TRANSPARENCY, FLEXIBILITY, SIMPLICITY:FROM BUZZWORDS TO STRATEGIES FOR REAL PSS IMPROVEMENT

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ABSTRACT

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, with the aim to increase the understanding of the added value of the mechanisms that underlie the MPS framework. Methodologically speaking, it utilised workshop specific surveys, a general ex-post survey and participatory observation. Although small-N, the results seem to indicate that MPS does improve several of the bottlenecks of PSS implementation defined in other studies: it provided a better fit between the PSS characteristics and the strategy-making processes, it increased understanding of the possibilities (and limitations) of PSS, it fostered acceptance and improved use (awareness and transparency were not significantly influenced). 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 will provide directions for further research.

Keywords: Planning Support Systems, implementation gap, mediation, user orientation, land use and transport, strategy making

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.[1] Starting with the 1973 seminal paper by Douglas Lee, a consolidated list of fundamental bottlenecks has been identified. In general, the family of Computer Aided Planning instruments (PSS is its most recent member next to Large Scale Urban Models and Spatial Decision Support Systems) are seen by their intended 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 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, use is defined in its broader sense ('knowledge provided by the tool is used to support and influence planning strategies'), instead of the strict instrumental sense ('the tool is being used') (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 should shift their focus away from comprehensiveness and the technically developable towards 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, see for example: 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).

[1] Following Richard Klosterman Klosterman, R. E. (1997). "Planning Support Systems: a new perspective on Computer-aided planning." *Journal of Planning education and research*, 17(1), 45-54., Planning Support Systems are defined as an infrastructure that systematically introduces relevant (spatial) information to a specific process of related planning actions.

During the past 30 years most PSS research has been following a strong *syntactic r*esearch program; that is, research aimed to explain PSS development and implementation in terms of abstract conceptualizations and their interrelationships (see also Abbott 2004, p. 26). From Lee (1973) to Vonk (2006), many scholars contributed to building this abstract model of PSS implementation based on theoretical and empirical studies, which resulted 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. Learning through experience what does (not) work and why is crucial in developing realistic solutions that can support us in improving the implementation rate of PSS. This paper attempts to provide such experiential testing. With this, it contributes to a growing need for more insight in how to improve the use PSS to support planning. It does so in a methodological way, by showing how such a research can be structured and in an empirical way, by showing the results of a first concrete test of a possible intervention to improve PSS usability. First, the chosen structure for such testing is explained, followed by considerations on the research design and methodology. Then, the hypotheses are formulated and their translation in a concrete intervention is discussed. The paper continues with a discussion of the cases and empiral data before closing with conclusions and a discussion of the findings.

CLOSING THE EXPERIENTIAL LEARNING CYCLE FOR PSS SOLUTIONS

If the underutilization of PSS is defined as a practical field-problem, one should move away from only trying to understand and conceptualise the bottlenecks towards developing and testing strategies to overcome them, i.e. applying the full experiential learning cycle (see Figure 1) (Kolb and Fry 1975) .

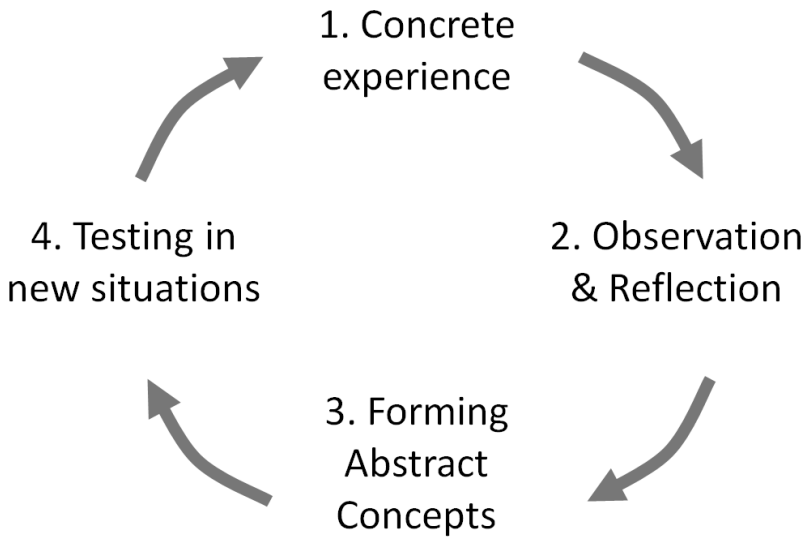

Figure 1 – The experiential learning cycle (Kolb and Fry 1975)

