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PSS are more user-friendly, but are they also increasingly useful?

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ABSTRACT

Planning Support Systems (PSS) can provide important and much needed knowledge and support in strategy-making processes, by bringing explicit information to daily planning practices. However, as decades of academic studies show, their use is riddled with barriers and bottlenecks.

Academic studies generated insight in these bottlenecks and identified a number of directions to bridge the implementation gap. Most notably, the transparency, flexibility and interactivity of PSS needed to be enhanced to align the instruments more with the dynamic characteristics of urban strategy-making processes.

However, PSS developers do not seek instrumental use only; they seek to increase the quality of planning through this use. Accordingly, academic analysis should go beyond the user-friendliness of the PSS themselves. There are a number of studies that focus on the relations between PSS and planning quality. This paper aims to construct links between these studies of usefulness and the body of knowledge on user-friendliness. To do so, it operationalizes the characteristics of user-friendliness and the potential added value that PSS have on the qualities of planning (specifically the strategy-making phases). Consequently, the relations between these concepts are further explored.

Five experiments measured user-friendliness and usefulness indicators of different PSS and explored the relations between these two concepts. The findings indicate high user-friendliness across the board, while usefulness was only found in very limited cases and for very limited dimensions (notably Insight and Consensus). The correlations between the perceived user-friendliness and usefulness on different planning qualities reveal that for the self-reported Enthusiasm of participants all user-friendliness indicators have a positive effect. For perceived gains in Insight, only Credibility and Clarity of output have a significant positive effect.

1. Introduction

Planning Support Systems (PSS) aim to structure the exchange of different types of knowledge in planning processes (Klosterman, 2001). Following the premise that strategic urban problems are 'wicked' (Rittel and Webber, 1984), do not have one optimal solution and are increasingly political and contested, PSS attempt to improve the strategic capacity and the

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ability of planning actors to go through a shared 'enlightenment' process and create 'negotiated knowledge' (Amara et al., 2004; Gudmundsson, 2011). PSS have the explicit aim to support and improve specified steps of the planning process (Geertman and Stillwell, 2003). To do so, explicit/codified information (often provided by these computer models) is systematically fed and shared in planning processes. PSS are mostly designed as visually attractive platforms that structure the mutual exchange of knowledge among many actors. Typically organized in a setting of one or more workshops, a group of planning actors comes together to learn about the planning issue at hand and to develop shared ideas.

Although planners 'can obviously use all the support they can get' (Couclelis, 2005), and large private and public funds are used to further develop the suite of tools, PSS use in planning practice still lags far behind expectations (Vonk, 2006). A mismatch persists between characteristics of the PSS and those of strategy-making processes. Planners see PSS as overly detailed and precise, mathematically complex, rigid, slow, unintelligible and not transparent enough to be compatible with the unpredictable and dynamic nature of strategy-making processes (Te Brömmelstroet, 2010; Vonk et al., 2005).

Much of the research on PSS implementation focuses on understanding and improving the user-friendliness of the instruments (Fig. 1). Although this is an important topic to address, it is crucial to realize that user-friendly PSS are a means rather than a goal. Research should expand—even principally shift its focus—on the actual goal: improving the quality of planning practice. PSS, especially those that claim to support the more strategic phases of planning, aim to be used to enlighten (Amara et al., 2004; Gudmundsson, 2011). While this requires user-friendly technology as condition, this enlightenment-goal refers to improving the quality of planning: in terms of better planning outcomes (e.g. strategies, plans, projects) or in terms of enhanced processes. The focus on improving PSS user-friendliness presumes that PSS, once user-friendly, have an intrinsic ability to improve these qualities. This assumption, often implicit, is explicitly acknowledged by Vonk (2006). Recently, several researchers started to question this assumption (Goodspeed, 2013, 2015; Pelzer et al., 2014; Pelzer and Geertman, 2013; Te Brömmelstroet, 2015).

