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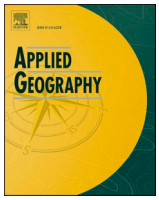

The evolution of public participation GIS (PPGIS) barriers in spatial planning practice

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ABSTRACT

Over the last three decades, PPGIS practices have shifted from a paper to digital format and have become cheaper, more user-friendly, and more versatile. The literature recognizes the potential of PPGIS, but researchers also note that the impact of PPGIS in practice is not yet pronounced. This study seeks to identify the barriers that hinder the widespread adoption of PPGIS in planning practice. Building on the literature, an analytical framework is developed to identify three main categories of barriers and their respective subcategories. This analytical framework is complemented by the results of five workshops with practitioners on the use of PPGIS in planning for green open spaces. This mirroring of literature and empirical data clarifies which (sub)categories are actually perceived as barriers and which are not. The findings show a shift from epistemological and technological barriers to cultural barriers that involve institutions and participants. While each of the three categories can start or stop a PPGIS process, having a pioneer in at least one category can aid in overcoming the remaining barriers.

"There is little difference between obstacle and opportunity; the wise are able to turn both to their advantage."

-Machiavelli.

1. Introduction

Schroeder (1996, p. 28) defines public participation geographic information systems (PPGIS) as "a variety of approaches to make GIS and other spatial decision-making tools available and accessible to all those with a stake in official decisions." Throughout history, PPGIS have faced different barriers that have hindered their dissemination to academia and practitioners. The first critiques of PPGIS can be traced back to the early 1990s, when debates between GIS practitioners and human geographers soared (Schuurman, 2000). The merits of GISs were questioned, highlighting their ethical, epistemological, and methodological conflicts (Schuurman, 2000). These debates were part of the "science wars," which de-escalated in the late 1990s thanks to the collaboration of GIS critics and GIS researchers in "Initiative 19" at the National Center for Geographic Information Analysis (NCGIA) (Schuurman, 2000; The Economist, 1997). This collaboration laid the foundation for increased cooperation between the two parties and overcame the initial epistemological barriers.

Because a core component of PPGIS is to reach out to the public, technological barriers include the transition of GIS from a tool that only professionals are familiar with, to one that the general population can use. Therefore, several authors have highlighted the key role of user-friendliness in maximizing participation efforts (Haklay & Tobón, 2002; Peng, 2001; Rzeszewski & Kotus, 2019; Tang & Waters, 2005; Wong & Chua, 2001). While technological barriers have not completely disappeared, they do not pose the same threat as they once did. One reason for this is the "technology boom" (GIS Geography, 2020) of the 2000s, which has encouraged the spread of GIS into policy work, classrooms, businesses, and the general public, thereby democratizing GIS, data creation, and analysis (Goodchild, 2009; Panek & Sobotova, 2015). Moreover, authors such as Bowie et al. (2014), Slade et al. (2013) and Hudson-Smith et al. (2009) argue that the state of GIScience changed fundamentally in 2005 with the release of API products such as Open Street Map, Google Earth, and Google Maps. These free and open-source products fostered a significant boom in participatory

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mapping thanks to their price and exceptionally user-friendly design compared to more traditional GIS desktop software packages or Java Applets, which are more cumbersome.

Since this watershed moment, the use of Google Maps API has doubled, becoming one of the most popular APIs on the internet (Mosqueira-Rey et al., 2018). This popularity, in tandem with the increased availability of affordable smart personal devices around the 2010s (Goldman, 2010), has created a novel category of digital platforms distinguished by smaller screens, sensors, touch interfaces, and well-integrated native apps,[2] which have made GIS more accessible to the masses (Ballatore et al., 2019). Today, about four-fifths of the world's population has access to this technology in the palm of their hand without the need for large computers or professional experience (Statista, 2022).

These technological advancements work to the advantage of the adoption of PPGIS in spatial planning, building on the premise that PPGIS enables a planning practice that is more democratic and inclusive. However, the adoption of PPGIS in planning practice is currently underwhelming (Brown, 2012b; Denwood et al., 2022b). In the academic literature, the number of papers on PPGIS or other digital participation mapping tools has increased since 2005. Of these articles, only a few report that they are intended to influence policy making, and less than half imply that they have succeeded in doing so (Denwood et al., 2022b).

There is always room for improvement, yet it seems that neither epistemological nor technological barriers are the main pitfalls keeping PPGIS from becoming widespread in practice. Instead, authors argue that data quality, user-friendliness, and lack of conceptual and theoretical underpinnings remain critical barriers (Anderson et al., 2009; Brown & Kyttä, 2014; Cheung et al., 2022; Johnson & Sieber, 2012; Monz et al., 2019; Rzeszewski & Kotus, 2019). Ballatore (2019, p. 329) highlights that "social, political, and cultural obstacles can be harder to overcome than technological ones." These types of barriers for PPGIS are common among public participation methodologies: the inability to reach a broad spectrum of people (Brown & Kyttä, 2014), the need for representativeness (Elwood, 2006a; J. A. Robinson, Demšar, et al., 2017), lack of trust (Rzeszewski & Kotus, 2019), lack of impact (participation results not reflected in the final product) (Kantola & Tuulentie, 2020), and the attitude of authorities toward the public (Brown & Kyttä, 2014; Kantola, 2021).

While there has been a rising interest in addressing the technological and epistemological barriers of PPGIS in recent years, there is a gap in the literature for a structured analysis of the determination, assessment, and, when possible, overcoming these barriers. Therefore, this study aims to provide an analytical framework that offers a clear picture of the current factors that hinder the adoption of PPGIS in practice. To do so, we undertake a scoping literature to gather barriers to PPGIS usage. Then, through a series of workshops with planning practitioners, we explore these barriers in the context of our proprietary PPGIS platform. By this methodology, we address the following research questions: *What are the current barriers to the adoption of PPGIS in practice? How can these barriers be categorized? Furthermore, what are the remaining barriers to the adoption of PPGIS in practice?".*

2. Methodology

This study is comprised of three methodological steps. First, an analytical framework was developed by reviewing the literature and summarizing current knowledge of barriers to the adoption of PPGIS in practice. These analysis results constitute a table of 37 barriers drawn from 75 literature sources (Table 1). Second, a series of workshops were held with planning practitioners to discuss a specific PPGIS tool, my green place, and its barriers in a SWOT (Strengths, Weaknesses, Opportunities, Threats) format. Third, based on Table 3 and the workshop results, the barriers acknowledged by the practitioners were compared with the framework table.

