their instruments or address the implementation issues that they face more seriously. If they choose the first (perfectly legitimate) goal, they should leave references to the support of practice out of their arguments. If they choose the latter, they have to engage in real planning practice (instead of attempting to simulate it) and learn to analyse and describe their efforts in less abstract and formalized terms. Their goal should be to understand the interactions between the tools and different contexts instead of only presenting general guidelines. In this, we might loose some elegance and breadth in the academic claims, but probably win on relevance and depth of our presented solutions.

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Chapter 4

Land Use and Transport PSS: Meaningful Information through a Dialogue between Modellers and Planners
One of the key barriers to integration of land use and transport planning is the lack of a ‘common language’ (i.e. tools, instruments, indicators) that can support planners from both domains in developing shared visions and integrated strategies. Many of such tools and indicators have been developed in recent years, but not so many are implemented in practice. In this chapter a new, participatory development approach for Planning Support Systems (PSS) is proposed, termed ‘Mediated Planning Support’ (MPS) that addresses bottlenecks blocking this implementation. It is founded on insights from knowledge management, system dynamics and software innovation and is applied in the Greater Region of Amsterdam. This chapter discusses the evolution of the PSS, highlighting the most useful elements which can be applied in other land use and transport planning projects. It offers insights for practitioners and researchers interested in land use and transport planning integration and for professionals that are dealing with supporting planning with information and technologies.

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4.1 SUPPORTING THE INTEGRATION OF LAND USE AND TRANSPORT PLANNING

A better integration of transport and land use planning is believed to be crucial in achieving more sustainable mobility patterns in urban areas and is advocated by academics (e.g. Banister, 2005; Cervero, 1998; Meyer and Miller, 2001), professionals (e.g. Transportation Research Board, 2004), governments (e.g. European Commission, 2007; European Conference of Ministers of Transport, 2002) and business (e.g. WBCSD, 2001, 2004) alike. Underlying this is the belief that if the land use and transport systems are reciprocally supportive, important benefits of mobility are increased (i.e. improved access to activities and jobs, a higher standard of living (WBCSD, 2004, p. 13)), while negative impacts (i.e. pollution, risk, congestion etc. (see e.g. Banister, 2005; WBCSD, 2001, 2004)) are reduced. Several empirical studies support this belief, by showing strong interactions between both systems (overviews in: Banister, 2005; Hanson and Giuliano, 2004; Meurs, 2002; Meyer and Miller, 2001; Wegener and Fürst, 1999). It also reflects a long-standing body of theory on the relationship between land use and transport (Giuliano, 2004; Manheim, 1974; Meyer and Miller, 2001; Mitchell and Rapkin, 1954; Wegener and Fürst, 1999).

From planning theoretical considerations, such integration can be most fruitful if it occurs in early phases of the planning process (Friedmann, 1987; Healey, 2006). The minds of the planners in both domains are still open in these phases; this is necessary in order to come up with innovative ideas and shared concepts and visions. The issues that are being dealt with here are also less contested due to their abstract nature. It is assumed that with shared land use transport (LUT) visions and concepts in place, the chances of conflicting land use and transport plans and projects are significantly reduced.

Yet, in general, real integrated LUT planning processes are often absent in planning practice, especially in these early phases of planning (Banister, 2005; Stead et al., 2004; Transportation Research Board, 2004). Now both domains develop their own separate visions, scenarios, plans and projects focussing on either specific land use or transport issues. As a result, plans and interventions that are derived from these visions are often (unintended) suboptimal or, in the worst case, conflicting (e.g. car dependent development or unprofitable public transport systems).

A number of factors seem to explain this difficult integration. The cited studies name both institutional/procedural discrepancies (i.e. different planning institutions, financial arrangements, etc.) and substantive differences (i.e. different planning objects, information, knowledge etc.). This is also recognized in recent, dedicated research projects such as DISTILLATE in Great Britain (Hull and Tricker, 2006; Jones and Lucas, 2005) and IMPACT in Sweden (TransportMistra, 2007). Although we recognize that the institutional and substantive domains are strongly interrelated, the focus of this chapter is mainly on the substantive barriers.

There have been significant academic and professional efforts to develop common LUT concepts in recent years with the goal to bridge the substantive differences between the two planning domains. The outcome of this is a host of integral
indicators (i.e. potential accessibility measures (see e.g. Bertolini et al., 2005; Geurs and Van Wee, 2004)), tools and instruments (i.e. Land Use Transport Interaction tools such as MARS (Emberger and Ibesich, 2006) and UrbanSim (Waddell, 2002). However, recent studies show that this information and these ‘state of the art’ instruments are hardly used to support LUT integration in planning practice (NICHES, 2007, and chapter two of this dissertation). Especially in the early phases of planning there is still a deficiency of relevant integral information and tools (see Hull, 2005; Jones and Lucas, 2005; Te Brömmelstroet, 2010). The tools that do find their way into planning practice are in most cases developed to support the analysis of trends, the evaluation of alternatives or the assessment of projects. Not many of them are able to support scenario-building, story-telling or visioning, all specific tasks in early planning phases. This is not unique for land use and transport planning. The so-called ‘implementation gap’ is shown in many different studies on the (lack of) use of dedicated information and instruments to support (spatial) planning (see Brewer, 1973; Couclelis, 2005; Danziger, 1977; Klosterman, 1997; Klosterman, 2007; Langendorf, 1985; Lee, 1973; Lee, 1994; Stillwell et al., 1999; Uran and Janssen, 2003; Vonk et al., 2005). Note that the gap is not only apparent in a wide range of planning domains, but it is also consistent as a trend over a long period of time.

Generally, two extreme types of reactions on this implementation gap exist (Meadows and Robinsons, 2002). On the hand, notably planners argue that they do not need tools and instruments in strategic phases. Intuition and experience are enough. On the other hand, notably modellers suggest that current models fail to represent much of the complexity of real life and more sophisticated models have to be developed to convince planners to use them. We assert that in strategic phases an understanding of the crucial mechanisms of reality is crucial to develop efficient strategies, as these mechanisms can be counterintuitive. So supportive models are needed to enable the planner to learn and play with interventions, but they can only be used if they offer a better understanding to the planners; without understanding of the (key mechanisms in) the model, the planner can not learn and translate these lessons in more efficient strategies. The central challenge is to find this balance between complexity and understanding (Bertolini et al., 2005).

To address this challenge, we have taken an approach based on insights from several related academic fields and focus on linking the existing routines of planners in specific planning contexts and existing models in more meaningful ways. Following findings in the academic fields of knowledge management, software development and system dynamics (Checkland, 2001; Checkland and Scholes, 1990; Nonaka, 1994; Nonaka and Konno, 1998; Rouwette et al., 2002; Stapleton and Constable, 1997; van den Belt, 2004) we hypothesize that such an approach can give us more valuable insights in how we can truly support the land use and transport planners in the very specific tasks of early planning phases. Firstly, these are insights in how planners work now, where they see chances of land use transport integration and what characteristics dedicated information has to have to support this. And secondly, these are insights in the different sorts of information and instruments, how they are perceived in specific situations and how they can be linked to the specific knowledge field of both land use and transport planners. A context-specific combination of
these two kinds of insights seems crucial in bridging the ‘implementation gap’. The approach that we have used for this is coined ‘Mediated Planning Support’ (MPS). The reference is to the notion of Planning Support System (PSS), defined here as an infrastructure that systematically introduces relevant (spatial) information to a specific process of related planning actions (based on Klosterman, 1997). Our specific approach to its development is through a mediation process with modelers and planners.

The goal of this chapter is (1) to present MPS as an innovative development method to overcome the implementation gap of land use and transport integration tools and (2) to show the results of a first test case in the Netherlands in terms of the specific requirements for information to support integration of land use and transport planning in early phases. These insights are formulated as field-tested hypotheses that will have to be further tested in other cases based on a design oriented research approach (see Pawson and Tilley, 1997; Van Aken, 2004, 2005).

In the following, we will start by defining differences that exist between the sort of knowledge used by land use and transport planners and how these hinder integration. Then, we will shortly discuss how instruments that attempt to bridge these differences are currently used and perceived by planners. Following that, the current debate on the implementation gap of Planning Support Systems is summarized, focusing on proposed directions for improvement. We then make the case that key concepts developed in the practice and literature of knowledge management, system dynamics and software development can serve as useful guidelines for this. We shortly introduce this body of work and modify it to be useful for developing PSS, and thus introduce the MPS approach. The body of the chapter addresses how the MPS method was used in integrated planning processes for the greater Region of Amsterdam. We will synthesize the general insights on the requirements for supporting information and close with conclusions on the developed LUT PSS, a methodological reflection on MPS and recommendations for further research.

4.2 A DEFINITION OF KNOWLEDGE
The substantive barrier between land use and transport planning is related to the differences in types of knowledge used in both domains, fostered by the differences in educational backgrounds and the dominant epistemological frameworks that are used. Before we proceed with the analysis of these differences, it is essential to define how we use the term ‘knowledge’.

The existing literature provides no clear consensus about what precisely constitutes knowledge and how it is distinguished from information (Checkland and Holwell, 1998). This chapter adopts the definition that knowledge is a meaningful collection of information, such that it can be used in a specific context (Ackoff, 1989). For our argument, we will make use of a distinction between “tacit knowledge” and “explicit knowledge”, a concept developed in the field of knowledge management (see Nonaka and Takeuchi, 1995; Polanyi, 1967). Here, explicit knowledge is characterized as easily codified, formalized and expressed in words and numbers. It can be shared
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in systematic language, maps and indicators (Nonaka, 1994, p. 16). Tacit knowledge on the other hand is deeply rooted in action, meaning and personal experience in a specific context. It is harder to codify and share. Converting existing knowledge into new knowledge (i.e. separated land use and transport knowledge into integrated LUT knowledge) requires interaction between tacit and explicit knowledge in an iterative fashion (as is elaborated in Nonaka and Takeuchi, 1995).

4.3 DIFFERENCES IN LAND USE AND TRANSPORT KNOWLEDGE

Substantive differences between land use and transport planning are not only related to explicit knowledge (e.g. differences in indicators, theories and planning objects); there are also strong differences in tacit knowledge domain. We posit that these differences are 1) one of the primary reasons for the lack of implementation of existing LUT tools and 2) largely ignored in the development of these tools. Below we will shortly introduce these differences. The differences sketched below are somewhat extreme, in the sense that they show archetypes of two planning domains. We realize that practice is less black and white, but see this as a useful characterization.

However increasing attention for communicative approaches (see for example Banister, 2008), scientific instrumental rationality still seems the predominant paradigm in the field of transport planning (Willson, 2001). Therefore, transport planners tend to use more quantitative information concerning e.g. transport flows, levels of service and costs. They focus more on general theories and computer models and tend to have an engineering background (Willson, 2001, p. 2). In general, transport planners focus on solving problems (i.e. congestion) and optimizing the transport system, without much attention for wider (social, economic) goals that can be achieved. In other words, the focus is on finding the means (e.g. congestion charge or highway extension) for a given goal (e.g. efficient functioning of the network). Transport planners often use predictive forecasting methods to deal with uncertainty in the future (Jones and Lucas, 2005; van der Bijl and Witsen, 2000; Wachs, 1985; Zaphatha and Hopkins, 2007).

On the other hand, land use planners tend to use more qualitative spatial information about places and functions, work in more communicative settings and often have a background in design or the ‘soft’ social sciences. Today’s predominant land use planning mode is (at least theoretically) based on communicative, deliberative rationality in which multiple stakeholders are included (e.g. Forester, 1999; Healey, 1997; Innes, 1995). The focus lies on confronting and bringing together multiple goals from multiple disciplines in inclusive strategies. They deal with uncertainty in the future in many different ways (planning, scenario’s and visioning) (van der Bijl and Witsen, 2000; Zaphatha and Hopkins, 2007).

4.4 THE STATE OF PRACTICE OF CURRENT LUT PLANNING SUPPORT TOOLS

In 2007, an internet based survey was conducted among planning practitioners in the Netherlands that had experience in attempts to integrate land use and transport planning processes (Te Brömmelstroet, 2010). The goal was to explore patterns in the lack of implementation of existing tools and broad directions for possible
improvement. Findings showed that the respondents (62 transport oriented, 60 land use and 2 unknown) think that current tools don’t provide enough insight in LUT relations, that tools are often used to justify choices that have already been made, that the tools do not fit the planning process and that they are not well linked to the political decision making process. There is not enough support for the generation of alternative solutions and the tools are often implemented too late in the planning process (Te Brömmelstroet, 2010, pp. 12-13).

Four possible bottlenecks behind these problems were seen as (big) problem by more than half of the respondents; (1) the tools are not transparent enough, (2) they are not user friendly, (3) they are not useful in interactive settings and (4) the communication value of the outcomes is too low to be useful in the planning context.

These findings echo those of the broader international debate on decision and planning support tools, where it was found that planners see most of these tools as far too: generic, complex, technology oriented (rather than problem oriented), narrowly focused on strict technical rationality and incompatible with the unpredictable/flexible nature of most planning tasks and information needs (Bishop, 1998; Couclelis, 2005; Geertman, 2006; Klosterman, 2001; Lee, 1973; Lee, 1994; Ottens, 1990; Scholten and Stillwell, 1990; Vonk, 2006). Geertman asserts that the history of planning support tools shows a continuous mismatch between the characteristics of developed tools and characteristics of dominant planning traditions (Geertman, 2006, p. 876). To break through this, Geertman proposes to focus on a better link with the tacit knowledge of the actors in the planning process, with relevant planning issues and with the context-specificities of the planning process, explicitness and transparency in underlying premises, methods and outcomes, and an adaptation of planners (e.g. a more constructive-critical attitude towards models) (Geertman, 2006, pp. 877-878). Planning support tools should be an integral part of the planning process, they must meet context and user requirements (also proposed by other scholars, notably Lee, 1973; Lee, 1994; Vonk, 2006).

4.5 TOWARDS A BETTER LINK BETWEEN PSS DEMAND AND SUPPLY

For the support of integrated LUT strategy development this means that the focus should be on developing a common LUT language that can bridge both tacit and explicit differences in real-life planning contexts. To face this challenge we have to shift the focus from developing innovative explicit information to incorporating the tacit elements of knowledge, the context specifics of the LUT planning process and the user requirements.

Many other disciplines have dealt with similar challenges in the past. Based on lessons from these fields and integrating these with the context-specificities of planning support, a process framework was proposed that facilitates a constructive and structured dialogue between model developers and planners. This method is shortly introduced below. Then, a case study in which the framework was used to support LUT strategy development is discussed leading to some first findings on how to develop meaningful LUT knowledge.
4.6 MEDIATED PLANNING SUPPORT

The academic foundations of our framework (which we coin ‘mediated planning support’ (MPS)) are comprehensively discussed in a separate paper (Te Brömmelstroet and Schrijnen, 2010). Here, we will limit ourselves to introducing the main elements of the approach (figure 4.1). The core principles are:

- A iterative stepwise approach: to give structure, but take double-loop learning effects into account (Argyris, 2005; Stapleton and Constable, 1997);
- Experience, reflecting, conceptualizing and experiment for every (sub)product, according to the learning cycle of Kolb (1984);
- Socialization, externalization, combination and internalization incorporated in the entire process to link tacit and explicit knowledge (Nonaka, 1994; Nonaka and Konno, 1998);
- From problem definition to defining strategies for an existing planning problem to stay close the questions of the client and make the PSS an integral part of the planning process (Checkland and Scholes, 1990; Lee, 1973; Vonk, 2006);
- Constructive and continuous dialogue between planners and PSS developers (Meadows and Robinsons, 2002; van den Belt, 2004; Vennix et al., 1997);
- Focus on group learning to come to planning LUT strategies (Argyris, 1999; Vennix et al., 1997);
- Use as much standing technologies as possible to overcome acceptance bottlenecks (Vonk et al., 2005);
- Keep it as simple as possible, but not simpler than necessary (Meadows and Robinsons, 2002; van den Belt, 2004).

Figure 4.1 The MPS framework
With reference to figure 4.1, a MPS process starts with a focus on the definition of the specific planning problem at hand (in this case the early integration of LUT planning on an urban regional level). At this point, also the group of participants has to be identified (land use planners, transport planners and preferably also stakeholders from both domains), followed by introductory interviews. In this way the participants’ views of the planning problem and their expectations of the MPS process and its results are clarified. Subsequently, both a problem definition and a first design brief for a PSS have to be formulated. This is step one of the MPS process.

A series of workshops follows where a planning product and a PSS (process and information) are simultaneously developed. This combination is important, as it creates a continuous testing ground for the intermediate results and fosters mutual learning effects. Working with the PSS also generates new insights in the user’s needs. The second MPS step focuses on a process protocol, i.e. the necessary steps for arriving at a desired planning product. In the third step, the participants have to identify which information is useful and understandable in each step. In this workshop a first prototype of the common language (information protocol) is created. Through dialogue, the PSS developers and planners have to find out what kind of information is seen as useful in supporting the process protocol. By identifying where the information should be used, an information protocol is developed. These first two stages can be seen as a prototype development. Using the protocols and redefining them takes place in the next two stages.

In the fourth stage, this prototype is put to the test; the group of participants has to work with the PSS to arrive at the defined integrated planning product (the desired output is defined by the participants in the first and second stages). Depending on how the group has defined the process protocol, this stage can stretch over multiple workshops. The fifth and last stage focuses on improving the PSS (based on the lessons learned) and on finalizing the planning product. The result is a final PSS.