Applying this concept to research in planning, Straatemeier et al. (2010) showed that while practitioners mostly learn by a short reflection loop (sequence 1,2, and 4 in Figure 1),

researchers mostly follow the sequence 1,2 and 3, thus ending in abstract conceptualisations. When developing solutions for field-problems, researchers should go a step further. He/she should engage in real situations to gain insights in the practical relevance of the scientific findings (often leading to new/sharper research questions). . This paper attempts to close a first experiential loop for solutions to the PSS implementation gap, by testing them in real practices. It reports on these experiences and observes and reflects on the findings, in turn to formulate new academic insights and sharpen the abstract conceptualizations.

To learn from the concrete experience and to generalise findings to a certain extent, a research design recently proposed in management sciences; the so-called CIMO framework (Pawson and Tilley 1997; Van Aken 2004). The aim of CIMO (Context-Intervention-Mechanism-Outcome) is to develop 'technological rules' (a sort of prescriptions) that guide practitioners in finding solutions for particular problems (in this case (non-)use of PSS). While designing solutions to address the PSS implementation gap and applying these in real–life situations, the researcher is searching for prescriptions, 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 these in practice and analysing how they work (or do not work), the researcher can develop prescriptions that are *grounded* (in academic theory) and *tested* (in real planning contexts) (Van Aken 2004). This technique is very suitable method for closing the full experiential learning cycle. The central question in this article is the following: what are mechanisms that improve the usability of PSS that aim to support strategy-making and how do they work (in theory and practice).

RESEARCH CONSIDERATIONS

Following the experiential research approach discussed above, MPS was applied in three cases of integrated land use and transport strategy-making. Below, these cases are shortly introduced and it is analysed whether MPS supported the PSS developers in improving the usability of their instruments. For this purpose, a number of complementary research techniques were used. During the workshops participatory observation was used to see how certain interventions influenced the individual participants and the group as a whole. Also, immediately after the workshops, participants were asked to fill out a workshop specific survey. These questions related to their experience of the workshop and the information they learned and/or were planning to use in their daily activities. The starting point of the analysis is an ex-post survey, administered per email after the MPS interventions, which 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 discussion of the four hypotheses is already covered in a previous paper (Te Brömmelstroet and Schrijnen 2010), this paper will focus on *testing* these hypotheses, more specifically on steps 3, 4, and 5 in the process (as outlined in Figure 2).

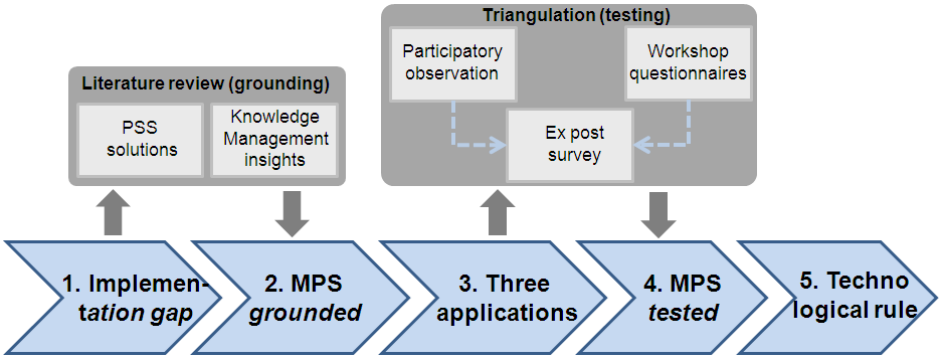

Figure 2 – Research design

Below, first the central hypotheses about improving PSS implementation are introduced. Further, the theoretical foundations and the operationalisation will be shortly discussed. Very briefly, the translation of these hypotheses into concrete interventions is discussed and the three practical cases are presented. Then, the paper will continue with the analysis of the hypotheses based on these cases (using the different research methods: workshop specific surveys, a general ex-post survey and participatory observation). This analysis results in a 'grounded and tested prescription' (technological rules according to Pawson and Tiley [1997]). The paper will close with a discussion of the findings and the implications for the MPS approach and PSS development in general.

HYPOTHESES FOR IMPROVING PSS IMPLEMENTATION

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 key 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 books many 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). Although recent publications show increased use of a number of PSS (notably Brail 2008; Geertman and Stillwell 2009), wide scale implementation (especially for supporting strategy-making) is still not taking place (also acknowledged in Lee 1994; Vonk et al. 2005). Also, it is questionable if the described use of PSS goes further than the narrow

instrumental definition of use.