The analytical framework on barriers to the adoption of PPGIS in practice was developed through a scoping review of existing literature. Scoping reviews "aim to provide an overview or map of the evidence" (Munn et al., 2018, p. 3). They provide a middle-ground between a traditional and systematic literature review. Whilst not exhaustive, scoping reviews can nevertheless provide a useful tool for a range of applications, including to clarify key concepts or definitions, to identify types of evidence that are available in a given field and to explore how research is conducted in a certain field (Munn et al., 2018). The scoping review was conducted using a traditional Web of Science (by title and topic) and Google Scholar search, as well as the "Science Research Assistant" extension for Google Chrome. This extension allowed an additional cross query across multiple journals and databases, as well as other meta searches such as Google Scholar and Google News and book sites such as Amazon and Gutenberg Library. The queries included the following combination of keywords: PPGIS, challenges, barriers, limitations, adoption, implementation, and practice. This literature exploration provided a total of 105 articles, 75 of which were used to construct the framework. The other articles were excluded because, although they contained some of the keywords, they did not fit within the context of this research.

Next, we combed through each article for statements about the barriers, challenges, or limitations in the adoption, implementation, and practice of PPGIS. The statements were copied verbatim in an Excel file and summarized into a more compact format.

Subsequently, we attributed each statement to a category, grouping statements based on similarities such as their source or whom or what they affected. We defined three main categories: institutions, participants, and tools. After further refinement, each of these three categories was subdivided into five subcategories, which can be seen in the final framework in Table 3. Each of these subcategories was also assigned a code. Some barriers could be classified in two or more subcategories; in that case, the column labeled "overlap" shows this possibility.

The second methodological step in this study, which was conducted simultaneously yet independently from the first step, was to obtain the input of practitioners regarding what they acknowledge as barriers to the widespread adoption of PPGIS in practice. This input was collected through four online workshops with 25 practitioners in spatial planning from the city of Ghent in Belgium (10 attendees), the valley of the Woluwe river in Belgium (13 attendees), and the Camden and Islington boroughs in London, United Kingdom (2 attendees) in October 2020 and April to May 2021 (Table 2). Most of these practitioners were originally contacted[3] during the data collection of the "We Love Gent," and "We Love Woluwe" campaigns as a means of increasing our dissemination channels (Aranda et al., 2021, 2023). Once the data was collected and analyzed, we re-contacted them to report the results and discuss the tool.

The Ghent workshop was conducted in October 2020 in Dutch, while each of the two workshops in Brussels were conducted in the last week of April 2021, one in Dutch and one in French, depending on the native languages of the practitioners. Finally, the London workshop was conducted in the first week of May 2021 in English. The length of each workshop was 2 h, including a brief presentation (15 min), a demonstration of the PPGIS tool my green place (5 min), a short break (5 min),

[2] See https://www.esri.com/en-us/arcgis/products/index?rsource=https%3A%2F%2Fwww.esri.com%2Fen-us%2Farcgis%2Fproducts%2Fapps-for-everyone%2Foverview.

[3] The practitioners from the Parks for Health initiative in the boroughs of Camden and Islington were contacted after a GOS: green open spaces mapping session with the residents using ESRI's Survey 123 in December 2020. While the PPGIS tool, in this case, was different, it offered an interesting point of view when compared with my green place. Hence, the input of the practitioners was used in this research.

Table 1
Excerpt of processing table for literature barriers.

Verbatim	Compact	Barrier	Category	Year	Author	Title	Journal
Government agencies lack experience in innovative and non-legalistic public participation techniques. Many simply do not know how to effectively engage and manage the public in planning processes.	Government agencies lack experience in innovative and non-legalistic public participation techniques.	Lack of Experience	Institutional	2012	Brown, Greg	Public Participation GIS (PPGIS) for Regional and Environmental Planning: Reflections on a Decade of Empirical Research	Journal of Urban and Regional Information Systems Association

Table 2
Details of the workshop attendees regarding their case study: We Love Gent (WLG), We Love Woluwe (WLW) and Parks for Health (P4H).

Case	Language	Gender	Role	Organization
WLG	NL	F	Deputy of the board	Green service at the City of Ghent
WLG	NL	F	Communication coordinator	Ghent city
WLG	NL	F	Communication coordinator	Green service at the City of Ghent
WLG	NL	M	Undisclosed	Undisclosed
WLG	NL	M	Landscape architect	Green service at the City of Ghent
WLG	NL	M	District director Drongen	Ghent city
WLG	NL	F	Project leader air quality and environmental noise	Environment and Climate Department at the City of Ghent
WLG	NL	F	Data & information administrator	Ghent city
WLG	NL	F	Policy officer of agriculture and horticulture	Ghent city
WLG	NL	F	Landscape architect	Regional Landscape Meetjesland
WLW	NL	F	Project designer, landscape expert, urban planner	Flemish Land Agency
WLW	NL	M	President	NEOS (Network Entrepreneurial Seniors)
WLW	NL	M	Project designer	Flemish Land Agency
WLW	NL	M	Project leader	Flemish Land Agency
WLW	NL	F	Project engineer	Flemish Environmental Agency
WLW	NL	F	Project coordinator in the Woluwe valley area	Regional Landscape Brabantse Kouters vzw
WLW	NL	M	Plan designer	Flemish Land Agency
WLW	NL	M	Teacher and chairman NP MaViSt	Regional Landscape/ Karel Buls
WLW	FR	M	Undisclosed	Coordination Senne asbl
WLW	FR	M	Councilman	Municipality of Woluwe-Saint-Lambert
WLW	FR	X	Undisclosed	Undisclosed
WLW	FR	F	Project manager	Coordination Senne asbl
WLW	FR	M	CEBE member	CEBE (association managing the natural site of the Hof Ter Musschen)
P4H	EN	M	Green space development manager	Camden green space team
P4H	EN	M	Outreach officer	Islington green space team

a SWOT analysis (60min), and a final discussion of important points to cover anything that was missed (10 min). A SWOT analysis is a strategic planning and management tool that is used in the early stages of decision-making processes and to assess the strategic position of organizations (e.g., for-profit enterprises, local and national governments, and NGOs) (Caves, 2005; Mariani, 2017). It aims to identify the internal and external factors that might hinder or facilitate a project's objectives (Sarsby, 2012). In this study, the SWOT analysis was employed to identify barriers within the attendees' organizations that could hinder the widespread adoption of PPGIS in their line of work. The analytical framework that was developed in the first step was not brought into the discussion so as to not to steer or influence the discussion amongst practitioners. The workshops were conducted via Microsoft teams with the support of a Mural board to aid practitioners in taking notes. The workshops were recorded and later transcribed and translated into English.

