Usefulness of Planning Support Systems

Conceptual perspectives and practitioners' experiences

Nut van Planning Support Systemen: conceptuele perspectieven en gebruikerservaringen

(met een samenvatting in het Nederlands)

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Peter Pelzer

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Promotoren
Prof. dr. S.C.M. Geertman
Prof. dr. ir. R.E.C.M. van der Heijden
Prof. dr. M.J. Dijst

Peter Pelzer

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Foreword

Usually a foreword of a dissertation starts with something along the lines of 'the quest is finished', indicating that a heavy and solitary journey has finally reached its destination. Personally, I believe these kinds of analogies are exaggerations. As PhD candidate in the Netherlands you're actually in quite a comfortable position. Income is decent and stable. You're not bothered with all kinds of organizational issues in the university; academic substance is all that matters. If you like to go to a bar on weekdays and sleep in the next day, no one will bother. This obviously involves that you have to compensate some other time, but I actually liked sitting in an empty Van Unnik building in the evening – my former colleagues must think I'm lunatic by now.

Perhaps more important than the freedom to organize your work as you seem suited, is that you have the freedom to think, research and write what you want. While nobody is value free and academic research has rules and limitations – as we saw in Stapelgate one cannot make up empirical findings! – the researcher in the end decides. While I always felt this was a great merit, it also brings responsibilities. The first is obviously to develop a coherent, consistent and empirically correct narrative, which I'll hope you'll find in the following pages. The second, particularly for a practice-oriented discipline like planning, is that I believe you have to be able to communicate your research to a wider audience. That wasn't always easy for a relatively technical topic like Planning Support Systems (PSS). I should have kept records of all the people that mistakenly spoke of PPP (*public-private partnership*).

Bringing a definition into the equation did not help either. A sentence like: "Well, PSS are geo-information based instruments that incorporate a suite of components that collectively support some parts of a unique professional planning task" led to only more puzzled faces. Clearly a complex problem for which I had to find a solution. Tom Puss, invent a ruse![1].

I figured analogies would be suitable solution, because they can compare complex academic matter to real life situations to which people can connect. So over the last three and a half years I continuously searched for proper analogies to describe my research, sometimes in collaboration with my fellow analogy-lovers Niek and Marco. The process of finding a suitable analogy can best be described as trial-and-error: I tried out an analogy for a while and when it didn't work, I moved on to the next one. While many variations have come by, the three below are the most important ones.

I started with an analogy relatively close to PSS: ***SimCity***. This is a computer game in which you are mayor of a city and you have to build and manage your own city. This involves building highways, factories and energy plants in order to

[1] Tom Poes, verzin een list! Zie de Bommelsaga van Marten Toonder.

make your residents happy. As observed in the literature before[2] this game has a close resemblance to spatial planning. More specifically, SimCity is based on a set of behaviorial and impact models, which are not unlike PSS. It seemed like the perfect analogy for PSS. I came to realize, however, that only a few people, without an exception men, actually know what SimCity is. They had usually played it as a kid , resulting in very, very enthusiastic reactions. However, most people had no clue what I was talking about and only knew the successor of SimCity, the much more popular computer game the Sims. Hence, while the comparison seemed perfect, I had to continue my search for a suited analogy.

Then I started to work with TNO on organizing digitally supported workshops. “It is actually a large IPad”, I heard Ralph from TNO explaining to a student involved in the workshop. Of course! Everyone knows ***Apple***. And of course I tought Steve Jobs’ flashy product presentations in jeans and sneakers, in which he introduced something we don’t need yet, but which will soon be an inevitable part of our lives – IPod, IPhone, IPad. This can be described as ‘technology push’, users did not ask for the innovative technology, but are convinced by esthetics, user-friendliness marketing etc. And this is where the shoe started to pinch. In my dissertation I argue that the PSS field should do exactly the opposite of Apple. Don’t push a new computer model, interface or touch table to users, but carefully listen to their demands and apply PSS accordingly. Thus, another failed analogy. While everyone knows Apple, the comparison with my research makes no sense.

For the third and final analogy I decided to turn a bit more meta. A couple of years ago I went on a holiday to the Balkans, in Eastern Europe. One of the stops was Sarajevo, the current Capital of Bosnia and Herzegovina. Here I visited the Latin bridge, the place where Gavrilo Princip assassinated Archduke Franz Ferdinand, after which the First World War broke out. Historians are still debating the question: ***what if*** Gavrilo Princip would have failed in his attempt? Would the war have still broken out or would history have taken a very different turn? A couple of years later I started to realize that PSS are actually also about continuously asking what if questions – albeit at a very different level. What if a wind mill is placed in a new neighborhood? Will it have impact on energy and noise? What if the traffic intensity of an arterial road is decreased, is it still possible to live next to it? This seemed the perfect analogy. People ask what if questions continuously, ranging from the heavy life events (should I marry this person?) to very mundane issues (should I buy this icecream?).

However, comparing PSS to what if-questions is unfortunately not my invention. Dick Klosterman, one of the PSS godfathers, in 1990s also looked for a name for his newly developed PSS. The name of his tool….? What if?®. While it took me some time, I simply reinvented the wheel. Or put more positively: earlier experiences provided me insight. This acutally also goes for this dissertation.

2 See for instance an article by Oswald Devisch in *Planning Theory and Practice* (2008).

While the work is mine, it draws upon the insights of practitioners and other academics. These were mostly the people with whom I could speak without having to bother about analogies, but who were interested in the same substance as I was.

Foremost, I owe my gratitude to all the Dutch practitioners who shared their time, insights and coffee with me. This brought me to many interesting medium-sized cities, which are usually a bit off-radar, including Middelburg, Deventer, Arnhem and Zwolle. It was definitely worth it, and without my interviewees this dissertation would not have been possible. Particular thanks to the practitioners that participated in my workshop in the VISA skill lab in Nijmegen – after having already been interviewed extensively by me! Thanks to the Municipality of Utrecht for exploring Urban Strategy in the workshop at TNO. Moreover, during several stages of my research I was in contact with the Province of Utrecht, who for instance let me join their course *Duurzaam Gebiedsontwerpen*, which was very helpful. A special mentioning to project team *Mobiliteitsvisie IJmond*, who let me be a 'spy on the wall' during their meetings for two years. While there is no specific chapter in this thesis devoted to this empirical study, it has shaped by thinking about models in planning greatly. Reinier, Herbert, Kommer, Sophie, Rien, Ruud: thanks!

I also collaborated with several people active in the world of developing or applying PSS. Thanks to Laura van der Noort (IVAM), Fieke van Leest (Grontmij) and Hanne van den Berg and Kymo Slager (both Deltares). Jaap de Kroes' (Mapsup) insights about applying PSS and guiding me to potential interview candidates were invaluable. I collaborated several times with his former employee, GIS-expert, Dr. and friend Gustavo Arciniegas: muchas gracias! The collaboration with TNO had somewhat of a rough start, but after a while things started to fly and we became a smooth machine. Ralph Klerkx and Bas Kolthof: thanks for the collaboration, inspiration and fun time we had organizing all the workshops.

Also on an academic level, this thesis did not evolve in isolation. I visited many conferences during the course of this research, which contributed greatly to this thesis. In hindsight the ones most critical to this dissertation were the AESOP Young Academics workshop in Reading (2012), the AESOP PhD workshop in Izmir (2012), the CUPUM conference in Utrecht (2013) and the COST/CITTA conference in Porto (2014). In addition, since this dissertation consist mainly of published articles, the anonymous reviewers also deserve a word of thanks for their valuable comments.

The two and a half months I spent at the University of Michigan, were a great time to work without too much distraction on this dissertation. I had the great pleasure to work with Rob Goodspeed, working on very similar topic and a bright scholar. I really enjoyed our PSS discussions at the sunlit patio of Taubman College. Moreover, thanks to all faculty and PhD students at Taubman, who made me feel very much at home. In particular thanks to Steve, Carla and Conrad for showing me there is life beyond the library in Ann Arbor.

I also was a ‘guest researcher’ at the Radboud University in Nijmegen. Although my visits were relatively scarce, I always felt at home, in particular because of the help and input of several people: Etiënne Rouwette, Linda Carton, Sander Lenferink, Ron Wunderink, Tanja van Voorst and Yvonne Cremers.

Thanks to my colleagues at the Department of Spatial Planning and Human Geography. In particular our small spatial planning section: Thomas, Patrick, Gert Jan, Annelies, Friedel, Caroline, Tejo, Fennie, Bram. Thomas: you suggested once to just focus on knowledge in planning and get rid of PSS. An interesting thought, but as you can see I ignored it nevertheless. Leendert van Bree was a colleague for only a very brief time, but our ‘sparring partner’ sessions at the Netherlands Environmental Assessment Agency (PBL) contributed greatly to sharpen my ideas. Jeremy Rayner and Traysi Smith improved the English language in this dissertation. A special mentioning goes to the students that assisted me in my empirical research: Thijs Briggeman, Werner Pison and in particular Lisanne de Wijs.

This dissertation research was part of the CESAR project, funded by the Ministry of Infrastructure and the Environment and the Dutch National Science foundation. I enjoyed the meetings with our research team. Thanks to Martin Dijst for leading CESAR, and the other involved people: Gert Jan Steeneveld and Bert van Hove. Of course I should mention the two fellow PhD’s in CESAR, Lars and Natalie. I really enjoyed our meetings in which we discussed topics way beyond the scope of our project.

Marco te Brömmelstroet was also part of the CESAR-team. We collaborated successfully in a range of workshops and articles. Thanks, Marco, for being and excellent example as a rigorous and societally engaged academic. I hope this dissertation worthily succeeds yours.

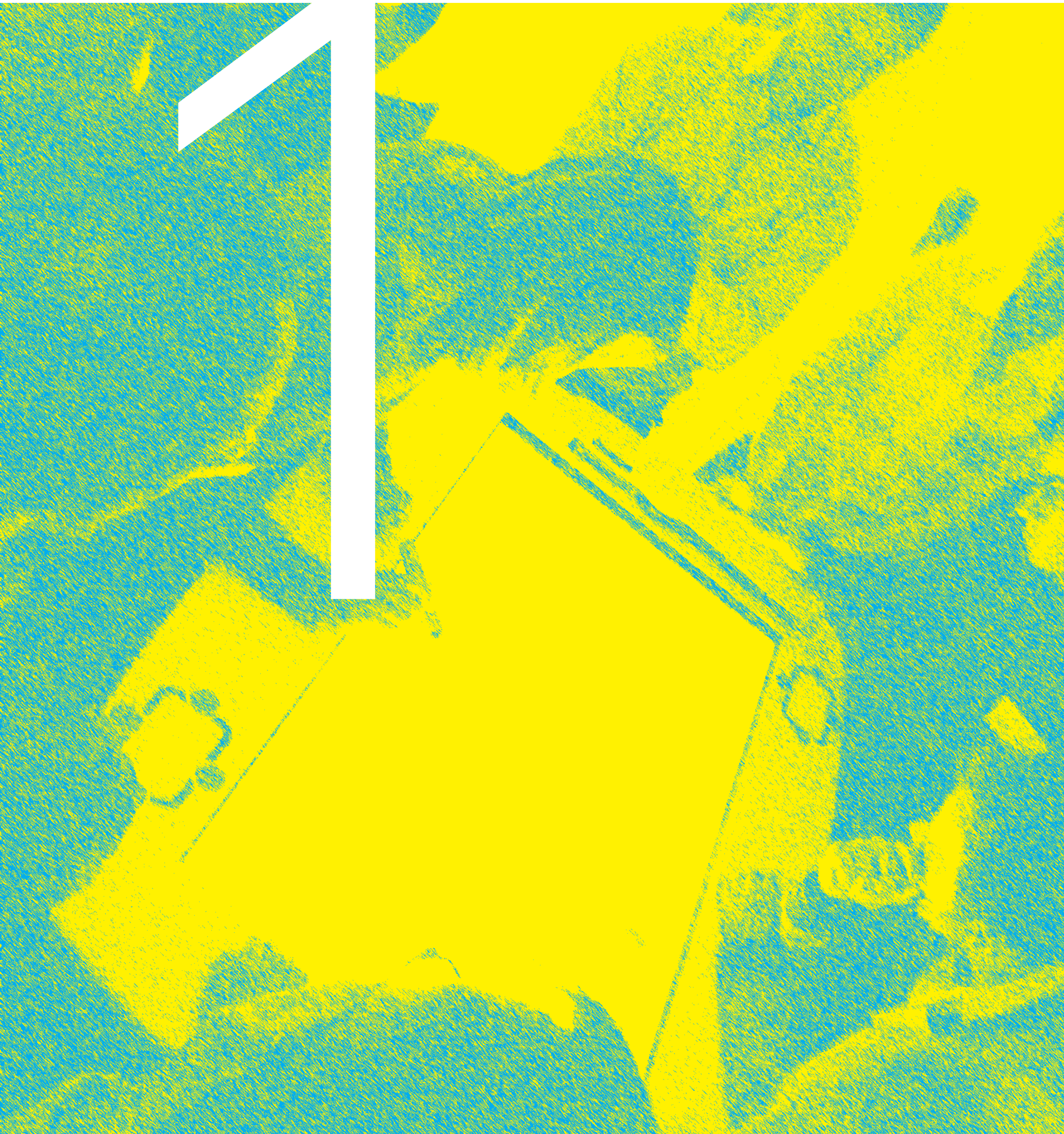
Rob van der Heijden, my promotor, taught me one lesson I’ll never forget: always stay calm, however busy you are. Rob: it seems there is no correlation between your stress level and your always impressive work load as a Dean. Thanks for your valuable substantive feedback, continuous emphasis on careful writing, and the insistence on the inclusion of ‘flesh and blood’. In our meetings you always kept the end goal in sight, which made me quite relaxed. Perhaps that’s why I think describing a PhD research as a heavy journey is an exaggeration.

This dissertation started with Stan Geertman, my supervisor. While I was initially not very attracted to the field of PSS, you convinced me to take the job. I have never regretted this decision. Just like me you were very eager to further develop the practioner’s perspective on PSS. Your extensive knowledge about the PSS debate helped me to find my way in a new and sometimes confusing debate. Moreover, your sharp eye for the structure of an article greatly benefited my writing and thinking. I’m very happy we are almost simultaneously taking a next step in our academic career: you by becoming a Professor, me by becoming a Doctor.

Thanks to my friends and family for to sticking to the question: “Is everything OK at work?” More elaboration is a quite long and complex story, as you will find out in the following pages.

Chapter 1

Introduction



***Clearly land-use planning can use all the help it can get from the broadest possible spectrum of academic fields, and indeed there is hardly a discipline in the natural or social sciences, and even the humanities, that does not have something to contribute to it* (Couclelis 2005, p.1355).**

The question of supporting planning and policy making with dedicated information is an old and important one (e.g. Harris 1965, Weiss 1977, Van Lohuizen 1986, Innes 1998, Geertman 1996, 2006, Gudmundsson 2011). However, the question is as poignant as ever. The challenges planners face are vast and complex. For instance, the recently emerging concept of resilience calls for more insight into the complex ways in which spatial phenomena work. Yet, contrary to traditional, modernist beliefs about planning, these challenges can likely not be addressed by simply conducting more research and providing more scientific information (Hajer et al. 2010, Healey 1992, 2007, Rydin 2007, Salet & Faludi 2000). Research about the relationship between science and policy has revealed that the application of scientific insights in policy making is far from straightforward (e.g. Amara et al. 2004, Weiss 1977). In order for information to be fruitfully applied it has to connect to the interactive, participatory and fuzzy nature of planning (cf. Healey 1992, Klosterman 1997). Consensus about the knowledge that is used is at least as important as scientific validity. But, to make it even more complex, a planning process runs the risk of using 'negotiated nonsense': knowledge about which all the actors agree but which lacks validity (Van de Riet 2003).

A promising trend with regard to these challenges is the increasing availability of technology in our daily lives. The smart city concept, for instance, describes how increased availability of big data and technologically sophisticated techniques potentially improves the management of cities (Batty et al. 2012). Concomitantly, on the micro level, dedicated tools are increasingly available to support planners in their tasks. These are often captured under the header of Planning Support Systems (PSS), which can be defined as: '... geo-information technology-based instruments that incorporate a suite of components that collectively support some specific parts of a *unique professional planning task*' (Geertman 2008, p.217 – emphasis in original). However, although many waves of excitement about these kind of instruments have been observed, they still have not revolutionized planning and, at best, they play a modest role in planning practice (Goodspeed 2014, Klosterman 1997, Vonk 2006, te Brömmelstroet et al. 2014). Vonk et al. (2007), for instance, show how Dutch provinces have a rather low uptake of geo-information based systems, whereas Goodspeed (2013a) emphasizes that there are vast differences in the extent to which American metropolitan planning organizations have support tools embedded in their organization. While many variations and nuances can be observed in different contexts, it is clear that the usage of PSS in practice does not match the potential as perceived by PSS developers.

According to Geertman (2006, 2008), an important reason for this under-utilization or implementation gap is that the focus in the PSS debate tends to be on improving the instrumental characteristics of a PSS, rather than on improving its relevance for planning practitioners. Recent contributions have started to acknowledge this omission (e.g. Couclelis 2005, Goodspeed 2013b, Moore 2008, te Brömmelstroet 2010, 2013). Yet, whereas these are promising developments, some notable gaps in the debate can still be observed, which will be dealt with in more detail in section 1.4. For now, it suffices to remark that the PSS debate lacks a detailed understanding, both conceptually and empirically, of the contribution a PSS has or can have for planning practice.

A concept potentially helpful to fill this gap is *usefulness*. According to computer scientist Nielsen (1993, p.24) this involves the 'issue of whether the system can be used to achieve some desired goals'. Applying this concept to the case of PSS leads to challenging questions. In particular 'desired goals' are far from straightforward in the case of planning and vary based on different planning issues and users. In some instances, the stakeholders involved do not even know what the desired goals are. However, it is more or less agreed upon that the general aim of PSS lies in improving the role of knowledge in planning. Moreover, it is increasingly emphasized that this insight can only be achieved if the perspectives of practitioners are taken into account (Geertman 2008, te Brömmelstroet 2013). Consequently, two research aims for this particular research can be distilled:

- To achieve a better conceptual understanding of the way in which the role of knowledge in planning can be improved by the application of PSS, and;
- To achieve more empirical insight into the way in which practitioners perceive the usefulness of PSS applications.

These two aims can be addressed with the following research question:

> *CQ: How can the usefulness of Planning Support Systems for planning practice be conceptualized and how do practitioners experience this?*

Before answering this question, it is helpful to review the earlier work in the PSS debate in more depth. This will be approached by exploring the three letters in the abbreviation PSS step by step but in a somewhat different order, beginning with Systems, followed by Planning and ending with Support.

1.1 Systems: the oft-foretold revolution

The story of the S for systems starts with the development of large scale urban land-use models somewhere in the 1960s. These developments were accompanied by a strong belief that these kinds of instruments are suitable for supporting or even improving urban and regional planning (Forrester 1969, Harris 1965). Responding to these developments, Lee (1973) bluntly argued that these attempts are doomed to fail, because land-use models are, among other things, too complex and too expensive in their operational use to connect to the praxis of planning and policy making. The twenty years following Lee's critique saw a steady improvement in the quality of spatial models but did not lead to a strong uptake by planning practice, urging Lee (1994) to repeat his critique in the *Journal of the American Planning Association* (see Klosterman 1994).

In reconfirming his argument from two decades prior, Lee (1994) missed some critical, partly technological, developments that occurred in the late 1980s and early 1990s. In a seminal article, Harris (1989,) used the term planning support systems, which 'must have the capability to employ locational and spatial interaction models, both to produce parts of plans constructively and to provide diverse measures of planning effectiveness' (*ibid*, p.90). Harris emphasized that this PSS has to be flexible in order to connect to the diverse tasks of planning. In addition, he posits that such a PSS includes a Geographic Information System (GIS). These have experienced an enormous development since the 1960s, hereby also providing a data platform and visualization possibilities for PSS. Hence, some of the critiques as couched by Lee (1973) have arguably evaporated. For instance, data is now much better and more accessible and GIS packages have become relatively affordable.

However, according to Britton Harris, but also others (Brail 2006, Harris 1989, Brail & Klosterman 2001), a PSS is more than just a GIS, since it has to include some kind of impact model, which describes what the outcomes for a certain spatial area will be under different circumstances – either imposed by planning interventions or based on external developments (i.e. scenarios). Other definitions also emphasize that a PSS is different from a GIS but do not see impact models as the determining factor. In these definitions a PSS is distinctive from a GIS in the sense that it supports *unique planning tasks* (Geertman 2008, Klosterman 1997). This, for instance, implies an interface tailored towards practitioners and functionalities meant to support planning tasks (e.g. Van der Meulen 1992, see examples in Geertman & Stillwell 2009).

A whole range of edited volumes with case studies from the late 1990s onwards shows how PSS is maturing as a research field but simultaneously illuminates a strong variation in different kinds of PSS and their applications (Brail 2008, Brail & Klosterman 2001, Geertman et al. 2011, 2013, Geertman & Stillwell 2009, 2003, Scholten & Stillwelll 1990, Stillwell et al. 1999). Reviewing these books reveals that the last two decades show important technological developments related to PSS. A very notable development is the improvement of the underlying models of PSS. Spurred by developments in computer technology and increased scientific insight, environmental, transport and land-use modelling has seen impressive progress (e.g. Guhathakurta 2003a, Rasouli & Timmermans 2013). A notable improvement is that different kinds of models are now increasingly coupled. For instance, the PSS Urban Strategy is based on an integration of a traffic model and a range of environmental models (www.tno.nl/urbanstrategy, also: Chapter 7). Another notable example is the development of cellular automata (CA) models, based on transition rules for grid cells, which have proved particularly useful for understanding land-use change. Well known tools include the Environment Explorer (Couclelis 2005, Engelen et al. 2003), SLEUTH (Clarke 2008) and LEAM (Deal & Pallathucheril 2009). However, no matter how sophisticated and technologically advanced these CA-models are, they are not widely used in planning practice (cf. Hagoort 2006).

An insightful analysis of this lack of uptake is given by Klosterman (2012), who argues that complex models (like the CA-models mentioned earlier) are not necessarily more useful in practice than simple – not simplistic – models. Klosterman illustrates this through the development and application of his PSS “What if?”, which is based on a rather simple rule-based model (Klosterman 1999). Without very complex modelling efforts or data input, it allows planning practitioners to explore the spatial future of an area under different circumstances. Whether a simple or a complex model is more suited for practice depends on the context. In the last two decades it has become clear, however, that more scientific *rigor* in a model does not automatically lead to more *relevance* in practice. A way to improve the relevance of PSS is to make the output more appealing to users. This leads to a focus on instrumental characteristics other than the underlying model, like visualization capabilities. This includes 3D visualization, attractive and visually appealing maps and dynamic visualizations that indicate the change that is taking place (e.g. Miller et al. 2009). Under the headings of ‘geovisualization’, new fields have emerged which study the human interaction with spatially visualized information (e.g. MacEachren & Brewer 2004).

The increasing attention on simple models and the visualization capabilities of PSS can be considered part of the overarching debate on usability, which refers to ‘the question of how well users can use [a] functionality’ (Nielsen, 1993, p. 25). The usability of PSS has been evaluated in several recent empirical studies (e.g. Arciniegas 2012, te Brömmelstroet 2014, te Brömmelstroet et al. 2014, Vonk 2006). Therein, usability is often separated into a set of relatively discrete indicators, for instance the extent to which a PSS is flexibly applicable, user-friendly and transparent (e.g. Vonk 2006, te Brömmelstroet 2014). This attention reflects a break with the past. As of 2003, Geertman & Stillwell (2003, p.5) noted in the introduction to their edited volume: ‘most of the current proprietary tools that do exist are far too generic, too complex, too inflexible, incompatible with most planning tasks, oriented towards technology rather than problems and too focused on strict rationality’. Since this overview was published, several PSS with a relatively high usability were applied in practice. A case in point is CommunityViz, an add-in for the frequently used GIS software ArcGIS, which allows practitioners to set indicators and impact models themselves (Walker & Daniel 2011). CommunityViz has been widely used in practice over the last decade in a range of different applications and with varying characteristics. For instance in a case study discussed in this dissertation (Chapter 5), the software helped to calculate the environmental impact of proposed planning interventions. An important trait of CommunityViz is that it is usable by a relatively wide group of people. This does not necessarily imply, however that it is also useful, this is also dependent on other dimensions related to the PSS application.

Notably, an important addition to the usability of the instrument is the process related to the PSS application. Te Brömmelstroet (2010) proposes that both the development and application of a PSS should be a 'structured dialogue' between land-use planners (users) and transport planners (modelers/developers). This notion is inspired by studies in 'mediated modelling' and 'group model building' (Rouwette et al. 2002, Van den Belt 2004, Vennix et al. 1996). According to an article in this field by Vennix et al. (1997, p.103): 'Most learning takes place in the process of building the model, rather than after the model is finished'. Hence, PSS are increasingly seen as 'knowledge technologies' on which practitioners should reflect in a collaborative process, rather than providers of unambiguous answers (cf. Gudmundsson 2011, Guhathakurta 2003b). Although these are all very promising developments, they have not revolutionized planning – yet. Arguably, one of the most important explanations is that planning is a moving target; it has changed fundamentally over the last few decades and will continue to do so in the future. Consequently, PSS research should continuously monitor conceptual developments in the planning debate.

1.2 Planning: coming to grips with the communicative turn

The development of PSS stems from an integral and scientific-analytical approach to planning (Harris 1994, Salet and Faludi 2000). Therein, integral quantitative analysis was seen as a way to embed scientific knowledge in the planning process. The logic was primarily deterministic: valid and comprehensive scientific knowledge would automatically lead to better plans. However, while quantitative models became more integral and more easily applicable, planning changed, becoming more communicative, collaborative and focused on consensus-seeking (e.g. Geertman 2006, Healey 1992, Innes 1998, Klosterman 1997). This 'communicative turn' (Healey 1992) has many dimensions and nuances. For the purpose of this dissertation two developments are relevant.

First, planning has become a collaborative process, in which communication and dialogue are critical (e.g. Healey 1992, Innes & Booher 2010, Salet & Faludi 2000). Rather than being a top-down provider of comprehensive analyses, a PSS should facilitate discussion and dialogue. Or as Klosterman (1997, p.51 – emphasis in original) puts it: 'planning support systems should facilitate *collective design* – social interaction, interpersonal communication and community debate that attempts to achieve collective goals and deals with common concerns'. Several examples of PSS applied in such collaborative settings can be found in recent case studies (e.g. Goodspeed 2013b, Geertman & Stillwell 2009).

Second, the status of scientific knowledge itself has changed (e.g. Friedmann 1987, Healey 2008, Pielke 2007). From being an uncontested body of knowledge that is often being generated in a setting separate from practice and based on relatively universal causal laws, scholars increasingly emphasize the socially constructed nature of knowledge (Healey 2007, Rydin 2007). This places scientific knowledge in a challenging situation. Actors can agree upon the validity of knowledge (i.e. the input and output of a PSS), but this agreement can be based on invalid assumptions. Relevant in this regard is the work of Van de Riet (2003), who studied the risk of 'negotiated nonsense': knowledge about which all actors agree, but that has no solid ground in robust analysis.

To sum up, in order to respond to these two trends PSS should (a) find itself a place in a collaborative and communicative planning setting and (b) be positioned in relation to the changed status of scientific knowledge. On the one hand, such a solution requires a more in-depth conceptual analysis of the relation between PSS and knowledge in planning. In addition, responding to this trend requires zooming in to the micro level, which in this regard refers to the tasks and activities that comprise planning processes. This can be conceived as the *support dimension* and addresses how the instrumental characteristics of a PSS (System) lead to a certain influence on planning tasks in a specific planning context (Planning). The support dimension will now be dealt with.

1.3 Support: promising but inconclusive developments

Most definitions of PSS use the notion of *supporting* planning tasks as a central aim of PSS (e.g. Geertman 2008, Klosterman 1997). This reflects increasing attention to the demands of users (i.e. connection with a planning task), rather than the instrumental characteristics of a PSS. While not being an entirely new topic (e.g. Van der Heijden 1986), recent studies have started to pay increasing attention to this S for Support. One direction within this research stream focuses on very carefully tailoring the tool to the characteristics of the user and planning question (Arciniegas et al. 2013, Eikelboom & Janssen 2013). These kinds of studies tend to use questionnaires to assess what kind of spatial visualization is the most effective for particular practitioners. In a similar vein but with a different thematic focus, Jankowski and Nyerges conducted experiments to get a better understanding of the group dynamics in a workshop in relation to GIS-based support technology (Jankowski & Nyerges 2001, Nyerges et al. 2006). These studies are methodologically robust, but have not provided conclusive answers about the support function of PSS, particularly because only a few studies have followed up on this work of studying workshop dynamics.

Te Brömmelstroet (2010) did pay attention to the workshop characteristics, applying a design research approach, in which improving existing practices was as important as understanding them. The central support function of PSS in his workshop was learning, particularly through the exchange of knowledge between land-use planners and transport planners. More recently, Goodspeed (2013b) also focused on learning effects. His methodological approach was different, however. Rather than being involved in organizing the workshops (as all of the previous scholars were), he observed and analyzed the characteristics of the PSS workshops as an outsider.

In summary, the PSS debate has shifted over the last few decades from a primary focus on the S for system, to more attention to the P for planning and the S for Support. While these are promising and arguably necessary developments, this dissertation still observes some important omissions in the debate. In the next section, these omissions will be outlined and a set of research questions will be formulated, which help to address them.

1.4 Omissions in the PSS debate: toward research questions

An observation related to the discussion above about the P for planning, is that the last two decades have arguably led to relevant and insightful theoretical discussions about PSS in relation to the wider debates in planning (Couclelis 2005, Geertman 2006, Klosterman 1997, 2013). An omission is that these studies have not approached the role of PSS from the specific perspective of a changing status of knowledge and an increasingly collaborative planning context. Hence, the first research question reads:

> *RQ1: How can the role of PSS be conceptualized in a way that is sensitive to both the changing role of knowledge in planning and the increasingly collaborative nature of planning?*

This question will be answered in Chapter 2 in a chiefly conceptual way, building on literature about storytelling, planning theory, knowledge use and earlier PSS studies. This results in an approach that provides a different perspective on the role of PSS in contemporary planning practice. It does not result in concrete, empirically grounded insights into the perspectives of practitioners, however. Therefore the second research question reads:

> *RQ2: What is the usefulness of PSS according to planning practitioners?*

This question is particularly relevant because the usefulness or added value of PSS is often claimed but hardly ever empirically measured (te Brömmelstroet 2013). Put differently: surprisingly few studies have actually asked practitioners about the usefulness of PSS. In this dissertation this omission will be addressed through a uniform conceptual framework, which was empirically applied through two different empirical research methods. Chapter 3 describes the application of a Group Decision Room (GDR) session combined with semi-structured interviews. The advantage of this approach is that it leads to a more in-depth understanding of the usefulness of PSS for practitioners. The flipside, however, is that the focus on one particular case (the MapTable), limits the generalizability of the findings. Therefore, and complementarily, Chapter 4 describes the results of questionnaires that were conducted after four different PSS applications.

Chapters 3 and 4 have a broad focus, exploring all possible dimensions of usefulness. The next step is to zoom in on one of these usefulness categories in order to come to a more precise description of its characteristics and explain some of the mechanisms leading to it. The focus is on the usefulness concept of learning, because it is broadly considered to be a central dimension of planning and to play a key role in planning support (e.g. Bertolini 2011, Goodspeed 2013b, Innes 1998, te Brömmelstroet 2010). While learning can take many forms, in this thesis the focus is particularly on learning in professional settings. In the Netherlands, where the empirical material for this analysis will be gathered, PSS are mainly applied in professional settings. Hence, the usefulness of PSS in this regard mainly lies in facilitating learning between professional stakeholders with, possibly, a variety of disciplinary backgrounds. Despite the importance of interdisciplinary learning for both planning and the PSS debate, a well elaborated conceptual perspective and systematically collected empirical findings are missing in the debate (cf. te Brömmelstroet 2010). Therefore, the third research question is formulated as:

> *RQ3: How can a PSS facilitate interdisciplinary learning?*

This research question will be answered in Chapter 5. Herein first a conceptual perspective on interdisciplinary learning is developed, which is strongly influenced by the work of Donald Schön and his collaborators. Next, this perspective will be used to study two different PSS applications in the Netherlands. Whereas these cases both included learning, the planning tasks conducted were very different, leading to a different role. Because of this importance of planning tasks, the final research question delves into this issue. This leads to the following research question:

> RQ4: *How can a focus on planning tasks lead to more insight into the usefulness of PSS?*

This research question will be answered in Chapters 6 and 7, both of which have a strong empirical basis, but are different – and thus complementary – in their research approach. Both chapters apply the notion of task-technology fit (Goodhue & Thompson 1995), which connects the characteristics of planning tasks to the capabilities of PSS. Chapter 6 describes a comparative case study into the application of CommunityViz in four different planning applications. Chapter 7 is complementary to this chapter by mainly focusing on one planning task (selection) and one support capability (analysis).

Finally, Chapter 8 draws the conclusions of this research and will reflect on the methods and findings of this study. In addition, a set of policy recommendations will be formulated. The research questions, the chapters in which they are addressed and the journals in which they are published are summarized in Table 1.1.

1.5 Reading guide

Since this dissertation is based on a set of papers published in scientific journals, some of the chapters show overlap. This is particularly the case in the Introduction and Literature Review of each chapter. It was decided, however, to leave the papers in their published form because (a) this is the form in which the blind peer-reviewers considered the papers that are already published to be of an acceptable scientific quality and (b) in each chapter the literature review is framed in such a way that it connects to the research question and empirical material of that particular chapter. Moreover, because most papers already have a separate methodology section, little attention is paid to the methodology of this research in this introductory chapter. The Conclusion will reflect more extensively on the methods used in the different chapters.

While the chapters show some overlap, their variation is arguably much larger. Chapters 2 and 5 are particularly suited for those with an interest in the combination of planning theory and PSS because they have a strongly conceptual focus. Readers interested in learning about how practitioners perceive the added value of a PSS are referred to the chiefly empirical Chapters 3 and 4. Finally, Chapters 6 and 7 have the strongest orientation towards planning practice by focusing on the way in which a PSS supports planning tasks. For those interested in the implications of this study for planning practice, it is of interest to read the recommendations for planning practice as formulated in the Conclusion.

Table 1.1 Overview of research questions

Research Question	*Chapter(s)*	*Title*	*Published in*
RQ1: How can the role of PSS be conceptualized in a way that is sensitive to both the changing role of knowledge in planning and the increasingly collaborative nature of planning?	2	'Knowledge in communicative planning practice: a different perspective for planning support systems.'	*Environment and Planning B: Planning and Design (2015).*
RQ2: What is the usefulness of PSS practitioners?	3	'The added value of Planning according to planning practitioner's perspective.'	*Computers Environment and Urban Systems (2014).*
	4	'The added value of Planning Support Systems: a comparative perspective.'	*Resubmitted to Computers Environment and Urban Systems.*
RQ3: How can a PSS facilitate interdisciplinary learning?	5	'Planning Support Systems and Interdisciplinary Learning.'	*Planning Theory & Practice (2014).*
RQ4: How can a focus on planning tasks lead to more insight into the usefulness of PSS?	6	'Planning Support Systems and task-technology fit: a comparative case study.'	*Applied Spatial Analysis and Policy* (in press).
	7	'Understanding the Usefulness of Planning Support Systems: a conceptual framework and a case study from practice.'	Submitted to a peer reviewed journal.
CQ: How can the usefulness of Planning Support Systems for planning practice be conceptualized and how do practitioners experience this?	8	'Conclusion'	n/a

Chapter 2

Knowledge in Communicative Planning Practice: a Different Perspective for Planning Support Systems

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Abstract

Although planning support systems (PSS) have now undergone more than two decades of research and development, this is not reflected in their practical application. This paper argues that one of the reasons for this is that too much emphasis has been put on the instrument rather than on the usage and planning context. A better understanding of the relationship between planning practice and PSS is needed to improve the role of PSS. We argue that communicative and analytic approaches to planning should be combined. A key to this is a more careful conceptualization of the concept of knowledge and the role of planning support. In order to do so, we develop a conceptual framework in which the characteristics and evaluation of knowledge and the role of planning support are central. Combined with the notion of storytelling, we believe this results in a perspective for PSS that has potential for future applications. The paper concludes with recommendations for future research.

2.1 Introduction

For many years, the focus in spatial planning was on designing a plan based on the input from a limited group of scientific experts. This approach has been criticized from various angles and alternative approaches have evolved. The 'communicative turn' in spatial planning is arguably the most profound. Since this turn, a much stronger emphasis has been put on the collaborative, interactive, communicative and participatory nature of spatial planning (e.g. Healey 1992, 2007, Innes 1998, Innes & Booher 2010). Rydin (2007, p.54) states that this is a 'new orthodoxy [that] clusters around the idea that the core of planning should be an engagement with a range of stakeholders, giving them voice and seeking to achieve a planning consensus'. However, this approach has also led to relativism, and scholars have warned of the production of 'negotiated nonsense' (van de Riet 2003). In the words of geo-information researchers Deal and Pallathucheril (2008 p.61): 'In recent years, community visioning exercises have been increasingly used (...) but those activities are rarely grounded in data or deep analysis; sometimes they amount to little more than wishful thinking.'

We posit that particularly geo-ICT tools that are specifically designed for spatial planning – namely planning support systems (from now on: PSS) – can play a crucial role in combining analytic and communicative approaches to planning.

PSS can be defined as '... geoinformation technology-based instruments that incorporate a suite of components that collectively support some specific parts of a unique professional planning task' (Geertman 2008 p.217). According to Klosterman (2009, iv) , '(....) the development of PSS can be seen as part of a larger effort to return the planning profession to its traditional concern with using information and analysis to more effectively engage the future.'

In order to prevent conceptual confusion, we consider it important to make a distinction between 'planning support' and 'planning support systems' (PSS). 'Planning support' refers to the activity of aiding planning processes, an act which can take place in many forms and can be supported by a range of tools. PSS are a means to achieve this goals, whereby its distinctive characteristics (compared to for instance a Geographic Information System, from now on: GIS) are the focus on aiding specific planning tasks and paying attention to the relation among the tools that encompass a PSS. Put differently, 'PSS usually consist of a combination of planning-related theory, data, information, knowledge, methods, and instruments that take the form of an integrated framework with a shared interface' (Geertman & Stillwell 2009, p.3).

The enormous technological advancements made in recent decades and the specific focus on supporting professional planning activities are not reflected in a widespread use of PSS in planning practice (Vonk et al. 2007a, Goodspeed 2013a), arguably due to the lack of acceptance of new technologies in planning (Vonk et al. 2005, 2007b) and the overly instrumental focus of PSS developers (Geertman & Stillwell 2003, 2009; te Brömmelstroet 2010). In the words of Batty (2008 p.6): 'Technique rather than theory has come to dominate, and thus developments in computational technologies are tending to drive the field.' As a response to this situation, we believe a reorientation of the potential role of PSS in planning practice is needed.

In this article, we develop a new perspective on PSS in spatial planning practice. We will argue that although relevant contributions have recently been made to address PSS use from a planning perspective (e.g. Geertman 2006, Moore 2008, te Brömmelstroet & Schrijnen 2010, Vonk et al. 2007a), this perspective is in need of a more detailed analysis and stronger roots in the planning theoretical debate, which can lead to new directions for research on and better utilization of PSS. We hereby seek to combine communicative and analytic approaches to planning. In doing so, we will explicitly build upon authors who discuss the knowledge in planning (Healey 2007, Rydin 2007), the role of planning support (Amara et al. 2004, Weiss 1979), and the potential of storytelling (Couclelis 2005, Guhathakurta 2002, Hajer et al. 2010).

The paper is structured as follows. Section 2 argues why PSS are underutilized in planning practice. We will conclude here that a new perspective of planning support should be adopted. This new perspective consists of paying more detailed attention to the concept of knowledge in relation to (instances of) planning support (section 3) and associated to that, adopting a different view on the role of planning support (section 4). In section 5 we develop a perspective for

PSS that combines the insights from the previous sections. Here we will elaborate on 'storytelling' as an important insight to improve the application of PSS in planning practice. We conclude in Section 6 with a synthesis of the findings and a brief discussion.

2.2 PSS in planning practice

2.2.1 The roots of planning support

The essence of planning support is to introduce and handle information and knowledge in planning practice and policy making processes leading to better planning processes and outcomes. This topic has extensively been studied in the past, although with different concepts and coming from different fields (e.g. Amara et al. 2004, Healey 2008, van Lohuizen 1986, Weiss 1979). From the 1960s onwards computer tools were available to aid planning, for instance in the form of large scale models and Decision Support Systems (DSS) and later on GIS. The term PSS first appeared in 1989 in an article by Britton Harris (Harris 1989), although as stated the first ideas date from the sixties. To an important extent the development of the notion of PSS was a response to the failure of its predecessors to meet the specific demands of planners. In the 1990s but especially after the year 2000 the development of PSS was boosted by technological improvements and increased availability of (desktop) computers and GIS in educational and professional circles. It is debatable, however, if the 'always imminent revolution' of computer-aided planning has indeed occurred (Klosterman 1997).

