Improving Planning Support

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Improving Planning Support

The use of Planning Support Systems for spatial planning

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Preface

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Guido Vonk
Utrecht, December 2005

1 Introduction

1.1 Planning

1.1.1 The object of planning

Human beings use plausible accounts to explain events in the past and present, but also as a basis for controlling the future (Faludi, 1973). Forming such plausible accounts is an intrinsic motive for human behaviour and action (Fishbein and Ajzen, 1975). Planning is the activity of forming and evaluating such plausible accounts to solve existing problems or anticipate future problems in society. In an operational sense it attempts to link knowledge to actions in the public domain (Friedman, 1987). The knowledge consists of scientific and experiential knowledge, implicit and explicit knowledge, technical knowledge and social knowledge, owned by a range of societal actors (Dammers et al., 1999). When these actors enter the planning arena their knowledge is used to assemble actions into some orderly sequence, to deliberately achieve some objective (Hall, 1975). The objective usually concerns social, economic and environmental guidance and transformation (Friedman, 1987; Forester, 1989). This thesis has a particular focus on urban and regional planning. Urban and regional planning refers to "planning with a spatial, or geographical component, in which the general objective is to provide for a structure of activities (or of land uses) which in some way is better than the pattern existing without planning" (Hall, 1975). Figure 1.1 shows planning as an ongoing process, connecting various kinds of knowledge to actions in the public domain.

The need to plan follows from the notion that no "invisible hand" can be relied upon to produce a good arrangement of the whole from a combination of separate treatment of the parts in urbanized areas. An authority of wider reach, therefore, needs to intervene and tackle the collective problems (Nelissen, 1997). Although administration oriented planning activities associated with land ownership, trade and safety have a much longer history, the first real burst of authorities tackling collective problems by means of planning took place in the heartlands of late 19th and early 20th century European cities. In the aftermath of the industrial revolution, overcrowded urban slums caused living conditions in many of these cities to be so appalling that solutions were needed. Building rules, zoning rules and housing schemes were set up to improve the situation. (Nelissen, 1997; Hall, 2002). Several decades later, great architects of the

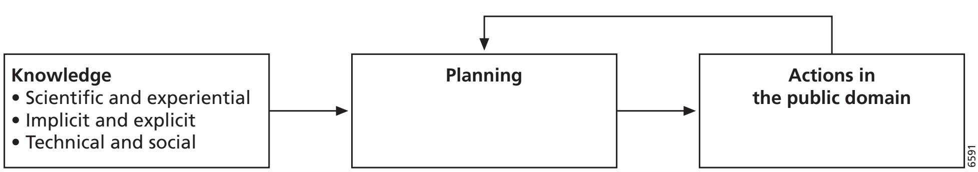

Figure 1.1 Planning, connecting knowledge to actions in the public domain

modernist movement like Berlage, Gropius and Le Corbusier completely reorganized many European cities with their large housing schemes and city plans (Hall, 2002). Their plans involved planned dispersion, increased green areas in cities and better infrastructure among others. The underlying objective of planning in this period was to balance social justice and the forces of market expansion that gave autonomy and independence to some people and powerlessness and dependency to the great majority of people (Forester, 1989; Hall, 2002). In contrast to Europe, in the US and Australia, the poor were a minority, which caused planning for housing purposes to be unpopular and associated with problems of a social nature, such as redundancy, crime, etc. in those areas.

Planning in Europe took a somewhat different course after the Second World War, when it reoriented itself towards rebuilding what had been ruined (Hall, 2002). In this period, planning became very important as a political activity. Prestigious planning acts were developed, great strategic plans for European cities were developed, and planning itself developed many sub-directions, such as economic planning, traffic planning, social planning, etc.

Until the 1970's, expansion of market and society took place against the background of an environment that did not provide limitations of the severity and scale we experience today (see figure 1.2). The environmental problems that did exist were apparent and mainly related to local scale sanitary conditions and treated as social problems (Nelissen, 1997). The less apparent, larger scale and longer-term environmental interests did not enter the political agenda until the 1970's. The reports of the Club of Rome made clear that long-term growth would cause societies to meet the limits of the carrying capacity of their living environment and the earth in general. Since then, the environment gradually became integrated as one of the main pillars in planning. Sustainable planning aims to balance the social and environmental with the economic interests, thereby integrating these three pillars. Sustainability was accepted as a global goal in the 1992 convention on environment and development in Rio de Janeiro. Also during this period, increasing globalization placed great pressure on economies in western societies. With the loss of the old manufacturing economies, they had lost their main engines. Planning has since become concerned with the introduction of the new engine: the knowledge economy (Hall, 2002).

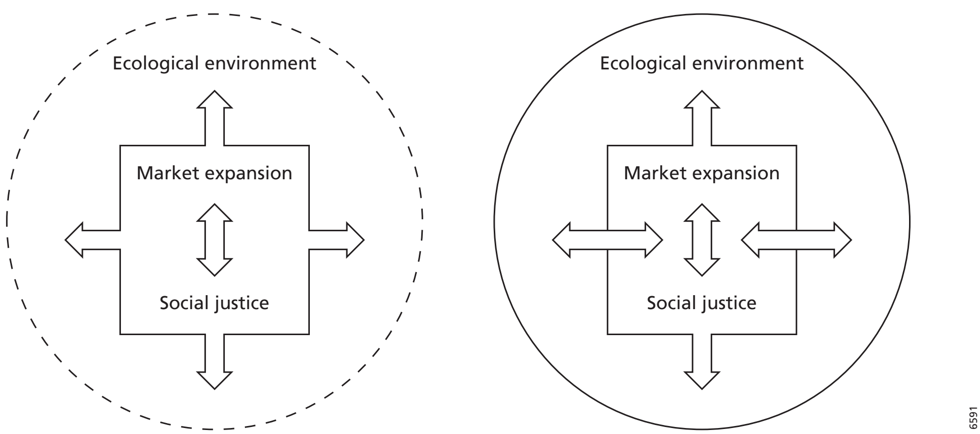

Figure 1.2 Planning shifts from the dual balance of market and social justice to the triple balance of market, social justice and quality of the ecological environment

1.1.2 Planning traditions

Planning theorists distinguish a science *of* planning which refers to the 'how' of planning, in other words the methodology, and a science *in* planning, which relates to the 'what' of planning, in other words the plan content (Faludi, 1973; Archibugi, 2004). According to some of them, we have a great need of a science of planning in order to determine what science in planning is (Harris, 1967). Although such a science may provide a range of methods and instruments, the 'best' way of planning does not exist; it is time, place, and context based. The problems responsible for this apparent impossibility of stating what the best way to plan is are of an historical-political nature. This causes planning to have many different appearances. Friedman distinguishes four planning traditions; policy analysis, social learning, social reform and social mobilization (Friedman, 1987). During certain periods and for certain purposes, one or two forms of planning discourse have a tendency to dominate (Friedman, 1987). Figure 1.3 depicts these traditions. Although largely derived from a US perspective, they still provide useful insights.

The fact that past and present planning practice in most western societies shows quite strong coherence indicates that the historical-political determinants of planning traditions occur on a large scale. Particular areas have developed their particular varieties, but in general four periods with associated dominant planning traditions can be distinguished.

In the first period, beginning after WWII and roughly ending in the beginning of the 1970's, planning was done in a rather technical way, related to the social reform tradition above. The emphasis was on solutions and future states. Planning was conducted as a rational activity, carried out by specialized planners (Klosterman, 2001c). Planners made master plans for a range of area sizes and time scales, with the emphasis being placed on larger and longer scale planning rather than on smaller and shorter scale planning. In these practices, planners were oversimplifying the way to get to the desired future state or problem solutions. This oversimplification caused many plans to fail to meet their pretentious objectives and elicited waves of criticism regarding the way planning was done (Brail and Klosterman, 2001; Geertman, 2006).

Social reform: those writing in this tradition regard planning as a 'scientific endeavor', and one of their main preoccupations is with using the scientific paradigm to inform and to limit politics to what are deemed to be its proper concerns. Scientific Politics.

Policy Analysis: strongly influenced by Simon. What was the best course would eventually be constrained by normal constraints on rationality, the model of bounded rationality. There was a guidance model of seven identifiable stages: goals and objective formulation, identification of alternatives, prediction of consequences, evaluation, decision, implementation, feedback. Implementation concerns are now already integrated very early in the process. Much of the language in policy analysis derives from work with specific analytical techniques such as gaming, simulation, evaluation research, linear and nonlinear programming, and the like. Advocates are technicians.

Social learning: knowledge is derived from experience and validated in practice, and therefore it is integrally a part of action. Social learning theorists have asserted that social behavior can be changed through social experimentation, careful observation of the results, and willingness to admit to error and to learn from it.

Social mobilization: It asserts the primacy of direct collective action from below. In the social mobilization tradition, planning appears as a form of politics, conducted without the mediations of 'science'. Nevertheless, scientific analysis, particularly in the form of social learning, plays an important role in the transformative process sought by social mobilization. Change is onset by politics of disengagement or by politics of confrontation.

Figure 1.3 Four planning traditions distinguished by Friedman (1987).

In the second period, the 1970's and early eighties, emphasis was refocused on the process of change. Mainstream planning in this period is associated with the tradition of social mobilization. Society changed at a high pace when WWII baby boomers stood up to the older generations and their policy styles, leading to an activism that spread like a wave across a large part of the world. As a result, policy regimes changed. It was acknowledged that society could not be shaped by government actions alone. This entailed a huge change in the ambition of planners. Instead of making master plans with the focus on end-states and solutions, the emphasis shifted to the facilitation of communication among the societal drivers of change. Since these societal drivers' joint actions changed on a day-to-day basis, only modest aims could be embraced in planning (so-called incrementalism) (Lindblom, 1959). This resulted in short term planning for small areas.

In the third period, the 1980's and beginning of the nineties, both the end-states and the means of getting there were once again coupled in so-called strategic planning (Geertman, 2006). This way of planning has much in common with the tradition of policy analysis. Strategic planning entails a multi-level perspective in which a larger scale long-term strategy orientation interacts with shorter-term small-scale orientation concerning the question of how to implement the strategy (Etzioni, 1968). In this way, the role of the drivers of societal change and the effects they have on the feasibility of the strategy is acknowledged and translated to a more realistic strategy.

The fourth period, the 1990's, is characterized by increased emphasis on plan implementation. Over the course of years, an autocratic style had gradually slipped into planning. Consequently, planning in many western societies could be characterized as an approach of 'Decide, Announce, Defend', which has led to a loss of trust, damaged relationships, the inability to resolve disputes when stances are firmly held, and also to plans not being implemented either at all or only with great difficulty. This causes planning to be very ineffective and inefficient. Furthermore, it became clear that society not only possesses values that could influence change, as in the second period, but that society also has information and knowledge indispensable to the planning process. Increased public participation and participatory planning is seen as an answer. The subsequent change in planning style causes a way of planning that involves mutual adjustment, negotiation and accommodation between the involved parties rather than direct control, a style also known as governance. This shift towards governance has been accompanied by a shift towards so-called development planning in the Netherlands (Van Woerkum and Aarts, 2002; Dammers et al., 2004). This way of planning proposes to return to opportunities for change instead of imposing restrictions, thereby allowing more space for solutions in governance. It is an answer to the legacy of past plans and existing policy at different government levels, which have caused the opportunities to be strongly restricted. These restricted opportunities have led to striking delays and failures in projects that were otherwise well initiated, and also to a loss of societal trust. Increased opportunities and fewer restrictions may increase the chances that plans resulting from public participation become realized, which might restore public trust in the government and in the effectiveness of plans. Governance with development planning is in the early stages of development. Time still needs to tell if this will lead to the expected results. Planning in this period continues to shift towards the tradition of social learning.

This historical overview shows that planning keeps on changing, in response to political and socio-cultural changes as well as to obtained results. Planning is involved in a continuous search for an identity suitable for handling the complexity and dynamics of society.

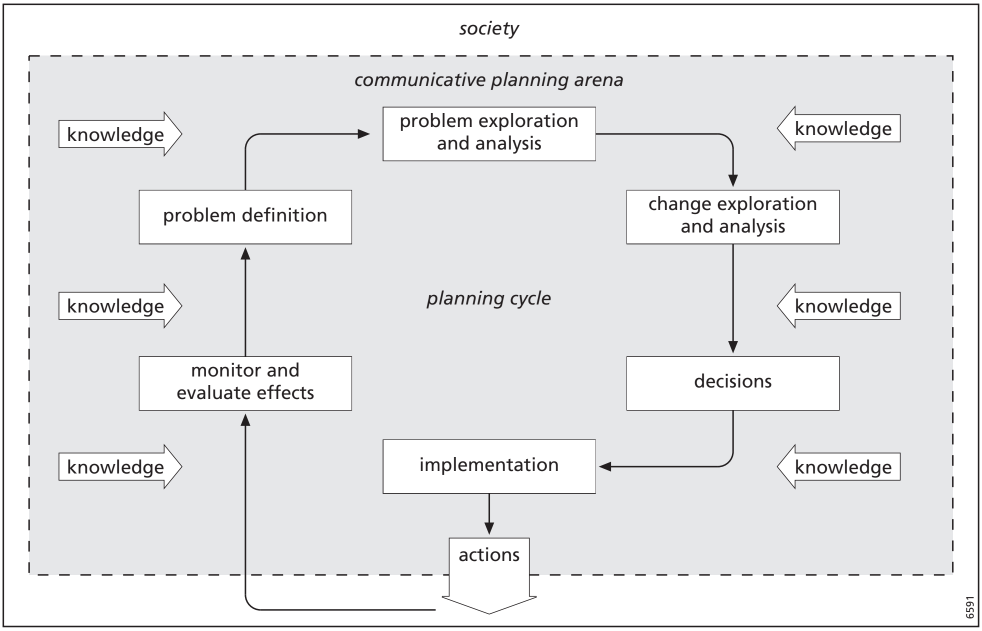

Figure 1.4 Planning as connecting knowledge to actions in the public domain by a cycle of analytical tasks that take place in a communicative planning arena

1.1.3 Framing the planning process

Figure 1.4 shows the perspective of the planning process as it will be applied during this study. This study regards the planning process as a continuous cycle of analytical planning stages that take place in a communicative planning arena. The cycle consists of the following analytical planning stages: problem definition, which includes problem signalling and agenda setting etc.; problem exploration & analysis, which includes inventory of conditions, analysis of trends, future exploration, etc.; change exploration and analysis, which includes development of alternatives/scenario's, impact assessment research, evaluation of alternatives, plan development, etc.; decision, which includes decision on goals, alternatives, implementation modes, etc.; implementation with the tasks dissemination and starting actions etc.; and monitoring & evaluating effects. The knowledge required for these analytical planning tasks is distributed over societal actors, scientists, politicians, etc. They are part of a communicative planning arena in which their knowledge is connected to decisions and subsequent actions in society and in which the democratic feasibility and the social and political feasibility of these actions are shaped. This leads to consultation, discussion and negotiation of goals, alternatives, implementation modes, etc. during the stages of the cycle.

1.1.4 Planning complexity

Planning as indicated in figure 1.4 is a highly complex activity (Geertman, 2006). The described developments in the content of planning show that solutions that are mostly based upon short-term interests with high collective priority or economic value are no longer satisfactory. The described developments in the process of planning, having scientific rationality, attributed with values of societal drivers of change, a strategic multi-level perspective and stakeholders with their tacit knowledge has changed planning from a rational scientific analysis and design operation into an extremely complex process. The complexity of planning consists of a range of dimensions. Firstly, planning is complex due to the fact that most of the processes which need control are human processes, which are less well understood and work with much less certainty than laws in the physical sciences. Secondly, the basic objectives are not well understood. There is more than one objective and perhaps even dozens (Hall, 1975). Thirdly, the fact that they occur on different time and spatial scales causes the amount of necessary information and specialized expertise required for their involvement to be enormous. Fourthly, there is a need to frame and then weigh up different objectives in order to develop sophisticated integrated solutions. This requires positioning functions, objectives and stakes in a limited space with the highest possible synergy and the least possible conflict. Integrated solutions that effectively balance the involved stakes and that remain effective for the collectively experienced or economically desired core issue are hard to find. In most cases there is no clear resolution, and the most the planner can do is to try to reach a decision within a clear and explicit framework (Hall, 1975). Fifthly, the solutions need to be aligned with existing policy, reflected in the many other plans, e.g. social and economic plans at the various administrative levels. Sixthly, planning is complex because communication is highly important in addition to the more analytical elements. Communication with those involved in the process and with the broader public serves the important role of generating a basis of support that is required for a plan. This has become increasingly complex since more people are directly involved in the currently popular participatory planning forms and since the broader public is more outspoken, independent and demanding. In order to successfully manage such communication processes, planners need excellent communication skills and tools as well as the related skills to operate in a highly political environment. Any account of planning must face these political realities (Forester, 1989).

Current planning practice shows many examples of planning failures (Norris, 1994; Cullingworth, 1997; Weitz and Selzer, 1998; In 't Veld, 2000; In 't Veld, 2001; Tijdelijke-Commissie-Infrastructuurprojecten, 2004; Body, 2005). A large part of these failures can be assigned to planners' inabilities to handle the aspects of the complexity of planning. Therefore, in this thesis the focus is on providing planners with better means to handle these aspects of complexity, in particular by using dedicated information technologies.

1.2 Planning Support

1.2.1 Geo-information technology for planning support

Since more than 80 percent of planning knowledge has a geographical component (Huxhold, 1991), it is quite surprising that planners make relatively little use of geo-information technologies to support their daily practices (Stillwell et al., 1999a). The use of computers does not make planning easier, in the sense that it somehow becomes more automatic, and it does not diminish the area of human responsibility to take decisions. However, where planning connects knowledge to action, what geo-information technologies dedicated to support planners can do is help planners to efficiently capture, store, update, communicate, manipulate, analyze, model and display the required knowledge.

Using information technology for planning support is not a new phenomenon. The first ideas of supporting planners with computer-based geo-information tools originate as early as the 1950s (Batty, 2003). During a period known as the quantitative revolution in social sciences there was a strong belief in science and technology to solve problems in society. Britton Harris was among the first to notice the potential for utilizing computer-based modelling and analysis instruments to support planners (Harris, 1960). During the 1960s large metropolitan models were used by planners, but by the end of the decade they left the scene again after a series of failures (Lee, 1973). In these years planning itself changed distinctively from being rationalist, centralized and top-down to being communicative, decentralized and bottom-up (Klosterman, 2001a; Hall, 2002). This left little room for the models of those days. However, developments in geo-information technologies did not cease. Since the 1980s, geo-information technologies such as Geographical Information Systems (GIS) and Spatial Decision Support Systems (SDSS) were boosted by progress in microcomputer technology. However, despite their technological progress, usage by planners has remained limited (Innes and Simpson, 1993; Geertman and Stillwell, 2003c). An assessment of spatial planning practice at the end of the twentieth century suggests that the adoption and use of geo-information tools (geographic information and spatial modelling systems) is far from widespread and far from being effectively integrated into the planning process (Stillwell et al., 1999a). From this assessment it may be concluded that many planners now have access to the geodata and meta-geoinformation facilities of their organizations, and many are proficient in using their geo-information tools to perform spatial queries and generate thematic maps. Progress towards the use of these tools beyond these basic activities to help solve key planning problems through more sophisticated analysis however remains very limited (Stillwell et al., 1999a). Geo-information tools appear to be seldom used for those tasks unique to planning, such as visualising, story-telling, forecasting, analysis, sketching, and evaluation (Klosterman, 1997; Couclelis, 2003). Studies to explain the shortfall in the adoption of geo-information tools have often taken a broad, systems analytical perspective, suggesting reasons of a technical nature, but also human, organizational and institutional factors. Alleged reasons are that most current tools are far too generic, too complex, too inflexible, incompatible with most planning tasks and oriented towards technology rather than problems and too focused on strict rationality (Klosterman and Landis, 1988; Couclelis, 1989; Scholten and Stillwell, 1990; Harris and Batty, 1993; Innes and Simpson, 1993; Bishop, 1998; Nedovic-Budic, 1998; Sheppard et al., 1999; Sieber, 2000; Aerts, 2002; Batty, 2003; Geertman and Stillwell, 2003d; Uran and Janssen, 2003).

1.2.2 Planning Support Systems

A new generation of geo-information technologies called Planning Support Systems has recently entered the scene. These so-called Planning Support Systems distinguish themselves from earlier tools by their dedication to support planners in the execution of their tasks, instead of being general-purpose tools that can also be used for planning support (Geertman and Stillwell, 2003b). Planning Support Systems (PSS) have been defined as a subset of geo-information technologies, dedicated to support those involved in planning to explore, represent, analyze, visualize, predict, prescribe, design, implement, monitor and discuss issues associated with the need to plan (Batty, 1995). In recent years many researchers have devoted their attention to developing a broad range of PSS (Brail and Klosterman, 2001; Geertman and Stillwell, 2003b). The existing literature describes a range of systems and their applications that make use

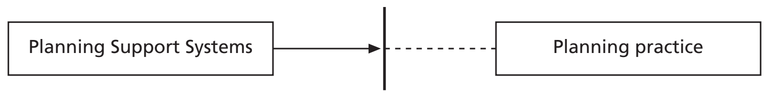

Figure 1.5 Planning Support Systems do not reach planning practice

of many different technologies. The last years have seen the number of scientific papers on PSS increase quite remarkably. Some trends in the literature can be distinguished. First, although a great range of systems has been described, there is still no real overview of what PSS entails. Cross comparisons of systems are rarely made, let alone that many lessons have been learned that can serve as the basis of best practices. Only a few attempts to bring structure into PSS developments have been made (Bishop, 1998; Hopkins, 1999; EPA, 2000; Geertman and Stillwell, 2003b; Snyder, 2004). Secondly, there is little proof of their worth, and only very few systematic evaluations have been made. Thirdly, little research has been done on user demands, which makes it hard to prove that PSS distinguish themselves from other tools by being dedicated to demands of planning practice. Furthermore, it is technology that continues to drive planning instead of the other way around (Batty, 2003). Moreover, inventories show that currently, a large diversity of PSS exists, but that the implementation in spatial planning practice lags far behind the supply of tools (Stillwell et al., 1999b; Brail and Klosterman, 2001; Geertman, 2002; Geertman and Stillwell, 2003b; Geertman and Stillwell, 2004) (see figure 1.5).

This under-use is problematic since spatial planning is becoming increasingly complex and planners demand support. Despite the under-use, many believe that PSS do have great potential to support planners in handling various aspects of complexity in planning, e.g. communication, management, integration of multidimensional information. The deficit in demand cannot fully be explained with reference to existing knowledge. Just how the use of PSS in practice could be enhanced is unclear.

1.3 Theoretical Approach

1.3.1 Three problem approaches

The problem of PSS not being used widely in planning practice despite the fact that planners are demanding support in handling the complexity of spatial planning, can be regarded from a number of angles, each emphasizing various specific aspects of the problem. Starting from the problem as shown in figure 1.5, this study distinguishes 3 different viewing angles that correspond with problem approaches: The 'instrument' approach, explains the problem mainly from the instrumental quality of the PSS, thereby focusing particularly on usefulness and user friendliness of the PSS. The 'user approach' explains the problem from the extent of user acceptance of PSS, thereby focusing on a broader set of factors related to the accepting environment. The 'transfer' approach explains the problem from the extent of diffusion, thereby focusing particularly on the flow of PSS from sender to receiver. Figure 1.6 shows these three approaches in relation to the problem, as well as the aspects that are emphasized in each approach.

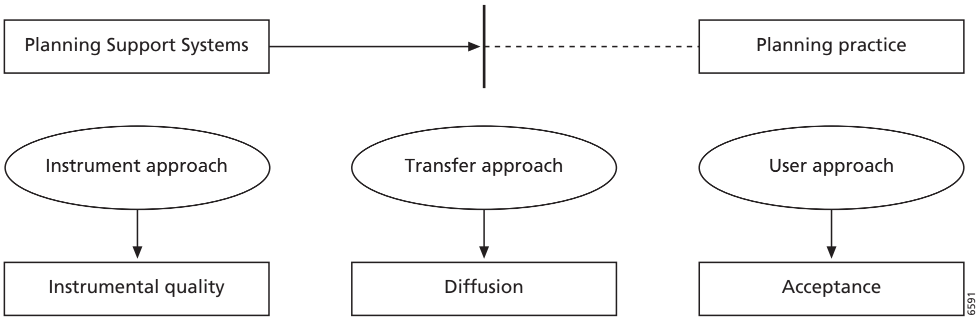

Figure 1.6 Three theoretical approaches to analyze under-use of PSS

Figure 1.7 Usage explained by the fit between PSS, planning task and user

1.3.2 Instrument approach

The first approach to the problem explains usage of PSS in planning practice from aspects of the PSS instruments themselves. It does so by focusing on those aspects of the instrument that determine their instrumental quality. The assumption is that poor instrumental quality of PSS hampers users from using PSS. This approach takes PSS themselves as a more or less dependent variable. It emphasizes the sense in which they should change in order to increase usage. This study defines instrumental quality as consisting of a judgment of how well the instruments are capable of carrying out the tasks that they were made for and how well they fit to the capabilities and demands of intended users. Goodhue and Thompson (1995) showed the importance of these aspects as determinants of usage of information technologies in their model of task-technology fit (Goodhue, 1995; Goodhue and Thompson, 1995; Dishaw and Strong, 1999; Dishaw et al., 2002). This model is used as a basis of the instrument approach to explain usage of PSS. Figure 1.7 shows the application of this approach to explain usage of PSS.

1.3.3 User approach

The second approach to the problem explains usage of PSS in planning practice from user-related aspects. It does so by focusing on those aspects of the user that determine their acceptance. The assumption is that non-acceptance hampers users from using PSS. This approach takes the user as a dependent variable. It emphasizes in what sense they should change in order to increase usage of PSS. This study defines acceptance as "the process through which an individual or other decision-making unit passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of his decision" (Rogers, 1995). The acceptance process is seen as influenced by user characteristics, instrument characteristics, organizational characteristics, characteristics of the social environment, characteristics of the external environment and facilitating conditions. These factors that influence acceptance have been framed in the 'Technology Acceptance Model'. Since its first publication in 1986, the model has been refined numerous times and applied to a broad

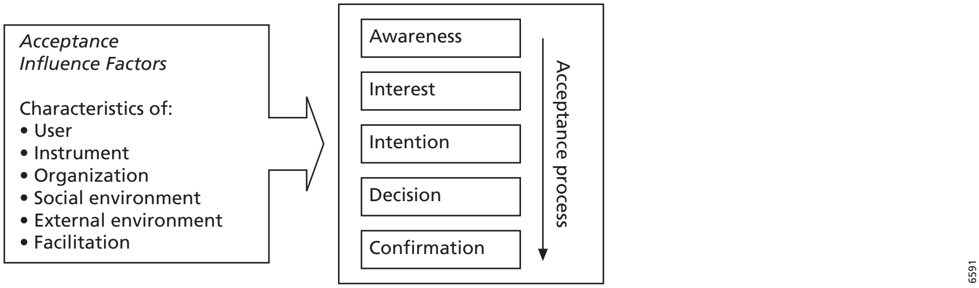

Figure 1.8 User approach to explain usage of PSS: the Technology Acceptance Model

range of information technologies (Davis, 1986; Compeau and Higgins, 1991; Mathieson, 1991; Keil et al., 1995; Dishaw and Strong, 1999; Karahanna and Straub, 1999; Venkatesh and Davis, 2000; Frambach and Schillewaert, 2002; Venkatesh et al., 2004). Figure 1.8 shows the essence of what the Technology Acceptance Model entails.

Figure 1.8 shows on the right the acceptance process in terms of the five stages distinguished by Rogers (Rogers, 2003). Looking at figure 1.8, the lack of acceptance of PSS implies that intended users: 1) are not aware of the existence of PSS; 2) do not show interest in using PSS; 3) have no intention to use PSS; 4) decide not to use PSS; or 5) do not apply and continue using PSS. The origin of these processes being hampered lies in one of the acceptance influence factors shown on the left in figure 1.8.

1.3.4 Transfer approach

The third approach to the problem explains usage of PSS in planning practice from aspects of the transfer of PSS towards planning practice. It does so by focusing on those aspects of the transfer that determine PSS diffusion. Innovation diffusion has been defined as “the process by which an innovation is communicated through certain channels over time among members of a social system” (Rogers, 1995). It is concerned with the transfer of an innovation into a practice context, through the adoption by individuals within groups, groups within organizations and organizations themselves. The assumption is that hindered diffusion hampers users from using PSS. This approach takes the diffusion processes as a dependent variable. It emphasizes the ways in which they should change in order to increase usage of PSS.

In figure 1.9 on the right, diffusion is envisioned as an evolutionary process that takes place by acceptance at the various levels of aggregation; system developer, individual, group, organization, and branch of organizations. In diffusion through the organizational system, the aggregation of entities at each level that have adopted the innovation follows a path such as described by the innovation adoption curve. The curve shows that a group of innovators are the first to see opportunities. They are most likely to perceive the complexity of adoption as a challenge or see themselves capable of handling the complexity. They are followed by early adopters, early majority, late majority and finally the laggards who cannot but accept the innovation after having been confronted with it everywhere by people who adopted the innovation before they did. The innovation reaches the next aggregation level if the adoption at the previous level has reached a certain mass. This is described by the overlap in the curves in the right figure. At a certain stage in the adoption at each level the adoption process becomes self-enforcing. Instead of being

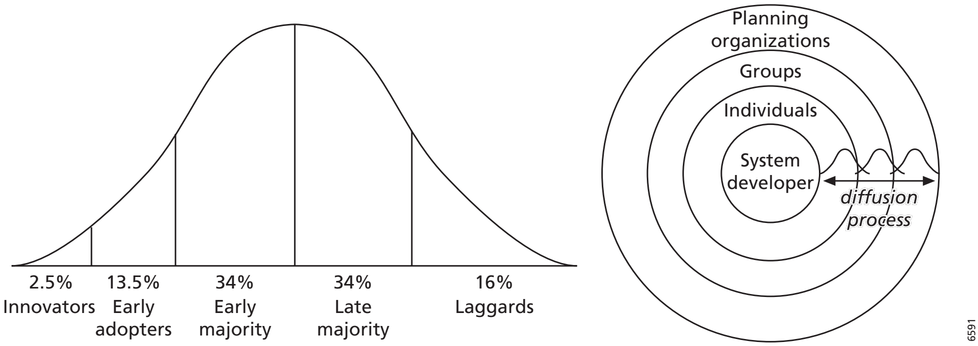

Figure 1.9 The innovation adoption curve (left) and its application to the diffusion of PSS over various aggregation levels (right)

pushed towards adoption, the entities at a level will be pulled towards using the innovation by the fact that they do not want to fall behind the times and remain qualitatively below the mark. When push changes to pull the innovation has reached the next aggregation level that then starts to function as an attractor and attain a growing body of entities. Due to the overlapping adoption curves, the process of pulling and pushing may take place across various levels, e.g. an organization may be pushed to adopt by an individual and individuals may only be pulled to adopt by the organization. During the course of adoption, the organization gradually adapts itself to the change in the environment. The fact that PSS are not used widespread in planning practice indicates that their diffusion has not evolved beyond the initial levels of diffusion.

1.4 Research outline

1.4.1 Research setup

Supported by the given analysis of planning, its complexity and the opportunities to use geo-information technologies to support planning, the main assumption of this research is that PSS-technology in general can contribute to the capability of those involved in planning to handle the complexity of spatial planning. Although research based upon this assumption may seem somewhat peculiarly motivated for science standards, the assumption is inevitable in studying the use of new and complex technologies that still lack convincingly proven benefits.

From this perspective, it is the primary aim of this research project to shed more light on the reasons for the relative under-utilization of PSS in spatial planning practice with respect to their wide availability and the assumed potential. It is the secondary aim to formulate guidelines for enhanced PSS application in spatial planning. For these reasons, this study questions why PSS are used in spatial planning as infrequently as they are and how their use can be enhanced.