As figure 4.1 shows, the process has a dominant direction, but there are many recursive learning effects (the thin lines). For example, gaining new insights about an ideal sequence of planning steps can lead to a reformulated process protocol (learning by doing), which in turn can lead to new information needs.

Besides addressing the ‘implementation gap’ of PSS, such an iterative and inclusive approach is believed to foster interaction between tacit and explicit knowledge and to create improved relationships between planners and model developers (see also Ehrmann and Stinson, 1999; Meadows and Robinsons, 2002).

The next section will present a case study in which the MPS approach was used to develop a LUT PSS to support integral strategy development. According to the design oriented research approach, this case is used to find out how the MPS approach works in planning practice and what outcomes such a process would generate: what are requirements for a PSS to support strategic LUT planning? These will have to be tested further in subsequent cases to ground them as ‘technological rules’ (following Pawson and Tilley, 1997; Van Aken, 2004). To come to these field-tested hypotheses
different qualitative research methods and techniques were used before, during and after the workshops. These included participant observation, questionnaires and action research methods (Argyris et al., 1985). Two researchers of the University of Amsterdam and one from Delft University of Technology prepared and attended the workshops. One researcher was chairing and preparing the sessions while the other two were observing the participants. After each session, the participants were individually asked to reflect on the products and the process. In-depth interviews and meetings were held to clarify how the approach was received and what was gained through participating in it.

4.7 MEDIATED PLANNING SUPPORT APPLIED: THE CASE OF AMSTERDAM

MPS was applied to support an integrated LUT strategy development process in the Greater Region of Amsterdam (figure 4.2). This region is a semi-formal cooperation of 16 municipalities surrounding Amsterdam, encompassing about 1.4 million inhabitants. Amsterdam is the biggest and central city in this area. Leading job locations are located in the city centre, at the southern part of Amsterdam and near Schiphol airport.

The municipality of Amsterdam is the only Dutch municipality with their own fully functional transportation model – GenMod. It is a static and multimodal four step transportation model based on household surveys and mobility counts. GenMod does not represent the state-of-art looking at models available in research environments, but it can be seen as a common type of transport model applied for planning in the Netherlands (state of practice). Following the MPS principle of using as much as possible standing technologies and the belief of participants that while relatively simple, GenMod could still generate useful (i.e. complex and understandable enough) insights in LUT interaction mechanisms in early, strategic phases of the planning process, it was decided to use it as main source of information. GenMod covers 933 zones and includes extensive car and public transport networks. The model is capable of calculating transportation impacts for
land use and transport developments in the Greater Region of Amsterdam. Recent test results have shown that the outcomes of the model are the best available in the Netherlands. Despite this, the model is not used to its full potential (especially in strategic phases of the planning process). It seems that the model is too narrowly focussed on producing rigorous-calculation results, to be used as input for a technical rational planning process. Hence, it is not useful for the (also in Amsterdam much needed) support of LUT integration in early phases. In 2005 the Transportation Planning Department of Amsterdam (DIVV) and the University of Amsterdam thus started cooperation in a project aimed at increasing the usefulness of GenMod for the support of LUT integration in early phases of regional planning (e.g. integral visioning). For this, MPS was implemented.

Involving approximately ten to fifteen participants, the MPS process included six formal meetings, from April 2006 to May 2007. Depending on the particular phase, the group of participants consisted of: two to four transport modellers, four to five transport planners, two land use planners (all from the Amsterdam municipality), one land use planner from the regional authority (Stadsregio Amsterdam), the Dutch Railway company as stakeholder and a group of scientists.

4.8 DEVELOPED MPS PRODUCTS FOR LUT PLANNING SUPPORT

Below, we will discuss the developed products in the initial order of the MPS stages (figure 4.1). This does not always reflect their order of development; due to recursive learning effects, often the products were redefined later in the process, as already discussed above.

4.8.1 Problem Assessment

The MPS for early LUT integration started with a session discussing current planning processes, focusing on bottlenecks blocking integration throughout the (cyclical) planning process. One of the conclusions was that transport planners see themselves reacting on already defined land-use plans, instead of jointly participating in earlier planning phases.

It continued with a discussion on the current planning process. According to the participants, planning is a cyclical process. It often starts with either a land use or a transport idea, followed by an internal discussion among (land use or transport) experts and stakeholders, where a shared vision is developed. Subsequently, risks, needs and opportunities are analyzed and decision makers have to decide on a “go – no go” basis, often followed by a ‘benefit and necessity’ discussion, which is a long process also involving citizens. This can either lead to the implementation of the land use/transport idea or to a new planning cycle. For concepts developed from a land use perspective there is often no support from the transport side and vice-versa, resulting in mutual competition and potential for conflict in later stages. Improving integration in the early phases (of concept development) would prevent such conflicts. As discussed below, in its current form GenMod is not suited to provide support for this.
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A second session focussed on discussing the planning problem that should be addressed in an integral LUT process. The participants agreed on working on alternatives to accommodate the economic growth that the region is expecting until 2030. This growth calls for an addition of 150,000 houses and 150,000 jobs. Also, the infrastructure faces a challenge to accommodate the corresponding traffic. Working on combined transport and land use alternatives was expected to create insights and lessons in to how these challenges can be coped with in an integrated fashion.

4.8.2 Process Protocol

In the following workshop the participants discussed which functional process could overcome the identified bottlenecks. The results of this discussion were interpreted by the researchers of the University of Amsterdam, who presented a process protocol in the next workshop. Again, this protocol was discussed (and used), eventually producing the one depicted in figure 4.3a. Key characteristics of the process protocol are:

• The first planning step should focus on generating land use alternatives based on issues of accessibility and sustainability (derived from an analysis of existing urban development programs/trends). In this step, existing land use constraints (e.g. ecological protected areas) have to be considered in order to avoid the development of an overly idealistic LUT strategy.

• In the second step, the alternatives have to be tested on their network implications (e.g. level of service) and on the same indicators as in step 1 to show the dynamics of these indicators. This will lead to an optimizing design exercise (but possibly also to more radical reframing) in which choices made in the various alternatives can be altered. Also infrastructure measures can be introduced here.

• The third step of the process protocol is to analyze and discuss the differences and similarities between the developed alternatives and consequences, in order to discern robust choices for future LUT systems (land use and/or transport planning decisions which are always beneficial) and interdependencies (‘if we want this then we should do that’ or ‘if we do this then we can expect that’). This was considered more useful than drafting a ‘best LUT plan’; supported by the belief that, while central and comprehensive planning of regional LUT developments is not feasible, being aware of broader implications is essential in order to decide and act consistently on specific issues as they appear (e.g. infrastructural projects, local housing development plans).

• Learning effects can lead the participants (ideally also including information providers) to reconsider the LUT choices made earlier in the process (i.e. in the first developed alternatives).
4.8.3 Information Protocol

The next step towards the LUT PSS was selecting the preferred information characteristics with the participants in relation to the envisaged process protocol. Discussions and individual exercises revealed that user needs in such a process were very different from the current characteristics of GenMod. The planners acknowledged that the explicit knowledge currently does not link to their tacit knowledge, as was also discussed above. They need a common language to discuss strategies, to sharpen concepts and ideas and to build visions. Characteristics as “detail” and “precision” are considered to be of minimal relevance. GenMod should be used to test existing insights and create new ones, instead of delivering ‘facts’ and evaluating existing plans and projects. Furthermore, GenMod is neither transparent nor user-friendly, generating a black box feeling. The model should not only predict future macro situations, but also create insight in LUT choices and opportunities. Finally, it was recognized that there are different layers of ‘users’ (i.e. citizens, stakeholders, experts) with different information needs, a feature that has to be included in a PSS.

The second step towards the information protocol was to judge and discuss the existing LUT information. In a workshop, the participants rated and discussed archetypical LUT maps and data that could be useful. A selection was made and related to the steps in the process protocol. The resulting information protocol (again after iterations of testing) is shown in figure 4.3b. Important characteristics are:

- In the first planning step (constructing the land use alternatives), spatial maps are key. For the design of land use alternatives the participants wanted to know the spatial situation of indicators, such as potential accessibility (e.g. the number of people or jobs accessible from each zone within acceptable travel time) and sustainability (e.g. the number of people or jobs reachable within a crow flight distance\(^7\)). Also spatial constraints have to be considered (e.g. valuable landscape features).

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\(^7\) This indicator is seen as a proxy for sustainability, because it shows the number of activities within reach by slow modes (walking and bicycles), or by shorter trips on motorized modes (proximity).
The LUT information for the first step should in the first place function as a platform for discussions (linking tacit and explicit knowledge). For this purpose the information has to be (1) understandable for all participants, thus transparency of it is crucial (2) qualitative rather than quantitative and (3) simple rather than sophisticated.

In the following step (showing the LUT consequences of the choices made) GenMod should calculate network consequences (e.g. level of service), network opportunities (e.g. for more efficient use) and the dynamics of the indicators used in the first step. This creates an understanding of which choices have a positive impact on the chosen indicators and which a negative one.

In the third and final planning step (selecting robust choices and identifying interdependencies) the model should present clear overviews of all indicators and maps. These are then used to facilitate a closing discussion between the participants on the LUT lessons learned and to create a list of appropriate LUT choices and strategies.

For these two latter steps, the information should sharpen existing ideas and can therefore be more complex. However, to be useful it should be (1) understandable, by explanation and discussion among the participants (2) more quantitative than qualitative and (3) transparent in its assumptions and calculations.

4.8.4 Final LUT PSS

The resulting product of the development approach was the final LUT PSS, a result of testing the proposed process and information protocol in the development of integrated LUT strategies. The participants were overall satisfied with the first version of the process protocol. It seemed that the alternative development and optimisation supported an early integration of LUT planning.

The information protocol as depicted in figure 4.3b was the subject of more group discussion. While everybody agreed on the usefulness of most indicators, the land use planners requested more transparency of the potential accessibility maps; what is included, what is excluded and what are the assumptions. Also, “next to these basic indicators, flexible availability of other relevant information” is desired, according to one land use planner. This is something that has to be improved in the final PSS, which is currently being developed in cooperation with the model developers and the University of Amsterdam. The focus lies on the creation of a ‘GenMod light’, with an increased interactive character and on better documentation to increase the transparency of the information.

4.8.5 Integrated LUT Strategies

The desired end product of the MPS process is not only the final PSS, but an integrated LUT strategy. In the case of Amsterdam, the participants agreed upfront that they did not want to create the best possible alternative from a LUT perspective, but foremost they wanted to improve their insight into LUT relations and the consequences of possible land use and/or transport choices and opportunities. The desired outcome of the process is a list of robust choices for future LUT systems (land use and/or transport planning decisions which seem to work in different
scenarios) and interdependencies (‘if we want A then we should do B’ or ‘if we do A then we can expect B’). Both lists should be accompanied by the corresponding information that was used (explicit knowledge) and discussions that took place (tacit knowledge). Such a product can then be presented to other municipalities in the region, to stakeholders and to decision makers.

An example of a robust choice in the case discussed was to: “concentrate land use programs along existing public transport infrastructure corridors”. This was not an entirely new notion, but according to the participants the information provided clearer argument for this idea (currently not applied in land use planning!). Also, an expressed robust choice was to: “stop the expansion of the road network after the current A6-A9 link and optimise the regional public transport network of the Amsterdam region in combination with increasing the densities of the existing built-up areas”.

An example of a LUT interdependency that became evident in the process (as noted by a transport planner) is “if we want to further develop the new town of Almere, faster public transport connections have to be developed (not mere capacity expansion) and development should occur only on the Westside of the existing town”. Interestingly and contrary to the official views, the developed land use alternatives also showed that from a LUT perspective the existing program could be developed almost without putting more pressure on Almere. The choice to build more houses there (the government plans to add 60,000 houses there before 2030), does not seem to be logical one from a LUT perspective. Such an intervention will probably result in unsustainable traffic on the road- and rail-links between Almere and Amsterdam. Creating more job opportunities in Almere seems to be a more robust choice. In the same vein, better housing location from a LUT perspective, and still acceptable form other perspectives, were also identified.

4.9 CONCLUSION AND DISCUSSION
This chapter started with signalling the importance of LUT integration and the lack of it in planning practice, especially in early phases of the planning process. It was argued that this was partly due to a substantive barrier. A survey among practitioners in the Netherlands showed that current instruments and PSS that attempt to overcome this barrier are not used, largely because of so-called soft reasons: tacit and explicit knowledge do not seem to match. These findings echoed general research on the implementation gap of PSS and it was proposed to follow guidelines suggested by other academic fields and to construct a structured dialogue between modellers and planners to develop and use existing LUT information for the support of early planning integration: Mediated Planning Support (MPS). This method was applied in the Greater Region of Amsterdam.

The outcome of the MPS process in Amsterdam is twofold; the LUT PSS (consisting of a process and an information protocol) and the shared LUT strategies. Below, we will summarize their main characteristics focussing on possible generic features applicable to other strategic LUT processes. These are presented as first ‘field-tested’
principles, which will be further tested in consecutive cases. In closing the chapter, we reflect on the approach taken and suggestions for further research.

4.9.1 *PSS for strategic land use and transport planning*

The process protocol (figure 4.3a) provided a stepwise approach to get land use and transport planners in a cooperative process of developing shared strategies:

- Starting with a shared concept of the problem statement seems crucial; it can show the planners that the two domains have similar goals and can thus result in shared ideas or strategies.
- Developing alternatives in mixed groups of land use and transport planners is important to get diverging possibilities to solve the LUT problem, to support and guide the discussion between the planners, to learn about system dynamics and to test different strategies.
- The preferred outcome is a shared ‘feeling’ for the dynamics of LUT relations, as materialized in the identification of robust choices and important interdependencies. This enhances the learning effect (for participants) with a view on informing the negotiations where strategic decisions are made (i.e. by showing cross implications and trade offs of such decisions).

The information protocol (figure 4.3b) shows which kind of explicit information might be useful in which step of the strategy developing process:

- The generation of alternatives seems best supported by geographical mappings of the current situation. This means that some transport issues have to be translated in a geographical indicator (to improve understanding of their spatial implications).
- Simplicity is key: Although the planners and modellers recognized that more complex measures are needed later in the planning process, simple indicators were deemed most useful in this early process. Much ‘tacit’ awareness about the complexity was already present at the table. Putting it in the indicator could even hamper a fruitful discussion.
- Network maps showing the functioning of important transport links are important for understanding the impacts of the generated alternatives (rather than helping generating them), so they can be compared and optimized (or more radically questioned).
- Most additional information should be provided in the form of a background database (i.e. on a laptop) that can be consulted during discussions; especially the indicators that show the dynamics between alternatives.
- In the final stage (selecting robust choices and identifying interdependencies) graphs are helpful in indicating the impact of certain interventions. It also helps to visualize the variation in impacts between the various alternatives. In particular maps showing the differences in geographical indicators seem to help planners grasp the internal dynamics of the alternatives. Where do certain effects occur when a certain intervention is planned?
4.9.2 LUT strategies
The participants mentioned that the primary gain of this process is not (only) new LUT insights, but rather an increased (and perhaps most importantly a shared) awareness of the rationale behind LUT relations and choices. Or even, as one transport planner asserted: “it created insight that existing ideas are not the only ones that make sense”. The participants also noted that the process perfected existing ideas and concepts, enriched their evidence-base and created a common language to address these issues. The transport planners emphasized that they now have useful process framework and guidelines, which might allow them to be involved in earlier phases of the planning process.

4.9.3 The MPS approach as mechanism
The process in Amsterdam has shown that working through the steps of the MPS framework results in a better fit between the existing transport model and the specific demands of LUT strategy development. Overcoming several of the identified bottlenecks (most notably increased transparency of the tool, increased interactiveness, improved communication value) resulted in more or better argued LUT insights, an improved fit with the planning process and improved support for the generation of alternatives, compared with the previous situation.

One of the key mechanisms seems to be the structured discussion and deliberation between the modellers and the planners. The planners feel that they now have more useful information that is understandable and that shows the crucial and relevant LUT relations. Due to the discussions in the workshops, all participants were fully aware of the limitations of the information and the assumptions behind them. This awareness seemed to be a condition for the creative use of the information.

During the process, much attention was given to how the information should be presented to be useful for the planners. The GenMod developers learned that spatial representation of transport impacts is crucial in supporting land use planners; increase and decrease categories (“better”, “similar”, “worse”) communicate better than detailed figures and graphs are useful to compare different designs and interventions.

4.9.4 Importance of context and further research
Unlike other regions, the Greater Region of Amsterdam can use a transport model that is managed by the municipality of Amsterdam. This unique situation makes it easier to adapt calculations and output to specific demands by planners. Also, the urban dynamics of the region are higher than that of other regions in the Netherlands, especially with respect to the expected economic growth in the coming decades, resulting in a greater sense of urgency. Moreover, the land use and transport planners in the region and the municipality of Amsterdam are relatively highly educated (Healey, 2007) which might make them more capable and willing to work in innovative settings than those of an average municipality. Finally, the workshops only included planners (and one stakeholder), future cases need to include also decision makers and more stakeholders to see if such an approach can be applied in wider planning settings.
These characteristics may have important implications for the outcomes of the process and the potential to generalize them. Both the MPS approach as mechanism and the outcomes have therefore to be subjected to further testing in other contexts. The integration of more up-to-date models in the planning process should be also experimented with. Such research has to focus on how changes in context affect the usability of the MPS approach and if the LUT PSS features presented here are general principles or have to be adapted.