This paper builds initial links between these two strands of PSS research, by analysing the potential relations between elements of user-friendliness and planning qualities (also sometimes referred to as performance or usefulness). It turns the main assumption of PSS research into the following hypothesis: The user-friendliness of PSS is positively correlated with its usefulness for planning practice. To test this hypothesis, user-friendliness and usefulness are operationalized into multiple dimensions. A research project that conducted five consecutive experiments with different PSS provides the empirical data set for analysing these dimensions. The paper closes with an assessment whether user-friendliness and usefulness are correlated, and, if yes, on which dimensions. This leads to potential lessons for what PSS developers should focus on and where there are interesting research directions.

2. PSS user-friendliness and usefulness

Imagine the following two situations:

1. You have a coffee machine at home that has a good balance between ease of use (e.g. it fits your table well; it is easy to operate) and its coffee brewing qualities.
2. You are a regular visitor of a particular coffee bar, where you wait in line to be served by a barista who operates a sophisticated coffee machine. You pay a premium price for your cup because you expect that this process gives you a very good coffee.

Hands-on user-friendliness of the coffee machine is obviously more important in the first situation. In the second case the quality of coffee is key, especially if you can choose from different bars in the vicinity. In that case, but only when the coffee is good enough, you easily accept that you need to rely on an intermediate person who operates the machine. In other words, the user-friendliness of the machine itself (in terms of the hands-on experience with operating it) becomes irrelevant; you only care about the quality of the outcome (and maybe the process). A similar dichotomy exists when we analyse and discuss PSS: Should we operate the machine ourselves or rely on a PSS barista? And what does this mean for understanding (the importance of) user-friendliness and usefulness?

In most PSS studies *user-friendliness* relates to the ease of use for planning practitioners as the end users. In this situation, perceived user-friendliness is defined as 'the degree to which a person believes that using a particular system would be free from effort' (Keil et al., 1995, p. 76). This definition relates to the 'hands-on' experiences that planning practitioners have with the instrument, and how easy and intuitive is it to operate (is it transparent; does it have an understandable interface etc.). In the literature on the PSS implementation gap, a wide range of heuristics to improve this user-friendliness are proposed, mainly focused on improving the technological interface between the models and the planning practitioners (see e.g. Brail, 2005; Geertman and Stillwell, 2009; Geertman et al., 2013; Te Brömmelstroet, 2010; Vonk, 2006). From these studies PSS user-friendliness can be operationalized into the following characteristics:

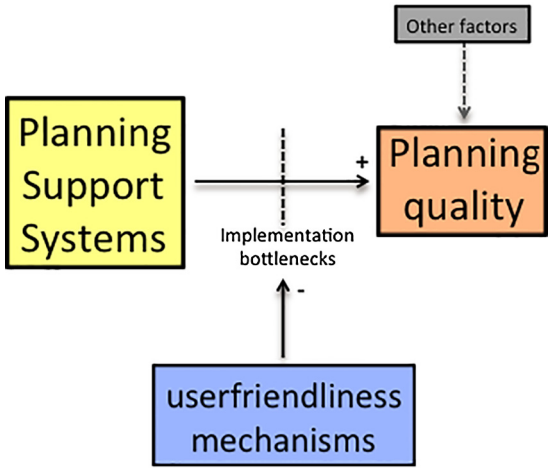

Fig. 1. Conceptual scheme of the PSS literature.