Figure 1.10 shows the design of the research project. To achieve the primary aim, in a first research stage this study will focus on the problem of the relative under-usage of PSS in general, and secondly the study will specify the obtained results to particular PSS types. The first research stage has been delineated into three parts that correspond with the described approaches of

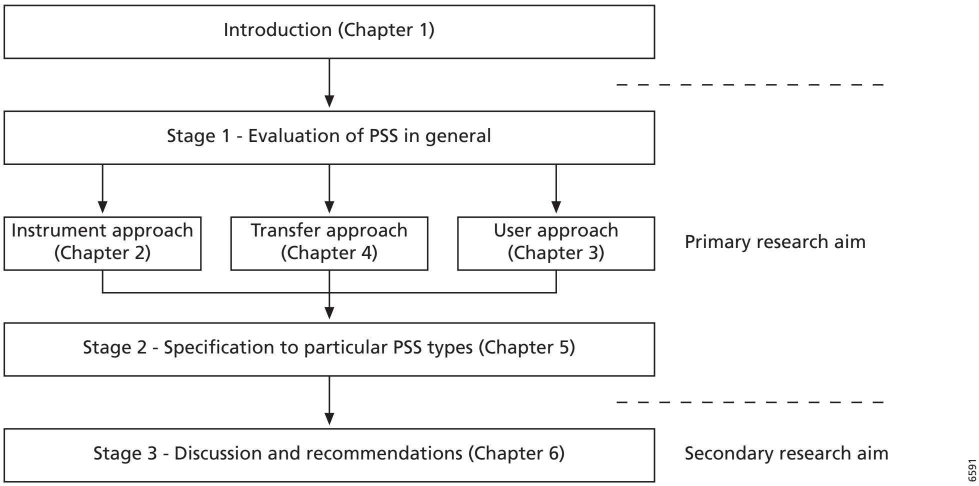

Figure 1.10 Research design

regarding the problem of under-use of PSS: the instrument approach, the user approach and the transfer approach. Based upon these three approaches the study defines the following three research questions to analyse the problem of under-use of PSS in spatial planning.

Which instrumental quality factors explain the hampered use of PSS in planning practice?
Which factors explain the hampered PSS acceptance in planning practice?
Which factors explain the hampered PSS diffusion in planning practice?

The answers to these questions will subsequently be integrated into a part that applies the three approaches to particular groups of PSS. Here the following research question is defined:

Which factors explain differences in usage of PSS types?

To achieve the secondary aim it is built forth upon the primary aim by finding ways to improve PSS from the factors that explain why their widespread usage is hindered. The following research question is defined.

How could usage of PSS become more widespread?

It is expected that different actors will have different opinions on these questions. Therefore this study combines knowledge from experts, end-users and system developers. The broad start with *worldwide surveys* serves the purpose to find the main factors that are blocking widespread usage of planning support systems in spatial planning. In a second stage this study focuses on factors that appear to be important by performing a *literature survey* and by holding *interviews* among employees of Dutch provinces. Additionally performed *case studies* of which the results have not yet been explicitly included in this thesis indirectly enriched this knowledge base.

1.5 Thesis outline

The thesis before you reflects the outcome of these studies. It consists of the following 6 chapters:

1. Introduction
2. A SWOT analysis of Planning Support Systems.
   To be published as: Vonk, G., Geertman, S. and Schot, P. (2006). A SWOT analysis of Planning Support Systems. Environment and Planning A 38. Forthcoming.
3. Bottlenecks blocking widespread usage of Planning Support Systems.
   Previously published as: Vonk, G., Geertman, S. and Schot, P. (2005). Bottlenecks blocking widespread usage of Planning Support Systems. Environment and Planning A 37. pp 909-924
4. 'New Technologies Stuck in old Hierarchies'; an analysis of diffusion of geo-information technologies in Dutch public organizations.
   To be published as Vonk, G., Geertman, S. and Schot, P. (2006). 'New Technologies Stuck in old Hierarchies'; an analysis of diffusion of geo-information technologies in Dutch public organizations. Public Administration Review 66. Forthcoming.
5. Concluding Analysis: Why are some PSS used more widely than others?
6. Integrating PSS into planning processes

2 A SWOT analysis of Planning Support Systems

[This chapter is a preprint of an article accepted for publication in Environment and Planning A © 2006 Pion Ltd.]

Abstract
Insight into the strengths, weaknesses, opportunities and threats (SWOT) of Planning Support Systems (PSS) is fragmented between users and system developers. The lack of combined insights blocks development in the right direction and makes potential users hesitant to apply PSS in planning. This study presents strengths, weaknesses, opportunities and threats of Planning Support Systems from a combined user-developer perspective. They are firstly expressed in terms of combinations of planning task, PSS information function and user, and subsequently used a literature survey, a series of interviews and a web-survey to gather views from developers, users and PSS-experts. The analysis shows that planners mainly use simple information storage and retrieval systems for exploration tasks, while the majority of PSS are technically much more advanced and aim to support complex tasks. The potential of these advanced PSS can only be realized if planners and system developers start to share knowledge and demands and identify opportunities in a cooperative PSS development process. Without such a process the advantages and opportunities of PSS will remain unexploited.

2.1 Introduction

Geo-information technologies are slowly becoming used for supporting spatial policy tasks (Stillwell et al., 1999b). Planning Support Systems (PSS) are a subset of these geo-information technologies, dedicated to support those involved in planning to explore, represent, analyze, visualize, predict, prescribe, design, implement, monitor, and discuss issues associated with the need to plan (Batty, 1995). PSS bring together the functionalities of GIS, models and visualization, to gather, structure, analyze, and communicate information in planning. They take the form of "information frameworks", that integrate the full range of information technologies useful for supporting the specific planning context for which they are designed (Klosterman, 1997; Geertman and Stillwell, 2003c). Tools like GIS and SDSS are related to PSS and some overlap exists. In general however, PSS aim to focus purely on planning support, while many SDSS and GIS technologies can be used for planning support if required, but are not particularly dedicated to that use (for more information on general differences between PSS, GIS and SDSS see Geertman and Stillwell 2003b). Many see PSS as capable of supporting spatial planning in terms of handling complexity, thereby increasing quality of plans and decreasing time and money spent (Batty, 1995; Bishop, 1998; Stillwell et al., 1999b; Brail and Klosterman, 2001; Laninga, 2001; Couclelis, 2003; Geertman and Stillwell, 2003b).

Although the history of computer-support in planning dates back to the 1950's (Harris, 1960), practical realization of PSS has become technically possible only with the rise of powerful microcomputer technology in the last few decades. Inventories show that currently a large diversity of PSS exists and that 'UrbanSim', 'CommunityViz,' and 'What If' are currently the most well known PSS among experts (Brail and Klosterman, 2001; Geertman and Stillwell, 2003b; Geertman and Stillwell, 2004; Vonk et al., 2005). Still, most PSS are in a laboratory stage and PSS are hardly used in planning practice by the intended users (Geertman and Stillwell, 2004). This is mainly caused by little awareness of, and experience with PSS among users (Vonk et al., 2005). System developers on the other hand have little awareness of the demands of users (Geertman and Stillwell, 2004). Development of PSS towards a full-grown technology is expected to benefit from combination of knowledge from both sides (Lundvall, 1988; Oudshoorn and Pinch, 2003). At this moment, aspects of a combined view only exist fragmentarily in the heads of a few experts, which hampers the development of appropriate PSS. This is problematic, considering their assumed potential to improve planning.

This study generates insights into strengths, weaknesses, opportunities and threats (SWOT) of PSS, combining the technical knowledge of system developers with practical knowledge of users and views of PSS-experts who have some knowledge of both sides, with the overall aim to enhance PSS development and application. The underlying assumption is that such combined insights may make users more aware of PSS, convince them of their value, and subsequently stimulate application and willingness to cooperate with system developers to improve existing PSS. Likewise, such insights may give system developers a new impulse to improve their instruments. Thus insights may become a basis on which to bring users and system developers together for cooperative innovation in PSS. In this way, combined technical and practical insights may constitute an important contribution to the development and application of PSS technology.

2.2 Theoretical framework

2.2.1 Task-Technology-User fit

Studies in the fields of innovation and management sciences show that an information and communication technology (ICT) cannot be fully evaluated on its strengths, weaknesses, opportunities and threats without taking into account its suitability for performing the task at hand and to the user who would use it (Davis, 1989; Goodhue and Thompson, 1995; Dishaw and Strong, 1999; Dishaw et al., 2002; Rogers, 2003; Venkatesh et al., 2004; Beaudry and Pinsonneault, 2005). This study regards PSS as a particular type of ICT and proposes a framework to study strengths, weaknesses, opportunities and threats of PSS in terms of present-day and future fit between planning task, PSS (-technology) and user (see figure 2.1). In this

Figure 2.1 Conceptualization of the SWOT analysis in terms of fit between planning task, PSS-technology and user

study, strengths and weaknesses refer to the present-day fit and opportunities and threats to the fit that can be expected in the future. For this purpose we specified the concepts of planning task, PSS, and user, by means of classification.

2.2.2 Classification of planning tasks

Planning processes are shaped in a multitude of ways. The dynamic character between and within planning processes makes it impossible to make a general theory of how to plan, let alone to make a suitable classification of programmatically applied planning tasks (Mandelbaum, 1979; Alexander, 1998; Archibugi, 2004). Nonetheless, some basic tasks or activities occur repetitively in various planning styles and systems, since they are directly related to the core of planning as a means of 'reasoned' exploring and anticipating the future or solving existing problems in society, alone or with others (Geertman and Stillwell, 2003c). The following seven planning stages are distinguished: 1) problem definition, with the tasks problem signaling and agenda setting; 2) problem exploration and analysis, with the tasks inventory of conditions, analyze trends, explore future; 3) change exploration and analysis, with the tasks develop alternatives/ scenario's, impact assessment research, evaluate alternatives, develop plan; 4) consultation with the tasks discussion and negotiation of goals, alternatives and implementation modes; 5) decision with the tasks decision on goals, alternatives, implementation modes; 6) implementation with the tasks dissemination and starting actions; and 7) monitor and evaluate effects. Depending on the planning style, the stages occur in various combinations of sequences. Figure 2.2 shows these stages and tasks in their relation to the classified PSS.

2.2.3 Classification of PSS

Instruments for planning support have previously been classified based on sort of technology and planning type or application field (Brail and Klosterman, 2001; Geertman and Stillwell, 2003b). For this study, a more task-dedicated classification has been used, based on a system's function with respect to handling information in planning processes (Burrough and McDonnel, 1998). Six information handling functions are distinguished: (1) information gathering, for example traffic monitoring systems; (2) information storage and retrieval, for example geo-databases; (3) information visualization, for example 3D visualization kits; (4) information communication, for collaboration between actors, for example cognitive mapping systems, electronic brainstorming systems, electronic collaborative sketching systems, (5) information analysis, to generate new information from existing information, for example multi-criteria-analysis systems, statistical trend analysis systems; (6) information modeling, to simulate processes based on information in the system, for example land use models, physical process forecasting models. Figure 2.2 shows the subdivision of PSS into these six classes.

2.2.4 Classification of users

The history of planning shows periods in which planning was mainly the domain of executives, planners and geo-information specialists and also more participatory periods, in which there was increased involvement of stakeholders and citizens in planning (Geertman, 1996; Brail and Klosterman, 2001; Hall, 2002). Mainly since the '90's, participation in planning has increased and this is expected to increase further in the near future (Stillwell et al., 1999a; Brail and Klosterman, 2001; Driessen et al., 2001; Margerum, 2002). Based on this trend, the following planning actors are distinguished as main users of PSS in present-day and future planning practice: 1) planners,

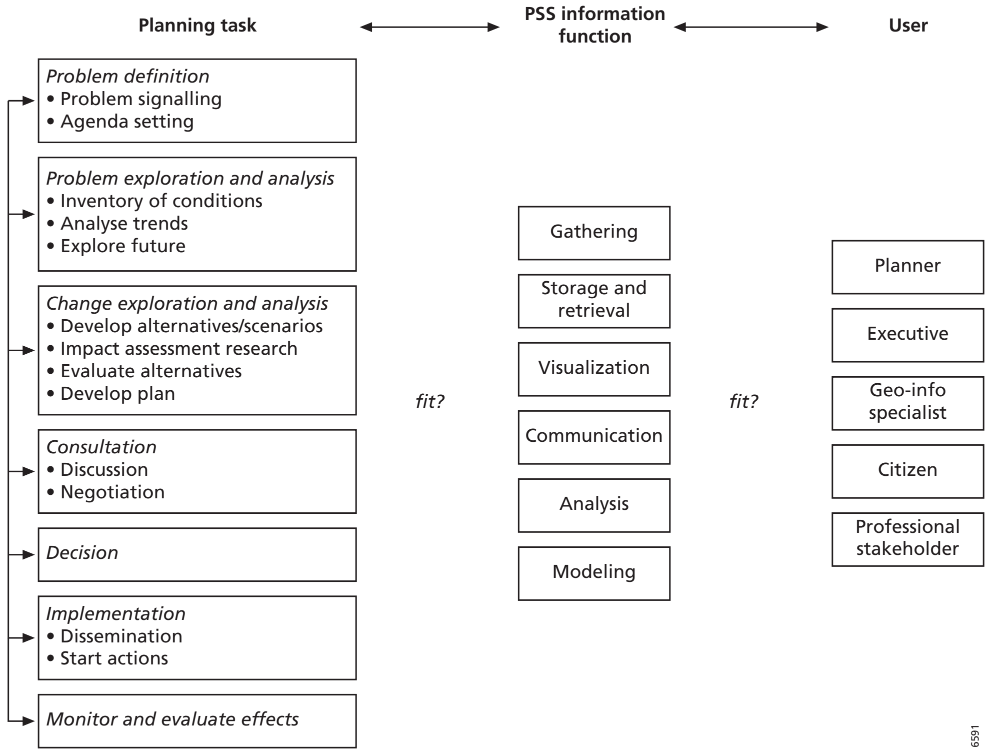

Figure 2.2 Conceptual framework describing the fit of combinations of Planning task – PSS information function – User

including designers, planning policy workers and planning consultants; 2) executives, including managers and politicians; 3) geo-information specialists working within planning organizations, consultancy organizations or universities; 4) citizens; and 5) professional stakeholders, including representatives of groups of people or organizations. Actors that are not among these 5 are not considered main users of PSS in planning practice. The distinguished users are shown in figure 2.2.

2.2.5 Conceptual model of Task-Technology-User fit for PSS

The conceptual model in figure 2.2 reflects the possible linkages between planning tasks, information (handling) functions of PSS, and users. The following sections will show how this framework has been applied to investigate strengths, weaknesses, opportunities and threats of PSS.

2.3 Method

To measure present and future task-technology-user fit this study combined the technical expertise on this subject of system developers with more practice-oriented expertise of users. This knowledge base has been enriched with the views of PSS experts, since these are expected to have knowledge of both the developers' and the users' side. It is realized that these three groups are not fully distinct in their knowledge and experience and account for this in the analysis. The knowledge and expertise of these three groups has been gathered between June and December 2003.

System developer views of PSS have been quite well recorded in scientific literature. Therefore, this study tracked their perspectives on task-technology-user fit by conducting a literature survey. For the literature survey, 58 PSS were placed in a large table and compared on the basis of a wide range of criteria, related to planning task, PSS information function, and user. In the selection of systems a broad definition of PSS has been applied, including all instruments that claim to be PSS. This allows accounting for the discourse among experts on the content of the PSS concept, concerning what exactly entails dedication to planning tasks and planning actors. Only literature published after 1998 has been included to account for the shifting meaning of PSS with advancing technological possibilities. The study included books and reports on PSS, papers from geographic information science related conferences and journals. The two main sources were the two books on PSS edited by Brail and Klosterman (2001) and Geertman and Stillwell (2003a).

User views of PSS have been gathered by holding a series of interviews among 43 employees of 12 highly comparable Dutch regional planning organizations. In particular, interviews were held among three of the earlier distinguished archetypes of users that currently have an important role in using and evaluating PSS: the geo-information specialist, the planner, and the executive. Since the study focuses on the fit of PSS with a set of planning tasks and users that are common to virtually all planning organizations in western and non-western societies, independent of the planning system, planning style, legal system etc, specific for each country, it is expected that these archetypes are capable of providing a good and representative overview of user perspectives on PSS-technology.

In addition to this, earlier studies show that the state of the technology itself is highly comparable in western societies (Brail and Klosterman, 2001; Geertman and Stillwell, 2004; Klosterman and Pettit, 2005; Vonk et al., 2005).

In the end, most of the participants were geo-information specialists (15), planners (12), and executives (3), but people with strongly related specializations also joined in (13). The interviews were carried out in groups during 12 sessions of several hours each.

Expert views of PSS have been gathered by means of conducting a worldwide web-survey. Via several PSS-related listserv e-mail networks 800 persons interested in PSS were asked to participate. Among the total of 40 respondents, the 30 persons who indicated that they had had practical experience with at least two PSS were considered experts. The survey consisted of open questions on strengths, weaknesses, opportunities and threats of PSS, as well as closed questions in order to express the perceived fit of a range of combinations of planning task, PSS and user, and to express experience with these combinations. Respondents could judge the fit by selecting from 'not useful', 'neutral', '(very) useful' and 'don't know'.

During interpretation, the findings of the literature survey, the interviews and the web-survey were combined and interpreted in terms of the conceptual framework (figure 2). Subsequently, the findings were developed into an aggregate overview of strengths, weaknesses, opportunities, and threats of PSS.

2.4 Results

2.4.1 System developer views

Inspection and analysis of literature survey data showed results described in the following. Table 2.1 shows the number of PSS from the sample of 58 that are dedicated to the information functions, planning tasks and user types distinguished in the conceptual framework. Note that a single PSS can be dedicated to multiple tasks, information functions and users, e.g. most PSS with analysis function also do storage and retrieval.

Regarding *planning tasks*, the literature survey shows that very few systems are dedicated to support problem definition and decision-making. A few systems support implementation in terms of dissemination and a few other systems support monitoring. Somewhat more systems focus on consultation of stakeholders and citizens. In recent years, significant progress has been made in citizen-oriented and web-based systems for consultation in web-based settings and the number of PSS for consultation in collaborative settings has also expanded (Jankowski and Nyerges, 2001; Craig et al., 2002). However, the majority of systems that currently exist focus on support of problem and change exploration and analysis.

Regarding *PSS information functions*, the literature survey shows that a minority of systems focus on gathering information, advanced visualization and communication of information. By far, the majority of systems focus on analysis and modeling. Although many PSS with storage and retrieval functionality were found, only very few are actually dedicated to this use. Most systems incorporate it as a necessary condition for analysis and modeling, on which the emphases lies in these systems.

Regarding *PSS users*, the literature survey shows almost no systems dedicated to executives. Many more systems focus on supporting participatory forms of planning with stakeholders or citizens. However, most systems focus on supporting planners themselves in doing their planning tasks. Among these systems are many PSS that incorporate or consist totally of land use models. Only a part of these systems is actually user friendly enough to be used by planners. Those that are not seem to be only suitable for usage by geo-information specialists. Apart from their being difficult to use, many systems remain one-off applications, operated by the university researcher who developed the PSS in the first place.

2.4.2 User views

The results obtained from the interviews are described in the following. Table 2.2 provides a summary of these results, in terms of interviewee perceptions of usefulness of PSS dedicated to a

Table 2.1 Number of PSS dedicated to a range of planning tasks, information functions and user types

Planning task		PSS information function		Users	
Problem setting	1	Gathering	11	Planner	48
Problem exploration and analysis	55	Storage and retrieval	58	Geo-info specialist	2
Change exploration and analysis	52	Advanced visualization	13	Citizen	26
Consultation	20	Communication	13	Professional stakeholder	23
Decision	1	Analysis	46	Executive	22
Implementation	3	Modeling	35		
Monitor and evaluate effects	3				

range of planning tasks, information functions and users. Most users claimed that they currently make very limited use of PSS in their daily practices, so that most of their judgments indicate estimated present-day and future usefulness.

Regarding *planning tasks*, the interviews show that users see little use for PSS in problem definition. For tasks in the problem exploration and analysis stage however, the interviewees see using PSS for tasks within the problem exploration and analysis stage as particularly useful. They indicated that most planners nowadays use computer-based systems for early and rather simple exploratory tasks, such as making inventories of conditions and sometimes, analyzing spatial interactions and trends, which can be the basis of scenario formation. In the stage of change exploration and analysis, PSS are currently hardly used. Nonetheless, some of the interviewed users think that application of PSS for future oriented tasks in this stage could be very useful. In the consultation stage of current planning, PSS are hardly made use of, but users see increasing opportunities due to the intensified consultation of professional stakeholders and citizens. In the decision stage PSS are hardly used at all. Users almost unanimously indicate that the nature of decision-making allows little space for computer-based instruments. In the implementation stage, planners disseminate the plan by publishing their products on the Internet for citizens and professional planners. For monitoring and evaluating effects, the used systems range from simple systems with periodically updated maps to more advanced real-time traffic monitoring systems. These systems are seen as useful.

Regarding the *PSS information function*, the interviews showed that many planners nowadays use dedicated systems that combine information storage and retrieval with simple analysis and visualization. These technologically simple systems are the systems with which planners have had most experience and usually these are also the only systems they use. In particular, younger planners are often eager to use these systems. Most planners have access to such applications that are usually intranet based desktop viewing systems which retrieve information from a central geo-database. Geo-information specialists in two organizations indicate that in responding to this demand, they were developing more systems dedicated to support these tasks. Some users also see promise in more technically advanced systems or toolboxes that combine all information functions and that are able to support all exploration and analysis activities on their desktop. One thing they find particularly useful is the ability of such PSS to help find spatial relations and patterns that lead to a determination of the physical suitability of areas. This is information that can be used to delimit possible future development ranges. As an example, users indicated that professional planners could benefit from a viewer with metadata, trend analysis tools, spatial

Table 2.2 Usefulness of PSS dedicated to a range of planning tasks, information functions and users as indicated by PSS users (++ = very useful; -- = not very useful)

Planning task		**PSS information function**		**Users**	
Problem definition	-	Gathering	+	Planner	+
Problem exploration and analysis	++	Storage and retrieval	++	Geo-info specialist	++
Change exploration and analysis	0	Visualization	++	Citizen	+
Consultation	+	Communication	+	Professional stakeholder	+
Decision	-	Analysis	+	Executive	-
Implementation	+	Modelling	0		
Monitor and evaluate effects	+	Combinations	++		

scenario models and visualization tools for these purposes. Although such more advanced systems are seen as promising, according to most users they need further development. Currently, many of these systems are not regarded to fit to present day planning and are seen as far too complex to be handled by professional planners. In their current state, users find the models mainly tools for geo-information specialists, which are mostly used in the academic world. For communication this study distinguishes web-based consultation systems and collaborative systems that support consultation in meetings. The former systems are now mostly used for dissemination of planning results, but two-way communication could become very useful in enabling real consultation. Such systems are seen as useful since they will provide lots of different views to base designs upon. The latter systems are now used in their simplest form, a smart board, by two organizations. Users see such systems as particularly useful if many information functions are integrated.

Regarding the *PSS users*, the interviews showed that planners nowadays leave most analysis tasks to geo-information specialists. Most planners themselves only use viewer type PSS. The users also see PSS as useful for citizens and professional stakeholders if participation increases. Many organizations are already experimenting with intensified consultation in their planning processes. A new range of systems that support this could be useful in such processes by enabling citizens and stakeholders to carry out their own exploration and analysis tasks, while such systems would give them better-informed views in the consultation process. The majority of users agree that PSS are hardly useful for executives. Only the most basic tools that provide easily interpretable crystal clear images at high speed could be used as a means of power to support the executive in the political process. Decision makers need to be able to quickly make good choices about highly complex issues, a process which PSS is thought to obstruct. Furthermore, the exactness of the outcome of analytical systems is also seen as different from the reality where uncertainty and ambiguity rule. Nonetheless, some users see some room for PSS, as they do not accept the obscure character of many decision-making processes and indicate that a system could help to present information clearly, thereby increasing the transparency of the black box of policy making. Users in one organization have even had positive experiences with highly advanced systems used by politicians to support their decisions.

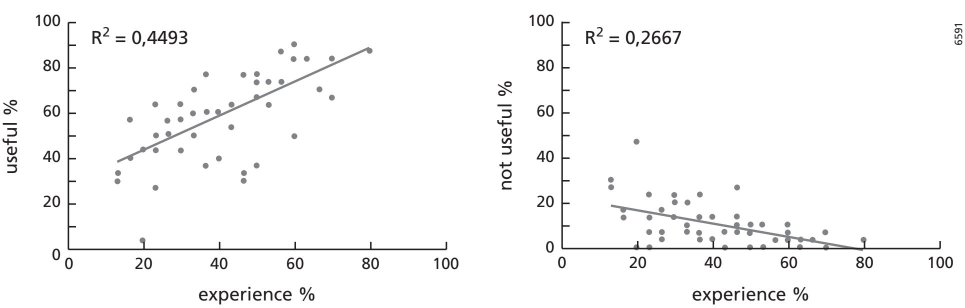

Figure 2.3 Relations between experience and usefulness of PSS (average frequency of 30 users on 50 aspects of PSS in relation to planning task and user)

2.4.3 Expert views

Inspection and analysis of web-survey data show the following results. Figure 2.3 shows the results of an analysis performed in order to find dependence patterns in the variables concerning experience and usefulness.

The two graphs in figure 2.3 suggest that the more experience one has, the more one will judge PSS as useful. Although these judgments come from experts only, this result is a strong argument for enhanced application of PSS.

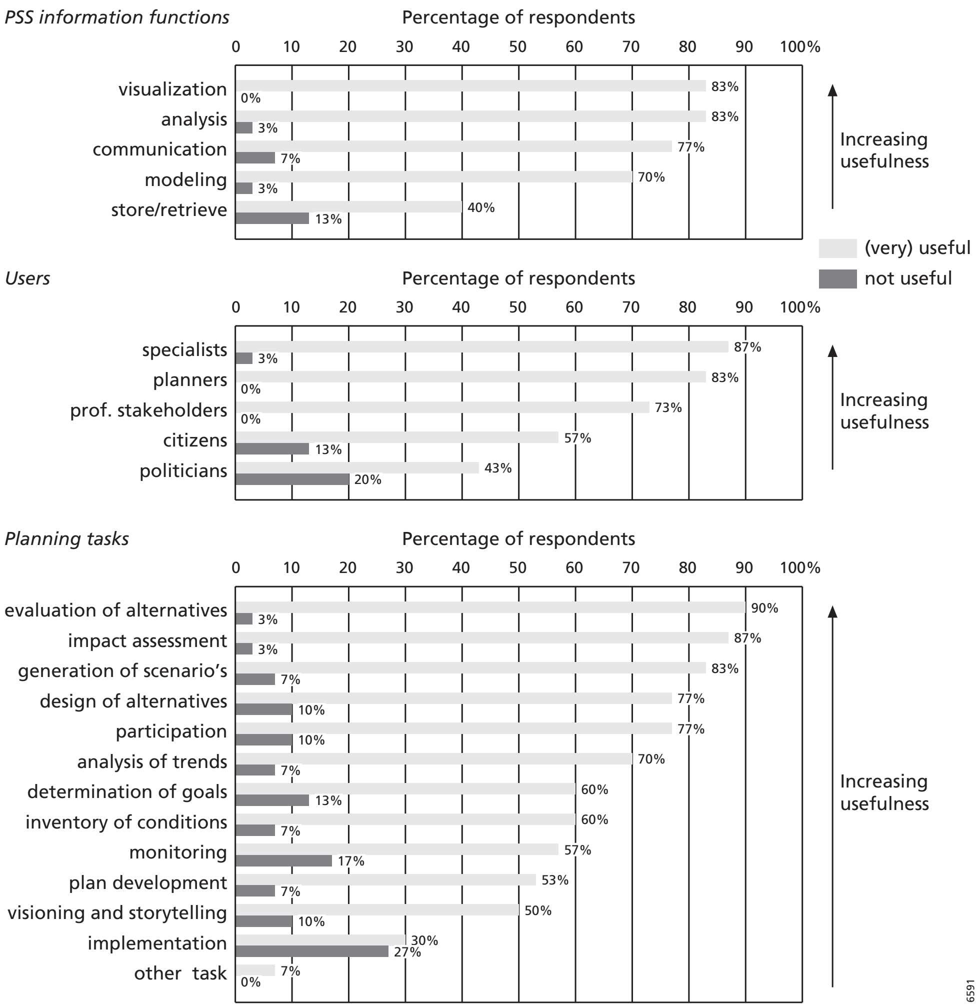

Figure 2.4 Frequencies of experts indicating level of usefulness of PSS for a range of information functions, users and planning tasks

Figure 2.4 shows expert respondents' judgments of the level of usefulness of PSS for a range of information functions, users and planning tasks.

Regarding the *planning tasks*, experts see PSS as most useful for evaluation of alternatives, impact assessment and generation of scenarios. Analysis shows that these are also the applications with which they have had most experience. Implementation has the highest frequency score on 'not useful'. Analysis shows that respondents have also had the least experiences with PSS for implementation.

Regarding the *PSS information functions*, results show that visualization, analysis, communication interface and modeling are all seen as highly useful functions. Systems that combine these functions would possibly be very useful. Analysis shows that the judgment of analysis and modeling systems, as well as visualization systems is mostly based upon experience. The function of information storage and retrieval is seen as the least useful in a planning support system, having the highest score on not useful. This is probably because this function is seen as simple and obvious in computer-based systems. Analysis shows that experts have less experience with communication instruments.

Regarding the *users of PSS*, the survey results show that experts see PSS as useful for geo-information specialists, planners and professional stakeholders, these being the highest scoring users. Analysis shows that most experiences have been obtained with applications for specialists, citizens and professional planners. PSS are seen as least useful for politicians (highest score on not useful), who also had the least amount of experience in using PSS. Despite the fact that experts reported a lot of experiences in which citizens used PSS, quite some of them see PSS as not useful for citizens.

2.5 Interpretation

2.5.1 Task-Technology-User fit for PSS

Comparison of the strongest with the most promising combinations of planning task, PSS information function and user, indicates that implementation of PSS is still in a development stage. These strongest combinations in current planning practice and most promising combinations for future planning practice are shown in figures 2.5 and 2.6, and are subsequently interpreted in terms of strengths, weaknesses, opportunities and threats.

2.5.2 Strengths, weaknesses, opportunities and threats

Strengths

Figure 2.5 and the additional results indicate three main strengths of PSS-technology in current planning practice. A first strength is that most planners experience PSS as useful for information storage and retrieval, as well as simple information visualization, in their current planning activities. Most planners have had experience with systems for such purposes. They often use a centralized database with intranet based data viewers with simple overlay and zooming functions, predominantly to make inventories of conditions and to help them analyze trends. In particular the quick and easy visualization functions are seen as highly useful. They judge these non-analytical instruments as more useful than analysis and modeling instruments. Planners indicate they have little or no experience with advanced analysis and modeling systems.

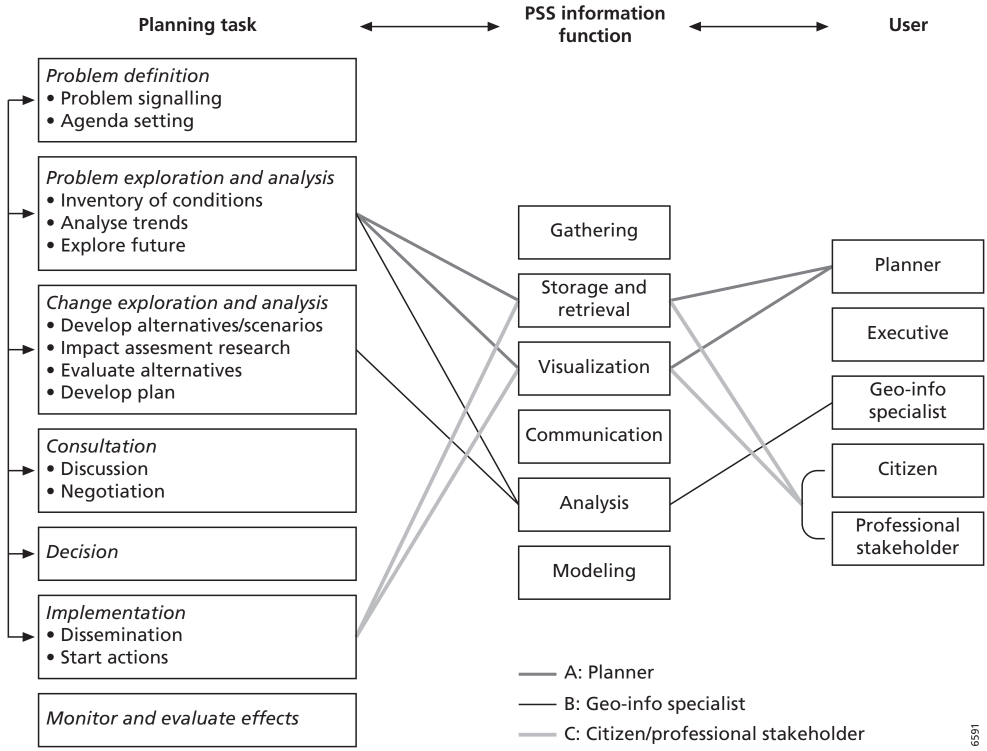

Figure 2.5 The currently strongest combinations of Planning task – PSS information function – User

A second strength is usage for analytical tasks by geo-information specialists. Most geo-information specialists use GIS, to analyze spatial data and produce maps used as input by planners for problem and change exploration and analysis. In contrast with less skilled users, GIS are very much like PSS for geo-information specialists, since GIS are dedicated to their operating skills. These skills enable them to operate task undedicated general-purpose tools such as GIS as if they were PSS for the easier tasks. Some geo-information specialists develop tailor-made PSS-applications from their generic GIS, to be used by planners. In exceptional cases geo-information specialists also use modeling for planning support, although in general they receive little demands for advanced analysis and modeling work.

