Computers, Environment and Urban Systems 56 (2016) 25–35

Contents lists available at ScienceDirect

Computers, Environment and Urban Systems

journal homepage: www.elsevier.com/locate/ceus

A comparison of the perceived added value of PSS applications in group settings

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ARTICLE INFO

Article history:
Received 4 November 2014
Received in revised form 3 September 2015
Accepted 29 October 2015
Available online 18 November 2015

Keywords:
Planning support systems
Perceived added value
Questionnaires
Comparative case study
Group decision-making

ABSTRACT

Research on planning support systems (PSS) is increasingly paying attention to the added value that PSS applications have for planning practice. Whereas early studies tended to have a rather conceptual focus, recent studies have paid more attention to empirics. Although this is a step forward, there is still a notable gap in the literature: a dearth of empirical evaluations of PSS applications from a comparative perspective. This paper addresses this gap, based on an earlier published conceptual framework that identifies the potential added values of PSS applications. The paper also tentatively explores the effect of three explanatory factors: support capabilities of the PSS, usability, and the context. In doing so, it reports on research of four PSS applications in The Netherlands. The research method consisted of questionnaires completed directly after the session, open interviews and conversations with stakeholders, and observations. With regard to added value as perceived by the participants, the findings indicate that learning, both about the object and about others, was a key perceived added value in all four cases, despite differences in context, support capabilities and usability scores. Moreover, although usability perceptions of the PSS applications varied, overall they were relatively positive. Context appears to have a substantial effect on the perceived added value of the PSS application, making it hard to distil the exact effect of the support capabilities and usability perceptions. The effect of context is one of the topics that could be picked up in further studies into the added value of PSS. One way to accomplish this in future research is by comparing a larger number of different PSS applications in different contexts, resulting in a higher n in order to enable correlational analyses and cross-national comparisons to better grasp the influence of the institutional context.

1. Introduction

Planning support systems (PSS) are 'geo-information technology-based instruments that incorporate a suite of components that collectively support some specific parts of a *unique professional planning task*' (Geertman, 2008, p. 217 — emphasis in original). Early studies mainly focused on instrumental characteristics (Brail & Klosterman, 2001; Geertman & Stillwell, 2004, 2009), sometimes complemented by theoretical accounts (e.g. Klosterman, 1997). The last two decades, however, have seen the development of the first contours of a 'PSScience' (Geertman, 2013),[1] in which the interrelationships of the concepts in the term PSS – planning, support and systems – are studied in more depth. Two important developments can be discerned within this emerging body of research.

Firstly, there is now a fairly rich set of articles embedding PSS within the wider debates on planning theory, such as the advent of communicative planning (Batty, 2008; Couclelis, 2005; Geertman, 2006; Guhathakurta, 2002; Pelzer, Geertman, & van der Heijden, 2015. Secondly, more empirical research is being conducted into PSS applications (Arciniegas, Janssen, & Rietveld, 2013; Goodspeed, 2013; Nyerges, Jankowski, Tuthill, & Ramsey, 2006; Pelzer, Geertman, van der Heijden, & Rouwette, 2014; Pettit, Raymond, Bryan, & Lewis, 2011; te Brömmelstroet, 2014). These studies apply such research methods as observation, questionnaires and interviews to gain a better insight into how users perceive and use PSS, which might lead to ways to improve the PSS and/or its application.

The central dependent variable in most of these studies is the added value a PSS application has for planning practice. Earlier empirical studies used varying conceptions of added value, including learning (Goodspeed, 2013), effectiveness (Arciniegas et al., 2013) or frameworks that include multiple dimensions (Pelzer et al., 2014; te Brömmelstroet, 2014). The studies in the emerging field of PSScience have three gaps. Firstly, several of the empirical studies that are taking place are based on experiments with students (e.g. Arciniegas et al., 2013; te Brömmelstroet, 2014). While this allows for in-depth study in a controlled setting, it leads to issues of external validity: the question is whether a planning workshop with students reflects real-world

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

http://dx.doi.org/10.1016/j.compenvurbsys.2015.10.008
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planning practice to a sufficient degree. Secondly, and partly related to external validity, almost all of these studies are single case studies, which makes it hard to generalize their findings to other instances in which a PSS was applied. Thirdly, in the case of the comparisons of different PSS applications, the analysis tends to be at a conceptual level (Geertman & Stillwell, 2004) or be based on an interpretation of earlier studies (te Brömmelstroet, 2013), rather than on primary empirical data.

This paper fills these three gaps by answering the research question: what is the perceived added value of different kinds of PSS application according to practitioners? In answering this question, we use the following definition of added value: 'a positive improvement of planning practice, in comparison to a situation in which no PSS is applied' (Pelzer et al., 2014, p. 16). From that perspective, this paper focuses on the added value as perceived by practitioners. Here, it is important to underline that this paper focuses particularly on group settings in which a PSS is applied, which is in line with the importance of collaboration and communication in contemporary planning. As Klosterman (1997, p. 51) pointed out: 'planning support systems should facilitate collective design — social interaction, interpersonal communication and community debate that attempts to achieve collective goals and deals with common concerns.' The focus on PSS in group decision settings applies to both the conceptual framing and the empirical results presented in this paper.