2.2.2 The PSS debate

In the last decade, several edited volumes and individual articles (Brail & Klosterman 2001, Brail 2008, Geertman & Stillwell 2003, 2009, Geertman et al. 2013) have sketched the characteristics, applications and alleged virtues of a range of planning support tools, such as What If? (Klosterman 1997, 2008), LEAM (Deal & Pallathucheril 2008, 2009), UrbanSim (Waddell 2011, Waddell et al. 2008), CommunityViz (Janes & Kwartler, 2008) and SLEUTH (Clarke 2008, Dietzel & Clarke 2007). Despite these technological advancements, the number of planning institutions that actually use PSS in their regular working processes still is limited. Moreover, knowledge and experience of how to apply PSS is lacking in most organizations (Vonk et al. 2005).

Based on the academic literature, we distil two reasons for this underutilization. First, there is the notion that technology implementation takes time and has to overcome a diversity of bottlenecks and barriers, such as resistance to change and fixed working habits that have been in place for years (Vonk et al. 2005, Timmermans 2008). Vonk et al. (2005) describe the diffusion of PSS as an innovation process, in which a range of bottlenecks have to be overcome. Or as stated by Timmermans (2008, p.42) concerning the dissemination of dedicated tools in planning: ‘Often, this process is much like the well-known S shape. Only after some time, when many colleagues or competitive organizations have adopted a new technology, will many others follow. However, it often does take a generation.’ From this perspective, the underutilization of PSS in spatial planning practice can be explained by a variety of rather generic bottlenecks that hamper the acceptance of any new technology by a profession and/or in an organization.

Other studies have drawn attention to a second reason for underutilization. The central argument here is that PSS are not sufficiently sensitive and attuned to the specific demands of planners and the characteristics of the planning process (Geertman 2006, 2008, te Brömmelstroet 2010). Van Kouwen et al. (2010) even argue that: ‘(...) DSS [decision support systems] and PSS tools do not bridge the gap between knowledge and policy making, but are rather part of the problem.’

This problem can be understood by focusing on how the role of planning support tends to be perceived by professional planners. This role has traditionally been envisioned in scientific-analytical terms; simply stated, it was assumed that there is a linear relationship between the way in which scientific knowledge is generated and provided, and its usage in practice. This idea has been fiercely criticized by scholars who emphasize planning’s power-driven nature (Flyvbjerg 1998) and communicative nature (Healey 1992, Innes 1998).

A result from a scientific-analytic view on the role of planning support is that in discussions on the application of PSS, most emphasis is put on the support technology itself rather than on its added value for planning practice, as already noticed before by several authors (Campbell 1995, Geertman 2008, te Brömmelstroet 2010, 2013). In fact, this added value for planning practice is often taken for granted and considered to be related to the quality of the support technology itself. In contrast, the characteristics and knowledge demands of planning practitioners should be put central to the analysis of how planning support should take place, not the PSS itself that is applied. Or as Campbell (1995, p.104) observed already fifteen years ago: ‘(...) technologies do not function independently of their environments, rather, they gain meaning only as individual staff members in a particular cultural and organizational context interact with them.’

Also Geertman (2006) acknowledges that the PSS debate focuses far too much on technology. He argues that too little attention is paid to what he calls the ‘planning-conceptual’ aspects of planning. In developing his argument, Geertman distils several explanatory factors for the potential role of planning support (including amongst others the position of the users and the planning context). In this paper, we focus on a factor noted by Geertman which we notably consider to be in need for an improved conceptualization and connection to the PSS debate: knowledge.

2.3 Knowledge

2.3.1 Information and knowledge

Since planning is essentially about 'turning knowledge into action' (Friedmann 1987), the wish to understand planning support starts with understanding the characteristics of knowledge and the knowledge demands of planning. As a first step we define two of the key elements of planning support: information and knowledge – terms that are often used interchangeably in both the planning and the geo-information literature.

We conceive information as elements that describe a specific part of reality. In the case of geoinformation science, it often means a way of organizing and presenting data in a meaningful manner, for instance through a map or a model. A crucial next step is to convert this information into knowledge, which refers to its interpretation and appreciation by stakeholders. Based on the work of Dretske, Couclelis (2003, p.165) distinguishes the two prosaically: '[There are] two types of information-processing system: the type that is capable of converting the information it receives into knowledge and the type that is not. (...) The first kind of information-processing system, the kind capable of converting information into knowledge, is we; the GIS is of the second kind'. Hence, knowledge can be defined as (translated from van de Graaf & Hoppe 1989, p. 69): 'Both the stock of data and information a planning stakeholder possesses, but also the interpretations and appreciations of data and information a planning stakeholder (to a certain extent) considers to be just or correct.' Innes & Booher (2010) emphasize the importance of a dialogue in planning in order to convert information into knowledge with the aim to improve planning: 'We contend that knowledge built through a collective learning process builds the capacity of all players to make sounder choices' (*ibid,* p.144),

In line with the mentioned reorientation of the scientific-analytic view of planning to more communicative view on planning, a reinterpretation of the role of knowledge in planning support is required. Therefore, in the next subsection we will develop a more refined conceptualization of knowledge and its role in planning support from in which the communicative view of planning gets more attention. Therein, two interrelated issues with regard to knowledge will be elaborated upon: validity and complementarity. Validity is of relevance because from a communicative viewpoint to planning, the value of knowledge as a source of planning support is complex to evaluate. Conversely, knowledge is not identical to scientific knowledge, but can take different forms that should be treated complementarily to each other in the light of planning support.

2.3.2 Validity: knowledge claims

Rydin (2007) acknowledges that communication and collaboration are critical characteristics of planning, but that planning should not only be about processes, but also about what happens in the physical world, because otherwise 'the material world can catch up with us' (Rydin 2008, p.212). In order to prevent this, she argues that testing the validity of knowledge claims posed by different stakeholders in the planning process, should be an important part of planning. In order to do this in a relatively structured way, she distinguishes four types of claims about reality: empirical claims, process claims, predictive claims and normative claims.

›› *Empirical* knowledge claims are about the socioeconomic and environmental situation at a specific moment in time. This can refer to the current situation, as well as to the future situation after a planning intervention has occurred. Impact analysis, for instance is a well-known approach to analyzing a situation in the future after an intervention has occurred.
›› *Process* knowledge claims refer to the dynamics of planning, that is, to how societal processes work and how they conjunct with planning interventions.
›› *Predictive* knowledge claims deal with prediction of trends, which in this regard can be extended to all kinds of trend scenarios without an intervention, something Couclelis (2005) refers to as what *may* be.
›› *Normative* knowledge claims are 'a kind of knowledge involved in specifying the goal of planning' (Rydin 2007, p.61), Rydin's description of normative knowledge claims is a bit more subtle than simply stating what ought to be, since: 'It is not exclusively normative though – and it is here that its character as a form of knowledge lies – since not any imaginings will serve as a planning goal. There has to be an engagement with possible realities (...) (*ibid).*

This fourfold distinction is relevant to planning support, since it provides a systematized way to evaluate the different claims about knowledge that play a role in planning. Hereby Rydin (2007) reminds us that different knowledge claims can coexist; planners should test the validity of different claims in a deliberative process. Rydin further argues that there is no a priori hierarchy of knowledge claims: scientific insights are not necessarily more valuable than experiential knowledge. Scientific insights have a very different form than insights related to local experiences. Hence, it is necessary to relate to the form of knowledge, which we call complementarity.

2.3.3 Complementarity: knowledge forms

In his famous book *Planning in the Public Domain: From Knowledge to Action* (1987), Friedmann argues that experiential or practical knowledge is equally important to planning as scientific or technocratic knowledge. Healey (2007) elaborates on this issue when she discusses the forms that knowledge in planning can take. She argues: 'What we know exists in many forms, from systematized accounts and analyses, and practical manuals, to stories exchanged in the flow of life, and skills exercised in doing practical work' (*ibid.,* p.245). Both systematized knowledge (based on logic and analysis) and experiential knowledge (based on experiences and often 'tacit' in nature) should thus be taken into account.

An interesting example hereof is given by Carton and Thissen (2009), who state that the role maps in planning depends on the frame of the users, which is related to their knowledge base. For instance, stakeholders with a so-called ‘design frame’ (e.g. urban designers, landscape architects) tend to rely on experiential knowledge, whereas stakeholders with a so-called ‘analytic frame’ (e.g. environmental analysts, transport planners) often have a systematized knowledge base (see also Pelzer et al. 2013).

While the work of Friedmann (1987), Healey (2007) and Rydin (2007) helps us to understand better the role of knowledge in planning, these authors do not explicitly focus on the role of knowledge in planning support. In the following, we will therefore present some examples of how knowledge claims and forms can be applied to instances of planning support.

2.3.4 Claims, forms and planning support

Table 2.1 gives an overview of the interrelations between knowledge forms and knowledge claims and provides a set of examples of how these are related to planning support.

Table 2.1 Knowledge forms and claims and examples of planning support

Claim ***Form***	*Empirical*	*Process*	*Predictive*	*Normative*
Systematized knowledge	Impact analysis	Group model building	Forecasts	Cost-benefit analysis (CBA)
Experiential Knowledge	Participatory GIS	Best practices	Context scenarios	Charrette

An example of the combination of systematized knowledge and empirical knowledge claims is *impact analysis*. Crucial in planning is the ability to assess the impact of planning interventions on forehand (*ex ante*) (Brail 2006, Klosterman & Pettit 2005). Impact analysis is used to support the assessment of the impact of planning interventions resulting in a new situation at a certain moment in time (described by an empirical knowledge claim). This is a form of planning support that connects to systematized knowledge demands of planners, for instance, traffic planners who assess the impact of an extra bridge across a river (e.g. Deal & Pallathucheril 2009).

Empirical knowledge claims and experiential knowledge result in a different example of planning support: the burgeoning field of *participatory GIS* (e.g. Dunn 2007, Geertman 2002, Kahila & Kÿtta 2009, McCall & Dunn 2012). Here, the main purpose of planning support is to gather local or lay knowledge and introduce it into the planning process. Therein, residents’ perception of their neighborhood can be visualized through illustrations, mental maps, photos, drawings and statements, which then can be communicated among planning professionals.

The combination of systematized knowledge and process knowledge claims is not a very common instance of planning support. However, in the field of system dynamics attention is paid to these aspects (e.g. Vennix 1999). System dynamics often applies *Group Model Building,* which is: 'a generic label for all approaches that involve the client in the system dynamics model building process, be it in the conceptualization and/or formalization and simulation of the model (*ibid,* p.392). Crucial here is that this methodology is applied in multi-actor workshops with the additional aim to strengthen the process of interaction, usually among professional stakeholders. Dedicated software can be applied to understand the relevant causal linkages (for a planning example, see Van Kouwen et al.2009).

An example at the crossroad of experiential knowledge and process knowledge claims are *best practices.* It is now very common that planners and policymakers look at other cities and regions to understand how they did something. Hereby, stories and experiences of local stakeholders are important input with regards to the question how change is accomplished.

Forecasts (systematized knowledge and predictive knowledge claims) support planning by describing trends in for instance demography, the economy and traffic in a systematized and quantitative vein. Whereas forecasts are inherently fallible, they often give direction to the decisions that are taken. In instances with high uncertainty, context scenarios are more common.

Context scenarios refer to future developments that may occur independent of the planning interventions. To support planning, a limited set of context scenarios (usually up to four) about possible macro-developments are used. Often the input of these scenarios is based on local experiences and insights. An interesting example in relation to PSS is given by Van Delden and Hagen Zanker (2009), who connect the development of context scenarios ('qualitative storylines') to quantitative modelling exercises. According to Van Delden and Hagen Zanker (*ibid.*, p.363) this has various benefits: 'By going through an iterative process, communication and social learning will be enhanced and will lead to a better understanding of the overall scenario that includes narrative storylines as well as quantitative modelling'.

An instance of planning support for normative knowledge claims and systematized knowledge is *cost-benefit analysis* (CBA). A CBA is an approach to support the judgment about an idea or plan by providing an overview of (financial) effects of a plan. Based on a range of models, indicators and expert judgments the aim is to come to better informed normative knowledge claims. Hereby, Beukers et al. (2012) point at the potential of applying CBA as a learning process in communicative planning.

Finally, planning support that combines normative knowledge claims and experiential knowledge can be found in a *charrette,* which is: 'a multi-day planning process during which an interdisciplinary professional design team creates a complete and feasible plan that reflects the input of all interested parties by engaging them in a series of feedback loops' (Lennertz 2003, p.1). Whereas a charrette likely also include other knowledge forms and claims, experiential knowledge claims about what should be (i.e. normative claims), are key to come to the resulting plan in a relatively short time span, since interests are likely to be expressed as experiential knowledge claims, and the main focus of consensus seeking is about what should be changed in the future, not necessarily the current situation or causal dynamics.

In sum, in planning practice different instances of planning support can be found, supporting different knowledge claims and forms. Hereby, the logical follow-up question is *how* planning support functions in planning practice. In other words: what is the role of planning support.

2.4 Roles of planning support within planning practice

As noted in the introduction, many studies either implicitly or explicitly have an instrumental or a scientific analytical conception of the role of planning support within practice: output from a planning support instrument is considered directly applicable to solving a planning problem. Following among others Weiss (1979) and Amara et al. (2004), we argue that this perspective covers only a part of the way in which planning support functions. Following these authors, four roles of planning support can be discerned: scientific analytical, tactical, learning, and interactive roles. These are now elaborated in more detail.

›› *Scientific analytical* planning support refers to the direct application of knowledge in planning practice. It can be considered part of the classical approach to spatial planning. This approach is found in situations in which science precedes practice ('survey before the plan') and where the planning problem is well-defined and agreed upon. It rests on the belief that following the right arguments, procedures and techniques will result in an optimal planning solution. This view has been very attractive to developers of a variety of quantitative models ranging from land use to traffic flows. The scientific-analytical view of planning support has particularly been criticized by planning scholars specialized in power relationships for being naïve and not acknowledging the power relations that pre-empt rationality (Flyvbjerg 1998, Flyvbjerg & Richardson 2002).

›› *Tactical* planning support acknowledges the lack of attention to power mechanisms by stressing the potential one-sided application of knowledge as a way to sustain predetermined positions or interests rather than to gain new insights or solve problems (Weiss 1979, Amara et al. 2004). It is therefore critical to analyze the position and interests of the different actors in the planning arena. Hereby it should be noted that interests and politics are inseparable from planning. Inspired by Weiss (1979), Van Schaick (2011, p.94) states that this kind of planning support has: 'Little relation to the substance of the research. It is not the content of the findings that is invoked, but the sheer fact that research is being done'.

›› The central premise of planning support as *learning* is that knowledge is used in an indirect, unexpected and implicit way (Amara et al. 2004, Innes 1998). Knowledge is not used for direct problem solving, but for enlightenment and understanding, which occurs in a nonlinear way. An important contribution to spatial planning in this regard is Donald Schön's *The Reflective Practitioner* (1983), in which he emphasizes the importance of experiential learning and continuous reflection by planning stakeholders. A relevant example is given by Van der Hoeven et al. (2009, p.162) about the Land Use Scanner tool: 'It aims to facilitate the learning of the user on the subject, instead of giving unambiguous answers on what management strategy is preferable'.

›› *Interactive* planning support starts from the perspective that planning support is a social process in which all stakeholders should be involved. Consensus seeking, collaboration and are central notions, which resonates strongly with Habermas's premise of communicative rationality (Habermas 1983; for spatial planning, see Healey 1992, Innes 1998, Innes and Booher 2010). This role of planning support is also gaining more attention in the field of participatory GIS (e.g. Dunn 2007, Geertman 2002). Soutter and Repeti (2009, p.386), for example, state about their SMURF tool: 'In our experimentation, participation is used to constitute a knowledge base that supports decision making and consensus building'.

2.5 Towards a new perspective

In the previous section, we have described four different roles of planning support. In practice, it is most likely that one will find a combination of these four roles. The relative importance of each role depends on the specific circumstances. For instance, in strongly multidisciplinary planning issue, it is likely that an important function for planning support lies in facilitating learning, in order to understand the perspective of other disciplines.

We believe that each of the roles of planning support has its particular value (as well as particular pitfalls) in a planning process. In order to get a more specific understanding of how planning support might work in terms of added value and pitfalls, we will now connect it to the insights about knowledge outlined in section 3.

2.5.1 Planning support as knowledge claim testing

Rydin (2007) argues that in planning knowledge claims should continuously be tested. She describes this as:'(...) the planning system should be conceptualized as a series of arenas in which a variety of knowledges engage with each other, with planners not just responsible for procedural aspects of the engagement but more actively involved in the co-generation of knowledge through testing and recognizing knowledge claims' (*ibid,* p.58). As argued before, different knowledge forms should be included in testing these claims. Three out of the four roles of planning support (scientific-analytical, learning, interactive) can be applied to this idea of claim testing; for tactical planning support – in which the validity of the claim is not of relevance, but the fact that planning support takes place! – the testing takes a different form: one of the aims of the knowledge claim testing is to prevent tactical planning support based on invalid knowledge claims.

The central idea of Rydin's (*ibid*, p.58) notion of testing knowledge claims is that of 'opening-up' and 'closing-down': 'There needs to be space for giving voice to these various claims – *opening-up* – but also for testing and ultimately recognizing these claims – *closing-down'*. 'Opening-up' with regard to knowledge claims involves offering a stage in which knowledge can be introduced, gathered, and recognized. This knowledge can take different forms (experiential, systematized) and can be provided by multiple stakeholders. 'Closing-down', on the other hand, is arguably an even more complex endeavor. This implies deciding upon the validity of a certain knowledge claim. In this regard, stakeholders commonly accept that a knowledge claim is, at least temporarily, valid. For instance, this might apply to a shared understanding about how the near future will unfold with regard to demographic changes.

With regards to 'opening-up', the function of scientific-analytical planning support lies mainly in ensuring the inclusion of systematized knowledge through the input of data, models, quantitative maps etc. This is particularly relevant in instances in which the process of planning is leading and/or when emotions are dominant. Input of systematized knowledge claims can trigger a more rational analysis. The latter is also relevant when scientific-analytical planning support is related to 'closing-down'. Planning support can function as a 'sieve' to roughly separate sensible ideas from nonsense or non-productive emotions. Moreover, scientific-analytical planning support is in various decision contexts a legal requirement, for instance to evaluate whether a plan meets the environmental legal regulations.

Planning support as learning is crucial in the phase of 'opening–up'. Facilitating insight in knowledge claims which take different forms ensures that different knowledge claims are not only put on the table, but also potentially grasped by others. An example can be found within professional planning circles, in which different professions with distinctive disciplinary backgrounds need to communicate their knowledge claims. Wyatt (2004) points in this regard at the problematic communication between architects and planners. Moreover, 'closing-down' can be considered the outcome of a learning process. After a process in which arguments and perspectives are exchanged and an attempt has been done to understand knowledge claims which have a different form, stakeholders can decide to accept or reject the validity of a specific knowledge claim.

Interactive planning support is related to the entire process of knowledge claim testing, which should occur in a continuous collaboration among the involved stakeholders. According to Rydin (2007, p.58) this connects to Habermas' (1983) view of communicative rationality: 'Rather than being at odds with the Habermasian roots of collaborative planning theory, there are strong connections since Habermas sees the illocutionary acts of speech as necessarily involving validity claims if they are to constitute communicative action'. The specific role of interactive planning support lies in ensuring that all knowledge claims, in different forms, are on the table and facilitating the search for consensus about these claims. In the case of spatial planning, this can be done by providing a spatial language (e.g. maps, GIS), which supports the debate among different professions about the validity of the different knowledge claims. Nonetheless, whereas testing knowledge claims is a very relevant element of planning, it is not an encompassing perspective to make sense of or give guidance to planning. We believe such a perspective is needed in order to relate the idea of knowledge claim testing to planning support. In that, the concept of 'storytelling' can be of help.

2.5.2 Storytelling

Hajer et al. (2010, pp.22-23) describe storytelling in a way which resembles Rydin's (2007) idea of knowledge claim testing: 'Good regional planning is like a tribunal, at which all claims – knowledge, position, interests – are confronted with each other with the aim of arriving at a final verdict, a cohesive story'. The notion of storytelling is strongly rooted in the idea of planning as a deliberative and discursive practice. Planning is conceived as developing a story about a specific spatial area, a plot with a beginning, a middle and an end (Kaplan 1993). This story is developed in a continuous iteration, in which stakeholders modify or add to the larger whole (Hemel 2010). According to Van Hulst (2012), storytelling can be considered both a model *for* and a model *of* planning. Put differently, it is both an analytic lens to better understand how planning works and at the same time a normative perspective of how planning should be conducted. Both foci are of relevance from the perspective of planning support, but the emphasis here is on the potential of storytelling as a model *for* planning.

According to Couclelis (2005, p.1367), storytelling is an explorative identification of how the future *could* look like (Couclelis 2005, p.1367). This approach combines empirical knowledge claims (what is our point of departure and what are the effects of interventions?), process knowledge claims (how do spatial phenomena and planning processes work?), predictive knowledge claims (how might the future look like?) and normative knowledge claims (how should the future look like?).

Storytelling integrates different knowledge claims whereby, systematized and experiential knowledge forms are combined. Hereby, the aim of storytelling is not so much the search for a truth claim at a future point in time, but to develop a cohesive story about how the spatial future might unfold as a result of both planning interventions and autonomous trends. Or in the words of Guhathakurta

(2002, p.909): ‘It is commonplace in modern relativism to have multiple versions of events, and stories about them, which raises suspicion about claims of the ‘real’ or the ‘true’ version of that event. However, the value of storytelling is not to separate the `true’ from the `false’ but to make sense of that reality’. While coming from a very different direction, both Guhathakurta (2002) and Rydin (2007) emphasize that planning is not about searching for a universal ‘truth’, but to collaboratively make sense of and evaluate knowledge claims about reality. Relevant for Planning Support Systems (PSS) is that both Couclelis (2005) and Guhathakurta (2002) emphasize that support tools based on a form of quantitative models can be connected to storytelling.

2.5.3 The role of PSS

For Couclelis (2005) the role of a PSS in supporting storytelling lies in separating sense from non-sense. She argues that a PSS ‘can provide methods and tools for distinguishing between possible futures and utopias’ (Couclelis 2005, p.1368). In general, PSS tend to include quantitative (impact) models, which will provide systematized knowledge as input to evaluate claims (scientific-analytic planning support). On the other hand in a PSS the combination of a map (GIS, paper etc.) and a model can facilitate communication (interactive planning support) and learning processes (planning support as learning).

A challenge that permeates all these roles of planning support in the PSS debate is to balance between systematized and experiential knowledge. Kahila and Kÿtta (2009) describe for instance how they apply their PSS ‘SoftGIS’ to gather local and experiential knowledge, and how this forms valuable input for policy-making. The real challenge, however, evolves when systematized knowledge (e.g. based on modelling noise pollution of traffic flows) are confronted with experiential knowledge (e.g. local experiences about traffic pollution adjacent to certain roads). PSS should arguably take some distance from its predisposition to modelling and systematized knowledge and rather be more sensitive to experiential knowledge. Experiences with for instance participatory GIS are promising in this regard (Dunn 2007, Geertman 2002). Hereby, it should be noted that it will not be always possible to come to a widely appreciated test of knowledge claims. However, when communication among stakeholders from different backgrounds is improved, it becomes easier to distinguish between knowledge claims upon which agreement can be reached directly, and those that are ambiguous, that need follow-up research, and/or that lead to conflicting viewpoints.

An important finding from the application of Group Model Building (e.g. Vennix 1999) and a recent study about PSS (te Brömmelstroet, 2010) is that the activity of developing the model or tool in a collaborative process is at least as important as applying the result for further analysis. The collective story is actually developed during the process of setting the right parameters, identifying relevant factors or causal relationships, etc. Since this is a collaborative process, it relates to interactive planning support. Therein, learning is a crucial aspect too, since developing a model might be as important as using it, something called ‘modelling as learning’ (Vennix 1999, p.379). Furthermore, this collaborative process of PSS development can include a stepwise inclusion of the four types of knowledge claims (empirical, process, predictive, normative), whereby it can be decided what claims will be tested at what stage in the planning process. If this is organized well, the development of a PSS helps to set the agenda for a systematized approach to test the relevant knowledge claims.

Besides, a PSS can also function as a memory or log book: previous discussions and knowledge claims that had been closed already can be retraced (a ‘logbook’), and in that making long-term planning processes less vulnerable to changes in personnel, and potentially stimulate a long lasting usage of a story in the planning area.

2.6 Conclusions and future research

In this paper, we were triggered by two observations. The first observation concerns the present dominance of communicative or collaborative approaches in planning, in which participation, collaboration and the process of planning sometimes seem to have become more important than the substance of the planning issue at stake and its rigorous analysis. The second observation from which we started concerns the identification of the potential of PSS to link the analysis of substance with the interactive and collaborative process of planning, although this requires further conceptualization. A barrier that has to be over-come in that is the present-day prime focus on the technological characteristics of PSS instead of on its supporting role in applications. Therefore, in this paper we developed a perspective for PSS that is more sensitive to the role of know-ledge and its supportive application in spatial planning. We basically believe that an improved understanding of planning support will contribute to an improved spatial planning. PSS (as an instance of planning support) can lead to better justified outcomes (based on more complementary and validated knowledge), as well as a more open and systematized process of planning.

For this new perspective we argued that it is critical to pay attention to the characteristics of knowledge in the planning process (in particular knowledge forms and claims) and to the roles in practice that PSS can fulfil related to these characteristics. Notably, the concepts of ‘knowledge forms’, ‘knowledge claim testing’, and ‘storytelling’ constitute the core of this new perspective for PSS. A PSS can facilitate in a systematized way the testing of different knowledge claims in planning. Therein, it can fulfil several specific functions: setting the agenda, gathering experiential knowledge, providing input of quantitative information, function as a logbook, facilitating communication between participants with different backgrounds etcetera. We will now conclude this paper with some reflections on how the field of PSS can contribute to this endeavor.

The field of PSS is a dynamic one in the sense that both technology and planning are changing continuously. We believe that the presented view on planning support provides chances for a better support function of PSS. With regard to the instrumental characteristics of PSS, it will be essential for PSS to be able to accommodate both quantitative and qualitative information. This will help to support different types of knowledge demands, rather than a one sided support of more technically inclined stakeholders. Information-technological developments provide several opportunities for this purpose: 3-D visualizations are very easy to develop, and software like Google Maps is used even by people with absolutely no affiliation with GIS. Including (spatial) visualizations and quantitative models might also contribute to what Hajer et al. (2010) call a ‘strong story’, because it is not just rooted in words, but also in numbers and maps.

Besides capabilities of PSS to handle different knowledge forms and types of information the PSS application context is at stake too. Attention for the context characteristics of a PSS application should be part of the development of an appropriate PSS methodology. Central to this methodology is the careful attention for the knowledge demands of the involved stakeholders. In a small setting of scientifically oriented professionals like environmental analysts and transport planners, a complex PSS that strongly relies on quantitative data might work well. However, in case the group of participants also includes urban designers or for instance residents, more attention has to be paid to visually appealing and intuitive ways of presenting information. Moreover, inherent to storytelling and knowledge claim testing is that during the planning process a possible planning intervention or a knowledge claim has to get ‘closed-down’. Consequently, a PSS methodology requires moments of both diversion (‘opening-up’) and conversion (‘closing-down’).

Since this paper presents mainly conceptual considerations, empirical research is needed to evaluate and refine these ideas. It is hereby critical that scholars in the field of PSS more systematically report on the factual experiences of the stakeholders (te Brömmelstroet 2013). It would be relevant to study empirical case studies in which PSS is applied for ‘opening-up’ and ‘closing-down’ of different knowledge claims in different knowledge forms. Both research and practice potentially can learn a lot from these kinds of knowledge-oriented PSS case studies.

Chapter 3

The added value of Planning Support Systems: A practitioner's perspective

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Abstract

Planning Support Systems (PSS) are geo-information based tools to support planning. Since the term PSS appeared for the first time in the late 1980s it has evolved into a serious academic subfield. In this debate, little systematic attention has been paid to the added value of PSS for planning practice. In particular the perspective of users requires more empirical attention. This paper attempts to fill this gap by answering the question: What is the practitioner's perception of the added value of PSS? In doing so we first develop a conceptual framework including the most important added values of PSS observed in the literature. Next, we describe an empirical study of the MapTable PSS, a support tool that is relatively frequently used in the Netherlands. Fifteen interviews were conducted and a Group Decision Room workshop was organized in order to systematically gather perceptions of users about the added value of this PSS. Added values that particularly emphasized are improved collaboration and communication among stakeholders, something which resonates with recent trends in planning. The added value of a better informed outcome is, somewhat surprisingly, considered less important. In order to deepen our understanding, we recommend more research in different contexts and with different tools.

3.1 Introduction

Since the term Planning Support Systems (PSS) appeared for the first time in the late 1980s (Harris 1989) it has evolved into a serious academic subfield. PSS can be defined as '... geoinformation technology-based instruments that incorporate a suite of components that collectively support some specific parts of a unique professional planning task' (Geertman 2008, p.217). This corresponds to Klosterman's conception (1997, p.47 – emphasis in original), for whom PSS 'includes only the computer hardware, software and related information *used for planning*'. The focus of PSS studies in the last two decades has been mainly on instrumental characteristics (Geertman & Stillwell 2004, Geertman 2006), due to the fact that the enormous improvements of models, software and hardware have made it much easier to connect these instruments to planning practices in a more flexible way. For instance, calculation time has become vastly shorter, making it possible to directly conduct impact analyses during a workshop (e.g. Dias et al. 2013). Moreover, hardware improvements have opened up new opportunities, such as map-based touch tables (e.g. Hopkins et al. 2004, Pelzer et al. 2013, Vonk and Ligtenberg 2010) and theatre-like settings (Miller et al.

2009). Another example is the advent of microscopic models, which according to some scholars have the potential to significantly improve decision making (Rasouli & Timmermans 2013).

These technological developments are exciting and open up a wealth of new possibilities. However, they might also obscure a significant research question in PSS: to what extent does the application of PSS improve planning? In a recent contribution, Te Brömmelstroet (2013) shows that case studies about PSS tend not to systematically test the claims stated about advantages for planning. In other words, most research in the field of PSS lacks systematic and rigorous attention to the *added value* of PSS for planning practice, something that was already observed fifteen years ago for the field of GIS by Nedovic-Budic (1999). Hereby it should be noted that several case studies do assess the added value of the PSS they describe, albeit often in an implicit and not systematized way (see for examples: Geertman & Stillwell 2009, Geertman et al. 2013). Added value is defined in this paper as: 'a positive improvement of planning practice, in comparison to a situation in which no PSS is applied'.

Traditionally, starting from the scientific-analytical or rational approach to planning (e.g. Salet and Faludi 2000), the added value of PSS was mainly seen as improving the outcome of planning. The assumption was that the input of rational analysis and scientific insight would lead to better decisions and plans. However, in the last two decades the focus has shifted to the process of planning. This 'communicative' or 'collaborative' turn in planning (e.g. Healey 1992, Innes & Booher 1999) emphasizes social aspects like social interaction, participation and group dynamics. This notion has also been picked up in the PSS debate (Deal & Pallathucheril 2009, Klosterman 1997, Geertman 2006). According to Klosterman (1997, p.51 – emphasis in original), 'planning support systems should facilitate *collective design* – social interaction, interpersonal communication and community debate that attempts to achieve collective goals and deals with common concerns'.

A logical follow-up question is how this added value with regard to the process of planning should be realized and measured. Boroushaki and Malczewski (2010) developed a quantitative procedure to measure the consensus reached with the tool *ParticipatoryGIS.com.* In addition, experiments with PSS allow careful study of the usability of tools (e.g. Arciniegas & Janssen 2012, Jankowski & Nyerges 2001). We consider all of these to be very relevant and valuable approaches but they do not fill the omission in the PSS debate with regard to the 'user perspective' (Geertman 2008). This omission has two aspects. On the one hand, experiments, often done by students, teach us a lot about the usability of tools but not necessarily about the perceptions and habits in planning practice. On the other hand, while possible added values from adjacent disciplinary fields like sociology (Jankowski and Nyerges 2001) and group psychology (Te Brömmelstroet 2013) are very relevant conceptual buildings blocks, it is not a given that they can be transferred to the field of spatial planning (cf. Campbell 1995). Increasing our knowledge base in this specific field of enquiry could significantly improve PSS development and research. We hereby acknowledge the importance and relevance of process-related concepts like communication and collaboration but argue that the added value of PSS should also be understood in terms of outcomes. In addition, what the added value of PSS is can only be analyzed by focusing on the perspective of the actual users. As Campbell (1995, p.104) states: 'technologies do not function independently of their environments, rather, they gain meaning only as individual staff members in a particular cultural and organizational context interact with them'. Hence, the central question of this paper is: What is the practitioner's perception of the added value of PSS?

To answer this question, the paper is structured as follows. In section 3.2, we will conduct a literature review, describing the state of the art in the literature with respect to the added value of PSS and then develop a conceptual framework. Next, we will describe a study of the experiences of frequent users of a PSS in the Netherlands, in which we analyze the perceived added value through a combination of semi-structured interviews and a digitally supported group interview in a group decision room (GDR). In section 3.4, the findings of this empirical study are presented. Next, we will reflect on these findings and relate them to the existing literature and the chosen method. The paper will end with conclusions and recommendations for future research.

3.2 Literature review: the Added Value of PSS

In the last decade a significant body of literature has been developed about PSS, in particular in edited volumes (e.g. Brail 2008, Brail & Klosterman 2001, Geertman et al. 2013, Geertman & Stillwell 2003; 2009; Stillwell et al. 1999) and journal articles (e.g. Geneletti 2008, Pettit 2005). Two kinds of contributions can be discerned in this debate. On the one hand there are case studies describing an application of a PSS in a specific context. These studies often focus on the technical and instrumental aspects of a PSS, such as the underlying models (e.g. Geneletti 2008, Klosterman 1999). On the other hand, there is a range of overview articles, attempting to interpret trends in the field and connect PSS to abstract and theoretical considerations (Couclelis 2005, Geertman & Stillwell 2004, Geertman 2006, Klosterman 1997, Vonk et al. 2005). In these studies added value is often conceived as 'potential', implying that, compared to current practice, PSS can be much better utilized to support planning than is the case at present. Conversely, the question permeating these studies tends to be how PSS could be used more and in a better way. In this paper, we approach this issue differently. Rather than framing the issue in terms of underutilized potential, we ask the question: given that a PSS is applied, how do its users perceive the contribution (i.e. added value) to their daily planning practice?

In a relevant recent contribution in this journal, Te Brömmelstroet (2013) develops a framework to measure the added value of PSS[3]. This framework

[3] Note that Te Brömmelstroet (2013) uses the term 'performance' rather than 'added value'. However, we consider the two terms to be essentially identical.

is based on an overview study by Rouwette et al. (2002) about Group Model Building (GMB). GMB applies collaborative modeling in order to better understand the problem at hand, support group processes and develop interventions. Although it has a different focus – in particular: it isn't GIS-based – it has a lot in common with PSS. The fields of GMB and of PSS are both about supporting policy development processes through the use of dedicated instruments. Inspired by these studies, we developed a framework consisting of three levels: the individual level, the group level, and the outcome level. Below, we describe the main added values at each of these three levels.

3.2.1 Individual level

The central added value of PSS at the individual level is learning (Amara et al. 2004, Innes 1995). Two main types of learning can be distinguished:

1. Learning about the *object* of planning. What is the problem and what are its causes? And what is the possible effect of planning interventions? Van der Hoeven et al. (2009, p.162), for instance, show how their Land Use Scanner PSS helps individuals to gain more insight into flood risks: 'The system is developed to support the discussion on the long-term adaptability of the Netherlands to flood risk. It aims to facilitate the learning of the user on the subject, instead of giving unambiguous answers on what management strategy is preferable'.
2. Learning about the perspective of *other stakeholders* in planning. For instance, an expert could learn about a resident's perspective (Kahila & Kÿtta 2009), a land-use planner about a transport planner's perspective (Te Brömmelstroet 2010), whereas a designer has much to learn about a geographer's perspective (Steinitz 2012). An example of these perspectives are 'frames' held by different stakeholders, such as 'analysis', 'design' and 'negotiation' (Carton and Thissen 2009, cf. Pelzer et al. 2013). Reflecting on these frames provides more insight into how other stakeholders act and think (Innes & Booher 1999, Schön & Rein 1994).

3.2.2 Group level

Based on literature about PSS (e.g. Boroushaki & Malczewski 2010, Te Brömmelstroet 2013, Vonk & Ligtenberg 2010), planning (e.g. Innes 1998, Innes & Booher 1999) and GMB (Rouwette et al. 2002), four potential added values can be discerned at the group level: communication, collaboration, consensus and efficiency.

1. In the literature about both planning and PSS, the importance of *collaboration* is acknowledged (e.g. Healey 1997, Klosterman 1999, MacEachren 2000, Vonk & Ligtenberg 2010). As Vonk and Ligtenberg (2010, p.168) state: 'collaboration is fundamental to the practice of contemporary planning. Such collaboration typically consists of acts of interaction, sharing representations and revisiting arguments'.

2 An important outcome of collaboration is the improvement of *communication.* In several recent studies this is addressed as the main aim of applying a PSS (e.g. Te Brömmelstroet 2010, Arciniegas 2012). Vonk (2006) sees 'communicating PSS' as one of the central functions, in which 'PSS aims to facilitate communication and discussion between those involved in planning through supporting the flow of planning-related information between them' (*ibid,* p.79).

3 The importance of planning as building *consensus* has been widely acknowledged. In particular, it has been emphasized that successful communication and collaboration can result in – depending on the planning issue at hand – a consensus about problems, decisions, knowledge claims and criteria (e.g. Boroushaki & Malczewski 2010, Innes & Booher 1999, Rydin 2007).

4 Increased *efficiency* is about lower investments in time or money for the same amount of work – or even more. It is 'the ease of performing regular tasks faster, or by doing more in the same time with the same effort' (Te Brömmelstroet 2013, p.302).

3.2.3 Outcome level

Measuring the added value at the outcome level is a very complicated task. It is very difficult to measure, in practice, whether a plan or decision would have been different without the application of a PSS. Hopkins (2001, pp.46-47) discerns four criteria to determine whether a plan works: effect, net benefit, external validity and internal validity. We argue that the role of PSS in improving plans, and thus achieving added value, lies primarily in improving the internal validity of a plan, which refers to whether this plan is 'internally consistent with the logic of how plans work'. We argue that this dimension is particularly relevant for PSS, since its components such as models, visualizations and map layers all contribute, in their own vein, to the internal consistency of a plan; for instance in terms of interdependence of the factors that comprise the spatial phenomena a plan describes. The emphasis on the internal validity of a plan connects to Klosterman's (2009, p. iv) remark that 'the development of PSS can be seen as part of a larger effort to return the planning profession to its traditional concern with using information and analysis to more effectively engage the future'. Hence, the added value of PSS at the outcome level is conceived as: 'better informed plans and decisions'.

3.3 The MapTable

3.3.1 Map-based touch tables

Planning has become an increasingly collaborative activity. Parallel to this trend, in recent years the PSS debate has devoted more attention to collaboration and group processes (e.g. Arciniegas and Janssen 2012, Klosterman 1999, Miller et al. 2009, Van der Hoeven et al. 2009, Vonk & Ligtenberg 2010, cf. Geertman & Stillwell 2004). Vonk and Ligtenberg (2010, p.167) stress that attention must be paid to PSS that explicitly facilitate group processes, since traditionally PSS 'often build on the single-user desktop-computer paradigm when aiming at supporting group work also hampers usability'. In the context of GIS and cartography, MacEachren (2000) calls this 'same place collaboration'. In response to the emphasis on collaboration, hardware solutions in the form of a digital table specifically dedicated to support group processes have been developed and applied (e.g. Hopkins et al. 2004, Pelzer et al. 2013, Sharma et al. 2011, Vonk & Ligtenberg 2010). These 'map-based touch tables' are particularly tailored to support collaborative planning.

In combination with other components like data, software and models, map-based touch tables function as a PSS. Studying them can reveal a relatively representative picture of the perceived added value of a PSS in contemporary communicative planning. In addition, to go beyond a single case study – as was already done in the exploratory work of Hopkins et al. (2004) and Vonk and Ligtenberg (2010) – we looked for a tool that is used by multiple organizations. We found such a suitable instrument to be the MapTable, because this is a PSS that is used by at least fifteen planning organizations in the Netherlands. Moreover, because the MapTable, on the one hand, normally contains geo-information-technology-based software for performing database management tasks, analysis and visualization purposes and, on the other hand, the MapTable possesses dedicated functionality to support specific planning tasks like designing, scenario-building, visioning and evaluation, we consider this instrument a PSS.