A third strength is use of PSS by citizens and professional stakeholders in terms of taking notice of planning results, disseminated by planning organizations on their websites. The disseminated products become increasingly technically advanced, following opportunities offered by geo-information technology and web-technology.

Weaknesses

Results indicate three main weaknesses of PSS-technology in current planning practice. A first weakness of PSS-technology is that planners' usage of PSS remains limited to rather simple information functions and relatively un-complex tasks, while system developers mostly focus their development on advanced instruments for complex change exploration and analysis tasks by planners. In other words, a dichotomy exists between demands of planning practice and systems that are being developed. Lack of cooperative development clearly hampers the enhancement of PSS technology, for which the dichotomy is considered to be the greatest weakness of PSS-technology. Underlying this weakness is the general weakness of advanced PSS to fit to the non-technically skilled user in terms of ease-of-use, and to fit to the planning process and tasks. Many advanced systems try to rationalize things that cannot (yet) be rationalized and are incapable of handling inherently vague, synergetic and qualitative elements of planning. Linked to this is the hesitation of planners to change their ongoing practices and start using PSS. As long as developers keep focusing primarily on advanced instruments there will remain a gap between their products and the demands of planning practice. As long as users remain hesitant to experiment with advanced PSS, these will not get a chance to mature. The fact that many systems for information storage and retrieval that planners see as most useful are not even considered PSS by experts is illustrative for the dichotomy.

A second weakness of PSS is their limited usage by executives in decision-making because most PSS are seen to interfere with the nature of politics as a game of power. Only visualization systems with convincing results and systems that are able to support the power position of the executive are sometimes seen as useful in decision-making. Agility with computers and speedy generation of outcomes is vital for such use.

A third weakness is that although internationally there are large differences, citizens and professional stakeholders currently make little use of PSS. This is a weakness since PSS could facilitate their participation in planning more widely and to a greater extent. This is caused among others by a low degree of participation of these actors in current planning practice altogether and by the sparse usage of PSS in planning processes in general. Consequently, the ability of PSS to support communication between citizens, professional stakeholders and planners remains largely underused.

Opportunities

Figure 2.6 and additional results indicate a range of opportunities for application of PSS-technology in future planning practice in addition to the current applications. A first opportunity is that users see a short-term potential in usage of simple analysis oriented PSS by planners for tasks within the problem exploration and analysis contingent. In change exploration and analysis they see some potential for more advanced instruments, but to most of them this is still far from the current reality. Users indicate that information storage and retrieval systems are most used in planning practice and are the most useful. Therefore this study distinguishes opportunities for simple systems providing quick and highly visual information.

A second opportunity for PSS is that both experts and users see a high potential for PSS for advanced visualization of information and communication between planners, citizens and professional stakeholders involved in a planning process. Visualization is seen as a basis for communication and stimulates creativity during citizen participation and in other interactive settings with planners and stakeholders. In particular collaborative communication systems, web-based communication systems and systems that combine information functions for problem and change exploration & analysis and consultation tasks are seen as promising. The opportunities for such applications are likely to increase owing to the increasingly participatory nature of planning.

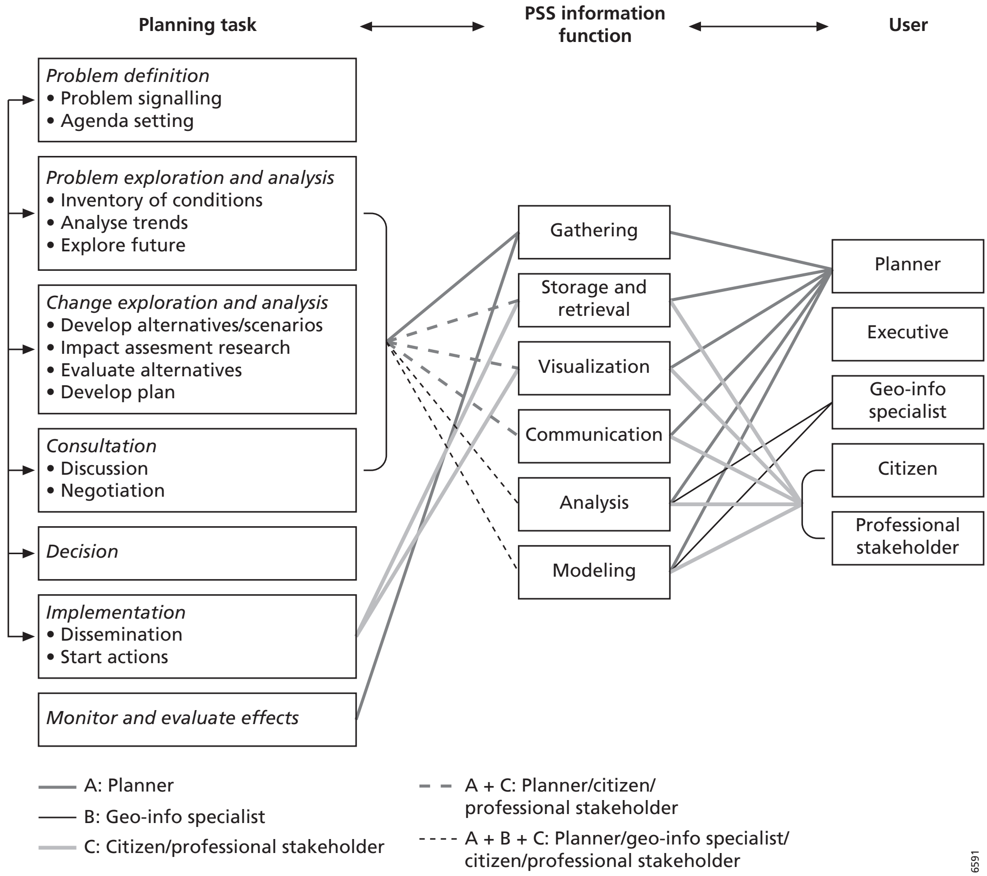

Figure 2.6 The most promising combinations of Planning task – PSS information function – User

A third opportunity of PSS-technology is use for analysis and modeling applications. Both experts and system developers see the core benefit of PSS in these applications. Although researchers and geo-information specialists are now the main users of analysis and modeling systems, both experts and system developers see significant potential for usage by planners and professional stakeholders if the systems are made user friendly and fit to the planning process. Most experts see such PSS as suitable for the generation of scenarios, the design of alternatives, impact assessment, the evaluation of alternatives and for the development of a plan. Users are mostly unaware of these opportunities and have mixed feelings about the potential of advanced systems.

Threats

The results indicate several threats for PSS-technology that may prevent realization of the opportunities. A first threat is that the dichotomy between supply and demand of PSS is not taken away. Therefore increased cooperation between system developers and practitioners is needed. In this, geo-information specialists within planning organizations can play an important role in communication between the supply and demand sides. System developers should focus on the niches identified by experts and users as strengths or opportunities. This will often mean at least in the first instance, restricting oneself to developing simple low-tech systems instead of immediately going for the most sophisticated technology all at once.

A second threat is that the current bottlenecks blocking development of PSS and diffusion towards planning practice will not be taken away. Earlier studies showed that lack of awareness, lack of experience and lack of general intention to use PSS among users are the main bottlenecks that hold back diffusion of PSS (Vonk et al., 2005). A second study showed that power issues hold back PSS diffusion: those in power are afraid to lose their position to instruments they cannot control (Vonk et al., 2006a). Furthermore these studies show that a perceived lack of overview of (short-term) benefits of using PSS holds those in power back from adopting PSS.

A third threat is going to practice with PSS in early stages of development. Many such PSS will not yet be sufficiently dedicated to the demands of planning processes and users. Subsequent troublesome application may cause an image of PSS as being difficult to handle to be formed or upheld among users. PSS in early stages of development should therefore first be applied in research simulation settings instead of real planning processes in order to learn lessons for improvement.

2.6 Conclusions and recommendations

From studying strengths, weaknesses, opportunities and threats, it is concluded that the currently existing large diversity of PSS, the lack of standards and little usage in practice, indicate that PSS technology is still in an early and exploratory stage of growth. PSS are quite far from being standardized software instruments, widely used in planning practice. The ongoing diversification and lack of standards associated with this phase causes ambiguity regarding what constitutes PSS and makes it virtually impossible to arrive at a suitable instrumental description of current PSS. In addition, the continuously improving technology forces instruments that were previously seen as PSS to make room for new instruments that better support planning. This also causes the practical meaning of PSS to shift in time. Nonetheless, results indicate that most experiences with PSS application are positively evaluated, even among a broad range of application types.

It is furthermore concluded that in the current state of PSS the lack of insights in mutual demands, knowledge and possibilities between users and system developers causes a dichotomy to persist between developed systems and user demands. System developers develop cutting edge analysis and spatial modeling systems. Although users are quite positive about the potential of a lot of such systems, they demand much simpler systems, dedicated to the storage, retrieval, visualization and communication of information during problem analysis & exploration. Bridging the gap between researchers' activities and the practical needs of practitioners presents a great obstacle to PSS development and adoption.

To decrease the dichotomy between users and system developers this study recommends PSS users increase internal and external cooperation on information technology development and start experimenting with PSS instruments that go further than simple data viewers. Although the somewhat more advanced systems may not yet be perfect, continued development in practice is highly useful for systems that have reached a certain stage of laboratory development (Oudshoorn and Pinch, 2003). Likewise, it is recommended to PSS developers to increase contacts with users to develop products fit for practice. They should realize that there is significant research potential in the dedication of systems to planning en planners. This study recommends they develop their instruments within the niches that planners see as the most promising niches, and to go step by step in further development to make sure that the developed systems appeal to planners instead of to researchers only. Exploration of new niches could perhaps better be done in development laboratories.

To enable successful cooperation, the various user groups, system developers and researchers must realize that they are part of the innovation network concerning PSS. Development of good PSS is expected to benefit from investment of time and efforts from all actors of this network (Pittaway et al., 2004; Novikova, 2005). This study recommends they engage in a form of interactive learning to further develop PSS technology (Christensen and Lundvall, 2004). The organizational form this study recommends for such efforts is so-called communities of practice on PSS (Brown and Duguid, 1991). These are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly (Wenger, 1998). The involvement of all the relevant actors of the innovation network concerning PSS in these communities may enable them to find common ground for experimenting with and testing of instruments in practice without being blocked halfway by factors that were unaccounted for. It is expected that the sharing of knowledge between different communities will stimulate development of PSS in general and will make them more attuned and dedicated to specific practices in particular (Brown and Duguid, 1991). A community of practice with planning practitioners, researchers and system developers, initiated in 1998 by the US Department of Energy, has already generated some highly useful insights into requirements for attuned and dedicated systems (Snyder, 2003). To researchers it is suggested to take an active role in these communities. On the conceptual level, they can contribute to the communities by providing guidelines for cooperation and by providing the latest research results. On the content level the communities will facilitate them to study the application of PSS dedicated to certain planning tasks in practice in order to learn lessons and set up standards of best practices. A basic prerequisite for the proper functioning of these communities however is a common concern or passion. In the case of PSS this common concern or passion can be the need to tackle the ever-increasing complexity of the planning task.

3 Bottlenecks blocking widespread usage of Planning Support Systems

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Abstract

Research on Planning Support Systems (PSS) is characterized by a strong emphasis on the supply side, whereas little research has been undertaken on the successes and failures in the adoption of PSS within the planning community (demand side). What becomes clear from the existing research is that usage is not widespread. In this paper it is aimed to find the main bottlenecks blocking the widespread use of PSS in spatial planning. To achieve this, a global online survey was conducted, in which almost 100 PSS experts participated and for which a theoretical framework from the field of business studies served as a basis. The results show that a multitude of factors cause the under-utilization of PSS, their characteristics being human, organizational and institutional as well as technical. In particular the lack of awareness of and experience with PSS, alongside the relative lack of recognition about the value of PSS within the spatial planning community, tend to block widespread usage and adoption in planning practice. On this basis, recommendations are offered for the enhancement of PSS adoption, namely to disseminate more profoundly information and knowledge about the existence and benefits of PSS within the spatial planning community. Real world example projects and in-depth research on potential benefits of PSS application in planning practice will be crucial in this.

3.1 Introduction

An assessment of spatial planning practice at the end of the 20th century suggested that the adoption and use of geo-information tools (geographic information and spatial modeling systems) are far from widespread and far from being effectively integrated into the planning process (Stillwell et al., 1999a). From the assessment it may be concluded that many planners now have access to the geodata and meta-geoinformation facilities of their organizations, and many are proficient in using their geo-information tools to perform spatial queries and to generate thematic maps. Progress towards the use of these tools beyond these basic activities to help solve key planning problems through more sophisticated analysis, however, remains very limited (Stillwell et al., 1999a). Geo-information tools appear to be seldom used for those tasks that are unique to planning, such as visioning, story-telling, forecasting, analysis, sketching, and evaluation (Klosterman, 1997; Couclelis, 2003).

Studies to explain the shortfall in the adoption of geo-information tools have often taken a broad, systems analytical perspective, suggesting not only reasons of a technical nature, but also human, organizational and institutional factors. Alleged reasons are that most current tools 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 (Klosterman and Landis, 1988; Couclelis, 1989; Scholten and Stillwell, 1990; Harris and Batty, 1993; Innes and Simpson, 1993; Bishop, 1998; Nedovic-Budic, 1998; Sheppard et al., 1999; Sieber, 2000; Batty, 2003; Geertman and Stillwell, 2003d; Uran and Janssen, 2003).

Quite recently, a new generation of geo-information tools has entered the scene that is focusing directly on support of spatial planning tasks, the so-called Planning Support Systems (PSS). As a precursor Harris (1989) defined PSS as appropriate models for combining a range of computer-based methods and models into an integrated system that can support the spatial planning function (Harris, 1989). PSS bring together the functionalities of GIS, models and visualization, to gather, structure, analyze and communicate information in planning. Or, as recently defined by Geertman and Stillwell (2003b), PSS can be considered a subset of geo-information based instruments that incorporate a suite of components (theories, data, information, knowledge, methods, tools, etc.) that collectively support all of, or some part of, a unique planning task. In this way, PSS take the form of 'information frameworks' that integrate the full range of information technologies useful for supporting the specific planning context for which they are designed (Klosterman, 1997; Geertman and Stillwell, 2003c). Tools like GIS and spatial decision support systems (SDSS) are related to PSS and some overlap exists. In general however, PSS aim to focus purely on planning support, whereas many SDSS and GIS technologies can be used for planning support if required, but are not particularly dedicated to that use (for more information on general differences between PSS, GIS and SDSS see Geertman and Stillwell 2003b).

Over the last few years, individuals or groups based at scientific, research or planning institutions around the world have been involved in the development, testing and implementation of a range of PSS (Batty and Densham, 1996; Bishop, 1998; Edamura and Tsuchida, 1999; Hopkins, 1999; EPA, 2000; Klosterman, 2001b; Landis, 2001; Wegener, 2001; Guhathakurta, 2002; Waddell, 2002; Dijst et al., 2003; Omer, 2003; TCDDM-V, 2003; URISA, 2003; Voss et al., 2003; Snyder, 2004). Several authors have attempted to create a comprehensive picture of the extent of planning support tools that constitute PSS. This effort resulted in two books, among others: one that concentrates on the different aspects related to PSS (Brail and Klosterman, 2001); the other showing the immense diversity of PSS by presenting the outcomes of a worldwide survey of PSS in planning practice (Geertman and Stillwell, 2003b).

Besides these two more or less supply-side oriented contributions, there remains little insight into the demand for PSS in planning practice. This absence of insight is remarkable because one can conclude that the widespread adoption and implementation of PSS in planning practice is dragging far behind the supply of PSS tools. This under usage is problematic at a time when spatial planning is increasingly complex and planners are showing an increasing demand for support (Bishop, 1998; Geertman and Stillwell, 2003a; Voss et al., 2003).

A review of the scarce literature on the application of PSS in planning practice reveals some hints as to the reasons for the shortfall. First, the literature confirms the aforementioned reasons for underusage of geo-information tools in general. However, hardly any studies provide general insights into bottlenecks for the specific field of PSS. Somewhat more than a decade ago, Harris and Batty (1993) concluded that the lack of existing PSS leads planners to be ignorant of their potential, causing lack of demand. A few years after, Bishop (1998) concluded that existing tools are too loosely coupled for them to constitute a PSS. Recently, Geertman and Stillwell (2003c) stated that a great diversity of PSS has been developed, but that there is a serious need for focusing more explicitly on the P(Planning) and the first S(Support) of PSS instead of – as is often the case – on its second S(System) aspect. They provide a series of recommendations, based on interpreted bottlenecks from a series of cases.

A more thorough overview of empirical bottlenecks does not yet exist. The deficit in demand for PSS therefore cannot be fully explained with reference to existing knowledge. It is the primary aim of this paper to shed more light on the reasons for this under-utilization. This is done by explicitly questioning developers and users about which bottlenecks may be preventing widespread usage of PSS in planning practice. Insights from this investigation may help developers of PSS to attune their tools better to the demands of planning practice. and at the same time it may help potential users of PSS – the planners – to formulate their requirements more explicitly. By advancing our knowledge in this way, it is hoped that the study stimulates the application of PSS in planning practice and improves the handling of practical planning problems.

3.2 Theoretical framework

This study regards the adoption and implementation of PSS as a special case of adoption and implementation of any Information and Communication Technology (ICT) system. In this way, use can be made of extensive lines of research on adoption and implementation of ICT from the theoretical domains of innovation science, management science and business studies (Rogers, 1962; Davis, 1986; Mathieson, 1991; Thompson et al., 1991; Dishaw and Strong, 1999; Venkatesh and Davis, 2000; Frambach and Schillewaert, 2002; Wilson et al., 2002; Rogers, 2003). Innovation science research on technology adoption and implementation has evolved largely around Rogers's famous work 'Diffusion of Innovations' (Rogers, 1962; Rogers, 2003), in which technology adoption and implementation are considered at both an organizational and an individual level. The core of this research line is a model consisting of five sequential stages in innovation adoption and implementation: (1) generation of awareness of existence of an innovation; (2) persuasion and the formation of an attitude towards the innovation; (3) an adoption decision; (4) implementation; and (5) confirmation.

In management science, research on technology adoption and implementation originates from a basic theory in social psychology, the theory of reasoned action (Fishbein and Ajzen, 1975). This research line was land-marked by the publication of the 'Technology Acceptance Model' by Davis in 1986 (Davis, 1986). This model has been verified over a hundred times since and was updated and extended by Venkatesh and Davis in 2000 (Venkatesh and Davis, 2000). Technology acceptance is considered here only at an individual level. Its main components are the attitude towards an innovation, leading to acceptance of the innovation, and continued usage of the innovation. This attitude is formed by two central *factors*, 'perceived usefulness' and 'perceived ease of use', which are influenced by a number of external factors such as 'output quality' and 'job relevance' of the innovation.

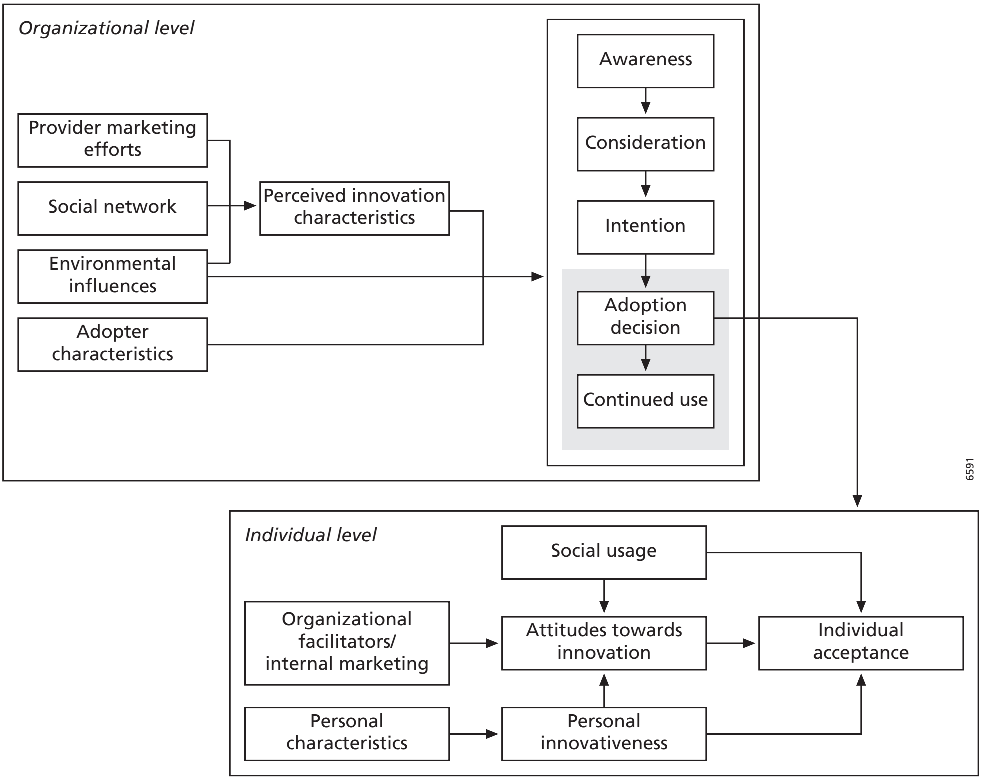

Figure 3.1 Framework for innovation adoption (after Frambach and Schillewaert, 2002).

As both lines of research can to some extent be considered two sides of the same coin, quite recently, Frambach and Schillewaert integrated the two in a comprehensive multilevel framework (Frambach and Schillewaert, 2002). This integrated framework, which was published in the field of business studies, has been used as a basis for the study presented in this paper. A version, showing only influence factors at an aggregated level, is shown in figure 3.1.

Figure 3.1 shows that an *organization-level* decision to 'adopt an innovation' that may lead to 'continued use' is preceded first of all by generation of 'awareness', after which potential users may start to 'consider' using an innovation and from this they may form an 'intention' to use. These factors are directly influenced by the 'adopter characteristics' (for example, organization size), organization 'environmental influences' (for example, competitiveness) and the 'perceived innovation characteristics' (for example, perceived complexity); and are indirectly influenced by 'social network' characteristics (for example, network participation), 'supplier marketing efforts' and also the organizational 'environmental influences'. Following the organizational-level adoption decision, the innovation will only actually be used if the individuals within the organization adopt the innovation. Within the context of an organization, acceptance and usage at the *individual level* are influenced directly by 'attitude towards an innovation', 'social usage' characteristics (such as social pressure) and 'personal innovativeness'; and indirectly by 'organizational facilitators and internal marketing' (for example, training), 'personal innovativeness' (depending on personal characteristics) and 'social usage' (for example, persuasion by colleagues) (Frambach and Schillewaert, 2002).

The main advantage of this framework lies in the combination of major organizational and individual factors determining innovation adoption in one systematic framework. It enables one to undertake research on adoption of an innovation as a whole, instead of focusing on particular aspects as in many other studies (Schmitz and Fulk, 1991; Karahanna and Straub, 1999). Nonetheless, the framework also has some severe limitations when applied to PSS. First, the applicability is limited to top-down technology adoption and implementation. This implies that first an adoption decision is taken at an organizational level and only thereafter the employees of the organization decide whether or not to start making use of the innovation. In the perspective of this study, successful adoption and implementation can start at both the individual and the organizational level. For instance, in a bottom-up acceptance (individual level), a planning professional finds out about a system, evaluates its usefulness and, usually with managers' consent, he or she will start using it. The second limitation, linked to the first, is that the framework suggests that the characteristics of a technology are relevant only at an organizational level and not at the end-users' level. It assumes that end-users do not judge a system on its capabilities. This seems to contradict Venkatesh and Davis's model, in which they consider 'output quality' and 'job fit' as important determinants of individual technology acceptance (Venkatesh and Davis, 2000). Moreover, it contradicts our experience with end-users. Third, the presented framework focuses on information technology in general and not on PSS in particular. Some refinement is required because, after all, PSS are not the same as word processors or a spreadsheet programs.

Because of these limitations, we undertook some modifications on the Frambach and Schillewaert framework, in line with mentioned shortcomings. Pure top-down technology adoption and implementation is replaced by a mutual top-down and bottom-up process. Moreover, some factors were added which were considered missing at one of the two adoption levels, for instance, 'awareness', 'consideration' and 'perceived innovation characteristics' at the individual level and 'social influence' among managers on the organizational level. In addition, the third limitation required some further research of the literature on PSS, as well as related technologies like GIS and SDSS, and expert judgment from colleagues. Several factors considered important for explaining PSS adoption and implementation were found in Crosswell in his (1991) paper on GIS-adoption, and in books on PSS by Brail and Klosterman and by Geertman and Stillwell (Croswell, 1991; Brail and Klosterman, 2001; Geertman and Stillwell, 2003b). As a result, extra factors were added to the framework, for instance factors concerning 'hardware issues' and 'data issues'. Finally, the framework was somewhat simplified for visualization purposes. Figure 3.2 shows the adapted framework. In this adapted version, the upper dotted boxes within different factors correspond largely with the organizational level boxes in figure 3.1, the lower with individual level boxes. The inclusion of both levels in the framework enabled studying the adoption of PSS from a broad perspective, in agreement with expectations that adoption of PSS may start at the individual and the organizational level.

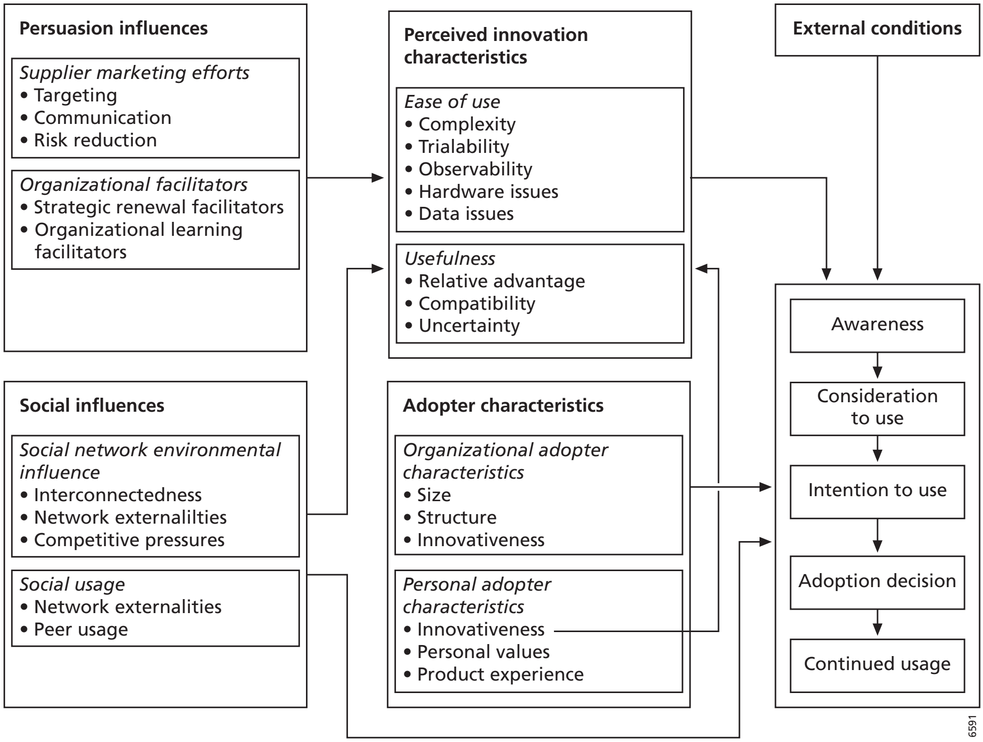

Figure 3.2 Theoretical framework for this research project

A survey was conducted to determine the importance of the influence factors in explaining why the use of PSS for spatial planning is not widespread. For this purpose, *factors* were converted to bottleneck *indicators*, the importance of which was measured with bottleneck *statements*.

3.3 Method

Using the theoretical framework a web-survey was constructed to discover empirically the main bottlenecks preventing the widespread use of PSS in spatial planning practice. In March 2003, via several electronic mailing lists, approximately approximately 800 people involved in PSS around the world were asked to participate in the survey by filling out an online form.

The main part of the questionnaire consisted of 67 *statements,* referring to potential bottlenecks, of which the importance had to be judged. These statements were based on technology adoption studies in information systems literature and in geo-information literature (Davis, 1989; Croswell, 1991; Masser and Onsrud, 1993; Dishaw and Strong, 1999; Karahanna and Straub, 1999; Venkatesh and Davis, 2000; Brail and Klosterman, 2001; Geertman and Stillwell, 2003b; Rogers, 2003; Uran and Janssen, 2003). For each statement, respondents could distinguish between 'unimportant', 'important', 'very important' and 'don't know'. For evaluation of the received enquiries, questions were added to determine the characteristics of the survey population, such as their origin, working position, affiliation to PSS and experience with PSS. In particular, the experience of the respondents was considered crucial to the value of their replies; their experience was determined by asking respondents to select from a list of 34 well-known and less well-known PSS, those they had worked with or heard about. The list consisted of a selection of planning tools described in an Environmental Protecion Agency (EPA) study and two PSS overviews (EPA, 2000; Brail and Klosterman, 2001; Geertman and Stillwell, 2003b). In addition to the closed statements and questions, open questions were provided to suggest additional bottlenecks that were not on the list and to add comments about bottlenecks.

First, during the analysis, PSS experts were distinguished from non-experts, according to the criterion that experts should have at least heard of, or worked with, two out of 34 listed PSS.

Second, the indicated importance of each of the bottleneck statements was calculated by combining the frequency scores of the answer categories 'important' and 'very important'. For interpretation, these combined scores were compared with frequency scores for 'unimportant' and 'don't know' to determine how unanimous respondents were in their judgments about the importance of the statements.

Third, the 67 bottleneck statements were classified into 24 bottleneck *indicators*, to increase transparency and consistency. Consistency was particularly important since many statements were close in meaning or even partially overlapping. The average frequency score of contributing statements reflects the importance of a bottleneck indicator. Consistency of the indicators was evaluated by using distributions of frequency scores of contributing statements.

Fourth, results were validated, by analyzing and comparing the results from subgroups of respondents with the results for all respondents. Small differences in results indicate unanimity among respondents, which contributes to the general validity of the results, whereas larger differences indicate the opposite. Subgroups were distinguished on the basis of geographical origin and expertise. With regards to geographical origin, subgroups were made consisting of Europeans and North Americans, as these were the only subgroups large enough for analysis. With regard to expertise, subgroups were made consisting of 'moderate experts' – those knowing more than one but less than ten PSS – and 'greater experts' – those knowing more than ten PSS.

Fifth, the bottleneck indicators were interpreted in relation to the theoretical framework, thus providing insight into how the important bottleneck indicators are interrelated and how they affect adoption and implementation. To this end, the bottleneck indicators were grouped, as far as possible, into the *factors* distinguished in the theoretical framework. The average frequency score per group of bottlenecks was calculated and represents the factor score. From this measure it is possible to derive the relative importance of the factors in the theoretical framework.

Finally, the rankings of important bottleneck indicators, and their interrelations and effects on adoption and implementation, were used to develop an overall interpretation of bottlenecks preventing more widespread usage of PSS.

3.4 Results

3.4.1 Bottleneck indicators

Exploration of responses
In total 96 respondents filled out the form, which is estimated as approximately 12% response ratio. Figure 3.3 indicates the level of PSS knowledge of the 96 respondents. It shows that 90% of respondents (86 respondents) had heard of or worked with more than one (so at least two) of the systems, and this group was therefore included in the category experts in further analysis. The other 10% (ten respondents) were excluded. In general, respondents' knowledge of PSS seems to be quite high, as 50% of respondents had heard of or worked with more than six systems. One respondent declared to know all of the 34 listed PSS. Moreover, the analysis of respondents' PSS knowledge also revealed that 'UrbanSim' (56%) was the best-known system, followed by 'What If' (44%) and 'CommunityViz™' (41%) (Klosterman, 2001b; Kwartler and Bernard, 2001; Waddell, 2002).