The paper is structured as follows. Section 2 presents a conceptual framework and a categorization of added value dimensions, and identifies potential explanatory factors. Section 3 describes the case selection and the research methods. Section 4 presents the main findings from the four cases, after which Section 5 reflects on the most important findings. In Section 6, it answers to the research question and implications for future research are presented.

2. Conceptual framework

When addressing the perceived added value of a PSS application, two questions should be answered. The first is: what does 'added value' actually mean? It can, for instance, be conceived at the process or outcome level (te Brömmelstroet, 2013). This paper addresses this issue in Section 2.1. The second question is: how can this added value be explained? Section 2.2 addresses this issue by elaborating on three categories of explanatory factors: the support capabilities of the PSS, its usability and the planning context in which it is applied (cf. Geertman, 2006).

2.1. Added value

The added value of a PSS application is often claimed in PSS case studies. Only a few researchers, however, have empirically studied the added value concept in practice (te Brömmelstroet, 2013). An example is a recent paper by Pelzer et al. (2014), who made use of a 'group decision room' (a room with collaboration support tools and process guidance) and qualitative interviews to study the perceived added value of the application of a PSS called MapTable. Their study revealed that particularly improved communication and collaboration are perceived by practitioners as important added values of this PSS application. However, the researchers also pointed to an important caveat related to MapTable: only a few respondents reported on the role of some kind of impact analysis model, which allows one to quantitatively assess the effects of a proposed intervention. Several scholars regard impact analysis as a distinctive feature of a PSS (cf. Brail, 2006). Goodspeed's (2013) study of PSS applications in Austin, Texas, did include impact analysis, and he found learning to be an important perceived added value in these instances. A study by te Brömmelstroet (2010) on transport models (an impact model for exploring the consequences of infrastructure and traffic measures) also reported learning effects of the PSS application, notably an increased insight into the planning issue or into the perspective of other stakeholders. Hence, it can be concluded on the basis of these studies that learning seems to be an important perceived added value of PSS applications.

In this paper, learning is not seen a priori as one of the most important perceived added values of PSS, but is considered to be one of a set of perceived added values. These multiple values of PSS applications can be summarized in a framework that was developed by Pelzer et al. (2014) and is depicted in Table 1. Here, we only briefly explain the main premise of this framework; more details and examples can be found in the original article by Pelzer et al. (2014). The individual level concerns learning effects for the participants involved, which indicates increasing insight into (1) the object of planning that is being discussed and (2) the perspective of other stakeholders involved in the planning process. The added value at the group level involves four dimensions: (1) collaboration between the stakeholders involved, (2) communication, involving the exchange of information and knowledge among the stakeholders involved, (3) consensus, which refers to agreement among the stakeholders about a specific issue, and (4) efficiency, which indicates that the tasks being conducted in a collaborative setting are performed in less time than usual. Finally, the outcome level concerns the extent to which the PSS actually influences the plan or decision resulting from the planning process. This is labelled as a better informed outcome.

2.2. Explaining added value

Te Brömmelstroet (2015) rightly argued that properly identifying the effect of independent variables on the added value of PSS can only be done in a control-rich setting, such as an experiment. However, PSS applications in planning practice never take place in a controlled setting, nor are they ever repeated. It is therefore plausible to assume that the perceived added value is inherently dependent on the context. Geertman (2006) categorized the influence of the context on PSS applications by identifying several context-related factors, such as the characteristics of the users, the process characteristics (e.g. extent of participation) and the unique content of the planning issue at hand.

In addition to the context, the perceived added value is arguably dependent on the support capabilities of the PSS, which can be defined as 'the features of a PSS that facilitate a specific dimension of planning'. Following Vonk (2006), three types of support capabilities can be discerned:

- *Informing*: the primary capability to send information unidirectionally from the PSS to the user.
- *Communication*: the primary capability of the PSS to improve the knowledge exchange among multiple users.
- *Analysing*: the primary capability of the PSS to answer users' questions, particularly through quantitative modelling and analysing.

Table 1
Summary of added values of PSS applications.

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

Source: Pelzer et al., 2014.

Recent literature has argued that the presence of these support capabilities alone does not suffice. Above all, support capabilities should be usable (te Brömmelstroet, 2010; Vonk, 2006). 'Usability' refers to the extent to which practitioners can satisfactorily make use of the support capabilities of a PSS. A lack of usability is traditionally seen as a barrier to successful PSS applications (see Vonk, 2006). In contrast, a recent European COST project on accessibility-based PSS instruments found that the practitioners (mostly transport planners) in the PSS workshops generally had positive perceptions about the usability of the instrument (Te Brömmelstroet, Silva, & Bertolini, 2014), which appeared to be related to technological improvements, resulting in a higher level of user-friendliness and a shorter calculation time (see also Dias, Kuipers, Rafiee, Koomen, & Scholten, 2013; Miller, Vogt, Nijnik, Brondizio, & Fiorini, 2009). Appendix 1 presents an overview of usability indicators based on recent literature (Arciniegas, 2012; Goodspeed, 2013; te Brömmelstroet, 2010, 2014; Vonk, 2006). In relation to this overview, it is important to note that the perceived usability is related not only to the PSS, but to the application as a whole. For instance, a PSS can be perceived as transparent because of the instrumental characteristics or the interventions by a chauffeur. While the distinction between the two can be made analytically, it is very difficult to do so empirically. Therefore, in this paper we talk about the usability of a PSS application.

