Manuscript

Urban Analytics and City Science

EPB: Urban Analytics and City Science
2023, Vol. 0(0) 1–19

DOI: 10.1177/23998083231217784
journals.sagepub.com/home/epb
Sage

Place-bound planning support systems for deliberation: Affording better communication and comprehension

Raz Weiner
Technion, Israel

Filipe Mello Rose
WISSENSAR-CHITEKTUR – Laboratory of Knowledge Architecture, Technische Universität Dresden, Germany

Batel Yossef Ravid
Technion, Israel

Jörg Rainer Noennig
Digital City Science, HafenCity Universität, Germany

Meirav Aharon-Gutman
Technion, Israel

Abstract

Despite planning support systems (PSS) becoming increasingly useful for citizen participation processes, the effects of such systems' material and spatial setup on citizen participation processes still need to be studied. PSS have long been equated to software- and data-based technologies, and only little attention has been put on *place-bound* PSS that prescribe onsite face-to-face collaboration. As closing the 'implementation gap' requires extensive conceptualisation, description, and critical analysis of different ideal types, workings, and use cases of PSS, this study researches this understudied place-bound type of PSS. More precisely, this study uses empirical material from Haifa's 3 S Lab to contribute to closing the implementation gap by identifying place-bound PSS – an understudied type of PSS – as useful for deliberative decision-making – an overlooked implementation context. This research advances the conceptualisation of PSS by discussing *place-bound* PSS and their hypothesised utility, practical setup, and empirically tested benefits for deliberative citizen participation. We find that the benefits of place-bound PSS for planning lie in *deliberative affordances* that

Corresponding author:
Raz Weiner, Faculty of Architecture and Town Planning, Technion, Segoe Building, Haifa 3200003, Israel.
Email: weiner.raz@campus.technion.ac.il

Data Availability Statement included at the end of the article

ease the communication and comprehension deficiencies that often plague deliberative citizen participation processes. As *place-bound* PSS, the 3 S Lab provides an immersive shared space that improves communication, while its interactive visualisation techniques afford improved comprehension of complex urban issues.

Keywords
Deliberation, technological affordance, place-bound planning support system, immersion, interactive visualization

Introduction

This research explores the place-boundedness of planning support systems (PSS) as a characteristic that affords improvements to deliberation-based citizen participation. PSS are computer-based tools that 'assist planners to more effectively undertake their day-to-day professional jobs' (Geertman and Stillwell, 2020: 2). These systems can facilitate various routine planning activities 'through big data analysis, visualisation, and modelling' (Pelzer, 2015). While PSS have diverse material and spatial configurations, they have long been equated to software- and data-based technologies (e.g. Pettit et al., 2018). Little attention has been given to PSS that are closely linked to specific hardware, such as interactive 'Maptables' (e.g. Baeza et al., 2021; 2021; Champlin et al., 2019). To explore this understudied type of PSS, we distinguish between *place-bound* PSS that prescribe onsite, face-to-face collaboration and *web-based* PSS that enable decentralised, networked collaboration. Naturally, many applied PSS are situated between these two 'ideal types'. In parallel to the development of PSS, urban planning has become increasingly focused on coordinating communication between diverse stakeholders (Klosterman, 1997), particularly by inviting citizens to participate in urban planning (e.g. Bingham et al., 2005; Fung and Wright, 2001; Healey, 2004). Citizen participation underwent a 'deliberative turn' (Ganuza and Francés, 2012; Thompson, 2008) towards structuring citizen participation through informed, reasoned, and intellectually honest communication (Bächtiger et al., 2010; Cohen, 2005; Steiner, 2018). Both trends – the use of PSS and deliberative communication methods – overlap. PSS can function as information infrastructures that integrate vast information relevant to planning and support 'interactive, integrative and participatory procedures' (Klosterman, 1997: 51; also Flacke et al., 2020). This overlap of planning support systems and (increasingly deliberative) citizen participation is the initial research interest of this paper.

Research on PSS has long lamented an 'implementation gap' between the increasing supply of PSS and limited actual demand for these systems by planning authorities (Jiang et al., 2020). This 'implementation gap' can be mitigated by describing and analysing use cases and best practices (Jiang et al., 2020; Vonk et al., 2005). In other words, these case studies should not only advance the understanding of different types of PSS and the contexts of their implementation but also demonstrate how these systems benefit planning practice (Vonk et al., 2005). In this light, the present study uses empirical material from Haifa, Israel, to contribute to closing the implementation gap by identifying place-bound PSS – an under-studied characteristic of specific PSSs – as useful for deliberative decision-making – an overlooked implementation context – in which planning practice benefits from PSS use. This research thus aims to advance the conceptualisation of PSS by discussing *place-bound* PSS and their hypothesised utility, practical setup, and empirically tested benefits for deliberative citizen participation.

The empirical testing of the benefits of place-bound PSS for citizen participation occurred during a participatory process on the state of older citizens conducted by Technion's Smart Social Strategy Lab (3 S Lab) in Haifa, Israel, between January and November 2021. The empirical material

includes semi-structured interview data and transcripts of the participatory work sessions in which participants reflect on their personal experience of the work in the 3 S Lab.

This study finds that the benefits of place-bound PSS for planning lie in creating *deliberative affordances* that ease communication and comprehension problems hindering effective deliberation-based citizen participation. Technological affordances refer to the complex relationship between an 'object/technology and the user that enables or constrains potential behavioural outcomes in a particular context' (Evans et al., 2017: 36). In other words, affordances frame but do not dictate the users' possibilities for action. In this study's case, place-bound PSS afford improvements in deliberative citizen participation in (at least) two ways. First, place-bound PSS represent a shared immersive space that reduces communicative shortcomings by easing empathetic and respectful communication among deliberation participants. Second, place-bound PSS afford a better comprehension of complex urban issues through interactive visualisation of urban data and bridge knowledge gaps between participants and between different kinds of knowledge (for instance, professional, experiential, or tacit knowledge).

Our study primarily contributes to planning support science, an emerging field at the crossroads of planning, urban design, and city science (Geertman and Stillwell, 2020). The contributions primarily lie in conceptualising place-based PSS and highlighting how they can be used as participation technologies that use data analysis and visualisation techniques to improve participatory design and governance processes. By investigating how citizens using PSS perceive and react to technological affordances, we advance knowledge on how the interplay of data, software, and hardware consciously and unconsciously structures participants' cognition and behaviour. Moreover, by theorising 'deliberative affordances', our research contributes to the literature on deliberation, a sub-field of political science. By discussing the potential of technological solutions to improve deliberation, this research provides insights into the relationship among participatory governance, democratic innovation, and technology.

The remainder of the paper is structured as follows. To contribute to closing the implementation gap, this study first conceptualises place-based PSS and their use of deliberative citizen participation based on the newest literature. Then, the context of the implementation and use of an existing PSS is described in a second section. Finally, we analyse the benefits of using place-bound PSS for deliberation-based citizen participation before concluding with a discussion of our conceptual and empirical propositions.