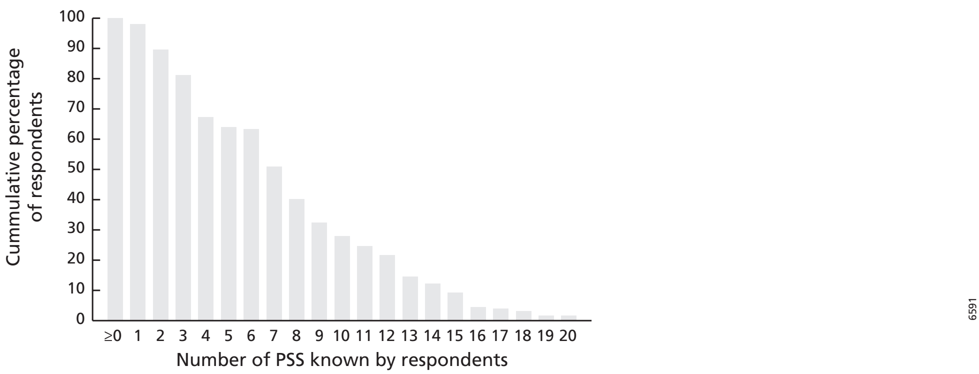

Figure 3.3 Cumulative frequency of PSS knowledge of respondents

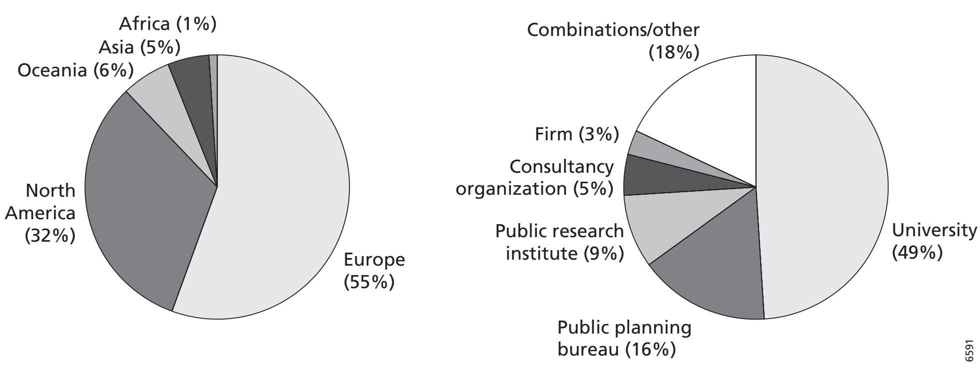

Figure 3.4 Origin of respondents (left pie-chart) and their work organization (right pie-chart)

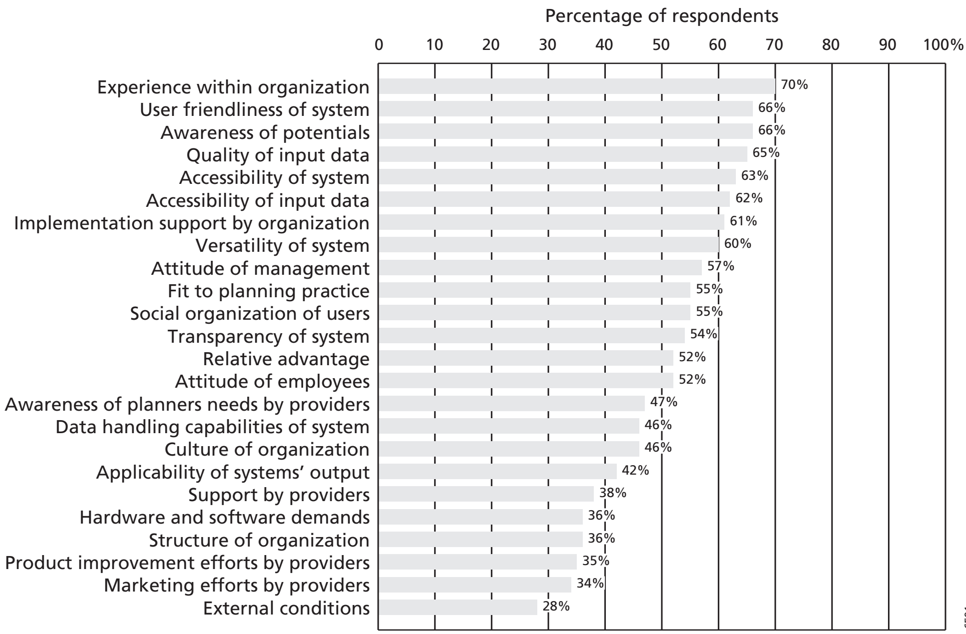

Figure 3.5 Bottleneck indicators with their importance

Figure 3.4 shows that most of these eighty-six respondents originate from Europe (55%) and North America (30%) and that most of them work at universities (49%). Furthermore, although not shown in figure 3.4, most of them consider their affiliation with PSS to be as consultants or researchers (55%) and only a few as users or developers.

Analyzing bottleneck indicators

Figure 3.5 shows the bottleneck *indicators* with their importance scores (frequency of 'important' plus 'very important') derived from classification of the 67 bottleneck statements into 24 indicators.

It shows that a wide range of bottleneck indicators is considered to be important. Illustrative in this respect is that the lowest scoring indicator on importance ('external conditions') is still thought to be important by 28% of respondents. The ten highest scoring indicators will be shortly described. The three most important bottleneck indicators are 'experience within the planning organization', 'user friendliness of PSS' and 'users awareness of the potential of PSS'. The importance of awareness and experience confirms the present supply-side orientation in PSS development. Besides these three most important indicators, data issues are also seen as important. Both 'quality of input data' and 'accessibility of input data' are seen as insufficient and blocking widespread usage of PSS. In addition to the difficulty of accessing required data, the 'accessibility of the system' itself can be seen as problematic. Furthermore organizations do not really seem to put enough effort into 'implementation support', which may be a result of the 'attitude of the management'. The PSS are also seen as neither having sufficient 'versatility' nor sufficient 'fit to planning practice'.

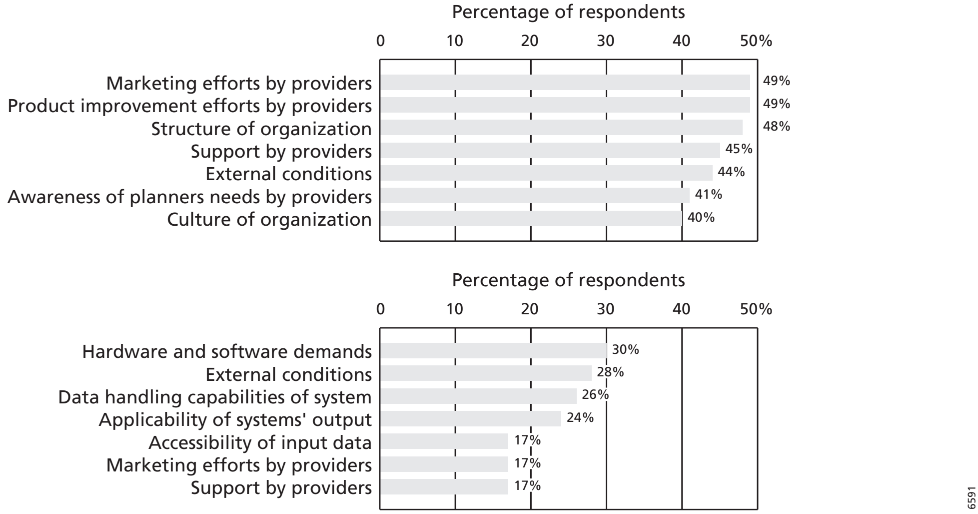

Figure 3.6 Highest scoring bottleneck indicators with their scores on 'don't know' and 'unimportant'

Figure 3.6 shows the seven highest scoring *indicators* in the 'don't know' and 'unimportant' categories. Besides interpretation of the scores as they are, they were also used to place the before distinguished important bottleneck indicators in perspective. For example, an important bottleneck that also has a high score in the 'unimportant' or 'don't know' categories indicates ambiguity or doubt among respondents, which lead to questioning the actual importance of the bottleneck.

The bottleneck indicators related to role of the provider, 'structure of organization', 'culture of organization', and 'external conditions', possess high scores of between 40% and 50% in the 'don't know' category. The most unimportant indicators are quite diverse, including 'hardware and software demands', 'external conditions', 'data handling capabilities of the systems', 'applicability of systems output', 'accessibility of input data' and also indicators related to the role of the provider. The four highest scoring unimportant indicators distinguish themselves from the others by quite a margin. In the combined indicator 'hardware and software demands', respondent feedback indicates that hardware is judged as more unimportant than software. Although 'hardware and software demands' is the most unimportant bottleneck, the relatively low maximum score of 30% shows that little unanimity exists among respondents about the unimportant bottlenecks. Still scores of 24% to 30% in the 'unimportant' category are considered as substantial.

The fact that neither of the indicators with high scores in the 'don't know' and 'unimportant' categories is among the highest scoring indicators on importance ('important' plus 'very important') supports the value of these as important bottleneck indicators.

Bottleneck indicators for subgroups of respondents
Subgroups of respondents were analyzed to find out more about the validity of their answers. Small differences between the results for subgroups and the general results would indicate

unanimity, which would contribute to the validity of the general results, whereas larger differences would indicate the opposite.

Figure 3.7 shows the scores of the ten *indicators* distinguished earlier, which scored highest on importance ('important' plus 'very important') in general, compared with the scores from subgroups of respondents based on geographical origin. The subgroups consisted of 47 Europeans and 28 North Americans. In general, differences between the groups are rather small.

The pattern of scores shows, however that the respondents from North America were more outspoken than their European counterparts, with higher scores on nearly all of the shown bottleneck indicators (and also on those that are not shown here). One might explain this observation by cross-cultural differences or differences in knowledge of PSS. The correctness of these explanations was checked through analysis of the 'don't know' answers. The analysis showed little difference in knowledge of PSS between Europeans and North Americans: frequency scores show that both groups know little about the importance of approximately the same subjects and that their overall frequencies of subjects responding with 'don't know' are more or less similar for both groups (35% for Europeans, 36% for North Americans). North Americans are therefore more likely to be outspoken because of their culture and not by superior knowledge. Besides the difference in outspokenness, both groups see approximately the same bottleneck indicators as important. A noteworthy difference is the emphasis of North Americans on 'user friendliness' as their main bottleneck indicator. Moreover, analysis showed that North Americans and Europeans also see approximately the same indicators as unimportant.

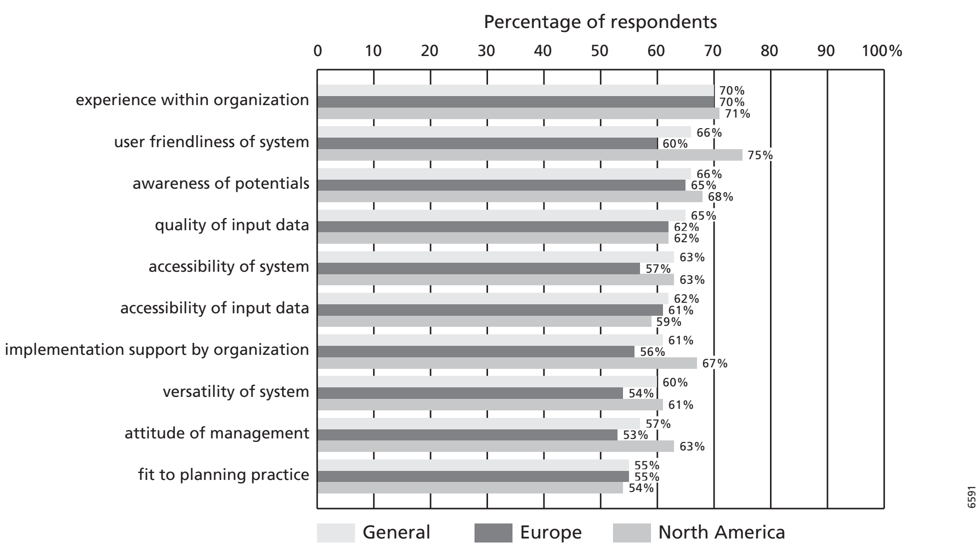

Figure 3.7 The ten most important bottleneck indicators for all respondents, the Europeans and the North Americans

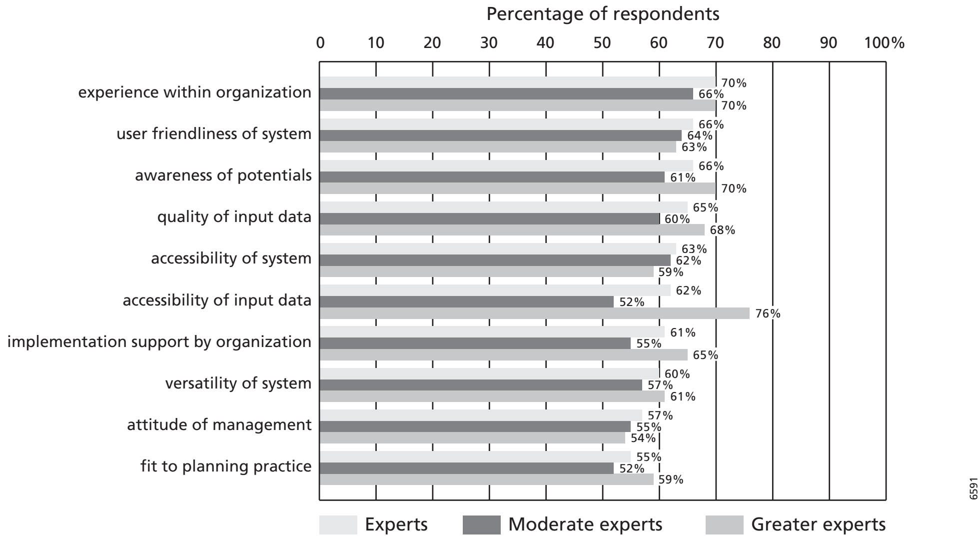

Figure 3.8 The ten most important bottleneck indicators for PSS experts, moderate experts and greater experts

Figure 3.8 presents the scores of the ten *indicators* distinguished earlier which scored highest on importance in general, compared with the scores for subgroups of respondents based on their knowledge of PSS. The subgroups consist of 61 moderate experts and 25 greater experts. In general, differences between the groups are minimal, although there are some exceptions: it is noteworthy that the bottleneck indicator 'accessibility of input data' is seen as a much more important bottleneck indicator by the group of greater experts than by the group of moderate experts. Furthermore, the greater experts have somewhat higher scores, on average, than the moderate experts, which we believe is a direct reflection of their awareness of the stated bottlenecks. Analysis showed that both expert groups see approximately the same bottlenecks as unimportant.

Results for the subgroups agreed, in general, with the results obtained earlier for all respondents for both the important and the unimportant bottleneck indicators. This contributes to the general validity of the results.

3.5 Interpretation of results

3.5.1 Interpretation in terms of the theoretical framework

Just by reading the list of *indicators* shown in figure 3.5, one can see that some indicators are related. From such a list, however, these relations are not very clear. The developed theoretical framework on innovation adoption helps to interpret these relations and therefore helps to add value to the results. Figure 3.9 shows the theoretical framework, with the bottleneck *indicators* and their importance scores incorporated within the suitable *factors*. The percentages were

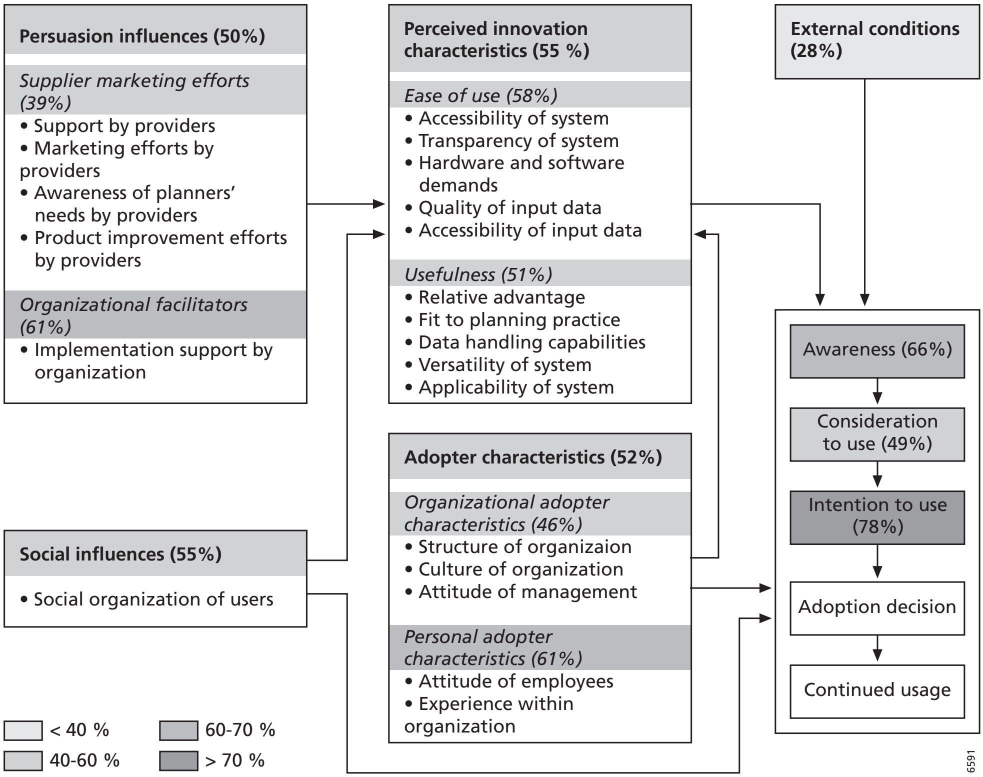

Figure 3.9 Bottlenecks blocking widespread usage and acceptance of PSS in terms of the theoretical framework with importance scores

calculated from average frequency scores of the indicators contained within each factor and indicate the importance of factors.

The earlier notion that there is not a single bottleneck blocking widespread usage and acceptance of PSS, but quite a diversity, is clearly conveyed by figure 3.9. Almost all of the factors of the theoretical framework seem to be bottlenecks. Only 'external conditions' and 'supplier marketing efforts' score quite low (<40%). The higher scoring factors range from those related to the 'adopter characteristics', 'social influences', 'persuasion influences', 'perceived innovation characteristics' and 'consideration to use', which score about 40-60%, to 'awareness', 'personal adopter characteristics' and 'organizational facilitators', which score significantly higher (60-70%). All of these factors directly or indirectly influence the highest scoring factor (>70%), which is the 'intention to use'. As a result of the structure of the theoretical framework, aggregation effects may well have caused the high scores of some of these factors. Because of its influential position, if 'intention to use' is a bottleneck, this more or less confirms that adoption decisions will be blocked, therefore preventing the use of PSS becoming widespread.

3.5.2 Overall interpretation of bottlenecks preventing adoption of PSS

The rankings of important bottleneck indicators, as shown in figure 3.5, and their interrelations and effects on adoption, as shown in figure 3.9, were used to develop an overall interpretation of bottlenecks which prevent more widespread usage of PSS. It appears that a wide diversity of bottlenecks is considered to be important. Also, there seems to be little experience with PSS among planners (indicator: experience within organization). In addition to having little experience, respondents indicate that many planners are not even aware of the existence and potential of PSS (indicator: awareness of potential), suggesting that the activities going on within the PSS developer community stays largely within that community. Once users have been informed about PSS they have a hard time finding them and experimenting with them (indicator: accessibility of system). If users do manage to find PSS, many of them do not value them and reject the tools immediately (indicators: attitude of managers, attitude of employees, intention to use). This negative attitude is likely to be partially caused by the image that PSS has among planners as 'black boxes' that are difficult to operate (indicators: transparency of system, user friendliness of system). The many years of research emphasizing the development of transparent and easy to use systems have clearly not changed users' perceptions a great deal. Once adopted, there are also many implementation bottlenecks to conquer before applications become a success (indicators: implementation support by the organization, accessibility of input data, quality of input data). The data issues are especially persistent as efforts to solve these problems have been going on for many years now. Finally, the results also clearly show that the tools themselves need improving to be able to offer better support for planning tasks so that planners feel that PSS offer advantages for their work (indicators: fit to planning tasks, versatility of system, transparency of system, relative advantage). With regards to the most unimportant bottlenecks, it seems that hardware issues have been solved (indicator: hardware and software demand). Respondents do not have a clear idea of the role played by providers in blocking usage of PSS (support by providers, marketing efforts by providers, awareness of planners needs by providers, product improvement efforts by providers), as these indicators scored highest in the 'don't know' category.

3.6 Methodological reflection

Several assumptions, practices and outcomes may have affected the results.

First, no empirical verification of the theoretical framework of Frambach and Schillewaert was found in the literature. This absence was not considered to be detrimental to the value of the results obtained, because its constituents have been verified separately in extensive lines of research dedicated to innovation adoption. As the only apparent application of the framework, this study may be also valuable for the field of business studies from which the framework was derived.

Second, because of our selection procedure based on the number of known PSS respondents with many years of practical experience would have been excluded, if they had experience of only one system and had not heard of any other. However, this is not expected to decrease the validity of results, because the enquiry was not established to find out the value of one particular system, but to gain insight into the broader field of PSS and its application in spatial planning practice.

Third, with respect to the respondents, there is an emphasis on the geographical hotspots of Europe and North America, on universities, and also on researchers and consultants. Although it is likely that the mailing lists are partly to blame for this emphasis, it is not expected to result in a large decrease of the broader validity of the results, because European and North American universities remain prime breeding grounds for new developments in geo-information. Still, it must be recognized that the emphasis on university workers and researchers is important considering the aim of this study to find out why spatial planners tend not to use PSS. The low response of planners themselves may be explained by the fact that nonusage makes it, by definition, difficult to answer the questionnaire; this is particularly indicated by the fact that a substantial mailing to planners resulted in little response. It therefore had to be assumed that university workers and researchers are well qualified to replace the planners themselves. In general, it is believed that the number of responses and the expressed knowledge on PSS form a solid basis for a sufficient quality of data and, thus, reliable outcomes for the further analysis of the expressed bottlenecks.

Fourth, some assumptions were made in development of the list of statements and in classifying the statements to indicators and factors. It was assumed that (1) the list of statements reflected the existing bottlenecks appropriately, (2) that indicators reflected the meaning of grouped statements sufficiently and (3) that statements and indicators had equal weightings in the classification to indicators and factors. Considering the absence of respondents commenting on this, and considering the sound theoretical framework used to distinguish indicators and factors, it is believed that, in general, these assumptions are valid and do not decrease the value of the obtained results.

The findings suggest that the aim has been achieved, because there now exists an overview of the main bottlenecks blocking widespread use of PSS in spatial planning. However, for particular PSS there can be numerous reasons why they would fail under particular circumstances or succeed in other settings. The bottlenecks found in this study refer to the state of the art of the technology as a whole instead of referring to particular systems. The validity of the results is expected to reach beyond PSS for spatial planning only. Based on similarities between the tools themselves, processes in which they are applied, and current research topics in relation to these tools, it is expected that the results are at least partially valid for PSS in general (Geertman and Stillwell, 2003d); GIS (Allen and Goers, 2002; Carver, 2003; De Man, 2003); Spatial Decision Support Systems (SDSS) (Crossland et al., 1995; Uran, 2002; Uran and Janssen, 2003); Integrated Assessment models (Rotmans, 1998; Hisschemöller et al., 2001); Decision Support Systems (DSS) in general (Shim et al., 2002); and Information Systems in general (Frambach and Schillewaert, 2002; Rogers, 2003; Windrum and De Berranger, 2003).

3.7 Conclusions and recommendations

Literature suggests that the widespread adoption and implementation of PSS in planning practice is lagging behind the supply of PSS tools. The primary aim of this study has been to shed more light on the reasons for the shortfall by asking explicit questions about bottlenecks which prevent widespread usage of PSS in spatial planning practice.

The main conclusion is that there is a multitude of bottlenecks blocking widespread usage and acceptance of PSS in spatial planning practice; these can be summarized in three main categories.

First, the PSS experts questioned see *little awareness* among planners of the existence of PSS and for the purposes for which PSS can be used. Second, they feel there is a *lack of experience* with PSS, which means that potential users are unaware of benefits of using PSS and of the conditions under which they could best be applied. Third, they feel there is a *low intention* to start using a PSS among possible users. These categories are probably interrelated. It is clear that, although system development is continuing at a rapid pace, this development has remained largely unnoticed by the intended users. If the planning community remains unaware, it will not acquire experience and so demand will not develop, which will result in insufficient pay-off of the investments in PSS development. Furthermore the process of improvement of existing tools by learning from practice will remain slow. This means that in terms of a product life cycle, the product will not get a chance to mature and to reach the point where its development and proliferation become self-enforcing. Therefore, if no marketing action is taken, it is likely that PSS will not get a good chance to prove their worth as a means for improving spatial planning practice. These conclusions are expected to be at least partially valid for a broader set of computer-based tools, such as PSS in general, GIS, SDSS, Integrated Assessment models, DSS and Information Systems in general.

For anyone who believes in PSS technology and wants to further it, in both a commercial and non-commercial sense, it is of great importance to start spreading the news about the existence of PSS and their benefits. If planners become aware of the existence of PSS, they might consider undertaking real-world example projects, which will give them experience. Positive experiences could increase users' intentions to start using a PSS structurally in their planning practice. It may be very difficult to convince planners because many have negative attitudes towards computer-based planning tools in general. To have clear arguments to convince potential users besides the positive results of real-world example projects, thorough research into the potential benefits of PSS for spatial planning is recommended. Such a study could be the next step in an attempt to discern the successes and failures of PSS for spatial planning.

4 'New Technologies Stuck in Old Hierarchies' An analysis of diffusion of geo-information technologies in Dutch public organizations

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Abstract

Some 25 years after the introduction of the first geo-information technologies in public administrations, strategies to manage their diffusion are still inadequate. This is problematic in light of the new generation of geo-information technologies that has become available and the aim to invest in these new information technologies so as to move towards e-government. This study questions how strategies for diffusion of geo-information technologies in public planning organizations can be improved. The current study shows that classic top-down management often enhances informal diffusion activities that deviate from the formal diffusion strategy. A knowledge management approach, in which geo-information specialists and planners participate in the formation of diffusion policies, can enhance the quality of the formal strategy, thereby preventing deviating informal diffusion activities. Public planning organizations aiming for e-government are recommended to utilize this knowledge to improve their diffusion strategies for geo-information technologies.

4.1 Introduction

To keep up with the pace and demands of the information society, governments need to invest in information technologies (Huber, 1990; Kraemer et al., 1993; McClure, 1997; Bretschneider, 2003; Stowers, 2003; Farazmand, 2004). Information has become 'the lifeblood of government' in the digital age. Information technologies help government organizations to more effectively and efficiently store, analyse and retrieve the information (Bretschneider, 2003). Still, many governments are among the 'laggards' of society in using information technologies. A decade ago in the US with the National Performance Review and more recently in Europe with the Lisbon Agenda, the issue of catching up on the backlog and going towards e-government has entered the public debate (Gore, 1993; Brown and Brudney, 1998; Jorritsma, 2000; Prodi, 2000). Owing to the geographical component of 80-90% of government information, geo-information technologies are among the major information technologies for governments in which investments are needed (Huxhold, 1991; Brown and Brudney, 1998). This study defines these technologies as an organized collection of computer hardware, software and geographic data designed to efficiently capture, store, update, manipulate, analyse, model and display all forms of geographically referenced information (Anderson, 2005). Some examples are Geographical Information Systems (GIS), Planning Support Systems (PSS) and Spatial Decision Support Systems (SDSS). For a broader range of examples it is refered to Stillwell *et al* (1999b).

Diffusion is the process by which (geo-information) technologies are communicated through certain channels over time among the members of an organization (Rogers, 2003). Diffusion of geo-information technologies in government organizations has known many failures (Chan and Williamson, 1999; Caron and Bedard, 2002). Such failures often evolve from visionary middle-level and frontline public servants' attempts to innovate. Their attempts often end up in processes of incrementally 'groping along' the hurdles of bureaucracy before fading away entirely (Behn, 1988; Borins, 2000). As an answer to the many failures, ever since the early nineties, studies have recommended paying more attention to *informal aspects* instead of just *formal aspects* of diffusion of geo-information technologies (Obermeyer, 1990; Croswell, 1991; Innes and Simpson, 1993; Masser and Onsrud, 1993; Pinto and Azad, 1994; Huxhold and Levinsohn, 1995; Nedovic-Budic, 1998; Sieber, 2000; Tomlinson, 2003). These formal aspects consist of "predetermined goals, prescribed roles, authority structure and rules and regulations," and are contained within the so-called *formal setting* of an organization. The *informal setting* contains informal aspects and refers to "the various kinds of informal practices, norms and social relationships among the members of an organization" (Rogers, 1983; Chan and Williamson, 1999). Diffusion-oriented *actions* taken within the formal and informal setting constitute a *diffusion pathway*.

Notwithstanding recommendations, few authors have actually studied the informal aspects in relation to diffusion of (geo-information) technologies within organizations, which causes their role to have remained obscure (Sahay and Robey, 1996; Chan and Williamson, 1999; Caron and Bedard, 2002). The importance of informal aspects was strikingly shown in a recent study by Caron and Bedard, who showed that geo-information technology projects very often follow an informal diffusion pathway that deviates from the formal diffusion pathway presented by officials (Caron and Bedard, 2002). This indicates that some 25 years after the introduction of the first geo-information technologies in public administrations, strategies to manage diffusion of these technologies are still inadequate. With the rise of new advanced geo-information instruments that are much more dedicated to the demands and capabilities of government workers and more technologically advanced than former instruments, there is a strong need for more effective diffusion management strategies and so-called best practices (Brail and Klosterman, 2001; Geertman and Stillwell, 2003b).

This study questions how to improve effectiveness of strategies for diffusion of geo-information technologies in public planning organizations. In particular it aims to find more effective strategies that prevent diffusion processes from following a deviant informal pathway instead of the formal pathway. To achieve this aim this study applies the technology acceptance model in combination with a more process-oriented model that shows diffusion as a communicative learning process that takes place in the formal and the informal setting in planning organizations. These models have been applied to study diffusion of advanced geo-information technologies in Dutch regional planning organizations, aiming to find the main diffusion bottlenecks, the applied solutions and their success. The analysis will contribute to the formation of best practices in public sector innovation management and will give planning organizations an image of good practice in organizational diffusion of the new geo-information technologies they are confronted with. The analysis will also be useful as a reference for the information technology changes needed in government organizations to reach the goals of the Lisbon Agenda.