In the third step, the workshops with the planners and other practitioners were reviewed and the results were analyzed through the lens of the framework. This was done by manually coding the transcripts in an Excel sheet once they had been translated to English (the same procedure and coding as in the first step). Using the coded table, we checked whether each barrier had been mentioned (or not) by the attendees. The resulting comparisons were coded as agreed, disagreed, or not mentioned, as can be seen in column four in Table 4.

The structure of barriers found in the literature was translated into an interlocking system of three categories: the (PPGIS) tool, participants, and institutional. Each category consists of five subcategories in which specific barriers are classified (Fig. 1). Table 3 shows the classification of barriers found in literature, their coding, a brief description, and the sources where they can be found. The logic behind the framework visualized as an interlocking mechanism is due to the interweaving of the barriers, which can also be seen in the overlap column in Table 3. Table 4 displays the classification of the practitioners' input according to the three interlocking mechanisms.

2.1. Description of categories

2.1.1. Tool

The tool category refers to barriers that affect PPGIS tools (apps, software) and their associated technology. It includes five subcategories: engagement, analysis tools, user-friendliness, data quality, and technical problems. User-friendliness barriers prevent the tool from being easy and intuitive to use, thus making the user experience unsatisfactory. Engagement represents the purposeful choices users make to get what they want. Therefore, potential engagement barriers are those that prevent people from obtaining value from the user experiences enabled by the PPGIS tool. Engagement is often neglected when designing PPGIS tools because, for years, the focus has been on making GIS friendlier to the masses (Haklay & Tobón, 2003). Nonetheless, great user experience does not necessarily translate into engagement any more than meaningful engagement inherently assures a great user experience (Schrage, 2012).

Technical problems include but are not limited to bugs, internet connection issues, and lag. Data quality refers to the type and quality of data collected and how it adheres to the standards held by the practitioners (or others) who will use it. Analysis tools are somewhat connected to data quality barriers because if data quality is poor or the data obtained through the PPGIS is diverse, it might complicate the tools and protocols for data analysis (Kantola, 2021). A lack of suitable and more automatable analysis mechanisms to transform PPGIS data into useable information can become a barrier, especially for organizations with limited capacity.

Fig. 1. Literature-based framework explaining the arrangement of barriers that hinder the adaptation of PPGIS in practice.

2.1.2. *Participants*

The participants in this study were members of the general public who would be directly or indirectly affected by the results of the tool. They lived in the area where the participation process took place; were not professionals, planners, or practitioners; and were, in most cases, the main input providers. The barriers in this category can be divided into skills, willingness, trust, accessibility, and resources. Skills refer to the capacity of a participant to operate the tool, which can be limited for different reasons (e.g., low computer literacy, lack of IT skills, lack of map reading skills, or compromised cognitive, motor, and sensory abilities), many of which were more likely to be present in the elderly, novices, or people with mental or physical disorders (Gottwald et al., 2016). Willingness refers to the disposition to act or respond and is a critical barrier, as things only get done when people are truly motivated.

Trust (mistrust) is often related to a lack of assurance that the authorities will give information about upcoming issues openly and early enough so that people do not feel sidelined. Another common way trust can become a barrier is when the collected data is not used or the impact is not disclosed after consultation. Thus, it is essential to build trust regarding practitioners' commitment to reach participants when planning issues arise and that the public is informed on participation possibilities widely and through different and reliable channels.

Accessibility barriers limit access to relevant and appropriate scientific and non-scientific data (Anderson et al., 2009; Jankowski & Nyerges, 2003). Although this might not represent a major limitation for government stakeholders, for community-based projects with little or no academic affiliation, this presents an impediment to progress and the quality of the data collected. Therefore, if input coming from community PPGIS-run projects is to be integrated into planning and policy, accessibility to accurate data must be available in the public domain. Finally, resource limitations concern those that affect funding (e.g., licensing, trained personnel, maintenance, and equipment).

2.1.3. *Institutions*

Institutional barriers refer to barriers within organizations that implement the PPGIS process, which are often governmental planning departments. These can be divided into five subcategories: communication, culture, politics, regulations, and resources.

Communication barriers hinder effective correspondence between organizations and the general public. If channels are not appropriate and if the dialogue is not correctly initiated, this can affect the PPGIS process by reducing the participation rate, i.e., thereby creating a biased, unrepresentative sample (Brown & Kyttä, 2014; Kantola et al., 2018; Robinson, Demšar, et al., 2017; Rzeszewski & Kotus, 2019). Likewise, if organizations do not share the results of participation sessions, participants cannot see what impact their opinions had and may consequently refrain from providing input in future consultations (Brown, 2012b; Brown & Kyttä, 2018; Kantola & Tuulentie, 2020; Rzeszewski & Kotus, 2019).

Cultural barriers are connected to prejudices and individual behaviors that extend to an organization's ethos. An expert-lay divide or the attitudes of authorities (e.g., rejection, opposition, undermining efforts) attitudes can be cultural barriers embedded in organizations where there is little room for experimentation, change is frowned upon, and tradition is encouraged (Brown, 2012b). This would translate to hostility toward trying new techniques such as PPGIS. Such distrust of technology and users (the general public) would translate into void results without real impact or application. Another cultural barrier that may affect the process is a lack of authorities' trust toward the general public. Experts may regard the public's knowledge as useless, and Brown (2012) states that practitioners are often fearful of the public because they deem them to be unpredictable and prone to questioning their leadership and avoiding consultation with them.