In sum, earlier research suggests that the context, support capabilities and level of usability explain the perceived added value of a PSS application. What exactly this effect is and how the causality works is largely unclear and should be explored empirically.

3. Methodology

We conducted a qualitative comparative case study analysis based on building and comparing rich pictures of each case. The cases were selected on the basis of a comparative logic and studied with various methods. This will be explained in the next sections.

3.1. Case selection

The case selection was based on the support capabilities of the PSS, because this is the only variable that could be considered before the case selection process (the role of usability and context could be assessed only after the study had been conducted). In addition, the PSS applications had to reflect real world planning practice as closely as possible. The assumption was that different support capabilities (or different PSS) would lead to different kinds of perceived added value. Here, the strategy was to generate a 'diverse' sample (Gerring, 2007), meaning that a variety of support capabilities had to be present in the sample. To be more precise, the criterion was that each of the three support capabilities mentioned in the previous section (informing, communication, analysing) had to be present in at least one of the case studies. Obviously, feasibility was also a critical selection criterion, since PSS applications in planning practice are still relatively scarce and getting access to study them in practice is not always easy. In total, four cases in The Netherlands were selected, involving the following PSS: SprintStad, MapTable, CommunityViz with MapTable, and Urban Strategy. Each PSS was applied in a workshop setting, involving between 9 and 20 participants. A more detailed description of the case studies is given in Section 4; Table 2 summarizes the most important characteristics of the four cases. As can be seen from the table, all three support capabilities were included in the sample. In two instances (SprintStad and CommunityViz with MapTable), two support capabilities were combined.

3.2. Research methods

PSS workshops are complex sociotechnical settings, which do not always take place as anticipated beforehand. Therefore, in order to get the richest possible picture, we applied the principle of 'methodological triangulation' (Denzin, 2006). The idea behind this approach is that the research object is studied from different methodological viewpoints. In this regard the three main methods involved questionnaires, observation during the sessions and interviews with participants. Whereas the questionnaires provided a mainly descriptive picture, the interviews and observations helped to explain findings and gain insight into the role of context. Below we will describe how each of these methods was applied.

- *Questionnaires* are an increasingly common tool to evaluate PSS applications (e.g. Goodspeed, 2013; Salter, Campbell, Journeay, & Sheppard, 2009; Te Brömmelstroet, 2015). A questionnaire was completed in all four cases by the participants directly after each workshop and consisted of four parts: background questions about the users, statements about usability, a question about added value and three open questions about the workshop (see Appendix 2). Participants were asked to identify the most important added value of the PSS application[2] by choosing from seven options (based on Table 1) or selecting 'other' and writing something down themselves. Usability was operationalized in terms of statements referring to 10 indicators (see Appendices 1 and 2). The respondents were asked to respond on a 1 (fully disagree) to 7 (fully agree) scale to statements about the usability of the PSS in the workshop. It was anticipated that the n would be too low for any more advanced statistical analysis[3] (cf. Salter et al., 2009). The background questions were used to gain insight into the educational level of the participants; almost without exception they were highly educated (i.e. they held at least the equivalent of a Bachelor's degree). The questionnaire ended with three open questions about the things that didn't go well during the workshop session (see Appendix 2).
- *Observations* were applied in different ways in the four cases. It was non-participant observation, in which the observants did not participate in the session (Bryman, 2004, p.167). The observants, which were university researchers with ample experience with PSS research, had no formal observation schedule making it 'unstructured observation' (Bryman, 2004).They focused their attention on the actions and interactions during the session, both with the PSS and among participants (Hennink, Hutter, & Bailey, 2010). Field notes were made of all the relevant actions and interactions during the session. In the Urban Strategy case, the whole session was filmed, so important moments could be checked again. The CommmunityViz with MapTable session was on the same date as the Urban Strategy session, so no observations could be made, which was compensated by extensively interviewing the session organizer. In the other two sessions there was 1 researcher (SprintStad) and 1 researcher and a research assistant (MapTable), who observed the whole session and made field notes.

[2] In the initial questionnaire *added value* was operationalized in two ways. First, as a set of Likert scales (1–7) with three items per scale. However, the internal reliability was too low to include them in the analysis (possibly because of the low n). Internal reliability is usually measured by Cronbach's Alpha, which is the correlation between different Likert items (in this case: 3) that comprise a Likert score on a 0 to 1 scale. If Cronbach's alpha is below 0.8 the internal reliability is typically considered too low (Bryman, 2004), as was the case for 5 out of the 7 Likert scales used for perceived added value in the questionnaire. Second, the participants were asked to indicate which added value of the PSS they considered to be the most important. This is a somewhat crude measurement because, on an individual level, it leads to a dichotomous conception of perceived added value. The advantage, however, is that it allows us to see distinctive patterns in the data, even in a case with a low *n*. In some instances, the respondents misunderstood the question and gave multiple answers. In these cases the answers were weighed. For instance, if they gave three answers instead of one, each answer counted for 0.33.

[3] Ideally, a regression analysis would have been conducted, in which 'perceived added value' is the dependent variable and usability scores, support capabilities and contextual variables serve as explanatory variables (cf. Goodspeed, 2013). However, due to the setup of this research only an analysis of the correlation between usability scores and perceived added value is possible. Moreover, because of the relatively low n, none of these correlations appeared to be significant at a 0.05 level.