- Transparency of assumptions of underlying models
- Communicative value of output
- Clarity of output
- Credibility of output
- Comprehensiveness of the models
- Focus of the models
- Level of detail
- Ease of understanding

Usefulness of PSS refers to something different: the PSS added value on the quality of the planning tasks (as discussed in Pelzer, 2015). Likewise, Nielsen (1994, p. 24) defines usefulness as the 'issue of whether [a] system can be used to achieve some desired goals'. In other words, a PSS can be very user-friendly without being useful and vice versa. Although the complete set of tasks is wildly diverse, there are some common characteristics, especially for strategic planning phases. These planning early phases focus much more on shared learning than on making decisions and more on diverging in terms of problem-solution combinations than converging. Adapting the framework developed by Te Brömmelstroet (2013) and following the work of Rouwette et al. (2002), the following dimensions for the quality of a strategic planning process were formulated:

- Individual reaction
  - o Enthusiasm
  - o Satisfaction
  - o Credibility
- Insight
  - o Insight into problem
  - o Insight into each other's assumptions
- Communication
- Development of shared language
- Consensus
  - o About the problem
  - o About goals
  - o About strategies
- Cohesion
- Efficiency

A recent meta-study that mapped claims in PSS literature showed that the explicit claims about added value of PSS overlap with these dimensions (Te Brömmelstroet, 2013).

3. Setup of the experiments

To test the hypothesis, empirical data was collected in five controlled experiments. This research design follows the logic of consequential manipulation, which states that 'if a causal factor, X, is manipulated, then, given appropriate controls, a systematic effect is produced on the response variable, Y' (Goldthorpe, 2001, p. 5). If a systematic effect exists and other relevant variables are constant, it can be causally associated with this manipulation. The main goal of these experiments was to test if PSS had an added value effect on the quality of planning. By also mapping the perceived user-friendliness of the PSS, we could also analyse the correlation between these sets of characteristics. In this paper, I zoom in on this data, which makes the exact treatment-control characteristics less relevant (the data only focuses on those groups that received PSS treatments). However, for the understanding of the data, the details of the experiments are first discussed.

3.1. Details of the five experiments

The five experiments were populated by different groups of students from urban planning or related studies. They were recruited at the University of Amsterdam (Master's and Bachelor's programme in Urban Planning), the Technical University of Munich (Transport Engineering), the Windesheim University of Applied Science (Traffic Engineering) and the Saxion University of Applied Science (Planning, Environmental Engineering). In each of these experiments, students were randomly divided into groups and informed that they were taking part in a national design competition. The main characteristics of the five experiments are presented in Table 1, and the general setup of each is described below.

In experiment 1, all groups (5–6 persons from two international master's programmes) were invited to develop an integrated strategy for the location of new housing and work units in the metropolitan area of Munich. The control groups did not receive any support in terms of process or content: when they entered the room they were informed about the task at hand and the time for completing it. The treatment groups (half of the groups that received PSS support) received a set of paper maps that were generated with the local accessibility instrument called Erreichbarkeitsatlas. These maps showed for each location in the region how many jobs and inhabitants could be reached within an acceptable travel time, indicating the location's development potential, a so-called Informing PSS (Vonk, 2006, p. 79). All treatment groups worked simultaneously, and the PSS developer walked among the participants providing explanations when needed.

In the second experiment in Amsterdam, the small population of the urban planning master's programme necessitated smaller groups (three persons). The students were invited to redevelop an existing urban infill plan in the old harbour area of Rotterdam. They where limited in their interventions to relocating buildings, alter infrastructure and develop the spaces around them. The treatment groups were supported by Urban Strategy, a PSS that allows quick calculations of the effects of urban interventions on a range of environmental, social and economic indicators, a so-called Analysing PSS (Vonk, 2006). Also, two chauffeurs[1] from the PSS development team were present to facilitate the exchange between the instrument and the participants.

The third experiment was done with a larger population of first-year urban planning students from Amsterdam, allowing us to increase the group size to six individuals. Again, all groups worked on the same Rotterdam case study, with 15 extra minutes compared to experiment 2. Also, the default plan was made more complex by adding more houses and office buildings. All these changes aimed to bring the conditions of the experiment closer to planning practice (based on own observations and case descriptions). Half of the groups (the treatment groups) received similar support from PSS Urban Strategy and two chauffeurs. Urban Strategy was supplemented with a Maptable, a big horizontal touchscreen used to visualise and interact with model output.