Political barriers are those that relate to political representatives and their shortcomings. Partly overlapping with cultural barriers,

politicians' attitudes can strongly benefit or undermine PPGIS processes. While politicians have the power to demand a redo of participation in projects and interventions, they can also hide results that are not in their favor or in favor of the party they represent. In this way, a lack of impact and accountability for killing or not delivering consented projects based on the outcomes of PPGIS processes can not only affect public perception of the representative but also reduce trust in the process itself (Kantola & Tuulentie, 2020).

Regulations refer to legislation or policies that directly or indirectly prohibit practitioners from carrying out PPGIS processes. Often, government organizations have bureaucratic protocols that limit information collection, analysis, and reporting, among other things (Brown, 2012b). Resource barriers can be understood as everything from human resources (skilled employees), software licenses, and knowledge to financial resources.

3. Results: practitioners' perceptions of barriers to PPGIS practice

This section addresses the outcomes of the comparison between the analytical framework, the results of a scoping literature review, and the barriers identified by the 25 practitioners who attended the various workshops. These results are presented in Table 4, which builds on Table 3 by adding a new column, "workshop consult," reporting practitioners' opinions about the barriers. Sections 3.1 to 3.3 present an overview of each barrier category, their discussion in the workshops, and quotes from the practitioners.

3.1. Tool

Regarding user-friendliness, there was a consensus that the tool was intuitive, easy, and quick to use. Moreover, practitioners acknowledged that it provided detailed information without sacrificing ease of use or customization for different project scales, with some practitioners being impressed by its range and depth.

In terms of data quality, practitioners agreed that this was not an issue that would prevent them from using PPGIS in their area of work. Several practitioners noted that what PPGIS has to offer is equivalent to or even better than their current survey and sampling methods:

> Actually, now our participation is not representative either … There is a lot of potential for the tool [my green place] to be complementary in this participation processes to reach those we don't reach … (Ghent workshop participant)

Although most respondents felt that data quality and representativeness were not an obstacle, some practitioners noted that the issue of data quality might depend on the purpose of the data. The level of detail achieved in our case study research and the possible outcomes are excellent for application forms that are common for project funding in local planning and monitoring. However, practitioners pointed out that it may not be suitable for statutory planning, which requires a higher level of precision and fewer qualitative attributes.

While practitioners dismissed most technological barriers related to user-friendliness, technical problems, and data quality, barriers related to engagement and analytical tools were still recognized as issues requiring further research. Until recently, engagement barriers were dismissed or confused with user-friendliness because they were recognized as a major roadblock to widespread use by non-professional users. However, it is possible for a PPGIS tool to be user-friendly while also lacking in engagement. This means that a tool must not only be easy to use (user-friendliness) but also be entertaining and rewarding enough for users to come back to it or share it with their contacts.

This is particularly important in times such as the COVID-19 pandemic, during which many everyday activities shifted to the digital realm, causing people to be more selective about their screen time. The findings show that the pandemic has put an enormous strain on the attention people pay to digital interactions, which can cause "digital" and "consultation" fatigue, making people more selective about what they do online (Shipley & Utz, 2012; Williams, 2021). Therefore, participants might only spend their time on a PPGIS if it is engaging and easy to use:

> One of our biggest barriers we got is that if people see it as a hassle, they just won't do it … (London workshop participant)

The Ghent and Woluwe case studies used a PPGIS tool that uses its own "hook," an algorithm that provides respondents with feedback and recommendations for places and activities based on their input (Aranda et al., 2021, 2023). Through open comment sections within the tool and practitioners' input during the workshops, this simple hook at the end of my green place proved successful in engaging and rewarding those who completed the survey while also motivating them to share their results with friends and family:

> The suggestions about the place are brilliant. Like Spotify suggesting to you what you might like, so it is very nice. Potentially quite powerful for parks for health to make people more aware of how they can get involved and what is going on in their green spaces. (London workshop participant)

While analysis capabilities were not directly identified as a barrier, practitioners did discuss and inquire about the implications of analyzing the output of my green place and the resources it would require from their department. In the case of Ghent and London, practitioners were quite comfortable with the task, as they both had human and technical in-house resources for this purpose. However, practitioners from the Woluwe area recognized that while their department would be capable of completing such a task, smaller neighboring municipalities with smaller departments and workforces would need assistance, as some do not have an in-house GIS department.

3.2. Participants

Regarding the participants category, two out of five barriers were considered problematic, while the rest were not mentioned during the discussions. Practitioners mentioned that participants' skills, mainly those related to the "digital divide," can have a significant impact on response rates and that this greatly depends on age groups and education levels:

> We are super aware of the digital divide and how that has an impact on people particularly as a result of COVID but also before it. (London workshop participant)

> Not everyone knows how to read maps. (Ghent workshop participant)

> … and also the fact that we contacted people who weren't internet savvy, and I think that's something maybe we haven't historically done, or we have struggled to do. (London workshop participant)

This result somewhat conflicts with the user-friendliness barrier in the tool category, where practitioners acknowledged that my green place is easy to use. The widespread use of smart devices and apps such as Google Maps has helped to familiarize participants with PPGIS tools, thereby drastically reducing the impact of skill barriers on PPGIS use. However, this barrier may remain an issue due to its interconnectedness with other categories, such as regulations from the institutional category or technical problems from the tool category.

Willingness is a barrier that is deeply interconnected with the engagement (tool) and communication (institutional) subcategories. These are critical barriers that are not exclusive to PPGIS efforts, as they are well-known in general public participation methods (Brown & Kyttä, 2014). Practitioners reported that expectation management is an issue that can affect both the willingness of institutions to ask questions and that of participants to reply to them:

Table 3
Framework structure and literature sources.