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Chapter 5

Integrating Land Use and Transport Knowledge in Strategy-Making
There is broad and growing consensus regarding the central place of integrated Land Use and Transport (LUT) strategy development in establishing more efficient and sustainable urban environments. However, empirical evidence shows that such integration is hard to achieve in daily planning practice, due to many institutional barriers and substantive differences. More specifically, the tools developed to support LUT strategy development have very low implementation rates in daily planning practice.

This chapter introduces the concept of ‘knowledge generation’ as a potentially useful mechanism for closing the gap between support tools and planning practice. Through two specific Dutch planning cases, we analyze the applicability of this concept in supporting integrated LUT strategy development. The chapter focuses on the developed strategies, how these differ from current practice, and how knowledge generation supported their development.

We argue that socialization produces shared strategies and that effective socialization needs to be supported by efficient mutual exchange between tacit and explicit knowledge. We conclude by discussing the implications of this argument for the wider practice of LUT planning integration.

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5.1 THE STRUGGLE FOR LAND USE AND TRANSPORT INTEGRATION

As extensively discussed by other scholars, there is a growing awareness that the integration of land use and transport (LUT) planning is a crucial prerequisite for more sustainable planning outcomes (see for example Banister, 2002, 2005; Cervero, 1998; Meyer and Miller, 2001; TRB, 2004). However in the Netherlands (and in other countries) such integration is scarcely present in daily planning practice (see for instance Hull and Tricker, 2006). If anything, one can speak of policy coordination rather than ‘integration’; i.e. it is dialogue or information exchange which is geared at avoiding conflicts between projects, but does not seek to establish similar policy goals (Stead et al., 2004). Achieving integration in earlier phases of planning (for example strategy development, goal orientation or visioning) can potentially produce shared policy goals, which would promote mutually reinforcing (instead of obstructing) land use and transport measures.

A wide variety of barriers block such early integration, for example: distinctive budgets, different procedures, weak/contradictory incentives for cooperation, reluctant departmental culture or the lack of efficient management mechanisms (see Cabinet Office, 2000; Hull and Tricker, 2006; TRB, 2004). Beside these institutional barriers there are large substantive differences between the domains of land use and transport planning in: planning objects (places vs. networks/flows); tools and instruments (e.g. spatial GIS vs. mathematical transport models); operational modes (holistic visioning vs. optimizing problem solving); and educational carriers. Hence, the two professions speak different professional languages (a point further elaborated in Te Brömmelstroet and Bertolini, 2008; :see also van der Bijl and Witsen, 2000; Wachs, 1985). In early planning phases, focusing on the development of new (and shared) knowledge and group learning, this lack of a common lexicon is particularly problematic (Couclelis, 2005; Jones and Lucas, 2005; Klosterman, 2007). Tennøy recently used the concept of conflicting reference frames (Schön and Rein, 1994) to analyze the conflicting ways that different parties (e.g. land use and transport planners) view the issue of sustainability (Tennøy, 2009). This showed how this results in two different sets of planning languages, which are hard to integrate. Although we recognize the great importance of institutional barriers to LUT integration, in this paper we focus on these substantive barriers, while they have been addressed much less extensively in the literature.

Many (computer based) tools and instruments have been developed to try and provide such a common LUT language for integrated visioning or strategy development, for example UrbanSim (Waddell, 2002) and MARS (Emberger et al., 2006) (for extensive overviews see Wegener, 2005; Wilson, 1998). However, these instruments face serious implementation problems. Recent research shows that the gap between instrument development (by consultants and/or universities) and daily planning practice creates the main implementation bottlenecks. The present technology— rather than user–focus produces unsuitable instruments: focused only on scientific rigor rather than also on practical relevance; not adapted to the complex and dynamic planning context; not transparent; not user friendly and inflexible. Therefore, such instruments cannot link-up with the context specifics of early LUT integration (Te Brömmelstroet, 2010). These findings mirror the wider
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academic debate on implementation bottlenecks of these so-called Planning Support Systems (PSS) (see for example Geertman, 2006; Uran and Janssen, 2003; Vonk et al., 2005) and on the role of transportation models in an increasingly communicative planning practice (see e.g. Timms, 2008; Willson, 2001).

5.1.1 Towards Improved Support

Similar problems are addressed in the knowledge management literature. In recognition of the limited role of scientific and technical information in decision-making, it introduced concepts which addressed the personal and softer dimension of knowledge. In their seminal study on innovations in Japanese companies, Nonaka and Takeuchi (Nonaka and Takeuchi, 1995) introduced the concept of knowledge generation. Innovating companies designed enabling environments in order to provide a confrontation between technical information and the personal dimensions of knowledge. Iteratively going through these confrontations produced new knowledge and thus innovative potential. This provides useful insights for successfully linking the technical information of LUT PSS with personal knowledge.

To assess this potential, we have used the concept of knowledge generation to structure two exploratory cases where a group of planners engaged in integrated LUT strategy-making in the Netherlands on a regional (Amsterdam) and local scale (Breda). This paper will 1) describe these applications, focusing on their divergence from existing practices, and 2) analyze the contributions of the knowledge generation concept.

Our research methodology followed the logic of realistic evaluation (Pawson and Tilley, 1997), which seeks to identify a solution for a particular class of problems, or a ‘technological rule’. A technological rule follows the general form: “if you have a context C, use an intervention type I, to achieve outcome O through the mechanisms M” (Denyer et al., 2008; Pawson and Tilley, 1997). In section two of the paper, we will introduce a division of knowledge and elaborate on the concept of knowledge generation, exploring its possible applicability to LUT strategy-making. Sections three and four will provide detailed examinations of the two cases, including: the context (LUT planners in LUT strategy design processes on the local/regional scale in the Netherlands), the intervention (the concept of knowledge generation) and the outcome (integrated strategies). The fifth section will further analyze the general relationship between the identified mechanisms and outcomes, after which the paper will close with conclusions and a discussion of possible implications for wider planning practice and support.

5.2 KNOWLEDGE, KNOWLEDGE GENERATION AND PLANNING SUPPORT

The differences in knowledge used in LUT planning are a substantive barrier which hinders integrated LUT strategy-making. The academic domain of knowledge management offers useful insights for overcoming the gap between these professional languages.
5.2.1 *Explicit and Tacit Knowledge*

In the field of knowledge management, Polanyi (1967) introduced the distinction between explicit and tacit knowledge. Explicit types of knowledge are formal (ex. data, scientific formulas and general/universal principles and theories) and are therefore easily codified with a wide validity. Explicit knowledge usually resides within certain (planning) disciplines, following institutionalized rules about: the manner of creating new knowledge, conducting analysis or surveys, and the validity of evidence or argumentation. Recently, Healey used the term *systematized* to refer to similar knowledge in strategy-making processes (Healey, 2007). The second dimension is *tacit knowledge*, sometimes referred to as invisible knowledge. This is personal and hard to formalize, which makes it difficult to communicate or share with others (for example practical know-how, intuitions and hunches). In the words of Polanyi: “one can know more than one can tell” (1967, p. 138). Tacit knowledge and information are not necessarily related to particular disciplines, but rather to people’s (ex. planners) individual experiences (Gibbons et al., 1994). Nonaka and Konno asserted that, “tacit knowledge is deeply rooted in an individual’s actions and experience as well as in the ideas, values, or emotions he or she embraces” (1998, p. 42). Polanyi introduced the concept of tacit knowledge to conceptualize the knowledge that (by definition) cannot be described or talked about (writing it down would make it explicit). Here, we will use the term less strictly to broadly conceptualize the experiential knowledge of planners in order to assess its relationship with the explicit (or systematized) knowledge of for instance transport models (an argument also made by Healey, 2007).

Several authors (Gibbons et al., 1994; Innes, 1998; Khakee et al., 2000; Scharmer and Kaufer, 2000) emphasized that tacit knowledge plays an increasingly important role in formal decision-making, and should be duly recognized in planning processes. If planners want to address complex socio-economic planning problems (and thus cope with the many associated uncertainties), explicit knowledge and information should play an important role; however, it is pivotal to realise that the explicit should be combined and confronted with the tacit. If explicit information is not made understandable and more transparent, and if it remains disconnected from daily practice, the practitioners will not use it. In addition to satisfying academic rigour, scientific knowledge should thus also be relevant, useful and understandable for the planning actors. This was already one of the key elements of Friedmann’s transactive planning (Friedmann, 1973). Interestingly, instead of highlighting the ‘democratic’ motives for improving inclusiveness, “the argument for transactive planning is that expert knowledge should be wedded to experiential knowledge to achieve a greater rationality in decision-making” (ibid., p. 378).

5.2.2 *Knowledge generation*

At the end of the last century, Western and Japanese research on knowledge management arrived at similar insights concerning knowledge generation, describing it as a social process. Creating rigorous and relevant knowledge required linking the explicit with the tacit through interaction (Gibbons et al., 1994; Nowotny et al., 2001). In their seminal work on knowledge creation in Japanese companies, Nonaka and
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Takeuchi conceptualized four key modes of knowledge conversion in their SECI model (Nonaka and Takeuchi, 1995, pp. 61-71):

- **Socialization** (tacit with tacit) - sharing experiences to create new tacit knowledge, observing other participants, brainstorming without criticism;
- **Externalization** (tacit with explicit) - articulating tacit knowledge explicitly, writing it down, creating metaphors, indicators and models;
- **Combination** (explicit with explicit) - manipulating explicit knowledge by sorting, adding, combining, looking to best practices; and
- **Internalization** (explicit with tacit) - learning by doing, developing shared mental models, goal based training.

Figure 5.1 shows the resulting matrix of knowledge generation. The spiral represents a process of knowledge generation within a group, iteratively acting in all four modes of knowledge conversion.

![Figure 5.1](image)

Various authors criticized the model due to its methodological inconsistency (tacit knowledge per definition cannot be made explicit) (Tsoukas, 2003) and the limited empirical support for the model (Gourlay, 2006). In spite of these shortcomings (also recognized by Nonaka (2006), the SECI model has enjoyed enthusiastic acceptance in organizational science and practice, and also has a paradigmatic status in the field of knowledge management. We use it to provide a conceptual framework for linking different kinds of explicit scientific knowledge with strategic urban planning processes.

**5.2.3 Knowledge Management to Support Strategy-Making**

LUT strategy-making is a social learning process in which actors use not only explicit information but also earlier experiences, concepts from their educational careers and personal feelings (Healey, 2007; Mintzberg and Waters, 1985; Simon, 1993). The concept of knowledge generation can be a useful guiding principle for improving this learning process in integrated LUT strategy-making. In this, it links to, and attempts
to further articulate the concept of the reflective practitioner, as originally developed by Donald Schôn (1983).

By experiencing the four knowledge conversion modes, planners can develop a shared explicit language and use it to develop integrated strategies. Socialization provides a platform where people can interact and learn from each others’ concepts of reality, views of the planning object, working modes and professional languages. In this first important step, the participants build a common understanding of each others’ tacit foundations. In step two, Externalization, the planners are challenged to formalize this in a shared working process (including a planning problem, planning steps and a preferred outcome) and in a shared set of indicators, information and models. Externalization takes place in dialogue with PSS developers who can explain the available explicit LUT knowledge and its possibilities/shortcomings. The end result is a contextualized professional LUT language, combining the planners’ preferences and the available PSS. In the third knowledge conversion step, Combination, the PSS developers link different models and indicators (based on a mutual LUT language) which provide support for the different steps of the externalized strategy-making process (ex. designing or choosing alternatives). Internalization occurs when the PSS output is presented to the planners (ex. demonstrating the effects of alternative strategies). In order for this explicit LUT knowledge to be useful for the planners, it has to be explained and discussed. The PSS developers have to provide transparency by explaining the assumptions and uncertainties in the modelling, thus enabling the planners to internalize these results and to discern their cause–effect relationship. After these four steps, the planners have a mutually understandable and applicable set of explicit knowledge. Through the use of this language, some of their tacit knowledge has changed (land use planners incorporate new transport insights and vice versa), thus adding value to other strategy-making processes. Also, new shared LUT strategies have been developed. After the four steps are finished a new round can start, when the planners use the internalized knowledge to discuss new interventions.

This knowledge management approach to planning support shares elements of other normative methods that aim to support the use of explicit knowledge in collaborative working. Joint Fact Finding aims to facilitate the use of technical or scientific knowledge in a contested environment (Ehrmann and Stinson, 1999, p. 2). However, its focus is to fill information gaps and explore uncertainties and does not explicitly give guidelines for the use of this information and the iterative (and reciprocal) exchange with the tacit knowledge of participants. Group Model Building facilitates the development of a shared view on reality, often a conceptual framework of a problem (Vennix, 1996). This important first step in many collaborative endeavours does still not mention how to organize the full circle of knowledge generation. The SECI model emphasizes—in addition to these methods—the importance of going through at least one full circle of tacit-explicit-tacit. It identifies four specific phases of knowledge transition with unique dynamics and thereby adds to our understanding of how such processes work and can work. To explore if and how the SECI model can support real-life integrated LUT strategy-making processes, we applied it in two Dutch cases: in the Amsterdam region and in
the city of Breda. In both cases, planners from the municipality approached the University of Amsterdam to guide them in a process of integrated land use – transport strategy-making. Together with these planners, potentially relevant providers of explicit planning support knowledge were selected and asked to support this process. The authors of this article were involved in both cases as organizers and chairs of the sessions. Both experiences were made possible by the Dutch national government sponsored research programme TRANSUMO (“Transition to Sustainable Mobility”). While addressing real-world issues with real-world stakeholders, they had no formal relationship with the political decision-making process.

From a methodological point of view, we followed the realistic evaluation approach of (Pawson and Tilley, 1997) as described above. Following this approach, below we will describe the context, intervention and outcome of both cases and how these differ from existing practices. Based on data obtained from direct observations, questionnaires and in-depth interviews, we will then explore the link between the outcome and the concept of knowledge generation (the hypothesized mechanism).

5.3 FACILITATING GROWTH IN THE AMSTERDAM METROPOLITAN AREA

5.3.1 Context: Substantive and Institutional
The Amsterdam metropolitan area (Figure 5.2) is facing substantial land use and transport challenges in the coming decades. As one of the few Dutch regions where economic and population growth is foreseen in all future scenarios, the region has to plan for a large number of new high quality jobs and houses (both around 150,000 until 2030). However, mainly due to nature preservation and airport noise regulations, space for new urban development is scarce. In addition, the region is facing dramatic growth in traffic flows and congestion in the near future. Instead of seeing these as separate challenges needing separate strategies, the municipal (and regional) land use and transport planners are looking for ways to develop integrated strategies.

![The Amsterdam Metropolitan Area](adapted from Noordvleugel, 2008)
Many of the planners (especially in Amsterdam) already work together in several (thematic or geographical) project teams. The Municipality of Amsterdam is also known for its strong strategic capacity and close collaboration with the university (Healey, 2007). However, the planners experienced that it was sometimes difficult to develop strategies together. In this case, not so much due to separated institutions, but because of difficulties in using information that was understandable and meaningful in both planning domains.

Since the 1980s, Amsterdam has been using its own in-house transportation model (GenMod), a static and multimodal four-step transportation model based on household surveys and mobility counts. GenMod is capable of calculating transportation impacts for both land use and transport developments in the Amsterdam metropolitan area. Despite the fact that it is considered one of the best transportation models in the Netherlands, it is not being used to support strategic planning processes in early phases (let alone integrated land use and transport planning endeavours), but only to assess and detail already developed strategies. This is felt as a missed opportunity to develop more LUT integrated strategies.

5.3.2 Intervention: the Sessions

In 2006 and 2007 six sessions were held in the Amsterdam region. In these sessions land use and transport planners from the Municipality of Amsterdam and the Amsterdam Metropolitan Area (Stadsregio Amsterdam), transport modellers and a strategic planner from the Dutch Railways set out to develop integrated LUT strategies for the region up to 2030. We used GenMod to support this effort. The sessions were designed to allow the different phases of the SECI model to take place (see discussion under ‘Mechanism’ below).

In the first step, the participants discussed and agreed on the framing of the LUT planning problem - to foster economic growth up to 2030 (and thus create space for 150,000 additional jobs and houses) with supporting LUT strategies. The second step involved a discussion on how to shape the planning process for developing integrated strategies. The iterative strategy-making process chosen had three steps: first diverging (developing alternative urbanization and [later] transport interventions), then converging (assessing and comparing effects) and finally selecting (identifying strategies). The participants also agreed that they did not want to develop a ‘final LUT plan’, but rather wanted to develop common insights in ‘no regret’, or ‘robust’ strategies (strategies that can work in different future scenarios) and in LUT interdependencies (“if....then...” statements, improving understanding of the implications of the options available). In the third step, the PSS developers introduced information deemed useful for this planning process. The participants discussed it and consequently selected as pertinent: (for diverging strategies) spatial accessibility and sustainability maps based on cumulative opportunity measures and measured in travel time and distance; (for converging strategies) network maps of the effects of strategies on the road and transit networks; and a number of indicators for the effects of strategies (overall accessibility indicators for the region). By using it, the information was also transformed, namely made simpler and more transparent. In the fourth step, spanning three separate sessions, they developed
shared LUT strategies. After two design sessions, the effects on the indicators of the developed strategies were presented. They supported the final step, the selection of ‘no regret’ strategies (using different sets of assumptions on future conditions in the region) and interdependencies (“if we do A....than we should be aware of effects as B”). All the steps are synthesized in Figure 5.3 below.

