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

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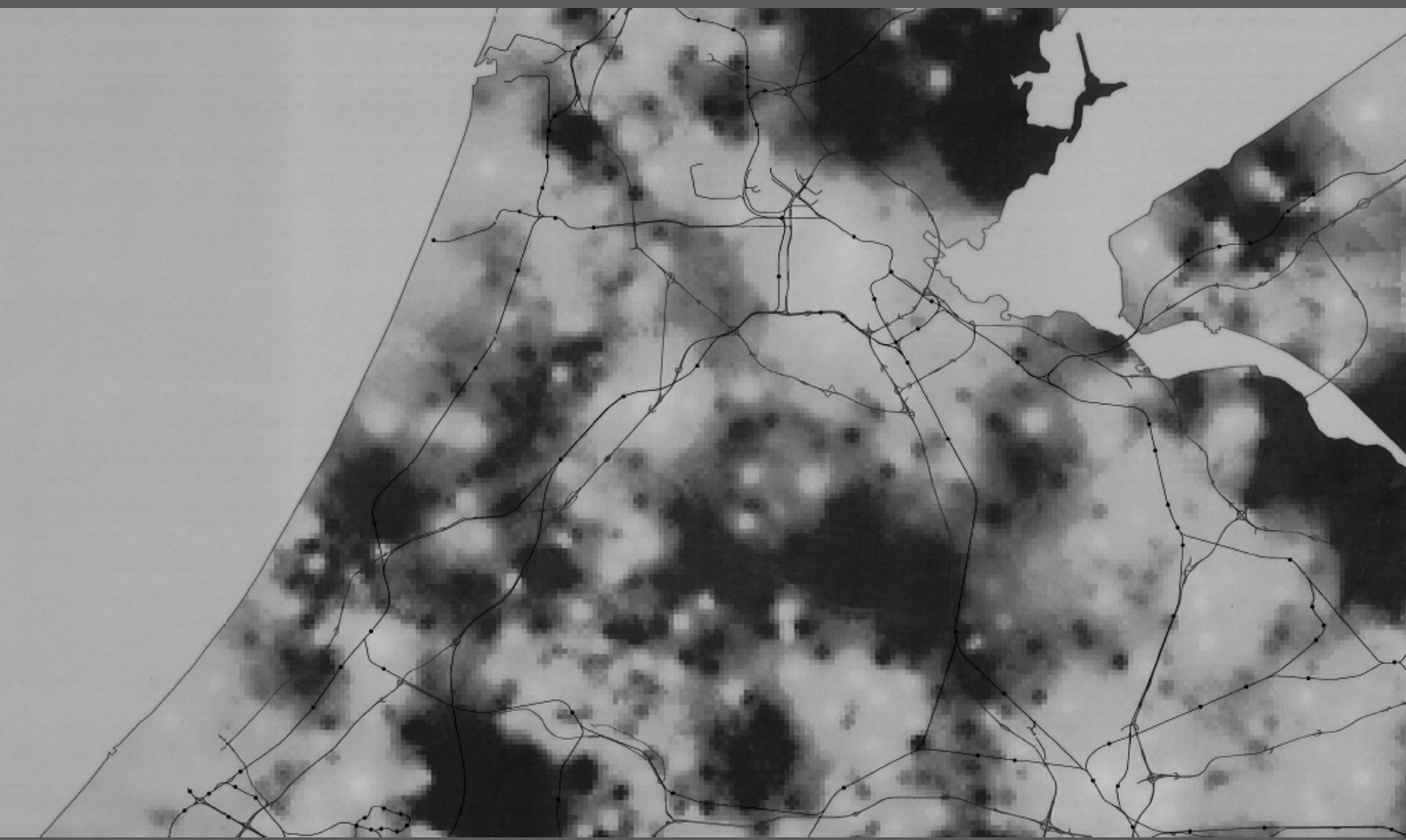
Chapter 6

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.

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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.[8] 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).

[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.

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.