4.2 Theoretical framework

4.2.1 Diffusion process model

In contrast to some of the most influential studies of diffusion in public organizations that adopted a holistic and empirically driven approach (Borins, 2000; Borins, 2001a), the current analysis will be based upon theory of organization, innovation and management. The theoretical framework for this study combines a 'diffusion process model' with the 'technology acceptance model' (Davis, 1986; Venkatesh and Davis, 2000; Venkatesh et al., 2004). The diffusion process model distinguishes the formal and informal setting and the communication processes that lead to diffusion within these settings. The model emphasizes the process-oriented aspects of diffusion. The core of this model is a framework by Crossan *et al.* that describes strategic renewal processes as the result of a range of learning processes between the members of an organization, communicating across the various organizational levels (Crossan et al., 1999; Crossan and Berdrow, 2003). This framework has been modified to represent the formation of informal and formal diffusion processes and pathways. The technology acceptance model describes the broad

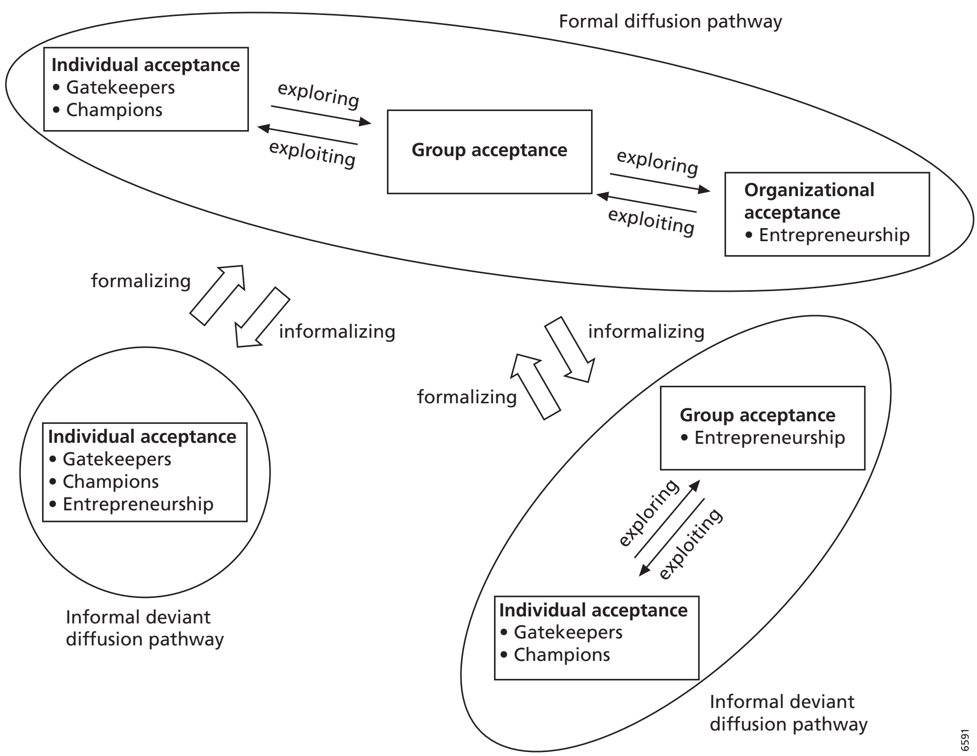

Figure 4.1 Formal and informal deviant diffusion processes

range of factors that explain information technology acceptance. The model has been updated and extended many times and for the current study a version of this model has been applied dedicated to explain organizational and individual acceptance of geo-information technologies (Vonk et al., 2005). The model describes how organizational and individual awareness, consideration, acceptance and continued usage of geo-information technologies are influenced by perceived innovation characteristics, personal and organizational characteristics, social and environmental influences, organizational facilitators and provider marketing efforts. The theoretical framework (figure 4.1) combines both models, thereby accounting for the dynamic process-oriented aspects as well as the more static explanatory factors of diffusion. This combined approach allows us to analyse whole patterns in diffusion of geo-information technology innovations instead of diffusion flows or acceptance factors only (Glor, 2001).

The framework puts forward a *formal diffusion pathway* consisting of a range of learning processes that communicate knowledge across the organizational levels (Crossan et al., 1999; Crossan and Berdrow, 2003). The chains of connected processes directed upwards and downwards the organizational levels describe *exploration* of new knowledge flowing from the individual to the group to the organizational level and *exploitation* of knowledge that has already been institutionalised in the opposite direction (March, 1991; Crossan et al., 1999; Crossan and Berdrow, 2003). During organizational diffusion *individuals*, *groups* and the *organization* are faced with the choice of *accepting* and learning the technology before they can start using the technology in their daily practices. Individuals who, owing to the possession of certain qualities, can have a disproportionately large effect on the effectiveness of the learning and acceptance processes have been described as 'change agents' (Rogers, 2003). This study distinguishes the *gatekeeper* as the change agent who stands at the interface of either the organization and the external environment, or the interface between subunits within the organization (Cohen and Levinthal, 1990). In terms of the framework of the current study, the gatekeeper brings new knowledge to the organization by intuiting. This study also distinguishes the *champion* as the change agent with large skills and charisma, who is able to answer a range of questions on the technology from the organization and propagate a technology within the organization (Tomlinson, 2003). Champions can easily communicate knowledge from the individual level to the group level, or directly to the organizational level to become institutionalised. Who actually fulfils this role and how effective this person is in fulfilling this role is very important to the analysis.

Apart from the formal diffusion pathway, the framework shows two *informal deviant diffusion pathways*. Based on the Theory of Reasoned Action (Fishbein and Ajzen, 1975), its modifications (Triandis, 1979) and the Social Cognition Theory (Bandura, 1986), it is assumed that individuals and groups change their behaviour from following the pathway indicated by the formal diffusion strategy to a self-driven informal diffusion pathway (informalizing) and vice versa (formalizing), as a result of two major factors: the perceived rationality of formal/informal behaviour and social pressure to show formal/informal behaviour. Starting from formal behaviour, a low perceived rationality of formal behaviour relative to informal behaviour among groups and individuals may cause them to start *informalizing* their behaviour, if this is not sufficiently corrected by social pressures to remain with the formal strategy. Starting from informal behaviour, a low perceived rationality of informal behaviour relative to formal behaviour among groups and individuals may cause them to start *formalizing* their behaviour, in particular if social pressures to behave according to the formal strategy are relatively strong. In terms of this study's framework, informalizing is likely to occur under the circumstance that ideas from individual or group exploration processes do not reach the organizational level and influence strategy formation. In such situations they are guided by management supported exploitation processes that disagree with their own ideas of rational behaviour. If individuals and groups subsequently start informalizing their behaviour due to a lack of social pressures to remain with the formal strategy, they will start showing their own *entrepreneurship* and take informal diffusion-oriented actions in agreement with their own ideas of a good diffusion strategy. These informal actions will often be the source of informal deviant diffusion pathways that cause formal diffusion pathways to be ineffective. Low-level entrepreneurship, independent of entrepreneurship at the organizational level is therefore a likely cause of informal deviant diffusion pathways. It is emphasized that informal diffusion behaviour may occur in nearly all parts and hierarchic levels of the organization. Only the diffusion behaviour of the management team as a whole is seen as exclusively formal, with regard to its effects on the organization. Informal and formal diffusion processes therefore do not automatically coincide with bottom-up and top-down directed processes.

4.2.2 Managing diffusion pathways

Theoretically, the problem of an inadequate formal diffusion strategy and evolution of an informal deviant diffusion pathway can be alleviated in three ways: (1) adapting the informal setting to the formal setting; (2) adapting the formal setting to the informal setting; and (3) adapting both to meet each other somewhere in the middle. These options correspond with three different approaches to manage diffusion processes. These approaches differ in the sense of who is involved in formulating the diffusion strategy and, as a result, the tasks of various groups in acquiring new knowledge (exploration) and utilizing existing knowledge (exploitation).

Diffusion management strategy 1: The strategy that adapts the informal to the formal setting corresponds with the classic way of managing strategic renewal processes (Minzberg, 1981; Mahnke and Aadne, 1998; Minzberg et al., 1998). Strategies are formed by the organizational top and implemented in a straightforward process, aiming to get groups and individuals to accept the formal strategy and behave accordingly. In general, this exploitation oriented diffusion strategy improves the formal strategy by convincing people of the rationality of the formal pathway and/or by socially repressing the informalizing process.

Diffusion management strategy 2: The strategy that adapts the formal to the informal setting corresponds to a bottom-up approach. It acknowledges that the whole organization has potential to substantially contribute to thinking about new futures with their ideas and knowledge, instead of just the organizational top. This involves acquiring new knowledge by decentralization of power and responsibilities, an approach known as organizational learning (Argyris and Schon, 1978; Huber, 1991; Doughty, 2004). In general, this diffusion strategy improves the formal strategy by allowing all kinds of exploratory learning processes to take place and influence the formal strategy, instead of holding them back as in classic management.

Diffusion management strategy 3: The strategy that adapts both settings to meet in the middle is associated with knowledge management (Malhotra, 1996; Rubenstein-Montano et al., 2001; Barret et al., 2004). It acknowledges both the need of organizations to explore and learn new ways of doing things, while also exploiting what they have already learned to reach organizational goals. Similar to the second approach, the whole organization is involved in strategy formation in bottom-up processes. Managers are faced with the critical challenge to recognize and manage the tension between exploration and exploitation (Crossan and Berdrow, 2003). In general, this third diffusion strategy attempts to find a balance between allowing informal learning processes to influence the formal strategy and exploiting what has been learned, thereby repressing informal deviant processes.

4.3 Method

The above theoretical approach has been applied to study successes and failures in the diffusion of Planning Support Systems (PSS) based on geo-information technology in regional planning organizations in the Netherlands. These PSS have been defined as computer-based decision support systems, dedicated to support those involved in planning to "explore, represent, analyse, visualize, predict, prescribe, design, implement, monitor and discuss issues associated with the need to plan" (Batty, 1995). The organizations in which successful adoption has been followed by successful intra-organizational diffusion are considered success stories in diffusion and all others as failure stories. The method applied for testing consists of five steps.

First, 12 regional planning organizations were selected, these being the provincial governmental organizations in the Netherlands. These organizations function in a three-layered policy structure that consists of national government, province and municipality, and govern geographical areas of approximately 1400-5000 km^2. These provincial organizations are highly comparable as most of them have 15 to 20 years of experience in applying geo-information technologies in their practices but are still in quite early stages in the application of dedicated geo-information technologies for planning support (PSS), which makes them highly suitable for finding the origins of success of diffusion strategies.

Second, 63 employees from these organizations were invited to participate in the current study. In particular, it was asked for three archetypes of employees playing an important part in diffusion of PSS: the geo information specialist, the spatial planner, and the manager. In the end, 43 employees were found that were willing to participate. The participants were geo-information specialists (15), spatial planners (12), managers (3), and people with strongly related specializations often joined in as well (13).

Third, a survey based upon the 'technology acceptance model' was conducted among the employees, to find the main failing factors for diffusion of PSS within the studied organizations. Such a broad start helps to select which focal points to study more extensively during the interviews that followed. In the survey the employees were asked to judge a series of 62 potential failing factors regarding their importance in blocking diffusion of PSS. Respondents could choose between 'unimportant', 'important', 'very important' and 'don't know'. The survey was more or less similar to an earlier worldwide survey (Vonk et al., 2005).

Fourth, 12 in depth group-interviews were held with the 43 participating employees to investigate stories of success and failure and find patterns in them. They were asked to explain primarily three issues. First, they were asked to explain the motives for diffusion within their organizations. Second, they were asked to explain how the earlier identified failing factors caused the failures. Third, they were asked to explain how success in diffusion of geo-information technologies has been achieved or could be achieved.

Fifth, the results were interpreted to find the formal diffusion strategies that have lead to success. For this purpose, the results were confronted with the three distinguished management strategies and the theoretical framework of this study. The following sections show the results and their interpretation.

4.4 Results

4.4.1 An analysis of motives for diffusion

The results from the survey and interviews were analysed in three steps: 1) analysis of the interview results to find the prime source and motive for diffusion in relation to success and failure; 2) analysis of the survey and interview results to find success and failing factors for technology acceptance or rejection within the organizations; 3) analysis of the interview results to find patterns of how these factors influence success and failure in diffusion processes in these organizations. This section will describe the outcomes of the three kinds of analyses undertaken to find patterns in the stories of success and failure.

Table 4.1 shows the *motives* for diffusion of PSS in the studied organizations with successes and failures, based on the interviews. From the table it becomes clear that a group of initiatives concerning PSS diffusion has been inspired by a *problem* or *crisis*. This group contains more failures than successes. Another group of initiatives originated in experienced *opportunity*. Two of these initiatives resulted in successes, the other six (!) in failures, in the sense that either the innovation was not picked up by a gatekeeper or the intra-organizational diffusion was not completed. Finally, an *outlook of prestige* produced only one story of success.

The initiatives inspired by a *problem or crisis* that ended up in failure had a great managerial impetus at the start, which gradually faded away. The strong managerial impetus from the start often gave way to innovative thinking: "…When the governor presented the plan of a highway exit where a new urban district was located for five years already, this was the signal that fundamental changes in geo-information management were required…" (geo-information specialist). After the swift start, the shock effect from the problem or crisis among managers faded rather quickly, causing criticism of the new projects to gradually rise. When this was the case, intra-organizational diffusion slowly resulted in failure: "…One year after the highway exit planning incident, we do not have enough people or funding anymore to develop a good data system…" (geo-information specialist). The success story inspired by a problem or crisis concerns an organization using PSS containing land use models and doing experiments with electronic sketching on a smart-board: "… Our governor used real-time scenario calculations in discussions with the minister…" (Manager). The success was enhanced by the fact that implementation efforts consisted of formal and informal exploration efforts throughout the organization supplemented with exploitation efforts by the management, enlightened governors in particular.

Table 4.1 Motives underlying PSS diffusion within the studied organizations

Motive	Success stories	Failure stories
Experienced problem/crisis	1	2
Experienced opportunity	2	6
Outlook of prestige	1	-

The failure stories inspired by *opportunity* had in common that geo-information specialists informally started diffusion activities, based on a perceived opportunity to improve the organization with geo-information technologies. Such processes usually ended up in messy processes, in which geo-information specialists provided the impetus by learning and teaching, but continuously faced resistance from managers, spatial planners, the organizational structure, insufficient data e.g., causing the intra-organizational diffusion process to go very slowly: "… Investments in ICT always take twice as long and are three times as expensive as planned…" (Manager). Such processes tend to stay rather technical in nature, which causes them to have few users and fade away, failing to meet the potential predicted by advocates: "…We were the first to start developing such a tool but it never really became widely used within the organization and, despite all our efforts, right now it is hardly used any more…" (geo-information specialist). Successes in diffusion that followed from experienced opportunity were one organization which developed dedicated tools mainly for planning information supply and one organization which is in a somewhat earlier stage in diffusion and makes fast progress. Employees in both organizations had convinced the management of the use of geo-information technology. They both followed a path of explorative learning supplemented with institutionalising and support.

The success in diffusion that followed from an *outlook of prestige* as a reason to start using a PSS has many similarities with the one which followed a problem or crisis (one organization). At the start, managers provided the impetus and made way for a lot of innovative thinking for the prestigious project: "…When the governor needed an advanced risk map as a prestigious accomplishment to show at his retirement, all resources were mobilized and innovation in geo-information technology became possible…" (geo-information specialist). However, usually when the projects were finished employees had to go back to daily business, causing the newly obtained knowledge and skills to become lost again instead of being exploited to improve daily practice. Therefore these are only short-term successes.

4.4.2 An analysis of success and failure enhancement factors

The *failure enhancement factor* statements that resulted from the survey based on the technology acceptance model were grouped in a number of categories to gain consistency. Figure 4.2 shows the importance of these failure enhancement factor categories in explaining adoption of PSS for the organizations involved (cutoff at 30%).

The results clearly show the relative importance of organizational and human failure enhancement factors for usage of PSS within the studied organizations: 'attitude of management', 'social organization of users', 'awareness of potentials' and 'implementation support by organization' are factors which score particularly high. The other software/system and provider related issues are considered significantly less important or even unimportant. The results confirmed the need to focus on human and organizational explanatory factors for diffusion of PSS during the interviews and to find out what underlies the high scoring factors.

Table 4.2 shows the *success factors* for diffusion of PSS that were found from the interviews, the involved employees, as well as effects on adoption by gatekeepers and subsequent intra-organizational diffusion.

Of the eight success factors shown in table 4.2, several relate to the activities of only one of the three mentioned actors, such as ‘support for innovation’ and ‘perform gatekeeper role’, and several others relate to the activities of more than one actor, such as ‘awareness and affinity’ and ‘cooperation as champions’. The success factor ‘existence of data warehouse/implemented GIS’ is unrelated to activities of specific actors but rather to a state of the organization. Several of the indicated success factors positively influence the adoption by the gatekeeper only, such as ‘social network’ and ‘perform gatekeeper role’, while several others positively influence intra-organizational diffusion only, such as ‘cooperation as champions’ and ‘awareness and affinity’ or both, such as ‘opportunity to innovate’ and ‘enthusiasm’. Although the factors shown in figure 4.2 and table 4.2 provide some overview of what underlies successes and failures in PSS diffusion in the studied organizations, combination with a process approach is needed to better understand just how the successes and failures actually come about.

Table 4.2 Success factors for PSS diffusion, resulting from the interviews

Factor	**involved employees**			**positive effect on:**	
	geo-info specialist	**planner**	**manager**	**adoption by gatekeeper**	**organizational diffusion**
awareness and affinity	*	*	*		*
social networks	*	*		*	
opportunity to innovate	*	*		*	*
Enthusiasm	*			*	*
perform gatekeeper role	*			*	
support for innovation			*	*	*
cooperation as champions	*	*			*
existence data warehouse/ implemented GIS					*

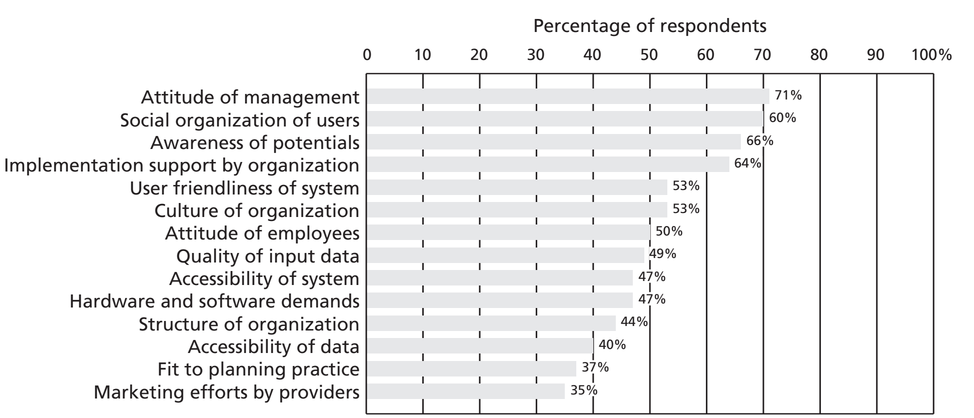

Figure 4.2 Importance scores of failure enhancement factors for PSS diffusion, resulting from the survey

4.4.3 An analysis of patterns of success and failure

Interview respondents indicated a wide diversity of factors to explain the failures and successes. Many of these factors relate to the roles of and interaction between geo-information specialists, managers and spatial planners and most are applicable for innovation diffusion driven by problem/crisis, opportunity as well as outlook of prestige.

A major failure enhancement factor for opportunity driven PSS diffusion is that managers and spatial planners are usually *unaware of PSS* and its potentials and are not able to keep track of PSS developments due to *little affinity* with geo-information technology: "…Why do we still do a lot of work by hand? Because nobody ever shows us what else there is!…" (spatial planner).

The geo-information specialists are usually aware of the opportunities of geo-information technology for spatial planning support in general, but few have heard of the term PSS specifically, which could be due to the insufficient social organization in inter-organizational networks, which was seen as a main bottleneck: "…Our current networks consist of only geo-information specialists, but I think that *social networks of both planners and geo-information specialists are needed* to further these technologies…" (geo-information specialist). Nonetheless, this does not fully account for the gap between supply and demand or its solution, since geo-information specialists claim to have enough affinity with geo-information technology and see themselves as sufficiently educated to keep track of PSS developments. This makes them the most likely to function as change agents (gatekeepers and champions).

A significant number of geo-information specialists have already adopted these roles as change agents, and some of them have done so successfully. Although geo-information specialists have the potential to utilize PSS, they indicate that they have so many tasks and work under such intense time pressure that innovation by means of undertaking opportunity driven experiments with PSS is often not possible, even though they are willing to spend time on it: "…I would very much like to do more advanced analyses in my work, but we are expected to do data maintenance, GIS work and a part of the automation for the whole organization with just a few people, so there's no time…" (geo-information specialist). To solve this problem and utilize the potential of PSS for the organization, *geo-information specialists need to be given opportunity* to scan the environment for new geo-information technologies, to experiment with and evaluate geo-information technologies, and to spread the news throughout the organization: "…PSS will be an initiative from the work floor, as has been the case for GIS…" (geo-information specialist). By showing real world instead of fictional examples, awareness and support among management and end users can be developed: "…We tried to make managers aware and convince them by telling the stories, by showing examples of applications and by showing the broader developments in the policy field that the organization needs to face…" (geo-information specialist).

However, time is not everything since interview results suggest that quite some of the geo-information specialists lack an innovative attitude and will therefore not perform the demanded change agent roles. In some cases this evolved from being fed up with managerial resistance to bring new ideas further within the organization: "…Maybe we should just wait until the present generation of managers has retired.…" (geo-information specialist). These geo-information specialists are not well capable of convincing their managers and the spatial planners of the benefits of using PSS. The success stories show the importance of *enthusiasm of the employees themselves*, *charisma, innovativeness and openness to learn*, illustrated by the quote of a successful geo-information specialist: "…Waiting? No way! It cannot go fast enough if you ask me. People are not aware of what's possible at this moment and we continuously try to make them aware…"

(geo-information specialist). Managers have an important role in making *these geo-information specialists perform as change agents*.

If geo-information specialists are not capable of reaching managers with innovative ideas due to lack of opportunity and efforts, in their turn, these managers see no particular reason to stimulate the use of PSS. Certainly since spatial planners, being end-users, do not demand PSS because of lack of awareness and time: "…Our products need to be finished yesterday rather than tomorrow…" (spatial planner). Furthermore managers themselves usually have little affinity with PSS. The lack of managerial structural support and geo-information specialists' 'advertising' efforts cause geo-information specialists to become isolated from their managers, further complicating the implementation of PSS. Consequently, although geo-information specialists' efforts may slowly change opinions and internal culture during a learning process, increasing structural changes require that the outcomes of their informal learning and teaching become formalized, be fed forward to organizational level, influence the formal strategy, and be followed by *managerial support:* "…We used to just show examples and give people software, but stopped this because it ended in disappointment, as we had not been given the means to facilitate them…" (geo-information specialist).

Without managerial support, geo-information specialists are hardly capable of reaching spatial planners. In those situations, there is also clearly a discrepancy between questions of planners and offers of geo-information specialists: "…You never hear from them [geo-information specialists] and if they do show themselves it is with products you never asked for…" (spatial planner). This indicates a total miscommunication in the studied cases of failure. One of the important exploiting efforts for the management is the organization of geo-information specialists and spatial planners in such a way that *technical knowledge and process knowledge come together* in order to learn from developments in the mutual fields and enable functional innovation: "…Functional applications will have to come from cooperation with policy departments…" (geo-information specialist).

The interviewees also propose the realization of a good *data-warehouse* and to *implement GIS* before starting with PSS. Most organizations agree that implementation of PSS is a step in geo-information technology development that follows these preliminary steps. This causes the focus in some organizations to lie on the realization of these rather than on the implementation of PSS: "…PSS is nice and all, but it is just one step too far for us since right now our main task is to organize our geo-data…" (Manager). This causes initiatives in organizations without a good data-warehouse to reach no further than the gatekeepers.

4.5 Interpretation and validation

The results provide many clues on the effectiveness of management strategies for diffusion of geo-information technologies. Interpretation of the results in confrontation with the distinguished management strategies results in the following inferences on the effectiveness of management strategies.

First, diffusion of geo-information technologies in regional planning organizations is currently more likely to start bottom-up than top-down. Many managers and planners are hardly aware of the existence and potential of many geo-information technologies and have so little affinity with these technologies that they cannot develop a good strategy. Geo-information specialists are often the only ones in the organization capable of initiating adoption and implementation from the bottom up in roles as gatekeepers and champions. Their diffusion-oriented actions are often motivated by an experienced opportunity.

Second, lack of opportunity for innovation allowed by the management and lack of the required personal characteristics often causes geo-information specialists to be unable to function as gatekeepers for geo-information technology. Furthermore, *exploring* processes of those geo-information specialists that do possess the required personal characteristics to be gatekeepers are often repressed instead of nurtured.

Third, regional planning organizations often *exploit* management-supported strategies on geo-information technology diffusion. These strategies often hold back significant steps in diffusion, since they are based upon a persistent negative image of geo-information technology that exists among many managers. Geo-information specialists that do take up their role as gatekeepers, often face a wall when trying to convince managers of the worth of new developments in geo-information technology. Showing examples in real projects has proven to be a good means of convincing managers, but their preparation requires innovation time, which geo-information specialists often do not have. This traps diffusion in a stalemate.

Fourth, the origin of an *informal deviant diffusion pathway* lies exactly here. Unheeded geo-information specialists and unwilling short-term oriented managers cause misalignment of the formal and informal setting, which may lead to *informalizing* among geo-information specialists. The subsequent deviating attitudes, behaviour and actions cause informal deviant diffusion pathways. A management strategy in which geo-information specialists are more facilitated in their role as gatekeepers and champions for geo-information technology could result in the formation of more rational diffusion strategies, thereby decreasing the chance that they will opt for informal deviant pathways instead. Becoming a learning organization and applying knowledge management would be a way to do this. Figure 4.3 shows the evolution of informal deviant diffusion pathways (left), as well as the cure that knowledge management offers by making informal diffusion pathways rejoin (right), in terms of the (summarized) theoretical framework.

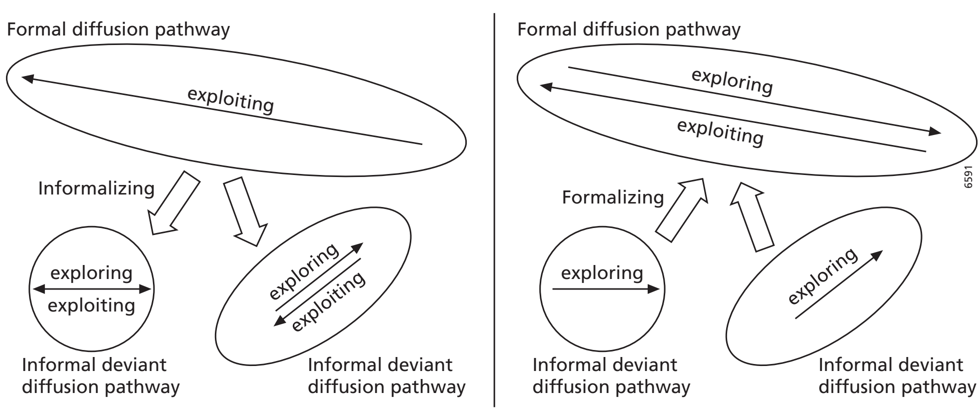

Figure 4.3 Evolution of informal deviant diffusion pathways (left) and the cure that knowledge management offers (right).

Fifth, geo-information specialists themselves are hardly ever able to reach spatial planners and cooperate with them. If they do, they often encounter a discrepancy between planners' questions and geo-information specialists' offers that obstructs successful cooperation. This hampers development of useful innovations that are applied in planning practice, since these are likely to evolve from cooperation of geo-information specialists and spatial planners. To solve this problem, managers should take the actions required to involve geo-information specialists in the spatial planning process and convince them of their roles as change agents.

Several arguments support the broader validity of this interpretation towards diffusion of geo-information systems in regional planning organizations in general. The involved employees are expected to be capable of providing us with a good and representative overview of perspectives on diffusion of PSS-technology since the archetypes they represent are common to virtually all planning organizations in western and non-western societies, independent of the planning system, planning style, legal system, etc., specific to each country. Furthermore, it is expected that results will have broader validity than only for the involved organizations based on three factors. First of all, the structure of the studied organizations is a form which occurs quite often in governments (Anthony, 1965; Minzberg, 1981; Minzberg et al., 1998). Second, the culture of most of the involved organizations is characterized by conservativeness regarding investment in geo-ICT, particularly among managers. According to earlier studies, this is characteristic of planning organizations in general rather than just the involved Dutch organizations (Vonk et al., 2005). And finally, the applied management concepts have cross-cultural value.

Still more convincingly, the results obtained in this study are very much in agreement with Borins' results for public management innovation in the US and Canada. He concludes firstly that in the US and Canada, public management innovations are most frequently initiated by local heroes, visionary middle-level and frontline public servants. Secondly, they are a result of both comprehensive planning and incremental groping along. Thirdly, the most frequent obstacles to innovations are internal to the bureaucracy, which are usually overcome with persuasion or accommodation (Borins, 2000; Borins, 2001a). Following a different theoretical research approach grounded in technology acceptance and organizational theory, and a methodological approach that builds forth on Osborne's voluntary participation instead of Borins' innovation awards (Osborne, 1998; Borins, 2001b), the current results for regional planning organizations in the Netherlands are very much in agreement with Borins' results for North America. This suggests the broader value of both Borins' and our own findings and is also a strong argument for the often-doubted existence and broad validity of best practices of public management innovation (Overman and Boyd, 1994; Lynn, 1996; Borins, 2001b).

4.6 Conclusions and recommendations

It is concluded that diffusion of geo-information technologies often follows a deviating informal pathway due to the informal activities of geo-information specialists. A combination of the following circumstances leads them to informally undertake the construction of a diffusion pathway that is in accordance with their own ideas. Firstly, they perceive the formal strategy as less rational than their own ideas for diffusion. Secondly, they do not experience sufficient social pressures to persist in following the formal strategy. Lastly, they are not able to influence the formal diffusion strategy with their own ideas. The resulting diffusion pathway usually deviates from the formal strategy. To alleviate this problem, the formal diffusion strategy can be improved in a range of ways described in this paper, from which a range of recommendations to planning organizations and researchers has been derived.

To planning organizations that want to start utilizing geo-information technologies, it is first recommended to adopt a management style of a learning organization, using knowledge management. Since learning organizations use the knowledge and learning capacity distributed over the organization for strategy formation, they are more likely to find, appreciate, adopt and implement geo-information technologies successfully than are classically top-down managed organizations. The second recommendation is that recruiters should hire geo-information specialists who possess not only the more technical qualities, but also with gatekeeper qualities, to ensure that innovations are picked up. A third recommendation is that an innovation manager should be appointed to perform the role of champion. This champion should ensure that the innovations that are picked up by gatekeepers are fed forward within the organization so as to reach management levels and once there, influence formation of diffusion strategies. This should be a person with both technical and policy knowledge and also a member of the management team. It is expected that an innovation manager will be much better capable of performing this role than geo-information specialists. Fourthly, it is recommended that managers should devote attention to bringing geo-information specialists and planners together, because their cooperation is needed for the development of successful PSS applications. These changes will contribute to more effective diffusion of geo-information technologies and may be necessary to keep up with the demands to public organizations in the current time frame.

To researchers within the theoretical domains of public management innovation, public sector information technology, and geo-information technologies in particular, it is first recommended conducting additional methodological research concerning acceptance and diffusion of (geo-) information technologies in public organizations. Given the IT backlog in many public organizations and the many failed diffusion attempts, it is of great importance to induce best practices. Without these practices governments will not achieve their aims for renewal and promising technologies will not stand a fair chance to prove their worth in practice, due to messy diffusion processes in which many of these technologies become caught up before showing benefits of their use. Second, researchers are recommended to study how to implement knowledge management as the strategy for diffusion of (geo-) information technologies in public organizations. Third, researchers are recommended to develop good and coherent insight into the benefits of existing geo-information technologies for planning support. Such overview would be a good means to convince managers and thereby stimulate diffusion of geo-information technologies.

5 Why some PSS are more widely used than others

Abstract
Previous research indicates that some types of Planning Support Systems for land use planning are more widely used in planning practice than others. This study aims to find out why these differences in usage exist. Usage of PSS is regarded from three perspectives: the instrument, the user and the transfer of the instrument towards the user. The first perspective emphasizes instrumental quality characteristics, the second emphasizes user acceptance characteristics and the third emphasizes diffusion characteristics. Using these approaches a study was made of differences in usage of three types of PSS that have been distinguished in the relevant literature: informing PSS, communicating PSS and analyzing PSS. The study concludes that informing PSS are much more widely used than many communicating PSS and analyzing PSS. The primary reasons for these differences are in awareness, experience and instrumental quality, secondary reasons are in user acceptance and diffusion. These reasons cause PSS that form more radical innovations for planning practice, like many analyzing PSS, to be locked out from usage more so than PSS that form only incremental innovations such as many informing PSS. Important underlying reasons are the miscommunication between system developers, users and experts on PSS, and the mismatch between PSS and the characteristics of their users and planning processes. To enhance utilization of PSS technology, it is recommended that system developers, experts and users focus on resolving these issues by improving their communication and cooperation and the match between PSS, their users and planning tasks.

5.1 Introduction

Regional planning of land use concerns the development of long-range strategic-level structure plans that organize land use functions. It is one of the most complex tasks of public organizations. Regional land use planners need to deal with a wide range of objectives occurring at different spatial and temporal scales, they must handle large amounts of information of various qualities to serve as a basis of solutions for planning problems, they must weigh and add up all this information to synthesize planning solutions with a high degree of synergy which leave little conflict and finally, they must communicate this all in such a way that their plans receive the support required to make them feasible (Faludi, 1973; Friedman, 1987; Forester, 1989; Hall, 2002; Archibugi, 2004). Planners demand support to handle these aspects of complexity of planning, but have so far only utilized very few of the opportunities for computer support (Stillwell et al., 1999a). The majority of planners use little more than generic office software to support them in their daily work that tends to be extended with simple spatial capabilities.