Figure 5.3 Intervention steps to support integrated LUT strategy-making

5.3.3 Outcome: Integrated LUT Strategies

Through this process (extensively described in Te Brömmelstroet and Bertolini, 2008), the group of participants developed a list of ‘no regret’ strategies and LUT interdependencies. These are specific outcomes of this group learning exercise and should be interpreted solely in this context. The following examples of ‘no regret’ LUT strategies highlight how they differ from current practices:

- Land use choices, due to their marginal influence on accessibility, can and should be based on existing accessibility characteristics (instead of trying to influence accessibility characteristics through land use choices). Land use planners reported gaining new insight that the influence of the existing regional urban fabric on the cumulative opportunity measures is very strong and minimizes the effects of new land use strategies.
- A polycentric ‘network city’ (centred on multiple public transport nodes) is not less accessible or less sustainable than a ‘compact city’. One of the alternative urbanization strategies based on this concept scored high (or even higher than the other alternatives) on sustainability indicators, which was a surprise for many of participants.
- Spatial programs should be developed in existing transit corridors. During the exercise it was discovered that some of the existing transit corridors offer additional opportunities for developing new station areas (notwithstanding existing restrictions such as nature reservation).
• The orbital bus rapid transit system should be extended to link several existing/upcoming housing developments with working areas. This is not a new idea, but during the exercise it was more widely shared and supported with explicit information.

• Once the currently planned extensions are completed, development of the highway network should stop. This highly controversial idea was supported by the indicators which showed that by implementing demand related interventions (i.e. road pricing) the current road network will retain sufficient capacity, even with increases in houses and jobs.

• Transit travel speeds towards the new town of Almere and capacity towards the airport Schiphol should be increased. The planners learned that job accessibility for Almere was contingent on reducing the travel time to Amsterdam within acceptable limits (in addition to direct job creation in Almere). On the other hand, Schiphol is already close to other important locations (also in travel time), but the number of tracks will become a bottleneck in the (near) future.

Based on the strategy design process and the effects shown in maps and indicators, the participants identified three important LUT interdependencies:

• If more housing is developed in and around Almere, then it has to be on the west side and a direct and fast transit link to Amsterdam (south and central) is crucial.

• If there is development around transit stations, then especially working (rather than housing) functions can have a significant effect on the modal split. Based on their research, the Dutch Railway planner explained that people are more likely to commute by train if the transit nodes are close to their destination. There is a sufficient number of acceptable travel options to the station on the origin side (including own bike or car); however, opportunities are lacking on the destination side. Many of the participants had not explicitly recognized this issue before the sessions.

• If the housing targets in the western part of the region (Bollenstreek) cannot be met, then regional growth figures have to be reduced. One of the land use planners emphasized the crucial position of this area, a completely new notion for the other participants.

Overall, the outcomes were not entirely new to the planners. However, the participants did find the concepts more thought-out, jointly deliberated, and supported by relevant information. On the individual level, some planners gained more confidence and insight in the use of the supporting model. As a result participants stated that there is an increased chance that such similar integrated strategy development processes will be used in the Amsterdam metropolitan area in the future. The questionnaires revealed that most planners felt that they had a more constructive attitude towards the need and possibility of strategy integration, due to the focus on collectively accepted explicit knowledge. This made it possible to discuss land use impacts of –on first sight– irrelevant transport strategies and vice versa. Especially the platform provided by the accessibility maps seemed to allow a free, and yet structured flow of tacit knowledge.
5.3.4 *Mechanism: Knowledge Generation*

The organized sessions helped the LUT planners to develop integrated strategies. The participants considered that process as an improvement to existing practices, especially in its enhanced sharing of insights and its providing improved support for concepts. To illustrate the mechanism behind this improvement, below we will discuss the four components of the SECI spiral of knowledge generation and how these supported the development of integrated strategies.

**Socialization**

In the first step (see figure 5.3), defining a shared LUT planning problem, the planners had to link together the specific issues of their domain and arrive at a definition of the overarching shared problem - how to facilitate growth in the region. Also, during the first step of designing alternatives, they exchanged tacit knowledge; experience and personal knowledge about the area. In turn, they increased their understanding of its strengths/weaknesses and produced individual strategies for intervention.

In the second step, the participants discussed their view of current planning processes and how to improve them through integration. This resulted in a shared view on the reasons why it is difficult to develop an integrated LUT strategy in practice and how to organize a process bridging these difficulties. Although one land use planner stated that, “with the current area-based approach [...] there is already an integral way or working,” another land use planner addressed that this open start, “without a presumption about which planning domain is leading,” was a positive change compared to common practices.

Finally, socialization occurred when the participants identified and shared their viewpoints regarding ‘no regret’ strategies and LUT interdependencies (in the words of one transport planner, “especially the interactive way of working was positive”).

**Externalization**

In the third step, participants translated their tacit into explicit knowledge, discussing different indicators suitable for the defined planning issue and thereby describing the issue in terms of explicit information. In the fourth step, designing scenarios, the planners externalized their strategies in concrete interventions on the map. This was a crucial trigger for dialogue between land use and transport planners; they had to explain to each other their preferred choices and the LUT strategy suitability of the particular choice.

**Combination**

Combination occurred when the planners used several different forms of model outputs to assess the effects of specific planning interventions in the fourth and fifth steps. The planners preferred having a large number of impact maps at their disposal, categorized in a digital environment. Such a system enabled them to access and combine several maps and indicators, thus articulating complex trends in multiple comprehensible maps.
Internalization

The participation of the modellers during all of the steps was crucial for internalization; they formed the essential bridge between the explicit information of GenMod and the tacit knowledge of the planners. In the last two steps, where the effects of certain interventions were presented, the planners asked the modellers many questions about the assumptions behind the information and the meaning of the presented indicators. Through dialogue, they could use the information to first optimize their own strategies and later to develop shared strategies. One transport planner emphasized the importance of making the indicators useful by providing “good explanation and clarification”. Simple (understandable) explicit information provided a necessary platform for exchanging tacit information. At first the modellers provided information (distance decay, competition and congestion effects) that was too complicated to be internalized and used, but through dialogue the information and its understanding were improved.

Due to this well supported internalization, the planners could start a second knowledge generation cycle aimed at further strategy development. The participants’ questionnaire responses highlighted the value of socialization, for example: “as a land use planner, I am now more aware of the different ways of using accessibility measures than before” and “although the information is often not exactly what you want, you are more aware of the information that is used.”

5.4 INTEGRATING STATION DEVELOPMENT AND LAND USE PLANS IN BREDA

5.4.1 Context: Substantive and Institutional

The city of Breda aims to develop a peripheral railway station on an existing railway line, located between its urban centre and the neighbouring city of Tilburg. The station should function as a Park and Ride facility (located near the A27 highway) and it should create opportunities for more public transport oriented development in the future (see top of Figure 5.4). This idea fits in the regional perspective of an intensified regional railway network (Brabantstad, 2003). Parallel to this transport concept, Breda developed a strategic land use plan for the eastern part of the city as an extension of the existing urban fabric, illustrated in Figure 5.4. The distance between the proposed railway station and the leisure centre (projecting 2 million visitors a year) is about one-and-a-half kilometres. The distance to the new housing and working areas is over three kilometres (while the A58 highway is only 500 meters away!). This evidently disjointed land use and transport thinking inspired a group of planners to approach us to explore the scope for an improved integrated strategy for this area.

As a baseline, this group of planners was less used to work across disciplinary boundaries than the Amsterdam group. In interviews prior to the sessions, the planners stated that overall there is limited cooperation between the land use and transport planning domain and that, in contrast to Amsterdam, they have very limited in-house modelling capacity (relying instead on input from consultancy firms hired for specific projects).
5.4.2 Intervention: the Sessions

In Breda, four sessions were facilitated in the period between April and November 2007. Land use and transport planners from the municipality of Breda and the neighbouring municipality of Oosterhout (potentially affected by the proposed railway station) deliberated how to integrate the train station with land use proposals that had recently been approved by the municipality. As a key stakeholder who determines the feasibility of the station, two strategic planners of the Dutch Railways facilitated the process with their Circalex model (calculating potential new train users based on land uses around the station), along with the transport consultant Goudappel Coffeng (who calculated the cumulative opportunity measures [accessibility] for different travel modes).

In the first step, the framing of the planning problem (see figure 5.3), the participants decided to split the group because they realized there were two (related but distinct) planning issues which needed specific attention: 1) how to optimize the user base of the railway station by maximizing functions in its catchment area and 2) how to integrate the recent land use proposals with the public transport system. In the second step, determining the appropriate planning process, both teams chose to

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**Figure 5.4** Spatial structural plan of Breda and the new railway station; black for housing, grey for working functions and shaded for a leisure centre (adapted from Gemeente Breda, 2005, p. 4)
work according to the three step design approach used in Amsterdam (diverging, converging, selecting). Again, they emphasized that the preferred outcome were shared LUT insights (‘no regret’ or ‘robust’ strategies and LUT interdependencies) and not a LUT plan. In the third step, the teams chose different supporting information. The railway station team decided to base their design on the Circalex model; considering development opportunities near the station, its support for train use was optimized by adding jobs and housing. The other team assessed and optimized the public transport strategies by using maps of the current networks and comparing them with sophisticated accessibility maps (which show the most accessible locations for car, transit, slow modes and combinations based on a cumulative opportunity measure). These maps illustrated the potential for a specific strategy to effectively change the accessibility of an area from car oriented to public transport oriented. Thanks to the preparatory interviews, these three steps could all be performed in one morning session. The fourth step, using the information to develop strategies, took place in the second and third session, during which the group also developed a list of ‘no regret’ strategies and LUT interdependencies (the final step). These steps follow the ordering presented in Figure 5.3.

5.4.3 Outcome: Integrated Strategies
Examples of ‘no regret’ LUT strategies in Breda were:

- Even if the new station is unlikely to be feasible at present, future spatial plans should always keep the option to develop high-end offices or housing near the proposed station open, and thus realize emerging opportunities. For example, if the region decides to invest in a regional rail network, the possibility of locating high density developments at the station would be very beneficial.

- Basic public transport (a regular bus travelling to the city centre every half hour) has to be provided in the new housing and working areas. It would significantly increase the accessibility by public transport, although it would not make Breda-Oost a top public transport location. In the present context, the latter is not a realistic option (an important point to be communicated to the municipal councilpersons).

- Do not develop a Bus Rapid Transit system only for this area, as there are insufficient numbers of inhabitants and jobs to support it. Despite the politicians’ drive to develop Breda-Oost into a top public transport location, the strategies demonstrate that it would be an expensive investment yielding weak results. Such analysis increases the politicians’ awareness of costs and benefits.

- As the new areas in Breda-Oost will not become a top public transport location it is necessary to also plan for car accessibility. If this is neglected, the area will probably face problems in the housing market and in the realm of mobility.

- Developing mixed living and working areas would increase employment opportunities in the close vicinity of housing and would encourage a more balanced use of (public transport) infrastructure. The accessibility maps showed that accessibility is not only improved by mobility but also by such land use measures.
Besides these strategies, the group learned about LUT interdependencies:

- *If* all the spatial opportunities in the vicinity are filled, *then* the railway station is feasible (for construction and exploitation by Dutch Railways); however, given the rural character of its surroundings this is hardly realistic.
- *If* there is no clarity about the exact spatial program, *then* the station should not be developed. All of the available land use potential needs to be developed in order for the station to be viable; therefore, uncertainty about the surrounding developments is not acceptable;
- *If* public transport is going to play a big role in this area, *then* it should focus on improving access to shopping activities in the city centre (in combination with a ‘Park and Ride’ near the leisure centre and pricing incentives for inner-city parking). The additional volume of users would make an enhanced bus service to Breda-Oost feasible.
- *If* the leisure centre focuses on big single national events and on young people (rock concerts) *then* the station can play an important role. *If* the focus is on regional/local events, on mixed public and on continuous visitors (e.g. skiing hall) *then* the train will play only a marginal role.

The participants acknowledged that they gained new insights about LUT interdependencies and recognized that such an integrated process “should have been included in the development process of the land use plans.” They also agreed that similar processes “should be done in early stages of future projects.” Especially the exchange of the previously one-directional land use or transport views of an area was seen as an added value (i.e., the exchange of tacit knowledge). Similar to the Amsterdam case, the initial discussion and agreement on what was relevant explicit knowledge for the issues at hand proved a starting point for a structured substantive exchange with more depth than usual. In the words of one transport planner: “although it makes the process more complex at the start, it will show its advantages in the end.” On an individual level, the participants stated that they learned more about the useful applications of explicit information in providing support to LUT projects.

5.4.4 Mechanism: Knowledge Generation

Below, we will again review the four elements of the SECI spiral and analyze how they supported the process of LUT strategy development.

**Socialization**

Even though for the specific case of Breda-Oost it happened too late in the planning process; socialization did produce valuable insights for future projects. The interaction with planners of the Dutch Railways was of particular significance, as the planners could better understand the company’s position regarding the financing of new railway stations. By explaining and openly discussing their reasoning, the Dutch Railways planners could link up with the knowledge and planning processes of the land use and transport planners and vice versa.

In the fourth step, designing strategies, the planners discussed the balance between the ideal and the feasible development around the station. The land use planners
emphasized to the transport planners their concerns regarding nature preservation in the area.

**Externalization**
Selecting and discussing an appropriate process and indicators (step two and three) were a crucial part of the first session. Due to a lack of modelling capacity in Breda, primarily the railway planners and the consultant provided the information; this involved a greater leap for all planners as they had no significant prior experience with this type of information. For instance, the Circalex model was not seen as useful at the start; however, while using information later to develop strategies (step four), the model was seen as more appropriate and had a central place in designing the interventions (a ‘learning by doing’ mechanism). Again, the evident difficulty of bridging tacit and explicit knowledge surfaced in the perception of the accessibility indicators as too complicated and insufficiently detailed. It seemed that the absence of the PSS developer (who did not attend all workshops) was an important barrier hampering the effective use of the information. In a following workshop, this was overcome through a dialogue between planners and the PSS developer in between workshops, which clarified the information demand.

**Combination**
Clear examples of combinations are found in the maps showing the current plans and possible intervention effects. The municipality provided the former, while the latter came from the Dutch Railways (in the station team) and the consultant (in the public transport team). As a result, the inconsistencies and (missed) integration opportunities were clearly identified.

**Internalization**
As in Amsterdam, the importance of modeller participation during the entire process was crucial. In the fifth step (during the third session), with the consultant absent, there was little internalization of the results and the public transport group was unable to develop a shared list of strategies. A fourth session was prepared, where the consultant could present and clarify the assumptions and reasoning behind the accessibility maps. Only then was the group able to compose a full and shared list of strategies.

**5.5 CONCLUSIONS**
The chapter started by introducing the difficulties of integrated LUT strategy development and the low implementation rates of associated planning support tools. We presented knowledge (specifically through the process of knowledge generation) as an important mechanism which can bridge the substantive differences between land use planners and transport planners. The cases of Amsterdam and Breda analyzed if and how knowledge generation (through socialization, externalization, combination and internalization) can support integrated LUT strategy-making. Based on the results, we can conclude that 1) integrated LUT strategy-making is still not commonplace practice in the Netherlands; 2) land use planners and transport planners have different sets of tacit and explicit knowledge, this gap hampers providing support with explicit knowledge; 3) the concept of knowledge generation
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and its application in a step-by-step iterative planning support development process offers useful guidelines for improving the link between tacit and explicit knowledge through a process of knowledge interactions; and 4) through such a process planners can develop shared knowledge and ultimately integrated strategies.

We set out in this chapter to explore the functioning of the mechanisms behind the intervention (knowledge generation) and its outcomes (shared LUT strategies), grounded in a specific context (land use and transport planners participating in strategy-making processes at the local/regional scale in the Netherlands). Based on a literature study and on observations, questionnaires and interviews of two explorative cases, we can conclude that:

- From knowledge management literature, it can be extracted that socialization is an important process which creates shared LUT knowledge, because it increases insight in the working methods and the underlying assumptions in both domains.

- From knowledge management literature, we learn that for socialization to be constructive, both processes of externalization and internalization are crucial. The planners are stimulated to express their tacit knowledge in a shared explicit language of indicators and information. The socialization process is steered beyond mere discussion into designing and testing of alternatives.

- Our cases confirmed these general findings. In addition, they emphasized that both the planning problem and the supporting information (content of the PSS) have to be discussed and selected in open dialogue between planners and PSS developers. The result is a contextualized PSS connected to the planner's specific needs and sets of tacit knowledge. It also takes into account what PSS developers can deliver in practice.

- The cases also indicated that PSS developers (modellers) need to be present throughout the process (from problem definition to strategy selection) to support externalization and internalization of the explicit LUT knowledge provided by their tools.