3.3.2 The MapTable

The MapTable is developed and commercialized by the geo-communication firm Mapsup (www.mapsup.nl). It is a digital, touch-enabled screen (46”) in the form of a moveable table. In principle it can work with all possible kinds of software packages. However, in the Dutch context the most common software packages are: ESRI's ArcGIS® environment, complemented in quite a number of instances with CommunityViz Scenario 360 software (www.communityviz.com), and web viewers developed by governmental organizations in order to depict different map layers. In some instances the MapTable is combined with other applications, such as Sketchbook Pro or Google Streetview. The essence of the MapTable PSS is that it has the form of a big table and the functionality and looks and feel of a PSS that is dedicated to supporting policy and planning processes, usually through a GIS, in order to support policy and planning processes. When practitioners refer to the MapTable, they tend not to make a distinction between the software, dataware, and hardware; they rather perceive the MapTable as one entity, with different characteristics.

3.3.3 Two examples: CommunityViz and participation

In order to familiarize the reader with the PSS tool that is the focus of this study, we will now give two examples of how the MapTable is used in practice. The examples refer to cases discussed in the interviews and *group decision room* (see section 4). The first example is the development of a zoning plan for a new neighborhood in the Dutch city of Utrecht (see Pelzer et al. 2013 for more details). This neighborhood had the ambition to grow to 8000 dwellings and to achieve an above average level of sustainability. To support this ambition, the MapTable PSS was applied in combination with the so-called Sustainability Profile of the Location (SPL). The latter is an indicator system of environmental values, based on the Dutch school grading system, in which 1 is the lowest and 10 is the highest. After a planning intervention has been exercised on the MapTable, the kind of effect this has on one or multiple SPL themes is directly visible. For instance, if one places a windmill, the effects on energy production are directly visible in a chart (see also Figure 3.1). In this case, a strongly analytic focus (based on the SPL-methodology) was combined with the collaborative aim of working together among different disciplinary experts around the MapTable.

The second example concerns the issue of participation. Rijkswaterstaat is the executive body of the Dutch Ministry of Infrastructure and the Environment. One of its main responsibilities is the construction and reconstruction of highways in the Netherlands. The MapTable is applied in order to communicate with local residents. Tentative plans are depicted on the MapTable, allowing local residents to gather information and directly provide input on plans. A very similar approach is found in Zeeland, a province in the south of the Netherlands where water management by and with local farmers is very important. The MapTable is applied there to provide information to local farmers as well as to gather their input.

3.4 Methodology

In order to increase our insight into the practitioner's perspective on added value we carried out qualitative research applying two methods: fifteen semi-structured interviews and a GDR workshop. The main purpose of the interviews was to gather in-depth information about added value and to get a context-rich understanding of what the concept means for practitioners, whereas the GDR workshop was meant to structure and prioritize the findings. We first identified all the organizations in which the MapTable was applied in policy making. After removing organizations that did not apply the MapTable for planning purposes (but for educational purposes or for engineering purposes like the analysis of

Table 3.1 Summary of added values at three levels

Added value	*Definition*	*Source*
Individual		
Learning about the object	Gaining insight into the nature of the planning object.	Te Brömmelstroet (2013), Van der Hoeven et al. (2009)
Learning about other stakeholders	Gaining insight into the perspective of other stakeholders in planning	Innes and Booher (1999), Pelzer et al. (2013), Schön (1983), Schön and Rein (1994), Te Brömmelstroet (2013)
Group		
Collaboration	Interaction and cooperation among the stakeholders involved	Healey (1997), Klosterman (1999), MacEachren (2000), Vonk and Ligtenberg (2010), Vonk (2006)
Communication	Sharing information and knowledge among the stakeholders involved	Te Brömmelstroet (2010), Arciniegas and Janssen (2012), Geertman (2008), Vonk (2006)
Consensus	Agreement on problems, solutions, knowledge claims and indicators.	Innes and Booher (1999, 2010), Boroushaki and Malczewski (2010)
Efficiency	The same or more tasks can be conducted with lower investments.	Te Brömmelstroet (2013)
Outcome		
Better informed plans or decisions	A decision or outcome is based on better information and/or a better consideration of the information	Hopkins (2001), Klosterman (2009), several examples in Geertman & Stillwell (2009)

In table 3.1 the hypothesized added values at three levels are summarized. We will now describe how we conducted an empirical study to get insight into the perceived added value of PSS by planning practitioners.

construction images, for example), a total number of fifteen cases remained. We then selected the key people in these organizations, i.e. those who had the most extensive experience with the MapTable. These people consisted of GIS-advisors, spatial planners and environmental advisors.

3.4.1 Interviews

Next, we conducted semi-structured interviews with them, ranging from 20 minutes to 2.5 hours. The interviews were semi-structured; the aim was to gather as much information as possible about their experience with the application of their PSS. Besides asking them about the added value of the tool, the interviewees were also asked about topics that are not discussed in this paper, such as facilitation of workshops, dispersion of technology within the organization and the importance of disciplinary background for PSS usage. All the interviews were recorded and transcribed verbatim. Next, these transcripts were analyzed using Atlas.ti® software (www.atlasti.com). This analysis consisted of four steps: (1) all the quotes that relate to added value were inductively coded (see Corbin & Strauss 1990, for related examples see Pettit et al. 2011 and Schroth et al. 2011); (2) the codes were grouped into categories derived from the framework in Table 3.1; (3) this resulted in a ranking of the clusters based on the number of codes that related to them; (4) finally, an advanced Masters student in Geographic Information Science independently repeated step 1, 2 and 3 in order to check the validity of the analysis.

Conducting and analyzing these interviews had two purposes. On the one hand, they allowed us to get an in-depth and illustrative understanding of the practitioner's perception with regard to added value of PSS in concrete planning situations. On the other hand, they supported the GDR workshop (see heading *Group Decision Room* below) in the following ways: (1) the interviews provided a way to select the people that were to be invited to the GDR workshop; out of the fifteen people that were interviewed, nine people who had intensive experience with the MapTable were invited to join the GDR workshop, (2) the findings of the interviews formed the structure of the type of questions that were asked during the workshop, and (3) the findings of the interviews were a cross-check on the validity of the outcomes of the first two steps in the GDR workshop, in particular the clusters that were formed by the participants (see below).

3.4.2 Group Decision Room (GDR)

We organized a workshop in a GDR in order to structure and refine the user perspectives on added value. A GDR is an '(...)"electronic meeting room" that enables fast and efficient stakeholder dialogue with real-time exchange of opinions, feedback of results, brainstorming and discussions' (Weitkamp et al. 2012, p.19). These `computer-facilitated workshops are similar to focus groups, but structured and enhanced with various interactive tools' (Wardekker et al. 2008, p.269).The discussions take place both face to face and anonymously through the software. Several studies in the social sciences and spatial planning have recently used GDR facilities for the following reasons: they allow both face to face and anonymous communication, they lead to a more structured discussion and facilitate a more efficient exchange of insights, and they allow basic statistical analysis (Bakker & Trip 2013, Rouwette et al. 2000, Van der Vlies 2011, Wardekker et al. 2008, Weitkamp et al. 2012).

Figure 3.1 The MapTable applied to explore the options in a plan area using CommuntiyViz

Figure 3.2 MapTable users working with the MeetingSphere software during the GDR workshop (photo: Ron Wunderink)

The workshop was conducted on the 17th of October, 2013 at the VISA skills lab of Radboud University Nijmegen (http://www.ru.nl/nsm/labs/visa-skills-lab/visa-skills-lab/, see Figure 3.2 and Figure 3.3) and lasted 2.5 hours. Participants were digitally engaged in a discussion on laptops with dedicated software called MeetingSphere® (www.meetingsphere.com). This is online meeting software, which includes a range of tools that aim to make meetings more productive and efficient. For this GDR workshop, two tools were mainly used: the brainstorm tool and the ranking tool. During the workshop, the participants were supported by a moderator who operated the software, and a researcher in the field of PSS who had also conducted the semi-structured interviews.

For the purpose of this paper, having a digitally supported GDR session was particularly relevant because it allowed us to conduct the three following steps systematically and efficiently:

- Step 1: *Brainstorm*. To start things off, an open brainstorm session was conducted, in which the participants answered the question: ‘What do you consider to be the added value of the MapTable?’ Here, it is important to note that the participants conceive ‘MapTable’ as the combination of hardware (the touch table) and software (GIS, impact models, etc.). The brainstorm session resulted in a total of 67 items (see Appendix 3.1). Before the brainstorm started, we asked the participants which base scenario we should compare the application of a MapTable with. It was agreed amongst the participants that the added value of the MapTable could be compared to: (1) desktop computers, (2) large paper maps, (3) a smart board and/or (4) no support at all. This was done to make explicit to what situation the added value of the MapTable was compared by the participants.
- Step 2: *Clustering*. Next, the participants were asked to identify clusters of items and 10 items into clusters. A total of seven clusters were identified, into which all the 67 items were classified (see table 3.2).
- Step 3: *Ranking*. Finally, the participants were asked to score the importance of the seven clusters, based on a 1 (lowest) to 10 (highest) scale (see table 3.2). This step was framed as indicating the relative importance of different arguments (i.e. added value) for the participants in favor of applying the MapTable.

3.5 Findings [4]

The findings from the GDR workshop show a strong overlap with the findings of the semi-structured interviews in terms of the items identified and the clusters. This underlines the reliability of the results obtained in the GDR workshop. In table 3.2, the seven clusters that were identified by the participants are

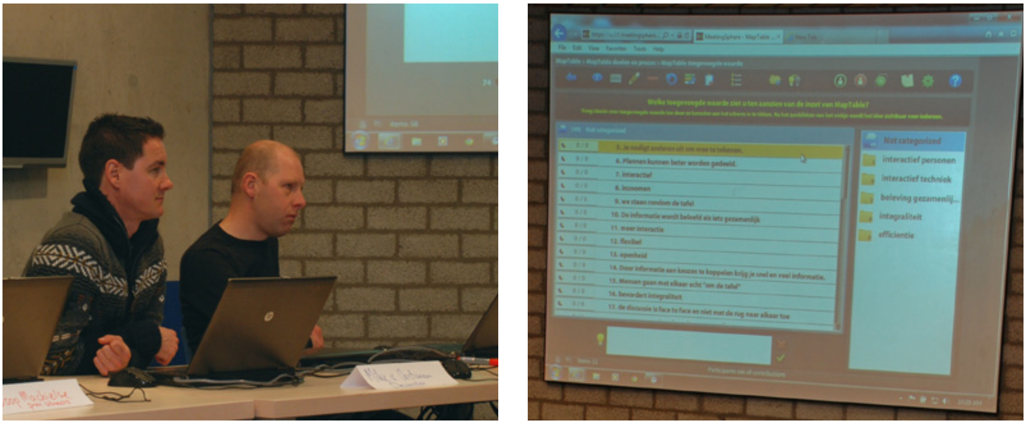
[4] All clusters, items and quotations are translated from Dutch.

Table 3.2 **Added value clusters identified by practitioners (n=9), their mean ranking score, standard deviation, number of items and typical items.**

Name of cluster as defined by participants	*Mean ranking score (1-10)*	*Standard deviation*	*Number of items (#67, items can be placed in more than one cluster)*	*Examples of items*
'interactive with people'	8.89	0.09	14	More interaction. You invite others to draw along
'togetherness'	8.67	0.08	8	It brings people together. The information is seen as something shared
'communication'	8.22	0.27[5]	14	Enhances communication. Around the MapTable discussions and ideas evolve more quickly than when everyone sits in their own place
'interactive with technique'	7.11	0.13	12	Panning multiple map layers. One is more flexible in depicting information
'efficiency'	7.00	0.26	19	Saving ideas is easy and after sessions you can send them to the participants. Speeds up the evaluation process
'quality of content'	7.00	0.20	8	Better preparation. More in-depth discussions
'integrality'	7.00	0.18	2	It enhances integrality. Integral way of working

5 This high standard deviation is caused by one participant who gave the lowest score (1), not because he thought it was an unimportant added value, but because 'Giving extreme scores would make the differences more visible.'

Figure 3.3 MapTable users interacting during the session and a projection of MeetingSphere.



depicted. If we look at mean scores, it is interesting to note that the clusters related to the group process ('interactive with people', 'togetherness' and 'communication') have higher scores than the other clusters. Moreover, whereas the clusters 'interactive with technique' (#12) and 'efficiency' (#19) consist of a relatively high number of items, this is not reflected in an equally high ranking score. We will now look at the added values at the three levels in more depth.

3.5.1 Individual level

In both the semi-structured interviews and the GDR workshop, the added value at the individual level was mentioned in only a few instances. This could be explained by the fact that the interviewees were often responsible for the workshops with the MapTable. Therefore, their perspective is more that of the group as a whole, rather than individual experiences. Moreover, the MapTable is specifically designed to support collaborative group processes. Nonetheless, some participants pointed to individual learning experiences. With regard to gaining insight into other stakeholders' opinions, this typically refers to interdisciplinary learning within a professional context:

> What such a table [MapTable] does really well is to pull people out of their discipline and force them to collaborate. They have to indicate the spatial impact of their discipline. And people see more of other people's work. (Interview #5, Sustainability Advisor at municipality)

Hence, it appears that the digital map displayed on the MapTable acts as a kind of spatial language, which increases the learning process about the perspective of other stakeholders - in this case, from a different disciplinary background. The spatial language, in combination with a dynamic and active way of working, also leads to learning about the planning object:

> We can directly gain insights. (...) People from different disciplines can independently show what they think. And then you see that while people are drawing around the table, interaction is evolving. Then we grasp the problem better. (Interview #2, Sustainability Advisor at municipality)

In summary, the MapTable was perceived to facilitate learning at the individual level, both in terms of other stakeholders and the object. Hereby, they are often intertwined; learning about the perspective of another discipline also increases the insight into the planning object and vice versa. The main role of the MapTable lies in facilitating a spatial language and ensuring the dialogue among the stakeholders – a prerequisite for learning – keeps going.

3.5.2 Group level

The main emphasis in the GDR workshop was put at the group level. The cluster 'interactive with the technique' is a prerequisite for all the added values identified in the conceptual framework (collaboration, communication, consensus, efficiency). Or as indicated during the GDR workshop:

> It is possible to show new data *during* a conversation. (GDR item, emphasis added).

The flexible and dynamic way of working with the MapTable is a condition for other added values, notably communication.

The added value with regard to *communication* lies primarily in the fact that information and knowledge are communicated in an interactive and dynamic way. The dialogue becomes more energetic and content is shared more easily. On the one hand, this concerns content that is already in the MapTable (e.g. map layers) but, on the other hand, the MapTable is also a means to communicate knowledge among stakeholders. A MapTable functions as a trigger to send and receive knowledge:

> When we show something on the MapTable, given that you have prepared it well, the issue becomes much more alive. I notice that people are starting to ask more questions. (Interview #10, Project Manager at municipality)

Another interviewee also emphasizes the importance of a dialogue as a way of communicating both knowledge and information:

> The added value is that you engage in a dialogue. That one can anticipate on things that are being said. (...) You either react on what is being said or react to the things you see. (Interview #8, GIS Advisor at municipality)

An important prerequisite for this kind of successful communication at the group level is *collaboration* among the stakeholders involved. During the GDR workshop, ‘interactive with people’ and ‘togetherness’ were considered important added value clusters. These clusters can be considered to be more operational elaborations of the notion of collaboration within the conceptual framework. An interviewee gives an illustrative example of the mechanisms at work with regard to communication and collaboration:

> It triggers the communication. The table is like a catalyst to work collaboratively on a plan. And it is a bit of probing and trial and error until you get to acceptance of each other’s viewpoints. (Interview # 6, Sustainability Advisor at province)

In this, ‘togetherness’ (see Table 3.2) is an important condition for collaboration that functions well:

> What I noticed is that when people stand around such a table, they stand shoulder to shoulder, which leads to a very different atmosphere. When you play around together with that thing [MapTable], people feel more free to throw their ideas into the group discussion. Whereas when they are in a circle with a cup of coffee, the one with the biggest mouth is usually dominant. (Interview # 15, PSS expert at consultancy firm)

The constructive atmosphere and open dialogue also seems to increase the chances of achieving a *consensus.* Because stakeholders are more involved in the planning issue, they are more likely to agree on assumptions, problem statements and possible solutions. Moreover, the MapTable makes this involvement very concrete:

> Because you made the story with others, the MapTable improves the communication. You were there when it was done, so you can re-tell the story. When a remark is documented it becomes more difficult to say no in a later stage (GDR note[6]).

The cluster of ‘togetherness’, as identified by the participants, functions as a precondition for achieving consensus. Besides a content-based dialogue ‘it brings people together’ (GDR item), because they literally ‘go around the table with each other[7]’ (GDR item), which increases the chance of reaching consensus among the participants.

In theory, improvements in these three aspects – communication, collaboration and consensus – also have positive effects on efficiency. However, efficiency was also frequently mentioned as an added value in its own right. As was remarked during the GDR session:

6 During the GDR workshop, notes were made by the moderator in the Meetingsphere® software, when an item required further explanation. This note was refined until all the participants agreed with the note.

7 This is a Dutch saying that is hard to translate, meaning something similar to: ‘having a good, open conversation’.

> Efficiency can also be achieved in different ways. (...) I can also do the things I do on the table [MapTable] on my desktop computer, but then nobody is standing around the table. That is a different situation. The table really helps to get things clear. (...) Talking with each other is often pivotal. (GDR transcript).

The 'efficiency' cluster had the most items from the brainstorming session (#19). Most of these items related to instrumental improvements in terms of availability of information and map layers, direct impact analysis and faster handling of proposed interventions and ideas. A GIS Advisor recalled his experiences with residents of an area prone to flooding:

> We let people fill out a small card with a code. And with that code they go to the table and fill in a form with their remark that is directly submitted. They do not need to do anything, not even sign it. (...) Because of this procedure we get 60 to 70 percent fewer complaints. (Interview #4, GIS Advisor at province)

In addition, it was also emphasized that by organizing workshops with a MapTable in professional settings, a lot of time can be saved.

> When you plan your sessions cleverly, you can gain a couple of months. But you have to adjust to specific times in the spatial planning process – for convergence and divergence of information – and decide when to go really in-depth with a couple of people. (Interview #10, Project Manager at municipality)

A final, very practical issue is that planning meetings become more active and shorter because people stand, rather than sit.

> I notice that we have very efficient meetings because people are standing – and that makes the time of a meeting shorter. (Interview #11, GIS Advisor at infrastructure authority)

Although efficiency has several dimensions, the ranking scores indicate that other added values related to the group level are more important. On the one hand this can be explained by the fact that working efficiently is a positive *characteristic* of a planning process and is not an *aim* in itself, contrary to communication, collaboration and consensus. On the other hand, participants also indicated that applying the MapTable in some instances led to *less* efficient sessions. Some GIS Advisors indicated that it took them more time:

> A low score for efficiency because it is more work for me. (GDR note).

Moreover, the sessions with a MapTable do not necessarily work smoothly:

> When you use the MapTable optimally, efficiency is possible, but optimal use is not always reached. (GDR note).

To sum up, most of the perceived added value by the practitioners is at the group level. *Communication and collaboration* were strongly emphasized, in particular; they both seem to function as a prerequisite for achieving *consensus*. *Efficiency* has a range of added value items but is perceived to have a lower priority for practitioners.

3.5.3 Outcome level

During the GDR workshop, two clusters were identified that relate to the outcome level: 'quality of content' and 'integrality'. Both clusters are arguably instances of better informed decisions: the quality of the content refers to the data and information used:

> When you are standing around the table with a group, someone can say the data is incorrect. (GDR Note)

Besides the quality of the data and information, the way in which an argument or decision is developed based on this data and information is also perceived as an added value:

> It is a means to make sense of a large amount of unstructured information, to make that understandable and simply make better informed choices. (Interview #10, Project Manager at municipality)

The second cluster identified, that of 'integrality', can be considered to be a specific instance of making sense of several information sources. An integral analysis is based on the evaluation of all the aspects that are relevant for a particular planning issue.

3.6 Reflections

Studying the added value of PSS is, both methodologically and conceptually, a complex endeavor in which trade-offs are inevitable. Therefore, we will now reflect on the chosen method and the findings.

3.6.1 Reflections on research method

The motive for the described analysis was that we wanted to study a PSS that is already frequently used in practice, hence not to study a specific prototype or pilot. Moreover, we considered generalizability of our findings an important criterion and therefore did not apply the method of an in-depth case study. The approach applied also has pitfalls. The structure of a GDR session and the diversity of involved participants does not allow for elaborate attention to the details of the tasks for which the PSS was applied. Hence, some of the concepts used remain at a somewhat abstract level. Our aim, in future research, is to relate added value more explicitly to specific planning tasks. Hopkins (2001, in particular: pp.187-191) provides very relevant conceptual building blocks to study the roles of PSS to support such tasks empirically. Moreover, we deliberately studied *perceived* added value because this is under-researched in debate and provides a much needed perspective of how the users see PSS (cf. Geertman 2008, Moore 2008). This is however not to argue that studying the perceived added value is the only possibility for empirical research. Earlier studies about PSS have shown that perceptions are biased by habits that have been in place for years (Vonk et al, 2005) and these perceptions are colored by the disciplinary background of the perceiver (e.g. Pelzer et al. 2013, te Brömmelstroet 2010). Hence, studies into added value should combine perceived added value with revealed added value, for instance through "before and after" questionnaires to reveal learning effects or a systematized comparison (e.g. through an MCA) of similar plans that are developed with and without a PSS.

3.6.2 Reflections on the findings

The findings from this paper contribute in two ways to the debate about the added value of PSS. First, this paper has generated a more refined understanding of what is meant by added value concepts like 'communication' and 'collaboration'. The various quotes throughout the paper give meaning to what the often heralded 'user perspective' of PSS means in the words of practitioners. Second, we have gained a better understanding of the relative importance of different aspects of the added value of PSS. Most of the types of added value that are mentioned frequently, and that were considered important, refer to effects at the group level. This might be explained by the fact that a MapTable aims to support collaboration among a relatively small group of participants (~6-10 participants). Moreover, it shows that an important part of the perceived added value lies in the hardware characteristics of the MapTable. The fact that practitioners stand around a table has benefits for collaboration. In the words of Hopkins at al. (2004, p.664): 'The horizontal orientation of the work surface appears to facilitate group interaction more so than in our observations of groups working with display surfaces oriented vertically'. Some caution should be taken into account when transferring the findings of the MapTable case to other PSS. This is particularly relevant for the relatively small amount of attention at the outcome level in the empirical findings, which can be considered surprising given that improving planning outcomes through better analysis and integration was one of the starting points of PSS. As Harris (1989, p. 87) notes in a seminal article: 'the planner will want to see how all aspects of the future plan fit together, and must find a way through the large number of different options that arise as many decisions are jointly considered.' This kind of integrative analysis, central in many recent PSS studies, received relatively little attention. This can be explained by the fact that not all the practitioners in our sample had experience with impact models. In those instances when there was a focus on this kind of software like CommunityViz Scenario 360, this resulted in more attention given to the outcome aspects. For instance, a practitioner who had worked intensively with CommunityViz in combination with an environmental impact model ('Sustainability Profile of Location', SPL) based on benchmarks stated:

> It is not just about decibels, but it is about the spatial translation of them. That is the added value of that table [MapTable combined with CommunityViz and SPL): it forces you to think about quality from the perspective of sustainability and the environment, not in terms of legal norms. (Interview #5, Sustainability Advisor at province)

In this respect, it should be noted that the added value at the outcome level is not independent of the other factors mentioned. Better informed decisions can only be made if learning occurs at the individual level and when communication at the group level functions adequately. This relates to the broader remark about the theoretical categories and levels that are applied to disentangle the concept of added value: they are valuable for analytical purposes, but it is equally important to acknowledge the interrelationships among them. These relationships transcend the three identified levels. For instance, collaboration is an important prerequisite for communication at the group level. Successful communication can subsequently lead to improving insight at the individual level, whereas if the stakeholders involved had better insight, it might result in a better informed outcome.

Another relevant insight in this regard concerns 'indirect' added values (Nedovic-Budic 1999). These are causally related to the identified 'direct added values' as discussed so far, that were mentioned in some of the interviews and that reflected in existing literature. The most notable is the dissemination of spatial thinking, or as some call it: 'geo-thinking':

> The added value is the promotion of geo-thinking among all the people around the table. These could be colleagues or external people. (Interview #4, GIS Advisor at province)

The promotion of 'geo-thinking' includes the diffusion of geo-ICT within the organization (cf. Vonk et al. 2007):

> I think it is a way of utilizing geo-information better; particularly because we have been investing a lot in geo-information for years now. (Interview #14, GIS Advisor at municipality)

However, spatial thinking also involves learning processes at both the individual level (National Research Council 2006) and the group level, where it functions as a 'shared language', potentially being beneficial to the other added values at this level (cf. Rouwette et al. 2002). In this regard, Schroth et al. (2011, p.67) point at the potential of interactive visualization to support the dialogue by citing an interviewee approvingly: 'The opportunity to generate any perspective supports factual discussions; all have the same image in front of them and think about it.'

3.7 Conclusions and future research

The central question of this paper is: What is the practitioner's perception of the added value of PSS? In answering this question, it should first be recalled that purpose wasn't to find *the* added value of PSS – which is arguably not even possible – but rather to better understand added value as perceived by practitioners in a particular context and for a specific PSS. The main answer to the central question is that added value at the group level is perceived to be central in the perception of practitioners - in particular, better communication and collaboration among stakeholders. This confirms the notion that collaboration and communication have become critical components in the role of planning support.

Most PSS – still – start from the substance of a planning issue – focusing on process aspects only in a later stage. In order to get the most added value out of PSS, it is arguably a fruitful way to turn this approach around and first ask the question: 'how can a PSS optimally improve efficiency, collaboration, communication and consensus?' Although we acknowledge that the specific added value differs from one situation to the other, we also believe that generic insights are a necessary condition for advancing the field. In this regard, Geertman (2013) calls for a 'planning support science' (PSScience), which inter alia should research the way in which PSS can optimally support planning. The concept of added value can become a central concept in PSScience, particularly because it could stimulate a systematized study of the *support* function of PSS (the second S), the study of which is an omission in current debate (cf. Geertman 2008). One of the conditions for gaining in-depth insights about the added value concept is that a sufficient number of empirical studies are conducted with an explicitly comparative focus. Te Brömmelstroet (2013) recently contributed to this aim by conducting a meta-study of PSS case studies.

However, there are many more avenues for future research. Some PSS software packages, like CommunityViz, What If? and UrbanSim now have such a large user base that a comparative analysis of the added value experienced by its users has become feasible. Such analyses would increase our understanding of the impact analysis component of PSS in relation to added value, something this paper has paid relatively limited attention to. GDR software packages, such as MeetingSphere that we applied, lend themselves well to conduct such an empirical analysis relatively quickly and efficiently. Most PSS software packages can be downloaded from the Web or are available as desktop packages, which enables a comparison of identical PSS in different regions or countries (e.g. Biermann 2011). Moreover, applying additional methods, such as the analysis of videos of workshops (e.g. Nyerges et al. 2006, Salter et al 2009), possibly including eye tracking (e.g. Poole & Ball 2006), can also deepen our understanding of the *revealed* added value, besides studying the *perceived* added value as was done in this paper. In a technology-savvy field like that of PSScience, applying such methods for introspection would be a logical next step.

Appendix 3.1 **Overview of the clusters and items as identified by the participants of the GDR**[8]

interactive with people (14)	*interactive with technique (12)*	*togetherness (8)*
1. Interactive	1. Zoom in	1. Equality
2. We stand around the table	2. Panning, multiple map layers	2. More than 2 (up to 6) people with the same view
3. More interaction	3. It is possible to show new data during the conversation	3. It brings people together
4. The technique is not central anymore	4. Compared to paper maps, it is possible to look at different scales	4. You invite other people to draw along
5. Increased willingness to make concessions	5. Add new information	5. The information is seen as something shared
6. Attractiveness of the table, participants walk towards the table	6. The possibility to collaboratively select new information sources/map layers	6.The distance between 'government' and 'stakeholder' is smaller when you stand around a table
7. MapTable is mobile and can be brought to people	7. One is more flexible in depicting information	7. Plans can be better shared
8. Possibility to give personal instruction when using the information	8. Faster availability of data	8. People really get together 'around the table'
9. Many people like to work with it	9. Plans can be better shared	**integrality (2)**
10. It brings people together	10. Saving ideas is easy and after sessions you can send them to the participants	1. It enhances integrality
11. You invite others to draw along	11. Visualizing dynamic processes (space-time)	2. Integral way of working

8 N=67, one item can be placed in multiple clusters and some items are described identically by different participants (e.g. better preparation).

interactive with people (14)	*interactive with technique (12)*	*togetherness (8)*
12. The discussion is face-to face and not with your back towards each other	12. Exploring future scenarios	**efficiency (19)**
13. It lowers barriers in discussions	**communication (14)**	1. Flexible
14. Around the MapTable discussion and ideas evolve more quickly than when everyone sits at their own place	1. Plans can be better shared	2. By connecting information to choices to get a lot of information in a short amount of time
quality of content (8)	2. Openness	3. Better preparation
1. More in-depth discussions	3. People really get together 'around the table'	4. Speeds up the evaluation process
2. It works as inspiration for the people around the table	4. The discussion is face-to-face and not with your back towards each other	5. Saving ideas is easy and after sessions you can send them to the participants
3. The aim is clearer because of the better preparation	5. Participants in a conversation have the possibility to make their question or point more exactly	6. Saving important decisions during the process
4. Better geographical data	6. Issues can be made visual more easily, also by non-professionals	7. Less preparation time needed
5. Better preparation	7. Enhances communication	8. All wishes and remarks are digitally noted. No issues are hand written
6. Combination of information (2 transparent map layers) leads to new information, possibly knowledge	8. The reading of maps is not always developed in other countries. By new smartphone technologies they seem to skip the step of an analogue map	9. Makes the consequences of choices visible (if combined with calculation module)
7. Better preparation	9. It lowers barriers in discussions	10. The meeting is shorter because you stand

interactive with people (14)	*interactive with technique (12)*	*togetherness (8)*
8. The reading maps is not always developed in other countries. By new smartphone technologies they seem to skip the step of an analogue map.	10. More equality among participants	11. Input by participants can be put on the map and disseminated directly
	11. Around the MapTable discussion and ideas evolve more quickly than when everyone sits in their own place	12. Enforces better preparation
	12. Saving ideas is easy and after sessions you can send them to the participants	13. Plans can be better shared
	13. Attractiveness of the table, participants walk towards the table	14. We stand around the table
	14. Can debunk ghost tales	15. The aim is clearer because of the better preparation
		16. You are more flexible in depicting information
		17. Better geographical data
		18. Forces participants to express more concrete ideas
		19. Can debunk ghost tales

Chapter 4

The added value of Planning Support Systems: a comparative perspective

Resubmitted to Computers, Environment and Urban Systems.

Abstract

Research about Planning Support Systems (PSS) is increasingly paying attention to the added value PSS have for planning practice. Whereas early studies tended to have a more conceptual focus, in recent articles empirical attention is also paid to this topic. Although this is a step forward, still a notable gap in the literature can be observed: there is a lack of studies empirically comparing PSS applications. This paper aims to address this gap, based on an earlier published conceptual framework discerning different added values of applying a PSS. Next to this, the paper pays attention to three independent variables: usability, the support capabilities of the PSS and the planning context. We studied four PSS applications in the Netherlands, which we refer to as: SprintStad, MapTable, CommunityViz and Urban Strategy. The added value was measured through a questionnaire filled in directly after the PSS session. The findings indicate that learning is a key added value throughout the four case studies, which corroborates earlier research. Moreover, in none of the cases too low usability seemed to be an issue. The low n in this study precludes advanced statistical analysis. This can be addressed in future research through a standardization of questionnaires, which would also allow for a comparison among different contexts in which PSS are applied.

4.1 Introduction

Planning Support Systems (PSS) are ‘geo-information technology-based instruments that incorporate a suite of components that collectively support some specific parts of a *unique professional planning task’* (Geertman 2008, p.217 –emphasis in original). Scientific research into PSS is becoming much more focused on looking into what it is that PSS actually does – its own practice. In early studies, the main focus was on instrumental characteristics (Geertman & Stillwell 2003, 2004, Brail & Klosterman 2001), sometimes complemented with more theoretical accounts (e.g. Klosterman 1997). However, over the last two decades, the contours of a PSScience (Geertman 2013)[9] seem to have started to develop, in which the interrelationships of the concepts in the term PSS – Planning, Support and Systems – are studied in more depth. Within this emerging body of research, two important developments can be discerned. Firstly, there now is a fairly rich set of articles embedding PSS within the wider debates about planning theory, such as the advent of the communicative turn (Batty 2008, Couclelis 2005, Geertman 2006, Guhathakurta 1999, Pelzer et al.

9 Geertman (2013) draws an analogy with the notion of GIScience (e.g. Goodchild 2006), which was used to demarcate research within GIS from research about GIS.

2015). Secondly, more and more empirical research is now being conducted into PSS applications (Arciniegas et al. 2013, Goodspeed 2013b, Nyerges et al. 2006, Pelzer et al. 2014a[10], Pettit et al. 2011, te Brömmelstroet 2014). These studies apply research methods like observation, questionnaires and interviews to get a better insight into how users perceive and use a PSS, which potentially leads to insights to improve the PSS and/or its application. The central dependent variable in most of these studies is the added value a PSS application has for planning practice. Earlier empirical studies start from varying conceptions of added value, including learning (Goodspeed 2013b), effectiveness (Arciniegas et al. 2013) or frameworks, including integration of multiple dimensions (Pelzer et al. 2014a, te Brömmelstroet 2014). In this study we use the following definition of added value: 'a positive improvement of planning practice, in comparison to a situation in which no PSS is applied' (Pelzer et al. 2014a, p.16).

Within studies in the emerging field of PSScience, two gaps can be observed. Firstly, some of these studies are based on experiments with students (e.g. te Brömmelstroet 2010). While this allows for in-depth study in a controlled setting, it leads to issues with external validity: in that the simple question is whether a planning workshop with students sufficiently reflects real-world planning practice. Goodspeed's (2013b) work can be considered an exception since he studied PSS workshops that were organized to tackle an existing planning issue in Austin, Texas. Secondly, and also related to external validity, all of these studies are single case studies, which makes it hard to generalize their findings to other instances in which a PSS was applied. Comparisons of different kinds of PSS applications that do occur tend to be at a more conceptual level (Geertman & Stillwell 2004) or based on an interpretation of earlier studies (te Brömmelstroet 2013).

This paper aims to fill this void in the debate, based on the experiences of practitioners in multiple case studies, by answering the research question: what is the added value of different kinds of PSS application according to practitioners? In answering this question, the paper is structured as follows. In section 4.2 we will present a conceptual framework, including a categorization of different added value dimensions. Section 4.3 describes the case selection and the questionnaire used to measure added value. Section 4.4 describes the main findings from the four cases, after which section 4.5 reflects on the most important findings. The paper closes in section 4.6, by answering the research question and sketching some implications for future research.

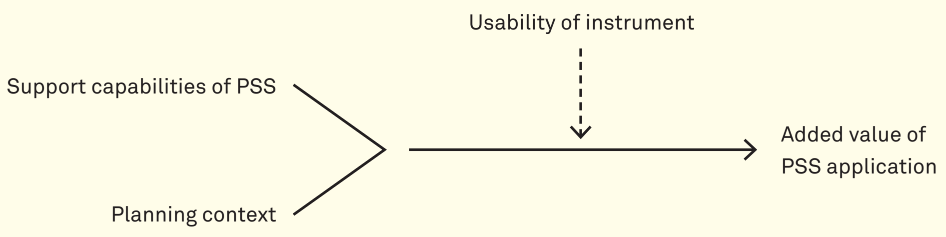
4.2 Conceptual Framework

Existing literature about the evaluation of PSS applications generally includes two dimensions. The first dimension, the added value, is inherently a

10 Pelzer et al. 2014a is the same paper as Chapter 3.

dependent variable. It describes the usefulness of a PSS application compared to a situation in which no PSS is applied. In this study we will focus in particular on describing and explaining different kinds of added values. The second dimension relates to the evaluation of the workability of the PSS application and is often addressed with the term usability (Nielsen 1993, te Brömmelstroet et al. 2014). In this study we perceive usability not as an aim in itself but as a confounding variable that has an influence on achieving added value. Inspired by Nielsen (1993), we define usability as: 'the extent to which the characteristics related to the instrument central in a PSS application can be properly utilized by practitioners'. Hereby it is important to note that the perception of usability of the PSS itself cannot be separated by participants from its situational application. Hence, when empirically assessing the usability of a PSS through questionnaires, this inherently also includes characteristics of the workshop like the planning issue and group dynamics. This argument also holds for the added value as perceived by users; this evaluation is inherently situational. We will reflect on this when interpreting the findings. In addition, two other independent variables should be taken into account: support capabilities of the PSS and the context in which the PSS application takes place (see Figure 4.1).

Figure 4.1 **Schematic depiction of the main factors related to the added value of PSS**



4.2.1
Added value

Whereas the added value of a PSS application is often claimed in PSS case studies, there is a dearth of studies actually operationalizing and researching this concept in practice (te Brömmelstroet 2013). In a recent paper, Pelzer et al. (2014a) made use of a Group Decision Room and qualitative interviews to study the perceived added value of the application of a PSS called MapTable. This study revealed that improved communication and collaboration, in particular, are perceived by practitioners as important added values of this PSS application. However, the paper also points to an important caveat: only a few respondents reported an instance in which the PSS being studied included some kind of impact analysis model, which allows one to quantitatively assess the effects of a proposed intervention and which, for several scholars, is a distinctive feature of a PSS (cf. Brail 2006). Goodspeed's (2013b) study of PSS applications in Austin, Texas did include impact analysis. He found that learning was an important added value in these instances. In a study by te Brömmelstroet (2010), focusing on transport models (also a kind of impact model), he also reported the learning effects of a PSS application. Hence, based on these studies it can be hypothesized that learning is an important added value of PSS applications.

So far the validity of this hypothesis has not been thoroughly empirically studied. Further testing is needed, given that in case of confirmation this might have serious consequences for the design and building of new PSS. To test this hypothesis it is necessary to develop a conceptual framework that is open to a more in-depth operationalization of added value and can be used to structure empirical research. For this we make use of a framework that was developed and published earlier and which is depicted in Table 4.1. We will only briefly explain the main premise of this framework; more details and examples can be found in the original article by Pelzer et al. (2014a). The individual level concerns learning effects for the participants involved, which indicates increasing insight about (1) the *object* of the planning that is being discussed and (2) the perspective of *other stakeholders* involved in the planning process. The added value at group level involves four dimensions: (1) *collaboration* between the stakeholders involved, (2) *communication*, involving the exchange of information and knowledge among the stakeholders involved, (3) *consensus*, which refers to agreement among the stakeholders about a specific issue, and (4) *efficiency*, which indicates that the tasks being conducted in a collaborative setting are performed in less time than usual. Finally, the outcome level concerns the extent to which the PSS actually influences the plan or decision resulting from the planning process. This is labeled as a *better informed outcome.*

Table 4.1 Summary of added values of PSS applications

Added value	***Definition***
Learning about the object	Gaining insight into the nature of the planning object.
Learning about other stakeholders	Gaining insight into the perspective of other stakeholders in planning.
Collaboration	Interaction and cooperation among the stakeholders involved.
Communication	Sharing information and knowledge among the stakeholders involved.
Consensus	Agreement on problems, solutions, knowledge claims and indicators.
Efficiency	The same or more tasks can be conducted with lower investments.
Better informed outcome	A decision or outcome is based on better information and/or a better consideration of the information

Source: Pelzer et al. 2014a (Chapter 3)

4.2.2 Usability

The work of Vonk (2006) and te Brömmelstroet (2010), in particular, has picked up on the notion of usability in relation to PSS applications. Vonk (2006), for instance, argues that a lack of usability is a barrier for widespread implementation of PSS. In a different vein, the work of te Brömmelstroet (2010) implies that high scores on usability characteristics lead to increased learning. Usability tends to be operationalized in relatively discrete indicators. In Table 4.2, the ten most commonly used indicators in the PSS debate are summarized (cf. te Brömmelstroet 2014). Whereas the research of Vonk (2006) empirically and convincingly showed the importance of usability problems as a barrier to PSS implementation, it is not clear whether this is still the case almost ten years later. Particularly as technological and organizational improvements have boosted usability characteristics like user-friendliness and calculation time (e.g. Miller et al. 2009, Dias et al. 2013), it can be expected that the perception of users has also improved. This was confirmed by a recent European COST project about accessibility instruments (PSS giving insight into how many destinations are accessible within a given time span), which found that practitioners who were involved in PSS workshops generally had positive perceptions about their usability (te Brömmelstroet et al. 2014).

Table 4.2 Commonly used usability variables in PSS research, based on Arciniegas (2012), Goodspeed (2013b), te Brömmelstroet (2010, 2014), Vonk (2006)

Usability variable	*Definition*
Transparency	The extent to which the underlying models and variables of the PSS are accessible and understandable to users.
Communicative value	The extent to which spatial information is aptly presented.
User friendliness	The extent to which participants are able to use the tool themselves.
Interactivity	The extent to which direct feedback is given by the instrument.
Flexibility	The extent to which the tool can be applied for different planning tasks.
Calculation time	The time participants have to wait before an analysis is finished
Data quality	The extent to which the input data is valid and relevant.
Level of detail	The extent to which the level of detail of the tool matches the perspective of participants.
Integrality	The extent to which the tool takes all the relevant dimensions into account.
Reliability	The extent to which the outcomes of the tool are perceived to be valid.