Not only PSS developers are to blame. 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 with the context of strategy making; 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 to 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.

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. In 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* is a term commonly applied (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 becomes 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 treating knowledge as an external entity (Gredler 2001), recent cognitive concepts prescribe 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, 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, (1) the use of and reflection on PSS prototypes by planning practitioners and (2) the presence of the PSS developer during workshops are central.

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 improves the transparency of the PSS but also improves the way that the planning practitioners look at their planning issue and its formal presentation 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 hypothesis 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 into 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, namely:

- Externalisation (turning a planning problem into PSS indicators) was translated into a sticker session that offered PSS developers different possible maps and indicators to support 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, crucial for the development of shared strategies.

TESTING HYPOTHESES IN REAL STRATEGY MAKING PROCESSES

The four hypotheses were tested by applying them in three cases of strategy-making, by translating them in a framework for PSS development: MPS or Mediated Planning Support (more on how this was done in Te Brömmelstroet and Schrijnen 2010). All three cases focused on the development of integrated strategies for the domains of land use and transport planning; with a marked strong need to integrate ‘hard’ information into the planning process. The spatial scale ranged from regional to local planning issues, and the composition of participants also differed (still most of them were planning professionals with a land use and/or transport planning background).

All cases started from a practical request to develop integrated land use and transport strategies. In all three cases, suitable supportive information was missing. The author, together with one academic colleague, organised the workshops for PSS developers and local planning practitioners. The two academics were responsible for facilitating/mediating and participatory observation (supported by sound recording). The number of workshops differed per case, depending on how many planning steps were taken. Usually, one workshop was needed for the first three steps of MPS, one or two for step four and one for the final step.

Referring to the broad definition of a PSS, provided by Klosterman (1997), we used a specific and limited set of PSS in the three cases. These were all transport related models. In terms of complexity they ranged from a classical sophisticated four step transportation models to a very simple circle method to calculate the number of potential users of a station. Also, accessibility maps (based on the potential reach from a given location) and public transport potential maps (based on a large scale survey of citizen preferences) were used. Although

different as models, they all aim to provide knowledge to support strategy-making. This again limits the generalisabilty of the findings.

Case 1: Accommodating economic growth in the Amsterdam Metropolitan Area

The Amsterdam Metropolitan Area is projected to face significant challenges up to 2030 in the domain of land use (150.000 extra houses and 150.000 extra jobs are expected) and transport (doubling of road and rail traffic intensities). 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 projected challenges in 6 workshops. They needed a PSS that could support their strategy-making process with a common explicit language (indicators, maps graphs). This is needed in order to bridge the domains that speak different formal languages, have different educational backgrounds and look differently at the region. The classical four step transportation model of the municipality (GenMod) was seen as potentially useful starting point. Currently it is mainly geared for project calculations, rendering it difficult to use 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).

Case 2: Integration of new station and urban area in Breda

East of Breda, a new railway station is planned; it should be used as a *Park & Ride*, a station for a new event centre as well as a connection between 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 establishing connected 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 meet and develop integrated strategies to improve this situation in 4 workshop sessions. As there was no in-house transportation model, external models and tools were used to develop the MPS approach: the Circalex method of the Dutch railways (a simple circular indicator that calculates the number of potential users of a train station based on inhabitants and jobs within a number of circles around a station) and accessibility maps (showing for each zone the number of inhabitants or jobs within acceptable travel times by car, public transport and slow modes). The latter information was provided by an external mobility consultant.

Case 3: Public Transport strategies in the Eindhoven City Region

The Eindhoven City Region was in the process of developing new public transport strategies. Planners stated that while these strategies were based on general technical insights on the organisation of public transport they did not incorporate insights on the public transport potential of certain neighbourhoods. Also, they wanted to explore strategies form the end user perspective, focusing on the users' needs and demands. The University of Hasselt and the University of Eindhoven jointly developed an instrument and in 2008 they started a MPS process of 4 workshops 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. Here again, two different models were selected by the planners and used in the process: the Accessibility maps (as described in the Breda case) and Public transport potential maps (showing the potential of transfer to public transport for each zone of non-public transport riders).

The differences and similarities between the cases are summarised in Table 1.