- Finally, the cases seem to show that for such an integrated strategy-making process to be useful for the planners, it has to be set up as an environment in which they can learn about important LUT relations. The absence of an immediate link to the formal political decision process seems part of this (for instance, when at one point in Breda an attempt was made to capitalize on the unfolding dialogue with the railways and elicit a deal the free exchange of knowledge abruptly stopped). The goal is not to develop a final LUT plan or vision, but rather to develop shared insights (in robust measures [no regret] and tradeoffs [LUT interdependencies]). This common knowledge can be used in future situations and can be communicated to politicians and other actors.

5.5.1 Reflection and Discussion

This study shows that socialization of knowledge might be an important element in integrated LUT strategy-making. However, simply placing the practitioners in one room will not produce the desired results; communication alone is not enough. To bridge the substantive barrier (linking their different sorts of tacit knowledge), they have to be systematically supported with relevant explicit LUT knowledge through processes of externalization and internalization. On the one hand, these processes
provide structure and content for debate, enabling learning effects; while on the other hand, they trigger participants to share tacit knowledge, develop new combinations of explicit knowledge and internalize a common language. When we compare this with other research about the caveats of collaborative planning (Innes and Gruber, 2005) we see that in our cases there was more distance between the meetings and actual decision making. Also, the meetings comprised mainly what Innes and Gruber call ‘staff’. This distance and composition allowed for more focus on learning instead of negotiation, although this focus had to be made clear from the beginning, and re-established on occasions. Innes and Gruber see conflicting planning styles as a major reason for the failure of collaboration. In our cases the styles of planners differ somewhat, but they all seem more or less to employ a technical /bureaucratic style. This is of course related to the closed composition with only limited involvement of external stakeholders. The lack of conflict also has to do with the history of cooperation among the planners. Although in Breda there were two municipalities involved, the focus on a relatively abstract level of strategy-making prevented a focus on conflict.

The two cases seem to show that full benefits of acquiring new shared knowledge can be obtained only by going through the entire knowledge generation cycle. The research methodology of practice oriented experiments does not allow for a control group; however, the examples of ‘normal’ daily planning practices where at best just socialization takes place (little or no systematic externalization, combination and internalization of knowledge) show that these processes mostly do not generate new LUT knowledge or strategies. This point was also confirmed by the participants. The same argument could be made for processes of simple combination; i.e. scientists or PSS developers building new models and instruments based on combinations of scientific insight and without interaction with planners’ tacit knowledge (and thus no internalization).

Although the concept of knowledge generation provides a useful analytic framework for analyzing new learning by artificially dividing the process in categories, in the real world the four modes of knowledge conversion overlap and dynamic shortcuts occur (see also Gourlay, 2003). In both cases there were moments where several (or even all) four steps were taken at the same time (simultaneous internalization and externalization during design steps). Also, some steps occurred more often than others and in different sequences. Thus, although all steps are important, the framework should be applied with some flexibility.

A social learning process seems important for successful LUT strategy-making (or other strategy-making which concerns separate planning and/or knowledge domains). The planners face complex planning environments in which they are only one of many actors who try to shape the future of a city or region. They are involved in planning processes, marked by great uncertainties and the unpredictability of shifting conditions on the ground. For them, it seems much more useful to develop better, and more shared knowledge about crucial relationships than to develop a final vision or plan. Also, if the participants realize that it is a learning process, they are more open to sharing their tacit knowledge and discussing their assumptions. In
Breda, one participant explicitly stated that he only joined the process because it did not aim at negotiation, which would have hampered learning. At least for the initial, strategy identification phases of planning processes, the prevalence of a learning mode seems essential.

The research described here, is based on observations, (qualitative) questionnaires, and interviews. However, more detailed analysis of the exact nature of what tacit knowledge was exchanged between the participants and how this impacted on the practical outcomes is still underway. This has to do with the different time scales of different kinds of outcomes. Direct learning effects can be analysed on the spot (accurately measuring them is a whole different matter), but the translation of these learning effects in concrete plans or other follow up (ex. more regular interaction between land use and transport planners in the organization) can take some time. Analysis of such outcomes is planned in the near future.

An interesting topic for further research would be to explore if such learning processes (four knowledge conversion steps) could also work with more actors and/or in less structured environments. For analytic clarity, we focussed on processes almost exclusively involving professional planners, but in practice strategy-making often involves cooperation with different stakeholders and citizens (especially so in North America, see Zapatha and Hopkins, 2007). The potential for such structured learning seems particularly high in these types of open processes, due to the big gaps between tacit and explicit knowledge.

This idea of strategy-making as social learning also has impact on the development of relevant planning support. As the cases show, in the early phases of planning, the selection and contextualization of a common language is a crucial part of knowledge generation; PSS which are developed on the basis of generic views of planning and models are therefore difficult to apply. For a PSS to be relevant, it seems that the developers (modellers) have be open to engage in the learning process as well and be open for implementing changes in their instruments (even if this implies sacrificing some scientific rigor for the benefit of practical relevance). In the world of land use and transport planning, this would imply a different way of using transport models (more as communicative instead of predictive devices), in turn recognizing their limitations and subjectivity (as also argued by Timms, 2008). This chapter focused on developing support for planners from two domains; however, more research is needed specifically on the position of the PSS developer (modeller) in this process.

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Chapter 6

Transparency, Flexibility, Simplicity: From Buzzwords to Strategies for Real PSS Improvement
There is a growing body of academic literature that deals with the gap between Planning Support Systems (PSS) and daily urban planning practices. In response to the identified bottlenecks for implementation and insights from knowledge management, a new approach for improving PSS implementation was recently proposed. This Mediated Planning Support (MPS) approach is grounded in several theoretical schools, such as knowledge management and cognitive science. This article discusses the testing of this approach in three cases of land use and transport strategy-making in the Netherlands, seeking to increase the understanding of the added value of the mechanisms that underlie the MPS framework. Methodologically speaking, it utilised a mail-in questionnaire and participatory observation.

The results of the analysis indicate that MPS does improve several of the bottlenecks of PSS implementation defined in other studies: providing a better fit between the PSS characteristics and strategy-making processes, more transparency, increased understanding and awareness of the possibilities (and limitations) of PSS, fostering acceptance and improved use. Important mechanisms for promoting these outcomes include an open constructive critical attitude of both PSS developers and planners, a prototyping process, and placing emphasis on externalisation and internalisation of knowledge. The paper closes with a discussion on the implications for PSS development and planning and an outline of further research directions.

6.1 RECENT CONTRIBUTIONS TO THE PSS DEBATE
A longstanding body of literature has addressed the low implementation rates of Planning Support Systems (PSS) in daily planning practices. Starting with the 1973 seminal paper by Douglas Lee, a consolidated list of fundamental bottlenecks has been identified. PSS (as a recent addition to the family of Computer Aided Planning instruments, which includes Large Scale Urban Models and Spatial Decision Support Systems) are seen by their potential users as inadequate, far too generic, complex, too technology oriented (rather than problem oriented), not transparent enough, neither flexible nor user friendly, too narrowly focused on strict technical rationality and finally incompatible with the unpredictable/flexible nature of most planning tasks and information needs (Batty, 2003; Bishop, 1998; Couclelis, 1989; Geertman and Stillwell, 2003; Harris and Batty, 1993; Lee, 1973; Lee, 1994; Sieber, 2000; Uran and Janssen, 2003; Vonk, 2006). From this list one can conclude that (1) most bottlenecks are rooted in the ‘soft’ social aspects of the tools and that (2) technological innovation and increasing computational capabilities cannot adequately overcome these bottlenecks. Recent research on the use of PSS for supporting integrated land use and transport strategy-making mirrored these findings (Te Brömmelstroet, 2010). In this paper I do not only define use in its instrumental sense (‘the tool is being used’); rather, I also use it in a broader enlightenment sense (‘the tool is used to support and influence planning strategies’) (Gudmundsson, 2009; Weiss, 1979).

Many PSS scholars have suggested general directions for improving the implementation rate of developed tools. First in 1973 and again in 1994, Lee proposed that the tool developers’ focus should shift from comprehensiveness and the technically developable to responding to the needs of practitioners, who prefer more “redundant approximations than detailed models” (Lee, 1994, p. 40). According to this view, improved structured communication between potential users and PSS developers is an important direction for improvement. This view is supported by research in software application development and system dynamics, which sees prototyping as a means of structuring this communication. Some examples include concepts such as Rapid Application Development (Martin, 1991), Soft System Dynamics (Checkland and Scholes, 1990) and Dynamic System Development Management (Stapleton and Constable, 1997).

More recently, Vonk (2006) made similar suggestion, providing the main guidelines for improving technical quality, awareness and diffusion of PSS:
- improve the fit of existing PSS with the competences of those involved in planning and the characteristics of planning tasks;
- increase and improve communication/cooperation between researchers and system developers: interactive PSS learning;
- use knowledge management insights to create so-called ‘learning organisations’ (Vonk, 2006.pp. 97-100).

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8 Following Richard Klosterman (1997), I define Planning Support Systems as an infrastructure that systematically introduces relevant (spatial) information to a specific process of related planning actions.
CHAPTER 6: TRANSPARENCY, FLEXIBILITY, SIMPLICITY

As argued by in (Te Brömmelstroet, 2009), during the past 30 years most PSS research has been following a strong syntactic research program; that is, it aimed to explain PSS development and implementation in terms of abstract actions and their interrelationships (see also Abbott, 2004, p. 26). From Lee (1973) to Vonk (2006), many scholars contributed to building such an abstract model of PSS implementation, resulting in several key suggestions: (1) make PSS more transparent and flexible to use, (2) focus on simplicity and (3) improve communication. However, the practical testing of these suggestions in real PSS developing practice is largely missing, a gap that this paper will attempt to fill.

6.2 PRAGMATIC RESEARCH TO UNDERSTAND PRACTICAL SOLUTIONS

As extensively discussed in (Te Brömmelstroet, 2009), PSS scholars should pursue a more pragmatic research paradigm in order to solve the implementation gap. PSS research should apply research methods from design oriented sciences to develop relevant solution directions. The researcher has to implement the PSS in real life situations and thus improve the understanding of what is (not) effective and why. In management sciences, a similar shift is discussed by van Aken (2004, 2005, 2007), by introducing the CIMO framework. Accordingly, research should focus on finding solutions in terms of technological rules that follow a context-intervention-mechanism-outcome logic (based on Pawson and Tilley, 1997). This implies that, while designing solutions for addressing the implementation gap and implementing these in real-life situations, the researcher is searching for technological rules, which have this form: ‘in order to improve planning support for strategy-making (C), one should work according to a specific approach (I) which improves the chances of implementation (O) through the integration of different knowledge types (M)’. By applying the proposed rules in practice and analysing how they work (or do not work), the researcher can develop technological rules that are grounded (in academic theory) and tested (in real planning contexts) (Van Aken, 2004). Such research outcomes are considered more relevant for planners and PSS development than the current explanatory focus that simply produces lists of bottlenecks or conceptual schemes based on theoretical explorations.

Te Brömmelstroet and Schrijnen (2010) was an attempt at translating some of the general PSS implementation solution directions (and knowledge management insights) into a set of concrete guidelines that can support the PSS developer in improving the implementation rate of his/her tools in practice. Following the pragmatic research approach, this set of guidelines, coined Mediated Planning Support (MPS), was applied in three cases of integrated land use and transport strategy-making through a series of workshops. This paper discusses these cases and analyses whether and how MPS guidelines supported the PSS developers in their effort to improve the implementation of their tools. I tested four central hypotheses about how to actively improve PSS implementation. For each, a short introduction of the theoretical foundation is discussed. To test each hypothesis, I utilised a triangulation of research techniques (as proposed by Yin, 1994, pp. 97-100). During the workshops participatory observation was used to see how certain interventions influenced the group and the individual participants in the workshops. Also, immediately after the workshops, participants were asked to fill out a workshop-
specific questionnaire. These questions related to their experience of the workshop and the information they learned and/or were planning to use in their daily activities. Central to the analysis is an ex-post survey, administered per email after the MPS interventions. In this questionnaire, I examined the attitude of both the planning practitioners and the PSS developers about the intervention, its effects and its wider application in their everyday work.

As the detailed *groundings* of the four hypotheses is already covered in a previous paper (Te Brömmelstroet and Schrijnen, 2010, chapter three of this dissertation), this paper will focus on *testing* these hypotheses, more specifically on steps 3, 4, and 5 in the process, as outlined in Figure 6.1.

Below, I will first introduce the central hypotheses about the best way to improve PSS implementation. Further, the theoretical grounding and the operationalisation will be shortly discussed. Very briefly, the translation of these hypotheses into a concrete intervention (Mediated Planning Support) and the cases in which it was applied are presented. Then, the paper continues with the analysis of the four hypotheses based on these cases (using the triangulation of the methods: survey, participatory observation and questionnaires). These results are the grounded and tested technological rules. The paper will close with a discussion regarding the grounded and tested rules and the implications of the findings for the MPS approach and PSS development in general.

### 6.3 GROUNDED HYPOTHESES FOR IMPROVING PSS IMPLEMENTATION

#### 6.3.1 Hypotheses about the requirements for structuring an effective PSS learning process

“You should fit a PSS into a planning process, for you cannot fit a planning process into a PSS”

*Attributed to Michael Batty*

A mutual learning process between PSS developers and planning actors is the factor for improving PSS implementation (Lee, 1973; Lee, 1994; Vonk et al., 2005), which requires establishing a structured dialogue. However, establishing this dialogue is
more problematic than it seems. The work by Meadows and Robinson on the use of computer models in the field of environmental issues aptly illustrates this challenge (Meadows and Robinsons, 2002). According to them, the model developing community does not have an open attitude; their reward incentives are not connected to increasing application of their tools but rather more to the exploration of innovative techniques (consultancies) and theories (academic scholars). The same holds true for the domain of PSS development (Vonk, 2006). Although in conferences and in their books many of them speak about (bridging) the implementation gap, in practice this gap has changed very little since the publishing of Douglas Lee’s REQUIEM OF LARGE SCALE MODELS (Lee, 1973). Also, the potential users do not have clear incentives to close this gap. Planners often look for specific support for a specific planning issue on an ad hoc basis; since they do not have the time to invest in a learning process, they are looking for off-the-shelf PSS solutions. However, when they face the (often) limited applicability of such off-the-shelf products to their unique planning case issue it feeds disappointment and strengthens their already negative attitude (fostering a negative spiral). To break through this negative spiral, the two domains have to come together in a structured way in which both can open up and learn from each other: PSS developers about the characteristics of real world planning implementations and planners about what a PSS can and cannot deliver. Accordingly, the first two hypotheses about the requirements for improving PSS implementation are:

(1) An open attitude of PSS developers towards the potential users and their practice context will result in increased compatibility of dedicated PSS; and
(2) An open attitude of planning practitioners towards PSS will result in increased awareness and understanding of the PSS.

Operationalisation of hypotheses 1 and 2
Meadows and Robinsons (2002) developed some guidelines for improving this mutual learning process. Translated into the PSS domain, their recommendations stipulate that PSS developer should insist on a clear problem definition (planning problem), match the PSS to the problem, include the planning actors in the PSS developing process and describe/explain the PSS in terms understandable for the planning actors. On the other hand, planning practitioners should focus on delivering a clear planning problem, contact a modeller whose method matches their problem, allocate time to follow and participate in the modelling process and insist on descriptions that they understand (Meadows and Robinsons, 2002, pp. 284-290; Vonk, 2006). In the MPS framework, this is translated in five steps that force both domains to start from a specific planning problem and together work their way towards a suitable and feasible PSS (process and information) for this specific problem (process steps and information). Building up a PSS, using it and then sharing the feedback is a process designed to improve the awareness of what is desirable from a planning point of view and what is possible from a PSS point (see also Figure 2 below).
6.3.2 Hypothesis about the structure of the MPS approach

"Most learning takes place in the process of building the model, rather than after the model is finished”

Professor Jac Vennix

The third hypothesis deals with the method of structuring a process that can actively improve PSS implementation. The domain of software development offers useful insights. As a response to the failure of linear development strategies (ask the client what he/she wants, make a design, develop an application and deliver it to the customer), this field developed a range of development approaches that include end user participation throughout all stages of the development process. Although each approach uses its own terms and techniques, prototyping can be considered a common term (Martin, 1991). First, Sub-products are presented to the users; by using and testing them, they learn how the PSS works and are able to voice concrete improvement requests. Thus, the product can become more transparent for the users and in the end concrete demands reach the developer. Hypothesis 3, dealing with the appropriate structure for improving PSS implementation, is therefore formulated as:

(3) A prototype development process for PSS improves the transparency of the assumptions and output of these PSS.

Operationalisation of hypothesis 3

Contrary to the classical behaviourist perspective on learning, which treats knowledge as an external entity (Gredler, 2001), social constructivist theory assumes that the behaviour and the learning processes of individuals are dependent on the context which gives meaning to their lives and work (Siemens, 2006). This shift in thinking stimulated the development of new learning strategies that combine the individual learning process with the learning process of a team or a community. There is no established format for structuring such learning; however, as a general guideline, Kolb (1984) found that a complete learning process combines four stages of perceiving and processing information: (1) concrete experience (feeling), (2) reflective observation (watching), (3) abstract conceptualisation (thinking), and (4) active experimentation (doing).