Table 2
Characteristics of the four PSS applications that were studied.

Name of PSS application	Primary support capabilities	Number of people (n) involved	Nature of PSS	Planning issue	Organizations involved
SprintStad	Analysing and communicating	20	Interactive game focusing on transit-oriented development	Transit-oriented development	Province of North Holland, Deltametropolis Organization
MapTable	Informing	11	Provides insight into issues through simple visualizations of a web viewer	A deprived neighbourhood	Municipality of Zwolle, civil organizations
CommunityViz with MapTable	Analysing and communicating	14	Facilitates negotiation based on transferable development rights	Spatial development rights	Municipalities, regional governments, province, Radboud University Nijmegen
Urban Strategy	Analysing	9	Provides interactive and integral environmental assessment	Redevelopment of brownfield area	Municipality of Utrecht, TNO, Utrecht University

- *Interviews* were conducted in a semi-standardized way (Berg, 2007). The interviewees (participants and organizers of the sessions) were asked in an open way what they thought of the session and the PSS. In addition, the findings of the questionnaires were discussed with at least one key stakeholder. There were some differences in how the interviews took place among the four cases. In the case of Urban Strategy a group interview with the participants was held directly after the session and a follow-up interview was conducted with a transport planner who helped organizing the session. In the other three cases the main organizer (in the SprintStad case there were more) of the session was asked to reflect on the workshop. This included questions during and after the workshop, but also a follow-up in which a small report with the key findings from the survey was sent to the organizer and he/she reflected on these findings and responded face to face or via e-mail.

4. Findings from the case studies

This section describes the context of each PSS application and outlines the main findings with regard to perceived added value.

4.1. SprintStad to encourage transit-oriented development

In The Netherlands, transit-oriented development (TOD; spatial development around transport corridor nodes with a high public transit connectivity) has become an important topic on the policy agenda (e.g. Bertolini, Curtis, & Renne, 2012). SprintStad is a serious game that is intended to facilitate the process of achieving this TOD development (e.g. Duffhues, Mayer, Nefs, & van der Vliet, 2014, see also http://www.deltametropool.nl/nl/game_sprintstad). The SprintStad sessions focused on the spatial development along transit corridors and involved civil servants from the province of North Holland (see Fig. 1). In the workshop, three types of relevant stakeholders were identified: municipalities (responsible for spatial development around the corridor nodes), the province (responsible for supra-local developments) and Dutch Railways (responsible for the train schedule).

Three successive rounds of serious gaming were played, and in each round each stakeholder had to propose a set of policy interventions. SprintStad then analysed what would actually happen; for example, where the spatial development would be allocated (for details, see Duffhues et al., 2014). In this case, a session was held at one of the offices of the province of North Holland in order to get a better understanding of corridor development. Twenty of the province's policymakers fulfilled the roles of various stakeholders as a preparation for the actual negotiation process with the involved parties.

Since SprintStad facilitated both the communication between the stakeholders and calculated the impact of policy interventions, the support capabilities were both communicative and analysing. In the words of Nefs and Duffhues (2011, pp. 34–38), the aim of applying SprintStad can be framed as 'a lot can be learned about the topic of the game and the way in which collaboration between the stakeholders involved takes place', which more specifically leads to 'insight into the importance of a shared approach about land use and mobility'. Hence, the practitioners assumed before the game that achieving learning effects was one of the aims of applying SprintStad.

The perceived added value of the SprintStad application is depicted in Fig. 2. The most important finding is that learning about the object of the study was mentioned by the majority of the participants as the most important perceived added value. The fact that learning about the object was perceived as the most important added value corresponds to a main aim of applying SprintStad. To a certain extent it is surprising that in a role-playing game like SprintStad, 'learning about others' was mentioned by only one of the participants. This is probably because the different roles (municipalities, National Railways, etc.) were not played by these real-world actors, but were represented by civil servants from the province of North Holland.

4.2. A MapTable to inform policymakers about deprived neighbourhoods

Civil organizations and the municipality of the medium-sized town of Zwolle, The Netherlands, are seeking policy initiatives to help people in deprived neighbourhoods by, for example, improving the insulation of dwellings in order to reduce energy bills. Information about the area plays a crucial role in this context. In order to provide their policymakers with information, the municipality of Zwolle is increasingly applying a MapTable (see www.mapsup.nl) to facilitate meetings. In most instances, including this case, the software tends to be relatively simple, such as basic GIS applications and the municipality's web viewer. The latter is a dedicated website that provides civil servants and residents with access to a range of GIS-based maps. In the case that was studied, the web viewer was used to identify policies for deprived neighbourhoods. In a brainstorm session with 11 stakeholders from non-profit organizations and governmental bodies, ideas were generated about how to improve the living conditions of people in deprived neighbourhoods (see Fig. 3). Two MapTables were used in subgroups of a total of 11 people to increase the insight into the neighbourhoods being studied. The aim of the sessions was to provide the stakeholders with spatial information about their neighbourhood on a range of dimensions, potentially leading to better and innovative solutions for the problems in these neighbourhoods. Hence, the support capability of the PSS was informing. However, because this was the first time that most of the participants had made use of the PSS, the intention was also for them to get to know the tool itself. Achieving all these aims together appeared to be quite a challenge.