4.2.3
Support capabilities of PSS

The added value of a PSS application is partly dependent upon the characteristics of the instrument. For instance, using a complex, cellular automata-based PSS like SLEUTH (Clarke 2008) is likely to produce a different perceived added value than a simpler PSS like CommunityViz combined with a map-based touch table (Pelzer et al. 2014a). Vonk (2006) developed a classification of PSS based on the function they have for planning practice. He argues that three types of PSS can be discerned: informing, communicating and analyzing. Hereby, it should be noted that several PSS combine more than one function. For instance, a combination of CommunityViz Scenario 360 (analyzing) with a map-based touch table (communicating), involves two types of PSS. Therefore, it is helpful to refer to the literature about Group Support Systems (GSS, see Dennis et al. 2002), which talks about the 'support capabilities' of a support tool, implying that one PSS can have multiple support capabilities. Support capabilities can be defined as: the features of a PSS that facilitate a specific dimension. Following Vonk (2006), this results in the following classification:

- *Informing:* refers to the primary capability to send information uni-directionally from the PSS to the user.
- *Communication:* refers to the primary capability of the PSS to improve the knowledge exchange among multiple users.
- *Analyzing:* refers to the primary capability of the PSS to answer users' questions, particularly through quantitative modeling and analyzing.

4.2.4
Context of the PSS application

Finally, the added value of a PSS application is also dependent upon the context in which it is applied. Geertman (2006) summarizes a range of planning context-related factors, such as the users involved, the process characteristics and the content of the planning issue. For instance, the disciplinary background and the psychological profile of the users of a PSS influence the way in which they perceive a PSS (e.g. Goodspeed 2013b, Pelzer & Geertman 2014). A case in point are urban designers, who tend to have problems with the often dominating quantitative nature of a PSS (Dias et al.2013, Pelzer et al.2014b, Wyatt 2004).

4.3
Methodology

In order to answer our research question, we conducted a comparative case study. The cases were selected on the basis of a logic, as described below. In order to study these cases, a generic questionnaire was developed, based on an operationalization of the concepts from Table 4.1 and Table 4.2. The patterns that emerged from these surveys were subsequently qualitatively interpreted.

4.3.1
Case selection

The case selection was based on the support capabilities of the PSS because it relates to the aim of this paper and it was the only variable in the conceptual framework that could be considered in the case selection process. Hereby the strategy was to generate a 'diverse' sample (Gerring 2007), meaning that a variety of support capabilities had to be present in the sample. To be more precise, the criterion was that each of the three capabilities had to be present in at least one of the case studies. Obviously, feasibility was also a critical selection criterion since PSS applications in planning practice are still relatively scarce and getting access to study them is not always easy. In total, four cases in the Netherlands were selected, involving the following PSS: SprintStad, MapTable, CommunityViz and Urban Strategy. Each PSS was applied in a workshop-like setting, involving 9 to 20 participants. A more detailed description is given in section 4 but in Table 4.3 the most important characteristics of the four cases are briefly summarized. As can be seen from the table, all of the three PSS support capabilities are included in the sample. In two instances (Sprint-Stad and CommunityViz), two support capabilities are combined.

Table 4.3 Characteristics of the four PSS applications that were studied

Name of PSS	*Primary Support Capabilities*	*Number of people (n) involved*	*Nature of PSS*	*Planning issue*	*Organizations Involved*
SprintStad	Analyzing and Communicating	20	Interactive game focusing on Transit Oriented Development.	Transit Oriented Development	Province of North Holland, Deltametropolis Organization
MapTable	Informing	11	Provides insight into issues through simple visualizations.	A deprived neighborhood	Municipality of Zwolle, Civil Organizations
CommunityViz with Maptable	Analyzing and Communicating	14	Facilitates negotiation based on transferable development rights.	Spatial development rights	Municipalities, Regional Governments, Province, Radboud University Nijmegen
Urban Strategy	Analyzing	9	Provides inter-active and integral environmental assessment.	Redevelopment of brownfield area	Municipality of Utrecht, TNO, Utrecht University

4.3.2 Research Methods

In order to evaluate the four case studies, a questionnaire was conducted directly after the workshop. Hereby, the primary focus was on the dependent variable (i.e. added value), with the secondary aim to also shed some light on the independent variables. The questionnaire (see Appendix 4.1) consisted of four parts: background questions about the users, statements about usability, a question about added value and three open questions. The open questions helped us with interpreting the findings. It was anticipated that the n would be too low for any more advanced statistical analysis (cf. Salter 2009). This was confirmed by the correlational analyses we conducted; significance was in almost all instances too low to report any meaningful findings. Therefore we will further focus on a description of the patterns that we found and a qualitative interpretation.

The background questions concerned the educational background and expertise of the participants. These were used as control variables but in this regard did not reveal meaningful explanations (cf. Pelzer and Geertman 2014). *Usability* was operationalized in terms of statements referring to the ten indicators depicted in Table 4.2 (See Appendix 4.1). The respondents were asked to respond on a 1 (fully disagree) to 7 (fully agree) scale to statements about the usability of the PSS in the workshop. To measure the *added value* of the PSS, participants were asked to identify the most important added value of the PSS application[11], for which they had seven options (based on Table 4.1) or the possibility to select 'other' and write something down themselves.

[11] In the initial questionnaire *added value* was operationalized in two ways. First, they were operationalized as a set of Likert scales (1-7) with three items per scale. However, arguably because of the low *n*, these questions did not lead to distinctive patterns in the data and Cronbach's Alpha was in several cases too low to include them in the analysis. Therefore, we decide to leave this approach out of the analysis. Second, the participants were asked to indicate which added value of the PSS they considered to be the most important. This is a somewhat crude measurement because, on an individual level, it leads to a dichotomous conception of added value. The advantage, however, is that it allows us to see distinctive patterns in the data, even in a case with a low n. In some instances, the respondents misunderstood the question and gave multiple answers. In these cases the answers were weighed. For instance, if they gave three answers instead of one, each answer counted for 0.33. Another important remark is that the standard deviations related to the statements about usability tended to be relatively high, in most instances higher than 1, with outliers up to 2. This indicates that there was strong variation in opinions among the participants.

4.4 Findings from the case studies

In this section the four cases will be described. This description consists of two parts. First, the main characteristics of the planning issue and the PSS application will be outlined. Second, the main findings from the questionnaire will be discussed.

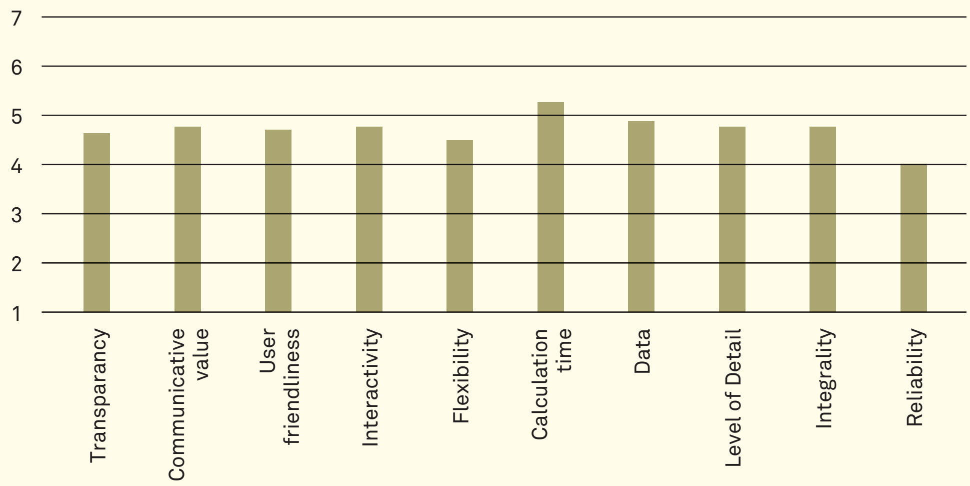
4.4.1 SprintStad to encourage Transit Oriented Development

In the Netherlands, transit oriented development (TOD) – spatial development on nodes on transport corridors with a high public transit connectivity – has become an important topic on the policy agenda (e.g. Bertolini et al. 2012). SprintStad is a serious game that aims to facilitate the process of achieving this TOD development (e.g. Duffhues et al. 2014). SprintStad sessions focus on transit corridors, in this case with civil servants from the Province of North Holland, the Netherlands (see Figure 4.2). Each participant plays the role of a stakeholder involved in the TOD development. In the workshop, three types of stakeholders were identified as relevant for the game: municipalities (responsible for spatial development on the nodes of the corridor), the province (responsible for supra-local developments such as community colleges) and the Dutch Railway (responsible for the train schedule).

Figure 4.2 **The SprintStad session in North Holland, the Netherlands (photo by author)**

Three successive rounds of serious gaming were played, in which each stake-holder had to propose a set of policy interventions. SprintStad then analyzed what would actually happen (e.g. where the spatial development would be allocated. For details see Duffhues et al. 2014). In this case a session was organized at one of the Province of North Holland's offices in order to get a better understanding of corridor development, whereby the Province's policy makers played the role of different stakeholders. Since SprintStad facilitated both the communication between the stakeholders (role playing) and calculated the impact of policy interventions, the support capabilities were both commu-nicative and analyzing. The aim of applying SprintStad can be framed as: 'a lot can be learned about the topic of the game and the way in which collaboration between the stakeholders involved takes place', which more specifically leads to 'insight into the importance of a shared approach about land use and mobility'

Figure 4.3 **Usability of SprintStad application mean scores on statements on a 1 (fully disagree) to 7 (fully agree) scale (*n*=20)**



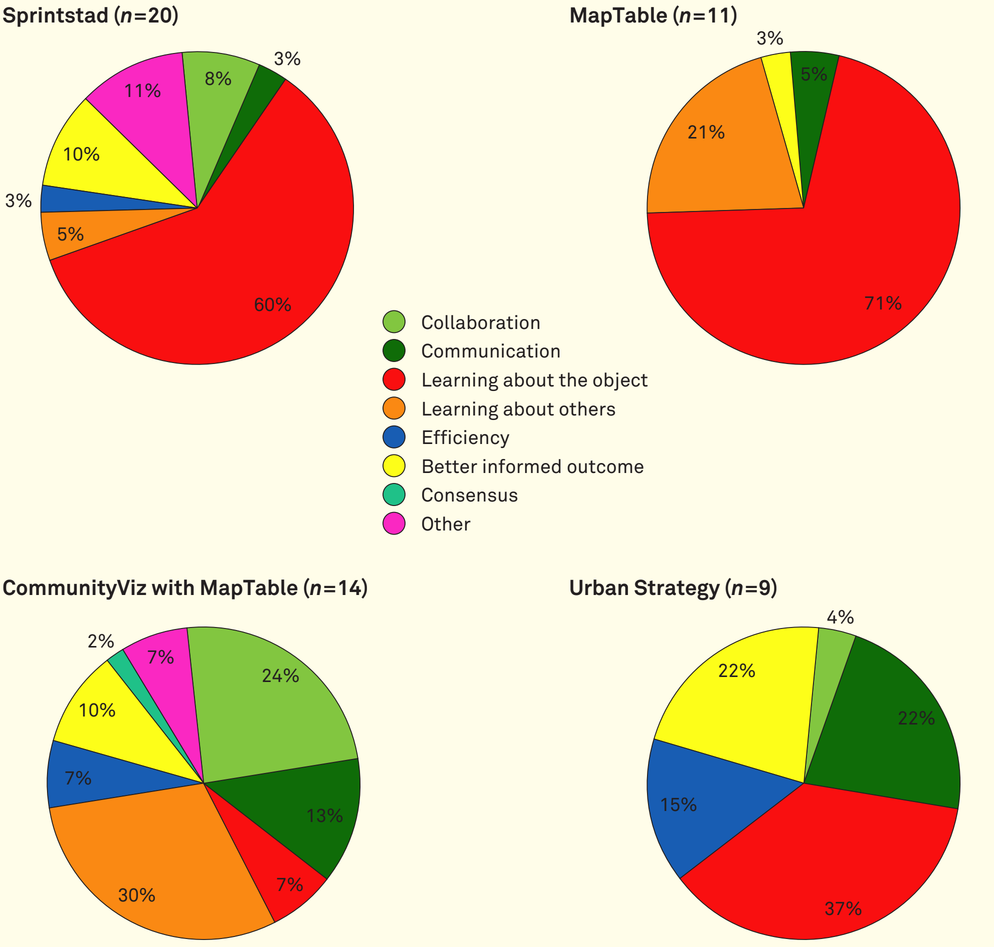
(Nefs & Duffhues 2011, pp. 34-38). In other words, learning about both the object and other stakeholders was conceived beforehand as being an important added value of SprintStad application.

In Figure 4.3 the findings about the 10 usability dimensions are depicted. The evaluation of the usability of the SprintStad application is fairly positive, whereby no extreme scores on specific dimensions are revealed. The mean scores on the 7 point scale are all between a range of 4.05 (neutral: reliability) and 5.35 (positive: calculation time). Hence, although there are some points for improvement identified, there is not a specific usability characteristic that seems to hamper the application of SprintStad. This was also corroborated by the written answers to the open questions; the main concerns of the workshop participants were related to the workshop: there was too little time and the group was too large.

In Figure 4.4 the perceived added value of the SprintStad application is depicted. The most important finding is that learning about the object of the study is mentioned by the majority of the participants as the most important added value. Moreover, the two added values in the category 'other' are also conceptually related to learning about the object, namely 'creating awareness' and 'increasing insight'.

The fact that learning about the object is perceived as the most important added value corresponds to a main aim of applying SprintStad. To a certain extent it is surprising that in a role playing game like SprintStad 'learning about others' is only mentioned by one of the participants. This is probably due to the fact

Figure 4.4 Perceived added value of the four PSS application



that the different roles (e.g. municipalities, the National Railway, etc.) were not represented by the real actors, but by civil servants from the Province of North Holland.

4.4.2 A MapTable to inform policy makers about deprived neighborhoods

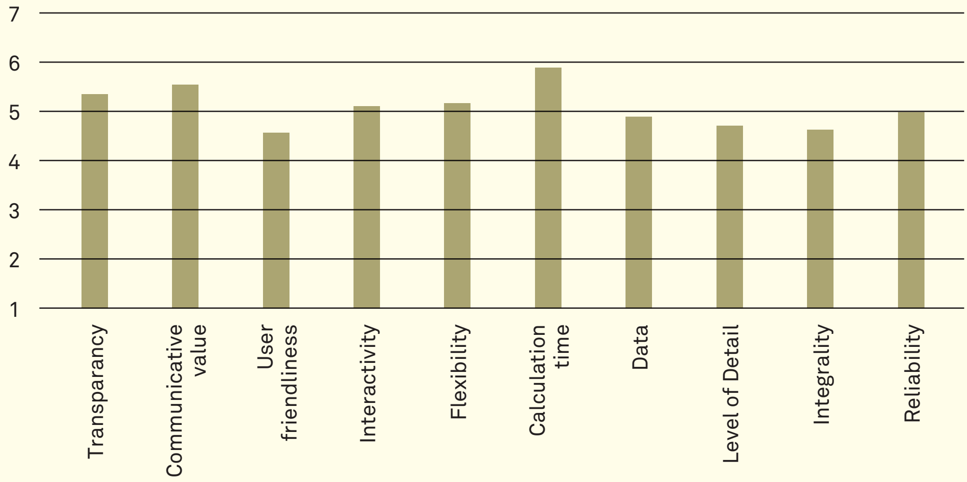
Civil organizations and the municipality of the medium-sized town of Zwolle, the Netherlands, are searching for clever policy initiatives to help people in deprived neighborhoods, such as improving the insulation of dwellings in order to reduce energy bills. Information about the area plays a crucial role in this context. In order to provide their policy makers with information, the Municipality of Zwolle is increasingly applying a MapTable (see www.mapsup.nl) to facilitate meetings.

Figure 4.5 The MapTable application in Zwolle, the Netherlands (photo by author).

In most instances, including this case, the software that is used tends to be relatively simple, such as basic ArcGIS applications and the web viewer of the municipality. The latter is a dedicated website, which civil servants and residents can address for a range of GIS-based maps. In the case that was studied, the focus was on policies for deprived neighborhoods. In a brainstorm session with eleven stakeholders from non-profit organizations and governmental bodies, ideas were generated about how to improve the living conditions of people in deprived neighborhoods (see Figure 4.5).

Two MapTables were used in sub groups to increase the insight about the neighborhoods being studied. Hence, the capability of the PSS was *informing.* The aim of the session with the MapTable was to provide the stakeholders with spatial information about their neighborhood on a range of dimensions, potentially leading to better and innovative solutions for the problems in these neighborhoods. However, because this was the first time that most of the participants had made use of the PSS, the intention was also to get to know the tool itself. Achieving all these aims together appeared to be quite a challenge. This was reflected by the answers to the open-ended questions, which indicated that the session could have been better prepared, and as a consequence, be more focused.

Figure 4.6 Usability of the MapTable application, mean scores on statements on a 1 (fully disagree) to 7 (fully agree) scale (*n*=11)



As shown in figure 4.6, the mean usability scores for the various items vary between 4.55 and 5.56 on a 7-point scale, indicating a relatively positive appreciation. Similar to the SprintStad application, the main added value of the MapTable application was learning about the object (see Figure 4.4). This is in line with the purpose of the workshop, which was to complement the mostly experiential knowledge of the stakeholders with quantitative data. However, the fact that some participants indicated that learning about others was important as well shows that the session also involved some communication, next to the focus on informing. This can be explained by the composition of the groups, with stakeholders from different organizations talking to each other, but also because of the communicative support capabilities of the MapTable (Pelzer et al. 2014a).

4.4.3 CommunityViz for tradable area development rights in the Achterhoek

Land is a scarce commodity in the Netherlands and it is widely acknowledged that municipalities should be careful when developing it. However, in the Dutch spatial planning context the financial rewards of spatial development is conceived as being high for municipalities because they earn from selling their land and from an increase in the number of residents within the municipal boundaries. These incentives for development potentially results in sprawl and vacancy. To address this issue, the Radboud University Nijmegen in the Netherlands studies the extent to which a new approach of tradable area development rights can lead to better planning outcomes (e.g. Samsura 2013). This approach draws upon the assumption that spatial development occurs in

Figure 4.7 **The CommunityViz with MapTable application in Nijmegen, the Netherlands (photo: Sander Lenferink).**

competition between municipalities, with a potential negative outcome being sprawl or vacancy. In order to prevent this, through the approach of tradable area development rights municipalities can be compensated for *not* developing, which can lead to developments taking place in the most suitable places, e.g. on transit oriented development sites. In order to test and refine this idea two workshops were organized with a total of fourteen stakeholders (see Figure 4.7).

One workshop consisted mainly of stakeholders from municipalities, the other of stakeholders from supra local authorities, such as the city region. The two workshops were supported by a PSS consisting of CommunityViz and a MapTable (for more detail see Pelzer et al. 2013 and www.communityviz.com.). As in the SprintStad case, the workshops were organized as a game with different rounds. In the first round the aim was primarily to gain insight into the interests and plans of other stakeholders, whereas in the later rounds the aim was to come to some kind of optimization, based on the demand and potential for transit oriented development.

Figure 4.8 Usability of the CommunityViz combined with the MapTable application, mean scores on statements on a 1 (fully disagree) to 7 (fully agree) scale (*n*=14)

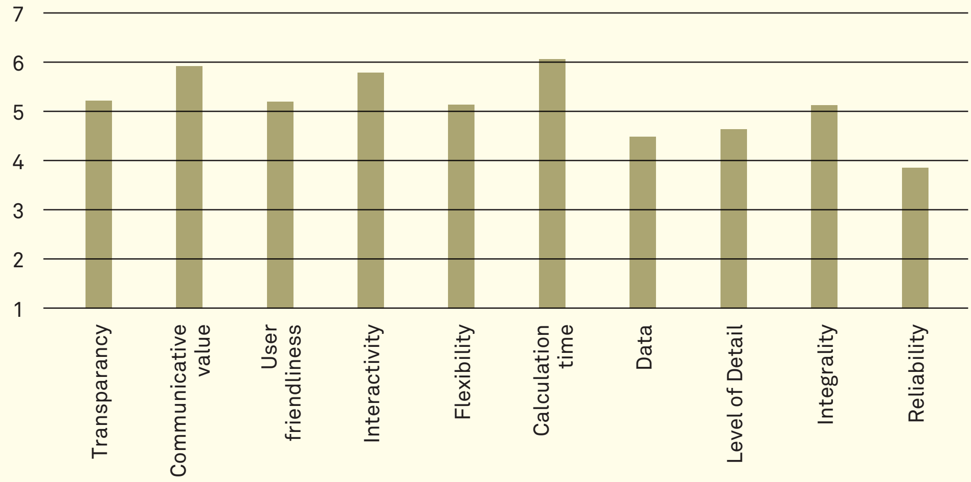


Figure 4.8 shows that the perception of usability in this case deviates somewhat from the other cases. It is noticeable that the data quality, level of detail and reliability have somewhat lower mean scores. This can be explained by the fact that not all the data in the PSS was considered to be up-to-date and available. Moreover, the model included some simplifications in order to make the session feasible. As one respondent noted in their response to an open-ended question: 'The most important parameters are not in the game. That makes it difficult to shift from the game to real-world planning settings'. Because the stakeholders involved were experts, they immediately noticed these issues. However, because the sessions were primarily a tryout with the aim being to increase insight in the possibilities of this approach, this was not considered to be very problematic. In addition, it is notable that the usability scores are overall higher than in the other cases.

Figure 4.4 depicts the main perceived added value of the application of the PSS consisting of a combination of CommunityViz and a MapTable. The result of the evaluation is in two ways different from the previous PSS applications. First, there is not one added value dominating. Second, the added values that are mentioned by a substantial proportion of the participants (learning about others and collaboration) are different from the other cases. An important explanation is the fact that the aim of the session was to encourage a dialogue among different stakeholders. Hence, learning about others and establishing collaboration as part as the negotiation about tradable development rights was the explicit aim of this specific PSS application. However, coming to some kind of optimization in the transfer of development rights was also an aim. This optimization can be achieved by separate coalitions of different players, without a general consensus being necessary. To a certain extent this is reflected in the findings: achieving consensus was only perceived to be an added value by one of the respondents. Hereby it should be noted that the different rounds seemed to differ in their focus and consequently the added value also: the first rounds focused on learning and dialogue, whereas the latter rounds emphasized optimization and forming coalitions. This is not reflected in the questionnaire, however.

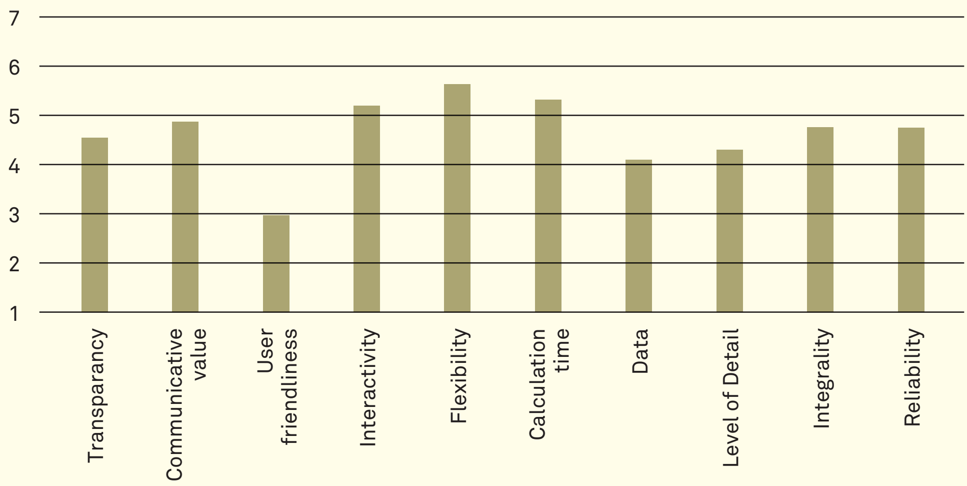
4.4.4 Urban Strategy to redevelop a brownfield area

The city of Utrecht has several brownfield areas, which will be converted into mixed commercial/residential areas in the forthcoming years. One of these areas, the Cartesiusdriehoek, has a very complex environmental context due to the presence of adjacent industry and transport infrastructures. In order to address the challenges in this area, Urban Strategy was applied. This is an interactive and integrative PSS developed by the Dutch research institute, TNO (www.tno.nl/urbanstrategy). It combines a traditional four step traffic model with state of the art environmental models and a GIS-environment (see Pelzer et al. 2014c). This offers the possibility to calculate the nature and magnitude of the impact of widening a road, which firstly leads to a change in traffic flows (transport model) and subsequently has a noise and air pollution impact (environmental model).
In order to evaluate the usefulness of this PSS application, a workshop was organized by the first author in collaboration with TNO and the Municipality of Utrecht. During this workshop, a group of nine civil servants from the Municipality of Utrecht, all with a different disciplinary background, applied Urban Strategy to increase their insight into the Cartesiusdriehoek (see Figure 4.8).

Therefore, Urban Strategy was used in a workshop to analyze what the effect would be of a range of future policy interventions, such as a road diet, adding more dwellings and building noise walls (see Pelzer et al 2014c). The participants were particularly interested in assessing the feasibility of different interventions. For instance, what would happen to the traffic situation if 7000 dwellings were added to the plan area?

Figure 4.8 **The Urban Strategy session in Utrecht, the Netherlands (photo: Stan Geertman).**

Figure 4.9 **Usability of Urban Strategy application, mean scores on statements on a 1 (fully disagree) to 7 (fully agree) scale (*n*=9)**



In Figure 4.9 the mean usability scores of Urban Strategy are depicted. The low score for user friendliness (3.00) is notable. According to the transport planner from the Municipality of Utrecht involved in the session, this indicates that the participants did not see Urban Strategy as a tool they can operate themselves without a chauffeur.

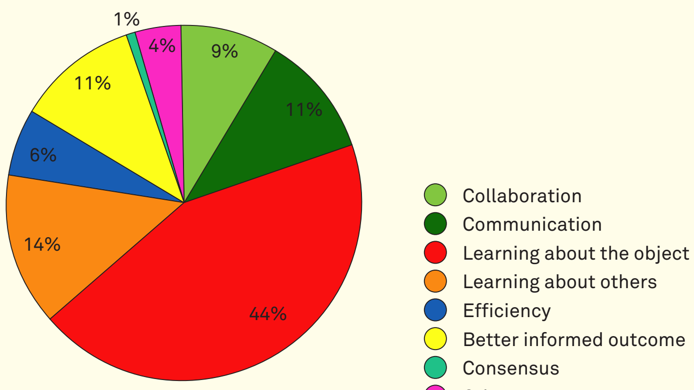
Figure 4.4 depicts the most important perceived added values of the Urban Strategy application. Learning about the object is considered to be the most important added value by most of the respondents. Hereby it should be noted that this finding refers more to the *potential* added value of applying Urban Strategy than to the *actual* added value of the Urban Strategy application. In the group evaluation conducted after the workshop and the open-ended questions the participants indicated that much of the information generated by Urban Strategy was not new to them. They indicated that Urban Strategy would have been of more value if it would have been applied earlier in the planning process and if it would have included additional indicators (e.g. train intensity on the adjacent railroad track).Moreover, communication and better informed outcome are mentioned as important added values. The communication likely relates to the exchange of information among disciplines: Urban Strategy helps to convey quantitative insights related to environmental analysis and transport planning. The better informed outcome probably refers to the fact that the quantitative analyses conducted using Urban Strategy provide robust arguments for putting through certain interventions or leaving them out. For instance, Urban Strategy corroborated the idea that problems with traffic and environmental quality would seriously increase when more than 7000 dwellings would be added to the area being studied. In general, there is a reasonable correspondence between the aim of the session and the perceived added value of the PSS application. Both better informed outcome and learning about the object are consistent with the aim of a better understanding of the feasibility of proposals for the plan area.

4.5 Reflections

4.5.1 Reflections about findings

Figure 4.10 depicts the mean added value of the four different PSS applications (each PSS application is weighed equally). The most notable observation is that the added value of learning (about the object and about others) is the one that is most frequently mentioned across the four case studies. This corroborates recent studies by te Brömmelstroet (2010) and Goodspeed (2013b) who consider learning as the main added value of a PSS application. This paper adds the notion to their work that learning is an important added value of a PSS application, notwithstanding differences in context. In addition, when qualitatively comparing the cases, an interesting observation in this regard is that, with some caution, patterns of added values can be discerned. When learning about the object is important, a better informed outcome also tends to be relatively important. Likewise, when learning about others important, collaboration and communication are important as well. Future research should deepen the insight into these patterns.

Figure 4.10 **Mean perceived added value of all four PSS (*n*=4)**



A way that these different sets of added values can be evaluated is by relating them to the purpose of a specific PSS application. For instance, in the Sprint-Stad case, the added value of learning about the object aligned rather well with the aim of letting participants learn about the causal dynamics related to transit-oriented development. However, it related less to the other aim therein of learning about the others, which can be seen as a crucial part of a serious gaming session. In the CommunityViz case, the aim of introducing the notion of tradable development rights, however, was accompanied by a variety of added values. This paper has shed some light on these kinds of relationships, but this could and should be addressed more systematically in future research. For instance, hypotheses could be developed about the minimum usability characteristics and specific support capabilities necessary for achieving a specific added value that a PSS application is aiming to achieve.

Although usability was rated as relatively high in most case studies described in this article, the applied set of indicators appeared to be too generic to connect to specific added value dimensions. In addition, no clear relationship was found between support capabilities and added value. The reason for this is likely to be that that the contextual variables have too strong a confounding effect. It is clear, however, that a sole focus on usability scores is too crude an approach to understand the dynamics leading to the added value of a PSS application. Moving beyond a focus on generic usability can be considered a step forward. This study overall shows relatively positive scores on usability despite some extreme scores such as the low user friendliness score for Urban Strategy (3.00) and the positive score for calculation time in the CommuntiyViz case (6.00). Since the support capabilities of a PSS and its usability are strongly related, it would be interesting to combine them in future research.

4.5.2 Methodological reflections

While the empirical approach of this paper arguably addresses an important gap in the PSS debate, several limitations can be observed. The most fundamental issue is that the empirical work of this study focuses on the added value and usability of a *PSS application*, not of the software itself. While this is a defendable choice – planning is a social process and it is not feasible to separate the software from its situational application – it is also problematic in the sense that contextual findings have strongly influenced the outcomes. Hence, when interpreting or transferring the findings, the contextual factors should be taken into account (cf. Geertman 2006). As part of the context, the background of the users is also a relevant variable in comparing PSS applications. While the respondents were asked for their educational level and disciplinary background, the findings were not meaningful, probably because of the low *n* and lack of variation in educational level. It is noteworthy, however, that the standard deviations in all the case studies were relatively high. Since the respondents participated in exactly the same workshop, this is likely to be related to their background. Possible dimensions here include: disciplinary background, psychological profile, age, gender and experience with technology. An indication hereof is given by Goodspeed (2013b), who found that psychological profiles partly explained the appreciation of a PSS.

Moreover, there are some other reflections about the questionnaire. Initially, this study aimed to apply Likert items and scales to measure both the usability and the perceived added value of the PSS application. With regards to usability, this was a reasonable measure, allowing us to distinguish empirical patterns in the different PSS applications. Hereby, it should be noted that most applications took place in a setting that was specially organized to apply the PSS; therefore it is plausible that respondents were rather positive because they also took the novelty and innovativeness of the PSS application into account. Unfortunately, Cronbach's Alpha was too low to use the findings from the Likert scales related to added value in a meaningful way. The option of letting the respondents pick one added value is effective because it forces participants to be really selective, hence resulting in distinguishable patterns. It is, however, also a somewhat crude approach because it does not allow participants to express multiple added values as being important. Alternatively, a question that involved ranking multiple added values could have been included. A final concern with regard to picking one added value was that they were all positive: the questionnaire did not allow for negative influence or no influence (i.e. no added value). Perhaps choosing a more neutral term like 'influence' might have been a better choice than the inherently positive concept of 'added value'.

4.6 Conclusions

This paper started by observing a notable gap in existing literature about PSS: the lack of empirical studies evaluating the added value of PSS applications, particularly from a comparative perspective. The findings in this paper should be considered a modest, but relevant extra building block for the newly developing field of PSScience (see Geertman 2013). The most important message from this paper is that learning – both about others and the object – is perceived by users of PSS to be the most important added value of PSS applications, despite differences in support capabilities and context. This corroborates earlier research by te Brömmelstroet (2010) and Goodspeed (2013b) who also stressed the importance of learning as a central added value of PSS applications, although mainly from theoretical considerations. Whereas learning was dominantly mentioned in the evaluations of the four cases described in this paper, almost all other added values were also selected by respondents, albeit less frequently. Moreover, in only a few instances respondents choose the 'other' category as the most important added value. This seems to imply that the conceptual framework about added value as developed by Pelzer et al. (2014a) and used in this paper is rather inclusive and robust and might be applied for other PSS applications. Hereby, it should be noted that the findings of this paper also point at specific patterns of added values, in which combinations of added values can be identified. This confirms earlier research, which has pointed out that collaboration and communication are conditions for learning (Beukers et al. 2014).

In addition to the interrelationships between different added values, this paper has also looked at other explanatory variables. The empirical material in this paper gives some hunches about the role of the three central explanatory factors – usability, the support capabilities of the PSS and the planning context. Notwithstanding some outliers, usability of the PSS applications tends to be rated as being relatively good and not perceived to be a bottleneck in achieving added value. The support capabilities of the PSS did not seem to have a dominant influence on the added value, which could partially be explained by the importance of contextual factors, such as the stage in the planning process and the planning issue. More research on the added value of PSS application is very relevant in this regard, which should also take into account the purpose of the PSS application. In addition, and in a similar way to the earlier work by Geertman (2006), several factors can be identified that have a likely influence on the perceived added value: the experience with the tool, the connection to existing planning practice, the background and interests of the users and the broader policy aim. Future research should provide a more precise understanding of the added value in other planning contexts and the explanatory factors that influence this.

To close this paper, we will provide some recommendations for this kind of future research. A first – and perhaps obvious – remark is that for this paper no correlational analysis was conducted because of the low n, while such an approach could lead to very interesting findings, as exemplified by Goodspeed (2013b). We believe the answer to this issue in future research lies in (a) systematically conducting questionnaires after PSS applications and (b) having some kind of uniformity in these questionnaires and the evaluation protocol in general to enable the comparison of PSS in different contexts and with different users. In addition, future research should not only be performed by asking about perceptions (i.e. perceived added value), but also through measuring actual behavior (i.e. revealed added value). Possible methods to facilitate such analyses include pre and post workshop questionnaires and analysis of video images (cf. Nyerges et al. 2006, Salter et al. 2009). The advantage of these kinds of methods is that the findings will not be influenced by socially preferred answers. In many instances, participants find it special and exciting to work with a PSS, which could potentially lead to inflated responses in questionnaires. True added value, however, is not only revealed by what people state but, in particular, how they actually behave in a situation in which a PSS is applied.

On a more distant level, however, revealed added value is not only related to the workshop in which a PSS is applied and the direct outcome of the session. After all, PSS somehow aim to facilitate people in making plans and decisions about the spatial environment that eventually have a real-world manifestation. Studying this is a great challenge, which was already exemplified by earlier research into the use of scientific knowledge in planning practice (e.g. Van Lohuizen 1986, Weiss 1977). In addition to conducting more systematic research at the individual and group level, the PSS debate would benefit greatly from studies that take a more longitudinal perspective to analyze the extent to which the PSS application actually has had influence. For instance, a PSS like “What if?” has been applied in various contexts over the last decade and its impact could very well be studied through a retrospective study. Combined with the type of research as described in this paper, this might lead to a better understanding of the added value that applying PSS has in planning practice.

However, future research should not only take the form of chiefly academic contributions in order to bring the field of PSScience further. In many instances researchers and practitioners collaborate closely in developing and applying a PSS. Hereby they gather insight about added value and usability, which can result in operational solutions for organizing workshops and developing the PSS. Such a design-like approach was central, for instance, in the aforementioned COST-project (te Brömmelstroet et al. 2014). Moreover, in the Australian AURIN project, aiming to support planning and policy making with digital tools and data, usability is continuously evaluated with a range of methods (Barton and Pettit 2014, also: www.aurin.org.au). These kinds of in-depth case studies, in which experiential knowledge of PSS developers is combined with commonly accepted social science methods has much to offer for the future.

Appendix 4.1 Overview of questionnaire questions[1]

Dimension	*Questions/Statements*
Added value (1)	What do you consider to be the most important added value of the PSS? Select one of the following options: 1 = learning about others 2 = learning about the issue 3 = better communication 4 = better cooperation 5 = more consensus 6 = more efficient work 7 = more informed result 8 = other: ....
Usability (10)	Likert scale (1-7) with statements about usability indicators: 1 The instrument was transparent. (*transparency*) 2 *The communicative value* of the instrument was high. (*communicative value*) 3 The instrument was user friendly. (*user friendliness*) 4 The instrument could be used interactively. (*interactivity*) 5 The instrument was flexible in use. (*flexibility*) 6 The calculation time of the instrument was acceptable. (*calculation time*) 7 The data that was used during the session was good. (*data*) 8 The instrument's level of detail was in line with the issue. (*level of detail*) 9 The instrument's integrated approach was in line with the issue. (*integrality*) 10 I consider the results of the instrument to be reliable. (*reliability*)
Background of participants (3)	1 What is your level of education? (open) 2 How would you describe your expertise in a maximum of 3 words? (open) 3 How much experience do you have with digitally supported workshops? (ordinal)
Open questions (3)	1 What were the most important frictions during the session? 2 What could be improved next time? 3 Do you have any other remarks about the session?

Chapter 5

Planning Support Systems and Interdisciplinary Learning

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Abstract

Planning is both an interdisciplinary and a collaborative endeavor. A range of disciplines are involved in planning, which arguably all have a specific frame through which they perceive reality and address planning issues. Three main disciplinary frames can be discerned: analytical, design and negotiation. Within this context, increasing usage is made of Planning Support Systems (PSS), which are integrated sets of tools, often digital, aiming to support different tasks in the planning process. PSS arguably have the potential to support the planning process by facilitating interdisciplinary learning processes, involving 'frame reflection' by different disciplinary actors. This paper studies this assumption through two case studies in which a PSS was applied in an interdisciplinary setting. It was found that only in one of the two case studies 'frame reflection' (double loop learning) occurred and that this involved several frictions between disciplines. In the other case study more practical forms of learning were found (single loop learning) - also valuable for planning. It is concluded that PSS have potential for interdisciplinary learning, particularly where the impact analysis function and a shared spatial language improve the quality of the dialogue. With regards to the latter, however, PSS should be prevented from dominating the discussion, as this is something which is particularly problematic for stake-holders with a design frame. In future research the role of local stakeholders in relation to PSS and interdisciplinary learning could also be taken into account.

5.1 Introduction

It is widely acknowledged that participation is a central element of urban and regional planning. In particular, the collaboration of a diversity of stakeholders has attracted significant attention (e.g. Innes 1995, Innes and Booher 2004). In a context of creating sustainable or resilient cities, it is necessary to include ideas and insights from various disciplines. Smooth communication among these disciplines, however, is a far from easy task. Several studies have indicated the problems that can arise; for example, frictions have been found in the communication between transport planners and land use planners (te Brömmelstroet & Bertolini 2010), between environmental analysts and land use planners (de Roo et al. 2012), between architects and urban planners (Wyatt 2004), and between urban designers and environmental analysts (Pelzer et al. 2013).

In the last two decades, attempts have been made to integrate planning information and knowledge from different disciplines with the help of planning support systems (PSS). PSS are ‘geoinformation technology-based instruments that incorporate a suite of components that collectively support some specific parts of a unique professional planning task’ (Geertman 2008, p. 217). Recent edited volumes report that most PSS now combine models and knowledge from several disciplines, such as transport planning, environmental analysis and land use planning (Brail 2008; Geertman et al. 2013; Geertman & Stillwell 2009). Moreover, the burgeoning field of geodesign explicitly attempts to connect geographic sciences with design professions (Steinitz 2012). An important, if not critical, feature of geodesign concerns the inclusion of geographic tools to calculate the effects of design interventions, for example their costs and environmental impact.

A range of often GIS(Geographical Information Systems)-based tools that support planning tasks in an increasingly fast, user-friendly and affordable way have been developed in recent decades. But however elegant and sophisticated they may be, these technical developments run the risk of remaining instrumental and academic applications rather than truly influencing urban planning practice. The critical lesson from the PSS debate in the last decade is that rather than developing ever more advanced tools, more attention should be paid to the user and the planning context (Geertman 2006, 2008, Klosterman 1997, Moore 2008; te Brömmelstroet 2010, Vonk et al. 2007).

Combining this user perspective with an acknowledgement of the inter-disciplinary nature of planning logically results in a focus on interdisciplinary communication as a research area related to PSS. The concept of learning is often used to specify digitally supported communication processes (Goodspeed 2013b, te Brömmelstroet & Bertolini 2008, te Brömmelstroet 2013). In this paper we will attempt to bring the debate a step further by exploring how interdisciplinary learning facilitated by a PSS takes place, in particular in workshop-like settings, and what the conditions are for successful applications. In doing so, we are aiming to answer the following research question: How can a PSS support interdisciplinary communication, in particular learning, and what are the conditions for successful future applications?