The population in experiment 4 was drawn from three different applied studies (group size increased to eight). In the setup, the differences between their backgrounds were accentuated to simulate differences that are present in planning practice. Each participant received only role-specific information based on his or her study background. The planning students were divided into economists and urban designers (the two characteristics of urban planning as emphasised in their curriculum), because their group was seen as too dominant in numbers. Again, the assignment was to redevelop the infill plan in Rotterdam. The treatment groups were divided into two, based on the structure of the group process. All these groups were supported by Urban Strategy and the two chauffeurs. Now, also a mediator structured the session. He offered two different treatment structures (experimental designs): three groups followed a group process of brainstorming, designing and writing the strategy, while for the other three groups collective brainstorming was replaced with individual brainstorming and reflection.

In the final experiment, again with first-year Urban Planning students and based on the lessons from experiment 4, role playing elements were introduced to increase similarity with planning practice. This time, all students had the same

[1] An individual that does not steer the session process, but only handles the technology (Pelzer et al., 2016).

Table 1
Characteristics of the five experiments.

	Experiment 1	Experiment 2	Experiment 3	Experiment 4	Experiment 5
Institute	TU München	UvA	UvA	Saxion Windesheim	UvA
Date	14-Dec.-11	20-Dec.-11	6-Nov.-12	21-Mei-13	29-Okt.-13
Students	Master's environmental eng. Master's transport eng.	Master's urban planning	2nd year urban planning	1st year traffic eng. 2nd year planning 2nd year environmental eng.	2nd year urban planning
# Students	34	17	70	57	69
# Groups	6	6	12	7	9
Conditions	3 control 3 PSS	3 control 3 PSS	6 control 6 PSS	1 control 3 group PSS 3 individual PSS	3 control 3 PSS A 3 PSS B
PSS	Erreichbarkeitsatlas	Urban strategy	Urban strategy	Urban strategy	A. Urban strategy B. Phoenix
Type of PSS	Informing PSS	Analysing PSS	Analysing PSS	Analysing PSS	A. Analysing PSS B. Communicating PSS
Minutes/session	60	45	60	60	90
Subject	New housing and jobs in Munich Metropole	Design of urban infill Waalhavens Rotterdam	Design of urban infill Waalhavens Rotterdam	Design of urban infill Waalhavens Rotterdam	Urban infill Cartesius Utrecht
Role playing	No	No	Air quality Noise External safety Mobility Economist	Planners divided in urban design and plan economists	Urban designer Transport engineer Environmental advisor Citizen

background and were randomly assigned a role (along with role-specific information and role-specific prizes to win). Each session was extended to 90 min, and two different PSS were used: (1) Urban Strategy, with two chauffeurs and one mediator; and (2) Phoenix, a Communicating PSS (Vonk, 2006) with two chauffeurs. Phoenix is a Maptable-based instrument that allows quick drawing and some basic computations. The two chauffeurs mainly used it to get different ideas on the table and to distinguish similarities and disagreements. Because of input data limitations, the assignment was changed into the redesign of an urban infill area in Utrecht.

3.2. Data gathering and analysis

Data about the user-friendliness and usefulness of PSS was gathered among the 24 groups that were subjected to a PSS treatment. The students filled in two short questionnaires immediately after their session. In the first, they were all asked to rate the user-friendliness characteristics of the PSS that they used (see Appendix A for the specific statements). In the second survey, the students were asked about their perceptions of the quality of the process based on the dimensions listed above (see Appendix B for the specific statements). Both questionnaires used statements with a 7-point Likert scale (Matell and Jacoby, 1971). Acknowledging the ongoing debate about the parametric vs. non-parametric nature of Likert scale measurements, this data was consequently analysed with standard parametric tests (e.g. Allen and Seaman, 2007; Norman, 2010). For the dimensions that are measured with multiple statements, the scores of each individual student are averaged. To test the hypothesis, correlations between individual scores on all dimensions of experienced user-friendliness and all dimensions of perceived usefulness were tested.