Through such prototyping iterations, which include these four steps of learning, the user becomes acquainted with the assumptions of the PSS. These iterations also tailor the PSS to the specific needs of the planning context and planning participants, with the main aim of improving the PSS’ transparency. In the analysis below, I especially looked at (1) the use of and reflection on PSS prototypes by planning practitioners and (2) the presence of the PSS developer during workshops.
6.3.3 Hypothesis about the added value of the MPS approach

"Not everything that can be counted counts, and not everything that counts can be counted"

Attributed to Albert Einstein

The prototyping process should foster a learning process, which will not only improve the transparency of the PSS but will also improve the way that the planning practitioners look at their planning issue and its formal representation in the PSS. As confirmed by a survey regarding the bottlenecks of land use and transport PSS, the latter is often perceived as too complicated and not sufficiently focused on fundamental relationships (Te Brömmelstroet, 2010). It seems that this poor fit hampers the acceptance of the PSS and their outputs by the planning practitioners; therefore, the fourth hypotheses about improving PSS implementation states that:

(4) An improved fit between the mental models of planners and PSS increases the chance of their acceptance and increased use of PSS.

Operationalisation of hypothesis 4

Knowledge management literature offers insights on how to integrate mental models and hard, explicit knowledge. These insights are translated to the PSS field. Especially the work of Nonaka with Takeuchi (Nonaka and Takeuchi, 1995) and Konno (Nonaka and Konno, 1998) provides useful guidelines. They identified two dimensions of knowledge: tacit (rooted in mental models) and explicit. To create new knowledge these two types have to be integrated in iterative circles, where knowledge exchange takes place. The consecutive exchanges that are proposed are socialisation (tacit – tacit), externalisation (tacit – explicit), combination (explicit – explicit) and internalisation (explicit – tacit). In the MPS approach the planning practitioners and PSS developers together went through these four steps; particular attention was focused on the steps were tacit and explicit knowledge are integrated (see Te Brömmelstroet and Bertolini, 2009), namely:

- **Externalisation** (turning a planning problem into PSS indicators) was translated into a sticker session which offered PSS developers different possible maps and indicators for supporting the specific planning problem. The planning practitioners then discussed and chose relevant indicators; and

- **Internalisation** (understanding the output in order to develop and alter strategies) was the communication and clarification of the outputs that was provided to the planning practitioners and enabled them to develop the shared understanding that is crucial for the development of shared strategies.

6.4 MEDIATED PLANNING SUPPORT AS GROUNDED INTERVENTION

As stated before, the four grounded hypotheses form the buildings blocks of the MPS framework. The hypotheses were used to formulate a concrete intervention which could be applied in different cases, involving a series of steps typically corresponding to a series of workshops. I will shortly describe the structure of these applications; the MPS is more thoroughly discussed in Te Brömmelstroet and Schrijnen (2010).
A MPS process starts with a focus on the definition of the specific planning problem at hand (see Figure 6.2). At this point, the group of participants has to be identified (e.g. land use planners, transport planners and preferably stakeholders from both domains), which is followed by introductory interviews. This helps clarify the participants’ views of the planning problem and their expectations of the MPS process and its results. Subsequently, both a problem definition and a first design brief for a PSS are formulated. This is step one of the MPS process. A series of workshops follows where a planning product and a PSS (process and information) are simultaneously and interactively developed. This combination is important, as it creates a continuous testing ground for the intermediate results and fosters mutual learning effects. Working with the PSS also generates new insights in the users’ needs. The second MPS step focuses on a process protocol, i.e. the necessary steps for arriving at a desired planning product. In the third step, the participants have to identify which information is useful and understandable in each step. In this step a first prototype of the common language (information protocol) is created. Through dialogue, the PSS developers and planners have to discern what kind of information is seen as useful in supporting the process protocol. By identifying where to use this information, an information protocol is developed. During these first two steps, a prototype is developed. The application and subsequent refining of the protocols takes place in the next two steps. In the fourth step, this prototype is tested; the group of participants works with the PSS in order to arrive at the defined integrated planning product (the desired output was already defined by the participants in the first and second steps). Depending on how the group defined the process protocol, this step can stretch over multiple workshops. The fifth and last step focuses on improving the PSS (based on the lessons learned) and on finalising the planning product. The end result is a final PSS.

Figure 6.2  Mediated Planning Support (from Te Brömmelstroet and Schrijnen, 2010)
CHAPTER 6: TRANSPARENCY, FLEXIBILITY, SIMPLICITY

This process has a dominant direction, but there are many recursive learning effects (the thin lines) and iteration possibilities (learning by doing). For example, gaining new insights about an ideal sequence of planning steps can lead to a reformulated process protocol, which in turn can lead to new information needs.

6.5 THREE CASES TO TEST MEDIATED PLANNING SUPPORT
The four hypotheses were tested by applying them in three cases of Dutch strategy-making. To understand the range of generalisations made below, it is first necessary to describe the context of these cases. All of them focused on the development of integrated strategies for the domains of land use and transport planning; with a marked strong need for integrating ‘hard’ information into planning process. The spatial scale ranged from regional to local planning issues, and the scope of participants differed; even though, most of them were planning professionals with a land use and/or transport planning background.

6.5.1 Accommodating economic growth in the Amsterdam Metropolitan Area
The Amsterdam Metropolitan Area is facing massive projected challenges between now and 2030 in the domain of land use (150.000 extra houses and 150.000 extra jobs) and transport (doubling of traffic intensities on roads and rail). In 2007, land use and transport planners of the Municipality of Amsterdam and the Amsterdam Metropolitan Area joined forces in developing integrated strategies to cope with these related challenges. They needed a PSS that could support their strategy-making process with a common explicit language (indicators, maps graphs). This is needed as a bridge between domains that originally speak different formal languages, have different educational backgrounds and look differently at the region. The transportation model of the municipality (GenMod) was seen as potentially useful starting point; however its newest form was only useful for project calculations not for supporting strategy-making processes. A MPS process was applied to develop a land use and transport strategy-making PSS from the GenMod model (extensively discussed in Te Brömmelstroet and Bertolini, 2008).

6.5.2 Integration of new station and urban area in Breda
East of Breda, a new railway station is planned that should be used as A Park & Ride, a station for a new event centre as well as a connection for the east side of Breda with the city centre. However, a recent land use plan shows that new housing and working areas are located more than two kilometres from this new station. Also, the event centre is about 1,5 kilometres away from the station. Both distances guarantee a low number of new passengers, making the new station not viable for the railway company. Also, it makes public transport to these new areas difficult. In 2008, land-use and transport planners from Breda and an adjacent municipality, together with strategic planners of the railway company (NS), decided to come together and develop integrated strategies for improving this situation. As there was no in-house transportation model, external models and tools were used to develop the MPS approach, more specifically the expertise of the NS planners (and their Circalex method) and an external consultancy firm (Goudappel Coffeng).

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6.5.3 **Public Transport strategies in the Eindhoven City Region**

The Eindhoven City Region was developing new public transport strategies. Planners stated that these strategies were based on general technical insights on the organisation of public transport, but that these strategies did not incorporate insights on the public transport potential of certain neighbourhoods. Also, they wanted to explore strategies from the user perspective, focusing on the users’ needs and demands. The University of Hasselt and the University of Eindhoven cooperatively developed an instrument and in 2008 they started a MPS process to further develop this instrument into a PSS. During this process, land use and transport planners of the Municipality of Eindhoven and of the Eindhoven City Region worked together with the Public Transport company that is currently operating the system in and around Eindhoven. The differences and similarities between the cases are summarised in Table 6.1.

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>AMSTERDAM</th>
<th>BREDA EAST</th>
<th>EINDHOVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale</td>
<td>Regional</td>
<td>Local</td>
<td>Regional</td>
</tr>
<tr>
<td>Planning</td>
<td>Land use planners city</td>
<td>Land use planners (neighbouring municipality)</td>
<td>Land use planners city</td>
</tr>
<tr>
<td>Participants</td>
<td>Land use planners region</td>
<td>Transport planners Breda</td>
<td>Land use planners region</td>
</tr>
<tr>
<td></td>
<td>Transport planners city</td>
<td>Transport planners Breda</td>
<td>Transport planners city</td>
</tr>
<tr>
<td></td>
<td>Transport planners region</td>
<td>Transport planners (neighbouring municipality)</td>
<td>Transport planners (neighbouring municipality)</td>
</tr>
<tr>
<td></td>
<td>Railway operator (NS)</td>
<td>Railway operator (NS)</td>
<td>Railway operator (NS)</td>
</tr>
<tr>
<td>PSS origin</td>
<td>Internal</td>
<td>External</td>
<td>External</td>
</tr>
<tr>
<td>Initiative</td>
<td>PSS developers</td>
<td>Land use planners</td>
<td>PSS developers</td>
</tr>
</tbody>
</table>

**Table 6.1** The case studies and their characteristics

6.6 **PRAGMATIC TESTING OF MPS**

6.6.1 **Hypothesis 1: An open attitude of PSS developers improves the compatibility of PSS**

In the ex-post survey, all planning practitioners who participated in the three cases were asked to share their opinion assessing how well did the general PSS fit to the characteristics of strategy-making processes. I will continue by discussing the findings of this survey. I used statistical analyses to highlight the effects and their correlations and to enrich the qualitative findings. To find out if the fit was improved by the MPS intervention, the practitioners were asked to rate both the general compatibility of PSS for strategy-making processes and the compatibility of the PSS developed and used in the MPS process (on a 1 to 10 scale). Also, they were asked to rate the added value and whether the open attitude of the PSS developer helped. Eleven planning practitioners responded (roughly 50% of the total) and finally nine
surveys were used for analysis, as presented in Table 6.2. They were evenly distributed across the cases and were usually the most active planners.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>N</th>
<th>STDEV</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general, how well is planning support information geared to the characteristics of strategy-making processes?</td>
<td>5.4</td>
<td>9</td>
<td>1.65</td>
<td></td>
</tr>
<tr>
<td>How well was the planning support information in the workshops geared to the characteristics of strategy-making processes?</td>
<td>6.9</td>
<td>9</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td><strong>Average Difference of means</strong></td>
<td><strong>1.5</strong></td>
<td><strong>1.94</strong></td>
<td><strong>0.028</strong></td>
<td></td>
</tr>
<tr>
<td>How much did the open attitude of the PSS developer contribute to this?</td>
<td>7.4</td>
<td>9</td>
<td>1.13</td>
<td></td>
</tr>
</tbody>
</table>

**Table 6.2** Compatibility of PSS for strategy-making

The results suggest that the MPS approach increased the compatibility of the PSS information, compared to general applications, with a significant effect of 1.5. The general compatibility is already scored as average, although there was a wide range in the answers. Respondents added that in general “the PSS are often highly specialised and [...] not compatible with strategic, multi-actor processes” and that “they are often designed based on availability and less from the users’ information needs”. One planner stated that the lack of compatibility is more related to the poor fit between the planning process and the processing time of PSS. He also stated that the PSS used in the workshops was not much different in that respect (pointing at the persistence of technological problems). The open attitude was seen as “a crucial prerequisite to fully interpret and use the information”. The range of marks given for this factor was fairly limited.

In the workshops, differences in the attitudes of the PSS developers were observed. The more eager the PSS developer was to learn from the planners and to adapt the product to their demands, the more the planning practitioners were able to use the outcomes for strategy-making. In Breda, one of the PSS developers was involved at a late stage and had therefore little time to participate in the entire learning process. Also, little time was allocated to making alteration in the PSS based participant comments. This made it very hard for them to interpret the outcomes and therefore this information was hardly used. Especially in the cases that were initiated by the PSS developers, the planning practitioners ranked the open attitude as an important element in the improvement of compatibility.

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9 To calculate the significance, a one-tailed paired t-test for means was applied.
6.6.2 Hypothesis 2: An open attitude of planners improves awareness and understanding

In the same way as above, all PSS developers who were involved in the three MPS cases were asked how much, both in general and during the MPS process, planners were aware of what their PSS can and cannot do, as well as what can and what cannot be taken into account in the model and its output. Similar questions were asked about the understanding of planning practitioners. Also, the PSS developers were asked to rate the contribution of the open attitude of the planning practitioners. There were four responses, with one developer participating in two case studies. Table 6.3 presents the results of the analysis.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>N</th>
<th>STDEV</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general, how aware are planning actors of the (im)possibilities of PSS such as yours?</td>
<td>5.3</td>
<td>4</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>How aware were the practitioners in the workshops of the (im)possibilities of your PSS?</td>
<td>7.5</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Difference in means</td>
<td>2.2</td>
<td></td>
<td>1.9</td>
<td>0.048</td>
</tr>
<tr>
<td>In general, how much understanding do planning actors have for the workings of PSS such as yours?</td>
<td>4.5</td>
<td>4</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>How much understanding did the practitioners in the workshops have for the workings of your PSS?</td>
<td>7.3</td>
<td>4</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>Difference in means</td>
<td>2.8</td>
<td></td>
<td>2.9</td>
<td>0.075</td>
</tr>
<tr>
<td>How much did the open attitude of the practitioners contributed to this?</td>
<td>7.5</td>
<td>4</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.3 Awareness of planning practitioners to the (im)possibilities of PSS for strategy-making

The MPS approach had a large effect on both the awareness of (im)possibilities (+2.2) and the understanding of the workings of the PSS (+2.8). The involved PSS developers rated the general understanding and awareness fairly low, mirroring the conclusions of Vonk (2006) and Te Brömmelstroet (2010). One PSS developer noticed that “planning actors have little understanding for research findings [as presented in PSS] and the PSS developers have difficulties in finding the right language to communicate with planners”. Another one stated that planning practitioners “are not interested in the workings of the PSS, but only in their outcomes”. Both the understanding and awareness increased considerably as a result of the MPS workshops. The dialogue between the PSS developers and planning practitioners was an important mechanism, in the words of one respondent, “the boundaries of the PSS became more and more clear”. On the other hand, the planning practitioners had trouble to see “the PSS as a tool, they want to have a straight-forward outcome”, according to one PSS developer. Being engaged in the cumbersome developing process of a PSS seems to ask for different expectations about outcomes (i.e. straightforward versus nuanced).

These findings mirror the observations made in the workshops. In all cases, there was a difficult start because both domains had to meet each other in language and expectations. Especially in the Eindhoven case, the final workshop greatly benefited
From this investment in learning in the first stages. The practitioners were positive and used the tool to support their strategy-making. However, the participants also expressed constructive critical suggestions for possible improvements of the PSS, which sometimes interfered with its use.

6.6.3 Hypothesis 3: Prototyping improves transparency of assumptions and outcomes

To test this hypothesis, the planning practitioners were asked to rate the transparency of assumptions and outcomes of PSS in general and in the workshops. Several studies showed that the lack of transparency is seen as a major bottleneck for the use of PSS. The respondents were also asked how much the prototyping process contributed to improving transparency, as illustrated in Table 6.4.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>N</th>
<th>STDEV</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general, how transparent are PSS for strategy-making?</td>
<td>6.2</td>
<td>11</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>How transparent was the PSS that was developed and used in the workshops?</td>
<td>6.8</td>
<td>11</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Difference in means</td>
<td>0.6</td>
<td>11</td>
<td>1.0</td>
<td>0.100</td>
</tr>
<tr>
<td>How much did the prototyping process contribute to this transparency?</td>
<td>7.1</td>
<td>11</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.4 Transparency of assumptions and outcome in general and in MPS

Surprisingly, the figures show that the transparency of PSS in general is considered as relatively good, which contradicts earlier finding about PSS (e.g. Te Brömmelstroet, 2010). This can be explained by the fact that the planners who voluntarily took part in the MPS process were already relatively well acquainted with some PSS. The transparency of the PSS in the workshop is rated slightly higher (not significant). In the comments, participants stated that “it took a long time before the assumptions were clear” and “it was only transparent after explanation”. This again shows the importance of the presence of the PSS developer. One PSS developer stated that through this involvement he learned a lot about the apparent ambiguity of his instrument. The users stated that their presence was “crucial in understanding and nuance the PSS outcomes” and it “helped to interpret the information”. The responses to the process of using the prototypes are mixed. Some clearly found that it improved transparency, in the words of one participant “sharing the information [among users] improves the basis for its subsequent use”. Another planner pointed to the difficulty of applying this approach in other contexts, due to the intrinsic dynamics of strategic planning processes. Continuity is another challenge; it is difficult to have all practitioners present for the entire duration of all workshops. Experiencing the prototype stages as a group is important for increasing PSS transparency, but it is very hard to accomplish in practice.
6.6.4 Hypothesis 4: linking mental models and PSS improves acceptance and use

To test the fourth hypothesis, the planning practitioners were asked to rate the rate of acceptance of applying PSS in general situations and in the workshops. Also, they were asked to rate to which extent the externalisation and internalisation contributed to this acceptance. The results are listed in Table 6.5.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>N</th>
<th>STDEV</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general, how well are PSS accepted and used by all planning actors?</td>
<td>6.0</td>
<td>11</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>How well was the PSS accepted and used in the workshops?</td>
<td>7.6</td>
<td>11</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Difference in means</td>
<td>1.6</td>
<td>2.4</td>
<td>0.027</td>
<td></td>
</tr>
<tr>
<td>How much did the discussion (sticker session) contribute?</td>
<td>6.6</td>
<td>9</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>How much did the presentation and explanation by the PSS developers contribute?</td>
<td>7.2</td>
<td>10</td>
<td>0.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.5 Acceptance and use of PSS in general and in MPS

On average the planning practitioners rated the general acceptance and use of PSS relatively high, which can again be explained by the self selection of participants. However, there are some finer nuances. One transport planner stated that “we simply don’t have alternatives [to transportation models as PSS]”, illustrating that its use is not always satisfactory. A municipal public transport planner added that there is “insufficient use of PSS to support strategic planning”. A land use planner said “there is always discussion about the assumptions, it is sometimes forgotten that it is just a supporting tool”.