Conceptualising place-bound PSS

Planning support systems: Web-based or place-bound

Since the 1970s and 1980s, the recognition that public decision-making in planning is inherently political has also changed the role of technology in planning towards a greater focus on communication and negotiation between stakeholders. During this time, early geographic information systems (GIS) and decision support systems represented initial planning support systems used as sources of information and knowledge (Batty, 2007). In the 1990s, computing had advanced to allow effective integration of planning tools into an information infrastructure (Klosterman, 1997). The improvements in computing capacity and user-friendliness eased the dissemination of planning support systems in the following decades leading to the emergence of *planning support science*, a field dedicated to studying and developing such systems (Geertman and Stillwell, 2020). According to a recent review by Daniel and Pettit (2022), this planning support science mainly consists of four research streams: (1) applications, case studies, and reviews; (2) modelling techniques; (3) multi-criteria analysis and land-use suitability; and (4) participatory systems. The four streams indicate the field's dual concern with proposing technological innovations (streams 2 and 3) and their

scientifically accompanied implementation in planning in general (stream 1) and for citizen participation processes in particular (stream 4) (Daniel and Pettit, 2022). This article focuses on applying PSS for citizen participation processes and is closely linked to the respective literature stream.

PSS are vastly heterogeneous regarding their material and spatial configurations. While some PSS are online applications that can run on any computer with enough processing power (e.g. Pettit et al., 2018), other PSS are closely linked to specific hardware, such as interactive tablets and 'Maptables' (e.g. Baeza et al., 2021; Champlin et al., 2019). However, while planning support science discusses data analysis and visualisation practices (see Daniel and Pettit, 2022), the material-spatial configurations characterising different PSS have only caught minimal scientific attention. Yet, recent evidence suggests that PSS are increasingly used as 'part of a dynamic workshop or process in which a range of stakeholders engage' (Champlin et al., 2019). Different spatial-material characteristics of PSS, such as the hardware used, influence the outcomes of PSS usage (Champlin et al., 2019). Research disentangling online PSS from PSS linked to different types of hardware or places is thus increasingly gaining relevance within planning support science.

To address this lack of distinction between different material and spatial configurations of PSS, we suggest distinguishing between two ideal types: web-based *PSS* that can run on almost all types of hardware and enables networked collaboration; and *fully place-bound PSS* designed for one specific place and onsite, face-to-face collaboration. This study will use this distinction to highlight how place-bound PSS can improve citizen deliberation processes.

Deliberation for urban planning

Deliberation aims to use collective intelligence to obtain fairer and better-informed policy decisions (Landemore, 2012). Deliberation-based citizen participation processes differ from referendum-style citizen participation processes in centring on argumentation in decision-making (Bächtiger et al., 2010: 35; Ryfe, 2005). In short, a deliberative approach to public decision-making means that 'collective decisions require justification to those subject to these decisions in terms that, on reflection, these individuals can accept' (Dryzek, 2001: 14). Implementing deliberation-based citizen participation is linked to the hope of overcoming the polarisation of democratic systems (Dryzek et al., 2019) by rejecting models of democracy that focus on the quantitative aggregation of preferences (Thompson, 2008: 498). In practice, deliberative ideals can be implemented through 'planning cells' (Dienel, 2001) or 'citizen panels' (Crosby et al., 1986), in which groups of non-expert citizens are provided with the time and the resources to co-decide on policy.

While deliberation is to some extent 'a natural human capacity' (Ryfe, 2005: 63), implementing deliberative participation 'requires particular knowledge, skills, and dispositions' (Sorial and Peterson, 2019: 25). In the absence of the necessary knowledge, skills, and dispositions, two major obstacles to the practical implementation of deliberation emerge (Rosenberg, 2014). First, participants often fail to *communicate* in a way that allows them to grasp each other's perspectives on the issues in question. Second, participants frequently demonstrate pre-set prejudices, beliefs, and experiences that make *comprehending* 'the means and ends of different courses of action' difficult (Rosenberg, 2014: 99).

To guarantee that 'all sides of the debate are heard' (Bächtiger and Beauvais, 2016: 10), overcoming communication failures and difficulties in comprehending complex problems requires active facilitation. This facilitation ensures that 'participants are working together as equals for a commonly valued goal' or fostering the 'formation of positive socio-emotional relationships among the participants' (Rosenberg, 2014: 115). Facilitators are also expected to actively provide information to the participants to guarantee that 'all stakeholders [have] equal and fair opportunities to be informed' (OECD, 2020). Well-facilitated deliberation allows participants to communicate and

have an 'understanding of the main competing arguments and their implications' (Fishkin, 2021: 20), thus overcoming both major obstacles to the practical implementation of deliberation.

Planning support systems for deliberative citizen participation

As mentioned above, over the past decades, PSS have been developed to support, scale, or improve communication in planning and participatory processes, including deliberative ones. The PSS include but are not limited to the participatory platforms (Anttiroiko, 2016; Deseriis, 2021; Peña López, 2019; Royo et al., 2020), 'open government' transparency portals, or tools for participatory film-making (e.g. Manuel and Vigar, 2021). The different material and spatial configurations of PSS shape their potential to facilitate deliberative citizen participation.

Web-based PSS, such as participation platforms, websites, and datasets, have proven effective in enabling an ever-greater number of citizens to participate in urban design and decision-making processes (Anttiroiko, 2016; Deseriis, 2021; Peña López, 2019; Royo et al., 2020). Digital participation platforms such as U_CODE, DIPAS, Adhocracy, or Decidim (Kneuer, 2016; Mello Rose, 2021; Soltani, 2019) represent a rapidly increasing field of application of e-democracy (Hennen et al., 2020). Such platforms focus on expanding access to participatory processes by facilitating asynchronous and low-cost online digital participation (Deseriis, 2021; Jankowski et al., 2019). Nevertheless, deliberation based on web-based PSS is often characterised by brief, superficial debates of radically opposing opinions rather than a search for common ground (e.g. Aragón et al., 2017). Other web-based PSS involve individual citizens as the source of (quantitative) data rather than stakeholders with complex opinions who are capable of participating in collective decision-making (Lin and Benneker, 2022). Thus, most digital participation platforms seem to be focused on gathering individually formulated and undebated proposals of the biggest possible group of citizens and/or on pursuing an aggregative model of democracy with referendum-style voting processes. In other words, deliberation on web-based PSS risks being 'shallow' in discursive depth and deliberative quality.

Place-bound PSS embed digital technologies into physical and social infrastructures. This way, place-bound PSS combine not only data and advanced software but also screens, projectors, interactive touch tables, or sensors *in dedicated spaces*. We therefore understand place-bound PSS to be most useful in a town hall meeting-type of (face-to-face) deliberative participatory processes. In contrast to web-based methods, place-bound PSS are 'an opportunity for face-to-face interaction, a real-time setting for an argumentative discourse, and an opportunity to create social bonds and trust' (Jankowski et al., 2019: 512). Based on this understanding of place-bound PSS, we identify a need to inquire into *how* place-bound PSS can function as suitable tools to support deliberation-based citizen participation in planning processes. This study will serve as a starting point for wider research of the ways through which technical/data-based interaction in place-bound PSS (e.g. touchscreens, wall projections, and tactile tables) can afford improvements in the diverse deliberation formats (e.g. citizen jury, parliament, court of law, and speakers' corner). This way, this study combines various strands of literature summarized in Table 1.