For a long time, geo-information technology developers have focused on supporting planners dealing with various aspects of complexity. In particular support of information management and scenario analysis have received a great deal of attention. Nonetheless, the large-scale urban models from the 1960s and 1970s have failed to meet expectations and have failed to become widely accepted as planning support instruments (Lee, 1973; Batty, 1979; Openshaw, 1979; Lee, 1994). Nor have the Geographical information systems (GIS) from the 1980s and 1990s become a great success in supporting planners (Croswell, 1991; Innes and Simpson, 1993; Stillwell et al., 1999a). Although many planners use them for basic information functions, most GIS are general-purpose tools that are poorly matched to the demands and capabilities of planners in the planning process. A new generation of geo-information technologies known as Planning Support Systems (PSS) is much more dedicated to the demands and capabilities of planners in planning processes (Geertman and Stillwell, 2004). These PSS may be better suited to assisting planners in handing the ever-increasing complexity of planning. They have been defined as a subset of geo-information technologies, dedicated to support those involved in planning in exploration, representation, analyzation, visualization, prediction, prescription, design, implementation, monitoring and discussion of issues associated with the need to plan (Batty, 1995). PSS bring together the functionalities of GIS, models and visualization and take the form of "information frameworks" that integrate the full range of information technologies useful for supporting the specific planning context for which they are designed (Geertman and Stillwell, 2003b; Klosterman, 1997). Inventories show that PSS cover a wide diversity of tools that are readily available for planning support purposes that have not yet become widely applied in planning practice (Brail and Klosterman, 2001; Geertman and Stillwell, 2003b). Figure 5.1 schematically indicates this problem.

Previous studies have taken three different approaches to explain the problem of many PSS not reaching planning practice. The approaches overlap in the sense that they all look at the same problem but each approach emphasizes slightly different aspects of the problem. The 'instrument' approach, explains the problem mainly from the instrumental quality of the PSS, thereby focusing particularly on fitness for use and user friendliness of the PSS (Vonk et al., 2006b). The 'user approach' explains the problem from the extent of user acceptance of PSS, thereby focusing on a broader set of factors related to the accepting environment (Vonk et al., 2005). The 'transfer' approach explains the problem from the extent of diffusion, thereby focusing particularly on the flow of information on and experiences with PSS from sender to receiver (Vonk et al., 2006a).

Although these approaches have been applied to explain why PSS in general are not widely used, results also indicate that the usage of PSS varies per type of PSS and application context. For example, they show that users demand simple systems for storage and retrieval, visualization, communication, while advanced analysis and modelling tools are hardly used in planning practice (Vonk et al., 2006b). Until now these differences in usage of types of PSS have not received much attention in research. There is little insight into what causes these differences in

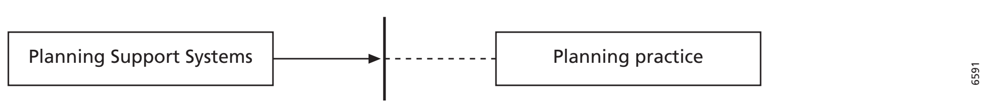

Figure 5.1 Planning Support Systems do not reach planning practice

usage. This is problematic since PSS are likely to remain underused without sufficient specific knowledge about usage of PSS types, while many see PSS as an aid for handling the ever-increasing complexity of planning experienced by planners.

This study aims to find out why some PSS are widely used while others are not. The following will first describe the three approaches that have been adopted to study the usage of PSS in general and the explanations found in following these approaches. Using results from expert surveys, surveys and interviews with users, and literature study, this study will specify the findings that explain usage of PSS in general for the three most common PSS types: informing PSS, communicating PSS and analyzing PSS.

5.2 Theoretical framework

5.2.1 Instrument approach

The first of three problem approaches explains usage of PSS in planning practice from a look at the characteristics of the PSS instruments themselves. It does so by focusing on those characteristics of the instrument that determine their instrumental quality. The underlying assumption is that poor instrumental quality of PSS hampers users from using PSS. This approach takes PSS themselves as a more or less dependent variable. It emphasizes the sense in which they should change in order to enhance usage. Instrumental quality is defined as consisting of a judgment of; a) how well the instruments are capable of carrying out the tasks that they were made for; and b) how well they fit the capabilities and demands of intended users. Goodhue and Thompson (1995) showed the importance of these characteristics as determinants of usage of information technologies in their model of task-technology fit (Goodhue, 1995; Goodhue and Thompson, 1995; Dishaw and Strong, 1999; Dishaw et al., 2002). In terms of this model that is shown in figure 5.2, under-use of PSS is explained by insufficient fit of PSS to user characteristics and planning task characteristics in comparison with other options that have a better fit. The latter options then may have a relative advantage over using PSS in terms of instrument quality, depending on costs of the options.

Studies with the Planning Task – PSS – User fit approach gives many insights into why PSS are not widely used in planning practice (Vonk et al., 2006b). One of the primary reasons that followed from this approach is that PSS technology is in an early stage of development. The large diversity and few standards associated with this development stage cause large differences in instrumental quality between instruments. Another finding from this approach is that a large dichotomy exists between PSS as demanded in practice and as supplied by system developers. While practice demands rather simple PSS for exploratory tasks such as making an inventory of conditions, the majority of PSS focus on more analytical tasks, especially modelling. These in their turn are seen as making a poor match with the demands of planning practice. The

Figure 5.2 Instrumental quality of PSS in terms of fit between PSS-technology, planning task and user.

instrumental quality of simple instruments is considered acceptable while that of advanced instruments is generally considered to be poor. Results suggest that simple instruments have a relative advantage over doing it all by hand, while for many currently existing advanced instruments, the advantage is doubtful at the least.

5.2.2 User approach

The second problem approach explains usage of PSS in planning practice by examining characteristics of the user, with the focus on characteristics that determine acceptance of PSS. This user approach is related to the instrument approach as it incorporates user perceptions of instrument characteristics as determinants of acceptance. Furthermore the approach incorporates a much broader set of acceptance factors to explain usage than the instrument approach. The underlying assumption of the user approach is that non-acceptance hampers potential users from using PSS. This approach takes the user as a dependent variable. It emphasizes in what sense users should change in order to enhance usage of PSS. The acceptance process is defined as "the process through which an individual or other decision-making unit passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of his decision" (Rogers, 1995). This acceptance process is seen as influenced by user characteristics, instrument characteristics, organizational characteristics, characteristics of the social environment, characteristics of the external environment and facilitating conditions. These factors that influence acceptance have been framed in the 'Technology Acceptance Model'. Since its first publication in 1986, the model has been refined numerous times and applied to a broad range of information technologies (Davis, 1986; Compeau and Higgins, 1991; Mathieson, 1991; Keil et al., 1995; Dishaw and Strong, 1999; Karahanna and Straub, 1999; Venkatesh and Davis, 2000; Frambach and Schillewaert, 2002; Venkatesh et al., 2004; Beaudry and Pinsonneault, 2005). Figure 5.3 shows the essence of the Technology Acceptance Model. In terms of this model, under-use of PSS is explained by a hindered acceptance process due to problems with acceptance influencing factors.

Studies with the 'PSS Acceptance Model' show that there is a large diversity of bottlenecks blocking widespread acceptance of PSS in planning practice. The main bottlenecks are a lack of awareness of the existence of PSS and the purposes for which they can be used; a lack of experience with PSS, which makes users unaware of the benefits of PSS and the conditions under which they can be used; and low intent among possible users to start using PSS. Other

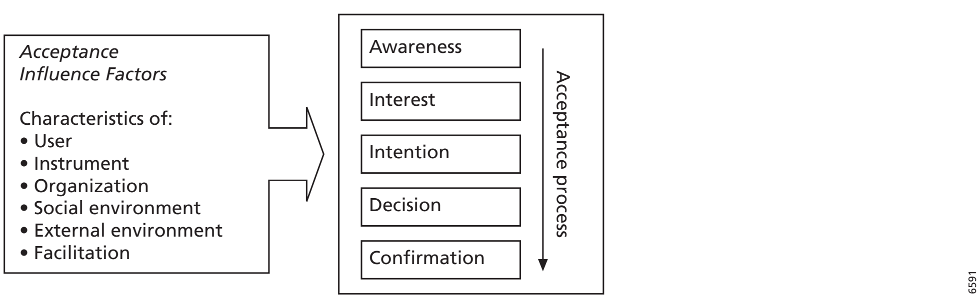

Figure 5.3 User approach to explain under-use of PSS: the Technology Acceptance Model

high scoring bottlenecks are insufficient user friendliness and usefulness, the absence of the required organizational facilitators and social influences, as well as data quality and accessibility problems (Vonk et al., 2005).

5.2.3 Transfer approach

The third problem approach explains usage of PSS in planning practice by considering characteristics of the transfer of PSS towards planning practice. It does so by focusing on those characteristics of the transfer that determine PSS diffusion. Innovation diffusion has been defined as "the process by which an innovation is communicated through certain channels over time among members of a social system" (Rogers, 1995). It is concerned with the transfer of an innovation into a practice context, through the acceptance by individuals, groups and organizations. The approach is different from the user approach in that it emphasizes the course of the innovation in its diffusion among users instead of a single user's acceptance process. The assumption that underlies this approach is that diffusion problems hamper users from using PSS. This approach takes the transfer processes as a dependent variable. It emphasizes the sense in which they should change in order to enhance usage of PSS. In figure 5.4 on the right, diffusion is envisioned as a process that takes the innovation from the system developers towards widespread usage in practice over the various levels of aggregation, namely, individual, group, organization, and branch of organizations. In diffusion, the aggregation of individuals within groups, groups within planning organizations, and planning organizations that have adopted the innovation follows a path such as described by the innovation adoption curve (Rogers, 1995). The curve shows that a group of so-called 'innovators' are the first individuals, groups or organizations to see opportunities and are most likely to perceive the complexity of adoption as a challenge or see themselves as capable of handling the complexity. They are followed by 'early adopters', 'early majority', 'late majority' and finally the 'laggards' who cannot but accept the innovation after having been confronted with it all over by individuals, groups and organizations who adopted the innovation before they did (figure 5.4, left). The fact that PSS are not widely used in planning practice indicates that their diffusion has not evolved beyond the inner circles of diffusion.

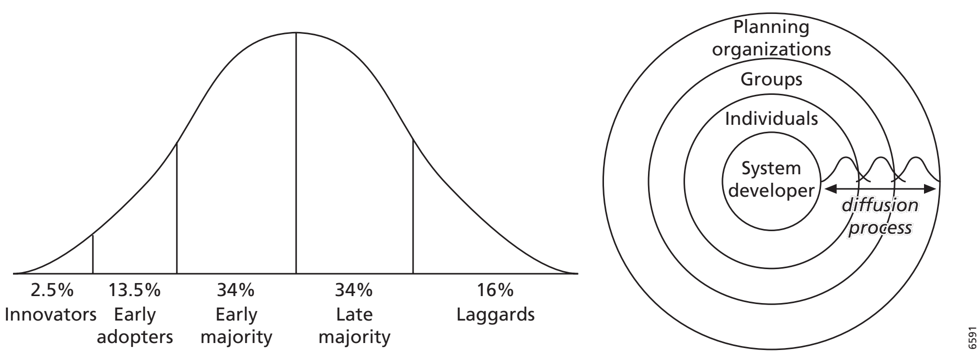

Figure 5.4 The innovation adoption curve (left); and its application to the diffusion of PSS over the various aggregation levels (right)

Studies with the diffusion approach show that diffusion of PSS in planning organizations is more likely to start bottom-up than top-down since geo-information specialists are more likely to spot and take up developments concerning PSS emerging from the environment. Nonetheless, lack of opportunity for innovation and personal characteristics often cause geo-information specialists at the bottom of the organization to be unable to take the technology from the external environment and bring it to the attention of the management at the top. In addition, they are not able to bring PSS to the attention of planners since geo-information specialists themselves are often unable to reach spatial planners and cooperate. Innovative ideas are also poorly diffused due to differences in appreciation of PSS between individual geo-information specialists and others within the organization. For example, geo-information specialists often encounter a discrepancy between planners' questions and their offers. In practice, regional planning organizations therefore often exploit management supported strategies on geo-information technology diffusion (Vonk et al., 2006a).

5.2.4 Conceptual framework

Figure 5.5 shows the conceptual framework of the current study. It shows 1) the problem of many Planning Support Systems being blocked from reaching planning practice and being widely used; 2) the perspectives available to look at this problem that correspond with an instrument approach, a user approach and a transfer approach; 3) the main focus of these approaches: instrumental quality, user acceptance and diffusion, and 4) the main reasons explaining under-use of PSS in general that were found in earlier studies using these approaches.

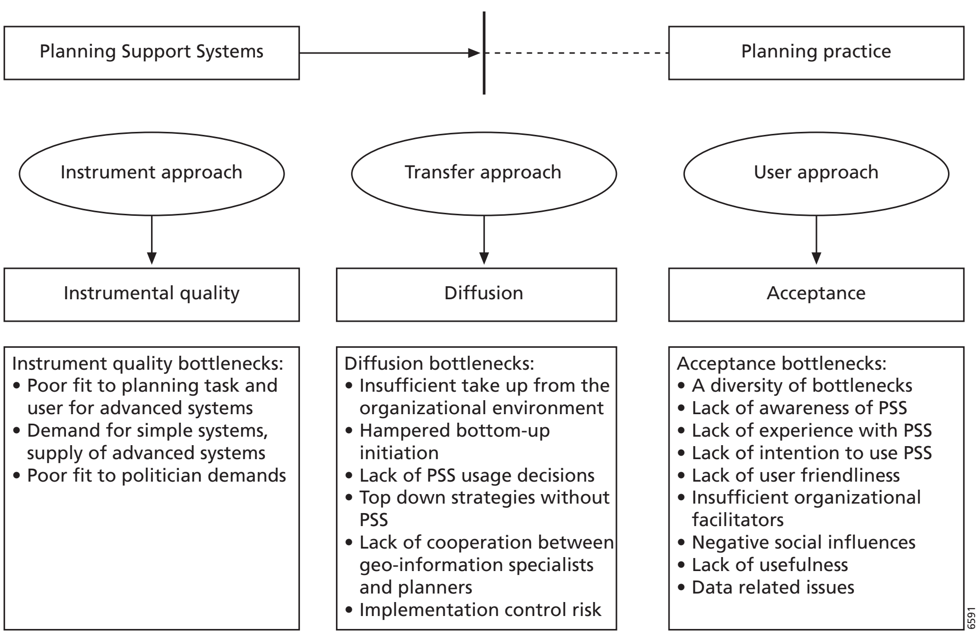

Figure 5.5 Conceptual framework explaining under-use of PSS from three different approaches

This framework has been applied to study the validity of the reasons for under-use of PSS in general for a number of PSS types.

5.3 Method

Using the intended task to support, or 'task support aim' as a primary criterion, three *types* of PSS are distinguished: informing PSS, communicating PSS and analyzing PSS (Geertman and Stillwell, 2003b; Klosterman and Pettit, 2005). The first type of *informing PSS* aims to make planning related knowledge and information accessible and interpretable by the flow of planning related information from an access point or sender towards a user. The second category of *communicating PSS* aims to facilitate communication and discussion between those involved in planning through supporting flow of planning related information between them. These PSS may incorporate informing or analyzing functionality, but the primary aim is always communication support. The third category of *analyzing PSS* aims to facilitate advanced processing of data and information in order to find patterns and underlying processes, and aims to facilitate information modelling for projection, simulation and evaluation. A range of *subtypes* are distinguished within the types that cover the most commonly occurring PSS (Brail and Klosterman, 2001; Geertman and Stillwell, 2003b; Vonk et al., 2006b). Among the informing PSS 'internal informing PSS' and 'external informing PSS' are distinguished. The first subtype aims to provide mainly those that are directly involved in the planning process with geo-information and the second subtype aims to provide the broader public with planning information. Examples of the first and second subtypes are geo-information viewers for planners and public informing websites respectively. Among the communicating PSS 'internal communicating PSS' and 'external communicating PSS' are distinguished. The first subtype aims to support communication among those that are directly involved in the planning process with geo-information at the same place and same time, and the second subtype aims to support communication from different places or at different moments in time between those that are and those that are not directly involved in planning. Examples of the first and second subtype are group decision room systems and interactive websites respectively. Among the analyzing PSS 'analytic modelling PSS' and 'analytic designing PSS' are distinguished. The former subtype aims to support scenario modelling, analysis and evaluation and the latter aims to support creation and reviewing of designs. Table 5.1 shows the types and subtypes of PSS.

To find what underlies the differences in usage of the types and subtypes of PSS, a combination is made of user perspectives, system developer perspectives and expert perspectives. It is realized that these three groups are not fully distinct in their knowledge and experience and account for this in the analysis. The knowledge and expertise of these three groups has been gathered

Table 5.1 PSS types and subtypes

PSS types:	Informing PSS	Communicating PSS	Analyzing PSS
PSS subtypes:	internal informing PSS external informing PSS	internal communicating PSS external communicating PSS	analytic modelling PSS analytic designing PSS

between June and December 2003. User views of PSS have been gathered by holding a series of interviews among 43 employees of 12 highly comparable Dutch regional planning organizations faced with the task of regional strategic land use planning, which they do by developing plans for water, traffic, environment, economy, etc. and integrating these into a comprehensive structure plan for the area governed. In particular interviews have been held among three archetypes of users that currently have an important role in using and evaluating PSS; the geo-information specialist, the planner and the manager. These are expected to be capable of providing a good and representative overview of user perspectives on PSS-technology in most of the developed world, particularly since evidence suggests the existence of more or less similar planning organizational environments in these societies and since it is not focused on specific aspects of the planning style. In the end, most of the participants were geo-information specialists (15), planners (12) and managers (3), but among the participants were also people with strongly related specializations such as environmental planning, economic planning, social planning and general IT (13). The interviews were carried out in groups, during 12 sessions of several hours each.

System developer views of PSS have been quite well recorded in scientific literature. Therefore, their perspectives on task-technology-user fit were tracked by conducting a literature survey. For the selection of suitable literature a broad definition of PSS was applied. In this way it is accounted for the discourse among experts on the content of the PSS concept. The study furthermore only includes literature published after 1998 to account for the shifting meaning of PSS with advancing technological possibilities. Books on PSS, papers of geographic information science-related conferences and journals were included. The two main sources were the two edited books on PSS by Brail and Klosterman (2001) and Geertman and Stillwell (2003a). In total views of 58 PSS were included, constituting a good overview of system developers perspectives on task-technology-user fit of PSS.

Expert views of PSS have been gathered by means of conducting two worldwide web-surveys. Via several PSS-related listserv e-mail networks, 800 PSS-interested persons were asked to participate. The first survey had 96 respondents; the second had 40 respondents. For the first survey 86, and for the second survey 30 of these respondents were considered experts, since they indicated to know at least two PSS from a list. The majority of the expert respondents were university researchers and employees of public planning bureaus dealing with planning support in their work. Although many users from planning practice were asked to participate, among the respondents they were a minority. The first survey consisted of a series of bottlenecks that potentially block widespread usage of PSS, to be judged on importance by the experts. The second survey consisted of open questions on strengths, weaknesses, opportunities and threats of PSS, as well as closed questions to express the perceived fit of a range of combinations of planning task, PSS and user, and to state experience with these combinations. Respondents could judge the importance of potential bottlenecks as well as the fit by selecting from 'not useful', 'neutral', '(very) useful' and 'don't know'.

The findings of the literature survey, the interviews and the web-survey have been combined to find what underlies the differences in usage of the distinguished types of PSS. The underlying explanations were found from the results by analyzing the subtypes on the validity of the bottlenecks that block widespread usage of PSS in general. Differences in instrumental quality have been identified by comparing subtypes on their fit to planning tasks, fit to user competences and relative advantage. Differences in acceptance have been identified by comparing subtypes of PSS on perceived user friendliness and usefulness, their users' awareness of, experience with and intention to use these instruments, as well as the presence of social influences and organizational facilitators that affect acceptance. Differences in diffusion have been identified by comparing subtypes of PSS on their take-up from the organizational environment, and feed forward and back through the organization by means of initiation, decision and implementation. The identification results are partially direct answers to questionnaires and interviews and partially follow from interpretation, which is indicated in the description of results in the following section by describing results as stronger statements or suggestions instead. The results for the subtypes of PSS are aggregated to find information on usage of the types of PSS.

5.4 Results

5.4.1 Informing PSS

Table 5.2 shows the indicators of instrumental quality and relative advantage in instrumental quality of the two subtypes of informing PSS. Results show that the instrumental quality is generally good for both subtypes. Furthermore, results suggest that working with these PSS subtypes offers a relative advantage over working without them. The results are based upon views of PSS developers, PSS experts and PSS users.

Results suggest that several benefits underlie the positive instrumental quality judgments of 'internal informing PSS'. First of all, many of these PSS are tailor-made by the geo-information or IT specialists within the organization or by consultants who are close to the organization, and in response to an experienced problem by planners, which often enhances fit to users and task. Secondly, 'internal informing PSS' make geo-information available on the desktop in an instant with accessibility for all users instead of only technically skilled users. In this way, the available geo information is likely to be used for policy making instead of being stored only. Thirdly, implementation is often relatively insightful compared to the other PSS types, which keeps managers' fear of runaway implementation processes low. Fourthly, 'internal informing PSS' are gradually becoming indispensable in planning practice as information and knowledge is becoming more important and paper maps are gradually replaced. Because of these benefits, the 'internal informing PSS' gain relative advantage over non-computerized methods. 'Internal informing PSS' with advanced visualization functionality (3D, animations) are much less widely used in practice than 'internal informing PSS' for 2D maps. Although advanced visualization is one of the main strengths of PSS, usually, systems for advanced visualization have a bad fit to the usage and implementation capacities of users in planning practice.

Results suggest that several benefits underlie the positive instrumental quality judgments of 'external informing PSS'. Firstly, these PSS offer the benefits of giving a large number of people access to planning processes, thereby enhancing the democratic content of process outcomes.

Table 5.2 Instrumental quality and relative advantage of informing PSS subtypes

	Fit to task	Fit to user	Relative advantage
Internal informing PSS	+	+	+
External informing PSS	+	+	+

Secondly, they are relatively well fit to the computer operation skills of the public at large. Thirdly, they are relatively easy to implement within the existing website development and management tools at rather low costs. Furthermore, since the greater part of geo-information specialists, planners and managers has had so much experience with the Internet these viewers form little threat. Notwithstanding these benefits, actual usage by intended users often remains limited to a group of active citizens who appreciate getting involved in policy making.

Table 5.3 shows the validity of the main bottlenecks for acceptance of PSS in general for the informing PSS subtypes. Results obtained for 'internal informing PSS' and 'external informing PSS' are almost similar. They show that the bottlenecks that block widespread acceptance of PSS in general do not strongly hamper the acceptance of these PSS.

In general there is awareness, experience and an intention to use 'internal informing PSS' among users. Nonetheless, planners and managers are still slightly more hesitant towards accepting 'internal informing PSS' than geo-information specialists, and consequently rely strongly on initiatives from geo-information specialists. The slight hesitance of planners and managers to accept these PSS requires geo-information specialist to do their very best in introducing applications. In this, they may experience bottlenecks in social influences and organizational facilitators that have their origin in hesitance of planners and managers. Data accessibility and quality are not problematic for the regular 'internal informing PSS'. The acceptance of 'internal informing PSS' with advanced visualization functionality is more strongly hampered, due to lack of awareness, difficulty of implementation and usage, limited 3D data availability and subsequently low intentions to start using these instruments as well as negative social effects and lack of organizational facilitation.

For 'external informing PSS' in particular, acceptance within planning organizations is the least hampered of all PSS subtypes. Due to the widespread usage of the Internet most employees have become aware of the opportunities and benefits of using the Internet. They have gained experience and therefore easily see opportunities in using the Internet for planning purposes. Intentions, social influences and organizational facilitators are therefore mostly directed towards utilizing these PSS, although again managers are slightly hesitant as regards their controlling abilities once projects grow bigger. It is expected the acceptance by the actual users, being the broader public, is hampered mainly by lack of awareness and the intention to start using these PSS.

Table 5.3 Acceptance bottlenecks for informing PSS subtypes

	internal informing PSS	**external informing PSS**
lack of awareness	-	-
lack of experience	-	-
lack of intention	-	-
lack of perceived user friendliness	-	-
lack of organizational facilitators	+/-	+/-
lack of social influences	+/-	-
lack of perceived usefulness	-	-
lack of data accessibility/quality	-	-

+ = bottleneck; - = no bottleneck

Table 5.4 Diffusion indicators for informing PSS subtypes

	take-up from organizational environment			initiation	decision	implementation
	geo-info specialist	planner	manager			
internal informing PSS	+	+/-	+/-	+/-	+/-	+
external informing PSS	+	+/-	+/-	+	+	+

Table 5.4 shows indicators for the diffusion of informing PSS subtypes. It shows that although 'internal informing PSS' are ahead of many other PSS subtypes in usage, their diffusion into planning practice still meets some minor obstacles. It also shows that the diffusion of 'external informing PSS' is hardly hampered at all.

'Internal informing PSS' and 'external informing PSS' are either developed by consultants and then transferred to the geo-information specialists, planners and managers within planning organizations, or developed by the geo-information specialists that work within the planning organization and then transferred to planners and managers. Only a few university based system developers and researchers focus their efforts on these viewers since these PSS are often considered to be on the edge of scientific relevance. Development of most viewer PSS requires rather standard programming skills and a keen eye for user demands rather than advanced technically oriented knowledge and large innovations that most university workers aim for. For them, most informing PSS stand in the shadow of communicating PSS and analyzing PSS, which they see as offering a much greater advantage. Only the most advanced informing PSS, such as 3D visualization systems, receive attention from university based system developers and researchers.

Many planning organizations have already taken decisions to utilize the informing PSS subtypes. Diffusion of these PSS is starting to reach the upper organizational level. The gradually evolving demand side takes over from the initially purely technology-push situation. System developers, vendors, and geo-information specialists are no longer alone in stimulating usage, but are joined by planners and managers, who use the PSS, or allow them to be used. Organizations have even started to cooperate on the further development of informing PSS as it has been shown that their implementation can be made into a success without causing difficulties that cannot be overcome. This leads to the formation of standards. Consequently, initiation and the taking of adoption decisions gradually become easier. Nonetheless, particularly for the somewhat more innovative and advanced informing applications, the geo-information specialists or consultants may still need to make significant efforts to break through managerial hesitance and initiate adoption decisions. Examples of such innovative and advanced systems are 'internal informing PSS' with advanced visualization functionality, which are still in an initial stage of diffusion, and systems extending towards communication support (external communicating PSS, see section 5.4.2)

5.4.2 Communicating PSS

Table 5.5 shows indicators for the instrumental quality and relative advantage in instrumental quality of two distinguished communicating PSS subtypes. Due to the fact that these PSS are currently only sparsely used in practice, results are based strongly upon system developer and expert views, while included users views are mostly their estimates. Results suggest that 'external communicating PSS' have a somewhat better instrumental quality than 'internal communicating PSS'. The relative advantage of using the former seems to be somewhat greater than using the latter.

Results show that most web-based applications remain limited to informing the public or have only a simple message reply option. In practice, planning often only becomes participatory during presentation of already made plans. Nonetheless, the potential of 'external communicating PSS' to increase the democratic content in earlier planning stages and to increase the knowledge base of planning are clear. Furthermore, the widespread experience with Internet applications causes most users to be capable of using web-based communication PSS. This suggests that the instrumental quality of these PSS is quite good and that they may have relative advantage over existing methods to involve the public in planning.

'Internal communicating PSS' are also used only sparsely. Users perceive the ability to store information from meetings easily as an advantage of these types of PSS and furthermore appreciate the speed benefits that can be gained by the quick information management capacities of these instruments. The often good fit to the competences of professionals with computer experience makes these PSS easy to work with for professionals with computer experience. Making these PSS fit to non-professionals without computer experience remains a challenge. To realize benefits, the instruments need to be very well fit to planning processes and the actors involved in planning. Only in this way can the speed advancement benefits actually be achieved without affecting the communication process too strongly by hampering free discussion. In general, the current instrumental quality and relative advantage of these PSS is somewhat doubtful. Nonetheless, results suggest that they have great potential.

Table 5.6 shows the validity of the main bottlenecks for acceptance of PSS in general for the two communicating PSS subtypes. Results suggest that several of the bottlenecks that are blocking widespread acceptance of PSS in general hamper the acceptance of the communicating PSS subtypes.

Although the general awareness of web-technology is large, the awareness remains mostly limited to using the web for informing instead of using 'external communicating PSS' for two-way communication between governments and public. The acceptance of two-way communication through 'external communicating PSS' is expected to grow if planning becomes

Table 5.5 Instrumental quality and relative advantage of communicating PSS subtypes

	fit to task	fit to user	relative advantage
external communicating PSS	+/-	+	+
internal communicating PSS	+/-	+/-	+/-

Table 5.6 Acceptance bottlenecks for communicating PSS subtypes

	external communicating PSS	internal communicating PSS
lack of awareness	+/-	+/-
lack of experience	+/-	+
lack of intention	-	+/-
lack of perceived user friendliness	-	+/-
lack of organizational facilitators	-	+/-
lack of social influences	-	+
lack of perceived usefulness	-	+/-
lack of data accessibility/quality	-	-

+ = bottleneck; - = no bottleneck

Table 5.7 Diffusion indicators for communicating PSS subtypes

	take-up from organizational environment			decision	implementation
	geo-info specialist	planner	manager		
external communicating PSS	-	-	-	-	-
internal communicating PSS	-	-	-	-	-

more participatory. It is expected that users accept these PSS quite easily because of the earlier described benefits. They are expected to lead to significant user friendliness and usefulness, positive intentions and social influences, and organizational support for acceptance. Professional stakeholders such as lobby/pressure groups, business organizations and institutional users are likely to accept somewhat earlier than citizens.

Relatively few experiences exist in planning practice with actual application of 'internal communicating PSS'. First of all there exists lack of awareness of opportunities and experience with using these PSS, but furthermore, the need to hire external specialists to install and apply them and the need for hardware investments that often exists clearly hampers opportunities for ad hoc trial usage in projects. Once the hardware is available, the PSS are installed and employees have been trained for usage, continued usage is expected to become gradually easier. Before first usage however, many managers in particular have doubtful or negative intentions towards using these PSS, which causes negative social influences and organizational bottlenecks to develop. The usefulness needs to weigh up to negative intentions, which it often fails to do. Usage of 'internal communicating PSS' is therefore often rejected or deemed more suitable for outsourcing to consultants.

Table 5.7 shows indicators for the diffusion of communicating PSS subtypes. It shows that both subtypes are still in an initial stage of their diffusion.

Simple 'external communicating PSS' are often developed in-house by IT specialists or geo-information specialists. The more advanced of these PSS are also developed by consultants and university researchers. Decisions to adopt 'external communicating PSS' benefit from planning organizations' need for more democracy and knowledge by having the public participate in planning. Right now the public often only participates in the later stages of planning projects once basic plans have already been formed. The need for increased democracy and knowledge causes decision makers to accept ways to communicate with the ever-critical public quite easily. The diffusion of advanced 'external communicating PSS' is hampered by the fact that they are not taken from the extra organizational environment. Users are often unaware of developments concerning these PSS. Instead, they gradually extend their informing PSS to become suitable for supporting two-way communication. For participation, most users simply organize meetings for discussion without using PSS.

'Internal communicating PSS' are usually developed at universities, government research institutes or by consultants. Their development usually requires a combination of technical expertise and planning insights that is not readily available in planning organizations. From their developers they are communicated towards geo-information specialists, planners and managers who may (decide to) use the PSS in practice. Right now the diffusion of these PSS is hampered by the fact that little or no demand for these systems exists. The demand is expected to increase if participation becomes more important in planning and experience grows. Due to lack of demand for 'internal communicating PSS', they are currently hardly taken from the extra organizational environment. This is enhanced by the absence of sufficient implementation related knowledge and skills in practice, which causes managers to perceive high risks of implementation projects to get out of hand in terms of time and money spent. To compensate for the lack of knowledge and skills in practice, the supplier often plays a large role in the application of these PSS.

5.4.2 Analyzing PSS

Table 5.8 shows the indicators of instrumental quality and relative advantage in instrumental quality of the two distinguished analyzing PSS subtypes. Results indicate that 'analytic modelling PSS' have a poor instrumental quality, while 'analytic designing PSS' have better instrumental quality. Both PSS subtypes have relative advantage, according to experts and system developers, while practice is negative, doubtful or simply unaware of their existence. The results are based upon views of PSS developers, PSS experts and PSS users.