The acceptance and use of the PSS in the workshops was rated significantly higher (+1.6), although some planners did not consider its workshop application as a real-life scenario. The developers saw a different picture. One even stated that “there was more discussion about the information than actual use”. The researcher observations of the workshops contradict this view. In all three cases, the PSS was used to support strategy-making. The maps and indicators supported the planners with different backgrounds used to express their views of the planning problem and potential solutions. In Amsterdam this was most successful because two iterations of strategic design and evaluation were executed. In Breda innovative strategies for the development of the station were developed. But also in the single Eindhoven workshop, the participants developed a list of potentially interesting public transport links with accompanying marketing and physical strategies.

The planning practitioners saw that the internalisation step as providing more added value to the acceptance and the use of the PSS than the externalisation step. This fits our own observations. It seems that the externalisation is especially important for the PSS developer, who can better adjust the PSS to the specific planning problem. However, indirectly, good externalisation is also a crucial factor for subsequent...
internalisation. It is important that planning practitioners recognise the indicators and maps as a product of their shared consensus.

6.6.5 Overall usability of PSS

As the above analyses show, the MPS approach increased awareness and understanding of the potential of PSS, increased transparency of assumptions and outcome, improved compatibility of the PSS with characteristics of strategy-making processes and increased the rate of acceptance and use. Subsequently, by improving some of the crucial bottlenecks of the PSS implementation gap, the usability of the PSS also increased, as demonstrated by Table 6.6.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>RESPONSE</th>
<th>N</th>
<th>STDEV</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general, is PSS useful for strategy-making?</td>
<td>7.7</td>
<td>11</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>How useful was PSS in the workshops?</td>
<td>6.9</td>
<td>11</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Difference of means</td>
<td>-0.8</td>
<td>11</td>
<td>1.2</td>
<td>0.021</td>
</tr>
</tbody>
</table>

Table 6.6 Usefulness of PSS in general and in MPS

Surprisingly, there was a strong consensus that the in the MPS workshops the PSS was perceived as less useful. Also, the high perceived usefulness of PSS is again surprising and in conflict with earlier studies, partially explained by self selection. The lower rate of perceived PSS usefulness in the MPS approach is linked to the discussion on the fourth hypothesis above. Some planners state that the PSS in the workshops is not really used for strategy-making, which holds true if strategy-making is narrowly defined as formulating concrete actions that are documented and delivered to decision makers. However, in a broader view, the PSS was used to discuss current strategies and develop shared views on new and existing strategies, often very abstract. These strategies are more a shared consensus and take the form of agreed no-regret strategies (“we should always pursue goal X”) and crucial interdependencies (“if we want X, we should also invest in Y”). Answers to related questions in the questionnaire support this view. Seven of the ten respondents stated that they either gained new insights in land use transport strategies and/or that they used specific insights from the workshops in other processes (explicit and implicit).

Although this adds some nuances to the results, there is also another explanation of the decrease in perceived usefulness. Due to the unusually open attitude of all participants, the planners became very critical towards the tool. In some workshops it took some effort to guide this criticism in a constructive direction. Therefore, it is crucial to have a facilitator/mediator (in this case the researchers) present, who can act neutrally and keep the dialogue open. Also, all parties should have clear and realistic expectations about the MPS workshop: a constructive critical dialogue with the goals of making the PSS usable and using it to develop a shared view on the problem and solution strategies. Finally, the specifics of the case-studies also can explain this finding: short time spans (MPS needs more iterations) and absence of
real-life characteristics (only with selected group of planners; no stakeholders or citizens were included).

6.7 CONCLUSION
This article started by exploring the PSS implementation gap in academic literature. I discussed seminal and recent studies that have identified the main drivers of this gap and proposed some general directions for improvement. Consequently, I argued that in order to develop more relevant and useful insights for bridging the PSS implementation gap a more pragmatic research approach is needed, one that aims to develop grounded and tested technological rules. I applied such a pragmatic research approach in the testing of Mediated Planning Support (MPS), discussing the four main hypotheses, their theoretical groundings and their operationalisation in MPS. These hypotheses were tested based on three implementations, with the aim to develop a technological rule.

6.7.1 Context, intervention, mechanism, outcome
Although the premises of the MPS approach are relevant for PSS development in general, they have only been tested in a limited range of cases. These cases all focused on supporting strategy-making processes with (mainly) land use and transport planning practitioners, which limits the generalisability of the findings. First, the participants had more than average experience in applying PSS; there were no citizens or stakeholders present. Secondly, although it did differ between cases, the participants shared similar goals. Because there was no conflict situation, it was easier than usual to find common ground in indicators. This noted, the cases did represent the core characteristics common to general strategy-making processes. Participants had different backgrounds and thus had to find a common language, one that could represent the fundamental elements of the planning issue and could be understood by all involved. Also, the planning issue itself was still rather vague and abstract, which makes the use of concrete and straightforward indicators problematic.

The analysis of the cases suggests that the MPS intervention in this specific context improved the compatibility of PSS to the characteristics of strategy-making processes, increased planning practitioners’ awareness and understanding of the PSS, enhanced transparency of its assumptions and outcome and increased acceptance and use. The expected increase of usefulness of the PSS to support-strategy-making could not be fully verified in quantitative terms, although participatory observation and workshop questionnaires seem to support increased usefulness.

The mechanism that produced these outcomes consists of several elements. The open attitude of both parties is important and should be fostered and guided throughout the process by a mediator/facilitator. This serves to preserve a open collaborative spirit and prevent a relapse into a destructive critical attitude. Secondly, the prototyping process is vital for structuring the dialogue, i.e. to make the planners’ demands more concrete and to communicate the (im)possibilities of the PSS. The result is increased commitment, understanding and acceptance. Thirdly, this prototyping process should emphasise the externalisation of tacit knowledge
and especially internalisation of explicit knowledge to support a mutual learning process.

<table>
<thead>
<tr>
<th>Context</th>
<th>Strategy-making processes with planning practitioners from different domains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>Mediated Planning Support (MPS) approach</td>
</tr>
<tr>
<td>Mechanism</td>
<td>Open attitude of PSS developers and planning practitioners</td>
</tr>
<tr>
<td></td>
<td>Prototyping with sub-products of the PSS</td>
</tr>
<tr>
<td></td>
<td>Iterative internalisation and externalisation for mutual learning</td>
</tr>
<tr>
<td>Outcome</td>
<td>Improved compatibility of PSS to strategy-making characteristics</td>
</tr>
<tr>
<td></td>
<td>Increased awareness and understanding of what PSS can and cannot do</td>
</tr>
<tr>
<td></td>
<td>Increased transparency of PSS assumptions and outcomes</td>
</tr>
<tr>
<td></td>
<td>Increased acceptance and use</td>
</tr>
<tr>
<td></td>
<td><em>(Increased usefulness of PSS to support strategy-making)</em></td>
</tr>
</tbody>
</table>

Table 6.7 Grounded and tested technological rule following the CIMO logic

6.8 DISCUSSION AND FURTHER RESEARCH DIRECTIONS
The findings of this article suggest that if PSS developers want to actively improve the implementation of their tools, they should open up their PSS to suggestions and develop more flexible applications. Flexibility means that PSS should leave room for assumptions and outcomes to be adjusted in such a way that they can address a (specified) range of planning issues. This can create more room for a real and realistic mutual learning process between PSS developers and planners. Planners should also be willing (especially in the strategy-making phases of planning processes) to invest time and energy in a learning process. Only then, can they improve their understanding of the PSS and in acquire improved – and also shared – understanding of the planning issue at hand.

Do to the nature our research method (actively engaging in real-life strategy-making cases), one has to draw causal conclusions cautiously. The steps of grounding and testing the technological rules help increase the understanding of the expected outcome of such research. It seems that most of the theoretical hypotheses about how to improve PSS implementation were supported by the practical testing. However, they were also some nuances. Especially the role of the mediator and facilitator appeared to be a crucial element for the ‘success’ of the MPS applications. Ideally, this testing and grounding translates in iterative circles where the researcher goes back to the literature, reports additional insights to the original hypotheses and tests them again in new cases. Therefore, it is essential to continue with the testing and grounding of the findings of this paper. The range of cases should be expanded to include other domains, other stakeholders, citizens and decision-makers. Also, it would be interesting to test if the technological rule is valid for situations of intensive conflict.
Parallel to this real-life testing spiral, one should also aim to create more formal ways to improve the understanding of the uncovered mechanisms. In formal experiments, as seen in other fields such as psychology (Cattell and Anderson, 1966), management (Rouwette, 2003) and economics (Davis and Holt, 1993), one can focus on the key mechanisms and control for the wide range of other influential factors. This can create new insights in bridging the PSS implementation gap and developing a fruitful link between the pragmatic and the syntactic research approach.

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Chapter 7

General Conclusions and Recommendations
The main conclusions identified throughout the dissertation, will be highlighted and summarised in this chapter. This will answer the central research question (as presented in Chapter 1) and offer fruitful directions for future research.

7.1 CONCLUSIONS
My argument is based on the discussions in academia and in planning practice about (1) the importance of integrated land use and transport strategy-making for the future sustainability of urban regions and (2) the difficulties of implementing academically and commercially developed knowledge to support integrated land use and transport strategy-making in daily planning practice. From these two main points, the main question of this dissertation was formulated as

*How to improve the use of Planning Support Systems that aim to support integrated land use and transport strategy-making?*

The current Planning Support Systems (PSS) that are used to support integrated land use and transport (LUT) planning seem well suited for some planning tasks, such as calculating the effects of new/existing strategies and providing background information for discussions. However, these PSS also have serious shortcomings; they do not provide new LUT insights, for example they: are used to justify positions that are already taken (i.e. ‘fact-fighting’), do not fit the planning process and are not well linked to planning practice. Land use respondents are more critical of these shortcomings than their transport counterparts. Moreover, the output is often too transport oriented and fails to provide a common LUT language to support the generation of strategies. Chapter Two highlighted the LUT strategy generating stage (where land use and transport planners need the most support) as the weakest link, which was attributed to: a lack of transparency, low communication value, lack of user friendliness and the impossibility to experiment with the PSS. PSS should function as laboratories where planners can collectively experiment and take part in group learning about LUT relationships, which will allow them to subsequently generate grounded and tested LUT strategies. In order to provide this support, the PSS should be easy ‘to play with’ and transparent regarding its assumptions. One promising strategy that was formulated in Chapter Two is to create a structural dialogue between PSS developers and potential users. This should use existing planning problems from daily planning practice and would correspondingly produce a ‘learning by doing’ dynamic. Around the planning problem, the PSS users and developers can cooperatively develop and use a PSS, iteratively conceptualising and testing it in iterative cycles.

Chapter Three continued with insights and lessons from the academic fields of knowledge management (the SECI model) and cognitive psychology (Kolb’s learning styles), and highlighted the methods and techniques that could address some of these problems. Based on these methods and techniques, the Mediated Planning Support (MPS) approach was presented as a potential answer to these challenges. The MPS approach focuses on situations where existing tools, instruments or PSS need to be further modified in order to be useful for planners. The MPS approach addresses some of the fundamental bottlenecks recognised in the PSS literature. The
transparency of the output and the assumptions of the (computer) models are improved through discussions and continuous explanations by the modellers. The PSS become more flexible and attuned to the particular characteristics of specific planning process, thus increasing their compatibility with existing planning tasks. Also, the planning participants can gain a shared ownership of the process and improved information choices. PSS developers can learn how their model and output is used in ‘wicked’ planning processes and how this unpredictability can influence the usefulness of their products.

The initial application of the MPS approach was discussed in Chapter Four. This application in the Greater Region of Amsterdam resulted in two outcomes: (1) the development of a PSS to support integrated land use and transport strategy-making and (2) shared strategies. For the PSS, several crucial characteristics were identified:

- The generation of alternatives seems best supported by geographical mappings of the current situation;
- Simplicity is key;
- Network maps showing the functioning of important transport links are important for understanding the impacts of the generated alternatives;
- Most of the additional information should be provided in the form of a background database (i.e. on a laptop) that can be consulted during discussions;
- In the final stage (selecting robust choices and identifying interdependencies) graphs are helpful for indicating the impact of certain interventions.

For the participants, the developed strategies were not the most important result of the MPS approach. Instead, an increased (and perhaps most importantly a shared) awareness of the rationale behind LUT relations and choices was identified as the main added value. Or even, as one transport planner asserted, “it created insight that existing ideas are not the only ones that make sense”. The participants also noted that the process perfected existing ideas and concepts, enriched their evidence-base and created a common language for addressing these issues.

Chapter Five set out to explore the functioning of the mechanisms behind the intervention (knowledge generation) and its outcomes (shared LUT insights). These mechanisms have been explored in the specific context of land use and transport planners participating in strategy-making processes at the local/regional scale in the Netherlands. Based on literature review (especially the SECI model of Nonaka and Takeuchi [1995]) and the observations, questionnaires and interviews of two explorative cases, it was concluded that:

- Socialisation is an important process that creates shared LUT knowledge;
- For socialisation to be constructive, both externalisation and internalisation are crucial processes;
- The cases emphasised that both the planning problem and the supporting information (content of the PSS) have to be discussed and selected in open dialogue between planners and PSS developers;
• The cases also indicated that PSS developers (modellers) need to be present throughout the process (from problem definition to strategy selection), in order to support externalisation and internalisation;
• In order to be successful, MPS processes should be set up as an environment in which planners can learn about important LUT relationships.

The case analysis of the sixth chapter suggests that the MPS intervention in this specific context did yield significant positive results: improving the compatibility of PSS to the characteristics of strategy-making processes, increasing the planning practitioners’ awareness and understanding of the PSS, enhancing transparency of its assumptions and outcome and increasing acceptance and use. The expected increase of the PSS’ usefulness in supporting strategy-making could not be fully verified in quantitative terms, although participatory observation and workshop questionnaires did support this finding. The mechanism that produced these outcomes consists of several elements. First, the open attitude of both parties is important and should be fostered and guided throughout the process by a mediator/facilitator. This serves to preserve a collaborative spirit and prevent a relapse into a destructive adversarial attitude. Second, the prototyping process is vital for structuring the dialogue, i.e. for specifying the planners’ demands and communicating the (im)possibilities of the PSS. The result is increased commitment, understanding and acceptance. Third, this prototyping process should emphasise the both the externalisation of tacit knowledge and especially the internalisation of explicit knowledge.

Overall, the research explored the implementation gap of PSS for integrated land use and transport strategy-making in detail. The proposed solutions focussed on the social side – instead of on the technical site – of the implementation bottlenecks. This was grounded in academic insights from knowledge management and cognitive sciences and tested in three cases of strategy-making in the Netherlands.

The main conclusion is that linking different types of knowledge (tacit and explicit) in a structured and iterative way improves the PSS use. It improves not only the quality and context specificity of the PSS, but also increases mutual awareness of (1) what a PSS can and cannot deliver and (2) the characteristics of strategy-making processes. Finally, the transparency and flexibility of the PSS are improved. Such an approach is situational: it has to be repeated – with varied detail – in each new planning situation. Thus, it is a continuous prototyping process in which the PSS developer and other participants gather new knowledge about strategy-making characteristics that influence the use of their instrument. Such a MPS approach is especially suitable for improving existing tools and instruments, which are often not utilised to their full potential for providing support to strategy-making (notably transportation models).

7.2 FUTURE RESEARCH DIRECTIONS
This research followed a strong pragmatic approach, which was focused on planning practice. This improved the understanding of (1) certain academically grounded interventions aimed at improving the usability of PSS and (2) how these (do not) work in the complexity of planning practice and why. This pragmatic research
approach enables an improved understanding of the complexity of real-life strategy-making situation and thus increases the relevance of the findings for practical situations. However, unlike classic experiments, there is only limited control over the variables, for example differentiation in variables between cases but even this control is questionable. In reality, numerous context variables influenced the success and failure of parts of the intervention. This limits the generalisability and the identification of universal patterns.

Future research should first focus on testing these findings in research environments with a weaker context but with more control (arrow [1] in Figure 7.1), i.e. more formal experiments. For example, they could test if and how the usability of PSS improves with increasing transparency or flexibility. But also the main assumptions about the conceptual use of PSS and its outcomes can be tested: how much does improved insight really matter in strategy-making?

A second important direction for future research takes the opposite approach. Consultants would apply the MPS approach in more real-life strategy-making contexts (arrow [2] in Figure 7.1), while the researchers would observe and record the outcomes. It would sharpen insights on the workings of the mechanisms discussed in this dissertation, in the context of land use and transport strategy-making.