The pilot application: 3 S Lab as a place-bound PSS for deliberation

To assess the affordances of place-bound PSS on deliberative practices, we conducted a pilot study on a deliberative process in the 3 S Lab, a pilot application of a place-bound PSS. This study rests on a qualitative case-study methodology. While most research in social sciences fails to produce absolute generalisations, case studies allow for the dissemination of context-dependent knowledge as the 'closeness of the case study [allows] to real-life situations and its multiple wealth of details' (Flyvbjerg, 2006: 223). This wealth of details allows researchers to generate hypotheses and

Table 1. Summary of main findings from the literature.

References	Key contribution to the research
Klosterman, 1997; Batty, 2007; Daniel and Pettit, 2022; Geertman and Stillwell, 2020	**Background of PSS and emergence of planning support science**: Geographic information systems (GIS) and decision support systems evolved into initial planning support systems that can improve decision-making with readily available information and visualization. These tools were increasingly used for collaborative decision-making. Planning support science is the field dedicated to studying and developing PSS with a particular focus on (1) applications, case studies, and reviews; (2) modelling techniques; (3) multi-criteria analysis and land-use suitability; and (4) participatory systems
Pettit et al., 2018; Baeza et al., 2021; Champlin et al., 2019	**Examples of different types and uses of PSS**: Pettit et al. (2018) highlight the variegated uses of fully digital PSS are useful to improve collaborative urban governance. Baeza et al. (2021) show that some PSS can also be linked to specific hardware. Champlin et al., 2019 show how PSS are increasingly used as in workshop setting to enhance stakeholder participation. The spatial-material setup of the PSS (i.e. either fully digital/online or in a place-bound/face-to-face setting) matters
Landemore, 2012; Bächtiger et al., 2010; Dryzek, 2001; Dryzek et al., 2019	**Definitions of deliberation and deliberative democracy**: Deliberation differs from aggregative, referendum-style citizen participation by centring on reflection and consensus-orientated argumentation. Deliberative citizen participation aims to achieve fairer and better-informed policy decisions through a reasoned debate among a representative group of citizens. More recently, deliberative decision-making is viewed as a means to overcome a growing political polarisation
Ryfe, 2005; Sorial and Peterson, 2019; Fishkin, 2021; Rosenberg, 2014	**Capacity of citizens for deliberation**: The capacities of (different groups of) citizens for successful deliberation have sparked debate among scholars. While Ryfe maintains that deliberation is 'a natural human capacity', others point to varying capacities across different parts of society. Crucially, Rosenberg (2014) highlights that two major obstacles to the practical implementation of deliberation are (1) communication and (2) comprehension
Sorial & Peterson, 2019; Fishkin, 2021; Bächtiger and Beauvais, 2016; Rosenberg, 2014	**Facilitation of deliberation**: To guarantee that deliberation is successful and involves all viewpoints, deliberative processes must be actively facilitated to ensure participants grasp the primary opposing perspectives and their consequences. Over the past years, multiple techniques of facilitation also involve technological tools
Deseriis, 2021; Peña López, 2019; Royo et al., 2020	**Facilitation of deliberation with online PSS**, such as participation platforms, websites, and datasets, has proven effective in enabling an ever-greater number of citizens to participate in urban design and decision-making processes

(continued)

Table 1. (continued)

References	Key contribution to the research
Aragón et al., 2017; Lin and Benneker, 2022	**Criticism of deliberation using online PSS**: A case study by Aragón indicates that online digital participation platforms feature superficial debates of radically opposing opinions, rather than a search for common ground. Lin and Benneker find that while web-based PSS support collaborative planning. However, these PSS often involve citizens as data source, rather than stakeholders with complex opinions that are capable of participating in the collective decision-making
Jankowski et al., 2019	**Facilitation of deliberation with place-bound PSS**: Place-based PSS allow in-person interaction which eases the real-time exchange of ideas and the emergence of a constructive debate, which requires a minimal level of social connections and trust that does not emerge online

conceptualise new research directions (Flyvbjerg, 2006) and practitioners to close the implementation gap (Jiang et al., 2020; Vonk et al., 2005).

While the generated knowledge of case studies is context-specific, situating a given case in relation to wider sets of cases allows researchers to draw careful conclusions beyond that single case (Flyvbjerg, 2006). In this sense, we approach the study on a 3 S Lab as a 'paradigmatic case' (Flyvbjerg, 2006) that presents the creation of a place-bound PSS as a paradigm which applies various international best practices to a single participatory space.

The 3 S Lab: A place-bound PSS

The 3 S Lab is an oval-shaped, 34-square metre interactive visualisation theatre (Orenstein et al., 2015; Yossef Ravid and Aharon-Gutman, 2022) inspired by the VR model of CAVE,[1] in which the real environment is 'augmented' by a virtual (computer graphic) display in a closed room (Hanzl, 2007; Mitasova et al., 2012; Portman et al., 2015) (see Figure 1). An interactive touch table with chairs is at the centre of the 3 S Lab. Around it, the lab features an (almost) 180-degree video projection on a concave wall and surround-sound speakers. Deliberation participants thus gather in a semicircle around the interactive table within the oval space of the 3 S Lab. Recent experiments with participatory planning processes relied successfully on interactive touch tables as their key technology (Noyman et al., 2017; Stelzle et al., 2021). The 3 S Lab includes a 'Digital Twin' of the surrounding area (Batty, 2018; Dembski et al., 2020; Ruohomaki et al., 2018) – that is, a digital 3D model of the Hadar neighbourhood in Haifa, Israel. The digital twin allows aggregation, spatial representation, and analysis of multiple layers and forms of data.

As part of its ambition of community engagement, the 3 S Lab is not located at the Technion's main campus but in the Haifa neighbourhood of Hadar. This neighbourhood has a considerable proportion of older, low-income citizens and suffers municipal neglect and high crime rates.

The deliberative process in the 3 S Lab on the state of the older citizens

In the pilot application of the 3 S Lab for deliberation between citizens, we observed that the parameters of communication and comprehension and their related affordances are a 3 S

Lab-initiated process to produce tangible improvements to the current state of older citizens in the Hadar neighbourhood.

Over 1 year, representatives of the community of older citizens, municipality officials, and civil-society community organisers met at the lab regularly and used its various technologies. The process was carried out in five sessions, of which four took place in the 3 S Lab, were 2 to 3 h long and had a specific topic and goal (Table 2).

The group of participants consisted of adults of a range of ages, both women and men, Jews and Arabs, who participated voluntarily. All members of the examined group of stakeholders have first-hand unmediated knowledge of the everyday lives of older citizens in the neighbourhood. The participants could compare their tacit and intuitive knowledge with statistical data and urban