4. Results

The goal of this paper is to explore if and how user-friendliness of PSS is related to their usefulness in planning practice. The experiments used to collect data and the outcomes are discussed below, covering first the scores on the dimensions of user-friendliness and usefulness, followed by a discussion of the correlations.

4.1. User-friendliness scores

The students experienced the different PSS as user-friendly. All mean scores are significantly higher than 4 (average) on a 0.01 level. Urban Strategy scores the highest on overall user-friendliness as an aggregated score. In general, the students are especially positive about the Ease of understanding, Clarity and Credibility. Focus, Transparency and Comprehensiveness are seen as the least positive elements. The differences between the perceived user-friendliness of the three PSS are significant for the dimensions Clarity (Urban Strategy and Phoenix high, Erreichbarkeitsatlas low), Credibility (Urban Strategy high, Phoenix and Erreichbarkeitsatlas low) and Level of detail (Urban Strategy high, Erreichbarkeitsatlas medium, Phoenix low) (see Table 2).

4.2. Usefulness scores

The general responses to the perceived usefulness scores are also relatively high. The students were quite enthusiastic about the sessions, also in the groups that did not receive a PSS treatment. The highest scores are on Reaction, Consensus and Communication (see Table 3).

4.3. Correlations between user-friendliness and usefulness

A bivariate correlation test on the two datasets on PSS user-friendliness and PSS usefulness by the participants was performed to test if individual scores on usability dimensions correlate with scores on usefulness dimensions. The hypothesis predicts that users that experience the PSS as user-friendly also rate the quality of the planning process higher. Because of the multi-dimensional operationalization, this could be tested for all possible relations. Table 4 presents the outcomes of this analysis on the level of the aggregated usefulness dimensions.

In Table 4, the correlations printed in bold with two asterisks are significant to a 0.01 level. The existence of many strong, positive correlations supports the hypothesis that PSS user-friendliness and usefulness are indeed positively correlated. There are however strong differences when we look at the different process quality dimension.

For example, Individual reaction and Insight are correlated with all user-friendliness characteristics. Credibility and Communicative value have a strong relation with both of these qualities. Cohesion as planning quality, however, has fewer correlating dimensions of PSS user-friendliness. From a PSS perspective, the user-friendliness dimensions that correlate with most planning quality dimensions are Communicative value, Clarity and Credibility. Each have a positive correlation with seven of the eight process qualities.

5. Conclusion and recommendations

5.1. Conclusions

The paper aimed to link the mainstream PSS literature that focuses on understanding and improving the user-friendliness of their instruments with the upcoming research on their usefulness (added value) for planning practices. It took the -often implicit- assumption that PSS have an intrinsic added value for urban planning and translated this into a hypothesis: The user-friendliness of PSS is positively correlated with its usefulness for planning practice.

This hypothesis was tested by operationalizing PSS user-friendliness (generic) and usefulness (for strategic planning purposes). The resulting multi-dimensional frameworks were used to collect and analyse empirical data from a large-scale study of five controlled experiments with groups of planning students in the Netherlands and Germany.

The study did not aim to falsify or verify this hypothesis, focusing instead on enriching it through further operationalization and detailed analysis. The findings suggest that there are strong and multiple correlations between many of the dimensions of PSS user-friendliness (as experienced by the users) and qualities of the planning process (as perceived by the users). Both are of course student participant perceptions and need further validation in studies of planning practice. Still, the data seems to support the mainstream focus of PSS researchers on user-friendliness as a way to unlock their usefulness.

5.2. Reflection

The study that was used to collect the empirical data was not setup for the purpose of testing this specific hypothesis. While it did provide a good basis for discussing this new and upcoming link in PSS research, it also faced several drawbacks that influence the validity of the outcomes, which are discussed below.