A third and final direction for research consists in extending the context in which the MPS framework is applied (arrow [3] in Figure 7.1), not only in other spatial planning sectors (such as environment, economy or water) but also in strategy-making situations with more conflicting interests and with more diverse sets of actors (stakeholders, citizens and decision-makers).
A last direction, more focused on pure research and methodology, would be to analyse whether there is a possible synergy between the pragmatic research approach (aiming for relevance above rigor) and the syntactic research approach (aiming for rigor above relevance). Is it possible to conduct research that can balance relevance and rigor or does the researcher have to choose one over the other?
Summary
SUMMARY
The essence of spatial strategy-making is the link that it establishes between, on the one hand, the knowledge about the urban context and on the other intervening actions, plans and strategies. The specifics (the how) of linking knowledge and action in current spatial strategy-making processes has been the object of much academic debate (Healey, 2007, chapter 8). Both in theory and practice, the debate revolves around what constitutes right, relevant or rigorous knowledge and who has the power to make this distinction. In response to theoretical, political and practical flaws of the classical approach of technical rationality (with professional/systematised/expert knowledge at its centre), there is a growing emphasis in planning research on various communicative and collaborative approaches. These aim to include other, more contextualised and personal types of knowledge from all the involved actors. Despite important differences, most of these approaches share the idea that planning should be first and foremost a social process of ‘reasoning together’, based on communicative rationality. Nevertheless, the question remains: how to integrate local and experiential types of knowledge with the more traditional, professional types of knowledge? Both the importance and the difficulties of this question are recognised in the academic literature on communicative planning and on the so-called Planning Support Systems (PSS). Current PSS (as instruments designed to provide this integration of knowledge) face structural implementation difficulties. Planners see them as far too generic, complex, technology oriented (rather than problem oriented), narrowly focused on strict technical rationality and incompatible with the unpredictable/flexible nature of most planning tasks and information needs. The fundamental problem of these instruments is their overwhelming focus on (computer) technological tools for producing systematised, scientifically rigorous knowledge. Far too little attention is paid to embedding the output in the planning context and connecting it with local and experiential knowledge. First, this technology biased focus fails to consider the different meanings that each planning actor attaches to the technical facts and outcomes. Second, it fails to take into account the rapidly changing context in which spatial strategy-making takes place.

Within spatial strategy-making, one of the central challenges is to integrate different planning domains. These are strongly interrelated but often have developed strict sectoral pillars of legislation, financial arrangements, institutions and education. It is a widely held notion that better integration of the land use and transport planning domains is a crucial prerequisite for designing sustainable spatial strategies. Such a sustainable strategy would foster opportunities for the inhabitants and businesses to take part in relevant social and economic activities which require mobility, while at the same time reducing the negative effects of this mobility. However, the professional sectoral languages developed throughout their careers equip the professionals with different the types of indicators and different modes of thinking. This makes shared spatial strategy-making difficult and sometimes even conflict prone. Land use and transport planners not only use different indicators and models, but also perceive differently the urban environment, its problems, and strategy-making. There have been significant academic and professional efforts to develop concepts, tools and instruments to support the integration of land use and transport
planning processes. However, recent studies show that this information and these ‘state of the art’ instruments are hardly used to support LUT integration in planning practice. Especially in the early phases of planning, there is still a significant deficiency of relevant integral information and tools.

The importance of integrated land use and transport strategy-making and the cumbersome relationship between knowledge and action in such processes stimulated the formulation of the following central research question:

*How to improve the use of Planning Support Systems that aim to support integrated land use and transport strategy-making?*

In answering this central question, the research took a design-oriented approach. It takes the object of study as a *mutandum* or ‘something to change’. The typical products of design sciences are *prescriptions* that are *tested* in practice and *grounded* in scientific knowledge. As a methodological framework, the experiential learning cycle was used, where the *observation of and reflection on concrete experience* leads to the *forming of abstract concepts*, which are then *tested in new situations*, eventually resulting in the adaptation of existing practices (i.e. *concrete experience*), starting a new loop.

The first research step explored the current implementation gap of PSS, which aim to support integrated land use and transport strategy-making. A literature review, semi-structured interviews and a web based survey were used to analyse the supply and demand side of this gap and to develop directions for improvement. General bottlenecks of PSS implementation found in literature were confirmed as hindrances to the specific set of PSS for land use and transport strategy-making. More specifically, planners found that these PSS do not provide enough new LUT insights, do not fit the planning process and are not well linked to planning practice. Especially for strategy making, the PSS lack transparency, have a low communication value, lack user friendliness and it is impossible to play with them. Instead, PSS should function as laboratories where planners can collectively experiment and take part in group learning about LUT relationships. In order to provide this support, the PSS should be easy ‘to play with’ and transparent on its assumptions. The current focus on improving the scientific rigor of the instruments seems contra productive in the face of these findings. Instead, or next to this, efforts should be concentrated on improving the fit with the context specific of strategy-making processes and finding a balance between rigor and relevance. This balance needs to be sought together with the planner: a shift from ‘developing for’ to ‘developing with’.

In the second step, a concept was developed that could support this shift: Mediated Planning Support (MPS). For this, an international literature review was carried out in the adjacent fields of knowledge management, process management, cognitive sciences, and system analysis. Central elements that were found as useful adaptations included a stepwise prototyping approach, a continuous exchange of the knowledge within instruments and the knowledge of the user, placing emphasis on the contextual nature of PSS and keeping the instrument ‘as simple as possible, but
not simpler than necessary’. These findings were combined and translated into the specifics of PSS development. It is hypothesised that the resulting MPS approach (see figure below) addresses some of the fundamental bottlenecks recognised in the first research step. The transparency of the output and the assumptions of the (computer) models that are part of the PSS would improve. The PSS would become more flexible and attuned to the particular characteristics of specific planning process, increasing their compatibility with the existing planning tasks. Also, planners should gain a shared ownership of the process and information choices. PSS developers could learn how their model and output is used in ‘wicked’ planning processes and how this unpredictability can potentially influence the usefulness of their products.

This MPS approach was consequently applied in three cases of integrated land use and transport strategy-making. The cases tackled different, locally specific planning challenges ranging from fostering of economic growth (Amsterdam), to improving the potential of a train station (Breda) and developing regional public transport strategies (Eindhoven). Participatory observation of these cases together with workshop specific questionnaires produced learning effects between the three cases, allowing the team to make small adjustments to the MPS approach. One key insight was that especially the processes of externalisation and internalisation were crucial for bridging the implementation gap. If these processes are neglected, planners have difficulties using the PSS generated knowledge to support their strategy-making.

The fourth research step closed the experiential cycle with a reflection on the use of the MPS approach in the three cases of integrated land use and transport strategy-making. Here, the hypotheses grounded in the second research step were tested, through a survey which was sent to all the participants. Also, participatory observation and workshops questionnaires were used in this step. This analysis suggests that the MPS approach significantly improves the compatibility of a PSS
SUMMARY

with the specific characteristics of strategy-making. It increased the planners’ awareness and understanding of the PSS, enhanced transparency of its assumptions and outcome, and increased acceptance. However, the relationship with the usability of the PSS proved more complex than expected. It seems that improved transparency first creates a critical attitude of the planners towards the PSS, because they understand better what the PSS can and cannot do. If the facilitator and PSS developers can keep this critical attitude constructive the usability can increase. This is however a delicate situation.

The insights developed in these four research steps provide an answer the general research question. To improve the use of Planning Support Systems that aim to support integrated land use and transport strategy-making, iterative processes of knowledge exchange (especially externalisation and internalisation) should be employed. Also, existing PSS should be made context specific through stages of prototyping, during which the specific characteristics of different parts of the PSS are determined in close cooperation between PSS developers and planning professionals.
Samenvatting
SAMENVATTING
De essentie van ruimtelijke strategievorming is het vormgeven van de link tussen kennis over de stedelijke context en interventies, acties, plannen en strategieën. De specifieke uitwerking (het hoe) van deze link tussen kennis en actie in huidige ruimtelijke strategievorming wordt veel bediscussieerd. Zowel in theorie als in de praktijk draait dit debat om 1) wat als juiste, relevante of als wetenschappelijk correcte kennis kan worden gezien en 2) wie de macht heeft om dit vast te kunnen stellen. In een reactie op theoretische, politieke en praktische bezwaren op het klassieke technisch rationalisme model (met professionele/systematische/expert kennis als centraal element) is er een groeiende nadruk op verschillende communicatieve planningsbenaderingen. Deze hebben als doel om andere, meer contextuele en persoonlijke typen kennis van alle betrokken actoren te betrekken. Ondanks belangrijke verschillen, deze communicatieve benaderingen delen het idee dat planning vooral gaat om het sociale proces van ‘samen beredeneren’, gebaseerd op het concept van communicatieve rationaliteit. Toch blijft hiermee de vraag over hoe de lokale en persoonlijke kennis met de meer traditionele professionele kennis moet worden geïntegreerd onbeantwoord. Zowel het belang van deze vraag als de moeilijkheden van het beantwoorden ervan worden erkend in de academische literatuur over communicatieve planningsbenaderingen en over Planning Support Systems (PSS). Huidige PSS (instrumenten die als specifiek doel hebben om verschillende soorten van kennis te integreren) worden zelden of niet in dagelijkse planningspraktijken gebruikt. Planners vinden ze te generiek, complex, technologisch georiënteerd (in plaats probleem georiënteerd), te smal gefocust op technische rationaliteit en niet verenigbaar met het onvoorspelbare/flexibele karakter van de meeste planningstaken en informatiebehoeften. Het fundamentele probleem van deze instrumenten is hun overweldigende focus op (computer)technieken om systematische, wetenschappelijk correcte kennis te produceren. Er gaat daarbij te weinig aandacht uit naar het inzetten van deze kennis in de context van planning en het verbinden van de kennis met lokale, persoonlijke kennis. Ten eerste wordt hierdoor over het hoofd gezien dat iedere planningsactor verschillende betekenissen geeft aan dezelfde technische feiten en uitkomsten. Ten tweede wordt hierdoor geen rekening gehouden met de snel veranderende context waarin ruimtelijke strategievorming plaatsvindt.

Binnen ruimtelijke strategievorming is het integreren van verschillende planningsdomeinen één van de centrale uitdagingen. Vaak zijn deze sterk gerelateerd, maar hebben ze in de afgelopen decennia sectorale wetgeving, financiële regels, instituties en opleidingen ontwikkeld. Het is bijvoorbeeld breed geaccepteerd dat een betere integratie van ruimtelijke- en mobiliteit planningsdomeinen een cruciale voorwaarde is voor duurzame ruimtelijke strategieën. Dergelijke duurzame strategieën bevorderen de mogelijkheden van burgers en bedrijven om deel te nemen aan relevante sociale en economische activiteiten waar mobiliteit voor nodig is, terwijl tegelijkertijd de negatieve effecten van deze mobiliteit worden beperkt. Echter, doordat beide planningsdomeinen een sterk sectorale ‘taal’ hebben ontwikkeld kennen ze ook zeer verschillende typen indicatoren en andere manieren om naar de werkelijkheid te kijken. Dit maakt gezamenlijke strategievorming lastig. Ruimtelijke- en mobiliteit planners gebruiken
niet alleen andere indicatoren en modellen, maar doordat ze anders naar de werkelijkheid kijken, zien ze andere soorten problemen and ontwikkelen ze op een andere manier strategieën. Er zijn vele academische en professionele pogingen gedaan om concepten, tools en instrumenten te ontwikkelen die de integratie van ruimtelijke- en mobiliteit planning ondersteunen. Recent studies naar het gebruik hiervan in de planningspraktijk laat zien dat deze ‘state of the art’ instrumenten niet of nauwelijks gebruikt worden ter ondersteuning van integrale planning. Vooral in the vroege planningsfases is er nog steeds een gebrek aan relevante integrale informatie en instrumenten.

Het belang van integrale ruimtelijke- en mobiliteit strategievorming en de moeizame relatie tussen kennis en actie in zulke processen hebben geleid tot de volgende onderzoeksvraag:

_Hoe kan het gebruik van Planning Support Systems voor integrale ruimtelijke- en mobiliteit strategievorming worden verbeterd?_
In de tweede onderzoeksstap, is een concept ontwikkeld om deze verschuiving vorm te geven: Mediated Planning Support (MPS). Hiervoor is een literatuuronderzoek gedaan in gerelateerde wetenschappelijk velden, zoals kennismanagement, procesmanagement, cognitiewetenschappen en systeemanalyse. Centrale elementen die bruikbaar bleken voor het ondersteunen van PSS ontwikkeling waren onder andere een stapsgewijze prototype ontwikkelingsopbouw, een continue uitwisseling van verschillende soorten kennis tussen gebruiker en PSS, meer aandacht geven aan de contextuele aard van planningsprocessen en het adagium ‘zo simpel mogelijk, maar niet simpeler dan noodzakelijk’. Deze inzichten zijn gecombineerd en vertaald naar de specifieke kenmerken van PSS ontwikkeling. De hypothese was dat de uiteindelijke MPS methode (figuur hieronder) een aantal fundamentele barrières voor het gebruik van PSS, zoals gevonden in de eerste onderzoeksstap, kan overbruggen. De transparantie van de uitkomsten en aannames van de PSS zou verbeteren. De PSS zou flexibeler worden en beter aansluiten bij de context specifieke karakteristieken van strategievorming waardoor het beter zou aansluiten bij planningstaken. Ook zou het helpen om een gedeelde consensus te krijgen over de gemaakte proces- en informatiekeuzes. PSS ontwikkelaars moeten leren hoe hun PSS en de uitkomsten ervan worden gebruikt in ‘wicked’ planningsprocessen en hoe deze onvoorspelbaarheid de bruikbaarheid van de PSS kan beïnvloeden.

Vervolgens is de MPS methode ingezet in drie cases van integrale ruimtelijke- en mobiliteit strategievorming. De cases behandelde verschillende, lokale planningsuitdagingen van het faciliteren van economische groei (Amsterdam) via het verbeteren van de haalbaarheid van een treinstation (Breda) naar het ontwikkelen van Hoogwaardig Openbaar Vervoer strategieën (Eindhoven). Participatieve observatie en vragenlijsten rondom de workshops hebben een leerproces
ondersteund tussen de drie cases, waardoor kleine verbeteringen aan de MPS methode konden worden meegenomen. Een centraal inzicht was dat de processen van externalisatie en internalisatie van kennis crucial bleken te zijn om het gebruiksgat van de PSS te overbruggen. Als deze twee processen worden verwaarloosd, hebben planners grote moeilijkheden om de gegenereerde kennis van de PSS te gebruiken om strategievorming te ondersteunen.

De vierde onderzoeksstap sloot de experiëntele leercyclus met een reflectie op het gebruik van de MPS methode in de drie cases. Hierbij zijn de hypotheses vanuit de literatuur (stap 2) getest door middel van een enquête onder alle deelnemers aan de workshops. Ook werden de inzichten van de participatieve observatie en de vragenlijsten hier gebruikt. Uit de analyse bleek dat door de MPS methode de compatibiliteit van de PSS met de specifieke karakteristieken van strategievorming significant verbeterd. Het zorgde ervoor dat het besef en begrip van planners voor de PSS toenam, het verbeterde de transparantie van aannames en uitkomsten en verhoogde de acceptatie van de PSS. De relatie met de bruikbaarheid van PSS bleek echter complexer dan vooraf aangenomen. Het bleek dat verbeterde transparantie eerst een kritische houding van de planner ten opzichte van de PSS kan creëren, omdat men nu beter weet wat de PSS wel en vooral niet kan. Als de facilitator en PSS ontwikkelaars deze kritische houding constructief kunnen houden, kan de bruikbaarheid sterk toenemen. Dit is echter een delicate situatie.

De inzichten die zijn ontwikkeld in de vier onderzoeksstappen geven samen een antwoord op de algemene onderzoeksvraag. Om de bruikbaarheid van PSS die integrale ruimtelijke- en mobiliteit strategievorming ondersteunen te verbeteren, zijn iteratieve processen van kennisuitwisseling behulpzaam (vooral externalisatie en internalisatie). Ook moeten bestaande PSS context specifiek worden gemaakt door meerdere fasen van ‘prototyping’. Gedurende dit proces kunnen verschillende delen van de PSS contextspecifiek worden gemaakt samen met de PSS ontwikkelaar en de planners.
Curriculum Vitae
PERSONAL DESCRIPTION
Marco te Brömmelstroet was born in 1980 in Gendringen, the Netherlands. After graduating his VWO education at the Isala College in Silvolde in 1999, he studied at the Saxion Hogeschool Uselland from 1999 to 2003, where he received a Bachelor of the Built Environment. From 2003 to 2005, he studied Environmental and Infrastructure Planning at the University of Groningen. He received his Master of Science degree by graduating on the topic ‘historical development of the European transport policy domain’. In 2004, he started his study on Geographical Information Management and Applications (a collaborative study of Utrecht University, Technical University Delft, Wageningen University and ITC Enschede). For this, he received his Master of Science degree in 2009 by graduating on the topic ‘socio-technical development approach for Planning Support Systems’.

In 2005, he started as a Ph.D. candidate at the Amsterdam institute for Metropolitan and International Development Studies of the University of Amsterdam on a research that was part of the Transition to Sustainable Mobility program. The focus of this research was on the role of knowledge in connecting the strategy-making of land use and transport planners. Currently, he is working as a PostDoc on a NOW sponsored research on sustainable urban strategies for the Randstad in the face of climate change. Also, he is running a bicycle shop in Munich, Germany.

ACADEMIC PUBLICATIONS

**SELECTION OF OTHER PUBLICATIONS**