Similar to the SprintStad application, the main perceived added value of the MapTable application appeared to be learning about the object (see Fig. 2). This is in line with the purpose of the workshop, namely to complement the mostly experiential knowledge of the stakeholders with quantitative data. However, the fact that some participants indicated, also in the subsequent interviews, that learning about others was also important, shows that the PSS also had some communication support capabilities in addition to the informing capabilities. This is likely a result of the usage of the MapTable, because the application evokes discussion, and of the composition of the groups, with stakeholders from

Fig. 1. The SprintStad session in North Holland, The Netherlands. Each participant had a laptop on which he/she fulfilled a role in the serious game. The large screen was used to show the outcome of each round (photo taken by author).

different organizations being interested in each other's perspective. The observations during the session confirmed this.

4.3. CommunityViz with MapTable for tradable area development rights in the Achterhoek

Land is a scarce commodity in The Netherlands and it is widely acknowledged that municipalities should be careful when developing it. However, in the Dutch spatial planning context the financial rewards of spatial development are large for municipalities because they earn from selling their land and from an increase in the number of residents within their boundaries. These incentives for development potentially result in sprawl and vacancy. To address this issue, Radboud University Nijmegen (The Netherlands) is studying the extent to which a new approach – tradable area development rights – can lead to better planning outcomes (e.g. Samsura, 2013). This approach draws upon the idea that spatial development occurs in competition between municipalities, with a potential negative outcome being sprawl or vacancy. In order to prevent this, tradable area development rights can be used to compensate municipalities for *not* developing, which can lead to

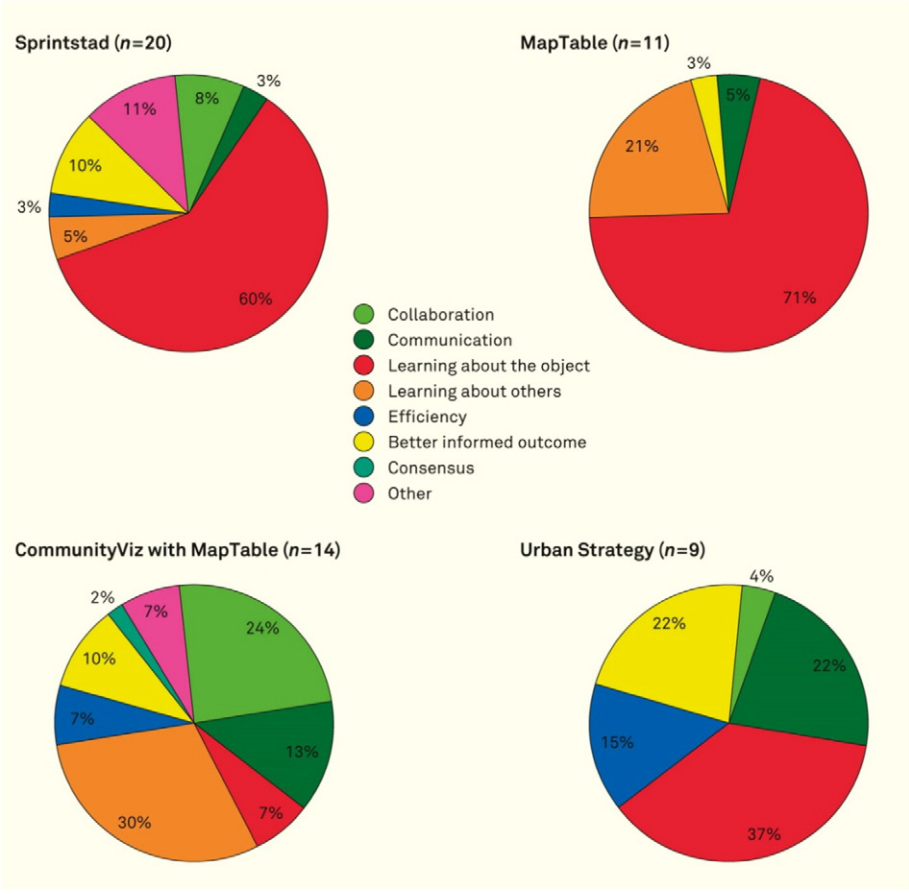

Fig. 2. Perceived added value of the four PSS applications.

Fig. 3. The MapTable application in Zwolle, The Netherlands, a chauffeur was operating the MapTable, but the participants could indicate what maps they wanted to see (photo by author).

developments in the most suitable places, for example on transit-oriented development sites. In order to test and refine this idea, two workshops were organized with a total of 14 stakeholders (see Fig. 4).

One workshop consisted mainly of stakeholders from municipalities, the other of stakeholders from supra local authorities, such as the city region. The two workshops were supported by a PSS consisting of CommunityViz and a MapTable (for more detail, see Pelzer, Arciniegas, Geertman, & Lenferink, 2015 and www.communityviz.com.). As in the SprintStad case, the workshops took the form of a game with several rounds. In the first round, the primary aim was to gain insight into the interests and plans of other stakeholders, whereas in the later rounds the aim was to arrive at some kind of optimization, based on the demand and potential for transit-oriented development.