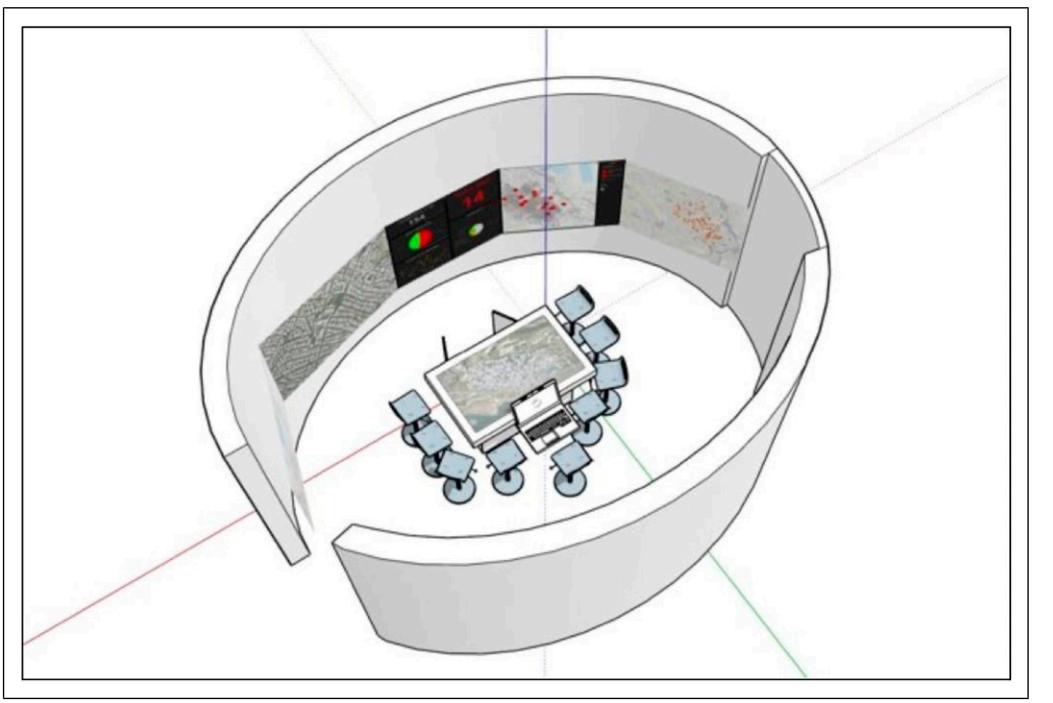

Figure 1. Proportional drawing of the smart social strategy lab. Drawing by arch. Batel Yosef-Ravid.

Table 2. List of sessions that formed the participatory process at the 3 S Lab.

S	Session date	Session number	Content of working session
1	17/03/21	1	Individual exploration of Digital Twin
2	13/04/21	2	Collective work within DTC
3	30/05/21	3	Tour – facilitated by the group members from the Department of Welfare and residents
4	29/06/21	4	Discussion and proposition of solutions
5	28/11/21	5	Each stakeholder suggested an 'action' relevant to their level of responsibility/involvement. Discussion about how to integrate the different actions

development plans, allowing them to evaluate the state of older adults in a collective and communicative process.

Analytical steps

We draw on empirical data from two major sources: (1) transcripts of the working sessions of the participatory process on the state of older citizens (Table 2) and (2) semi-structured interviews with eight participants, combining first and third-sector agents (i.e. social workers, community activists, and highly involved individual citizens; see Table 3). The participants of the workshops gave signed consent to be recorded during the session by the cameras and microphones installed in the 3 S Lab. All eight participants interviewed at the end of the participatory process had participated in at least three working sessions (see Table 3) and gave signed consent to be interviewed.

A qualitative methodology was applied to address the nuances of technological affordance rather than its intended use or impact (Guest et al., 2011). The data was analysed in the following steps: First, semi-structured interviews took place inside the 3 S Lab, each about an hour long, and consisted of a first open part where interviewees commented freely on the process and a second part in which they replied to specific questions about the use of technology in the process. Second, the textual data from the sessions' transcripts and interviews were divided into individual statements (n = 211), coded (using MAXQDA software), and grouped into the 10 most common thematical categories (i.e. thematic analysis). This allowed us to assess the main issues raised by participants in both the sessions and the interviews. All iterations were examined to be related to (1) communication, (2) comprehension, (3) both or (4) other (Figure 2). However, the thematic analysis of statements does not indicate the context in which they were uttered, nor is any value judgement implied. Therefore, to examine whether affordances were related by participants to enhanced communication or enhanced comprehension, a second stage of discourse analysis was applied, attending to the use of language, context, and syntax of individual statements (Brown et al., 1983) (Figure 2).

Deliberative affordances of place-bound PSS

Contextualising the outcomes of the deliberative process in the 3 S Lab

In their statements, the participants frequently indicated enhanced comprehension (41%), enhanced communication (17%), or both (7%) Figure 3. Taken together, more than half of the statements collected from participants' feedback were related to these themes. While the thematic analysis alone does not directly relate increased comprehension and communication to the technology of the

Table 3. List of interview sources.

I	Interview date	Interviewee profile	Sessions attended
1	12/26/2021	Female, charity CEO	1, 2, 4, and 5
2	12/26/2021	Female, elderly citizen dpt	2, 3, 4, and 5
3	12/26/2021	Female, social worker	1, 2, 3, 4, and 5
4	12/28/2021	Male, municipal community work coordinator	1, 2, and 5
5	02/03/2022	Female, community organiser	1, 2, 3, 4, and 5
6	02/03/2022	Male, elderly citizen activist	1, 2, 4, and 5
7	23/03/2022	Female, community organiser	1, 2, 3, 4, and 5
8	24/03/2022	Male, social worker, co of welfare NGO	1, 2, 3, 4, and 5

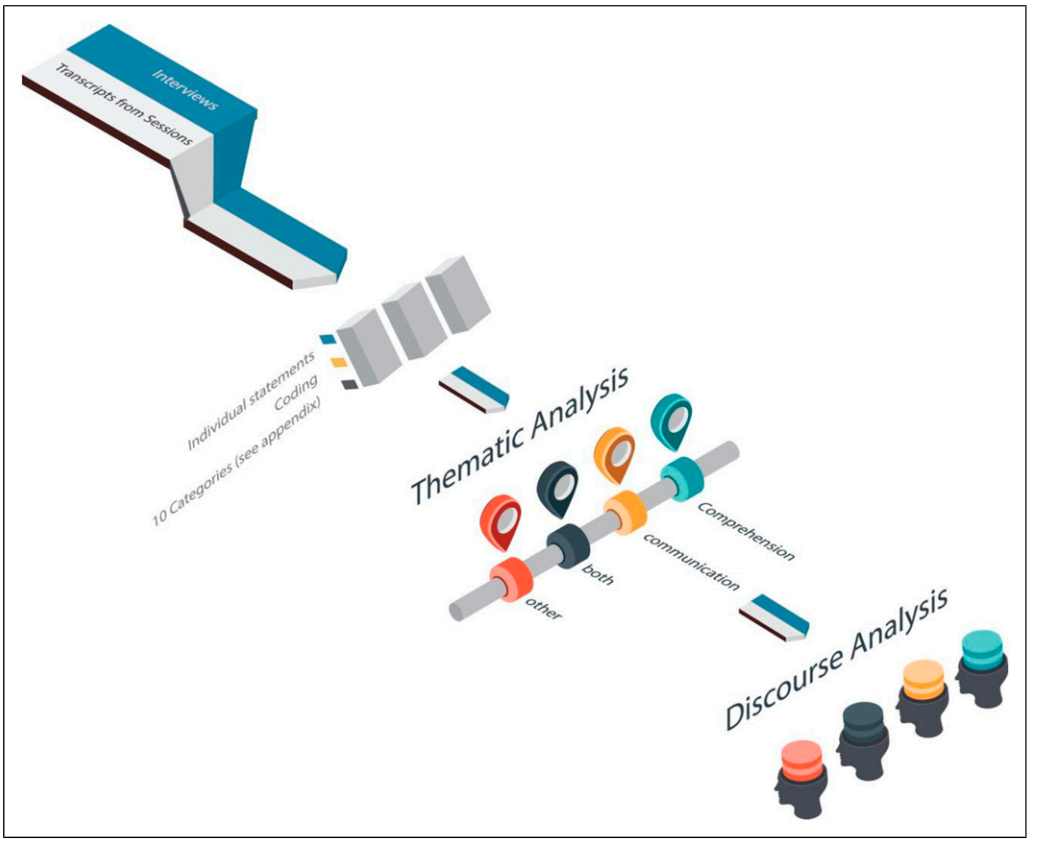

Figure 2. Methodological procedure scheme. 1. Coding (MAXQDA), 2. thematic analysis, and 3. discourse analysis. Graphics by Roni Mero.