In answering this question, this paper is structured as follows. In 5.2, we discuss the relevant literature and elaborate on how PSS are increasingly applied in collaborative settings. We discuss the work of Donald Schön and collaborators (Argyris & Schön 1974, Schön 1983, Schön & Rein 1994), which helps the understanding of interdisciplinary learning processes through the concept of single and double loop learning, frames, and frame reflection. In section 5.3 we will describe the methodology of the paper. Section 5.4 describes the findings of two case studies in which a PSS is applied in an interdisciplinary setting. Based on these and other empirical insights, section 5.5 comes to a synthesis about interdisciplinary communication in relation to PSS. Section 5.6 ends the paper with conclusions, reflections and recommendations for further research.

5.2 PSS in interdisciplinary settings

5.2.1 The collaborative turn and PSS

It is widely acknowledged that planning not only concerns substance and rigorous analysis but also processes and participation. Since the trend toward 'interactive', 'collaborative' or 'communicative' spatial planning, much more emphasis has been put on consensus-seeking, group interaction and discursive processes (e.g. Healey 1992, 1999, Innes 1995m Innes & Booher 1999, 2010, Salet & Faludi 2000). From this perspective, one of the critical elements of spatial planning is the communication among a wide diversity of stakeholders.

In a seminal article, Klosterman (1997) situates the role of PSS within this paradigm. Klosterman's article contains various interesting ideas, two of which are of particular relevance in this regard. Firstly, he emphasizes the potentially important role of PSS in collective settings: 'planning support systems should facilitate *collective design* – social interaction, interpersonal communication and community debate that attempts to achieve collective goals and deals with common concerns' (Klosterman 1997, p. 51; emphasis in original). This plea has recently found resonance, since several studies into PSS have paid attention to group processes and the organization and impact of collaborative workshops (e.g. Jankowski & Nyerges 2001, Arciniegas & Janssen 2012, te Brömmelstroet 2010).

A second important argument in Klosterman's paper is that he argues that PSS are a suite of tools (Geertman 2008), or an information framework, rather than a single instrument:[12]

> PSS must not be seen as a radically new form of technology that will replace the software tools planners currently find on their desks. Instead, it must take the form of an *information framework* that integrates the full range of current (and future) information technologies useful for planning. (Klosterman 1997, p. 51; emphasis in original)

Hence, in assessing the role of PSS in collaborative settings, at least two points are of relevance: communication among stakeholders is crucial in collaborative planning, and it is advisable to include and integrate different information technologies that are relevant to the job.

To follow up on the two remarks made by Klosterman (1997), we need a better insight into the relation between tools and the planning process. However, the PSS literature is still richer in technology and methods than in studies focusing

[12] Hence, because of the focus on the relation between different elements the term planning support system is used, rather than a planning support tool. Note, however, that several articles use both concepts interchangeably.

on the planning context in relation to PSS (Geertman 2006, see for exceptions Couclelis 2005, Guhathakurta 2002). Following recent PSS studies (te Brömmelstroet 2010, Goodspeed 2013b), we argue that this issue is in need of a more in-depth study. Moreover, we believe that the concept of learning is useful in unravelling this issue.

5.2.2 Learning in interdisciplinary settings and PSS

Learning

Several studies into both PSS and the wider field of the policy application of scientific research have emphasized the importance of learning as both an outcome and a means to achieve other goals such as consensus (Innes 1998, van der Hoeven et al. 2009, te Brömmelstroet 2013, Beukers et al.2014). It is implicitly asserted that in most instances a PSS can only indirectly influence the outcome via learning processes of involved actors. Recent studies into PSS usage focus on learning as an outcome of digitally supported workshops (te Brömmelstroet 2010, 2013, Goodspeed 2013b).

Te Brömmelstroet (2010) argues that by involving both transport modelers and land use planners in developing a PSS, this increases their insight into the planning problem. Like this paper Te Brömmelstroet focuses on the exchange of expert knowledge of different disciplines. An important insight from Te Brömmelstroet's work (2010) is the argument that tool involvement by different stakeholders leads to knowledge integration and – as a consequence – learning effects. In a similar vein, Goodspeed (2013b) used questionnaires to ask local residents who participated in digitally supported planning workshops in Austin, Texas, whether they 'learned a lot'. The emphasis of Goodspeed's study is mainly on explaining why learning effects occur. Explanatory variables he discerns include dialogue quality, instrument characteristics and personal and demographic traits.

Moreover, the work of Goodspeed (2013b) is inspired by the work of Donald Schön (Argyris & Schön 1974, Schön 1983, Schön & Rein 1994). Argyris and Schön (1974) discern two types of learning: single loop learning and double loop learning. Goodspeed (2013b, p.20) explains the difference based on earlier definitions: 'Single-loop learning takes place when the focus is on improved techniques of efficiency, and goals, values, and strategies are taken for granted. Double-loop learning involves questioning the role of the framing and learning systems, which underlie actual goals and strategies'. Put differently, single loop learning involves gaining relatively straightforward insights, for instance learning whether the proposed construction of a new highway meets environmental regulations. It does not, however, increase insight into the way in which other disciplines perceive and address the planning issue. Double loop learning, on the other hand, involves a change in the 'governing variables' of the 'theory of action' people use, in the terminology of Argyris and Schön (1973, p.18-19). In this regard, actors representing a certain discipline do get to understand how other disciplines perceive and handle a problem. Hence, double loop learning occurs when stakeholders reflect on the frames they hold by reflection on the problem handling by other disciplines.

Frames

Frames are 'schemata of interpretation' (Goffman 1974) that steer the way in which planning actors perceive problems and solutions and, as a consequence, fulfil their tasks. The notion of frames has been adopted by several studies in spatial planning, policymaking and social movements (e.g. Benford & Snow 2000, Carton 2007, Schön & Rein 1994). Carton (2007) relates the notion of frames to the perception of maps held by planning stakeholders. These frames are based on different rationalities that steer how the profession's tasks are conducted or should be fulfilled. These rationalities are in this regard similar to what Argyris and Schön (1974) call 'theories of action'. In Carton's view, the frame is determined to a great extent by the disciplinary background of the stakeholders. Carton distinguishes three frames that are relevant to understanding map usage: a design frame, an analytic frame and a negotiation frame.

- A *design* frame addresses problems and tools from the perspective of aesthetics, visualization and creativity. Urban designers and landscape architects typically work from a design frame.
- An *analytic* frame focuses on understanding and solving the problems at hand. This frame resonates strongly with the scientific–analytical approach to planning (e.g. Salet & Faludi 2000). Planning and policy-making are primarily seen as rational endeavors that are informed by quantitative information and models. Transport analysts and environmental analysts typically work within this frame.
- A *negotiation* frame sees planning as a tactical, political and power-laden process. Typical disciplines that work within this frame are political science and policy science, as well as approaches to planning focusing on negotiation and mediation (e.g. Susskind & Ozawa, 1984).

These three frames support the understanding of the various ways in which problems in planning can be comprehended. Particularly relevant for this paper is how these frames are helpful to understand how stakeholders from different disciplines perceive a PSS and, partly as a consequence, the PSS could be of help to learning more about the frames of other stakeholders. This is often referred to as 'frame reflection' or 'double loop learning' (Argyris & Schön 1974, Rein & Schön 1994).

Frame reflection

Double loop learning involves a change in the frame stakeholders hold. This 'frame reflection' (Schön 1974) is made possible by 'the ability to act from one perspective while in the back of our minds we hold onto an awareness of other possible perspectives, in a sort of double vision' (Innes & Booher 1999, p. 13; also Rein & Schön 1994, p. xvii). Thus allowing a planning problem to be perceived from a different disciplinary perspective. What is unique in this is that frame reflection can occur while performing a specific task. This 'reflection-in-action' is for practitioners 'the thinking what they are doing while they are doing it' (Schön 1987, p. xi). Hence, learning is not a passive and somewhat abstract process, but is rooted in concrete day-to-day experiences in practice. Or as Innes and Booher (1999, p. 13) state about frame reflection: 'Crucial to the usefulness of such double vision and, more generally, to reflective policy inquiry, in Schön and Rein's view, is the link to concrete practice. Dialogue that is grounded in practice, at least in part, helps participants to avoid being trapped in their own thought and failing to see assumptions and possibilities.'

This focus on concrete planning activities fits well with the focus of this paper on the application of PSS in interdisciplinary settings, which often takes place in the form of workshops. Moreover, as the research of Carton (2007) already indicated, frames are a useful perspective from which to study the usage of spatial support tools. A frame determines the overall perspective of problems and working habits of planning stakeholders. Moreover, a disciplinary frame also steers how support tools are conceived (Campbell 1995, Pelzer et al. 2014a). In order to better understand the role of frames and interdisciplinary learning in relation to PSS, we conducted an empirical case study.

5.3 Methodology

Our methodology consists of two interrelated parts (for details see Table 5.1). First, we studied two case studies of interdisciplinary workshops supported by a PSS. We selected these two cases on the basis of (a) the involvement of an interdisciplinary team working on a planning problem, (b) the availability of a state-of-the-art PSS, something which is still relatively rare in actual planning practice, and (c) variation in the PSS that was applied, allowing a better understanding of the effect of instrumental characteristics. We conducted interviews with the key stakeholders in the two case studies, asking them about their experiences during the workshop. All the interviews were transcribed verbatim and the transcripts were coded with nVivo. The coding scheme consisted of two broad categories: learning and disciplines, which included several sub-concepts which were partly derived from the literature and partly emerged during the coding process. For learning – these included single and double loop, whereas for disciplines these included: characteristics of disciplines, frictions and the role of the PSS. For one of the two case studies (Cartesiusdriehoek) additional methods were applied: observation (two researchers and video) and a quantitative survey.

Second and next to the two case studies, we conducted a total of 31 interviews consisting of two groups: planning practitioners representing a specific discipline, and planning practitioners who have experience in facilitating and supporting planning workshops with digital tools. For the purpose of this paper, the function of the interviews is twofold. First, the interviews were used to scope and frame this study in relation to the wider debate, something which Blaikie (2010) calls 'retroduction' and which involves a continuous feedback loop between theory and empirical data. Notably, using Carton's (2007) three frames as a conceptual underpinning was based on the mentioning in expert interviews of the frictions related to engaging urban designers in PSS sessions. Second, the expert interviews were used to inform section 5.5 as well, which attempts to distil conditions for successful interdisciplinary learning facilitated by a PSS.

Table 5.1 Overview of empirical data

Source	***Method***	***Disciplines interviewees***
Case study 1: Cartiusdriehoek, Utrecht, the Netherlands, supported by Urban Strategy.	1 group evaluation, 1 feedback interview, survey, observations and transcript of session.	Nine participants: environmental analysts (2), housing expert, urban designer, transport planner, financial analyst, economic development expert, complemented by an area manager and a secretary (all Municipality of Utrecht).
Case study 2: Rijnenburg, Utrecht, the Netherlands, supported by CommunityViz and MapTable.	4 semi-structured interviews	GIS advisor & chauffeur (consultancy firm), project leader and environmental analyst (Municipality of Utrecht), urban designer (consultancy firm), planner and environmental analyst of (Province of Utrecht)
Semi-structured interviews	31 semistructured interviews	environmental analysts, environmental advisors, financial analysts, GIS advisors, project managers, spatial planners, transport planners, urban designers.

5.4 Two case studies of PSS workshops

We studied two cases in which a PSS was applied in an interdisciplinary setting. After introducing the case and the PSS, we will elaborate on the learning that occurred among the involved disciplines.

5.4.1 Cartesiusdriehoek: modest single loop learning

Case description: Cartesiusdriehoek and Urban Strategy

Urban Strategy is an interactive and integral PSS developed by the Dutch research company TNO (www.tno.nl/urbanstrategy). It is based on the current legally accepted models with regards to the environment (e.g. noise, air quality, safety) and traffic in the Netherlands. The impact of a planning intervention is made directly visible on both a 2D and 3D interface. In March 2014 a workshop supported by Urban Strategy was organized[13]. The aim of the workshop was to gain better insight into the potentials of a redevelopment area, situated close to the center of the city of Utrecht. The stakeholders were particularly interested in the development opportunities in terms of housing and commercial functions, given that there are several environmental restrictions in the area because of transport infrastructure and heavy industry located adjacent to and in the area. The workshop was attended by nine participants all with different disciplinary backgrounds, forming the project team of the Municipality of Utrecht for the Cartesiusdriehoek. The workshop was organized by Utrecht University and TNO, two parties who were mainly interested in learning about the application potentials of the PSS. The substantive case of the workshop was provided by the Municipality of Utrecht, who had looked explicitly for a case in which Urban Strategy would be particularly useful.

Description of the learning effects

With regards to interdisciplinary learning, a central finding of this workshop is that double loop learning in the sense of frame reflection among involved disciplines did not occur. During the session, Urban Strategy mainly helped to give the participants a more detailed insight into the environmental and traffic dimensions of the proposed planning interventions. The existing assumptions or problem perceptions were not challenged; the learning can be considered single loop. For instance, the area manager said: *'Learning about others was not important to me at all'.* Furthermore, in the questionnaire, learning about participants with another disciplinary perspective was not considered an important added value of the PSS, whereas the 'learning about the object' was considered important by four out of the nine participants, but mainly concerns extending the detail of insight in the plan area as the group evaluation revealed. One participant, however, indicated that she would have liked to learn more about the underlying models. This indicates a curiosity for learning about the assumptions about the area, which could have led to double loop learning effects as participants reflect on the causal mechanisms that govern the plan area: *'I would have liked to get a better understanding of how this area works, I mean what is Urban Strategy based upon?'.*

Explaining – the lack of – learning

In summary, relatively little interdisciplinary learning occurred during the workshop, and most of the learning that did occur was single loop. It is interesting to evaluate why relatively little learning effects, particularly double loop, were observed. A working hypothesis before the session was that most participants would learn especially about the environmental and traffic dimensions, since Urban Strategy can provide detailed insights into these aspects. However, as the

[13] For more details about Urban Strategy and the workshop please refer to Pelzer et al. (2014c).

involved urban designer indicated afterwards: '*Since we have already studied this area for so long, the session did not lead to new results. This could have been different if we had done the workshop much earlier.'* Another possible explanation for this lack of learning was that Urban Strategy could not answer all questions that were raised. The involved economic development advisor pointed out the lack of detail: '*I would want to know what it means if you add a Sligro [large wholesale center]. That attracts traffic, freight and visitors. (...) That is important in our consideration.'* Finally, Urban Strategy is a rather complex system, which takes time to understand. This results in a focus on learning about how the tool works rather than about how other disciplines think or on the characteristics of the planning object. According to the area manager *'It took quite a while before I really understood the tool'*, after which the environmental analysts continued: *'A second time it would go very differently, because then you know what the tool can do.'*

5.4.2 Rijnenburg: the frictions of double loop learning

Case description: Rijnenburg and CommunityViz

The second case is also situated in the Utrecht area in the Netherlands and consists of five workshops (www.toolboxrijnenburg.nl), however, both the planning issue and the PSS are very different. The PSS consists of a map-based touch table called 'MapTable' and the CommunityViz Scenario 360 software (www.communityviz.com), complemented with an environmental model called the 'Sustainability Profile of the Location (SPL)[14]. The latter allows direct insight into the impact of a planning intervention (e.g. adding 200 dwellings) on a selected environmental indicator on a 1 to 10 scale (e.g. energy consumption). Experts from the Municipality of Utrecht set the values of the indicators in an interactive process. The workshops were facilitated by a technical GIS expert (a chauffeur) from a consultancy firm and a moderator with a background in environmental analysis from the Municipality of Utrecht. The planning issue in this case was developing a master plan (a so-called 'structure vision) for the new neighborhood of Rijnenburg, close to the city of Utrecht. The sustainability aims were unusually high by Dutch standards; the area had to be fully energy neutral and climate proof with regards to changing water levels. The PSS was applied to include sustainability values from the beginning onward. As a consequence, urban designers and environmental analysts were forced to collaborate and incorporate environmental values in the early stages of the planning process.

Description of learning

Compared to the Cartesiusdriehoek case study, this project was in an earlier stage, more open to new ideas and involved more sessions. Moreover, frame reflection was one of the implicit aims of the workshops, since the urban designer had to consider the perspective of environmental analysts, whereas

[14] For more details about the PSS and the details of the planning issue please refer to Pelzer et al. (2013).

environmental analysts had to think more like a designer, proposing solutions rather than restrictions. As the planner from the Province of Utrecht indicated: *'People had to be willing to look beyond their own specialism, consider trade-offs and contradictory issues. That in itself is a learning process.'* Moreover, the urban designer indicated that the project leader, who has a background in environmental analysis, started to better understand the design frame: *'Her perspective really became broader; like "Ah this is a way to approach the issue." She saw the obstructions, but also the possibilities [of the interdisciplinary communication]*'. As the GIS chauffeur indicated, the PSS played an important role in this regard: *'I think it [the PSS] pulls people of their islands, they come closer. It becomes much harder for an expert to say: this is not possible. (...) if you draw a wind mill, and the sound expert says: "draw it", and the MapTable says "no", the sound expert can propose a solution. (...) An expert can think along, rather than obstruct the process'.*

However, the communication between the environmental analysts and the urban designer (there usually was one) was far from frictionless. As the urban designer remarked: *'From a design side, we're on a very abstract level, making sketches in which a meter does not matter so much. I do it roughly and find out later what the exact contours will be. But then there is a number that is very precise, with three decimal places. And that does not fit the [more fuzzy] idea that I have in my head'.* This friction was acknowledged by the project leader: *'The interdisciplinary communication was difficult, because urban designers tend to be suspicious towards everyone that wants to be involved with their discipline and draw along. (...) It is mainly a creative process, and they do not feel like calculating and drawing from the beginning onwards'.* Besides double loop learning, the case also involved several instances of single loop learning, which mainly took place within the analytic frame. Environmental analysts from different sub-disciplines, such as noise, water and energy found it very helpful that the PSS provided a spatial translation of their ideas and analyses.

Explanation of strengths and frictions

An important reason for the fact that double loop learning among different disciplines occurred during the workshop was that the responsible staff explicitly acknowledged that an interdisciplinary dialogue was necessary to make the workshops a success. Hereby, two factors in particular contributed to frame reflection in this workshop. First, the participants unequivocally emphasized that the MapTable improved the dialogue quality (cf. Goodspeed 2013b). Directly seeing the impact of an intervention on a map improves the content of the discussion. As the urban designer remarked: *'it evokes questions'*, something which is complemented by the spatial planner from the Province of Utrecht: *'The whole dynamic of such a table [the PSS] makes it interesting. It is drawing and calculating, and you directly see the result of two drawings'*. In addition the sheer act of standing around a table and interacting rather than watching a presentation, is arguably beneficiary to learning processes. As the GIS chauffeur pointed out: *'Just the fact that you can stand around such a television [MapTable] with everybody suffices to have a conversation. (...) I noticed that when people stand around such a table, shoulder to shoulder, the* *atmosphere is very different'*. A second explanation lies in the fact that the stakeholders were involved in developing the indicators of the PSS that were used during the sessions. As is also acknowledged in earlier studies (te Brömmelstroet & Schrijnen 2010), this enhances trust in the model and is in itself a learning experience. The GIS chauffeur observed that creating the indicators on a one to ten scale improved the interdisciplinary communication: *'people had to think what they meant and what they actually want. And if they want something, how do you explain that to other people? That was tough, they had to think about that. But that leads them to phrase their story in a better way'.*

The explanation of the friction between urban designers and the other, mainly environmental, disciplines lies mainly in inherent differences between a design frame and the analytic frame. Although the importance of a design frame was widely acknowledged, the aim of the workshop and the structure of the PSS were chiefly analytically oriented. This refers to a broader debate with regards to the quantitative and analytical set-up of most PSS versus the creative and intuitive way of working of urban designers (Dias et al. 2013).

5.5 Understanding digitally supported interdisciplinary learning

These two case studies revealed insights in some of the characteristics of interdisciplinary learning supported by a PSS and the explanatory factors for successful instances of learning – or the lack thereof. We will now elaborate on these two dimensions in more detail, drawing on the two case studies, expert interviews and insights from the literature. We will start with describing digitally supported interdisciplinary learning.

5.5.1 Grasping the interdisciplinary learning process

The two case studies reveal some very different insights with regards to interdisciplinary learning. In the Urban Strategy workshop the – rather modest – learning was single loop, whereas the Rijnenburg case had more characteristics of double loop learning. It is important to underline that one of the two cannot be *a priori* considered as better or preferable. In planning situations with an initial, long term, wicked and visionary nature, double loop learning arguably has important benefits, whereas for more straightforward and specific issues single loop learning can be relevant.

In the case of single loop learning, the goal of the Cartesiusdriehoek workshop was not so much to really grasp and understand other disciplines, but to learn about specific insights from other disciplines that are relevant for the planning issue that has to be solved. During the Urban Strategy workshop, the metaphor of a library was used for the tool; participants used the tool to learn the answer about a specific question. This library, however, only provides books about quantitatively oriented disciplines - such as environmental analysis and transport planning. A problem during the session was that financial dimensions, which also have a strongly quantitative orientation, were lacking in the tool. This seems a resolvable data and model issue, rather than an inherent friction for PSS application (cf. Lieske et al. 2013).

As became apparent in the Rijnenburg case and underlined by the expert interviews, inherent frictions are part of interdisciplinary learning among stakeholders with different frames, in this regard particularly the analytic and design frame. The role of a library does not suffice, since the PSS has to contribute to an integration of different working habits and tool experiences. For instance, an urban designer describes her praxis as follows: *'I think this is something shared by writers, designers and artists. It is a certain energy that flows through the body that can be used for creation. And you use your hands to export that. I'm not sure if it's true, but when I'm thinking, because of the movement of my hand, making sketches, ideas evolve. I can see the connections'*. Hereby, pen and paper are important supporting instruments. A financial analyst, on the other hand remarks: *'I make an inventory of the costs and benefits and relate them to each other in time'.* Rather than pen and paper, the most important instrument is a spread sheet software package like Microsoft Excel. This underlines that a PSS has to be a suite of components (Geertman 2008), consisting of elements, which connect to both design frames and analytic frames. Only then can frame reflection among the involved disciplines occur. This is, however, only one rather broad condition for interdisciplinary learning; we will now describe some other conditions for PSS to support interdisciplinary learning in more detail.

5.5.2 Conditions for successful interdisciplinary learning with a PSS

In both the Cartesiusdriehoek case and the Rijnenburg case, stakeholders were involved in the development of the tool. In the Cartesiudriehoek case, transport modelers, who were not at the session, validated the transport model that was used, enhancing the trust of the workshop participants in the tool. The Rijnenburg case went one step further, asking stakeholders not only to validate the model and provide input data, but also to provide their expert judgment in order to develop the multi criteria analysis in the tool. Involving stakeholders in the development of an instrument is important for two reasons: it leads to trust in the PSS, which is arguably a condition for learning (cf. Beukers 2014) and the tool involvement is in itself part of the learning experience (te Brömmelstroet & Schrijnen 2010).

Tool involvement does not resolve the issue of 'frame friction' between analytic frames and design frames, since these tools tend to be built on assumptions related to an analytic frame. Hence, since someone with a design frame learns from someone with an analytic frame and vice versa, the PSS should also include functionalities that relate to both frames. Since the analytic frame tends to be aptly facilitated by a PSS, the challenge is mainly to connect to a design frame. This implies an important role for sketch tools, either analogue or digital (Dias et al., 2013). The main challenge in this regard, however, is to integrate these different instruments and working habits. This problem can arguably not be solved instrumentally, but involves social interaction, a dialogue (cf. Beukers et al. 2014). Hereby proper facilitation or mediation of the workshop is critical, a facilitator can improve the dialogue quality by applying interventions like a 'round robin' and handling stakeholders that are frustrated during the sessions

Another important role for the facilitator, and arguably a condition for workshops in general, is to ensure that a PSS enhances, rather than frustrates, the communication. In both case studies the PSS functioned to a certain extent as a barrier for communication. In the Rijnenburg case this was particularly related to the bias towards an analytic frame, since the urban designer did not always feel comfortable with the quantitative approach. In the Cartesiusdriehoek case, most of the attention was centered on the PSS, as a provider of information, rather than the existing disciplinary knowledge of the involved stakeholders. This was less of a problem in the Rijnenburg case, which to a certain extent can be attributed to the touch table, because this seems to make the dialogue more active and open. As a GIS-advisor who has worked a lot with the same MapTable remarks*: 'you really get a conversation because you are around a table with each other and not watching a PowerPoint presentation. We're really working actively on a topic'* (see also Hopkins et al. 2004, p.664).

Besides structuring the physical set up of a meeting, touch tables often depict maps, hereby putting a spatial language at the center of the conversation. The importance of spatial visualization for collaborative processes has been emphasized by earlier studies (e.g. Andrienko et al. 2007; MacEachren 2000, 2001). In a concrete example, Van der Hoeven et al. (2009, p. 162) point at the importance of maps to communicate the findings of their tool, the Land Use Scanner: 'Effects of flood risk management strategies should be presented spatially, i.e. on maps, to make them more easily understandable for decision makers'. According to the GIS chauffeur in the Rijnenburg case, the spatial language helps to make disciplinary insights explicit, potentially improving learning: *'We constantly were asking about the spatial impacts of ambitions. (...), all involved disciplines are forced to be very precise about what they want'.* Developing a spatial language is not without its problems, however. As became apparent in the two case studies and the PSS user interviews, it is very difficult to visualize information in such a way that it relates to all the stakeholders. This involves the difference between fuzzy and abstract related to a design frame versus systematized and quantified maps related to an analytic frame (e.g. Carton, 2007). However, this relates also to more generic issues. In the Urban Strategy workshop, for instance, it proved very difficult for all the stakeholders, including the transport planner, to interpret the resulting maps. Spatial visualization is a learning process in itself, in which involvement in tool development can help to develop a spatial language that connects to all the stakeholders.

5.6

Conclusions, reflections and future research

This paper aimed to gain a better understanding of the characteristics and conditions of interdisciplinary communication processes – in particular learning – facilitated by PSS. The two case studies and exploratory interviews provide an interesting, yet not conclusive, answer to this question. It is important to note that both single loop and double loop learning are relevant to understanding interdisciplinary communication. Single loop learning can have important added value in solving concrete planning issues, whereas the benefit of double loop learning mainly can be found in situations in which a holistic and comprehensive approach is needed, for instance when developing a long term vision or solving wicked planning problems. The categorization of frames as developed by Carton (2007) was particularly helpful to understanding the Rijnenburg workshops, in which one of the keys to interdisciplinary learning lies in a careful dialogue between participants with a design frame and an analytic frame. It is important to note that both the friction during the Rijnenburg workshops and the double loop learning effects were related to the interaction between these two frames. Hence, it should always be carefully considered whether double loop learning is indeed an aim of a PSS workshop. Achieving this goal takes time and careful preparation, whereas success is no guarantee – as some of the frictions reveal.

PSS in its current form might have potential to support interdisciplinary communication through learning, both single and double loop, but we argue that a set of conditions have to be met to truly have an effect in planning practice. Tool involvement prior to or during workshops seems to be both an important prerequisite for learning and a learning process in itself. In addition to that, it is important to carefully consider choices with regards to hardware and visualization. Future research could shed more light on the conditions for digitally supported interdisciplinary communication. While doing so, it is relevant to take some reflections related to this paper into account.

A first reflection is that this paper has particularly focused on PSS application at the workshop level. For single loop interdisciplinary learning other ways of working such as individual work or online collaboration could also work well. MacEachren (2000, 2001) pinpoints the important difference between same place collaboration and different place collaboration. Future research should study more systematically what this implies for interdisciplinary learning and the role of PSS. Additionally, it should be kept in mind that this paper has focused on professional stakeholders; on interdisciplinarity, rather than transdisciplinarity (cf. Gibbons and Nowotny 2001). In so doing, it provides just a partial picture of contemporary planning, in which other stakeholders, such as residents play a critical role. This has been acknowledged in the debate about PSS and participatory GIS (e.g. Kahila & Kÿtta, 2009, McCall & Dunn 2012). More specifically, in addition to the three 'professional' frames that were used here, it might also be relevant to take into account 'local' frames, namely frames that are based on the daily experiences of residents and that involve local and lay knowledge.

This focus beyond professional disciplines, inevitably also results in a broader conception of the dimensions that frames are dependent upon. From a psychological perspective, Nijstad (2009), points at the importance of knowledge, skills and abilities (KSA), which for instance include personality characteristics. In applying PSS successfully in interdisciplinary processes these characteristics are arguably as important as disciplinary characteristics, something that was also emphasized by several interviewees. This would be a very relevant avenue for future empirical and conceptual research, which could lead to a more fruitful exchange between planning research with a chiefly conceptual focus and research into analytical support tools with a strongly empiricist and positivistic background. The emerging concept of geodesign, which is accompanied by conferences and an increasing amount of publications, might spark this academic dialogue. This dialogue is something that is badly needed since interdisciplinary learning is as important for academics as it is for planning practitioners.

Chapter 6

Planning Support Systems and task-technology fit: a comparative case study

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Abstract

Studies in the Planning Support Systems (PSS) debate are increasingly paying attention to the support function of PSS. This involves among other things studying the usefulness of PSS to practitioners. This paper adds another dimension to this evolving debate by arguing that planning tasks should receive more attention. Although planning tasks are central in several PSS definitions, they have hardly received explicit attention in empirical studies. In an aim to fill this void we conducted an empirical study based on the perspective of task-technology fit. The latter consists of a combination ('fit') of analytical and communicative support capabilities ('technologies'), and three types of planning tasks: exploration, selection and negotiation. Next, we selected four case studies in the Netherlands, in which the same PSS was applied, which consists of a combination of the CommunityViz software and a touch-enabled MapTable. The cases differed in the planning tasks that were central during the workshop, resulting in different kinds of usefulness attributed to the PSS. For instance, in one case with a selection task the communicative support capabilities contributed to the transparency of the process, whereas in another the analytic support capabilities of the PSS improved the task of negotiation because of the iterative feedback it provided. The paper concludes with the observation that the concept of task-technology fit has potential be applied in different contexts and with different types of PSS.

6.1 Introduction

It is now widely acknowledged that in order to achieve a successful application of Planning Support Systems (PSS), it is necessary to pay attention to the demands and characteristics of planning practice (e.g. Geertman 2008, te Brömmelstroet & Bertolini 2008). Geertman's (2008) definition of PSS underlines this by pointing out that a PSS should improve the work of planners, since PSS are: '… geo-information technology-based instruments that incorporate a suite of components that collectively support some specific parts of a *unique professional planning task'* (Geertman 2008, p.217 –emphasis in original, cf. Klosterman 1997). However, in the literature the emphasis seems to be on two out of three letters in the PSS abbreviation (Geertman 2013). The first term, 'Planning' is increasingly receiving attention, particularly in more conceptually oriented articles (e.g. Couclelis 2005, Geertman 2006, Klosterman 1997). The third term, 'Systems', comprises the overwhelming majority in PSS studies, mainly describing the technical details, underlying models and structure of the instruments (e.g. Geneletti 2008, Demetriou et al. 2013, most of the chapters in Geertman et al. 2013). The middle term, 'Support', has only recently received more rigorous empirical attention (e.g. Arciniegas et al. 2013, Goodspeed 2013b, te Brömmelstroet 2013). In a range of applications the performance of PSS to support planning is evaluated, mostly in a quasi-experimental setting (Arciniegas et al. 2011, 2013, Jankowski & Nyerges 2001, Salter et al. 2009).

In addition, recent accounts provide conceptual frameworks to analyze this support function of a PSS (e.g. te Brömmelstroet 2013, Pelzer et al. 2014a). A central concept herein is 'usefulness', which entails the question of whether the application of a PSS leads to an improvement in comparison to a situation without a PSS (i.e. the added value). While these frameworks provide guidance in the broader debate about PSS, we argue here that the frameworks should be complemented with a focus on the different planning tasks they support. Developing a conceptual perspective that explicitly includes planning tasks is the first contribution this paper has to offer to the PSS debate. The second contribution of this paper is the empirical approach, which is a comparative empirical research in four planning situations with the help of the same PSS. To our knowledge and based on recent reports on PSS performance, such a comparative and real-world planning support assessment has hardly been conducted before (cf. Goodspeed 2013b). Hence, the research question of this paper is: How can a better conceptual and empirical understanding of the relation between planning tasks and PSS lead to improved insights about the support function of PSS?

In answering this research question, this paper is structured as follows. In section 6.2 we will develop a conceptual framework to address the relationship between planning tasks and PSS. This framework is the basis for the case selection on which we will elaborate in section 6.3, complemented by a description of the PSS we studied and the methodological approach. In section 6.4 to 6.7 we will describe the characteristics of the four cases we studied, followed by a synthesis of the main findings in section 6.8. The paper closes with conclusions and recommendations for future research in section 6.9.

6.2 Conceptual framework: task-technology fit

The ideas central in this paper are inspired by research in fields adjacent to the PSS debate, most notably Management Information Systems (MIS) and Group Support Systems (GSS). While the potential of these fields for PSS and urban modelling has already been pointed out before (Guhathakurta 1999), these ideas have not been really picked up in the PSS debate. We argue in this paper that this strand of literature has relevant insights to offers. More specifically, the extent to which a PSS supports planning tasks is in this literature conceived as the so-called task-technology fit (Goodhue & Thompson 1995). Whereas several definitions exist for task-technology fit (see Furneaux 2012 for an overview), the one arguably most suited for the PSS debate reads: 'The matching of the functional capability of available information technology with the activity demands of the task at hand' (Dishaw & Strong 1998, p. 154). In the PSS debate, the notion of task-technology fit has received relatively little attention. This can be considered somewhat surprising, since 'supporting planning tasks' is part of several definitions of PSS (e.g. Geertman 2008, Klosterman 1997). We are only aware of the work of Vonk (2006), which paid explicit attention to this perspective, finding that the fit between PSS and planning tasks often tends to be problematic. This paper argues that the concept of task-technology fit is helpful to understand the usefulness of PSS in relation to planning tasks. In order to develop a conceptual framework that connects PSS and the concept of task-technology fit, three questions ought to be answered:

1. What are planning tasks, in the case of PSS?
2. What is technology, in the case of PSS?
3. What is the relation ('fit') between tasks and technology, in the case of PSS?

6.2.1 What are planning tasks, in the case of PSS?

According to Hopkins (2001, p.187 – emphasis added): 'Tasks are combinations of planning behaviors that accomplish particular *functions or purposes'*. Hereby, the *function or purpose* is a critical defining element in the case of PSS. From a heuristic perspective, it is helpful to come to some kind of categorization based on this function or purpose. For that, we focused on literature from three different debates about support technology: GSS (Dennis et al. 2002, Zigurs & Buckland 1998), geocollaboration (MacEachren & Brewer 2004) and PSS (Geertman & Stillwell 2009).We hereby aim to develop a synthesis of a set of more or less generic planning tasks, not to develop an extensive or very detailed description of planning tasks.

Zigurs and Buckland (1998, pp.317-318) coming from the GSS debate, discern tasks based on their complexity, and not necessarily on function or purpose. They come to five different tasks, which have the following characteristics: simple, problem, decision, judgment and fuzzy. Dennis et al. (2002), also from the GSS field, have a simpler classification. They discern two tasks: generation (exploring different options, ideas, etc.) and choice (selecting options, ideas etc.). This partly overlaps with work about geocollaboration by MacEachren and Brewer (2004, p.7), who discern four kinds of tasks: execute, choose, negotiate and generate. From the field of PSS, in the introduction to their 2009 edited volume, Geertman and Stilwell (2009, p.3) approvingly cite Batty (1995), when he notes that PSS are 'a subset of geo-information technologies, dedicated to supporting those involved in planning to explore, represent, analyze, visualize, predict, prescribe, design, implement, monitor, and discuss issues associated with the need to plan. While this is quite an encompassing overview of the way in which PSS supports planning, not all terms can be considered tasks. For instance, 'visualization' facilitates other tasks, rather than having a specific goal or purpose.

In order to have a workable conceptual framework, we selected three tasks from these three strands of literature, which have a clear goal or purpose: exploration, selection and negotiation. Most of the terms mentioned by Batty (Batty 1995 in Geertman & Stilwelll 2009, p.3) also fit within one or more of these three tasks, whereas these tasks quite neatly overlap with the categorization by Dennis et al. (2002, GSS) and MacEachren and Brewer (2004, geocollaboration). *Exploration* concerns the generation of a range of ideas, challenges or alternatives, and is sometimes referred to as divergence. For instance, developing a range of scenarios about how a city will look like in the future. Or using predictions to explore how the future of a city region might evolve. *Selection*, sometimes referred to as convergence, concerns choosing (a set of) assumptions, indicators, etc. Analysis can contribute to this selection process, which ranges from rather detailed tasks in professional settings (e.g. what will be the exact location of a convenience store?) to fundamental decisions taken by politicians (e.g. will a shopping mall be built in this neighborhood or not?). In the case of PSS the emphasis tends to be on the former. In a planning situation where there is full agreement among the involvement stakeholders, exploration and selection tasks suffice. However, this is hardly ever the case as planning often involves conflicting interests. Therefore there is a third task: *negotiation.* Negotiation can be defined as a task in which actors try to reach an agreement through an iterative process, with elements of bargaining and compromising (Claydon 1996, Claydon & Smith 1997, Ruming 2009). Negotiations are usually about the creation or distribution of a monetary value, a share, a contribution or another, often monetary, concern (see Raiffa 1982, in Samsura 2013). For instance, negotiation could be required to reach an agreement on each actor's financial contribution to a common development project.

6.2.2 What is technology, in the case of PSS?

Technology can be conceived as the support capacities a PSS has for planning. Dennis et al. (2002) discern communication support and information-processing support, while Vonk (2006) distinguishes three types of PSS: informing, communicating and analyzing. For the purpose of this paper, two PSS capabilities are distinguished: communication support and analytical support. The main reason is that we believe these two best reflect the contemporary debate in PSS and planning. *Communication support* concerns technology that aims to improve the information exchange among stakeholders. A MapTable, for instance, is an example of communication support (see section 3.2). As Pelzer et al. (2014a) show, it evokes a more dynamic and content-based dialogue. *Analytical support*, on the other hand, concerns some kind of – usually quantitative – calculation, which results in information that support the planning process. Impact analysis is in the case of PSS the most well-known application of this sort (Brail 2006). Deal and Pallathucherhil (2009), for instance, used their LEAM (Land-Use Evolution and impact Assessment Model) PSS to analyze the impact of a new bridge on traffic flows.

The distinction between communicative and analytical support reflects broader debates in planning. According to Hopkins (2001) there are two types of rationalities through which planning can be conceived: a rational comprehensive rationality and a communicative rationality. Sager (1994, ix – emphasis added) explains the difference succinctly: ‘planning problems can be solved in two contrasting yet complementary ways: one can trust expert judgments based on *analytic technique* or *discuss* the matter and reach a *group* decision’. Whereas the former can be considered the part of the traditional, scientific-analytic approach to planning (Harris 1965, Salet & Faludi 2000), the latter reflects the more recent collaborative or communicative turn in planning (e.g. Healey 1992, Innes 1998). This is not the place for an extensive discussion about these two approaches; we agree with Sager (1994) that the two are complementary and therefore should both be part of the support capacities of a PSS, resulting in both communicative and analytical support.

6.2.3 What is the relation (‘fit’) between tasks and technology, in the case of PSS?

The fit between task and technology can be addressed as an *outcome.* Furneaux (2012) summarizes the outcomes of TTF as described in MIS and GSS research. A range of possible outcomes are discerned, including the quality of the decision or solution and the attitude about the technology and the intention to use it. (*ibid,* p. 99). One category discerned by Furneaux (2012) is particularly relevant for this paper: the perceived usefulness. Recent PSS studies have developed frameworks and conducted empirical research into the question what the usefulness (or added value) of a PSS is according to practitioners. For instance, Te Brömmelstroet (2013) and Pelzer et al. (2014a) developed frameworks with different dimensions of the added value of PSS, such as learning, efficiency, consensus and a more informed outcome. In a somewhat different vein, Te Brömmelstroet (2010) and Goodspeed (2013b) emphasize learning as an important added value of PSS. Figure 6.1 depicts the basic argument of this paper, whereas Table 6.1 provides some examples of outcomes in relation to task-technology fit. However, while recent research provide some insight about the different kinds of perceived usefulness of PSS, this notion has not been explicitly linked to the concept of task-technology fit. Therefore, the empirical study in this paper is set up as strongly inductive and exploratory, particularly with regards to the empirical outcomes (i.e. perceived usefulness).