Fig. 2 depicts the main perceived added value of the application of the PSS application. The result of the evaluation is different from the previous PSS applications in two ways. First, no single perceived added value dominates. Second, the added values that were mentioned by a substantial proportion of the participants (learning about others and collaboration) are different from the other cases. The approach of the session was to encourage a dialogue among different stakeholders, and the explicit aim of this specific PSS application was for the participants to learn about each other and to establish collaboration as part of the negotiation over tradable development rights. Arriving at some kind of optimization in the transfer of development rights was the overarching aim to which perceived added values like learning about others and collaboration might contribute.

Fig. 4. The CommunityViz with MapTable application in Nijmegen, The Netherlands. All participants stood around the table, the chauffer was operating the MapTable based on input of the participants (photo: Sander Lenferink).

4.4. Urban strategy to redevelop a brownfield area

The city of Utrecht has several brownfield areas that will be converted into mixed commercial/residential areas in the coming years. One of these areas, the Cartesiusdriehoek, has a very complex environmental context due to the presence of adjacent industry and transport infrastructures. Urban Strategy – an interactive and integrative PSS developed by the Dutch research institute, TNO (www.tno.nl/urbanstrategy) – was used to address the challenges in this area. This PSS combines a traditional four-step traffic model with state-of-the-art environmental models within a GIS environment (see Pelzer, Klerkx & Kolthof, 2014). This offers the possibility to calculate the nature and magnitude of the impact of changes in a road network, which possibly will lead to changes in traffic flows (transport model) and thus has a noise and air pollution impact (environmental model). In order to evaluate the perceived added value of this PSS application, a workshop was organized by the first author in collaboration with TNO and the municipality of Utrecht. During the workshop, a group of nine civil servants from the municipality, each from a different disciplinary background, applied Urban Strategy to increase their insight into the Cartesiusdriehoek (see Fig. 5) and to analyse the effect of a range of future policy interventions, such as a road diet, adding more dwellings and building sound barriers (see Pelzer, Klerkx, & Kolthof, 2014). The participants were particularly interested in assessing the feasibility of the various interventions, for instance, what would happen to the traffic flows if 7000 dwellings were added to the plan area.

Fig. 2 depicts the most important perceived added values of the Urban Strategy application. Learning about the object was considered to be the most important perceived added value by most of the respondents. In the group evaluation after the workshop and in response to the open-ended questions, the participants indicated that much of the information generated by Urban Strategy was not new to them and would have been of more value had it been applied earlier in the planning process and had included additional indicators (e.g. train intensity on the adjacent railway track). In general, there is a reasonable correspondence between the aim of the session and the perceived added value of the PSS application. Both better informed outcome and learning about the object are consistent with the aim of a better understanding of the feasibility of proposals for the plan area.

5. Reflections

5.1. Reflections on findings

Fig. 6 depicts the mean perceived added value of the four PSS applications (each PSS application is weighed equally). The most notable observation is that the perceived added value of learning about the object was most frequently mentioned across the four case studies. Moreover, learning about others was also relatively often perceived as an added value by practitioners. This corroborates recent studies by te Brömmelstroet (2010) and Goodspeed (2013), who consider learning – both about others and about the object – as the main perceived added value of a PSS application. This paper complements their work with the insight that learning is an important perceived added value of a PSS application, irrespective of differences in context and support capabilities.

A comparison of the four cases yields an interesting observation, namely patterns of perceived added values. When learning about the object is important, a better informed outcome also tends to be relatively important. Although these combinations of perceived added values are arguably a result of similar characteristics, in other instances there might be a causal relationship. For instance, communication and collaboration are often conceived as a precondition for learning about others (Beukers, Bertolini, & te Brömmelstroet, 2014; Pelzer & Geertman, 2014).

Overall, the participants were relatively satisfied with the usability of the PSS applications in the four cases (see Fig. 7). The CommunityViz with MapTable case scored somewhat higher than the others in this respect, whereas Urban Strategy scored relatively low on user friendliness (3.00). As mentioned, practitioners perceived usability as a combination of the characteristics of the instrument and the characteristics of the process related to the application. For instance, in the SprintStad case about half of the participants indicated in the open questions that the process was too short to properly use the PSS. Moreover, particularly

Fig. 5. The Urban Strategy session in Utrecht, The Netherlands, the chauffeur (standing) is explaining the output of the model runs on two large screens. On the table are paper maps. (photo by author).

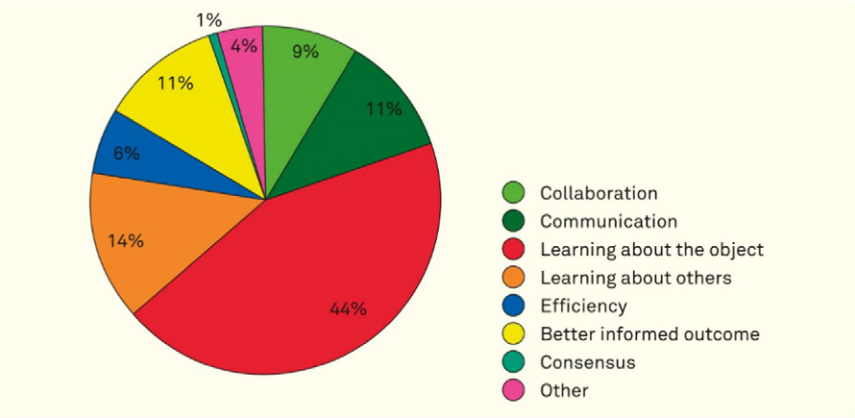

Fig. 6. Mean perceived added value of all four PSS ($n = 4$).