Table 1 – The case studies and their characteristics

Case Characteristics	Amsterdam Metropolitan Area	Breda East	Eindhoven City Region
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

PRAGMATIC TESTING OF MPS

In the ex-post survey, all (planning and PSS development) participants that were structurally present, were asked to respond to the four hypotheses in a self-completing questionnaire. The planners who participated in only one workshop were not included in this survey, due to their limited overview of the intervention and the outcomes. Eleven planning practitioners (a 50% response evenly distributed over the three cases) and all four PSS developers responded. For some hypotheses, not all responses were suitable for analysis, due to missing values.

The statistical analysis of this output (presented in the Tables 2 to 5 below) did not have rigorous testing of the hypotheses as a primary goal, but was rather used as a starting point to interpret the findings of the participatory observation and the workshop specific surveys. Due to two self-selection mechanisms it cannot be considered a random sample. As participation in the workshops was voluntarily, the participating planners and developers were those more interested in exploring the connection of PSS and strategy-making support. A second self-selection took place in the response to the survey. The voluntary respondents

can be seen as more involved in (understanding) the mechanisms of PSS implementation than those that did not respond. The generalisability of all data therefore only extends to a population of interested and involved planning practitioners and PSS developers.

To find out if the fit was improved by the MPS intervention, the practitioners were asked to rate both the general compatibility of PSS to strategy-making processes and the compatibility of the PSS developed and used during the MPS process (on a 1 (low) to 10 (high) scale).

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

The first question of the survey evaluated the compatibility of general PSS (described in the survey as indicators, maps and models) with the characteristics of strategy-making processes and whether this compatibility improved during the MPS process (on a 1-10 scale). Also, they were asked to rate whether the open attitude of the PSS developer was helpful (the average results are presented in Table 2).

Table 2 – Compatibility of PSS for strategy-making

QUESTION	RESPONSE	N
In general, how well is planning support information (indicators, maps, models) adapted to the characteristics of strategy-making processes?	5.4	9
How well was the planning support information in the workshops adapted to the characteristics of strategy-making processes?	6.9	9
Average Difference of means	**1.5**	
How much did the open attitude of the information supplier contribute to this outcome?	7.4	9

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 compatibility 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 low.

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 improve the PSS based on participant comments. Because this made it very difficult for

them to interpret the outcomes, this information was hardly used. Especially in the cases initiated by the PSS developers, the planning practitioners ranked the open attitude as an important element for improving compatibility.

Hypothesis 2: An open attitude of the planners improves awareness and understanding

All PSS developers who participated in the three MPS cases were asked how much, both in general and during the MPS process, the 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 PSS developer participating in two case studies (table 3).

Table 3 – Awareness and understanding of planning practitioners to the (im)possibilities of PSS for strategy-making

QUESTION	RESPONSE	N
In general, how aware are planning actors of the (im)possibilities of planning support instruments such as yours?	5.3	4
How aware were the practitioners in the workshops of the (im)possibilities of your instrument?	7.5	4
Difference in means	**2.2**	
In general, how much understanding do planning actors have for the workings of planning support instruments such as yours?	4.5	4
How much understanding did the practitioners in the workshops have for the workings of your instrument?	7.3	4
Difference in means	**2.8**	
How much did the open attitude of the practitioners contribute to this outcome?	7.5	4

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 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 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 produces different expectations about outcomes: planners learn that they cannot expect straightforward yes/no indicators, but that they should be open to the uncertainty and

nuances behind this information.

These findings mirror the observations made in the workshops. In all cases, it was difficult to start because both domains had different 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.

Hypothesis 3: Prototyping improves transparency of assumptions and outcomes

To test this hypothesis, the planning practitioners were asked to rate the transparency of PSS assumptions and outcomes, 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 4.

Table 4 – Transparency of assumptions and outcome in general and in MPS

QUESTION	RESPONSE	N
In general, how transparent is planning support information (indicators, models, maps) for strategy-making?	6.2	11
How transparent was the information that was developed and used in the workshops?	6.8	11
Difference in means	**0.6**	
How much did the prototyping process (use and reflection) contribute to this transparency?	7.1	11

Surprisingly, the figures show that the transparency of PSS in general is considered as relatively good, which contradicts other findings about the bottlenecks of specific land use and transport PSS (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, the participants shared that ‘it took a long time before the assumptions were clear’ and that ‘it was only transparent after explanation’. This again shows the importance of having a PSS developer present. 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 that 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. In order to increase PSS transparency, it is important to experience the prototype stages as a group; however, this is very hard to accomplish in practice with its high work pressure and complex agenda’s of participants.