Category	Code	Sub category	Overlap	Barrier	Literature
Tool	A	Engagement	A,C,G, H	Lack of engagement	Brown and Kyttä (2018) Kantola et al. (2018) Maptionnaire (2021) Stonich (2002)
	B	Analysis	B	Analyzing tools	Brown and Kyttä (2018) Denwood et al. (2022) Hasanzadeh (2021) Kantola and Tuulentie (2020) Kantola (2021) Macnab (2002) Nummi (2018) Tulloch (2002)
			B	Diversity of approaches	Brown and Kyttä (2014)
			B	Conceptual and theoretical foundations	Brown and Kyttä (2014)
			B	Variety of mapped attributes	Brown and Kyttä (2014) Harris and Weiner (2002) Kingston (2002) Kwaku Kyem (2002) Nummi (2018)
			B,C	Complexity of mapping the subjective	Brown and Kyttä (2014) Denwood et al. (2022) Godwin and Stasko (2017) Harris and Weiner (2002) Kwaku Kyem (2002)
	C	User-friendliness	C	Lack of customization	Brown and Kyttä (2014)
			C,A,F	Digital divide \ digital exclusion	Abreu (2015) Brown (2017) Craig and Elwood (1998) Crocker and Mazer (2019) Denwood et al. (2021) Denwood et al. (2022) Eilola et al. (2021) Elwood (2006a) Fagerholm et al. (2021) Frias et al. (2002) Goodchild (2009) Gottwald et al. (2016) Hasanzadeh (2021) Haworth et al. (2016) Kantola et al. (2018) Kovanen et al. (2012) Krygier (2002) Laituri (2002) Mariscal et al. (2019) Raymond et al. (2016) Shiffer (2002) Stratigea and Panagiotopoulou (2014) Stratigea et al. (2015) Szarek-Iwaniuk and Senetra (2020) Tulloch (2007) White and Selwyn (2013)
			C	Reducing content complexity, operation,	Ballatore et al. (2019) Barndt (2002) Getto and Moore (2017) Gottwald et al. (2016) Haklay (2010) Kantola (2021) Nivala et al. (2008) Rzeszewski and Kotus (2019) Stonich (2002) Szarek-Iwaniuk and Senetra (2020) Tang and Waters (2005) Tulloch (2007)
	D	Data quality	D,O	Data quality	Brown and Kyttä (2018) Hasanzadeh (2021) Huck et al. (2019) Kahila-Tani et al. (2019) Macnab (2002) Maptionnaire (2021) Tulloch (2002)
			D,B	High-quality, versatile knowledge	Maptionnaire (2021)
			D	Identification of threats to data quality	Brown and Kyttä (2014)

(*continued on next page*)

Table 3 (*continued*)

Category	Code	Sub category	Overlap	Barrier	Literature
	E	Technical problems	E	Technical issues	Ball (2002) Eilola et al. (2021) Frias et al. (2002) Harris and Weiner (2002) Kantola et al. (2018) Kantola (2021) Robinson, Demšar, et al. (2017) Stonich (2002) Tang and Waters (2005) Tulloch (2002)
Participants	F	Skills	F,C	Digital divide \ digital exclusion	Abreu (2015) Brown (2017) Craig and Elwood (1998) Crocker and Mazer (2019) Denwood et al. (2021) Denwood et al. (2022) Eilola et al. (2021) Elwood (2006a) Fagerholm et al. (2021) Frias et al. (2002) Goodchild (2009) Gottwald et al. (2016) Hasanzadeh (2021) Haworth et al. (2016) Kantola et al. (2018) Kovanen et al. (2012) Krygier (2002) Laituri (2002) Mariscal et al. (2019) Raymond et al. (2016) Shiffer (2002) Stratigea and Panagiotopoulou (2014) Stratigea et al. (2015) Szarek-Iwaniuk and Senetra (2020) Tulloch (2007) White and Selwyn (2013)
			F,C	Physical or cognitive limitations	Brown (2017) Carpenter and Buday (2007) Denwood et al. (2022) Duplaga and Szulc (2019) Fagerholm et al. (2021) Gottwald et al. (2016) Hasanzadeh (2021) Kantola et al. (2018) Konijnendijk et al. (2013) Kovanen et al. (2012) Laituri (2002) Raymond et al. (2016) Shiffer (2002) Vrenko and Petrovič (2015)
	G	Willingness	G,A	Lack of motivation	Brown and Kyttä (2014)
			G	Uncommitted participants	Kantola et al. (2018) Szarek-Iwaniuk and Senetra (2020) Maptionnaire (2021)
	H	Trust	H	Lack of trust	Ball (2002) Brown and Pullar (2012) Kantola and Tuulentie (2020) Kantola et al. (2018) Rzeszewski and Kotus (2019)
	I	Accessibility	I,J	Limited access to relevant and appropriate scientific and non-scientific data/ knowledge	Anderson et al. (2009) Barndt (2002) Craig and Elwood (1998) Denwood et al. (2022) Eilola et al. (2021) Elwood and Leitner (1998) Elwood (2006a) Frias et al. (2002) Harris and Weiner (2002) Hasanzadeh (2021) Macnab (2002) Malczewski (2004) Robinson, Demšar, et al. (2017) Sieber (2006)
	J	Resources	J,I	Limited financing for licensing, trained personnel, maintenance, equipment	Anderson et al. (2009) Barndt (1998)

(*continued on next page*)

Table 3 (*continued*)