in the Urban Strategy case it was found that facilitation interventions, rather than instrumental improvements, could help to increase the usability. Since in all cases except the SprintStad case the PSS was operated by a chauffeur, the results suggest that the performance of the chauffeur is just as important as the characteristics of the PSS. In a recent paper about the facilitation of PSS workshops Pelzer, Goodspeed, and Te Brömmelstroet (2015) argue that the key to a successful workshop is finding a precarious balance between involving the participants in the tool (e.g. setting the parameters) and preventing the tool to disturb communication process. This finding also applies particularly to the Urban Strategy case, in which the PSS disturbed the communication. Moreover, it should be noted that in the case of applying a MapTable, the chauffeur but operates the PSS and steers the workshop, whereas in the Urban Strategy case there was both a chauffeur (operating the PSS) and a facilitator (steering the workshop). A plausible hypothesis is that a PSS with more complex analytical support capabilities (e.g. impact models) requires both a chauffeur with substantive knowledge focusing on the PSS and a facilitator focusing on the group dynamics, whereas in instances of a PSS application with primarily informing and communicative support capabilities – including often less complex software – one person combining the roles of chauffeur and facilitator suffices.

In the conceptual framework, it was hypothesized that the perceived added value of a PSS application is influenced by the context, the support capabilities of the PSS and the usability. Since only four cases were studied, it is hard to develop reliable causal explanations. Whereas the four PSS applications showed varying results in terms of the perceived added value (although learning was mentioned in all cases), this cannot be attributed to the various support capabilities, because there are too many contextual factors, including different disciplinary backgrounds, different facilitation interventions and varying planning issues.

Still, with regard to the influence of the context, some insights can be distilled from the cases. All the participants had a relatively high educational attainment, which might be related to the emphasis on learning in the perceived added value scores. There is perhaps an alternative explanation for the strong emphasis on learning. While all four PSS applications dealt with real-world planning issues, applying a PSS was a novel experience, in which the participants gathered new insights into the instrument, new ways of working and the unique features of the planning area. Moreover, all cases were in a relatively early stage of the policy process at which the options were still relatively wide open. In the Urban Strategy case, this was somewhat problematic, because the focus of the workshop (early stage) did not completely match the developments in the area (late stage). A better alignment with the stage of the planning process might have resulted in a different perceived added value. With regard to the content of the planning issue, the SprintStad and CommunityViz with MapTable cases were relatively similar. Both focused on transit-oriented development and the interests of stakeholders, but did not result in a similar perceived added value. The Urban Strategy case was more detailed than the other cases, focusing on the micro-scale of a neighbourhood, rather than a transport corridor.

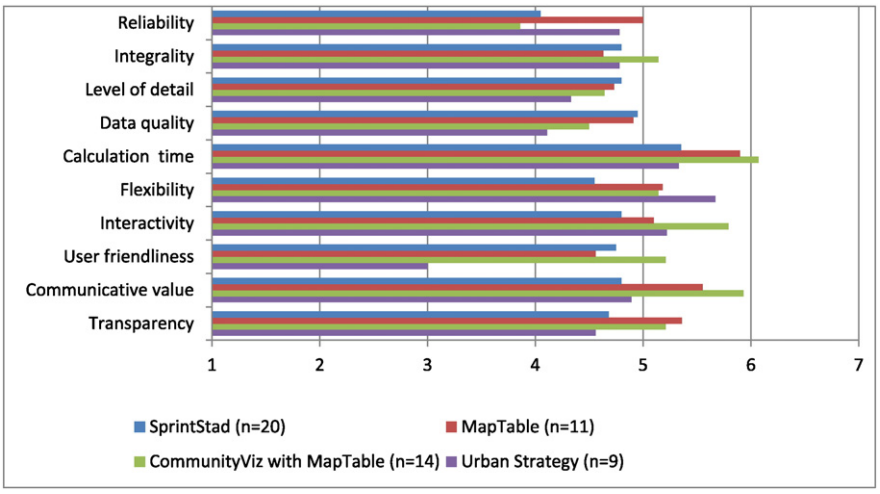

Fig. 7. Mean usability scores for each PSS application.

5.2. Methodological reflections

While the empirical approach of this study addressed a gap in the PSS debate, the study had several limitations, primarily for reasons of feasibility. Finding and then studying four suitable cases of PSS application were quite a challenge. The initial aim was to include more cases in the analysis, but several planned workshops did not proceed. This empirical research only included cases from The Netherlands, which limits the generalizability of the findings, particularly when bearing in mind that context was very important in understanding the perceived added value. In addition, we faced methodological issues. A first important methodological issue is that the empirical work of this study focused on the perceived added value of a PSS application, and not of the software itself. This choice was argued in Section 1 as being defensible: planning is a social process and it is not feasible to separate the software from its situational application. It is important to note that the perceived added value is related not only to the tool itself, but also to the characteristics of the application, such as the quality of the facilitator, the use of other support tools and group dynamics. Consequently, when interpreting or transferring the findings, it is essential to take these factors into account. Further, it is noteworthy that the standard deviations with regard to usability scores in all the case studies were relatively high. Since the respondents participated in exactly the same workshop, this is likely to be related to individual differences between the respondents. Possible dimensions to be tested include disciplinary background, psychological profile, age, gender, contextual position in the real-world planning process and experience with technology. An indication of this is given by Goodspeed (2013), who found that psychological profiles partly explained the appreciation of a PSS.