Figure 6.1 Task-technology fit conceived as the fit between PSS capacities and planning tasks

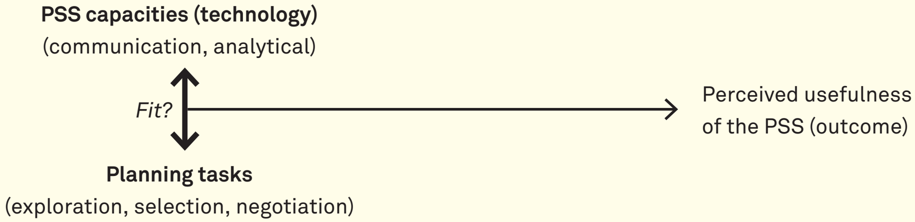


Table 6.1 **Examples of perceived usefulness of PSS as a result of a positive task-technology fit for the three planning tasks and two types of PSS capacities (technology)**

Technology ***Task***	*Communication support ('improving knowledge exchange among stakeholdeers')*	*Analytical Support ('provide information based on a calculation')*
Exploration	Learning about others and learning about the object	Learning about the object
Selection	Efficiency	More informed outcome
Negotiation	Consensus	More informed outcome

6.3 Case selection and Methods

In order to gain more insight in the task-technology fit of PSS, we conducted an empirical study in the Netherlands consisting of four different case studies. In this section we will describe the PSS that was used in all cases, the way in which we selected the cases and the research methods we applied.

6.3.1 Description of the PSS: the MapTable PSS

In this research we focus on one specific PSS, which we conveniently call the MapTable PSS. This PSS consists of two main elements: the MapTable hardware and the software ArcGIS/CommunityViz. The MapTable is a digital touch table developed and commercialized by the Dutch firm Mapsup (http://www.mapsup.nl). It contains a digital touch-enabled screen of large format (46-inch), designed to support group work around spatial information. The software in the MapTable is developed within the ESRI ArcGIS® environment using an ArcGIS extension called CommunityViz (http://www.communityviz.com). CommunityViz is widely used planning support software containing a wide variety of interactive planning support tools to model, analyze, and visualize geographic information (Walker & Daniel 2011). With the help of these tools users can draw on a digital layered map, make selections and perform calculations and view the results of their decisions in real time. We will now describe the way we selected the cases and the methods used to study the application of the MapTable PSS in the different cases.

6.3.2 Case selection

Filling all the possible categories in Table 6.1 was the starting point for our research strategy, the case selection was both *diverse* and *most similar* (Gerring 2007, p.89-90). First, it was *diverse*, meaning the cases (two or more) illuminate the widest possible range of the two explanatory variables ‘technology’ and ‘tasks’, leading to six possible combinations. After surveying PSS applications in the Netherlands, we found four suitable cases, with only the combination ‘analytical support’ and ‘selection’ not being present[15]. Second, the case selection was simultaneously *most similar,* which means the cases (two or more) are similar with regard to possibly confounding variables, which in this regard related to the specific characteristics of the PSS, such as the underlying model, the type of visual output and the supporting hardware. In order to have *most similar* cases, we studied four cases (from now on referred to as ‘Rijnenburg’, ‘Arnhem’, ‘’Deventer’, and ‘Achterhoek’, see Table 6.2) in which the same PSS (the MapTable combined with CommunityViz) was applied. The following four sections 4, 5, 6 and 7 provide a description of each case study.

Table 6.2 **The four cases of the MapTable PSS in the Netherlands selected for empirical study based on the task that was dominant.**

Technology / ***Task***	*Communication support*	*Analytical Support*
Exploration	Rijnenburg + Arnhem	Rijnenburg + Arnhem
Selection	Deventer	n/a
Negotiation	Achterhoek	Achterhoek

6.3.3 Research Methods

Interviews were conducted with stakeholders in all four cases. However, the way in which the interviews were conducted differed and in one case (Achterhoek) additional methods were applied. Therefore, we will now briefly elaborate on the research methods used for each case. For the Rijnenburg case four semi-structured interviews were conducted with the four key stakeholders, consisting of the project leader from the Municipality of Utrecht, a planner from the Province of Utrecht, the GIS advisor and technical operator from a consultancy firm, and the leading urban designer, also from a consultancy firm. For the Arnhem case, semi-structured interviews were conducted with two stakeholders of the project both representing the municipality of Arnhem, namely the city’s project leader and the city’s GIS office. The interviews were transcribed and analyzed. In the Deventer case, semi-structured interviews were conducted with market vendors and one officer of the municipality of Deventer in charge of managing and supervising the market. A randomly selected sample of five market vendors was interviewed at each vendor’s market stall. All respondents

15 It is important to note that this combination is logically very well possible, for instance in a case of site selection through multi-criteria analysis.

were present at the two workshop sessions. For all the three cases, the interviews were transcribed, and then analyzed. In the Achterhoek case, the input for the game model was verified by different experts from the Province of Gelderland and the City Region Arnhem-Nijmegen. Two meetings around the PSS were videotaped and transcribed, and observations were made by non-participant experts present at the meetings. After the meetings, evaluative group discussions were held and questionnaires were filled in by all participants.

6.4 Rijnenburg, Utrecht: developing a sustainable neighborhood

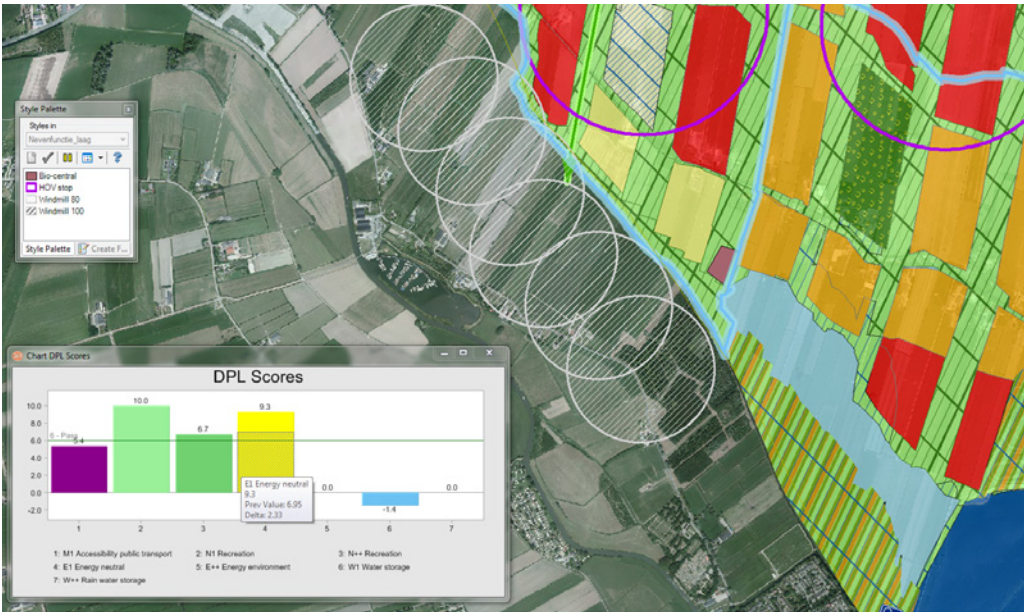
In 2008 the Municipality of Utrecht started to develop a future-oriented land-use plan – a so-called 'structure vision', in which 7,000 new dwellings were allocated for the neighborhood of Rijnenburg, an area of farmland south of the city of Utrecht in the Netherlands. Therein, a neighborhood with above-average levels of sustainability should be realized (e.g., energy neutral and climate proof). To accomplish this, it was deemed necessary that the involved diversity of professionals and in particular the professions of environmental analysts and urban designers would collaborate intensively from the very early start of the planning process. The MapTable PSS was utilized to support this collaboration and to assist in the calculation of the sustainability scores (see Figure 6.2).

Figure 6.2 The MapTable PSS used at a demonstration session (photo: www.toolboxrijnenburg.nl)

In this case the PSS was coupled with the so-called Sustainability Profile of the Location (SPL), a tool for assessing environmental quality of urban developments (htttp://www.ivam.uva.nl). SPL makes it possible to calculate the environmental impact of a new plan in terms of sustainability scores. Within the tool environmental values are represented by a set of indicators, which concern environmental issues like noise, energy, water, and ecology (http://www.toolboxrijnenburg.nl). The sustainability score calculated for each environmental issue is portrayed by an indicator ranging from 1 to 10 (see Figure 6.3). For a more elaborate description of SPL and its application within the Rijnenburg Utrecht case, please refer to Pelzer et al. (2013).

In the Rijnenburg case all the involved stakeholders were planning professionals, with no direct interest (e.g. ownership of land), therefore the negotiation task did not really play a role. Moreover, although some selection tasks were conducted during the workshops, the main focus was on exploration tasks, which we will consequently focus upon. With regard to the PSS capabilities, the MapTable PSS clearly involved both communication support and analytical support. Although the two are sometimes hard to disentangle in practice, the communicative support took mainly the form of a tabletop in combination with digital maps that facilitates the dialogue, whereas the analytical support was in this regard mainly the functionality of impact analysis, conducted with help of the SPL model.

Figure 6.3 **Screenshot of the Sustainability Profile of the Location**



With regard to the task of *exploration*, the PSS was used to support the creation of three scenarios for the neighborhood so that indicators of environmental quality and sustainability could be incorporated at the very start of the project instead of just at the end of it, which is usually the case in Dutch planning practice of environmental impact assessments. It enabled the different professionals to explore together the sustainability consequences of future l and use scenarios for the area. More specifically, the involved environmental analysts stated that the PSS provided good integrative and spatially explicit assessments of sustainability effects of the plan scenarios. The moderator of the workshops provided an example of this notion: *"It is different when you see it on the MapTable PSS. Those wind power people know that here is a noise contour around a windmill, but now it is directly visible after placing a windmill and watching the number of dwellings go down [as a result of its noise effects]. That is a different effect than when you know that in theory there is a noise contour"*.

Although these positive aspects were acknowledged, not all professionals were entirely convinced of the usefulness of the PSS for the task of exploration. The urban designer involved in the workshops noted that "*From a design standpoint, we work on a very abstract level, making sketches in which one meter does not matter that much. I do it approximately and find out later what the exact contours will be. But then [when using an interactive geo-information tool] there appears a number that is very precise, with three decimal digits. And that does not fit the idea that I have in mind. (...) I would prefer a rough sketch on the table (...) In the end it [the PSS] had little influence on the overall design. The primary reason is that it is a very difficult tool in terms of technique, in particular the software that was used"*. Hence, to a certain extent the PSS was viewed as a barrier (i.e. a negative fit), rather than a support instrument to conduct the task of *exploration.*

Learning arguably was the most important perceived usefulness of the PSS. The environmental analysts indicated to have learned a lot from each other (e.g., noise specialists from energy specialists and vice versa), however not so much from the other discipline of urban designers. The moderator noted on these disciplinary barriers: *"It [the PSS] gets people off their islands, they come closer. It becomes much harder for a specialist to say: 'that is impossible'."* As the urban designer noted: *"It is good that we are forced to think more like planners [and environmental analysts] (...) simultaneously we as designers want to stay at an abstract level and I think it is also good that planners [or environmental analysts] are becoming a bit less rigid".*

Besides the specific tasks the MapTable PSS aimed to support, it had a broader aim of supporting a constructive dialogue with increased collaboration and communication between different disciplines. In that, urban designers are forced to think at an earlier planning stage about sustainability indicators, while environmental analysts have to work in a much more design-oriented fashion. The workshop mediator literally described this as: *"The moderator and I agreed that the project would be successful if the urban designers would stay around the MapTable PSS until the end".* In turn, the urban designer involved had some positive thoughts on the communicative support function of the PSS: "*It is a very good communication tool during the design process, but as a calculation tool it is good in the final phase. (...) Its strength is that it evokes questions*".

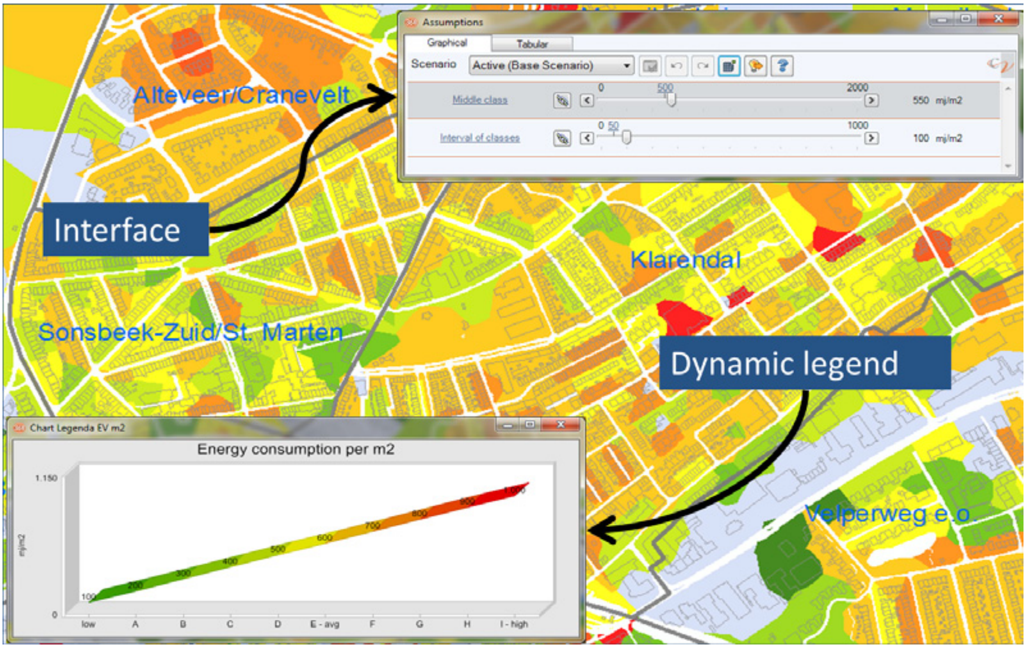
6.5 Arnhem: transition to sustainable energy

The Dutch city of Arnhem (150.000 inhabitants) has included in its policy the European Union goal to reduce greenhouse gas emissions by at least 20 percent in 2020 (European Union, 2008). As a consequence, about 20 percent of the energy use in the city should be generated in a sustainable way, while a 20 percent reduction in energy use should be accomplished by improving the energy efficiency. The city's ultimate goal is to become energy-neutral by the year 2050. In order to be able to meet these goals, the city of Arnhem needs to stimulate its citizens to reduce its fossil-based energy use. To accomplish this, the city is currently undertaking activities in cooperation with energy producers and others to stimulate the city's energy transition and the transition to greater energy efficiency. As part of this, all data relevant from the city of Arnhem and the other stakeholders were made available on an open-access database in such a way that these data and figures could be integrated, analyzed and visualized with the help of the MapTable PSS. The city organized workshop sessions in which the PSS was utilized to support the following activities (see Figure 6.4):

1. Visualize and discuss spatial distribution patterns of energy consumption to explore its relationship to current land use;
2. Monitor energy consumption over time based on the construction year of a building;
3. Highlight and discuss areas of excessive energy consumption to explore its relationship to current land use.

Figure 6.4 **The collaborative workshop in Arnhem with the MapTable PSS. (photo: Gustavo Arciniegas)**

Figure 6.5 **Screenshot of the MapTable PSS showing energy consumption patterns per postal code zone in a neighborhood in Arnhem.**



Map legend (bottom left) is dynamic as its class size and ends can be interactively modified by setting new values on the assumptions window (top right).

Figure 6.5 illustrates the working of the scenario-analysis tool built in the PSS. The focus of the PSS to the Arnhem case concerned primarily *exploration* tasks, which included the analysis and visualization of energy consumption patterns and the connection with the land-uses in the entire city of Arnhem, as well as the underlying existing geographical information collected from various sources (stakeholders). The analytical support in the PSS consisted of three elements: a dynamic energy consumption map per postal code, a set of dynamic bar charts showing aggregate energy consumption values on several aspects, and an interactive consumption legend to define and portray ranges of consumption values on the map, for various levels of detail (i.e. city, district, or street level). Charts show total consumption values in kJ/m^2 or KJ/m^3 or KJ/inhabitant for the entire city or per individual districts and on the basis of land use (schools, hospitals, restaurants, bars, etc.), m^2/inhabitant district and construction year. Figure 6.5 illustrates how the consumption map, its interactive legend and the dynamic charts are displayed on the MapTable PSS.

The city of Arnhem organized the workshops with the purpose of 1) assessing past and current energy consumption, 2) presenting its energy plans and 3) initiating a dialogue among the involved stakeholders. In doing this, the PSS was used as the main repository for the geographical information and the information on consumption originating from several sources. During the workshop all stakeholders were invited to present and explain to the other stakeholders their own information presented on the MapTable PSS. The MapTable PSS was used to first combine the information and then present it as past, current and expected patterns of energy consumption, overlaid with a map of current land use.

These activities can be captured under the header of the task of *exploration.* One of the goals of the workshop sessions was to visualize spatial distribution patterns of energy consumption and to explore its relationship to current land use. The participants of the workshop sessions were enthusiastic about how this information on consumption patterns was visualized and communicated. The connection between consumption and land use became very apparent. For example, through the use of the MapTable PSS, participants could associate high-consumption spots with information such as building year and land use. Several participants shared the quote that *"The MapTable [PSS] is a different way of visualizing and discussing energy consumption and land use".* The city's project leader noted that *"The possibility to combine and analyze as many map layers as possible and be able to explore spatial associations visible between these layers helps participants in the conversation to reach new perspectives"*.

This quote shows how both analytical and communication support improved the task of *exploration* through the depiction of spatial patterns, which both provided insight in the planning issue (i.e. analytical support) and sparked the discussion (i.e. communicative support). Indeed, with regard to communicative support, the project leader noted that: *"An underestimated aspect of the MapTable PSS is its ability to keep participants active around it, their attentions focused on the information presented in the maps and the topic and less on each other; participants are physically there and cannot look away from each other".* Hereby, the fact that the MapTable PSS passively "forces" people to stand, rather than sit, around the table results in a more active and energetic workshop.

6.6 Deventer: rearrangement of a market square

The Dutch city of Deventer has an outdoor shopping market called 'de Brink', which opens traditionally on Fridays and Saturdays and specializes in food items, flowers, clothing and fast food. Foremost due to bottlenecks in the access of emergency services and the insufficient functioning of the market, the municipal authorities decided to rearrange the spatial configuration of the market. This would involve a reallocation of 50 market stalls. Understandably, this caused a lot of commotion among the market vendors, because a large amount of them have their fixed position for a long time. In particular, the new locations for the stalls selling flowers, potatoes, vegetables, fruits, fish and fast food were debated heavily. The local newspaper 'De Stentor' published articles documenting these debates (De Stentor 2011a, b).

Figure 6.6 **Maps showing the original configuration of stalls (left) and the resulting new configuration with vendor names on top, after using the PSS MapTable during the session (right).**

To address these issues, the city council organized two workshops at the municipality hall in which all market vendors were invited to select the new places for their stalls. The MapTable PSS was used to support this task of *selection*. Participants were asked one by one to come to the room where the MapTable PSS was situated and indicate on the map their desired location. The order was based on the seniority (the time they had been on the market) of the vendors. In the meantime, the other participants waited in another room next door where a projected image of the MapTable showed the choices already made by previous vendors. The MapTable PSS showed a high-resolution aerial photo, the current spatial allocation of the market stalls and the reallocation progress as it resulted from the picking process. The result of the picking process was a map showing selected locations and the names of the market vendors displayed on top of the locations (See Figure 6.6).

The PSS offered support for the task of *selection.* The workshop participants considered the offered support to be generally adequate for this task. Reponses to the interviews revealed positive feedback about the MapTable PSS, particularly how it led to a fair, clear and transparent selection process. It was remarked that *"The integrated picture the PSS gives would guarantee transparency and fairness, given the sensitivity of the issues in question".* The PSS facilitated this difficult selection process. As one market vendor puts it: *"If I am asked to describe the value of the system in one word that would be 'clarity'".* Or as stated by a textile stall owner: *"While I disagreed completely with the city's plans to reorganize the market as I used to have a nice location, the system [MapTable PSS] worked well so that was not the issue".* Hereby, several market vendors agreed that the selection process *"Could have never happened with only printed maps and* *markers or with a blackboard and chalk".* In sum, this case study precisely demarcated the task of *selection*, in which the PSS provided communication support, and the main perceived usefulness was an increased transparency.

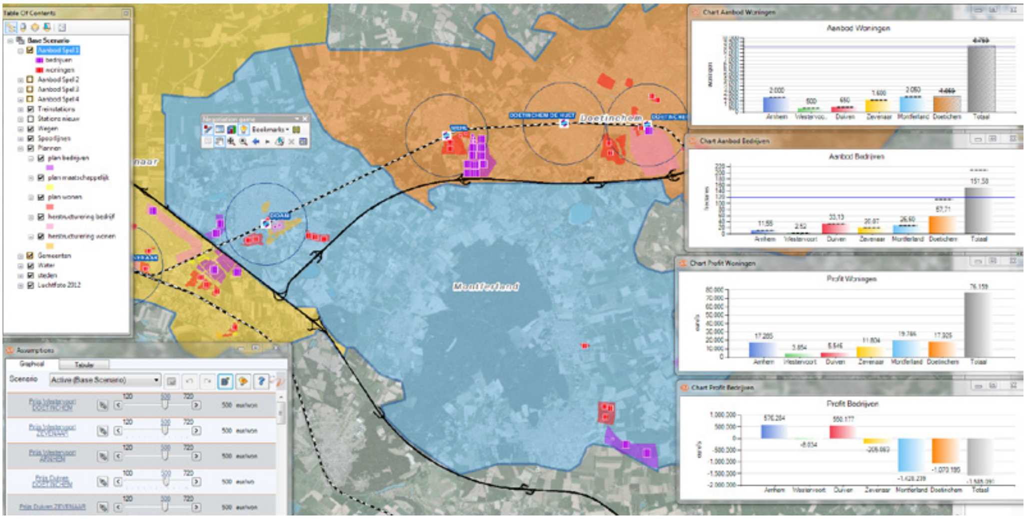
6.7 Achterhoek: negotiating planned developments

In the Achterhoek area in the eastern part of the Netherlands, there is an oversupply of planned locations for future area development. Under the so-called 'active land policy', the municipalities in this area have actively invested in acquiring land for future development. The present economic crisis and the continuation of expected demographic shrinkage in this Achterhoek area forces its municipalities to readjust their plans. One solution could be that the municipalities cooperate more closely to decrease the amount of planned development locations in general. Competition between the municipalities with regard to attracting new businesses and new inhabitants hinders such a solution. A compensation and redistribution mechanism referred to as 'Transferable Development Rights' (TDR) could be introduced to help adjust supply and demand in the corridor and potentially lead to an increased overall development (cf. Levinson 1997) .
In order to deal with the competition and cooperation between these municipalities as well as to investigate the preconditions for introducing transferable development rights, two workshops were organized by the Radboud University Nijmegen. Therein, a negotiation process was simulated between the six municipalities involved using local and regional financial and geographical data on the development of housing and industrial estates. In the first workshop regional participants from the region of Arnhem-Nijmegen and the province of Gelderland participated. In the second session civil servants from the six municipalities participated.

The MapTable PSS supported the spatially-explicit negotiated allocation of municipal development rights on the MapTable map for the Achterhoek area (see Figure 6.7). It featured an integration of the interactive GIS software and a gaming negotiation tool that included four rounds of a serious game (cf. Samsura 2013). The gaming negotiation tool calculates financial impacts as a function of the intended spatial developments as well as the maximum regional supply, individual municipal supplies, and the regional demand for future spatial plans. The goal of the game is that all players reach a fair distribution of spatial plans that generates profits as close as possible to their maximum theoretical profits. Players are required to negotiate with each other to increase and decrease their plans for housing and industrial areas. Changes made to these plans result in real-time calculations of the financial outcomes of all municipalities involved.

In the workshops, the PSS offered *communication support* for the negotiations between the participants. The municipalities needed to negotiate on their individual plans in order to solve the regional (Achterhoek) problem of over-supply of area development plans. The game was centered on the premise that by

Figure 6.7 Screenshot of PSS for the Achterhoek



The screenshot shows a list of background maps (left), map display (middle) and dynamic charts with financial impacts (right). Interactive sliders for price are also shown (bottom left). In the map display, development rights are represented by color-coded boxes of two sizes (small and big) for both housing (red boxes) and industrial spatial developments (purple boxes).

engaging in collaboration, the participants would come to a better outcome for the whole area; by applying a tit-for-tat exchange, everyone would be better off. Because the discussion took place with all participants standing directly around the MapTable PSS, the possibilities for participants to act as ‘free riders’ were limited. The participants could directly be addressed by other participants and convinced to participate in the collaboration process, in order to serve common regional public goals. Participants got the chance to communicate how they perceived the problem of oversupply of area development plans, and their perspective on how this could and should be solved. The MapTable PSS supported negotiations by making individual desires explicit, identifying the competitive tensions between the municipalities, and, potentially, supporting the achievement of agreements. However, when playing the game with the civil servants of the municipalities , the increased transparency through the communication support of the PSS did not always support reaching agreements, as illustrated by one of the civil servants: “*When I hear the plans of the other municipalities, I am not willing to reduce my plans. I expect a broader support for the reduction of development plans. I made a serious offer and I expect more* [from the other municipalities]”. The competitive tensions, which fuel this behavior of the municipal participants, did not obstruct the process of reaching consensus when the game was played with representatives from regional and provincial organizations in the first meeting. These participants were not burdened by local sensitivities, used the communications support of the PSS to act in the interest of the whole region and came to a decrease of the oversupply of development plans.

In terms of *analytical support* for the negotiation task, the MapTable PSS allowed participants to assess the impact of their negotiated business and residential development rights in financial terms. The economic model in the PSS calculates profits and losses, revenues and payoffs. Although the participants, especially those from the municipalities, contested some of the data for not being accurate and sufficiently up-to-date ("*Correct numbers are crucial for the game.*"), all participants expressed that they gained more insight into the plans of other municipalities and into the future economic consequences of these plans. As one participant remarked: "*The game did a fine job. We could stand around the map and zoom in and explore predicted outcomes of the plans*". In terms of usefulness, this was mainly perceived to be the iterative feedback from the MapTable PSS on the proposals and the wishes and desires of the other participants, which, in turn, facilitated a more focused negotiation.

6.8 Task-technology fit in the four case studies

Table 6.3 depicts the main findings about task-technology fit based on the four case studies. We will now describe these findings more in-depth.

Table 6.3 Main findings related to task-technology fit in the four cases studies

Technology ***Task***	*Communication support*	*Analytical Support*
Exploration	Active dialogue Spatial language	More insight into problem Spatial language Hampers creativity
Selection	Transparancy Systematized approach	n/a
Negotiation	Learning about other stakeholders	Direct feedback

6.8.1 Exploration

In general, both communication support and analytical support have positive task-technology fit for the task of exploration. One of the notable kinds of usefulness related to communication support, which was mentioned both in the Rijnenburg and Arnhem case, is that standing around the table leads to an active and energetic dialogue (cf. Pelzer et al. 2014a). Hereby the focus of the workshop was on the content of the planning issue, and not so much on procedural aspects or irrelevant tangents. This was further exacerbated by the provided analytical support. In the case of Rijnenburg, giving direct feedback on proposed ideas showed the feasibility of certain ideas (e.g. placing a windmill in a certain location), but also led to new ideas (e.g. solutions for the way in which water management should be considered in the area). In Arnhem, combining different map layers allowed disclosing of similar patterns and associated existing spatial information, helping the participants to see new problems and solutions.

More generally, both the communication and analytical support capabilities of the MapTable PSS helped developing a spatial language, which enhanced both understanding the planning issue at hand and improving the dialogue among the involved stakeholders. Hereby, it should be noted that this spatial language might also have negative effects (i.e. a negative task-technology fit). The urban designer in Rijnenburg did not feel comfortable with the rather rigid maps and the quantitative impact analysis function, arguing the PSS hampers creativity and the flow of the process. While the dialogue around maps proved active and dynamic, some stakeholders of the Arnhem case felt overwhelmed with the amount of spatial information presented. Something which is confirmed by other studies about the relation between urban designers and GIS-based tools (Dias et al. 2013, Pelzer et al. 2014b).

6.8.2 Selection

As remarked earlier, the empirical analysis does not include a combination of analytical support and selection tasks. Therefore, we restrict ourselves to the combination of communication support capabilities of the PSS and selection tasks. The main added value in the Deventer case was that using the MapTable PSS led to a transparent selection process, in which all the market vendors could make their own choices and both clearly and systematically see the choices that were made before by others. This setup allowed for an effective way of communication between the city and the affected vendors. Moreover, it facilitated a procedure that was considered systematized and fair – provided the stakeholders agreed with the seniority principle.

6.8.3 Negotiation

The iterative element in negotiation makes both analytical support and communication support necessary. Participants need to be able to use the feedback from the analytical support on their proposed solutions in their communication to other participants. By providing relevant analytical support, the MapTable PSS facilitated the iterations in the negotiation task: participants could check whether their proposals would lead to realistic and acceptable outcomes. This way the MapTable PSS helped to effectively combine the financial negotiations with relevant spatial information and come to a more focused negotiation. The feedback from the MapTable PSS was considered to be useful for the negotiation task by all participants in the Achterhoek case. They got the possibility to spatially clarify both conflicts and opportunities for negotiations in addressing these conflicts. This played a crucial role in the analytical support of the MapTable PSS: participants could use the PSS to relate better to each other's financial-economic position and reach a more informed outcome. The MapTable PSS also generated more understanding of each other's behavior. A better understanding can enhance the relations between the participants which can be seen as a first step towards solving the regional problem of area oversupply. This better understanding is partly a result of the analytical support, but can be primarily be attributed to the communication support of the Maptable PSS. By bringing the participants together around a MapTable and facilitating interaction between the participants supported by the MapTable PSS, the type of communication support is offered that could mean a first step towards reaching consensus.

However, the combined analytical and communication support can simultaneously be a potential bottleneck for the MapTable PSS. A first reason is that in some instances stakeholders might not want to share all information because of tactical reasons. The PSS makes the impact of choices very explicit, which might restrict the space to maneuver of the participants. A second reason is that the data quality in the MapTable PSS must be very high in order to directly facilitate decision-making negotiations. In the dynamic land and real estate market, it is nearly impossible to incorporate such up-to-date information in a model that effectively reflects the complexities of land development processes. In other words, the analytical support can hardly keep up with the communication support that is desired in real-world negotiations. Therefore, at first sight, the tool seems to fit best in the explorative stages of a decision-making process, when communication support seems more important than analytical support, because there is not yet a need for very detailed and quick reflections and solutions.

6.9 Conclusions and Recommendations

The research question raised in the introduction of this paper is: How can a better conceptual and empirical understanding of the relation between planning tasks and PSS lead to improved insights about the support function of PSS? In order to address this question, we investigated the concept of task-technology fit through a comparative case study. We believe this concept can lead to a better understanding of the usefulness that is reachable by different planning support capabilities of a PSS for different tasks. The task-technology fit depends on the support a PSS can offer to the planning tasks, in terms of analytical support and communicative support. In general, we can conclude that PSS can offer both these types of support, but that the usefulness for specific planning tasks differs. For instance, we found that analytical support can provide valuable feedback on the necessary iterations that are part of a negotiation task. With regards to communicative support, we found, among other things, that a table top displaying a digital map, sparks an active and content-based dialogue among the involved participants. However, some reflections about these findings should be noted.

The concept of task-technology fit means a PSS can both be positive and negative for conducting a specific task. The emphasis in this paper – arguably also that of the PSS debate in general – has been on the positive aspects related to a PSS application (i.e. 'usefulness' or 'added value'). However, support capabilities of a PSS can also have a negative effect on conducting a task. For instance, the urban designer felt the analytical support provided in the Rijnenburg case hampered successfully conducting the exploration task. This potentially negative role of technology is also found in a recent paper by Smith et al (2013), arguing that GIS can become performative, and hereby steering rather than supporting the process.

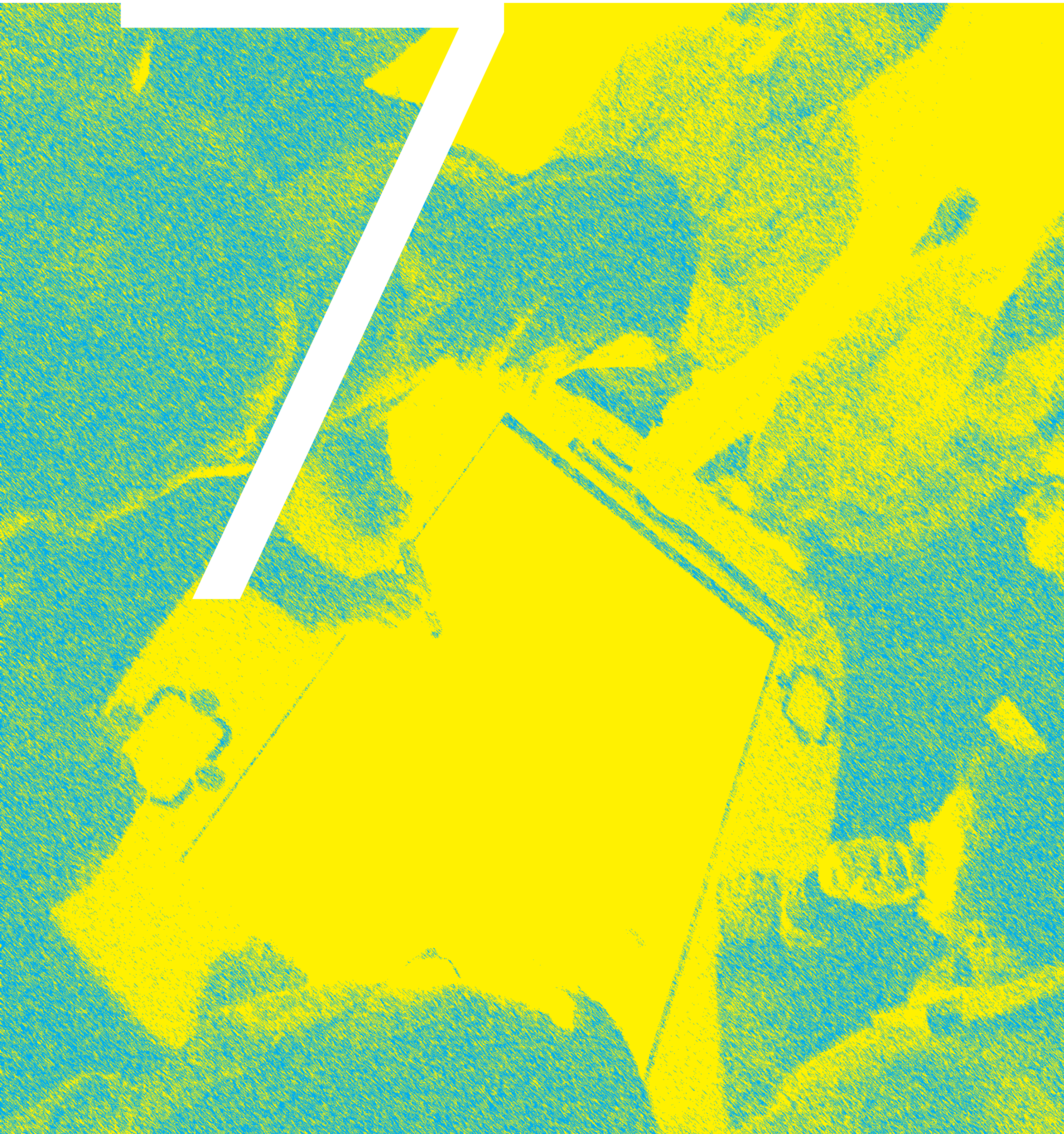
Moreover, whereas the distinctions among different support capabilities and different planning tasks are generally helpful, in some instances they are very hard to disentangle in empirical research. For example, feedback by the MapTable PSS on proposed solutions is considered analytical support, it might, however, also lead to a discussion among involved stakeholders, in which it functions as communicative support. Planning tasks are arguably easier to discern. A notably finding, however, is that negotiation often consists of elements of both selection and exploration. Hence, it is not so much distinguishable from the other tasks by the activities it is comprised of, but by the involved stakeholders (usually with diverging or contrasting insights) and the outcome of the task (often some kind of consensus or agreement).

Nonetheless, while a focus on planning tasks is valuable, this is not the only way in which the usefulness of PSS can be conceived. In several of the case studies the usefulness of the MapTable PSS was found to be at a higher level. For instance, one of the broader aims of applying a MapTable PSS in the case of Rijnenburg was to improve the collaboration and communication among different disciplines, which seemed quite successful. Moreover, in the Achterhoek case, the MapTable PSS helped to cross regional boundaries, because actors that were not used to talk to each other were urged to literally stand around a table together and discuss matters with each other.

This paper has only started to scratch the surface of empirical research about the usefulness of PSS for planning practice. Although the concept of task-technology fit has been out there for quite a while, we believe it has value for future empirical research in the field of PSS. The concept does not only provide a better understanding of the usefulness of PSS, but it also has concrete implications for PSS developments. Besides considering the content of the planning issue, which should always be the starting point for PSS development, PSS have to take into account support capabilities in order to successfully support specific planning tasks. Although this paper has carefully considered different planning tasks and support capabilities in its case selection, both the PSS (MapTable PSS) and the context (the Netherlands) are fixed. Future research with different PSS and in other contexts would be very valuable. Methodologically speaking, we believe comparative case studies are a helpful way to research this, because it helps to see the instrument applied in their respective contexts and prevents focusing too strongly on instrumental characteristics. Furthermore, at present such studies are becoming feasible, because besides CommunityViz also other PSS like What If? are relatively frequently used in planning practice. Such a larger body of cases would also allow for conduction unified questionnaires, which is – next to the TTF-concept – a common and fruitful tradition in the MIS and GSS debate.

Chapter 7

Understanding the Usefulness of Planning Support Systems: a conceptual framework and a case study from practice



Submitted a peer-reviewed journal.

Abstract

The purpose of Planning Support Systems (PSS) is to support different tasks conducted in planning or policy processes. In recent research more attention is paid to measuring their 'performance' or 'effectiveness'. This paper argues that this is a great step forward but simultaneously proposes that more attention should be given to the influence a tool has on the tasks that practitioners conduct. A conceptual framework is proposed in which 'usefulness' is understood in terms of usability and utility. This framework is evaluated through a real-world case study with Urban Strategy (US), a PSS based on coupled environmental and traffic models. A study was made on a workshop using a range of methods: a questionnaire, interviews and observations. The findings indicate that 'utility' in particular, conceived as task-technology fit, is helpful in understanding a PSS application. This concept helps to point out when a PSS has a negative effect on conducting planning tasks, for instance.

7.1 Introduction

Planning Support Systems[16] (PSS) are dedicated instruments to support planning and policy processes. Geertman (2008, p.217 – emphasis in original) defines PSS as: '... geo-information technology-based instruments that incorporate a suite of components that collectively support some specific parts of a *unique professional planning task*'. This definition underlines the fact that the focus in the PSS has shifted from primarily understanding and predicting spatial phenomena through quantitative models and spatial analysis to facilitating the tasks planners conduct. In hindsight, Britton Harris' article from 1989, in which he explicitly uses the term PSS, can be considered a turning point. Before that time, most of the academic attention was directed at improving the rigor of models, believing that this would also lead to better decision-making[17]. Already in 1973 and again in 1994, Douglass Lee Jr. formulated a devastating critique (a 'requiem') on this premise in relation to the specific characteristics of large scale models, which traditionally comprised an important part of a PSS.

16 For conceptual clarity, the term PSS is used consistently throughout the paper. Both the argument and empirical case study are arguably also relevant for Environmental and Spatial Decision Support Systems. Just like Nyerges et al. (2006), this paper sees these kinds of instruments as largely overlapping.

17 Note that in adjacent debates about decision support and the science-practice interface, other ideas about the role of support tools had already developed earlier (e.g. Van Lohuizen 1986, Weiss 1977).

Since Harris' (1989) article, a lot more academic attention has been paid to the way in which tools do not only describe and predict spatial reality, but in which they are also useful for planners. Roughly two categories can be discerned within this debate: articles with a more conceptual focus, often combining insights from planning theory with insights from spatial analysis (Batty & Harris 1993, Couclelis 2005, Geertman 2006, 2008, Klosterman 1997, Moore 2008) and case studies describing the application of a PSS in a specific planning context (for overviews: Brail & Klosterman 2001, Brail 2008, Geertman & Stillwell 2003, 2009, Geertman et al. 2013). Although these case studies show a strong awareness of the relation with planning practice, most of these studies are characterized by a central focus on the instrumental characteristics of the PSS (with the notable exception of Geertman & Stillwell 2009). Moreover, while increasing attention is paid to the added value of PSS for planning practice, this is hardly ever measured empirically (te Brömmelstroet 2013).

Recent studies have responded to this omission, by explicitly measuring and understanding the performance and effectiveness of support instruments (Arciniegas et al. 2013, Bennet et al. 2013, Goodspeed 2013b, Haasnoot et al. Inman et al. 2011, Nyerges et al. 2006, Pelzer et al. 2014a, te Brömmelstroet 2014, te Brömmelstroet et al. 2013). The results of these studies are not yet conclusive but it is clear that the performance of PSS can be expressed in terms of scores on a range of sub-dimensions related to both the process and outcome of planning and policy processes (McIntosh et al. 2011, Pelzer et al. 2014a, Te Brömmelstroet 2013). Hereby, it is not very clear how the causal relations work that lead to high performance. Whereas several ideas have been developed regarding explanatory variables, such as involvement in the development of the tool and the transparency of the tool (e.g. te Brömmelstroet 2010, Vonk et al. 2005, 2007), the exact relationship with performance remains somewhat opaque. One of the problems in this regard is that many empirical studies report on experiments or workshops aimed at evaluating the tool, rather than studying the usage of PSS in practice.