3 S Lab, it does confirm that both these deliberative elements were central to the reported experience of participants in the process carried out in it. The discourse analysis of the transcripts examined the contexts of individual statements relating to changes in communication and comprehension linked to the PSS.

Affording better communication through a shared immersive environment

The participants highlighted the importance of the personal presence of the different stakeholders in the lab and its role in encouraging collaborative thinking and initiative repeatedly (I1, I3, I4, I6, I7, and I8). In this, they indicated the strong influence of the room's setup, its unique oval architecture and immersive qualities, and the physical presence of the different stakeholders. Being in the room seems to represent a positive change from the day-to-day work environment of many of them (I2, I4, and I8). A social worker explained the following: 'We get stuck into the daily routine and forget to collaborate, each to her own, and you can't just live in one world. We must have integration between them, one informs the other' (S1). The transition into a unique, specialised environment markedly different from everyday routines is an initial indicator of the affordance of immersive technology. The immersive quality of the experience was relayed by participants in different ways, as a 'special feeling' of being in the room (I2, I4, and I7), making you feel 'surrounded by data' (I3). A civil

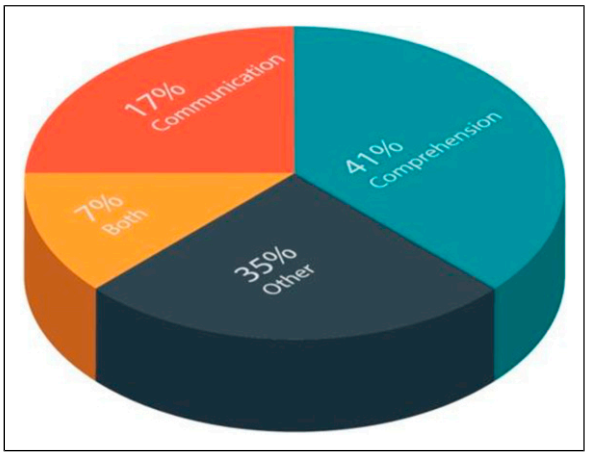

Figure 3. Thematic analysis: the proportion of statements directly addressing comprehension and communication out of the total sum of statements. Each statement is counted once (n = 211). Graphics by Roni Mero.

society activist said it made her 'feel uncomfortable to be side-tracked, to look at the phone [and lose focus]' (S2).

The positive perception of immersion by participants aligns with the growing literature on the positive relationship between immersion and agency (Hasler et al., 2021; Kishore et al., 2016; Orenstein et al., 2015; Sopher et al., 2019; Toland and Kilbane, 2018). However, differing from studies on individual immersive experiences, the quality of immersion was coupled by participants with the collective presence of the group in the room, highlighting the relevance of the lab for developing a joint strategy by 'connecting all the social bodies in the city' (S5). The effect of a shared immersive space seems to foster a motivation to participate and to encourage a re-evaluation of the potential of collaborations and teamwork. Participants associated collaboration with the mutual engagement of collectively witnessing and analysing data visualisations while being together in one place, as one group, around the touch table (I3, I6, and I7; see Figure 4). The sense of collective witnessing of data was enhanced by the size of the projection, which also serves an immersive function, where the data 'is in your face, you - literally - can't not see [the reality]' (S4, I2).

Beyond collaboration, special attention was given in the reflections to the ability to aggregate different points of view, varied subjective experiences, and information held by the different stakeholders in one place. 'The 3 S Lab enables synchronisation of knowledge. At the moment, this depends on [our] goodwill and personal conversations' (S1), said a social worker, foregrounding the potential of the lab to routinise the flow and integration of knowledge between different actors in the neighbourhood. 'We must connect all kinds of people that bring data: communities, NGOs, social workers' declared a community organiser (I4). Sitting around the table together and shifting the gaze from the visualised data on the screen to one another induced a sense of commitment and answerability between participants, as they 'look each other in the eyes' and are able to 'put egos aside' (I6 and I8, respectively).

Affording better comprehension through interactive visualisation

Visualisation techniques are foregrounded in the literature as a critical means to make (big) data accessible and available to non-expert stakeholders, citizens, and decision-makers in processes of

Figure 4. Interactive visualisation: participants explore different scales of data on a dashboard and on the neighbourhood digital tween together. Image captured on cameras of the 3 S Lab.

participatory planning (Cui et al., 2014; John et al., 2020; Lv et al., 2019). Aharon-Gutman et al. demonstrate how the visualisation of inequality through 3D topographic models exposes and facilitates trends and relations unaccounted for in 2D graphs and maps (Aharon-Gutman et al., 2018). As visualisation gradually takes predominance over written language (Mitchell, 1995), there is a need not only to show deliberators fixed images but also to allow interaction with visualisation technology as a means of expression, contemplation, and interpretation. Visualisation technologies, therefore, have the potential to improve deliberative practices by 'translating ideas into easily comprehensible visual representation [that] is key to effective deliberation about urban planning' (Gordon and Manosevitch, 2011: 79).

Participants' responses and reflections on the theme of vision and sight, highlighting the lab's capacity to generate a 'bigger picture', strongly align with the literature on visualisation and deliberation. Responding to a simulation of the neighbourhood that marks in red all the buildings where older citizens live, a welfare worker commented, 'this layer of information is highly important for us to get an idea of where we live, [to grasp] the actual reality of it' (S4). Given the close acquaintance of all group members with the reality of older citizens in Hadar, this statement foregrounds the potency of visualised data to generate a compelling 'sense of reality' or a 'reality check' (S4, also elaborated in I4). The experience of a shared revelation of previously invisible meaning through data visualisation significantly intercepts the affordance of vision with the affordance of shared space into collective witnessing, generating an experience of 'now *we* can all *see* it'. Many of the participants addressed the interaction with visualisation technologies in the lab as a means of control in relation to the ability to zoom in and out, that is, to interactively play with scales both conceptually and tactilely through the touch table (see Figure 4). 'There is a connection [in the lab] between the micro and the macro. I can look at a wide area and the street level' (S1), said a social worker.

Another visualization-related tension marked by participants is one located between the knowledge brought to the process by them and the data presented in the lab. Participants repeatedly indicated the relevance of verifying experiential knowledge through data to improving their work.

This appeared in (1) validation of subjective knowledge that empowers the participants' position and boosts their confidence and (2) the coming into awareness of issues of concern they did not know before. 'We can learn so much from what we see here, it explains things we feel all the time, but now we understand what they mean' (S4), said a welfare worker. One social worker explained 'what I see in the field during the past decade and that I keep saying all the time - now I can see it in 3D – finally, it has some visibility and acknowledgement' (S4). A third participant reiterates the previous two, saying '[now] we can prove statistically that we are right. This strengthens us, we come with the data, and we feel it in the field' (S4). The interactive nature of data visualisation technologies used in the 3 S Lab facilitated the comprehension of complex issues and served as a means to communicate, transcribe, and validate multiple types of knowledge. This way, the 3 S Lab allows the integration of multiple types of knowledge into productive deliberative communication.