The student participants were all relatively positive about the user-friendliness of the administered PSS. Although these PSS represent state-of-the-art technology and interfaces, the developers stated that this enthusiasm did not necessarily mirror their experiences in planning practice sessions. One explanation is that the students did not bring a career of

Table 2
User-friendliness scores (on 7-point Likert scale).

	Urban strategy		Phoenix		Erreichbarkeitsatlas		Total	
	N	Mean	N	Mean	N	Mean	N	Mean
Transparency	126	5.04	22	5.36	18	5.06	166	5.08
Communicative value	129	5.40	24	5.29	19	4.89	172	5.33
Clarity*	129	5.52	24	5.46	19	4.84	172	5.44
Credibility*	129	5.48	24	4.88	19	4.89	172	5.33
Comprehensiveness	128	5.15	24	5.38	18	4.67	170	5.13
Focus	123	5.10	24	5.08	18	4.61	165	5.04
Level of detail*	129	5.33	24	4.54	19	5.00	172	5.19
Ease to understand	128	5.56	23	5.57	19	5.32	170	5.54
Total		5.30		5.23		4.85		5.24

* Differences between the PSS mean scores are significant at the 0.05 level (2-tailed).

Table 3
Usefulness scores (on a 7-point Likert scale).

	Urban strategy		Phoenix		Erreichbarkeitsatlas		Total	
	N	Mean	N	Mean	N	Mean	N	Mean
Individual reaction*	120	5.36	23	4.94	19	4.80	162	5.24
Enthusiasm*	120	5.50	23	5.00	19	4.89	162	5.36
Satisfaction*	120	5.48	23	5.26	19	4.74	162	5.37
Credibility*	120	5.15	23	4.58	19	4.78	162	5.03
Insight	120	5.05	23	4.67	19	4.84	162	4.98
Insight into problem*	120	5.08	23	4.65	19	4.64	162	4.97
Insight in assumptions	120	5.02	23	4.70	18	5.07	161	4.98
Communication	120	5.27	23	5.04	17	4.88	160	5.19
Shared language*	120	4.70	23	4.24	18	5.17	161	4.68
Consensus	117	5.60	23	5.33	18	5.35	158	5.53
Consensus of problem	117	5.62	23	5.33	18	5.35	158	5.54
Consensus of goals	116	5.50	23	5.30	18	5.33	157	5.45
Consensus of strategies	116	5.63	23	5.35	17	5.41	156	5.57
Cohesion*	117	4.80	23	4.23	18	4.83	158	4.72
Efficiency*	117	5.24	23	4.48	19	3.79	159	4.96
Total		5.27		4.87		4.93		5.17

* Differences between the PSS mean scores are significant at the 0.05 level (2-tailed).

Table 4
Correlations between user-friendliness and qualities of process (N between 162 and 153).

	Individual reaction	Insight	Communication	Shared language	Consensus	Cohesion	Efficiency
Transparency	**0.418****	**0.292****	0.071	**0.240****	**0.311****	0.173*	0.187*
Communicative value	**0.452****	**0.316****	0.110	**0.281****	**0.447****	**0.252****	**0.269****
Clarity of output	**0.447****	**0.341****	**0.231****	**0.260****	**0.366****	0.138	**0.265****
Credibility	**0.522****	**0.417****	**0.217****	**0.259****	**0.363****	**0.280****	0.118
Comprehensiveness	**0.354****	0.184*	0.075	0.044	**0.281****	0.172*	**0.206****
Focus	**0.373****	**0.287****	0.115	0.117	**0.300****	0.200*	0.197*
Level of detail	0.197*	**0.256****	0.067	0.109	0.116	0.081	0.125
Easy to understand	**0.297****	**0.233****	0.053	0.102	**0.216****	0.072	**0.321****

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

negative experiences with similar instruments to the table. It can be expected that a similar positive bias is present in the perceived quality of the planning process. As a result, the relations between these two scores for each student are largely unaffected.