This paper develops the argument that in order to truly bring the debate about dedicated support tools forward, more attention needs to be paid to how users perceive the role of these tools. Whereas quality criteria related to the tool, such as validity and rigor, are important explanatory variables for an effective PSS application, they are sometimes conceived as dependent variables (e.g. Bennet et al. 2013). But arguably, what is more critical is the influence on practice. Or as a recent position paper in an adjacent field unambiguously puts it: 'if the EDSS [Environmental Decision Support System] does not bring added value to the decision-making process or is not cost-effective compared to other means of achieving the same outcome, the need to develop the EDSS must be questioned' (McIntosh et al. 2011, p.1400).

Achieving this added value for practice means paying careful attention to the demands and perspectives of users (Geertman 2008). With this user perspective in mind, this paper uses the term 'usefulness' rather than 'effectiveness', 'performance' or 'added value'. With reference to this discussion, the paper follows the work of Nielsen (1993), who proposes a rather simple framework in which usefulness is the result of the utility and usability of a PSS. In unravelling the concept of usefulness in relation to PSS and applying this in an empirical setting, the paper is structured as follows. It starts with a literature review describing earlier research into the usefulness of PSS and clarifying the concepts of utility, usability and usefulness. This section ends with a conceptual framework and two hypotheses. Next, the methodology section introduces the case study that was researched, including the research methods that were applied. Section 7.4 describes the main findings from the case study, followed by a reflection in section 7.5 in which the two hypotheses are assessed. The paper ends with conclusions and recommendations for further research.

7.2 The Usefulness of PSS

7.2.1 From leaps of faith toward usefulness

In a recent article, te Brömmelstroet (2013) laments about the fact that PSS case studies hardly ever systematically measure the claims about the performance[18] of the instruments they describe. Implicitly, in several case studies, assumptions are made about the added value of the PSS, such as more efficiency, better participation and a more sustainable outcome, but these are – perhaps very valid – leaps of faith rather than empirically grounded outcomes. This situation is arguably a result of the traditional focus on instrumental characteristics, in which measuring the function of the tool receives little attention.

In recent studies, more attention is given to this aspect. Firstly, several studies measure the extent to which the instrument is usable, which, for instance, refers to the extent to which the instrument is transparent (e.g. Bennet et al. 2013, Haasnoot et al. 2014, te Brömmelstroet 2013). Secondly, a range of studies measures the effectiveness of tools, which is a combination of usability characteristics and the effect on the planning or policy process (e.g. Arciniegas et al. 2013, Inman et al. 2011). Thirdly, and partly inspired by the earlier work in group model building (Rouwette et al. 2002), recent studies pay more attention to the explicit measurement of the impact of a PSS on the planning process. Pelzer et al. (2014a), for instance, applied a Group Decision Room (GDR) to get a better understanding of the added value of map-based touch tables in planning practice. They find that frequent users particularly emphasize process-oriented variables, like collaboration and communication. Whereas Pelzer (2014a) and also te Brömmelstroet (2013) use rather broad frameworks to categorize PSS performance, other studies focus on specific performance dimensions.

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[18] Note that the usage of the term ‘performance’ varies in the academic debate. For te Brömmelstroet (2013) it refers to the effect on process and outcome variables, whereas for Bennet et al. (2013) performance refers to the validity of the instrument itself.

Learning effects are an example of a usefulness indicator that is frequently mentioned in recent empirical PSS studies. Goodspeed (2013b), for instance, finds relatively strong learning effects in his study of planning workshops in Austin, Texas, supported by the PSS Envision Tomorrow. Important explanatory variables in Goodspeed's study are the quality of the dialogue in the workshop and the background of the participants.

Pelzer et al. (2013) and te Brömmelstroet (2010) focus on learning among different disciplines with the help of a PSS. They confirm the general awareness that in some disciplines (e.g. transport planning, environmental planning) quantitative methods are broadly accepted and applied whereas in other disciplines (e.g. spatial planning, urban design) such methods are much more foreign. A way to overcome this issue is to organize a careful dialogue, in which all the stakeholders have input in developing the PSS. In a somewhat simplified form, the causality in this regard works as follows. By involving users in the development of the PSS, their perception of the usability of the tool (e.g. transparency, user-friendliness) will increase and as a consequence, the usefulness (in this regard, learning) will also increase.

While there is clearly an increasing body of empirical literature about the usefulness of PSS, conceptualizations are not always consistent. For instance, Pelzer et al. (2014a) use the term 'added value', whereas te Brömmelstroet (2013) uses the term 'performance', while they essentially refer to the same thing: influence on the process and outcome. On the other hand Bennet et al. (2013) also use the term 'performance', but they refer to the rigor of the model. This paper proposes to use the term *usefulness*, which according to Nielsen (1993, p.24) is the 'issue of whether the system can be used to achieve some desired goals'. PSS usefulness has two interrelated dimensions: (1) the different *kinds* of usefulness a PSS can have, such a more informed outcome and increased efficiency, and (2) the *extent to which* practitioners perceive that a PSS can help them in conducting their planning tasks. In order to study the different *kinds* of usefulness, this paper uses a conceptual framework developed by Pelzer et al. (2014a), which is depicted in Table 7.1. Equally as important as understanding what usefulness is, is how it can be achieved. Put differently: what are the causal factors explaining usefulness? Nielsen (1993) proposes two main explanatory variables: utility and usability. These two concepts will now be elaborated in more detail.

7.2.2 Utility

According to Nielsen (1993, p.25): 'utility is the question of whether the functionality of the system in principle can do what is needed'. In the context of PSS, 'do what is needed' refers to the effect on the planning tasks a PSS aims to support (Klosterman 1997, Geertman 2008). A way to make sense of utility in the case of PSS is offered by the concept of 'task-technology fit' (from now on: TTF, Goodhue and Thompson 1995, cf. Vonk 2006). The basic premise of this concept is rather simple: utility can only be achieved if the characteristics of the technology (i.e. the PSS) are suitable for the planning task that has to be

Table 7.1 Overview of different kinds of usefulness, source: Pelzer et al. (2014a)

Kind of Usefulness	*Definition*
Learning about the object	Gaining insight into the nature of the planning object.
Learning about other stakeholders	Gaining insight into the perspective of other stakeholders in planning.
Collaboration	Interaction and cooperation among the stakeholders involved.
Communication	Sharing information and knowledge among the stakeholders involved.
Consensus	Agreement on problems, solutions, knowledge claims and indicators.
Efficiency	The same or more tasks can be conducted with lower investments.
Better informed plans or decisions	A decision or outcome is based on better information and/or a better consideration of the information

fulfilled. The work of Dennis et al. (2002), applied in the context of Group Support Systems (GSS), inspired this paper in the conceptualization of tasks and technology.

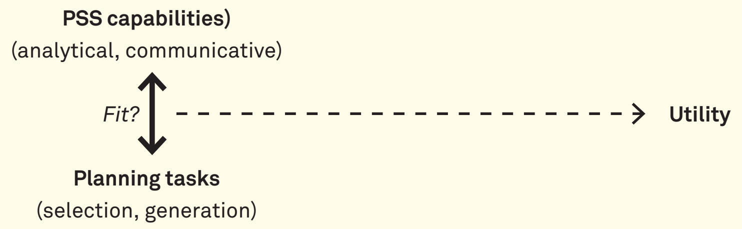
Planning *tasks* are: 'combinations of planning behaviors that accomplish particular functions or purposes' (Hopkins 2001, p.187). Dennis et al. (2002, p.171) make a distinction between 'generation tasks' and 'decision-making tasks'[19]. *Generation* tasks refer to a process of exploration, in which problems and possible solutions are explored. Decision-making tasks (from here on: *selection* tasks), on the other hand, refer to the choice for the issues that are put on the agenda in the context of problem identification or selecting and choosing a planning intervention: a process which can also be cast in terms of 'opening up' (generation) and 'closing down' (selection) (Rydin 2007, for PSS: Pelzer et al. 2015).

Technology refers to the capabilities of the PSS to support the planning tasks. Dennis et al. (2002) argue that there are two types of these support capabilities: communication support and information processing support. Based on earlier work in planning and PSS (in particular: Hopkins 2001, Vonk 2006), the support

[19] Note that Britton Harris, one of the godfathers of PSS, already made a very similar distinction in 1965.

capabilities of PSS can be considered either *analytical*[20] or *communicative*. Analytical support refers to capabilities of the PSS aimed at improving the understanding of the planning issue. The most notable, if not defining (cf. Brail 2006), characteristic of PSS in this regard is the ability to perform impact analyses, allowing us to see the effect of conducting a planning intervention. Another important characteristic, particularly for long term planning issues, is the ability to perform scenario analyses. This allows us to explore the different fundamental changes that may happen in the context of a planning system (e.g. Couclelis 2005, Hopkins and Zapata 2007). Communication support, on the other hand, recognizes that planning tasks are not conducted in laboratories but are collaborative processes including a range of stakeholders. The capabilities of a PSS should facilitate the communication between the stakeholders involved. Put differently, the focus is on knowledge exchange rather than information provision. In the aforementioned study by Pelzer et al. (2014a), it was found, for instance, that the so-called map-based touch table plays an important role in communication support because participants find it easier to make their ideas explicit on a geographical map. Moreover, standing around a table leads to a more intense dialogue. In Figure 7.1 the way in which utility is conceived in this paper is depicted.

Figure 7.1 Utility conceived as Task-Technology fit



7.2.3 Usability

A reason why map-based touch tables, for instance, can now be applied for communication support is that their *usability* has increased significantly over the last decade. Usability, according to Nielsen (1993, p. 25) relates to, ‘the question of how well users can use that [utility] functionality’. Recent studies have done a fairly thorough job in making the usability variables that influence the usefulness of a PSS explicit (in particular: Goodspeed 2013b, te Brömmelstroet 2010, Vonk 2006). In Table 7.2, the ten most important usability variables of PSS that are mentioned in current literature are summarized. Two important remarks should be made regarding this table. First, the importance

[20] This is similar to information processing as perceived by Dennis et al. (2002). We consider ‘analytical’ a more common concept in planning, however.

of these usability variables differs from one planning issue to another. For instance, when analyzing the future of a brownfield area with a group of environmental analysts, it might be very important to get a very detailed insight into the environmental factors (e.g. noise, air quality etc.), whereas when a long term vision for a region is developed, more unrefined information might be more suited (usability variable: *level of detail)*. Second, although these usability factors might in some instances be *necessary* conditions, they are not *sufficient* conditions for high usefulness.

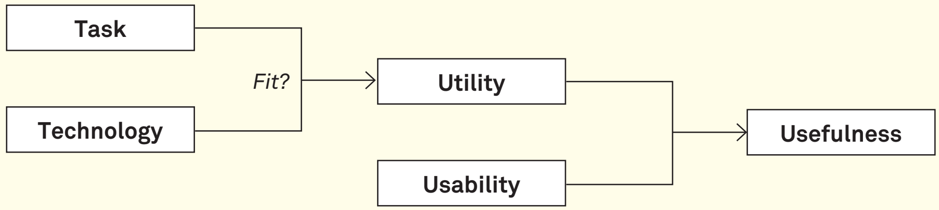
Table 7.2 **Commonly used usability variables in PSS research, based on Arciniegas (2012), Goodspeed (2013b), Te Brömmelstroet (2010), Vonk (2006).**

Usability variable	***Description***
Transparency	*The extent to which the underlying models and variables of the PSS are visible to users.*
User friendliness	*The extent to which participants are able to use the tool themselves.*
Interactivity	*The extent to which the tool can directly respond to questions and suggestions of the users.*
Flexibility	*The extent to which the tool can be applied for different planning tasks.*
Calculation time	*The time participants have to wait before an analysis is conducted.*
Data quality	*The extent to which the input data is considered valid.*
Level of detail	*The extent to which the tool's level of detail matches the perspective of participants.*
Integration	*The extent to which the tool takes all the relevant dimensions into account.*
Reliability	*The extent to which the outcomes of the tool are considered reliable.*
Communicative value	*The extent to which the visual output is useful for the participants.*

7.2.4 Conceptual framework and hypotheses

The framework including utility, usability and usefulness is graphically depicted in figure 7.2.

Figure 7.2 Usefulness as an outcome of Utility and Usability



The first and prime purpose of this paper is to evaluate whether this framework adds something to the existing literature on the added value of PSS. In doing so, the paper will assess the following hypothesis: *[Hypothesis 1] A conceptualization of the usefulness of PSS, from the perspective of usability and utility, is fruitful and feasible.*

In addition to this hypothesis, according to a very wide range of literature, resulting, arguably, in academic consensus, models have the highest level of usefulness for policymaking if the intended users are involved in their development (te Brömmelstroet 2010, McIntosh et al. 2011,Van Delden et al. 2011, Voinov and Bousquet 2010, Wassen et al. 2011). This can range from collaboratively developing a complete model, as in the case of group model building (e.g. Rouwette et al. 2002, Vennix 1996), to asking participants to give input about the parameters (Pelzer et al.2013). Hence, with regards to usability and utility, the hypothesis is that involvement in the development of the tools leads to higher scores on these dimensions and, as a consequence, a higher usefulness. This leads to the second hypothesis: *[Hypothesis 2] A positive relation exists between involvement of users in the tool and increased usability and utility, and as a consequence, usefulness.*

The concepts of usefulness, utility and usability, and the two hypotheses were studied through an in-depth case study that was conducted in the Netherlands. This study will be described in the next section.

7.3 Case description & methodology

In order to thoroughly research the usefulness of PSS in practice, this study looked for a situation in which a state of the art PSS was used *and* which reflected practice as closely as possible – something rather scarce in the current debate. In order to do so, a workshop was organized together with TNO (a Dutch research company) and the Municipality of Utrecht. The details of the workshop will be described below.

7.3.1
The PSS: Urban Strategy

The PSS that was researched in this case study is Urban Strategy, an interactive digital support instrument developed by the Dutch research company TNO (www.tno.nl/urbanstrategy). Urban Strategy is based on a framework that combines a range of impact models in a GIS-environment, in particular noise, air quality and traffic[21]. For instance, dwellings can be added to a plan area, which will change the land use. This then causes a rise in traffic in and to the area, which again generates changes in scores for noise and air quality. The outcomes from the model runs are visualized in a 1D environment (tables with scores), a 2D environment (a map) and a 3D environment (a Marquette), as illustrated in Figure 7.3. Urban Strategy has been applied in several case studies, particularly in the Netherlands, often in instances where the environmental situation is challenging, such as brownfield developments or areas close to arterial roads. Moreover, prior to the case study in this paper, Urban Strategy was extensively tested in experiments with students (te Brömmelstroet 2014).

7.3.2
Case description: Cartesiusdriehoek

The plan area, called the Cartesiusdriehoek, is located in the city of Utrecht in the Netherlands and is bordered by two railway tracks, giving it a triangle-like shape. Traditionally, the area had a primarily industrial function with some residential zoning. In the last few years it has become an explicit aim of the Municipality of Utrecht to make the area more diverse in terms of functions. The main arterial road in the area is the Cartesiusweg, which cuts the area into two parts. East of the Cartesiusweg is the actual 'Cartesiusdriehoek'. This is a so-called 'transformation' area where the Municipality of Utrecht aims to encourage the location and development of different activities, such as housing, amenities and commercial functions. The area west of the Cartesiusweg ('Werkspoorkwartier') contains industry and is bordered by a large industrial area (Lage Weide). No dwellings are planned in this area since the main aim is to attract small commercial firms.

7.3.3
Workshop description

The workshop was conducted on March 11, 2014 at TNO, a Dutch research institute, in Utrecht. It lasted for three hours and after the workshop a group evaluation was conducted. The workshop had the following characteristics (see Figure 7.5 for an impression):

›› It took place in TNO's ***workshop room*** (see Figure 7.4), which had a large table, several screens and a touch table. To facilitate brainstorming in separate groups, an additional room was available.

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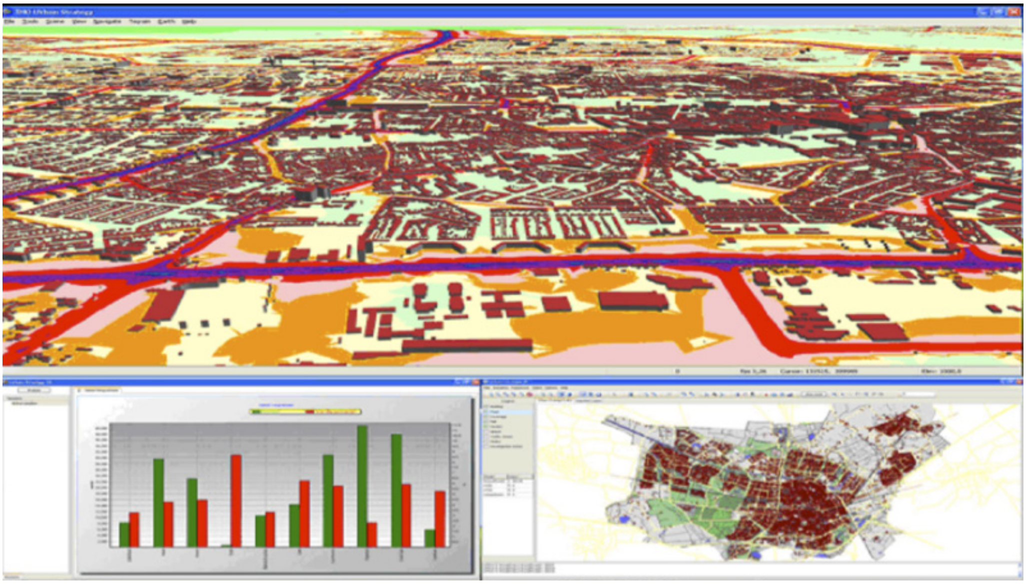
[21] In principle, any kind of impact model could be integrated in Urban Strategy. However, for Dutch applications the tendency is to use the models that are legally accepted.

Figure 7.3 **The 3 interfaces of Urban Strategy: 3D (above), 2D (right below) and 1D (left below).**



›› Besides Urban Strategy, several complementary ***support instruments*** were available: large paper maps, a whiteboard, a touch table and internet-connected computers with large screens to access Google Streetview and the website of the Municipality of Utrecht, which also has an extensive information base. The function of the support tools was twofold: to gather knowledge from the stakeholders involved (whiteboard, paper maps) and to provide the stakeholders with information (Urban Strategy, web browsers).

›› The ***stakeholders involved*** (n=9) were all part of the area team for the Cartesiusdriehoek at the Municipality of Utrecht. Central roles were fulfilled by the 'Area Manager' (leading the meetings) and the 'Area Secretary' (facilitating internal and external communication). The area team included several disciplinary experts, including: an environmental analyst, a transport planner, a housing expert and an urban designer.

›› The ***agenda*** of the session consisted of two main stages. The first 45 minutes were used to explore challenges and opportunities in two groups (*generation tasks*). This resulted in a list of problems and solutions, which were written down on a whiteboard. Next, a selection was made of the topics that could be further analyzed with the help of Urban Strategy. The remainder of the workshop focused on iteratively analyzing the problems that were raised in the brainstorm session (*selection tasks*).

Figure 7.4 Schematic depiction of the workshop room. Urban Strategy was depicted on the large TV screens and operated by the chauffeur via laptops.

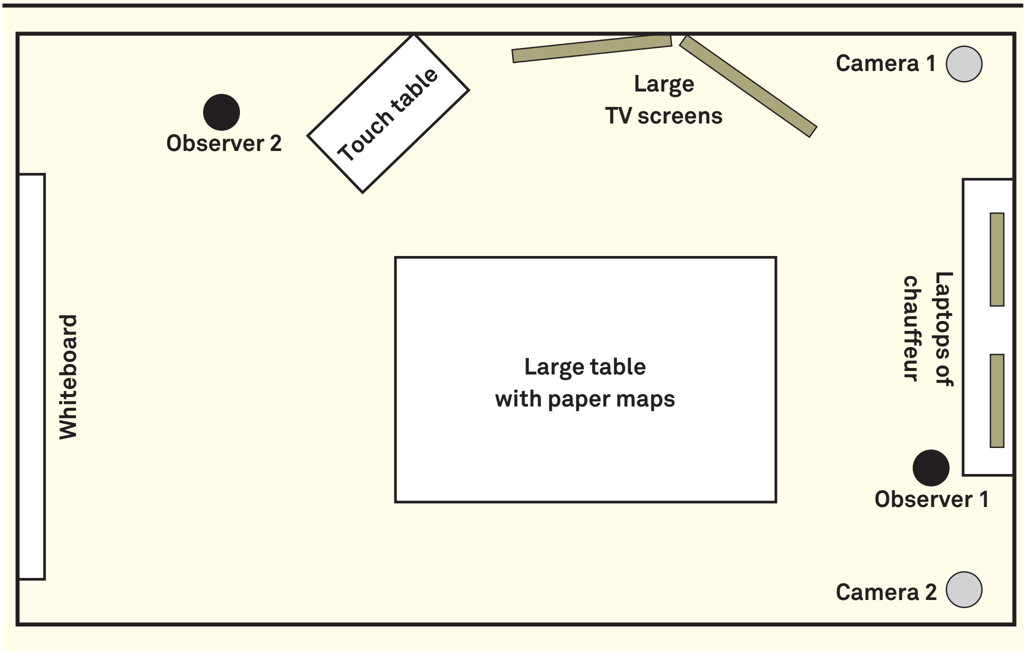


Figure 7.5 Pictures taken during the workshop.

7.3.4

Research Methods

The following methods were applied to study the workshop: ***a questionnaire, observations*** and ***qualitative evaluations.***

›› The ***questionnaire*** after the workshop focused on four dimensions: background characteristics of the participants, the focus of the workshop, the usability of the PSS and the usefulness of the workshop. It mainly consisted of Likert items and scales on a 1 to 7 scale (1= strongly disagree, 7 = strongly agree). Participants were also asked to identify the most important usefulness of Urban Strategy based on their experiences in the session. The survey started with some open background questions and ended with open questions about the session.

›› The workshop was ***observed*** in two ways. First, two external researchers observed the whole session and made notes, resulting in short reports. Second, the whole workshop was recorded with cameras and audio devices. All that was said during the session was described verbatim.

›› After the session, a ***qualitative evaluation*** was conducted in a group with all the participants, in which they reflected on the workshop and Urban Strategy. In order to let the participants speak frankly, the chauffeur and moderator were absent during this session. In addition, a feedback interview was conducted with the transport planner from the Municipality of Utrecht who was involved in organizing the session. He helped with interpreting the findings from the questionnaires, among other things.

7.3.5 Analytical approach

The empirical strategy to analyze the workshop aimed at making full use of the mixed methods that were applied. The three research methods outlined above were applied in order to achieve ‘methodological triangulation’, i.e. studying the research object from different viewpoints (Denzin 2006). Each of the methods has its specific benefits and shortcomings. The questionnaire was used to discern patterns in terms of usability and usefulness. Because of the low n, more sophisticated quantitative methods were not possible. The group evaluation provided a more nuanced, and sometimes different, insight into the utility, usability and usefulness of the PSS, whereas the observations led both to descriptive and explanatory insights about the workshop. Moreover, they provided a different perspective because they reflected the perspective of experienced PSS researchers, which is different from that of the practitioners. The empirical results from the three methods were analyzed as follows.

›› The findings from the questionnaire were analyzed to gain insight into the patterns of perceived usefulness and perceived usability.
›› The two observers wrote a short report based on their observations during the session. In addition, the transcripts and video images of the session were analyzed by a third researcher to corroborate and refine these findings.
›› The group evaluation and feedback interview was coded using NVivo© qualitative data analysis software. This was done in an open coding process (Corbin and Strauss 1990) whereby the focus was on identifying and understanding the positive and negative aspects of the session.

7.4 Findings

The workshop started with a brainstorm session of around forty five minutes, supported by a paper map (*generation task)* to identify the main challenges in the area. The following two and a half hours were dedicated to evaluating the different challenges in the area and their possible solutions (*selection tasks)*, which was supported by Urban Strategy. For the brainstorm session, the group was divided in two groups, which were then asked to indicate the most important challenges and potential solutions for the area on a map. This exercise went rather smoothly because the participants had already worked with the area for around two years. Hence, the generation task was a brief wrap-up of challenges and potential solutions that the participants were already aware of and it did not lead to new ideas.

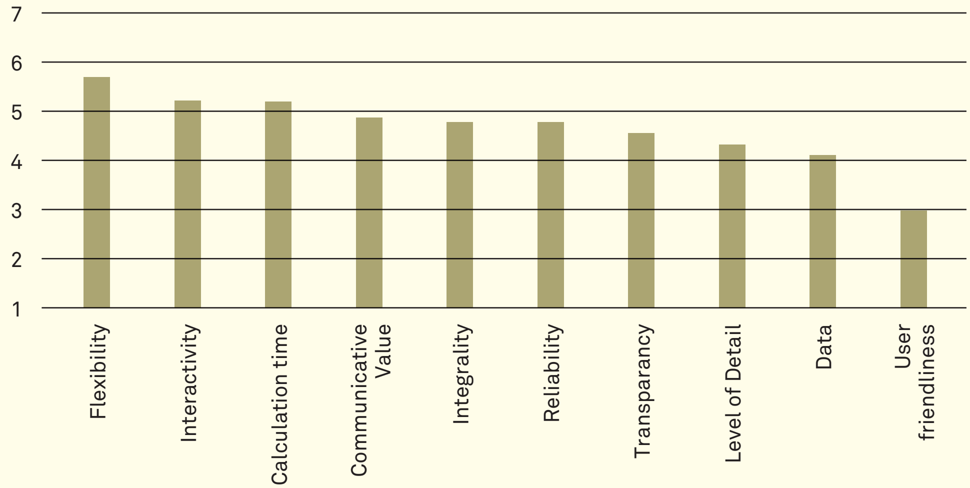
Next, the challenges and solutions that were identified on the paper maps were written down on a whiteboard, resulting in an unrefined list. In the following step, the chauffeur selected the ideas that could be further analyzed using Urban Strategy, including a proposal for a road diet for the main arterial in the area, adding additional dwellings to the area, and placing sound walls in order to reduce noise pollution in the area. In the next section I will zoom in on the findings related to the three main variables: usability, utility and usefulness.

7.4.1 Usability

Figure 7.6 depicts the average usability scores for Urban Strategy as measured by the questionnaire. Because the scores differ from participant to participant (for instance indicated by high standard deviations) these results should be treated with caution. Nevertheless, it is notable that the user friendliness of Urban Strategy is considered to be relatively low. When asked about this topic, it became clear that the main reason for this low score was the fact that the participants couldn't use Urban Strategy themselves: they always needed the support of a chauffeur.

Moreover, during the group evaluation it became apparent that the waiting time for the results of requested analyses was experienced as being relatively long but this was not considered to be a fundamental problem. Although the score in the survey was relatively high, the group evaluation conducted directly after the session revealed that Urban Strategy was not considered to be very transparent with regard to its structure of analysis and the models and calculation rules included. As one of the participants noted: *'I would have liked to get a better understanding of how this area works. I mean what is Urban Strategy based upon?'* However, because the tool was intensively prepared together with their co-workers from the Municipality of Utrecht (transport modelers who weren't at the session), in general, the participants trusted the outcomes. Moreover, the chauffeur, besides supporting the users in using the tool, also actively helped in interpreting the results, for instance about the way in which the different environmental models (noise, air quality) work and what the implications are.

Figure 7.6 Scores for Urban Strategy on the 10 Usability indicators on a 1 (very negative) to 7 (very positive) scale (n=9).



This need for interpretation was not so much related to Urban Strategy but to the fact that the workshop took place in an interdisciplinary setting, which requires extra explanation about the outcomes of transport and environmental models. Overall, however, the questionnaire indicates that the participants were relatively positive about the usability of the PSS.

7.4.2 Utility

Since the participants already had very extensive knowledge and ideas about the plan area, the *selection tasks* focused on refining challenges and solutions for the area. The support function of Urban Strategy for these tasks was evaluated as mixed. On a positive note, one of the aims, as indicated beforehand by the Area Manager, was to assess how much extra spatial development (i.e. dwellings, commercial functions) could be realized in the area before it would lead to significant frictions in terms of traffic congestion and environmental hindrance. Urban Strategy is well equipped to provide insight into this, according to the Area Manager.

Despite this positive note, a notable issue that became apparent at various times during the workshop was that certain thematic dimensions were lacking in the models included in Urban Strategy. Omissions were felt in particular with regard to traffic by other modalities than car: notably by bike and public transport, as well as with regard to a financial analysis model. The absence of the latter, in particular, was seen as problematic since financial considerations are critical in deciding about planning interventions. In addition, not all the analytical support provided by Urban Strategy was understood by all the stakeholders. This could partially be explained by some of the aforementioned specific usability issues, like a lack of transparency and low user-friendliness. In addition, other plausible explanations also emerged from the empirical material that will now be discussed.

A notable observation is that some of the tasks were simply too complex and unfamiliar to most of the stakeholders. For instance, understanding how traffic flows work requires quite a lot of background knowledge and perhaps even prior education. Hence, grasping how the analytical support of Urban Strategy works can be quite challenging. Hereby, part of the lack of understanding was related to the lack of experience with working with this particular technique and delving deeply into other disciplines, in particular transport planning and environmental analysis. As was indicated after the session by the Area Manager: *'It took quite a while before I really understood the tool'*, after which the Environmental Analyst continued: *'A second session would go very differently because then you know what the tool can do.'*

Although the primary aim of Urban Strategy was to provide analytical support, it turned out to play a role in communication support as well. The communication related to the selection tasks was between the participants on the one hand and the chauffeur and Urban Strategy on the other hand. Someone posed an issue or question to the chauffeur, who then entered it in Urban Strategy. After the calculation was finished, the chauffeur helped by communicating the outcomes to the participants again. Whereas this approach worked because it was well-structured, it was also considered to be a somewhat tedious exercise, rather than an energetic and dynamic dialogue in which knowledge was rapidly exchanged.

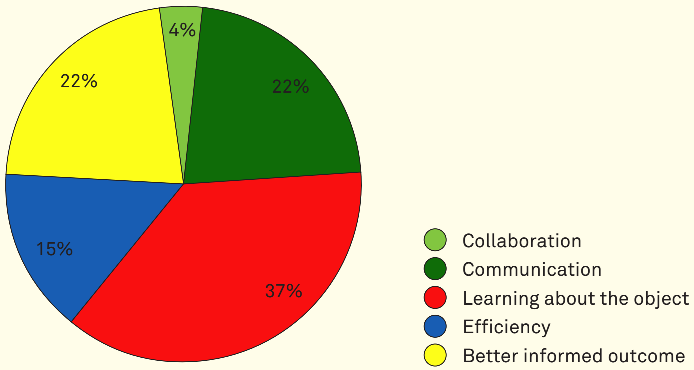
Besides that, Urban Strategy had an influence on the process of the workshop; it also had an influence on the substance. As was commented on above, topics emerging from the brainstorm session were filtered on their match with the available analytical support capabilities in Urban Strategy. However, as the workshop evolved, it became clear that the focus on transport dimensions (i.e. car traffic) and environmental dimensions (i.e. legal restrictions) limited the discussion. For instance, there is a railway track and a train station adjacent to the plan area, which weren't in the model. Participants indicated that they would have liked to perform more analyses on these dimensions (for instance, changing the frequency of passing trains).

7.4.3 Usefulness

The users of US were asked about the different *kinds* of usefulness of Urban Strategy. Figure 7.7 depicts the results of this measurement, showing a rather mixed picture. It is clear that there is no consensus about what the usefulness of Urban Strategy exactly involves; particularly learning about the object, better informed outcome and communication are mentioned a couple of times. Interpreted a bit differently, it can be argued that about half of the users indicated that usefulness is related to substance (learning about the object, more informed outcome) and the other half indicated that it relates to process characteristics (communication, collaboration, efficiency).

When asked about the *extent* to which Urban Strategy is useful in their daily practice, the participants acknowledged the potential of Urban Strategy, but argued that high usefulness could particularly be achieved when the tool is used selectively. More precisely, it was indicated that its analytic support capabilities are particularly useful in specific stages of the planning process (in this regard: in a much earlier phase) and for specific planning issues (in particular with a complex interaction of car traffic and environmental concerns). Moreover, the two observing researchers pointed out that not all of the practitioners experienced the same kind of usefulness; it can be questioned *for whom* the PSS is useful. A case in point is that during the workshop, the Area Manager was rather dominant and posed most of the questions which resulted in a series of calculations by Urban Strategy. Hence, whereas the Area Manager indicated afterwards that he got most of the answers he was looking for, this is less likely to be the case for all the other participants because they were less able to get the answers from Urban Strategy that they wanted. Although there was a dedicated facilitator aiming to improve the group process, the existing hierarchies and power relationships were also apparent during the workshop and this influenced the usefulness of the PSS.

Figure 7.7 **The most important usefulness of Urban Strategy ('added value') according to the participants of the session (n=9)**



7.5 Assessing the hypotheses

Section 7.3 proposed two hypotheses based on the literature used. These hypotheses will now be evaluated, based on the case study conducted using Urban Strategy.

7.5.1
Hypothesis 1

[A conceptualization of usefulness of PSS, from the perspective of usability and utility, is fruitful and feasible. Based on the experiences in the Urban Strategy case study, this hypothesis can be considered partly true. Whereas the distinction between usability and utility is, in principle, helpful, some overlap between the two concepts emerged in the analysis (e.g. communicative value as a usability indicator and communicative support capabilities as part of the utility). This problem could, however, be resolved by a more refined conceptualization. With regards to utility, this paper has only scratched the surface of the range of different planning tasks and the related planning support capabilities; the findings of the paper indicate that this is a relevant perspective. A case in point are the findings about utility (section 4.2), which are both more revealing and more extensive than the findings about usability (section 4.1). For instance, the insight that a PSS can – implicitly – have a negative communicative effect on a selection task is an insight that could be studied in future research.

The questionnaire indicated that the participants had varying opinions about the usefulness of Urban Strategy, which could partly be explained by the different backgrounds of the users. The aim of the Urban Strategy was not very precisely delineated beforehand, making it hard to compare this with the perceptions of users. In future research this could be addressed more explicitly.

Although the conceptual framework helped us to understand these issues, some issues remain. First, the background of the user is key in understanding the perceived usefulness of a support tool. Vonk (2006) calls this the technology-user fit. The fact that the utility (task-technology fit) of Urban Strategy was sometimes problematic is also related to the fact that for most users these kinds of selection tasks were both new and rather complex. Hence, when evaluating the support function of a PSS, the experience of users with a task and the complexity of the task itself should also be taken into consideration, since this might be an important confounding variable (Zigurs & Buckland 1998).

7.5.2
Hypothesis 2

A positive relation exists between involvement of users in the tool and increased usability and utility, and, as a consequence, usefulness.

To properly assess this hypothesis, a situation *with* involvement and a situation *without* involvement should have been part of the analysis. However, some relevant remarks can be made based on the case study. Most of the participants were not involved in the development of Urban Strategy. The main reason was that there was not much to choose for the users; Urban Strategy is based on fixed models representing legal environmental norms in the Netherlands. To a certain extent, the lack of involvement in the development of US limited the understanding of the function of the underlying models and hence the usefulness dimension of learning about the object (cf. te Brömmelstroet 2010).

At several times during the workshop, people were not sure how to interpret the outcomes of the model runs. This could explain why ‘learning about the object’ was mentioned in the questionnaire but was not a strong discussion point in the group evaluation. More involvement in tool development could lead to actually realizing this potential of learning. Moreover, some of the frictions with utility could have been prevented with more involvement of the users. For instance, Urban Strategy produced results that the group already knew about, or it could not address all relevant issues. Earlier involvement could have prevented this by focusing more strongly on analyses that would fit the selection task better.

Nonetheless, the participants did trust the outcomes of Urban Strategy. This was very likely due to the fact that the environmental and traffic modelers from the Municipality of Utrecht (their direct colleagues) were strongly involved in preparing Urban Strategy for the session. Hence, there was a sense of ownership related to the outcomes the different models produced, which had a positive influence on the usability scores of Urban Strategy. Although the tool was not transparent, the participants trusted the findings, nevertheless. This can be considered as a kind of indirect tool involvement, which can improve usefulness, with the notable exception of learning. Hence, with some caveats it can be argued that the role of involvement is dependent on the intended usefulness. If efficiency is the primary usefulness aim, a relatively light form of tool involvement (e.g. having trustworthy colleagues involved) is sufficient. However, if the primary aim is learning about the object, a much stronger involvement in setting the parameters and underlying models might be needed (e.g. a ‘structured dialogue’ during which the model is developed, see te Brömmelstroet 2010)

7.5.3 The importance of context

Whereas the case study provided insights enabling an assessment of the two hypotheses, it also pointed out an additional issue: the importance of context. In the case study, several unexpected and context-dependent factors emerged, such as existing organizational hierarchies and the timing of the policy process, which was already further ahead. This underlines a point made by Geertman (2006), who argues that when addressing the role of planning support, contextual variables, such as the planning issue, the users and the phase in the planning process, should be taken into account. The workshop made it clear that while Nielsen’s (1993) framework is a good analytic starting point, it should be complemented using contextual variables, which describe the real-world situation of planning practice.

The best way to understand usefulness is an integration of the frameworks of Geertman (2006) and Nielsen (1993). One of the main premises of such a combined framework is that precise yet generic causal descriptions are difficult to achieve because each PSS application is unique and therefore generates its own dynamics during application. A notable lesson from the last decade is that PSS have to be developed in close cooperation with users and be linked to existing practices. Universal theories – both for understanding and prescription – are not very likely to be successful (cf. Batty 2008). Although the findings from the workshop underline the need for researchers to be aware of contextual variables, it seems almost impossible to capture all of these in a determined conceptual model. Nonetheless, three illustrative examples with regards to the influence of context deserve some more attention.

First: the importance of hierarchical structures and power relationships. It is increasingly common in PSS studies to do research-driven pilot studies and/or experiments with students. The benefit of these laboratory-like settings is that it allows control, and hence a precise assessment, of the causal relationships at work (te Brömmelstroet 2014). This case study revealed, however, the importance of *power relationships* related to organizational structures, which are less likely to be found in pilot-like settings. For example, the Area Manager was rather dominant in the usage of the PSS, giving him a very different user experience than the other stakeholders and influencing the group dynamics.

Second, and related to this point, is the importance of users with a different *disciplinary background*. The characteristics of users (disciplinary background, existing habits, etc.) influence how the role of a PSS is perceived (cf. Pelzer & Geertman 2014). Hence, the application of a PSS should always cater to the users. For instance, Urban Strategy could be applied without a lot of explanation and interpretation in a setting of transport planners and environmental analysts because they are aware of the underlying models. However, in a setting with urban designers, the tool should be applied more sparsely and the steps that are undertaken should be explained in order to have all the participants on the same page (cf. Pelzer et al. 2014a). Hereby, it is crucial to be aware of the existing habits that users have. This is something which has been emphasized at length in earlier studies about technology acceptance (Davis 1989, Vonk 2006).

A third and final example concerns the *timing* of the PSS application. The case study revealed that the usefulness is closely related to the stage of the planning process. The workshop would have been more useful in terms of learning effects for the stakeholders if it would have taken place in a much later stage in the planning process. In a different vein, it could also lead to efficiency gains at a later stage, for instance when a limited set of proposed interventions have to be quickly compared regarding their effect on traffic and the environment.

7.6 Conclusions and future research

The aim of this paper was to evaluate the extent to which Nielsen's (1993) conceptualization of usefulness is helpful to study PSS applications. In general, the findings from the case study indicate that this is by and large the case. Three observations have been made. First, the focus on planning tasks is a way of going beyond the perceptions of users about the potential of a support tool; it is more about analyzing how a PSS functions during specific stages of the planning and policy process. Whereas usability can be a necessary condition to achieve usefulness, it is never a sufficient condition. A PSS can be extremely user-friendly and transparent but if there is no link with the planning tasks at hand, it is not useful at all. With regards to these tasks, the categorization in terms of selection and generation tasks is perhaps rather too simple and crude. It might be necessary to explicitly also distinguish more tasks, for instance negotiation tasks and fuzzy tasks (cf. MacEachren & Brewer 2004, Zigurs & Buckland 1998). Second, the task-technology fit approach allows us to discern the negative effects of applying a PSS. For instance, support tools can be analytically robust but a lack of communicative support capabilities can disturb tasks because the social interaction is limited. Traditionally, studies in the performance, effectiveness or added value of support tools overlooked this issue and focused on the underutilized potential of instruments (i.e. the positive influence).

Third, this study led to rather nuanced insights into the role of tool involvement, which could be further studied in-depth in future research. It can be hypothesized that for the usefulness category of learning, users have to be involved in the tool development themselves (see also te Brömmelstroet 2010). However, for other usefulness categories, like efficiency, it might suffice if trusted colleagues are involved in the tool development. While this might not lead to the full utilization of the potential of the PSS, it saves a lot of time of the stakeholders involved. This implicates that only when learning is a central aim of a PSS application, should the participants be involved in the development of the tool. Put differently: be selective with tool involvement.