Results show that in particular 'analytic modelling PSS' are seen as much too difficult and complex to be operated by planners. They are specialist tools that often are even too technically complex for geo-information specialists. Although they intend to support a major aspect of planning, they poorly fit planning practice and those involved in planning. Also, their performance is often low. Benefits that convince all potential users are hardly available. Plan quality benefits are hard to show from an independent perspective. Plan development time benefits may be easier to show. Results show that a good geo data warehouse is needed for successful usage of 'analytic modelling PSS', which implies that some organizations that do not have this are simply not able to start using these PSS. Moreover, the costs and risks of successfully implementing these PSS are so high that they often easily outweigh the often-intangible benefits, causing the relative advantage to be low. This shows that although 'analytic modelling PSS' may potentially improve scenario modelling and analysis, in practice such improvements are unlikely to show.

Table 5.8 Instrumental quality and relative advantage of analyzing PSS subtypes

	fit to task	fit to user	relative advantage
analytic modelling PSS	-	-	+/-
analytic designing PSS	+/-	+	+/-

Table 5.9 Acceptance bottlenecks for analyzing PSS subtypes

	analytic modelling PSS	analytic designing PSS
lack of awareness	+/-	+
lack of experience	+	+/-
lack of intention	+	+/-
lack of perceived user friendliness	+	-
lack of organizational facilitators	+	+
negative social influences	+	+/-
lack of perceived usefulness	+	-
lack of data accessibility/quality	+	-

+ = bottleneck; - = no bottleneck

Planners currently often make use of simple GIS derived 'analytic designing PSS' that are tailor-made to their work. These are often developed in-house by the geo-information specialists or by consultants who are close to the organization. They have the advantage of providing planners with knowledge to base their plans upon and are actually aimed at supporting analysis *for* design as opposed to supporting analysis *and* design. The more advanced commercially available 'analytic designing PSS' are hardly used in practice. Nonetheless, these commercial instruments have the advantage of flexibility by combining some of the functionality of informing PSS with analysis functionality, as well as the advantage of user and task dedicated toolbox environments. This makes them promising PSS to support planners. Disadvantages of 'analytic designing PSS' are that they require a good data warehouse and often also an underlying GIS program or CAD program with GIS functionality installed in order to become applicable. The former is often unavailable and the expensive licences of the latter make application as a standard planner tool costly. This affects the relative advantage of these PSS and hampers usage.

Table 5.9 shows the scores of analyzing PSS on the main bottlenecks for acceptance of PSS in general. Results indicate that many of the bottlenecks that block widespread usage and acceptance of PSS also hamper the acceptance of analyzing PSS.

The results indicate that most of the bottlenecks for PSS acceptance in general apply to 'analytic modelling PSS'. Awareness in practice hampers the acceptance of these PSS somewhat, but acceptance is mainly hindered by other bottlenecks such as lack of intention, perceived user friendliness and lack of perceived usefulness.

Commercially available 'analytic designing PSS' are not widely known in the planning environment. There is little awareness and experience with these PSS in practice and consequently, usage intentions are also low. Managers' negative experiences with IT investments

Table 5.10 Diffusion indicators for analyzing PSS subtypes

	take-up from organizational environment			initiation	decisions	implementation
	geo-info specialist	planner	manager			
analytic modelling PSS	+/-	-	-	-	-	-
analytic designing PSS	-	-	-	+/-	+/-	+/-

obstruct planning organizations from willingness to experiment with these PSS. Relatively simple 'analytic designing PSS' are more widely known and applied. They are tailor-made in-house or by consultants from a demand by planners and therefore often accepted more easily. The 'analytic designing PSS' that are used are usually seen as rather easy to operate and useful.

Table 5.10 shows indicators for the diffusion of analyzing PSS. It shows that 'analytic modelling PSS' are still in an initial stage of diffusion, while 'analytic designing PSS' are somewhat further diffused into planning practice.

'Analytic modelling PSS' are usually developed and applied by researchers working at universities or government planning bureaus or by consultants. Results show that the gatekeepers in planning practice do not function well for these PSS since they are hardly taken from the extra-organizational environment. Results furthermore show that if they are taken from the environment, initiation, decision and implementation of 'analytic modelling PSS' are hampered due to negative intentions towards use of these PSS within the organization. As decisions to utilize these PSS are only taken occasionally, they will usually remain at the diffusion level of intention formation by several technically oriented or visionary individuals.

Results show that decisions to adopt commercially available 'analytic designing PSS' are usually not taken. Results show that for these instruments, organizations have no gatekeepers that take up the PSS from the organizational environment; no effective initiators of adoption decisions, which prevents the decision to start using PSS from being taken and causes the exploitation phase to become totally ineffective, while exploitation is based on management supported strategies that avoid the risks associated with IT investment instead of on the result of exploration. For 'analytic designing PSS' that are developed in-house instead of taken from the organizational environment, initiation, decision and implementation do take place quite successfully, following from planners' demands.

5.5 Interpretation

5.5.1 Differences in usage of PSS types explained

The described results lead to the following notions on why some PSS are more widely used than others.

First, results show that there are significant differences in usage of types of PSS that can be explained by a diversity of bottlenecks. Informing PSS are much more widely used than communicating PSS and analyzing PSS in regional level land use planning (see figure 5.6).

Results show that these differences in usage originate from differences in instrumental quality, acceptance and diffusion. *Instrumental quality* of the less widely used PSS is relatively low primarily due to lack of fit to users and planning tasks as perceived by planners and managers, as well as fear of troublesome implementation with time and budget getting out of hand, causing the relative advantage of using these PSS to be estimated as low. These perceptions form the source of negative intentions among planners and managers that affect acceptance of less widely used PSS. *Acceptance* of less widely used PSS is hampered by these negative intentions and by a lack of awareness and experience with the less widely used PSS. These negative intentions cause negative social influences and hamper the organizational support required for *diffusion*. These factors hamper diffusion of less widely used PSS, since they cause organizational members to be insufficiently facilitated and supported in their efforts to take-up these PSS from the organizational environment and in their efforts initiate usage decisions. Their efforts are often even repressed. Due to these circumstances, these PSS are not taken up and, if they are, initiation of usage decisions is often unsuccessful, which prevents such decisions from being taken. The lack of decisions to use these PSS causes them not to be used and no experience to be generated. This hampers further awareness generation, subsequent formation of adequate instrumental quality images, acceptance, diffusion and usage. For the more widely used PSS on the other hand, there is a much higher degree of awareness and much better images of instrumental quality, which stimulates acceptance by geo-information specialists, planners and managers, and subsequent diffusion and usage. Figure 5.7 shows the usage model based on these results.

Secondly, results indicate primary and secondary reasons for the fact that some PSS types are more widely used than others. The primary reasons are differences in awareness of the existence of types of PSS, differences in instrumental quality perceptions, and differences in experience. Since experience enhances the degree of awareness and subsequent instrumental quality images, lack of experience is the most significant primary reason. In this way, lack of experience and awareness may lead to persistent inaccurate instrumental quality images for some PSS types, as

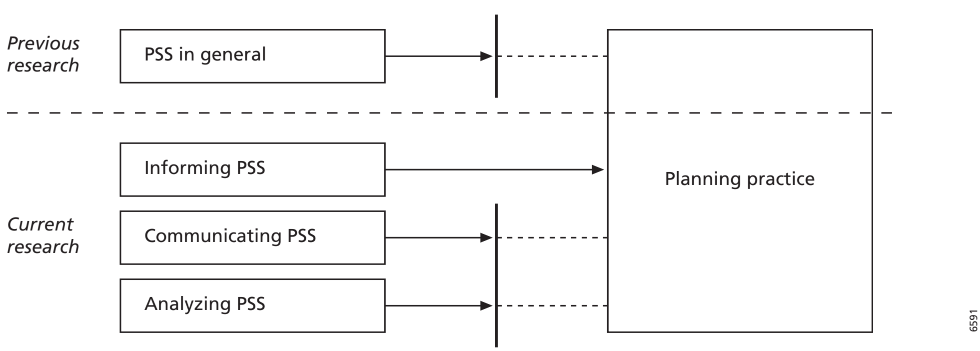

Figure 5.6 PSS, PSS types and their usage in planning practice

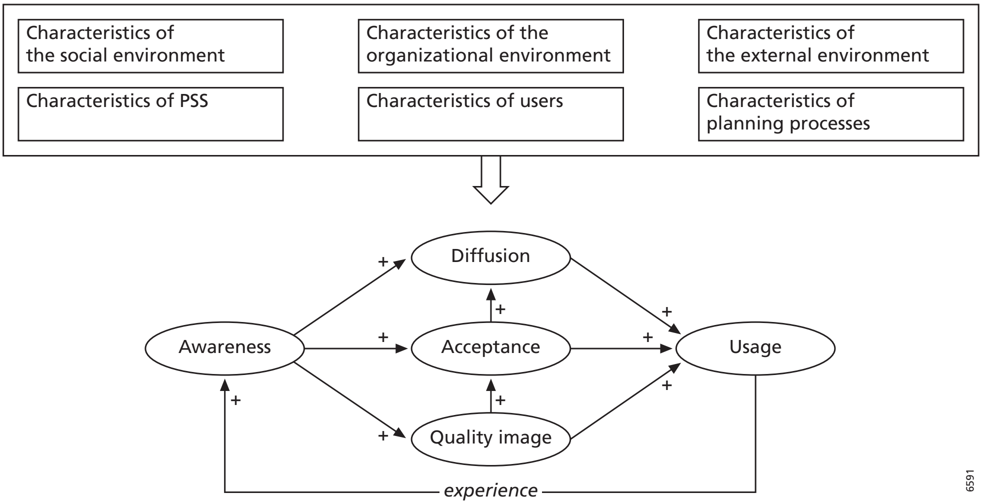

Figure 5.7 Model explaining differences in usage of PSS types

benefits have not convincingly been shown. The importance of experience is supported by the fact that expert survey results show lack of experience as the most important bottleneck blocking widespread usage of PSS (Vonk et al., 2005). These primary reasons for differences in usage of PSS types are responsible for a range of secondary reasons, related to differences in acceptance and diffusion such as differences in intentions to use PSS types, differences in the nature of social influences, differences in organizational support, differences in take-up from the organizational environment and differences regarding the effectiveness of the initiation of usage decisions.

Thirdly, results show that the characteristics of users, planning processes, the social, organizational and external environment in particular as well as the instrumental quality image, acceptance and diffusion which they constitute, are resistant to changes. This resistance in combination with the resistance that originates from the positive feedback loop of experience causes PSS types to become locked into usage and non-usage attractor states. Regarding the available PSS types, it is observed that the more radical the PSS innovations are with respect to planning practice, the stronger they are locked out and the less widely they are used. In particular using 'analytic modelling PSS' can be considered radical innovation from the viewpoint of planners and managers. Incremental innovations, through which planners, managers and geo-information specialists can keep doing their jobs as they are used to, but slightly easier, face less resistance. As long as no large changes of planning are demanded by macro-societal events or massive failure of current planning, PSS that form radical innovations are likely to be used only incidentally, for example in cases where existing methods incidentally fall short and/or in the sparse situations where particular individual PSS advocates are capable of bringing change to ongoing practices due to their personal dispositional qualities. A large change in planning due to the macro societal event of increasing democracy is the change towards more participatory planning. This might increase opportunities for communicating PSS in particular. Another change is the rise of development planning. Its emphasis on seeking opportunities instead of restricting spatial developments might increase opportunities for 'analytic designing PSS' in particular.

5.5.2 Underlying problems

Results show a range of problems underlying the primary and secondary reasons for differences in usage of PSS types. These problems contribute to the greater resilience of planning practice to use many analyzing and communicating PSS than to use informing PSS.

A first problem is the profound miscommunication on the concept of PSS between system developers, experts and users of PSS. This factor affects the generation of awareness and experience as well as instrumental quality images for many analyzing and communicating PSS in particular. Many system developers and experts have a strong focus on 'analytic modelling PSS' for complex tasks such as evaluation of alternatives. They tend to focus on dedication to a highly abstract scientific concept of planning, thereby sacrificing dedication to user capacities and demands and planning tasks as they are now carried out. Since many of them are university workers, these abstract and generally applicable innovations are also what they are paid for. Many of them see the intellectual challenge of capturing planning aspects in knowledge models greater than dedication to users and their demands. Users on the other hand focus on information and communication oriented systems for support of rather basic tasks, such as making an inventory of conditions or disseminating results towards the public. Furthermore, they seek dedication through incremental changes, driven by planning practice and the competences of planners. This shows the significant miscommunication around the PSS concept that largely underlies the problem of under-use of PSS.

A second problem is the mismatch between many analyzing and communicating PSS and planners operating skills, affecting instrumental quality perceptions. For some communicating and analyzing PSS subtypes, increased usage would require planners to gain a great deal of additional technical skills, close cooperation with geo-information specialists, or core tasks of planning to be delegated to geo-information specialists instead of planners themselves. The increased reliance on geo-information specialists using PSS to manipulate information and to do planner's jobs is often considered a threat to planners and the accountability of their work. The mismatch is also enhanced by lack of integration or at the least, easy interoperability between general office programs that are widely used in planning practice and many GIS environments from which many PSS originate. The difficult linkages hamper taking incremental steps towards usage of analyzing PSS on the desktop by informal trials. Instead, planners use the general office programs that many of them already have available at their desktop for simple analysis for planning support. The spatial representation and spatial analyses they cannot perform with these office programs are usually developed on-demand by geo-information specialists who use their GIS for these purposes.

A third problem is the mismatch between many analyzing and communicating PSS and the characteristics of planning. Results indicate that planners and executives are more likely to accept the PSS that focus on supporting elements of the planning process, rather than PSS that focus on the content of planning as a negotiating business in their working processes. Particularly for analysis and modelling oriented PSS, increased usage would require a large redefinition of planners' working processes. On a more abstract level, content support oriented PSS require the planning style that underlies the working processes to shift from emphasis on democracy, political rationality and design, towards knowledge. The current emphasis on democracy and politics follows from assumptions of many planners that land use changes, typically the outcome of human and political processes, cannot be captured in computers. In comparison, similar analysis systems are much more widely used in traffic planning and water planning to model dynamic natural and social processes that have a strong effect on the planning outcome and that can only be well understood by using computer models. The current emphasis on designing prefers the creative work of the designer above analytical solutions generated by computers on the assumption that computers cannot generate creative solutions. However, practice has shown that an overly strong focus on the human and political dimension of land use planning and on designing as a means to solutions has often led to failures. This is indicative of the need to rebalance knowledge, communication and design, which is a more fundamental critique of planning (Schot and Dijst, 2000).

Additional problems on a more detailed level are described in previous analyses (Vonk et al., 2005; Vonk et al., 2006a; Vonk et al., 2006b).

5.6 Conclusions and recommendations

In contrast to many other studies on usage of technologies, this study has taken a threefold approach to explain usage in this paper; instrument, user and the transfer of the instrument towards the user. The threefold approach has several benefits over applying only one or two perspectives. Firstly, it allows us not only to explain usage from technical factors, but also from human and organizational factors that are often very important determinants of usage, instead of only focusing on a single aspect. Secondly, it allows us to systematically analyze factors that determine usage and their interrelations. Knowledge of how the factors are interrelated provides more thorough insights into the mechanisms that affect usage, as well as giving handholds for usage enhancement strategies that account for effects resulting from these interrelations. Thirdly, it allows us to develop a systems model of usage, which helps to explain systems effects on usage. The highly explanatory technology lock-in and lock-out processes found in the current study could not have been found without the systems model. Because of these benefits it is recommended that others follow a combined approach in studying the usage of information technologies.

Studies of usage of PSS indicate that PSS are a technology that is in an early stage of development. They also indicate that PSS have not yet become widely used in planning, in spite of their potential to support those involved in planning in doing a range of planning tasks. Extensive studies of this problem have led to the following conclusions. First of all, it is concluded that there are significant differences in usage of types of PSS. Planning practice uses informing PSS to support early exploratory planning stages rather than communicating and analyzing PSS. This leads to the conclusion that informing PSS are relatively widely used, communicating PSS are less widely used and analyzing PSS are only used in their simplest form in planning practice. Secondly, it is concluded that these differences are explained by a multitude of factors. The primary causes for usage differences are differences in awareness, differences in experience and differences in instrumental quality. Of these three, differences in experience are even more important than the other two. Evolving from these primary causes are several secondary causes of usage differences that mainly affect acceptance and diffusion processes underlying usage. Thirdly, it is concluded that resistance to changes of the implementation environment causes PSS types to become locked into and locked out of usage and non-usage attractor states. The implementation environment is the least resistant to using informing PSS, more resistant to using many communicating PSS, and most resistant to using analyzing PSS.

Fourthly, it is concluded that problems that underlie the primary and secondary causes of differences in usage are a miscommunication between users, developers and experts of PSS as well as mismatches between characteristics of many analyzing and communicating PSS types and the characteristics of the planner and the planning process.

Following from these underlying problems, it is recommended that system developers, users and experts first improve their communication and cooperation on PSS. The current way of communication and cooperation hampers PSS development and usage. Secondly, it is recommended they focus on improving the match between PSS, their users in planning and planning processes. Thirdly, it is recommended they increase their attention for 'analytic designing PSS' and for communicating PSS. Although most of these are in a very early stage of diffusion and still need to prove their worth, these are seen as promising PSS due to their flexibility and dedication to planners and planning tasks.

6 Integrating PSS into planning processes

6.1 Discussion

Planning practice is currently incorporating informing PSS as standardized support tools for the early exploratory tasks of planning. PSS are less widely used to support communication and analysis in planning. Nonetheless these two less widely used PSS categories could potentially enable planners to better handle the complexity of planning by supporting communication and analysis. In order to enhance usage of these PSS types this study formulates a series of recommendations. These recommendations are oriented towards alleviating the problems responsible for the fact that most communicating and analysis PSS are less widely used in planning practice than informing PSS. The problems are lack of *awareness* of the existence and potential of communicating and analyzing PSS, lack of *experience* with these PSS, poor *instrumental quality* of these PSS, and hindered *acceptance* and *diffusion* of these PSS. Figure 6.1 shows the main recommendations to alleviate each of these problems and their effects on the variables that hamper usage of communicating and analysis PSS in planning practice.

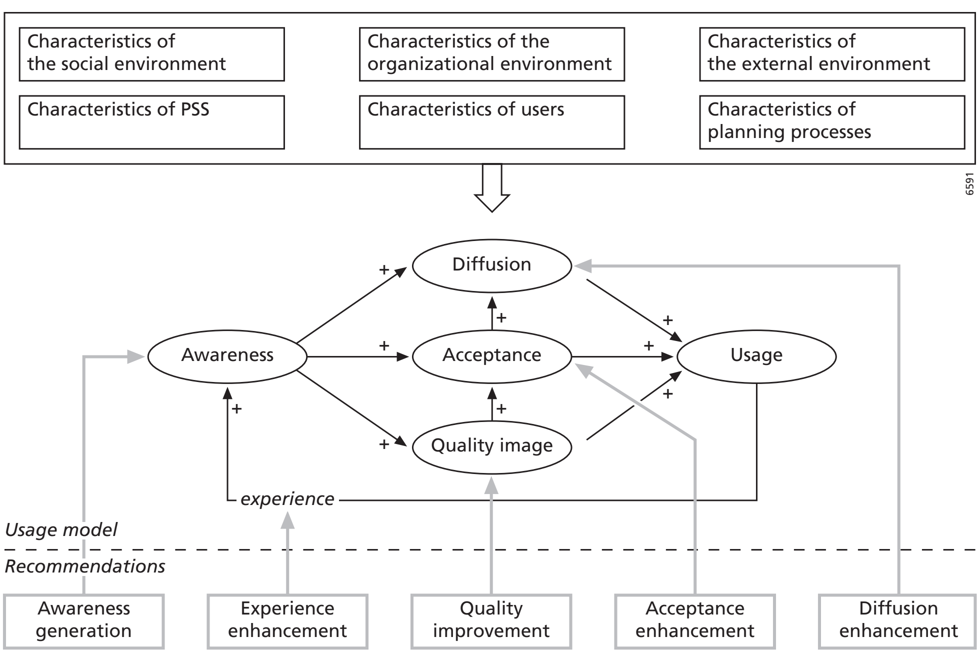

Figure 6.1 Recommendations affecting the main problem causing variables in the usage model

The main recommendation to enhance usage of PSS that summarizes all others is that it should be made clear which PSS types should be used for which particular planning tasks, by which kinds of users, in which kinds of organizations and under which external conditions. The following section will show several more specific recommended actions for PSS developers, intended users of PSS in planning practice and PSS researchers that might lead to enhanced usage of PSS. It is realized that PSS developers and researchers are not fully distinct groups. Some PSS research and development recommendations may therefore apply for both groups.

6.2 PSS development recommendations

To PSS developers aiming for enhanced usage of PSS it is recommended to take the following actions:

1. To primarily enhance awareness of PSS it is recommended to spread the news of the existence and potential of PSS in planning practice;
2. To primarily enhance awareness of PSS it is recommended that awareness generation actions do not stop after a single rejection since innovation in PSS may be a timely process of human and organizational adaptation;
3. To primarily enhance experience with PSS it is recommended to apply best practices of PSS application that will maximize chances that the gained experiences will be positive;
4. To primarily enhance instrumental quality of PSS it is recommended that system developers and geo-information specialists improve communication with practice in order to be capable of actively analyzing the tasks that may be supported by PSS and the application environments;
5. To primarily enhance instrumental quality of PSS it is recommended to improve the fit between PSS, planning tasks and the competence of those involved in planning.
6. To enhance instrumental quality, acceptance and diffusion of PSS it is also recommended that PSS developers and researchers working at universities increase their communication on PSS towards planning practice, government research agencies and consultants;
7. To enhance instrumental quality, acceptance and diffusion of PSS it is recommended that PSS government research agencies and consultants take an active role in development of PSS;
8. To enhance instrumental quality, acceptance and diffusion of PSS this study recommends the initiation of an interactive learning process among all the relevant actors of the innovation network concerning PSS;
9. To enhance quality, acceptance and diffusion, this study recommends incremental development of PSS technology, and a distinction of basic PSS that can be directly used in practice and advanced PSS that require intervention of specialized consultants or researchers.

These recommendations are described in more detail below.

Firstly, to increase primarily *awareness* of the existence and potential of PSS it is recommended that users, system developers and researchers that are already aware to spread the news of PSS more actively and through the appropriate communications channels. We furthermore recommend making the PSS message more suitable to the receivers in planning practice. The news on PSS may consist of the information of the general existence of (in particular) communicating and analyzing PSS and their benefits, but may also contain information on gained experiences in application of PSS. For example, system developers may make geo-information specialists in planning organizations aware by presenting opportunities on practice oriented conferences, by publication of their systems on the web, or by directly contacting the geo-information specialists. Geo-information specialists may then generate awareness among planners and executives within the planning organizations they work for. System developers may also try to make contact directly with planners and executives to show the benefits of their systems. However, considering the differences in backgrounds between many system developers, planners and executives, convincing them is usually quite difficult. Many of the interviewed practitioners indicated that showing examples with application of the PSS to a current planning problem for the organization is a good means of overcoming background differences. Those aware may also cooperate in generating awareness by jointly developing examples to convince others. System developers could assist geo-information specialists in cooperation with planners in developing good examples of the application of PSS, which they could use to convince planners and executives of the worth of PSS.

Secondly, to increase primarily *awareness* of PSS, these described awareness generation actions should not stop after one failed attempt. Innovation in complex user environments with heterogeneous realities of the involved actors may be a process that takes time and that may succeed at one time and be blocked at another time, depending on the factors on which awareness generators have only limited influence. The underlying reason is that innovation does not simply require the creation of new knowledge, but also the creation of new language, practices and meaning (Moss, 2001). During these processes, organizational members may gradually organize themselves into stable patterns of activity and communication that provide them with a common frame of reference regarding PSS and their usage. It needs no saying that the development of common language in a complex user environment may take a lot of time. It is for this reason that awareness generation should continue until enough new language, practices and meaning have been created to adopt PSS. This makes clear that awareness generation by means of merely providing the knowledge is not enough. Communicators of the PSS idea should focus on 'sense making' instead of knowledge provision only (Weick, 2001).

Thirdly, lack of *experience* with using PSS emerges from the conducted studies as the primary bottleneck blocking usage of some PSS types. Primarily to stimulate the generation of experiences that are most positive this study recommends applying 'best practices' of application of PSS. This implies making sure that none of the organizational hazards for successful usage occur and affect experiences negatively and using high standard systems. Regarding the organizational hazards, this study recommends following PSS usage recommendations described in the following paragraph. Regarding usage of high standard systems this study recommends focusing more attention towards the more advanced 'internal communicating PSS' that combine a range of communicating, informing and analysing functions to support planning processes. Their high degree of dedication and strong flexibility make these PSS promising tools for practice. Noteworthy examples of these systems are CommunityViz, What-If?, and Index (Klosterman, 2001b; Kwartler and Bernard, 2001). Despite their estimated benefits, planning practice is currently barely aware of the existence of these PSS. We furthermore recommend paying more attention to 'analytic designing PSS'. Although connections with already used office software could be improved, these PSS extend the field of application of already used systems instead of discontinuously focusing on whole new support options and may therefore be relatively easy to implement. A very good example of a place where users could find information on 'best practices' of PSS application is the website www.placematters.com (Snyder, 2004). This is a knowledge base on PSS that is very easily accessible to those working in planning practice. It contains examples of PSS, their applications in practice and guidelines for application.

Fourthly, to primarily enhance *instrumental quality* of PSS, it is recommended to system developers and geo-information specialists to actively start analyzing the tasks that may be supported by PSS and the application environments. Just as much as planning practice must be made aware of the existence and potential of PSS, system developers and geo-information specialists need to be made aware of the characteristics of planning processes and of the competence and demands of the actors involved in planning. They can use this information to enhance the instrumental quality of their instruments. We therefore recommend improving communication between system developers and practice. To increase the chances of learning useful lessons from practice, system developers should be open to learn from planners and engage in a dialogue instead of only communicating their message on the existence and potential of PSS. Their systems need to actually add something useful to existing practices to become used. Communication between developers and practice could be enhanced if software vendors are also consultants, which allows them to communicate with practice, which has already shown how to enhance communication and learning on GIS. Right now the development and usage of most analysing and communicating PSS is hampered by the profound miscommunication between system developers, experts and users of PSS. To these groups, this study recommends improving their communication on PSS.

Fifthly, to primarily enhance *instrumental quality* of PSS, it is recommended to improve the fit of existing PSS to the competences of those involved in planning and the characteristics of planning tasks. One way to do this is by making it easier to start using PSS in practice and in particular, showing how to improve connections between PSS and the office software that is often used in planning processes. If PSS are most likely to diffuse bottom-up, making it easy to try out these PSS is important. PSS that incrementally build forth upon existing practices and upon office software that has already been used in these practices stimulates employees to informally experiment with trial versions and the subsequent incorporation in working processes.

Sixthly, to enhance *instrumental quality, acceptance* and *diffusion* of PSS, it is recommended to university workers to increase their communication on PSS. A significant part of development of analyzing and some communicating PSS is taking place within universities right now. Also, universities are a good platform for comparing international developments on PSS, which is useful since PSS development is an international affair. Nonetheless, research results are poorly communicated to intermediary organizations, such as government research agencies and consultancy firms. Furthermore, research results are poorly communicated directly towards planning practice. This contributes to the fact that many intermediaries and practitioners are unaware of PSS developments or even of the existence of PSS. The poor communication with intermediary organizations and planning practice furthermore causes many university workers to be unaware of demands from planning practice, which makes it difficult to keep insight on the state of the art of PSS in practice and the development directions desired by planning practitioners. Although university workers may have problems communicating with planning practice, congresses and discussion groups and portals keep communication amongst researchers quite active. Although in some ways it negatively affects PSS developments, the existence of a communications gap between university and practice has its reasons. In the first place, scientists are traditionally expected to maintain a certain distance to the policy arena. Secondly, scientists are expected to develop scientifically cutting edge applications instead of getting involved in dedication of existing applications to users and planning tasks. This causes PSS to be developed independently from demand and causes a general difference in concern between developers and users. Thirdly, the scientific world also does not encourage scientists to communicate their results towards planning practice. Scientists are mainly judged for the number of publications in international scientific journals in the English language. As policy makers have their own tight schedules to work through, for which they have to handle large amounts of relevant information, they have no time to read these scientific journals. Furthermore, the articles are not easily comprehended. Scientists are not stimulated to publish their results in national professional journals in the national language or newspapers, which are much more accessible for policy makers. To enhance communication of knowledge concerning PSS towards planning practice this study recommends scientists increase publication in national journals that are read by planning practitioners and use other communication channels through which planning practice can more easily be reached. This way they might achieve increased awareness of the existence of PSS within the planning community.

Seventhly, to enhance *instrumental quality, acceptance* and *diffusion* of PSS, employees of national government research agencies and consultant organizations usually have greater knowledge of and accessibility to planning practice than scientists working within universities. This makes them better initiators of cooperative PSS development than university based system developers or researchers. This study therefore recommends that such intermediate actors take a major role in PSS quality improvement. While university based system developers can do the cutting edge research, government research institutes and consultancies could use the resulting knowledge to operate as systems integrators and develop PSS, dedicate the systems to users and to a certain extent the tasks as well, and enhance the development of standard applications in an enterprise ICT environment. An example of a government research agency that is performing its intermediary role in development of PSS is the Netherlands Environmental Assessment Agency (MNP). They cooperate with universities to further improve their Environment Explorer PSS, while also learning lessons from application in practice for the Dutch government. Another good example is the US Department of Energy that initiated cooperative development in a community of practice on PSS, including researchers, system developers and practitioners. Starting such cooperation usually requires a common concern (Wenger, 1998). This common concern could be the complexity of planning (Geertman and Stillwell, 2003b). To achieve such a shared concern people must interact to communicate their different perspectives and resolve their conflicting views. If the actors of the innovation network concerning PSS disagree on the nature of this problem and the desired solutions, it may require a lot of efforts to make the concern really shared. We expect that government research institutes and consultancies can do a much better job in getting people to work together than system developers due to their already intermediate position between policy and research.

Eighthly, to enhance *instrumental quality, acceptance* and *diffusion* of PSS, it is recommended to commence of a process of interactive learning among the relevant actors within the innovation network concerning PSS. Particularly for analysing and communicating PSS there is still much to be learned. This requires close cooperation of system developers within government research institutes, consultants, planners, geo-information specialists and managers. Such cooperation in experimental settings can lead to learning useful lessons on the dedication of systems to users and planning tasks. These lessons may be used to develop truly dedicated systems, thereby increasing the overall compatibility of systems. This study recommends all actors of the innovation network to take part in the cooperation. This implies system developers, researchers, geo-information specialists, planners and managers. Involving all these types of actors facilitates sharing the lessons on successful application of PSS by all of them instead of only in some categories. Furthermore, involving all the actors enables easier experimenting, e.g. without being held back too strongly by non-participating actors. In their interactions they need to find common grounds on development directions of PSS. As indicated earlier, this requires the development of common language, practices, etc., and at least more than the provision of knowledge. A Dutch example of interactive learning in which government agencies and universities are involved is the LUMOS project. This project aims to develop a spatial modelling toolbox to support planning. It includes the Space Scanner PSS and the Environment Explorer PSS, which are both spatial models applied for the Netherlands. Another example of interactive learning in which Dutch universities, government agencies, local governments, consultants and professional organizations participate is the DURP initiative. This initiative aims to set up a platform for digitally exchangeable spatial plans for Dutch municipalities and provinces and ministries. After implementing a shared spatial data format they now focus on the development of the PSS to access the spatial plans.

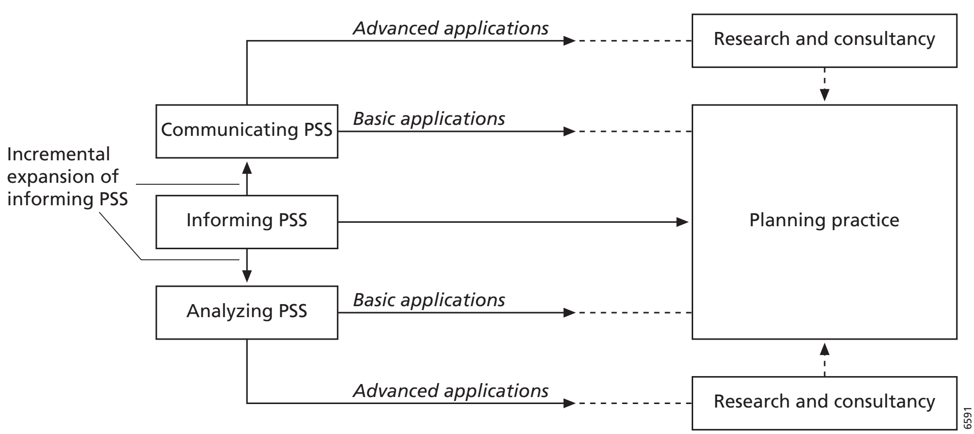

Figure 6.2 Incremental PSS development perspective, and distinction between basic applications directly delivered to planning practice, and advanced applications, delivered indirectly, through using intermediate researchers or consultants.