Discussion and conclusion

This article advances the study of PSS in two ways. First, we conceptualize place-bound PSS as a particular, understudied type of PSS. Second, we identify deliberation with citizens and civil society actors as an area of application in which the place-boundedness of PSS can be particularly useful. Both contributions – conceptualising different types of PSS and testing their real-world application – are measures that support closing the 'implementation gap' (Jiang et al., 2020; Vonk et al., 2005).

Our pilot application of place-bounded PSS in the 3 S Lab demonstrates how this type of PSS has deliberative affordances that address two main shortcomings of deliberation processes: failures in communication and lack of comprehension of complex policy problems. Place-bound PSS can, for one, afford a shared immersive space that improves communication among deliberation participants. For another, place-bound PSS enable interactive visualisation that affords better comprehension of complex urban issues and different experiences and subject positions. Furthermore, our findings indicate that the two *analytically* distinct affordances, immersion in a shared space and interactive visualisation, mutually reinforce each other. We, therefore, find that the 3 S Lab represents a paradigmatic example of how place-bound PSS can help overcome communicative and cognitive shortcomings that render deliberative citizen participation difficult to operationalise.

The shared immersive experience described by participants as a 'special feeling' represents a 'formation of positive socio-emotional relationships among the participants' that improves deliberation (Rosenberg, 2014: 115). Establishing such socio-emotional relationships is precisely possible because of the technology's place-bound character, necessarily requiring participants' co-presence in a common physical space. While online digital processes have the advantage of involving more participants by being more scalable (Jankowski et al., 2019), place-bound PSS create socio-emotional relationships that ease deliberative discussions.

Once the co-presence in a common physical space is established, the interactive visualisation affords participants a better comprehension of complex urban issues. The interactive visualisation allows participants to confirm and complement their tacit day-to-day knowledge of the neighbourhood. Even without mobilising complex simulations, the technologies of the 3 S Lab ease the analysis of urban problems by rendering urban data more easily accessible and understandable. This way, the 3 S Lab provides an easily usable and interactive way of enabling deliberation participants to familiarise themselves with local issues. Supporting participants with such interactive visualisation tools can enable them to make better-reasoned arguments, which are more likely to lead to other participants reconsidering their views in deliberative processes (Gerber et al., 2018). However, given the population's heterogenous capacities to use interactive visualisation technologies to make an argument, future research should engage strongly in debates regarding equality- or equity-based inclusion in deliberative processes (e.g. Bächtiger and Beauvais, 2016). Moreover, establishing and running (place-bound) PSS and carrying out deliberation-based citizen participation require

significant financial resources. Allocating scarce public resources with unclear returns and effects on planning practices might exacerbate inequalities within and across cities. Further research is thus necessary to learn more about the costs and benefits of supporting deliberative processes with place-bound PSS.

The two deliberative affordances mutually reinforce each other to allow participants to include and relate to different types of knowledge through contrast and comparison in a collective effort. The 3 S Lab highlights how the different components of (place-bound) PSS can afford different prerequisites of deliberation: visualised data affords rationalised and fact-based discussions (Cohen, 2005), while the collective immersive experience in the 3SLab affords the creation of emotional connections, answerability, and the facilitation of emotion-based arguments. These two affordances echo Ryfe's assertion that 'successful deliberation seems to require a form of talk that combines the act of making sense (cognition) with the act of making meaning (culture)' (2005: 63). The group setting of gathering around a table appears to support shared affective responses to data and feeds them back into the deliberation process. This way, rational arguments are synthesised alongside and in tandem with storytelling, affect, and intuition (following the deliberation model by Ryfe, 2005). The increasing use of technological tools in deliberative participatory processes also raises questions on the possibility of affordances to restrict deliberation, such as prioritising big data as the basis for deliberation over other input types. Future research should question the potentially adverse effects of technology on deliberative capacities. This could mean focussing on how a greater focus on data impacts the micro-social dynamics during deliberation processes using place-bound PSS.

The study of the pilot application in the 3 S Lab has multiple limitations. The generated knowledge is context-specific due to empirical reliance on a single case study from a particular urban, geopolitical and social context (i.e. Haifa's Hadar neighbourhood). As an analysis of a 'paradigmatic case' (Flyvbjerg, 2006), this research is conditioned by the exemplar character of the 3SLab. As a pilot of a novel form of place-bound PSS, only a few comparisons are available. The 3SLab's essentially unique design and setup as place-bound PSS limits even the most careful application of this paper's findings to all PSS of this type. Drawing from a single deliberative process, this study cannot control for different effects of the lab's components (i.e. screens, data, room, and interactive touch table). Future research should replicate this analytical framework in other case studies of place-bound PSS and distinguish between the workings of individual technologies by controlling the affordances of individual components.

These limitations notwithstanding and given the principal objectives of this study, we find that place-bound PSS, as exemplified in the 3SLab, *can* afford improvements to deliberative participation processes by creating positive social-emotional relationships and facilitating collective meaning-making. Naturally, in practice, integrating online and place-bound PSS is possible and even desirable (e.g. Thoneick, 2021). Yet, planning support science almost exclusively focuses on web-based PSS when discussing participation platforms (e.g. Anttiroiko, 2016; Deseriis, 2021; Peña López, 2019; Royo et al., 2020). In this sense, this study highlights the need for greater research into the workings, uses, and affordances of place-bound PSS.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Filipe Mello-Rose https://orcid.org/0000-0002-8348-5028
Jörg Rainer Noennig https://orcid.org/0000-0002-1681-7635

Data availability statement

Data supporting this study are included within the article and supporting materials.

Supplemental Material

Supplemental material for this article is available online.

Note

1. CAVE refers to 'Cave Automatic Virtual Environment', which is a different form of virtual reality application than a head-mounted VR display worn by a user.

References

Aharon-Gutman M, Schaap M and Lederman I (2018) Social topography: studying spatial inequality using a 3D regional model. *Journal of Rural Studies* 62: 40–52.

Anttiroiko A-V (2016) City-as-a-platform: the rise of participatory innovation platforms in Finnish cities. *Sustainability* 8(9): 922.

Aragón P, Kaltenbrunner A, Calleja-López A, et al. (2017) Deliberative platform design: the case study of the online discussions in Decidim Barcelona. In: Ciampaglia GL, Mashhadi A and Yasseri T (eds) *Social Informatics*. Cham, Germany: Springer International Publishing, 277–287. Lecture Notes in Computer Science.

Bächtiger A and Beauvais E (2016) Taking the goals of deliberation seriously: a differentiated view on equality and equity in deliberative designs and processes. *Regular Issue* 12(2).

Bächtiger A, Niemeyer S, Neblo M, et al. (2010) Disentangling diversity in deliberative democracy: competing theories, their blind spots and complementarities. *The Journal of Political Philosophy* 18(1): 32–63.

Baeza JL, Sievert JL, Landwehr A, et al. (2021) City scope platform for real-time analysis and decision-support in urban design competitions. *International Journal of E-Planning Research* 10(4): 121–137.