Category	Code	Sub category	Overlap	Barrier	Literature
					Barndt (2002) Billger et al. (2017) Bosworth et al. (2002) (Denwood et al., 2022) Elwood & Leitner (1998) Elwood (2006a) Frias et al. (2002) Harris and Weiner (2002) Kantola et al. (2018) Robinson, Demšar, et al. (2017) Stonich (2002)
Institutional	K	Cultural	K	Lack of trust (fear of public, reach)	Brown (2012)
			K	The unwillingness of authorities to enable participation by the public	Irvin and Stansbury (2004) Kantola and Tuulentie (2020) Kwaku Kyem (2002) Rzeszewski and Kotus (2019)) Szarek-Iwaniuk and Senetra (2020)
			K	Lack of acute need, motivation, and willingness to gather information	Devetag (2021) Kantola (2021) Kwaku Kyem (2002)
	L	Communication	L	The ineffectiveness to reach of people (quantity, quality, representativeness)	Brown and Kyttä (2014) Devetag (2021) Frias et al. (2002) Kantola (2021) Rzeszewski and Kotus (2019)
			L	Effectively arranging public participation (e.g. channels to share and receive information)	Brown and Kyttä (2014) Huck et al. (2019) Kahila-Tani et al. (2019) Maptionnaire (2021)
	M	Political	M,K	Lack of accountability	Kantola and Tuulentie (2020)) Szarek-Iwaniuk and Senetra (2020)
			M,K	Lack of impact	Kantola (2021) Kantola and Tuulentie (2020) Rzeszewski and Kotus (2019) Szarek-Iwaniuk and Senetra (2020) Tang and Waters (2005)
			M,K	Authorities attitudes	Kantola (2021) Kantola and Tuulentie (2020) Szarek-Iwaniuk and Senetra (2020)
	N	Regulations	N	Regulations, bureaucracy	Brown (2012) Elwood (2006b) Frias et al. (2002) Kwaku Kyem (2002)
	O	Resources	O	Lack of experience, knowledge	Ashley et al. (2006) Billger et al. (2017) Brown (2012) Eilola et al. (2021) Frias et al. (2002) Goodchild (2009) Robinson, Demšar, et al. (2017)
			O,M,K	Absence or limited institutional support: ephemeral or no grants and programmes	Ashley et al. (2006) Barndt (1998) Craig and Elwood (1998) Eilola et al. (2021) Elwood (2006a) Frias et al. (2002) Griffin and Jiao (2019) Kwaku Kyem (2002) Merrick (2003) Nyerges (2005) Robinson, Demšar, et al. (2017) Sawicki and Craig (1996) Szarek-Iwaniuk and Senetra (2020)
			O	Integration of PPGIS data into planning	Brown and Kyttä (2014)
			O	Producing high-quality, versatile knowledge	Kahila-Tani et al. (2019)
			O,D	Data quality	Brown and Kyttä (2018) Hasanzadeh (2021) Huck et al. (2019) Kahila-Tani et al. (2019) Macnab (2002) Maptionnaire (2021) Tulloch (2002)
			O,M	Timing (point within the process at which the public is consulted)	Kahila-Tani et al. (2019)
			O,M,K	Measuring impact/ effectiveness	Brown and Kyttä (2014, 2018) Kantola (2021)
			O,K	Expert- lay divide	Brown (2012)

> … there might be other authorities that are less keen to ask the questions because by asking the questions, you are raising a certain degree of expectation to do something about it. And as most places, we are experiencing budget cuts, and maybe there are some people who wouldn't want to expose themselves like that … (London workshop participant)

3.3. Institutions

In the institutional category, the practitioners recognized all five barriers as such. However, some were more prominent than others. Resource barriers were discussed in terms of capacity and finances. Attendees of the Woluwe workshops pointed out that some municipalities are not large enough to have a GIS department, making it difficult to conduct a PPGIS process and analyze it further. This particular resource issue is linked to the barrier of analysis tools in the tools category. This means that improving analysis tools for PPGIS results could help smaller municipalities with limited capacities to overcome this resource-related barrier.

In terms of financial resources, a participant at the London workshop gave an example of how an earlier national attempt to map and assess GOS: green open spaces failed due to lack of funding:

> The reason was finance. So, if it had been open-source, that might have worked, but because it was offered as a service and it needed people to be centrally coordinated, then it became expensive. So, once the government fund was cut, they couldn't afford to run it.

Regarding political barriers, practitioners acknowledged that political agendas could, to some extent, help or hinder the use of PPGIS. On the one hand, if the outcomes of the PPGIS process benefit a particular person, this person might exploit them. On the other hand, if certain results go against a certain agenda, such processes and their associated interventions may be discarded or not used again:

> Well, that is always the case. If the numbers would not show a positive light on the investment, chances are the municipality would not repeat it. That is the duality of numbers. People will interpret them in a way that is convenient for them. (Woluwe workshop participant)

The results showed that representativeness is a major issue in public participation sessions, which is also related to communication barriers. While the practitioners' channels are diverse, they highlighted that due to pandemic restrictions, many of their traditional channels were replaced by digital ones, which may have affected the groups they reached:

> There are certain target demographics that are hard to reach, and the tool [my green place] can help us reach them, but the tool is part of a puzzle, so it can help to deliver the bigger picture. And it would never be 100% representative, but we are always striving for better. (Ghent workshop participant)

> We got social media channels, we are on Instagram and Facebook for this specific park, so we reach a group of people, but there is a whole group we don't. Aside from using social media, we walk through the park asking people, trying to promote the activities, and via services within the council contacting people. Making contact with these hard-to-reach people is a struggle, and I like that you were really proactive with it. (London workshop participant)

Despite the complications caused by the pandemic, the shift to digital channels provided valuable evidence of how such tools could help to identify the impact of post-intervention investments more easily than methods such as postal or telephone surveys, which do not provide direct spatial data and are cumbersome due to the time and cost involved.

All three categories of barriers overlap because of the interconnectedness of the process. An example of this is the amalgamation of a communication-regulation barrier. Practitioners from Belgium agreed that language regulations for official channels and consultations can only be made in the official languages of the regions, namely Dutch and French in the Brussels-Capital Region and Dutch in the Flemish Region. However, about one-third of the population of the Brussels metropolitan area are expats or residents with a migrant background who do not speak any of the three official languages and are thus excluded from participation (BISA B. I. for S. and A, 2022). This means that the regulations of the same organization hamper efforts to overcome a communication barrier.

The cultural barriers are not as tangible as those in the tools category. Cultural barriers can span all three categories and were present in all workshops in an implicit manner. All practitioners and their respective organizations had their own GIS department with capable staff, proving that human resources are not a limitation. Except for the London workshop, all attendees stated that no one had ever used or was currently using a tool such as my green place. In the case of the London workshop, attendees had used a PPGIS tool in the past but pointed out its limited capacity and the difficulties encountered when used by the general public.