The data did only allow testing correlations between the scores on the dimensions of the two concepts with mostly positive scores, which leaves the possibility of thresholds untested. It could be that low PSS user-friendliness blocks any added

value of the PSS on the quality of planning until a higher score. An experiment specifically designed to test thresholds could control for the level of user-friendliness.

In the data analysis of all experiments, only very limited added value was measured between 'PSS support' and 'no support' groups (as discussed in Te Brömmelstroet, 2015). Here, we zoom in on the variation within the 'PSS support' group. Although this background is important for interpretation, it is important to realize that this analysis only uses the *variation* in experienced usefulness of the PSS.

The perceptions of the students were triangulated by rating the quality of the planning products that the groups produced, to verify the data about planning quality in the five experiments (see Te Brömmelstroet, 2015). The blind external rating procedure revealed a lower quality in general, and no—or sometimes even negative—effects of PSS support. This indicates that the positive scores of the students used in this paper are not per se a good proxy for planning quality. Another explanation can be that the process was indeed of high quality, but that it did not lead to a good product.

Finally, and related to several of the methodological drawbacks addressed above, the student-based experiment design has the obvious drawbacks of limited external validity. However, the resulting *internal* validity is a highly valuable addition in a field dominated by case studies. It allows researchers to zoom in on correlations in a controlled, randomized environment. But the findings need methodological triangulation to increase our understanding of how generalizable they are (as already partly done in: Pelzer et al., 2015a; Goodspeed, 2015).

5.3. Implications for research and practice

For PSS developers, the findings suggest that they should be clear about the exact planning qualities (i.e. usefulness) they aim to improve. Such focus would also help them zero in on the most important user-friendliness dimensions that help achieve these specific aims. This is in line with Pelzer's (2015) recommendations for more deliberate and more contextualized PSS with a clearer purpose. Understandable output relates to most of the usefulness dimensions as studied here. Improving the understandability of the output goes beyond the technological aspects of PSS usability, which are central in the academic debates, and places more explicit importance on the potential role of mediators. The quality of facilitation is hardly measured, and the academic contributions on how to improve it are scarce (a notable recent exception is Pelzer et al., 2015b). But a good facilitator that guides the knowledge exchange of a group of planners and structures the interactions between this group and the PSS could influence many of the classical user-friendliness dimensions. This assumption is supported by the gradual increase in the experienced user-friendliness scores in consequential experiments with Urban Strategy. The technical dimensions of the instrument remained unchanged, but the developer put more effort into the facilitation of the sessions. To further enrich our understanding of this, we should include the qualities of the mediator in studies on the use of PSS.

The research described in this paper advanced the academic debate on PSS use by the explicit operationalization of the concepts of user-friendliness and usefulness into concrete characteristics and by exploring how these characteristics interact. A PSS developer/mediator needs to be trained to listen carefully to the user's needs in a specific context and to adapt the PSS accordingly. Going back to the coffee metaphor, the barista needs to be trained to brew a good cup of coffee and to fulfil customer requests. User-friendliness is important, but hands-on experience seems to be less relevant for this. The most user-friendly PSS, according to the student participants, was the one fully operated by two mediators.

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Appendix A

Please give your group number:	
Please give your student number:	
Which maps did your group use?	