Ninthly, in order to enhance *quality, acceptance and diffusion*, this study recommends incremental development of PSS technology, by gradually expanding informing PSS with communicative and analytical functionality (see figure 6.2). For example, 'external informing PSS' can gradually be expanded with communication functionality to become 'external communicating PSS', and 'internal informing PSS' can be gradually expanded with analytical functionality. The human acceptance and organizational diffusion related lockout mechanisms are so strong that PSS which form more radical innovations are unlikely to become widely locked into planning practice. We therefore recommend distinguishing between basic applications that can become operational directly in planning practice, and advanced applications that are more suited to being delivered indirectly, as specialist services, by consultants or researchers (see figure 6.2). For example, PSS with basic analytical functions can be directly used by planners, while most advanced 'analytic modelling PSS' are likely to remain specialist tools that require the involvement of consultants or researchers. Planners can use the outcomes of models in planning instead of having planners do the actual modelling themselves.

6.3 PSS usage recommendations

This study recommends that PSS users take the following actions:

1. To primarily enhance acceptance and diffusion of PSS it is recommended that managers adopt the management paradigm of the learning organization;
2. To primarily enhance diffusion of PSS it is recommended that geo-information specialists perform the change agent role of gatekeepers;
3. To primarily enhance acceptance and diffusion of PSS it is recommended that geo-information specialists also perform the change agent role of champions or managers to appoint an innovation manager for this purpose;
4. To enhance awareness, experience, instrumental quality, acceptance and diffusion of PSS it is recommended that planners show more attention for PSS and communicate their demands to geo-information specialists.

These recommendations are described in more detail below.

First, to primarily enhance *acceptance* and *diffusion* of PSS, this study recommends that managers adopt the management paradigm of the learning organization (Senge, 1990) and adopt knowledge management (Nonaka and Takeuchi, 1995). This enables system developer activities to end up in acceptance and diffusion of PSS in practice. Managing information technology implementation is challenging for several reasons. For instance, the demands and opportunities differ over multiple workflow processes, and change over different development phases. Furthermore, individuals and organizations in different departments must quickly learn how to work together as a coherent team. Managing the development of PSS in practice is even more challenging, and adds an extra burden to an already complex management task. Little organizational learning by the flow of knowledge seems to manifest itself. Results indicate that adopting the managerial paradigm of the learning organization could change this. In this way, flow of knowledge and creativity towards innovations could be enhanced. The paradox of the need for control and the need for spontaneity and creativity in complex organizations suggests that, at least for a considerable subset of the employed workforce, structures and processes oriented around control can essentially shut down workers' innate creativity (Zhou and George, 2003). The following recommendations show some specific aspects of how planning organizations could become learning organizations aside from adopting the management paradigm.

Secondly, to primarily enhance *diffusion* of PSS, and become learning organizations, it is recommended that that geo-information specialists perform the role of gatekeepers for PSS. Geo-information specialists are usually the only ones within the organization capable of following and assessing developments in geo-ICT. As it is assumed that adoption of PSS is in the best interest of the organization as a whole, geo-information specialists have the important role of scanning the extra organizational environment, signalling PSS developments and evaluating them on their usefulness for the organization. If managers do not give them the opportunity to do so, the organization blinds itself to PSS developments that might offer assistance in handling the complexity of planning. Scanning the environment implies following relevant activities of government planning agencies, regularly visiting PSS related websites, attending practice oriented conferences, maintaining a network with colleagues in other planning organizations, etc. In any case geo-information specialists should realize their importance to the organization as often the only link that connects to these developments, and behave accordingly. In order to be well capable of translating planner demands into the opportunities that PSS offer, geo-information specialists should not only scan the external environment, but also the internal environment. This will stimulate their capability of making good matches between planner demands and PSS opportunities. This could be done by pro-actively maintaining good formal and informal contacts with other departments that use their products and possibly by getting involved in their projects. Managers have the task to convince geo-information specialists of their innovation responsibility and to awaken their creativity. Geo-information specialists operated in this way in the Dutch province of Overijssel, which was one of the success stories in organizational development of PSS. In this organization, geo-information technologies have diffused bottom-up from the start.

Thirdly, to primarily enhance *acceptance* and *diffusion* of PSS, and become learning organizations, it is recommended that managers appoint an innovation manager to take up the role of champion for PSS and other information technologies for policy support. This role implies that the innovation manager needs to bring the PSS further into the organization towards utilization of the opportunities PSS offer. To achieve this, the innovation manager needs to convince planners of the use of PSS for their daily practices and other managers to come to an adoption decision or at least leave space for experimentation. If managers do not appoint an innovation manager first, the geo-information specialists will have to perform the roles of both gatekeeper and champion for PSS. For this latter role geo-information specialists need leadership characteristics. In the role of champion, this study recommends that geo-information specialists show the benefits of PSS to their managers and to planners. A good way to achieve this is by making examples of PSS applications that run parallel to existing regular projects and that are also as realistic as possible in other ways. In this way, they present an alternative solution for an existing problem that makes the benefits clear at the time the receivers have their attention focused on this problem. Using problems unconnected to existing projects, hypothetical problems for the area governed, or even problems for other areas, is more likely to cause a lack of interest. Making things as realistic as possible generates realistic views of consequences and benefits of a potential decision to adopt. This implies giving insight in compatibility and complexity, thereby reducing the experienced risk associated with the adoption decision. The Dutch province of Noord-Brabant, which was among the most successful provinces in implementing PSS, had just assigned a senior employee with a charismatic personality, technical insight and management experience as the innovations manager at the time of the interviews. The province of Limburg, which was in an earlier stage of using PSS, had also appointed an innovation manager with the main task of organizing the spatial data that could serve as a basis for further analysis oriented developments.

Fourthly, although it is perhaps a somewhat utopian recommendation, to enhance *awareness, experience, instrumental quality, acceptance* and *diffusion* of PSS, it is recommended that planners open their minds to exploring opportunities of particularly, the more advanced internal communicating PSS and analytic designing PSS, both of which are commercially available at relatively low cost. It is also recommended that planners communicate their demands to geo-information specialists more actively. These geo-information specialists can then offer insight into the available opportunities that respond to these demands. Close cooperation between planners and geo-information specialists is essential for successful application of PSS.

6.4 PSS research recommendations

Since researchers and system developer groups overlap to some extent, the recommended actions for researchers may also apply to some system developers and vice versa. To researchers this study recommends conducting research oriented towards improving the instrumental quality of PSS, the user acceptance of PSS and the diffusion of the diversity of PSS. This study recommends in particular studying the following subjects:

1. To primarily enhance the instrumental quality of PSS it is recommended to study the 'best practices' of PSS supported planning;
2. To primarily enhance acceptance of PSS it is recommended to study the benefits of their application;
3. To primarily enhance instrumental quality of these PSS, it is recommended to study how to enhance fit to planning tasks and users of 'analytic modelling PSS' that now often have very poor quality;
4. To primarily enhance acceptance and diffusion of PSS, it is recommended to study how to implement the learning organization into organizational practice beyond just being a management style.

These recommendations are described in more detail below.

Firstly, to primarily enhance *instrumental quality* of PSS, this study recommends conducting further research into best practices of PSS supported planning. These studies should find out which requirements PSS should meet to fit well to the demands and competences of planners and the characteristics of planning tasks. Such a list of requirements can be made for each particular planning task, PSS or application environment. The list of requirements constitutes what can be seen as good or best practices of application of PSS supported planning. This study recommends in particular requirement studies with communicating and analysing PSS, since they are much less widely used than informing PSS and since there is little knowledge of how to successfully apply these PSS.

Secondly, to primarily enhance *instrumental quality* of PSS, this study recommends conducting research into the quality of 'analytic modelling PSS' in particular. Many researchers focus on development of land use and transportation models, mainly to understand land use and transportation changes, but usually with the underlying aim of applying these systems in urban and regional planning. However, in comparison with the enormous attention in land use change research, usage of these 'analytic modelling PSS' in practice lags far behind. To become more widely applicable in planning the instrumental quality of the models themselves needs improvement in the first place. Fit to users and planning practice are poor for many models. Even the most advanced models simulate remarkably low percentages of developments correctly. Fit to users is often totally discarded, since many models are used for research purposes rather than actually being applied in planning. The What-If PSS contains a positive exception to this latter point. This study recommends that model researchers compare the performance of different model concepts to find the best performance for particular situations and to try out new concepts rather than simply adding more variables to existing models and in doing so incrementally increasing instrumental quality.

Thirdly, to primarily enhance *acceptance* of PSS, this study recommends trying to measure the benefits of applying the diversity of PSS. Such demonstrable benefits are an essential prerequisite for widespread acceptance of PSS types. Currently it is not well known how to measure and express the benefits of most PSS. Real experiments to show benefits of PSS would give useful insights, but such studies have not been conducted yet for PSS specifically, although benefit studies have been performed for related (geo)-information technologies (Budic, 1994; Nedovic-Budic, 1998; Batenburg and Bongers, 2001).

Fourthly, to primarily enhance *acceptance* and *diffusion* of PSS, this study recommends studying how to implement the learning organization into organizational practice beyond just being a management style. In particular insight is needed into how managers can balance top-down and bottom-up activities in such a way that they reinforce each other. Combinations of management styles might be needed since adopting the learning organization management style affects the distribution of responsibilities and thereby the accountability of governments. In particular more insights need to be generated into the limitations and opportunities for combinations of the strategic management versus the learning organization approach. Also, to enable successful diffusion of PSS into practice, insights are needed about how to achieve cooperation between planners and geo-information specialists in planning organizations. On a broader level, this study recommends the study of the communication context aspects of information and knowledge in planning as a means of finding out how knowledge could best be brought into a particular type of planning process.

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Summary

Improving Planning Support
The use of Planning Support Systems for spatial planning

Planning is the activity of organizing land use functions in order to achieve collectively efficient solutions for land use configuration problems. Planning is one of the most complex activities of public organizations. The complexity has several causes. First, planning problems demand an integrated handling of a great number of themes. Second, planners need to balance multiple and possibly conflicting aims (Hall 1975). Third, planners have to deal with a large amount and diversity of information (Friedman 1987). Fourth, many political and power related aspects of planning processes contribute to their complexity (Forester 1989). Finally, the organization of communication with those that are involved contribute to complexity, in particular now that they are increasingly involved earlier in planning processes (Forester 1989).

A large diversity of methods, techniques and instruments has become available to support planners in doing their tasks and handling complexity. An inventory of European planning practice, made at the end of the 1990s shows that nonetheless that planners apply geo-information technology for little more than making maps or doing basic analyses. Only sparsely they are used for those tasks that form the heart of planning, such as spatial analysis, sketching, developing scenario's, modelling and evaluation of alternatives, etc. Reasons for the limited usage in practice are that existing geo-information technologies are too generic, complex, incompatible with planning tasks, oriented towards technology instead of planning problems and have an overly strong focus on strict rationality (Stillwell et al 1999)

Since approximately halfway the 1990s a new generation of geo-information technologies has become available, that is fully dedicated to the support of those involved in planning in doing their tasks: Planning Support Systems (PSS). They are related to GIS, but while GIS are general purpose tools, applicable for many different spatial related problems, PSS distinguish themselves by being specifically focused supporting spatial planning tasks. PSS consist of a combination of planning related theory, data, information, knowledge, methods and instruments, that take the form of an integrated environment with a shared interface (Geertman and Stillwell 2003). Many see PSS as good support tools that could enable planners to better handle the complexity of planning processes, leading to plans of better quality and saving time and money.

Recent studies by Geertman and Stillwell (2003) and Brail and Klosterman (2001) provide insight in the broad supply of PSS. The studies show that planners and researchers worldwide have developed a large number of systems that have been used only once or twice. A smaller number of systems has been developed further and are commercially or free available (Klosterman and Pettit 2005). Both Geertman and Stillwell and Brail and Klosterman conclude that usage of PSS in planning practice stays strongly behind in comparison with the broad supply (Brail and Klosterman 2001; Geertman and Stillwell 2003). This is problematic, regarding the

assumed potential of PSS to improve planners' capabilities of improving their ways of handling complexity of planning.

The primary aim of this research project is to shed more light on the reasons for the relative under-utilization of PSS in planning practice with respect to their wide availability and the assumed potential. It is the secondary aim to formulate guidelines for enhanced PSS application in spatial planning. We therefore question why PSS are used in planning as infrequently as they are and how usage can be enhanced. Instead of only accounting for the supply side, as has often been done in earlier studies, in this study insights of PSS users, PSS experts and PSS system developers are combined (Brail and Klosterman 2001; Geertman and Stillwell 2003; Geertman and Stillwell 2004; Klosterman and Pettit 2005). To achieve the aim, we approach the problem of under usage of PSS in three ways, each of which emphasizes specific aspects of usage of PSS: the instrument approach, that emphasizes *instrumental quality*; the user approach, that emphasizes user *acceptance*; and the transfer approach, that emphasizes *diffusion* of PSS into planning practice.

Results of an analysis of *instrumental quality* of the existing PSS show that PSS technology is still in an early stage of development, with thereby belonging a huge and diverse supply and a demand that still needs to catch momentum. The analysis also shows that there exists a dichotomy between the demands of planning practice and the supply of PSS: practice demands in particular simple systems, while many developers provide advanced systems. Results of an analysis of *acceptance* of PSS show that the main causes for the limited acceptance of PSS are: the lack of awareness of the existence and potential of PSS, the lack of experience with PSS, and the lack of intention to start using PSS among the intended users. Results of an analysis of *diffusion* of PSS show that diffusion is most likely to take place bottom-up. Geo-information specialists are the most suitable employees in practice to take the PSS from the extra organizational environment. However, bottom-up diffusion is often blocked by managers who perceive investments in ICT such as PSS as a risk, because of their experiences with many ICT projects that have run out of hand regarding investment of time and money without showing the promised benefits. These managerial attitudes and sometimes also lack of own initiative hinders geo-information specialists in taking the PSS from the extra organizational environment and in bringing the PSS further within the organization. Also, the geo-information specialists are often in a somewhat isolated position within the organization, which makes it difficult for them to reach planners and come to the cooperation that is needed to make PSS adoption into a success. Adoption of the knowledge management style would give more space for bottom-up diffusion activities, due to which PSS diffusion is expected to be stimulated.

The instrument, user and transfer approach were subsequently applied to explain differences in usage of PSS types. Results show that PSS with the primary aim of informing the actors involved in planning are applied widely, while PSS with the primary aim of supporting communication and analysis are much less widely used. The primary causes of less wide usage of communicating and analysing PSS are lack of *experience* with these PSS, lack of *awareness* of their existence and potential, and lack of *instrumental quality* of many of these PSS. Secundary causes are hampered *acceptance* and *diffusion*.

To enhance usage of PSS in planning practice, this study recommends to the actors involved in PSS development and application of PSS start improving their communication and cooperation in development and application of PSS. Interactive learning processes in which PSS developers, researchers and practitioners are involved can constitute the right combination of knowledge and experience to come to successful applications. These can furthermore lead to the availability of good examples that can convince others of the use of applying PSS to support their planning tasks. This can stimulate *awareness*, *experience*, *instrumental quality*, *acceptance* and *diffusion* of PSS.

Samenvatting in het Nederlands

Planning beter ondersteund
Toepassing van Planning Support Systems in de ruimtelijke planning

De ruimtelijke planning houdt zich bezig met het organiseren van land gebruiksfuncties met als doel om tot collectief efficiënte oplossingen te komen voor ruimtelijke vraagstukken. Ruimtelijke planning behoort tot de meest complexe activiteiten van publieke organisaties. Deze complexiteit heeft meerdere oorzaken. Ten eerste vergen planningsproblemen de geïntegreerde behandeling van een veelheid aan thema's. Ten tweede moeten afwegingen worden gemaakt van meerdere, mogelijk conflicterende doelen (Hall 1975). Ten derde moet worden omgegaan met een grote hoeveelheid en diversiteit aan informatie (Friedman 1987). Ten vierde dragen tal van politieke en machtsgerelateerde aspecten in planprocessen bij aan de complexiteit (Forester 1989). Tenslotte draagt de organisatie van de communicatie met betrokkenen bij aan de complexiteit, zeker nu deze in toenemende mate en eerder in het planproces worden betrokken (Forester 1989).

In de loop der jaren is een grote diversiteit aan methoden, technieken en instrumenten beschikbaar gekomen om planners te ondersteunen bij het uitvoeren van hun taken en het hanteren van de complexiteit. Een inventarisatie van de Europese planningspraktijk uitgevoerd aan het eind van de jaren '90, geeft echter aan dat geo-informatie technologie door planners momenteel voor weinig meer wordt ingezet dan voor het maken van kaartjes of eventueel het doen van eenvoudige analyses. Slechts in een enkel geval worden ze ook ingezet voor het ondersteunen van die taken die zo karakteristiek zijn voor planning als ruimtelijke analyse, schetsen, opstellen van scenario's, doorrekenen en evalueren van alternatieven etc. Redenen voor de geringe inzet zijn onder meer de algemeenheid, complexiteit, incompatibiliteit met planningstaken, orientatie op technologie in plaats van planningsproblemen en sterke focus op strikte rationaliteit (Stillwell et al. 1999).

Sinds circa halverwege de jaren '90 is een nieuwe generatie van geo-informatie technologie beschikbaar gekomen, die geheel is toegesneden op het ondersteunen van degenen die betrokken zijn bij ruimtelijke planning in het uitvoeren van hun ruimtelijke planningstaken: Planning Support Systems (PSS). Waar een geo-informatie technologie als GIS meer algemeen is van opzet en daardoor kan worden ingezet voor tal van ruimtelijk gerelateerde onderzoeksproblemen, onderscheiden PSS zich door hun specifieke focus op de ondersteuning van ruimtelijke planningstaken. PSS bestaan uit een combinatie van planningsgerelateerde theorie, data, informatie, kennis, methoden en instrumenten, vormgegeven in een geintegreerde omgeving met gedeelde interface. (Geertman and Stillwell 2003). PSS worden door velen gezien als een goed hulpmiddel dat planners in staat moet stellen de complexiteit in planprocessen beter te kunnen hanteren, met kwalitatief betere plannen en besparing van tijd en geld als gevolg.

Recente studies van Geertman en Stillwell (2003) en Brail en Klosterman (2001) geven inzicht in het brede aanbod aan PSS. De overzichten geven aan dat planners en onderzoekers wereldwijd een groot aantal systemen hebben ontwikkeld die slechts eenmalig zijn toegepast.

Een kleiner aantal systemen is echter verder ontwikkeld en gratis of commercieel beschikbaar (Klosterman and Pettit 2005). Zowel Brail en Klosterman als Geertman en Stillwell concluderen dat het gebruik van PSS in de planningspraktijk sterk achterblijft bij het brede beschikbare aanbod (Brail and Klosterman 2001; Geertman and Stillwell 2003). Dit is problematisch gezien het vermeend potentieel van PSS om planners beter in staat te stellen de complexiteit van planprocessen te hanteren.

Dit promotieonderzoek heeft tot primair doel om inzicht te verschaffen in de redenen voor de relatieve onderbenutting van PSS in de ruimtelijke planningspraktijk, gegeven de brede beschikbaarheid en het vermeend potentieel. Het secundaire doel is formuleren van richtlijnen voor de bredere toepassing van PSS in de ruimtelijke planningspraktijk. De centrale vraagstelling van dit onderzoek luidt: waarom worden PSS zo relatief weinig toegepast in de ruimtelijke planingspraktijk, en hoe kan het gebruik worden gestimuleerd? In plaats van hierbij alleen de aanbodzijde in beschouwing te nemen, zoals in eerdere studies uitvoerig is gebeurd, worden in deze studie inzichten van PSS gebruikers, PSS experts en PSS systeem ontwikkelaars gecombineerd (Brail and Klosterman 2001; Geertman and Stillwell 2003; Geertman and Stillwell 2004; Klosterman and Pettit 2005). Om de doelstelling te bereiken wordt de problematiek van toepassing van PSS op drie wijzen benaderd die elk specifieke aspecten van gebruik van PSS benadrukken: de instrumentele benadering, die nadruk legt op *instrumentele kwaliteit*; de gebruikersbenadering, die nadruk legt op *acceptatie* door gebruikers; en de transferbenadering, die nadruk legt op de *diffusie* van PSS in de planningspraktijk.

Resultaten van een analyse van de *instrumentele kwaliteit* van de bestaande PSS laten zien dat PSS technologie nog in een vroeg stadium van ontwikkeling verkeert, met daarbij behorend een groot en divers aanbod en een vraag die nog niet echt op gang is gekomen. Uit de analyse blijkt tevens dat er een tweedeling bestaat tussen de wensen uit de planningspraktijk en het aanbod van PSS: De praktijk wil vooral eenvoudige systemen, veel ontwikkelaars zetten in op geavanceerde systemen. Resultaten van een analyse van de *acceptatie* van PSS laten zien dat de belangrijkste oorzaken voor het geringe gebruik van PSS zijn: het gebrek aan bewustzijn van het bestaan en potentieel van PSS, het gebrek aan ervaring met PSS, en het gebrek aan intentie om PSS te gaan gebruiken onder beoogd gebruikers. Resultaten van een analyse van de *diffusie* van PSS laten zien dat diffusie het meest waarschijnlijk bottom-up plaatsheeft. Geo-informatie specialisten zijn het meest geschikt om de PSS van buiten de organisatie op te pikken. Deze bottom-up diffusie wordt echter veelal geblokkeerd door managers die investeringen in ICT zoals PSS als risico zien, door ervaring met tal van ICT projecten die uit de hand zijn gelopen voor wat betreft investeringen van tijd en geld zonder de beloofde voordelen op te leveren. De geo-informatie specialisten worden door de managers, en soms door gebrek aan eigen initiatieven, geblokkeerd in hun pogingen om PSS op te pikken en verder te brengen binnen de organisatie. Ook bevinden zij zich veelal in een zekere geisoleerde positie binnen de organisatie waardoor het moeilijk is om planners te bereiken en tot de samenwerking te komen die nodig is om PSS adoptie tot een success te kunnen maken. Adoptie van de kennis-managementstijl zou meer ruimte geven voor bottom-up bewegingen, waardoor diffusie van PSS effectiever plaatsvindt.

De instrumentele, gebruikers en transfer benadering zijn vervolgens toegepast om verschillen in toepassing van typen PSS te verklaren. Het blijkt dat PSS met als primair doel het informeren van de betrokkenen bij planning wel veelvuldig worden toegepast, maar dat PSS met als primair doel het ondersteunen van communicatie en analyse veel minder frequent worden toegepast. De primaire oorzaken voor geringer gebruik van communicatie en analyse systemen zijn gebrek aan *ervaring* met deze PSS, gebrek aan *bewustzijn* van het bestaan en de mogelijkheden van deze PSS en geringe *instrumentele kwaliteit* van veel van deze PSS. Secundaire oorzaken zijn verhinderde *acceptatie* en *diffusie*.

Om de toepassing van PSS in de planningspraktijk te stimuleren bevelen we aan dat de actoren die zijn betrokken beter gaan communiceren en gaan samenwerken in de ontwikkeling en toepassing van PSS. Interactieve leerprocessen waarin ontwikkelaars, onderzoekers en gebruikers zijn betrokken kunnen zorgen voor de juiste combinatie van kennis en ervaring om te komen tot successvolle toepassingen. Deze kunnen tevens leiden tot de beschikbaarheid van goede voorbeelden die anderen kunnen overtuigen van het nut van toepassing van PSS ter ondersteuning van hun planningstaken. Hierdoor kan *bewustzijn* worden gegenereerd, *ervaring* worden gecreeerd, kan de *instrumentele kwaliteit* van PSS worden verhoogd, en de *acceptatie* en *diffusie* van PSS worden gestimuleerd.

Appendix I: Web surveys

The web-surveys can be found at the following Internet addresses:

Web survey part I:
http://networks.geo.uu.nl/projects/participatoryplanning/inquiry.html

Web survey part II:
http://networks.geo.uu.nl/projects/participatoryplanning/inquiry2.html

Appendix II: Quickscan/interviews Participants

Date	Province	City	Quickscan/interview participants
june 26th 2003	Noord-Holland	Haarlem	Maarten Sobels Herkelijn Groskamp Marcel Uitert Jolanda Klein (feedback interview)
july 2nd 2003	Friesland	Leeuwarden	Hinko Talsma Saartje de Bruijn Dolf Janssen Cor de Wit
july 4th 2003	Overijssel	Zwolle	Peter Auke Nicolaij Esther Bernards Marc Ooms,
july 9th 2003	Utrecht	Utrecht	Jeroen van Vught Bart van den Berg Carolien Idema Olev Koop
july 10th 2003	Zuid-Holland	Den Haag	Andre Batenburg Gerard Loge Gerard Eppink,
july 14th 2003	Gelderland	Arnhem:	Ine de Visser Erwin Klerkx Annemarie Heinhuis
july 15th 2003	Noord-Brabant	Den Bosch:	Erik van Dietvorst Klazien Witteveen Herman Voet
july 16th 2003	Zeeland	Middelburg	Lies Dekker Lein Kaland
july 24th 2003	Limburg	Maastricht	Rien Huisman Ton Peeters Mariska van Tilburg
august 5th 2003	Flevoland	Lelystad	Alex Lucassen Paul Smeenk Christoffel Klepper Will van Woerkom
august 6th 2003	Groningen	Groningen	Ron Wardenier Caroline Bouwense
august 7th 2003	Drenthe	Assen	Gerk van der Ploeg Marcel van der Burg Richard de Bruin Rika Emmens

Appendix III: Interview procedures

Short introductory presentation (10 minutes)

- Frame setting: PhD research;
- PSS concept explained*;
- Research questions to be answered;
- Motivation for research in general;
- Present status of research;
- Motivation for interviews;
- Report on final results;
- Outline of interview: opportunities and limitations.

* Explanation in words by building forth on advanced GIS functions and by presenting visual examples of different functions of PSS on slides and in words

Interview (75 minutes)

Opportunities

1. Current use of geo-information technology consists for 80% of data storage and visualization.
   a. Does this correspond with your own impressions?
   b. Do you consider this problematic?
   c. In which situations could it become problematic?

2. What more would you like to do with geo-information technology in spatial planning within your organization (dream)?

3. What do you presently do with geo-information technology in spatial planning within your organization (reality)?

For questions 2 and 3 a set of sub questions is answered using a checklist of planning tasks (designing, political process, public participation, etc):

a. Do you apply geo-information technologies with the listed tasks?
b. In what way are geo-information technologies used for these tasks?
c. In which cases are geo-information technologies used in an advanced way?
d. To what extent is this current use considered to improve planning processes?
e. How else would you like to use geo-information technologies to support the listed planning tasks?
f. Why would this improve the existing ways of performing the tasks?
g. Which demands would you set to PSS for these planning tasks?

Limitations

1. To what extent are results from the worldwide web-survey on bottlenecks blocking widespread use of planning support systems valid for your organization?
a. Lack of awareness of existence and potential;
b. Lack of experience;
c. Hesitance with management and employees;
d. Mismatch with planning tasks;
e. Hard to get;
f. Difficult to handle.

2. To what extent are the main results from the quick scan on 'bottlenecks blocking use of advanced geo-information technologies for planning support' valid for your organization?

   Organization related limitations:
   a. Which form enhances the availability of opportunities for innovation in geo-information technology, centralized or decentralized organization?
   b. Does the technology-push or demand-pull model better suit the development of geo-information technologies in organizations?
   c. Are geo-information technology related questions from policy departments handled by taking an active supply oriented approach, or passively by waiting for demand?
   d. Is it wise to concentrate geo-information technology in one department or is it better decentralized and why?
   e. What should a policy department do to enable successful application of advanced geo-information technology?

   Management related limitations
   a. How do policy department managers influence geo-information technology adoption?
   b. Would there be a difference between process and content oriented managers?
   c. What should change to give managers a positive attitude towards the development of advanced geo-information technologies?

   Knowledge related limitations
   a. Is the lack of social networks for exchange of knowledge and experience limiting the use of advanced geo-information technologies?
   b. How could the resulting lack of knowledge be taken away?

3. Are there any other specific bottlenecks valid within your organization?

4. Could you explain how these bottlenecks (would) show in your organization and which are the causes underlying these bottlenecks?

5. How could you take away these bottlenecks to make use of planning support systems a success?

6. Imagine you are responsible for geo-information technology within your organization:
a. Which PSS would you start using for which tasks?

b. Which would be the system requirements?
c. How would you convince the organization to purchase the PSS?
d. How would you make sure that the PSS is indeed implemented?
e. How would you ensure that the system is used more often than only in a single occasion?
f. How would you ensure that PSS become widely seen as useful instruments for planning?
g. Would you do this at all?

Curriculum Vitae

Guido Vonk was born in Gouda, the Netherlands, on November 24th 1975. He completed his secondary education at the St. Antoniuscollege in Gouda in 1994. In April 2000 he graduated as a Master in Science and Policy (with distinction) at the Faculty of Chemistry at Utrecht University. One year later, in May 2001, he graduated again as an Master in Environmental Sciences, at the faculty of Geosciences at Utrecht University. During these studies many extra-curricular courses were followed in public law and environmental policy. Inspired by the law courses, in august 2002, he started a law study at the Bachelor level, which he hopes to complete soon. Also in august 2002, he started a PhD research project at the 'Networks in the Delta' interdisciplinary research group at the Faculty of Geosciences at Utrecht University. With several interruptions to teach and prepare courses, he worked on his PhD thesis during the three years thereafter. In between the completion of the PhD thesis and the defence he prepared a proposal to acquire funding for a postdoctoral position and worked as a consultant on geo-statistical analysis of public health data.

Two main lines can be discerned in his research. The first research line focuses on integrated water resources management. There is a particular focus on decision and planning support systems for water and environmental management. Within this line, the following research projects have been conducted: gathering and analysis of water visions of major stakeholders in the Rhine river basin, used to prepare the book 'Visions for the Rhine' (2000, Internship at RIZA); Development of river basin models for the Scheldt estuary (1999, MSc thesis Science and Policy), the Orinoco River Basin (2001, WWF Living Waters Campaign) and the Turkish Mustafa Kemalpasha river basin (2001, MSc thesis Environmental Sciences). These river basin models were used as planning support tools to support water quality management, impact assessment and design of dams and reservoirs. The second research line focuses on planning support systems for strategic spatial planning. This line, of which most is reflected in this thesis, provides insight into the current and potential match between supply and demand of Planning Support Systems for spatial planning. Whereas both research lines combine the technical aspects of decision support systems with the political reality of application environments, the main emphasis in his work has gradually shifted from study of technical aspects to study of implementation and application.

He has obtained international research experience before and during his PhD trajectory. During his internship in 2000, water visions for the Rhine river basin have been acquired from German, Swiss, French and Dutch organizations. During the summer of 2001 he resided in the Turkish Bursa region, to collect field information for his second Master's thesis. Having completed his PhD manuscript within three instead of the regular four and a half years, international activities as a PhD student have remained limited. Nonetheless, he has attented several international conferences (and presented papers), such as the 6th AGILE conference on Geographic Information Science (Lyon, 2002) and Computers in Urban Planning and Urban Management (London, 2005).

His teaching experience consists of (co-) development of master level courses in 'Integrated Water Resources Management' and 'Sustainability Assessment', as well as bachelor courses in 'Sustainable Development' and 'Environment, Population and Resources' for students in Environmental Sciences, Sustainable Development, Environmental Policy, Human Geography and Innovation Studies. Besides in course development, teaching experience has been obtained in teaching some of these courses and other Environmental Science courses.

Besides these 'curricular' activities, he has been a member of the management board of the Copernicus Institute for 1½ year representing the PhD students (2003-2004); co-organized a symposium on 'the gap between science and policy' (2003); acted as a reviewer for the conference 'Framing Land Use Dynamics' (2002); has been member of an experimental interdisciplinary research group (2002-2005); and co-organized a session at the 2nd Unesco World Water Forum (2000).

His current research interest is using complexity theory to contribute to the improvement of the theoretical and methodological fundament of co-operative integrative geoscience projects, for which he aims to start working as a post-doctorate researcher.