A common obstacle was the lack of overlap between the GIS and participation departments. Participation department staff conducted consultations by sticking to their usual methods or "known devils," such as paper or telephone consultations. The reason behind this is because they lacked GIS knowledge, while the GIS department conducted planning issues without the support of the participation and communication departments (Brown, 2012b). Therefore, the culture behind this sectoral approach can be identified as an implementation barrier:

> … lack of collaboration/communication across different organizations. Basically organizations' departments working isolated makes it [PPGIS use] more difficult … (London workshop participant)

This means that while there is capacity, a lack of familiarity with the potential of PPGIS, lack of internal cooperation in organizations, and insistence on sticking to old ways of doing things rather than encouraging innovation can keep PPGIS from being effectively utilized:

> In terms of how you get planners to use this, that's about making relationships with them and making clear what the opportunity is. (London workshop participant)

4. Discussion

4.1. Tool

In the early days of GIS, critics pointed to the ethical, epistemological, and methodological shortcomings that its incursion into social geography might represent (Schuurman, 2000). Today, there is still no widespread adoption of PPGIS in practice. With this in mind, the present study has explored barriers concerning the tool, users, and institutions.

Our research shows that practitioners do not perceive user-friendliness and technical problems as major issues. These results contrast with authors such as Czepkiewicz et al. (2016) and Rzeszewski and Kotus (2019), who believe that user-friendliness and technical limitations are still major problems for the use of PPGIS.

Given that PPGIS' premise is the inclusion of non-experts in the collection of spatial data, user-friendliness is a crucial aspect that can sink the process even before it has started (Ballatore et al., 2019). Neglecting the role of user-friendliness in PPGIS poses the risk that project funders might regret investing in such a "novel" technology and reduce future support for similar initiatives. Therefore, developing highly user-friendly PPGIS tools is key to avoiding such barriers to its further adoption in practice (Ballatore et al., 2019; Gottwald et al., 2016; Nivala et al., 2008). We suggest that further research explore the better integration of PPGIS and user-friendliness concepts at an early stage in the design and development of PPGIS tools.

Table 4
Results from crossing the workshop input with the barrier framework.

Category	Sub category	Barrier	Workshop consult
Tool	Engagement	Lack of engagement	Agreed
	Analysis tools	Analyzing tools	Agreed
		Diversity of approaches	Agreed
		Conceptual and theoretical foundations	Not mentioned
		Variety of mapped attributes	Not mentioned
		The complexity of mapping the subjective	Not mentioned
	User-friendliness	Lack of customization	Agreed
		Digital divide \ digital exclusion	Agreed
		Reducing content complexity	Not mentioned
	Data quality	Data quality	Disagreed
		High-quality, versatile knowledge	Disagreed
		Identification of threats to data quality	Not mentioned
	Technical problems	Technical issues	Not mentioned
Participants	Skills	Digital divide \ digital exclusion	Agreed
		Physical or cognitive limitations	Agreed
	Willingness	Lack of motivation	Agreed
		Uncommitted participants	Agreed
	Trust	Lack of trust	Agreed
	Accessibility	Limited access to relevant and appropriate scientific and non-scientific data/ knowledge	Not mentioned
	Resources	Limited financing for licensing, trained personnel, maintenance, equipment	Agreed
Institutional	Cultural	Lack of trust (fear of public, reach)	Agreed
		The unwillingness of authorities to enable participation by the public	Not mentioned
		Lack of acute need, motivation, and willingness to gather information	Not mentioned
	Communication	The ineffectiveness to reach of people (quantity, quality, representativeness)	Agreed
		Effectively arranging public participation	Agreed
	Political	Lack of accountability	Agreed
		Lack of impact	Agreed
		Authorities attitudes	Agreed
	Regulations	Regulations, bureaucracy	Agreed
	Resources	Lack of experience, knowledge	Not mentioned
		Absence or limited institutional support (ephemeral or no grants and programs)	Not mentioned
		Integration of PPGIS data into planning	Not mentioned
		Producing high-quality, versatile knowledge	Not mentioned
		Data quality	Disagreed
		Timing (point within the process at which the public is consulted)	Not mentioned
		Measuring impact/ effectiveness	Not mentioned
		Expert- lay divide	Disagreed

Our data suggests that neither data quality nor technical issues are major barriers to PPGIS adoption in their line of work (see Table 4). This contradicts Hasanzadeh (2021) and Kantola (2021), who argue that the data quality and technical difficulties are still barriers in PPGIS practice.

Regarding analytical tools, attendees agreed with authors such as Staffans et al. (2020) and Garcia et al. (2020), who argue that the variety and quality of data collected via PPGIS tools often require new data analysis tools, which poses challenges for planners and researchers. This often means that authorities might react critically to using PPGIS, given that they might not be able to use the methods they are familiar with (Kantola & Tuulentie, 2020). Thus, if analytical tools are difficult and time-consuming, the results often remain at the "presentation of knowledge" level, meaning it would not reach a practical application (Kantola & Tuulentie, 2020). Therefore, we recommend that development efforts should focus on efficient tools and methods to analyze PPGIS results. While organizations in major cities can rely on GIS capacities and departments for this task, smaller municipalities may still lack a GIS department. Therefore, by improving the analysis tools and methods, the entire process can be kept centralized (localized), thus preventing potential financial burdens or privacy issues (De Magalhães & Freire Trigo, 2017).

While there is no doubt that making more human tools is key for PPGIS's widespread use, higher usability cannot overcome deeper constraints and barriers on its own, but a complex PPGIS tool has a slimmer chance of succeeding (Ballatore et al., 2019). Hence the importance of keeping user-friendliness as a priority for further adoption of PPGIS in practice.

4.2. *Participants*

Attendees agreed with authors such as Anderson et al. (2009), Jankowski and Nyerges (2003), and Sieber (2006) that skills and resources are still issues that require attention. However, they also noted that they are not as important as issues related to trust and willingness. This is in line with authors such as Kantola (2021) and Natarajan (2017), who argue that issues associated with poor communication and weak distribution of information can undermine the most user-friendly, engaging, and well-justified PPGIS process and thus its outcome and further involvement in planning. Trust is a two-way street. Both practitioners and the general public must invest time and resources to build a relationship with a stable foundation. Ball (2002) argues that trust can be fostered by "continual referral back to the community groups and transparency in the use and presentation of the data and free access to the results of the mapping process." Moreover, effective communication would be paramount to delivering this information, which means tailoring communication channels to the audience to ensure a dialogue between stakeholders rather than a monologue.