Batty M (2007) *Planning Support Systems: Progress, Predictions, and Speculations on the Shape of Things to Come*. London, UK: Centre for Advanced Spatial Analysis. Epub ahead of print 2007.

Batty M (2018) Digital twins environment and planning B: urban Analytics and city science. *Environment and Planning B: Urban Analytics and City Science* 45(5): 817–820.

Bingham LB, Nabatchi T and O'Leary R (2005) The new governance: practices and processes for stakeholder and citizen participation in the work of government. *Public Administration Review* 65(5): 547–558.

Brown G, Brown GD, Brown GR, et al. (1983) *Discourse Analysis*. Cambridge, UK: Cambridge University Press.

Champlin C, te Brömmelstroet M and Pelzer P (2019) Tables, tablets and flexibility: evaluating planning support system performance under different conditions of use. *Applied Spatial Analysis and Policy* 12(3): 467–491.

Cohen J (2005) Delibration and democratic legitimacy. In: Matravers D and Pike J (eds) *Debates in Contemporary Political Philosophy: An Anthology*. London, UK: Psychology Press. Available at: https://public.ebookcentral.proquest.com/choice/publicfullrecord.aspx?p=241818 (accessed 24 April 2022).

Crosby N, Kelly JM and Schaefer P (1986) Citizens panels: a new approach to citizen participation. *Public Administration Review* 46(2): 170.

Cui B, Mei H and Ooi BC (2014) Big data: the driver for innovation in databases. *National Science Review* 1(1): 27–30.

Daniel C and Pettit C (2022) Charting the past and possible futures of planning support systems: results of a citation network analysis. *Environment and Planning B: Urban Analytics and City Science* 49(7): 1875–1892.

Dembski F, Wössner U, Letzgus M, et al. (2020) Urban digital twins for smart cities and citizens: the case study of Herrenberg, Germany. *Sustainability* 12(6): 2307.

Deseriis M (2021) Rethinking the digital democratic affordance and its impact on political representation: toward a new framework. *New Media & Society* 23(8): 2452–2473.

Dienel PC (2001) Die Planungszelle: eine Perspektive für die Demokratie. *Sozialwissenschaften und Berufspraxis* 24(2): 171–175.

Dryzek JS (2001) Legitimacy and economy in deliberative democracy. *Political Theory* 29(5): 651–669.

Dryzek JS, Bächtiger A, Chambers S, et al. (2019) The crisis of democracy and the science of deliberation. *Science* 363(6432): 1144–1146.

Evans SK, Pearce KE, Vitak J, et al. (2017) Explicating affordances: a conceptual framework for understanding affordances in communication research: explicating affordances. *Journal of Computer-Mediated Communication* 22(1): 35–52.

Fishkin JS (2021) Deliberative public consultation via deliberative polling: criteria and methods. *Hastings Center Report* 51(S2): S19–S24.

Flacke J, Shrestha R and Aguilar R (2020) Strengthening participation using interactive planning support systems: a systematic review. *ISPRS International Journal of Geo-Information* 9(1): 49.

Flyvbjerg B (2006) Five misunderstandings about case-study research. *Qualitative Inquiry* 12(2): 219–245.

Fung A and Wright EO (2001) Deepening democracy: innovations in empowered participatory governance. *Politics & Society* 29(1): 5–41.

Ganuza E and Francés F (2012) The deliberative turn in participation: the problem of inclusion and deliberative opportunities in participatory budgeting. *European Political Science Review* 4(2): 283–302.

Geertman S and Stillwell J (2020) Planning support science: developments and challenges. *Environment and Planning B: Urban Analytics and City Science* 47(8): 1326–1342.

Gerber M, Bächtiger A, Shikano S, et al. (2018) Deliberative abilities and influence in a transnational deliberative poll (EuroPolis). *British Journal of Political Science* 48(4): 1093–1118.

Gordon E and Manosevitch E (2011) Augmented deliberation: merging physical and virtual interaction to engage communities in urban planning. *New Media & Society* 13(1): 75–95.

Guest GS, MacQueen KM and Namey EE (2011) *Applied Thematic Analysis*. 1st edition. Los Angeles, CA: Sage Publications Inc.

Hanzl M (2007) Information technology as a tool for public participation in urban planning: a review of experiments and potentials. *Participatory Design Studies* 28(3): 289–307.

Hasler BS, Landau DH, Hasson Y, et al. (2021) 'Virtual Reality-Based Conflict Resolution: The Impact of Immersive 360° Video on Changing View Points and Moral Judgment in the Context of Violent Intergroup Conflict'. *New Media & Society* 23(8): 2255–2278. doi: 10.1177/1461444821993133

Healey P (2004) Creativity and urban governance. *Policy Studies* 25(2): 87–102.

Hennen L, van Keulen I, Korthagen I, et al. (2020) Studies in digital politics and governance. *European E-Democracy in Practice*. Cham, Germany: Springer International Publishing. Available at: https://link.springer.com/10.1007/978-3-030-27184-8 (accessed 23 April 2022).

Jankowski P, Czepkiewicz M, Młodkowski M, et al. (2019) Evaluating the scalability of public participation in urban land use planning: a comparison of geoweb methods with face-to-face meetings. *Environment and Planning B: Urban Analytics and City Science* 46(3): 511–533.

Jiang H, Geertman S and Witte P (2020) Avoiding the planning support system pitfalls? What smart governance can learn from the planning support system implementation gap. *Environment and Planning B: Urban Analytics and City Science* 47(8): 1343–1360.

John B, Lang DJ, von Wehrden H, et al. (2020) Advancing decision-visualization environments—empirically informed design recommendations. *Futures* 123: 102614.

Kishore S, Muncunill XN, Bourdin P, et al. (2016) Multi-Destination Beaming: Apparently Being in Three Places at Once through Robotic and Virtual Embodiment'. *Frontiers in Robotics and AI* 3. doi: 10.3389/frobt.2016.00065

Klosterman RE (1997) Planning support systems: a new perspective on computer-aided planning. *Journal of Planning Education and Research* 17(1): 45–54.

Kneuer M (2016) E-democracy: a new challenge for measuring democracy. *International Political Science Review* 37(5): 666–678.

Landemore HE (2012) Why the many are smarter than the few and why it matters. *Special Issue: Participatory Budgeting* 8(1): 7.

Lin Y and Benneker K (2022) Assessing collaborative planning and the added value of planning support apps in the Netherlands. *Environment and Planning B: Urban Analytics and City Science* 49(2): 391–410.

Lv Z, Ota K, Lloret J, Xiang W and Bellavista P (2019) Complexity problems handled by big data technology. *Complexity* 2019: 1–7.

Manuel J and Vigar G (2021) Enhancing citizen engagement in planning through participatory film-making. *Environment and Planning B: Urban Analytics and City Science* 48(6): 1558–1573.

Mello Rose F (2021) The unexpected persistence of non-corporate platforms: The role of local and network embeddedness. *Digital Geography and Society* 2(100020): 1–12. doi: 10.1016/j.diggeo.2021.100020

Mitasova H, Harmon R, Weaver K, et al. (2012) Scientific visualization of landscapes and landforms. *Geomorphology* 137: 122–137.

Mitchell WJT (1995) *Picture Theory: Essays on Verbal and Visual Representation*. Chicago, IL: University of Chicago Press.