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 externalisation and internalisation contributed to this acceptance. The results are listed in Table 5.

Table 5 – Acceptance and use of PSS in general and in MPS

QUESTION	RESPONSE	N
In general, how well is planning support information (indicators, maps, models) accepted and used by all planning actors?	6.0	11
How well was the information accepted and used in the workshops?	7.6	11
Difference in means	**1.6**	
How much did the discussion (sticker session) contribute?	6.6	9
How much did the presentation and explanation by the information supplier contribute?	7.2	10

On average the planning practitioners gave the general acceptance and use of PSS a relatively high rating, 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, which helped them 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 the internalisation step as providing more added value to the acceptance and the use of the PSS than the externalisation step. This fits with the observations of the researchers. It seems that externalisation is especially important for the PSS developer, who can thus 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.

Overall usability of PSS

As the above analyses show, the MPS approach increased understanding of the potential of PSS, improved the compatibility of the PSS with the characteristics of strategy-making processes and increased the rate of acceptance and use (awareness and transparency were not significantly influenced). Subsequently, by improving some of the crucial bottlenecks of the PSS implementation gap, it was expected that the usability of the PSS would also increases; however, the results of the ex-post survey (as shown in Table 6) indicate otherwise.

Table 6 – Usefulness of PSS in general and in MPS

QUESTION	RESPONSE	N
In general, is PSS useful for strategy-making?	7.7	11
How useful was PSS in the workshops?	6.9	11
Difference of means	**-0.8**	

Surprisingly, there was a strong consensus that 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 stated that the PSS in the workshops was 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 workshop specific surveys 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 does add some nuances to the results, there is also another explanation for 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), someone 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 a selected group of planners; no stakeholders or citizens were included).

CONCLUSION

This article started by exploring the PSS implementation gap in academic literature. The paper discussed seminal and recent studies that have identified the main bottlenecks and proposed general directions for improvement. Consequently, it was argued that in order to develop more relevant and useful insights for bridging the PSS implementation gap the full experiential learning cycle should be closed. This means applying abstract conceptualisations from literature and testing them in new situation, in order to develop concrete experience. The loop is closed by reflecting on the outcomes and translating the findings into new or improved concepts (grounded *and* tested prescriptions in terms of context, intervention, mechanism and outcome). The concepts of Mediated Planning Support (MPS) were therefore applied in three concrete planning practices (integrated land use and transport strategy-making).

Context, intervention, mechanism, outcome

Although the premises of the MPS approach are relevant for PSS development in general, they were tested only 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 an average experience of applying PSS and 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 regarding the 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 had several outcomes: improved compatibility of PSS with strategy-making processes, increased understanding of the PSS among planning practitioners, as well as increased acceptance and use. The expected increase of usefulness of the PSS to support-strategy is not supported by the ex-post survey. Increase of transparency and awareness was too small to be significant. However, it was observed that the information in all three cases was used to develop and discuss strategies, although often on a very abstract level (i.e. ‘it seems that you should leave options around the stations open, closing options for housing will render the station infeasible’). Also, in the workshop specific surveys, many planners stated that they reached some agreement on general strategies, which they could further apply in their day-to-day planning tasks.

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 an open collaborative sprit and prevent a relapse into a conflicting, unconstructive 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, in particular, the internalisation of explicit knowledge to support a mutual learning process.

Table 7 – Prescriptions following the CIMO logic

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)*

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 development process 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 be also 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 acquire improved – and also shared – understanding of the planning issue at hand.

Do to the nature our research method (actively engaging with real-life strategy-making cases), one has to be cautious in drawing causal conclusions. The steps of grounding and testing the prescriptions help to increase the understanding of the expected outcomes of such research. Even though the case studies supported most of the theoretical hypotheses about how to improve PSS implementation, they were also some nuances. Especially the role of the mediator and facilitator was the 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 in academic publications and tests these again in new cases (and so on). Therefore, it is essential to continue to test and ground the findings of this paper. The range of cases should be expanded to include other domains, other stakeholders, especially citizens and decision-makers. Also, it would be interesting to test whether the technological rule holds true in 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 mechanisms uncovered. Controlled experiments allow the researchers to focus on the key mechanisms and control for a wide range of influencing factors.[2] This can create new insights for bridging the PSS implementation gap and developing a fruitful link between the pragmatic and the syntactic research approach.

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