The notion of selectivity can be applied more generically to the usefulness of PSS. Only invest in applying a PSS when it is likely to achieve a usefulness that is worthwhile. Whether this last point is the case is dependent on a range of contextual variables: the background of the users, the stage in the planning process, the kind of problem, etc. (see Geertman 2006). Context influences both the extent to which a PSS is useful and the kind of usefulness that is achieved. For instance, in an early stage of a policy process, learning about the object might be the core of usefulness (cf. te Brömmelstroet 2010, Goodspeed 2013b), whereas in a later stage, efficiency might be more important.

Future research could address these topics more systematically. Hereby the rigor with which support tools are developed should also be applied to the measurement of their usefulness. If a PSS is applied and studied repetitively, the resulting higher n would allow for more advanced statistical analysis. However, in many cases each application is unique and the context is hard to take into account statistically. In this regard applying mixed methods, as was done in this paper, in order to achieve triangulation is a way forward. A notable insight from this paper is that these mixed methods should not only focus on the perception of users, but should also try to analyze what actually happens. Video observation or observing researchers are helpful for this purpose. Hereby, practical limitations should obviously be taken into account. Many PSS studies can be characterized as experiential; the researcher is involved in the development of the tool and attempts to improve it (Straatemeier et al. 2010). Such a research approach does not allow very rigorous control of the causal relationships under study because the variables are continuously modified. The challenge for the researcher is to be involved in the process but at the same time to keep a distance in order to objectively study what happens.

Chapter 8

Conclusion

This chapter concludes this dissertation. It is structured as follows. First, the findings of the dissertation will be summarized by answering the research questions that were outlined in the introduction. Second, some methodological reflections on the findings will be presented. This is a starting point for the third section, which sketches the implications for future resear ch in the PSS debate. Finally, the thesis concludes with a set of recommendations for planning practice.

8.1 Findings: answers to the research questions

The main research question of this thesis was formulated as follows:

> *CQ: How can the usefulness of Planning Support Systems for planning practice be conceptualized and how do practitioners experience this?*

To answer this question, four sub questions were deduced. The answers to these four research questions will be subsequently discussed before returning to the main research question.

> *RQ1: How can the role of PSS be conceptualized in a way that is sensitive to both the changing role of knowledge in planning and the increasingly collaborative nature of planning?*

Looking at the *changing role* of knowledge, it was argued that different knowledge forms should be taken into account in a planning process, involving not only systematized knowledge, but also experiential knowledge. The latter is traditionally rather poorly embedded in PSS applications. However, a sound mix of systematized and experiential knowledge should be a critical characteristic of a PSS application, particularly in an interactive or *collaborative* process. The resulting challenge is to develop an approach for PSS applications that is both sensitive to the input from an open and interactive process and the need for incorporating robust analyses. Chapter 2 developed such an approach, in which knowledge claim testing is introduced as a central notion (see Rydin 2007). This involves the so-called opening up and closing down of knowledge claims. For instance, a maptable or web portal can help to gather insights from different stakeholders (opening up, e.g. Kahila and Kÿtta 2009), after which an impact analysis-based tool like LEAM can be used to evaluate these claims and decide upon the extent to which these are considered valid (closing down, e.g. Deal & Pallathucheril 2009).

However, the chapter observes that a more encompassing concept is needed within which knowledge claim testing can be embedded. Following up on earlier work in the PSS field (Couclelis 2005, Guhathakurta 2002) the concept of storytelling is proposed. This concept perceives a planning process as developing a story, based on a range of causal elements that are interwoven through a narrative. Hereby, the story is never finished; developing the narrative with stakeholders from different backgrounds and with different interests is an enduring process. However, contrary, to other collaborative processes, having an encompassing procedure in which all stakeholders are heard is not the sole aim. The central, albeit moving, goal is to generate substance that both describes and prescribes spatial reality. While the emphasis in storytelling is often put on persuasion or appeal, a PSS can be complementary by putting an emphasis on providing validity checks of knowledge claims.

RQ2: What is the usefulness of PSS according to planning practitioners?

According to Nielsen (1993, p.24), usefulness concerns the 'issue of whether the system can be used to achieve some desired goals'. The literature review in Chapter 3 indicated that this question cannot be answered with a simple yes or no: it involves various dimensions, such as efficiency, collaboration and learning. Conversely, the findings from Chapter 3 and 4 indicate that the question should be framed in terms of for *what purpose* the PSS is applied and considered useful. The empirical outcomes of Chapter 3 and 4 show that almost all the usefulness dimensions distinguished in the conceptual framework in Chapter 3 are mentioned by at least some respondents. This is not to argue, however, that perceived usefulness is randomly dispersed. In Chapter 3, concerning the MapTable PSS application, communication and collaboration, in particular, were considered important, whereas in Chapter 4, which covers impact analysis-based PSS applications, learning was particularly emphasized.

To a certain extent these patterns can be explained by the support capabilities of the specific PSS being studied. It seems plausible to assume that there is a relationship between the analytical support capability of a PSS consisting of an impact analysis functionality and the usefulness dimension of 'learning about the object'. If a PSS facilitates the answering of 'what-if' questions (i.e. impact analysis), potentially, users get a better insight into the spatial phenomena at work in a plan area (i.e. learning about the object). However, while learning about the object could theoretically also take place behind a desktop computer or by reading a book, this is almost impossible for the related usefulness dimension of 'learning about others'. In order for this to occur a group of stakeholders has to collaborate, and, consequently, exchange knowledge (communication). Put differently, usefulness dimensions are related: learning about others (individual level) only takes place if conditions such as communication and collaboration (group level) are met. Hereby, collaboration within a group of stakeholders can be considered a precondition for the exchange of knowledge (i.e. communication), which can subsequently result in learning (see also Beukers et al. 2014). Following this line of reasoning, communication and collaboration can be considered intermediate usefulness dimensions, which have to be met before final usefulness dimensions, like achieving consensus, a more informed outcome or learning is achieved. This was also found in the two case studies that were conducted to answer the next research question.

RQ3: How can a PSS facilitate interdisciplinary learning?

Answering this question required two steps: (1) developing a conceptual perspective on interdisciplinary learning and (2) using this to study empirical settings in practice. The conceptual perspective started by acknowledging that different disciplines in planning practice have different frames through which they perceive planning tasks and the role of PSS therein. By reflecting on these frames, participants can learn how other disciplines perceive the problems at hand. The question then becomes how and to what extent a PSS can facilitate this process of so called frame reflection in planning practice. This latter question was answered primarily through an empirical study, the second step mentioned. Therefore, two case studies were researched in which a PSS was applied. In the Rijnenburg case study reflection about the frames of other participants did occur, but was accompanied by several frictions. For instance, it appeared that the quantitative and systematized nature of the PSS – which particularly suits an analytical frame – did not align with the working habits of the urban designer involved. In the Cartesiusdriehoek case, on the other hand, fewer frictions appeared to be related to the disciplinary frame, which is probably related to the fact that also less frame reflection occurred.

Hence, in answering the research question it should be noted that PSS can be a barrier to interdisciplinary learning, rather than a facilitator. Particularly the characteristics of impact analysis and a more traditional GIS environment are suitable for stakeholders with an analytical frame, but hamper the working habits of stakeholders with a design frame. This is not to argue that a PSS should not have an impact analysis function in an interdisciplinary setting. There are other, very valid, reasons for doing impact analysis, such as the improvement of the aforementioned notions of learning about the object and knowledge claim testing. Consequently, the key does not lie in a dichotomous conception of whether or not to use a PSS, but in being *selective* in its application. A way to ensure this is by including a facilitator in PSS workshops, who is not only responsible for the usage of the instrument, but also for the group dynamics during the workshops (see Pelzer et al.2014d). More specifically, a facilitator should ensure that the different planning tasks during a planning process are adequately addressed and supported. Therefore, the next research question explores the notion of planning tasks in relation to PSS.

> RQ4: *How can a focus on planning tasks lead to more insight into the usefulness of PSS?*

Planning processes consist of a range of planning tasks which are conducted in order to come to an outcome, such as a decision or a plan (e.g. Hopkins 2001). As commonly used definitions underline, the main role of PSS lies in improving the way in which planning tasks are conducted (e.g. Geertman 2008, Klosterman 1997). Hence, Chapters 6 and 7 addressed the usefulness of PSS from the perspective of the planning tasks that it aims to support. In order to empirically study this, the concept of task-technology fit (TTF) was applied which makes a distinction between the support capabilities of a PSS (the 'technology') and the central planning tasks. The answer to the previous research question revealed that a PSS application can have different kinds of usefulness. The answer to this research question complements this by emphasizing that the usefulness of a PSS application is dependent upon the interplay between planning tasks and the support capabilities of the PSS. This relates to the insights about selective usage outlined in answering the previous research question: a PSS is selectively useful, which differs from task to task and from context to context.

In operationalizing the concept of task-technology fit, three broad categories of tasks were distinguished: exploration (generating a variety of possible ideas or insights), selection (choosing from possible ideas or insights) and negotiation (to come to an agreement given different interests and given a set of ideas or insights). In addition, three kinds of support capabilities were discerned: analytical support (answering participants' questions, often through a calculation) informing support (providing participants with information) and communicative support (enhancing the knowledge exchange among participants). This TTF-perspective was used to study the empirical cases in Chapters 6 and 7. The first study (Chapter 6) compared the task-technology fit of CommunityViz combined with a maptable in four very different case studies. This empirical research confirmed that a combination of planning tasks and support capabilities helps us to understand the usefulness of a PSS application. For instance, for the task of negotiation about tradable area development rights it was found that the iterative feedback provided by the analytical capabilities of the PSS at hand was perceived to be useful. Information is provided about each step of the negotiation process through output generated by the impact model. Moreover, in a selection task concerning the redevelopment of an outdoor market, the applied PSS specifically increased the transparency of the selection process.

In the second case study (Chapter 7) one PSS workshop was studied intensively. Here, it was found that the concept of TTF helped to recognize the positive as well as the negative effects of a PSS application. A notable finding in this regard is that the fit between the analytic support capabilities of the applied PSS (Urban Strategy) and the task of selection was problematic because not all the relevant dimensions appeared to be included in the PSS. In addition, all the social interaction went via the chauffeur, rather than that the PSS application allowed for direct interaction among the participants. Arguably most suited to solve this friction is applying relevant facilitation interventions (see also Pelzer et al. 2014d).

After having summarized the answers to the four sub questions, we can now return to the main research question:

> *CQ: How can the usefulness of Planning Support Systems for planning practice be conceptualized and how do practitioners experience this?*

The underlying aim in all the chapters answering this question was to generate insights that contribute to an improved role of information in planning through the application of Planning Support Systems. The notion of knowledge claim testing is a specification of this goal, and is addressed – albeit not always explicitly – in most of the empirical work conducted for this thesis. While the answer to the central research question includes many nuances, which are described in detail in the chapters of this thesis, some key elements can be distilled. From a conceptual perspective the main insights are (a) that usefulness can be conceptualized in seven main dimensions and (b) that knowledge claim testing relates to these usefulness dimensions in different ways. Hereby, the central empirical finding, based on the experiences of practitioners, is that PSS applications are particularly effective when applied *selectively.* I.e. not during each stage and every situation in the planning process, but only when it has an expected positive influence. Assessing this is highly context-dependent and often requires a skilled and experienced facilitator. Nonetheless, some generic patterns about the relationship between usefulness, knowledge claim testing can be discerned, which are summarized in table 8.1. Hereby it is notable that usefulness is either a condition for or an outcome of knowledge testing. Below, the different usefulness will be subsequently dealt with.

Learning about the object and *Learning about others* are can be considered an outcome of knowledge claim testing. For instance, when new knowledge is introduced about how the urban system works (i.e. opening up). With regards to selectivity, impact analysis is particularly relevant when achieving learning about the object is an aim, whereas when learning about others is central, the main selectivity consideration lies in ensuring the PSS application connects to all involved disciplinary frames.

Communication and *collaboration*, have a different relationship to knowledge claim testing. As argued in Chapter 5, they are conditions for learning. In a similar vein, they can also be considered conditions for knowledge claim testing. Following Rydin (2007), knowledge claim testing can only occur in an interactive process. For communication, the main finding from this thesis with regards to selectivity concerns the insight that a PSS application should facilitate knowledge exchange in an appropriate way. In that, attention should be paid to the danger of blocking knowledge exchange, in particular by putting too much emphasis on quantitative information. With regards to collaboration it is particularly relevant that a PSS application facilitates the working together of stakeholders. Noteworthy in this regard is the role of hardware, such as touch tables, which can have a supportive role on the social interaction (see Chapter 3). Again, there is no generic prescription. The type of collaboration should be taken into account; a drawing exercise requires different instruments than a brainstorm.

Efficiency both contributes to knowledge claim testing, but can also be considered an outcome. With regards to the former, tasks can be conducted with less investments in time and money, making the process of knowledge claim testing more economical. For instance, the effect of an idea (i.e. testing a knowledge claim) can be directly assessed with a PSS application, rather than that is to involve different research steps. This mechanism also works the other

Table 8.1 **Usefulness dimensions of PSS application in relation to knowledge claim testing and selectivity**

Usefulness dimension	*Type of relation to knowledge claim testing*	*Primary selectivity dimension for applying a PSS*
Learning about the object	Is outcome of	Consider applying impact analysis function of PSS
Learning about others	Is outcome of	Ensure PSS connects to all disciplinary frames
Communication	Condition for	Ensure PSS facilitates and does not block knowledge exchange
Collaboration	Condition for	Consider utilizing hardware (e.g. MapTable, tablet)
Efficiency	Is outcome of, Contributes to	Consider whether PSS saves resources
Consensus	Is outcome of	Consider whether information is open
More informed outcome	Is outcome of	Consider whether PSS adds relevant and valid information

way around: knowledge claim testing helps to separate sense from non-sense, and therefore potentially preventing that 'negotiated nonsense' finds its way to plans and policy. With regard to selectivity, efficiency is particularly likely to be achieved in settings were the investments in time and money are traditionally high, such as research intensive planning issues, which include a range of successive quantitative studies.

The usefulness dimension of *consensus* can primarily be conceived as a manifestation of closing down, since a group of stakeholders comes to an agreement (i.e. consensus) about the validity of a knowledge claim. An important selectivity consideration here is the extent to which information is open and available. For instance, in the Achterhoek case (see Chapter 6), stakeholders had an interest in not providing all information. This clearly limits the potential role of a PSS, since only partial and incomplete analyses could be conducted.

The final usefulness criterion, *more informed outcome,* can be considered an outcome of knowledge claim testing. As was argued in Chapter 2, in order to combine the traditional purpose of PSS to improve the information used in planning, it should be combined with communicative approaches to planning. The notion of knowledge claim testing bridges analytical and communicative strands. From a selectivity perspective, it is recommendable to step back and reflect on the question whether the PSS added relevant and valid information to the planning process or even the outcome (e.g. a plan). For, instance, an important argument to apply a PSS in the Rijnenburg case study (see Chapter 5, 6 and Pelzer et al. 2013) was that it would lead to a more sustainable plan.

In addition to usefulness and knowledge claim testing, *planning tasks* were also a central concept in this dissertation. As argued before, focusing on tasks helps to understand how and in what situations different kinds of usefulness are achieved. Likewise, the applied concept of task-technology fit can be considered a liaison to selectivity. Only in situations in which the support capabilities of a PSS and planning tasks that have to be conducted match (i.e. a 'fit'), the criterion of selectivity is met. Hence, when considering whether a PSS application is useful, one can either start from the more abstract usefulness dimensions as identified in Chapter 3 and 4 or from the more concrete planning tasks outlined in Chapter 6 and 7.

8.2 Conceptual and Methodological reflections

This section will reflect on the concepts used and the methodology applied in this thesis. This involves a critical discussion of the concepts of usefulness and added value and a reflection on the methodological choices that were made, including the inherent trade-offs this involved. With regards to the latter, the focus will be on two methodological aspects: the case selection and the data collection methods.

8.2.1 Conceptual reflections

Some critical reflections about the concepts used in this dissertation should be made. In the academic debate quite a jumble of terms is used to evaluate PSS in practice. For instance, Te Brömmelstroet (2013) uses the term 'performance', whereas in this dissertation the concept 'usefulness' is used, as well as 'added value'. All terms have very similar meanings, and it is out of academic habit or increased insight that different terms are used. A critical observation is that terms like usefulness and added value assume that a PSS has a *positive* influence, whereas the findings from this thesis indicate that a PSS can also have a *negative* influence. This is an observation that has hardly been addressed before in the existing literature (cf. Smith et al. 2013). Based on this thesis, two kinds of negative influences can be discerned. *Obstruction* refers to a situation in which a PSS hampers the communication process. In professional settings this is relevant, for instance, for processes with a strong role for design-oriented disciplines like urban design and landscape architecture. Both this thesis and earlier work indicates that for design disciplines intuitive and flexible tools are crucial, and a PSS does not always cater to this, particularly because of its quantitative and sometimes rigid nature (Carton 2007, Chapter 5, Dias et al. 2011, Pelzer et al. 2014b, Wyatt 2004).The second negative influence, *performativity,* is less visible to discern, but arguably more pervasive. It refers to instances in which the tool starts to steer rather than facilitate the thinking of the people involved (e.g. Smith et al. 2013). For instance, in several PSS the underlying traffic model only concerns automobility, possibly leading to a problem perception focusing on cars and not on alternative modes of transportation (Pelzer 2012, 2014).

8.2.2 Methodological reflections

Case selection

Three main criteria drove the selection of the cases: *diversity, context-richness* and *feasibility*. With regards to *diversity*, the selection of cases can be considered to represent a relatively diverse picture of PSS applications in the Netherlands. It includes a variety of different PSS, different planning problems and different compositions of users. Two constraints should be noted. First, in the cases selected there is little to no attention to long term strategic planning and scenario analysis in relation to PSS (cf. Couclelis 2005). While this dissertation searched for this kinds of more strategic PSS applications in the Netherlands, these were not found. Second, most of the case studies include professional stakeholders and civil servants, so there is a lack of residents and other stakeholders with lay knowledge. Again, attempts were made to include these but no suitable cases were found. Hence, these two caveats should be taken into account when transferring the findings of this study to other contexts.

The second case selection criterion was *context-richness*. It is increasingly common in PSS research to conduct experiments with students or perform pilot applications with practitioners (e.g. Arciniegas 2012, Nyerges et al. 2006, te Brömmelstroet 2014). Whereas these approaches are valuable in the sense that they allow for careful and controlled research, it can be questioned whether they sufficiently reflect real-world planning practice and, consequently, giving insight into the usefulness of a PSS application for planning practice. An explicit aim in this dissertation was to stay as close to real world cases as possible. For instance the GDR workshop reflected insights derived from experiences in day-to-day planning practice with a MapTable. In those cases studying real-world planning situations appeared not to be possible; this study tried to stick as closely as possible to the real world by organizing workshops (see Chapter 7). In general, this thesis used a rich set of empirical data, which provided a rich and encompassing insight into the usefulness of PSS. Since most cases only consisted of small groups no statistical correlations could be calculated; nor could differences between groups be tested on significance. The large n required for such an analysis was not feasible, because this would mean studying multiple PSS workshops that are very similar to each other (cf. Goodspeed 2013b).

This relates to the final criterion: *feasibility*. The research strategy was to include as many different PSS applications in the Netherlands that actually took place as possible because there is a dearth of these kinds of empirical studies in the academic debate. However, at least half of the planned case studies did not proceed because of various organizational and financial reasons. A notable example is the development of a mobility vision for the IJmond area. Participant observation was conducted during stakeholder meetings for two years, but in the end it appeared that the proposed PSS (the 'Mobiliteitsscan') was hardly ever used (Pelzer 2012). Also because of time and research capacity constraints, for the purpose of this dissertation the choice was made to focus on PSS applications that actually took place, instead of investigating why several planned case studies did not proceed. A disadvantage of this approach is that the cases have a bias towards successful applications.

Methods

As for the case selection, the choice for the data collection methods was to an important extent steered by feasibility considerations. The motto was: better to have too much empirical data than too little. For instance, the Urban Strategy workshop was studied using almost all of the possible methods: recordings by three cameras, observation by two researchers, video and audio recordings and verbatim transcription of all of the conversations during the sessions, a questionnaire, a group evaluation and a feedback interview with a key user. *Within* a case, such as for the Urban Strategy workshop, this methodological plurality was a way of achieving methodological triangulation (Denzin 1978). *Among* the cases the different methods helped to provide a rich and encompassing picture. For example, the outcomes of the questionnaires indicated that learning is a key feature of usefulness in applying a PSS. Next, the interviews with people involved in the Rijnenburg case provided details into the characteristics of this learning process, through an in-depth analysis of transcripts supported by the qualitative data analysis software NVivo. In a more in general sense, the questionnaires helped to distinguish patterns, whereas the interviews and observations helped to make sense of these patterns. This study had to cope with several limitations: the complexity and unpredictability of planning practice, constraints on the time available for research and the limited funding to organize workshops. Given these restrictions, the methods used in this study are arguably the most suitable. This is not to argue, however, that there is no room for improvement in future research. Conversely, some methodological and substantive avenues for further study will now be discussed.

8.3 Academic recommendations

8.3.1 Methodological recommendations

From a methodological perspective, two directions for future research come to mind. Firstly, a very detailed study of the individual micro-behavior of participants, including, for instance, participant observation, careful video coding of group behavior and human-computer interaction during a workshop (cf. Nyerges et al. 2006, Salter et al. 2009). The advantage of such an approach is that it provides insight into the revealed behavior by users, rather than just their perception of their behaviors afterwards. This can reveal how much time users interact with the tool, for instance, and how much time users interact with each other, which indicates to extent to which the PSS steers the communication. This thesis (Chapter 7) also used video recordings, but these were not analyzed in great depth.

Secondly, a higher number of cases could allow for more advanced correlational analyses. It would be relevant to quantitatively analyze the relationship between usefulness (dependent variable) and explanatory variables like usability, utility and user characteristics. Recent work by Goodspeed (2013b), shows that this can lead to very relevant results. However, this is only possible if the PSS applications have relatively small differences in timing and characteristics, otherwise uncontrolled confounding variables lead to too much noise. In short, different methods will reveal different kinds of outcomes, whereby the choice for the most appropriate methods should be evaluated from case to case.

A generic condition for any methodological approach to be successful is that the researchers involved are sufficiently distanced from their research object. This remark is of relevance since it appears from scientific literature to be quite common that the developer and evaluator of a particular PSS are the same person or organization. For several well-known PSS, such as SLEUTH, What If?, and CommunityViz, the main persons reporting on its usefulness appear to be also strongly related to tool development and application (e.g. Clarke 2008, Janes & Kwartler 2008, Klosterman 2008) . This has brought the PSS field inevitably forward, but makes it also difficult to come to independent and critical conclusions about its usefulness. A way to overcome this issue is to collaborate with researchers who have no direct stake in the PSS development. An alternative approach that can also be applied by research with a stake in the PSS would be to develop unified assessment protocols in for instance the form of questionnaires for users, which is common in research fields like Group Support Systems (cf. te Brömmelstroet 2013, te Brömmelstroet et al. 2014).

8.3.2 Substantive recommendations

Whereas these kind of uniform questionnaires would give a *synchronic* insight into PSS applications, it would also be relevant to develop a *longitudinal* perspective on the effect of PSS applications. In particular, well-known PSS, such as CommunityViz, UrbanSim, LEAM and What If? have been applied for over more than a decade now. It would be very relevant to evaluate how and to what extent these have influenced planning outcomes. Studying the effect of PSS on the ultimate outcomes of the planning process is something that this dissertation has paid little attention to and can be picked up in future research. A challenge herein is that studying PSS over a longer time span, is like studying a moving target: both technology and the aims of planning itself are continuously changing. This would, however, involve a strong commitment, including long term research programs and/or retrospective studies, tracing the application of a PSS and its effects over the years.

Further, in recent academic debates, concepts are discussed which will likely influence the position of PSS. Particularly the notions of big data, smart cities, and geodesign are relevant in this regard (e.g. Batty et al. 2012, Goodspeed 2014, and Steinitz 2012). For future PSS research, two developments are particularly poignant. First, both the notions of big data and smart cities assume a more central role of computer technology in planning and governance. Ubiquitous data about travel behavior, for instance, allow for a much more precise insight into how the urban system functions. Moreover, big data potentially allows for more direct and real time steering of urban dwellers, as is often assumed in the smart cities literature. PSS has to place itself in this new constellation. On the one hand there are challenges: the focus on direct feedback and short term developments, might result in a situation in which long term and strategic planning – the traditional focus of PSS – receives less attention (see Couclelis 2005 for an early warning about the lack of future-oriented planning).On the other hand there is great potential, because big data widens the scope of possible analyses. Moreover, the increasing attention for smart cities potentially leads to a context that is more receptive to use support technology like PSS.

Second, a critical attitude remains necessary for this new wave of technological optimism. On the one hand it can be questioned whether notions like smart cities and big data are really changing practice, or have a similar fate as large scale urban modelling: great potential, but little utilization (Goodspeed 2014). On the other hand, if these trends are going to dominate planning practice, the functioning of PSS receives close attention. Herein, particularly the role of participation and experiential knowledge is something that should be monitored. This is also relevant with regards to the approach of geodesign, which combines design and quantitative approaches like modelling and GIS. Whereas one of its key thinkers, Carl Steinitz (2012), explicitly acknowledges the importance of local knowledge, in technology-intensive environments there is always a risk of quantitative information dominating or even becoming performative (see also Mouter’s (2014) work on cost-benefit analysis). Or as Dassen and Hajer (2014) put it, a city is truly smart when it not only uses technology cleverly, but also incorporates the knowledge of its residents. This thesis provided some ideas about how a PSS could facilitate the latter, in particular through the notion of knowledge claim testing. It is, however, up to future research to keep studying this issue in more in depth.

8.4 Recommendations for practice

In closing this dissertation, some recommendations for practice will be formulated. A key insight for practice stemming from this dissertation is that PSS are most likely to be useful when applied *selectively.* While several positive influences of a PSS were found, this thesis also found negative effects, such as blocking the creativity of urban designers and sometimes disturbing communication processes. This is important, since all too often PSS are implicitly considered as being a silver bullet that will improve the whole planning process and change existing planning practices (cf. Batty 2008). PSS are particularly useful in specific instances and for specific purposes.

For instance, a PSS with analytic support capabilities, like impact analysis, is particularly helpful in settings that already include a range of model runs, whereby several steps can be skipped. For instance, if insights are needed about whether a plan meets the legal norms in terms of traffic and environmental dimensions. However, when including models of human behavior, the complexity and uncertainty increases, making the PSS application more challenging. The same goes for settings with a strong design orientation. In general designers are less comfortable in working with impact analysis models, so there have to be good arguments to include a chiefly analytical PSS in such a setting. This was for instance the case in Rijnenburg, where the central aim was a thorough embedding of environmental dimensions in the design process.

Including just the communicative support capabilities of a PSS, such as a map-table, often lead to less friction, primarily because the existing working habits of participants are not fundamentally changed. Simultaneously, it can be questioned to what extent just applying the communicative support capabilities of a PSS (e.g. a maptable with a static map) adds value to business as usual. It can be hypothesized that a positive influence is particularly likely to be achieved when processes are gridlocked or dominated by procedures rather than substance. A maptable, for instance, helps to get an in-depth discussion, in which the planning issue is central, and not so much the procedures surrounding it.

Put more succinctly and somewhat more commonsensically: a PSS has to meet the demands of the context, including the planning problem, the involved users and the planning tasks (cf. Geertman 2006). A concrete way for practitioners to address this issue is to develop a kind of checklist or decision tree, which helps to decide how and in what situations a PSS should be applied and in what situations it preferably should not (see Mouter & Pelzer 2014 for an attempt). Hereby it is important to acknowledge that improving the usability characteristics of the instrument is no panacea that leads to a higher usefulness. A user friendly and intuitive tool is not necessarily more suitable for conducting planning tasks than a complex tool. The utility (here conceived as task-technology fit) is at least as important. Hereby, particularly for more complex tools, the learning curve to understand a PSS can be steep. Rather than continuously optimizing the tool, for instance by improving its userfriendliness, it could be wiser to invest in a more careful organization and facilitation of the PSS application; whereby a balance should be found between involving participants in the tool application and ensuring the instrument does not dominate the workshop (Pelzer et al.2014d).

Whereas this dissertation has focused more on the individual and group level than on the organizational level, some relevant recommendations can be distilled for the organizational application of PSS as well. Whereas the work of Vonk (2006) focused on how PSS can be used *more*, the main emphasis in this thesis was on how PSS can be used *better.* This change in perspective, from bottlenecks to influence, is also relevant at the organizational level. Since many traditional bottlenecks – like poor and unavailable data and long calculation times – have now been overcome, the central question is how organizations can use PSS in a selective yet useful way.

In formulating answers to this question in the future, it is recommendable to include universities or other research institutes to assess PSS applications, which can take the form of 'Communities of Research and Practice'. There is much to gain here. Although universities increasingly collaborate with practice in the PSS field, this often involves the development of a new instrument, rather than evaluating an existing one. A notable exception is the recent COST action about accessibility instruments (see www.accessibiltyplanning.eu). Here, all universities involved organized workshops with practice and used uniform questionnaires to evaluate the user perceptions about the PSS application. A noteworthy achievement that receives follow-up. However, the collaboration between research and practice can also take more informal forms. For this dissertation many interviews were conducted with PSS practitioners. It turned out that these conversations were not only meant to gather data, but also to disseminate findings. Many interviewees were very interested in insights from other contexts and conceptual considerations. Since these people make the PSS research as proposed in this dissertation possible, it is only logical that the favor is repaid.

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Nederlandse samenvatting

In het begin van deze dissertatie (***Hoofdstuk 1)*** wordt gesteld dat de vraag hoe planning en beleid met toegepaste informatie ondersteund kunnen worden een klassieke en belangrijke is. Sinds de jaren zestig wordt al geclaimd dat computertechnologie, bijvoorbeeld in de vorm van impactmodellen, mogelijk kan leiden tot rationelere en beter geïnformeerde planning. Vanaf het einde van de jaren tachtig ontstaat een onderzoeksveld dat zich specifiek richt op het ontwikkelen van instrumenten gestoeld op de wensen van planners. Deze worden Planning Support Systemen (PSS) genoemd. PSS kan gedefinieerd worden als: 'op geo-informatie gebaseerde instrumenten met meerdere componenten die samen een deel van een unieke professionele planningsstaak ondersteunen'. PSS is vaak software die helpt om mogelijke planningsbeslissingen beter te begrijpen en evalueren. Dit kan op verschillende manieren. Een PSS kan bijvoorbeeld inzicht geven in de impact van een nieuwe weg op verkeersstromen en milieueffecten. Of heel anders: grote GIS-kaarten kunnen een op analyse en informatie gebaseerde dialoog tussen betrokkenen ondersteunen.

Hoewel de instrumentele karakteristieken van PSS enorm zijn verbeterd de afgelopen twee decennia, heeft dit niet geleid tot intensief gebruik in de praktijk. Eerder onderzoek heeft de 'bottlenecks' aangetoond die meer gebruik in de weg staan. Een omissie in het wetenschappelijk debat betreft een analyse van wat het betekent als PSS daadwerkelijk wordt gebruikt in de planningspraktijk. Om deze lacune te vullen beantwoordt deze dissertatie de volgende onderzoeks-vraag:

> *Hoe kan het nut van Planning Support Systemen voor de planpraktijk worden geconceptualiseerd en hoe percipiëren betrokkenen uit de praktijk dit?*

De volgende zes hoofdstukken beantwoorden verschillende dimensies van deze onderzoeksvraag. ***Hoofdstuk 2*** heeft vooral een conceptuele focus. Hierin wordt benadrukt dat planning in belangrijke mate op samenwerking gericht en communicatief van aard is, terwijl PSS traditioneel ingebed zijn in een meer wetenschappelijke-analytische benadering van planning. Dit hoofdstuk stelt dat een betere rol voor PSS in het bijzonder gevonden kan worden in een zorgvuldige conceptualisatie van kennis, waar twee dimensies bij betrokken zijn. Ten eerste de karakteristieken van kennis, die bestaan uit verschillende kennisclaims en kennisvormen. Ten tweede de rol van planondersteuning waarin deze kennis wordt gebruikt. Er zijn vier mogelijke rollen: wetenschappelijk-analytisch, tactisch, lerend en interactief. Deze taxonomieën kunnen vertaald worden naar PSS-onderzoek en de praktijk door ze te combineren met het proces van het testen van kennisclaims. In dit proces worden ervaringskennis en gesystematiseerde kennis op een systematische wijze beoordeeld op hun validiteit. De rol van PSS in dit proces ligt vooral in het verzamelen en testen van kennisclaims die naar voren gebracht worden door verschillende betrokkenen.

Hoofdstuk 3 en ***Hoofdstuk 4*** gaan in op de toegevoegde waarde van PSS zoals die wordt gepercipieerd door gebruikers. Er is een conceptueel raamwerk ontwikkeld waarin toegevoegde waarde wordt gemeten op het individuele-, groeps- en uitkomstniveau. Dit raamwerk is toegepast met verschillende methoden:

vragenlijsten, semigestructureerde interviews, observaties en een Group Decision Room (GDR) sessie. In deze GDR sessie werd vooral communicatie en samenwerking genoemd als een belangrijke toegevoegde waarde van PSS, wat ten dele verklaard kan worden door de focus op digitale kaarttafels in deze GDR. De vragenlijsten geven aan dat vooral leren (zowel over het object als over anderen) een belangrijke toegevoegde waarde van PSS is.

Hoofdstuk 5 gaat in op interdisciplinair leren (een vorm van leren over anderen), dat gezien kan worden als 'frame reflectie' door betrokkenen met verschillende disciplinaire frames. Drie disciplinaire frames over planning en PSS worden onderscheiden: een analytisch frame (nadruk op rationeel begrip en kwantitatieve informatie), een ontwerpframe (nadruk op esthetiek en creatie) en een onderhandelingsframe (nadruk op de strategische en politieke dimensie van planning). De twee gevalstudies laten zien dat PSS zowel een positief als een negatief effect heeft. Het positieve effect is dat analytische frames begrijpelijk worden voor betrokkenen met een ander disciplinair frame. Het negatieve effect is dat een PSS vooral betrokkenen met een analytisch frame ondersteunt, waardoor dit frame dominant of zelfs performatief wordt. Een manier om dit te voorkomen is door PSS workshops zorgvuldig te organiseren, waarbij alle frames voldoende betrokken zijn. Dit kan bijvoorbeeld door de inzet van een getrainde facilitator of papieren kaarten en stiften.

Hoofdstuk 6 en ***Hoofdstuk 7*** richten zich op de planningstaken die worden ondersteund door de toepassing van een PSS. In beide hoofdstukken wordt het begrip 'task-techology fit' gebruikt, dat gaat over de mate waarin de ondersteuningsmogelijkheden van een PSS (d.w.z. de 'technologie') invloed hebben op de mate waarin planningstaken succesvol worden uitgevoerd. Hoofdstuk 6 beschrijft een vergelijkende gevalstudie waarin de PSS vergelijkbaar is, maar de ondersteuningsmogelijkheden en planningstaken anders. Deze studie bevestigt dat het perspectief van task-technology fit bruikbaar is voor het vakgebied van PSS, omdat verschillende combinaties van taken en ondersteuningsmogelijkheden leiden tot een heel verschillen gepercipieerd nut. Hoofdstuk 7 borduurt hierop voort. Hierin is één PSS-toepassing intensief bestudeerd door vragenlijsten, een groepsdiscussie, interviews en observaties. In deze casus sluiten de ondersteuningsmogelijkheden van de PSS niet altijd aan bij de planningstaak, omdat de PSS te dominant werd. In de groepsevaluatie met betrokkenen kwam naar voren dat een PSS vooral nuttig is als deze selectief ingezet wordt.

In de conclusie ***(Hoofdstuk 8)*** worden de gebruikte conceptuele perspectieven met betrekking tot het nut van PSS besproken, die zowel variëren in focus als empirische uitkomsten. Een algemene bevinding is echter is dat PSS vooral nut hebben wanneer ze selectief worden ingezet. Facilitatie kan een sleutelrol spelen om dit te bereiken. Toekomstig onderzoek zou dit verder kunnen bestuderen. Het is hierbij van belang dat het perspectief van gebruikers in het oog gehouden wordt, vooral omdat in de recente aandacht voor smart cities en big data de nadruk vooral wordt gelegd op technologie en niet op mensen.

Summary

This dissertation starts by observing (***Chapter 1***) that the question of supporting planning and policy making with dedicated information is an old and important one. From the 1960s onward it has been claimed that computer technology, in the form of for instance impact models, can help to lead to more rational and better informed planning. In the end of the 1980s a research field emerges dedicated to specifically cater instruments to the needs of practitioners, so called Planning Support Systems (PSS). PSS can be defined as 'geo-information based instruments that incorporate a suite of components that collectively support some parts of a unique professional planning task'. PSS is often software, which supports understanding and evaluating planning decisions. This can take different forms. A PSS can for instance give insight into the impact of a new road in terms of traffic flow and environmental effects. In a different vein, a large GIS-map can support a dialogue based on analysis and information among stakeholders.

While the instrumental characteristics of PSS have improved significantly over the last two decades, this has not resulted in intensive usage in planning and policy practice. Earlier research has shed light on the bottlenecks preventing this higher frequency of usage. It has hardly been studied, however, what it means for planning practice if a PSS is indeed used. This includes in particular the way in which knowledge is applied and how practitioners perceive the usefulness of PSS. In order to address this gap, this dissertation aims to answer the following research question:

> *How can the usefulness of Planning Support Systems for planning practice be conceptualized and how do practitioners experience this?*

The following six chapters answer different aspects of this research question. ***Chapter 2*** has a chiefly conceptual focus. It emphasizes the collaborative and communicative nature of contemporary planning, whereas PSS traditionally come from a scientific-analytical approach to planning. This chapter argues that a better role of PSS can particularly be found in a careful conceptualization of knowledge, which involves two dimensions. First, the characteristics of knowledge, which consists of different knowledge claims and different knowledge forms. Second, the role of planning support in which this knowledge is used. This can take four different roles: scientific analytical, tactical, learning or interactive. Moreover, it is argued that these taxonomies could be translated to PSS research and practice by combining them with the process of knowledge claim testing. Herein, experiential and systematized knowledge claims are systematically judged on their validity. The role of PSS in this process particularly lies in gathering and testing the knowledge claims that are brought forward by different stakeholders.

Chapter 3 and ***Chapter 4*** report about the added value of PSS applications as perceived by practitioners. A conceptual framework is developed, in which added value is measured on the individual, group and outcome level. This framework is applied through various methods: questionnaires, semi-structured interviews, observations and a Group Decision Room (GDR) workshop. In the GDR workshop particularly communication and collaboration are emphasized as important added values of PSS, which can partly be explained by the focus on map-based touch tables in this GDR. The questionnaires indicate that particularly learning (about the object and about others) is as an important added value of PSS.

Chapter 5 focuses in detail on interdisciplinary learning (part of of learning about others), which is conceived as 'frame reflection' by stakeholders with different disciplinary frames. Three disciplinary frames about planning and PSS are distinguished: an analytic frame (focusing on rational understanding and quantitative information), a design frame (focusing on esthetics and creation) and a negotiation frame (focusing on the strategic and political dimensions of planning). The two case studies reveal that a PSS can both have a positive and a negative effect. The positive effect is that analytic frames become understandable to stakeholders with another disciplinary frame. The negative effect is that a PSS particularly supports stakeholders with an analytic frame, which consequently becomes dominant or even performative. One of the ways to overcome this is by carefully organizing the workshop in which the PSS is applied, ensuring that all frames are sufficiently involved. Means to do this involve having a skilled facilitator and including paper maps and pens.

Chapter 6 and ***Chapter 7*** focus on the planning tasks that are supported by the application of the PSS. In both chapters the concept of task-technology fit is used, which refers to the extent to which the support capabilities of a PSS (i.e. the 'technology') influence the extent to which planning tasks are successfully conducted. Chapter 6 describes a comparative case study in which the PSS is similar, but the support capabilities and planning tasks differ. This study confirms that the perspective of task-technology is useful for the field of PSS, because the different combinations of tasks and support capabilities lead to a very different perceived usefulness. This is taken one step further in Chapter 7, in which one PSS application was studied intensively through questionnaires, a group discussion, interviews and observations. The results show that the support capabilities did always not match the planning task at hand, because the PSS became too dominant. In the group evaluation with practitioners it was concluded that the PSS is particularly useful when applied selectively.

In the conclusion (***Chapter 8***) the conceptual perspectives with regard to the usefulness of PSS are discussed, varying in focus and empirical results. An overarching finding is that PSS are to be particularly useful when applied selectively. Facilitation could play a key role in achieving this. Future research could explore this further. Herein it is important that the perspective of practitioners is kept in mind, particularly since the recent attention for smart cities and big data tends to have a chiefly technological focus.

Publications

Scientific publications

Pelzer, Peter, Gustavo Arciniegas, Stan Geertman and Sander Lenferink (2015) 'Planning Support Systems and Task Technology Fit: a comparative case study'. *Applied Spatial Analysis and Policy. Online first.* DOI 10.1007/s12061-015-9135-5

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