The questionnaire also had its limitations. We initially aimed to apply Likert items (usability) and scales (perceived added value) to measure the perceptions about the PSS applications. With regard to usability, this was a reasonable measure, allowing us to distinguish empirical patterns in the different PSS applications. With regard to the perceived added value, however, Cronbach's alpha was too low to use the findings from the Likert scales in a meaningful way. The option of letting the respondents pick one added value was effective because it forced them to be really selective, hence resulting in distinguishable patterns. It was, however, also a somewhat crude approach because it did not allow participants to express that multiple perceived added values are important. A question that involved ranking multiple added values could have been included (cf. Pelzer et al., 2014). Future research could and preferably should apply such an approach. Finally, the term 'added value' remains a difficult concept. The advantage of this concept is that it speaks to the life world of practitioners. A disadvantage from a methodological point of view is that it precludes negative or no influence. Perhaps choosing a more neutral term like 'influence' might have been a better choice than the seemingly inherently positive concept of 'added value'. These methodological lessons might be helpful to improve new comparative PSS research in future research.

6. Conclusions and future research

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

Our findings do not allow an assessment of the relationship between usability and perceived added value. It is notable, however, that in none of the applications a lack of usability was perceived to be a barrier. Relevant here is that in three out of four cases there was chauffeured use, in which the participants did not operate the PSS themselves, but the usability of the PSS was mediated. Such a workshop setting is different from a situation in which a PSS is used individually. In the latter case, human-computer interaction is central and usability might be situated more at the level of the instrument, such as the visualization capabilities and the interface characteristics (cf. Russo, Costabile, Lanzilotti, & Pettit, 2015). Experiences in other cases could show whether improved usability is a wider trend, for instance because of technological improvements or better facilitation (cf. Te Brömmelstroet et al., 2014). Moreover, this kind of future research could also more systematically study the effect of contextual factors, for instance through a larger n study and/or a cross-national comparison. A large n analysis would allow for correlational analysis, which was not possible in this study because of the low n. Such analyses might lead to interesting additional findings, as exemplified by Goodspeed (2013). We believe that the way forward lies in (a) systematically conducting questionnaires after PSS applications and (b) having some kind of uniformity in these questionnaires and the evaluation protocol in general to enable the comparison of PSS in different contexts and with different users. In addition, future research should be performed not only by asking about perceptions (i.e. perceived added value), but also by measuring actual behaviour (i.e. revealed added value). Possible methods to facilitate such analyses include pre- and post-workshop questionnaires and the analysis of video images (cf. Nyerges et al., 2006; Salter et al., 2009). The advantage of such methods is that the findings will be less influenced by socially preferred answers. In many instances working with a PSS is a unique experience for participants, which could lead to inflated responses in questionnaires. True added value, however, is revealed not only by what people state, but also by how they actually behave in a situation in which a PSS is applied.

However, measuring and interpreting revealed that added value is complex. It is related not only to the workshop in which a PSS is applied and the direct outcome of the session. After all, PSS are intended to help people to make plans and decisions about the spatial environment that will eventually have a real-world manifestation. Studying this is a great challenge, as exemplified by earlier research into the use of scientific knowledge in planning practice (e.g. van Lohuizen, 1986; Weiss, 1977). In addition to conducting more systematic research at the individual and the group level, the PSS debate would benefit greatly from studies that take a more longitudinal approach to analysing the extent to which the PSS application has actually had an added value. For instance, the 'What if?' PSS as initially developed by Klosterman (1999) has been applied in various contexts over the last decade and its impact could be studied through a retrospective study. Combined with the type of research described in this paper, this might lead to a better understanding of the added value that applying PSS has in planning practice.

Future research, however, should not only take the form of solitary academic contributions in order to advance the field of PSScience. In many instances, researchers and practitioners collaborate closely in developing and applying a PSS. By doing so, they gather insights into

perceived added value and usability, which can result in operational solutions for organizing workshops and developing the PSS. Such a design-like approach was central in, for instance, the aforementioned European COST action on accessibility instruments (te Brömmelstroet et al., 2014). Moreover, within the Australian Urban Research Infrastructure Network (AURIN) there is a focus on supporting planning and policymaking with digital tools and data, and usability and perceived added value is continuously evaluated with a range of methods (Barton, Goldie, & Pettit, 2015, also: www.aurin.org.au). These kinds of in-depth case studies, in which the experiential knowledge of PSS developers is combined with commonly accepted social science methods, have much to offer for the future.

Acknowledgements

The authors would like to express their gratitude to the two anonymous reviewers for their valuable comments. In addition, thanks to all the practitioners involved in organizing and participating in the four workshops. A specific word of thanks to Lisanne de Wijs voor her help with setting up and conducting the questionnaires, Sander Lenferink for providing information about the Achterhoek case and André Diepgrond for help with the figures. This study has partly been made possible by the knowledge initiative Connecting Sustainable Cities of the Netherlands Organisation for Scientific Research.

Appendix 1. Commonly used usability variables in PSS research, based on Arciniegas (2012), Goodspeed (2013), te Brömmelstroet (2010, 2014), Vonk (2006).

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

Appendix 2. Overview of questionnaire questions[2].

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

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