	Strongly disagree						Strongly agree	N.A.
	1	2	3	4	5	6	7	
The tool is **transparent** for me	◯	◯	◯	◯	◯	◯	◯	◯
The c**ommunicative value** of the output is high	◯	◯	◯	◯	◯	◯	◯	◯
The outputs of the tool are **well displayed**	◯	◯	◯	◯	◯	◯	◯	◯
The tool is **user friendly**	◯	◯	◯	◯	◯	◯	◯	◯
The outputs **are credible**	◯	◯	◯	◯	◯	◯	◯	◯
The tool is **broad enough**	◯	◯	◯	◯	◯	◯	◯	◯
The focus of the tool is **specific enough**	◯	◯	◯	◯	◯	◯	◯	◯
The **level of detail** of the maps is sufficient	◯	◯	◯	◯	◯	◯	◯	◯
The tool is **easy to understand**	◯	◯	◯	◯	◯	◯	◯	◯
The tool facilitated the **evaluation of alternatives**	◯	◯	◯	◯	◯	◯	◯	◯
The tool supported **creating ideas**	◯	◯	◯	◯	◯	◯	◯	◯
The tool supported **sketching ideas**	◯	◯	◯	◯	◯	◯	◯	◯
I understand what is **(not) considered in the indicators**	◯	◯	◯	◯	◯	◯	◯	◯
Due to the tool we were able to perform the work with less effort	◯	◯	◯	◯	◯	◯	◯	◯
Due to the Erreichbarkeitsatlas we were able to perform the work in less time	◯	◯	◯	◯	◯	◯	◯	◯
Due to the tool we were able to do more in the same time	◯	◯	◯	◯	◯	◯	◯	◯

Do you have any other remarks about the instrument: (i.e. Did you miss any information?)

Appendix B

Can you please give your group number:	
Can you please give your student number:	

	Strongly disagree 1	2	3	4	5	6	Strongly agree 7	N.A.
I have a good feeling about the session	○	○	○	○	○	○	○	○
The session resulted in valuable results	○	○	○	○	○	○	○	○
The session was successful.	○	○	○	○	○	○	○	○
I am satisfied with this session.	○	○	○	○	○	○	○	○
The other participants are satisfied with the session	○	○	○	○	○	○	○	○
The results of the session offer real solutions for the problem	○	○	○	○	○	○	○	○
The results of the session are based on correct assumptions on the underlying system	○	○	○	○	○	○	○	○
I am confident that the group solution is correct	○	○	○	○	○	○	○	○
My insight into the problem has increased.	○	○	○	○	○	○	○	○
The session has given me insight into relations between elements that compose the problem.	○	○	○	○	○	○	○	○
It is clear to me what the causes of the problem are.	○	○	○	○	○	○	○	○
I now have more insight into the processes that play a role in the problem.	○	○	○	○	○	○	○	○
The session resulted in new insights.	○	○	○	○	○	○	○	○
My understanding of the opinions of the other participants about the problem has increased.	○	○	○	○	○	○	○	○
I understand how other participants in the session perceive the problem.	○	○	○	○	○	○	○	○
Other participants understand how I perceive the problem	○	○	○	○	○	○	○	○
I better understand the proposed solutions of other participants in the session.	○	○	○	○	○	○	○	○
I support most of the results that were drawn during the session.	○	○	○	○	○	○	○	○
The process has given me insight into other people's opinions and ideas about the problem.	○	○	○	○	○	○	○	○
During the sessions we have developed a shared professional language	○	○	○	○	○	○	○	○
During the sessions a platform emerged that supported the sharing of ideas	○	○	○	○	○	○	○	○

We have reached a shared vision of the problem.	◯	◯	◯	◯	◯	◯	◯	◯
The results integrated diverse opinions and ideas of the participants.	◯	◯	◯	◯	◯	◯	◯	◯
We were able to reach a consensus on the problem.	◯	◯	◯	◯	◯	◯	◯	◯
We have reached a shared vision on the strategic goals	◯	◯	◯	◯	◯	◯	◯	◯
We have reached a shared vision on the possible solutions	◯	◯	◯	◯	◯	◯	◯	◯
I had a strong sense of being part of a group	◯	◯	◯	◯	◯	◯	◯	◯
The session brought me closer to the other participants	◯	◯	◯	◯	◯	◯	◯	◯
We experienced conflict during the session	◯	◯	◯	◯	◯	◯	◯	◯
There was conflict about the task we had in the session	◯	◯	◯	◯	◯	◯	◯	◯
The session was time efficient	◯	◯	◯	◯	◯	◯	◯	◯

Do you have any other remarks about the process?:

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