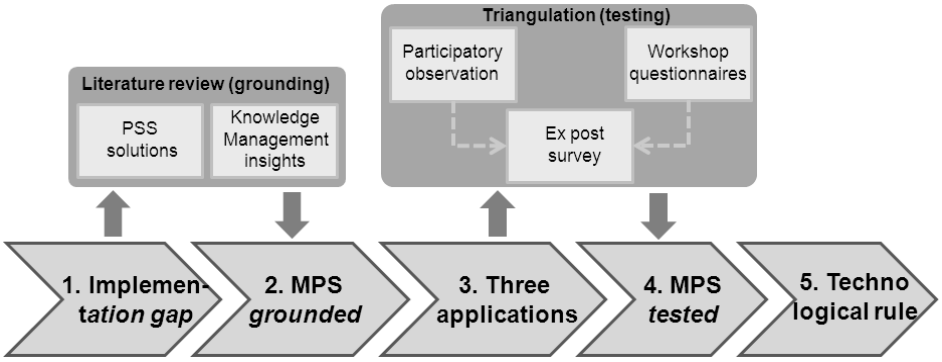

Figure 6.1 Research design

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**

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The hird 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 behaviouralist 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 of 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*.

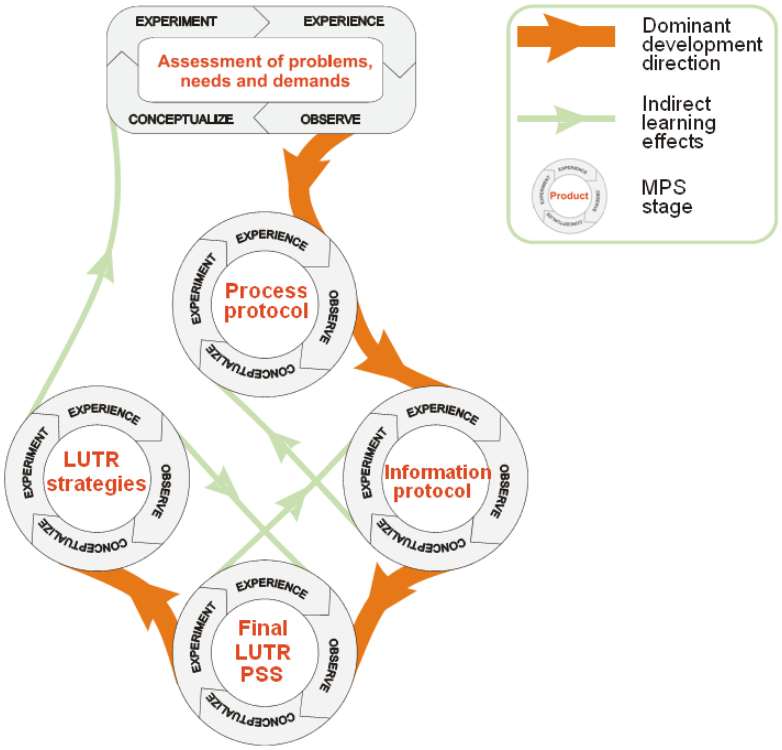

Figure 6.2 Mediated Planning Support (from Te Brömmelstroet and Schrijnen, 2010)

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).

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 form 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.

CHARACTERISTICS	AMSTERDAM	BREDA EAST	EINDHOVEN
Scale	Regional	Local	Regional
Planning Participants	Land use planners city Land use planners region Transport planners city Transport planners region	Land use planners Breda Land use planners (neighbouring municipality) Transport planners Breda Transport planners (neighbouring municipality) Railway operator (NS)	Land use planners city Land use planners region Transport planners city Transport planners region PT company (Hermes) Marketing experts
PSS origin	Internal	External	External
Initiative	PSS developers	Land use planners	PSS developers

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.

QUESTION	RESPONSE	N	STDEV	T-Value
In general, how well is planning support information geared to the characteristics of strategy-making processes?	5.4	9	1.65	
How well was the planning support information in the workshops geared to the characteristics of strategy-making processes?	6.9	9	0.93	
Average Difference of means	**1.5**		**1.94**	**0.028**[9]
How much did the open attitude of the PSS developer contribute to this?	7.4	9	1.13	

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.

[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.

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

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.

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

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.

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

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.

QUESTION	RESPONSE	N	STDEV	T-Value
In general, is PSS useful for strategy-making?	7.7	11	1.0	
How useful was PSS in the workshops?	6.9	11	1.1	
Difference of means	**-0.8**		**1.2**	**0.021**

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 straight forward 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 sprit 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.

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

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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