Noyman A, Holtz T, Kröger J, et al. (2017) Finding places: HCI platform for public participation in refugees' accommodation process. *Procedia Computer Science* 112: 2463–2472.

OECD (2020) *Innovative Citizen Participation and New Democratic Institutions: Catching the Deliberative Wave*. Paris, France: Organisation for Economic Co-operation and Development. Available at: https://www.oecd-ilibrary.org/governance/innovative-citizen-participation-and-new-democratic-institutions_339306da-en (accessed 18 March 2022).

Orenstein DE, Zimroni H and Eizenberg E (2015) The immersive visualization theater: a new tool for ecosystem assessment and landscape planning. *Computers, Environment and Urban Systems* 54: 347–355.

Pelzer P (2015) Usefulness of planning support systems: conceptual perspectives and practitioners' experiences. PhD Thesis, InPlanning, Mülheim An Der Ruhr, Germany.

Peña López I (2019) *Shifting Participation into Sovereignty: The Case of 'Decidim Barcelona'*. Barcelona, Spain: Huygens Editorial.

Pettit C, Bakelmun A, Lieske SN, et al. (2018) Planning support systems for smart cities. *City, Culture and Society* 12: 13–24.

Portman M, Natapov A and Fisher-Gewirtzman D (2015) To go where no man has gone before: virtual reality in architecture, landscape architecture and environmental planning. *Computers, Environment and Urban Systems* 54: 376–384. Epub ahead of print 2015. DOI: 10.1016/j.compenvurbsys.2015.05.001.

Rosenberg SW (2014) Citizen competence and the psychology of deliberation. In: Elstub S and McLaverty P (eds) *Deliberative Democracy*. Edinburgh, UK: Edinburgh University Press, 98–117. Available at: https://www.degruyter.com/document/doi/10.1515/9780748643509-008/html (accessed 24 April 2022).

Royo S, Pina V and Garcia-Rayado J (2020) Decide Madrid: a critical analysis of an award-winning e-participation initiative. *Sustainability* 12(4): 1674.

Ruohomaki T, Airaksinen E, Huuska P, et al. (2018) Smart city platform enabling digital twin. In: 2018 international conference on intelligent systems (IS), Funchal, Portugal, September 2018, 155–161. IEEE. Available at: https://ieeexplore.ieee.org/document/8710517/(accessed 12 January 2022).

Ryfe DM (2005) Does deliberative democracy work? *Annual Review of Political Science* 8(1): 49–71.

Soltani RN (2019) Culture driven co-creation: guidelines for super moderators in U_CODE project. Master Thesis, Delft University of Technology, Delft, Netherlands. Epub ahead of print 2019.

Sopher H, Fisher Gewirtzman D, Kalay YE, et al. (2019) 'Going Immersive in a Community of Learners? Assessment of Design Processes in a Multi-Setting Architecture Studio'. *British Journal of Educational Technology* 50(5): 2109–2128. doi: 10.1111/bjet.12857

Sorial S and Peterson A (2019) Australian schools as deliberative spaces: framing the goal of active and informed citizenship. *Curriculum Journal* 30(1): 24–39.

Steiner J (2018) The foundation of deliberative democracy and participatory governance. In: Heinelt H (ed) *Handbook on Participatory Governance. Handbooks of Research on Public Policy*. Cheltenham, UK and Northampton, MA: Edward Elgar Publishing, 33–52.

Stelzle B, Jannack A, Holmer T, et al. (2021) Smart citizens for smart cities. In: Auer ME and Tsiatsos T (eds). *Internet of Things, Infrastructures and Mobile Applications*. Cham, Germany: Springer International Publishing, 571–581.

Thompson DF (2008) Deliberative democratic theory and empirical political science. *Annual Review of Political Science* 11(1): 497–520.

Thoneick R (2021) Integrating online and onsite participation in urban planning: assessment of a digital participation system. *International Journal of E-Planning Research* 10(1): 1–20.

Toland A and Kilbane S (2018) 'City Mega-Models as Literal and Figurative Visioning Tools'. *Proceedings of the Institution of Civil Engineers - Urban Design and Planning* 171(4): 166–176. doi: 10.1680/jurdp.18.00007

Vonk G, Geertman S and Schot P (2005) Bottlenecks blocking widespread usage of planning support systems. *Environment and Planning A: Economy and Space* 37(5): 909–924.

Yossef Ravid B and Aharon-Gutman M (2022) The social digital twin: the social turn in the field of smart cities. *Environment and Planning B: Urban Analytics and City Science* 50(6): 239980832211370.

Dr Raz Weiner is a researcher of performance and political theory, incorporating theatre and performance practice into social research, digital queer humanities, and urban studies. He is a postdoc fellow at the Smart Social Strategy Lab, at the Technion, Haifa, and at the Institute of Cultural Management and Gender Studies, at The University of Music and Performing Arts, Vienna. His previous postdoc was at The School of Politics and IR in Queen Mary and he received his PhD from The School of Digital and Performing Arts at Royal Holloway. His work explores cognitions and affects of corporeality, data, and archives.

Dr Filipe Mello Rose is a researcher at the WISSENSARCHITEKTUR – Laboratory of Knowledge Architecture at the Technical University Dresden, Germany. He researches alternative platform urbanism, social movements, citizen participation, and smart city development. He recently co-elaborated a smart city strategies for Dresden and Ilmenau in collaboration with the local administrations after having completed his PhD in 2022 at HafenCity University Hamburg, Germany. Filipe Mello Rose holds a Master's in Urban Governance Studies and a Social Sciences Bachelors from Sciences Po Paris. He has done research stays at the Federal University of Pernambuco, Brazil, and at the Berlin Graduate School of Social Sciences at Humboldt University Berlin, Germany.

Architect Batel Yossef Ravid is a fully funded PhD student at the Faculty of Architecture and Town Planning at the Technion (IIT). Her research is focused on developing a new data-driven protocol that is based on the 'Digital Twin' model enabling co-production among academia, local communities, and local government addressing the urban planning decision-making process. Yossef Ravid received her MA from the Royal College of Architecture in London and her architecture bachelor's degree from the Bezalel Academy of Arts and Design. She was awarded a Clore-Bezalel Scholarship and the MLIS (Machine Learning and Intelligent Systems) prize.

Dr Jörg Rainer Noennig is Professor for Digital City Science at the HCU HafenCity Universität in Hamburg and also directs the WISSENSARCHITEKTUR Laboratory of Knowledge Architecture at TU Dresden. Noennig studied architecture at Bauhaus Universität Weimar, Polytech Krakow, and Waseda University, Tokyo. He worked at various universities outside Germany, such as the Universita degli Studi dell l'Aquila, Italy, the ISEN Toulon, France, TU Woronesch, Russia, and the Toyo Universität, Tokyo. Noennig was awarded the Grand Prix of the European Association for Architectural Education (EAAE).

Dr Meirav Aharon Gutman is an urban sociologist and a faculty member in the Faculty of Architecture and Town Planning at the Technion (IIT). She is an acting member of the National Planning and Building Council and the academic chair of the Technion's Social Hub. Her research interests include the development of innovative urban planning models designed to mainstream social considerations in the process of decision-making in the Town Planning realm. Aharon Gutman published in leading journals in her field guides students and teaches basic and advanced social planning courses in the Architecture and Urban and Regional Planning Tracks at the Technion.