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

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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)]

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; Khakée 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
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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.

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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.
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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;

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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.
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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

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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 (2006) 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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