Willingness overlaps through all three categories of the framework. On the one hand, the motivation of the general public to participate in PPGIS may be influenced by the user-friendliness or engagement of the tool (tool category). In this case, practitioners must ensure that the tool does not have bugs or errors that discourage use while also ensuring an engagement strategy that captivates people's attention while triggering action and fostering dissemination. On the other hand, willingness is also related to trust (participant category) and communication (institutions). If participants do not trust the stakeholder who reaches out to them for consultation, their willingness to participate may be limited. Arnstein (1969) argues that municipalities often dominate the flow of information (officials to citizens), notifying participants of their responsibilities and options without the equivalent of a reverse service, leaving participants without channels for feedback or the ability to negotiate.

When institutions fail to provide secure channels for feedback, participants develop a sense of mistrust, believing that their input will not be useful in their (potential) participation in future consultations (Kantola & Tuulentie, 2020; Natarajan, 2017). Thus, if practitioners and planners want to overcome the willingness barrier related to both the tool and the participants, they must change their attitudes and means of communication within and outside their organization. Therefore, we recommend that future research focus on improving communication strategies inside and outside organizations, especially across all age groups and different levels of education.

4.3. Institutions

All attendees agreed that the tool is very versatile and can help them solve current issues in their line of work. Moreover, the Belgian attendees reported that they had never used a similar tool in their department, nor had they seen such a systematic consultation. Attendees' opinions regarding the current state of my green place are in line with Munro et al. (2017), who argues that "social, political, and cultural obstacles can be harder to overcome" than issues directly connected to PPGIS tools and the technology behind them.

Furthermore, attendees agreed that there are many barriers in their organizations that prevent the widespread use of PPGIS, including resources, regulations, bureaucracy, and political issues, which is in line with authors such as Brown (2012b), Tang and Waters (2005), and Kantola and Tuulentie (2020). While these municipalities and practitioners had the GIS capacity to use PPGIS, they were unfamiliar with its suitability for their projects. It is this "unfamiliarity" with the tool's potential that can be seen as one of the main barriers to PPGIS in practice. Furthermore, there may be cultural barriers within a community that can prevent the use of PPGIS. This may be due to the application of a new method within an organization being received with uncertainty and skepticism in regard to its usefulness, thus requiring open-minded advocates who can vouch for the method (Kantola, 2021).

A paradigm shift must occur for meaningful participation to occur (Sager, 2011). This shift would require a genuine commitment from those initiating the process to listen to the results. Moreover, a change in governance procedures would be necessary to foster incentives and rewards when including PPGIS in decision-making so that it is not perceived as merely an extra duty (Chambers, 1997; Tippett et al., 2007). This is in line with authors such as Brown and Kyttä (2018), who argue that building capacity by finding or cultivating internal, bureaucratic champions is a prerequisite for wider use of participatory mapping by authorities and adoption by the public. These champions will recognize the value of participatory mapping methods and publicly articulate how input will be used (Brown & Kyttä, 2018). Moreover, we argue that to provide munition to these champions, they require "success stories" that show how this type of tool has been efficiently used in other scenarios. Champions can use these "success stories" to promote PPGIS in practice. For this, advocates require a good communication strategy both inside and outside their organization to promote this new type of technology.

Although each category and its respective components can make or break a PPGIS process, the remaining challenges and obstacles can be overcome if there is a champion in at least one group. This stems not only from the proposed framework but also from the nature of the PPGIS process. The three categories must be in harmony with each other for a successful participatory process to occur. While power dynamics may fluctuate at different stages of the process, a balance between the three categories is key to effective and useful outcomes that can be consistently integrated into planning and communities.

5. Limitations

This study aims to shed light on the current barriers that prevent the dissemination of digital PPGIS in practice. Limitations include the generalizabilityof the results. First, the known barriers in Table 3 were identified based on a scoping review of academic literature. Scoping reviews seek to provide a snapshot of the literature in the field, allowing for a more strategic and adaptable approach to the selection and extraction of evidence, as they lack the cumbersome rules of the systematic review (Cook, 2019). However, this type of review is limited by the incomplete appraisal of study quality and limited synthesis of evidence. The absence of quantitative synthesis and the subjectivity encountered in identifying relevant theories and original research studies should be kept in mind. Considering this, scoping reviews are useful as precursors for systematic reviews (Munn et al., 2018). Hence, we encourage further research to take the work presented in this study as a starting point for systematically exploring the barriers that hinder the widespread adoption of PPGIS in practice.

Second, the barriers identified from the practitioners' workshops were based on a specific PPGIS tool, my green place. This means that the results of our study only reflect the challenges that this one tool may face in regard to its adoption in practice and may not be generalizable to the wide array of PPGIS tools on the market. Further research should explore different PPGIS tools with different weights or levels of agreement and disagreement, focusing on areas beyond mapping CES: cultural ecosystem services in GOS: green open spaces, to obtain a clearer perspective of what could undermine their adoption in practice.

Third are the limited number of practitioners, their demographic characteristics, and their geopolitical context. This research and its practitioners are all based in Europe. Authors such as Norris (2001), Goodchild (2007), and Brovelli et al. (2016) argue that digital PPGIS adoption is easier in places that are more technologically savvy, which could exclude places that lack or have limited technological resources. Therefore, we recommend that further research focus on a more diverse sample of practitioners, controlling for more demographical factors such as age, educational level, background, and years of experience in countries with different technological access and knowledge levels, as this could influence the potential barriers. Moreover, this study focuses on the perspective of practitioners and politicians, as they are directly involved in planning organizations. However, it is also valuable to explore the perspectives of PPGIS participants and tool creators to obtain a more holistic view of the barriers.

Finally, given the important role that communication played in the results, we suggest that further research should explore how to better engage participants via online PPGIS tools. We suggest differentiating the engagement and tailoring the tools to the target audience rather than using a one-size-fits-all strategy (Kantola & Tuulentie, 2020; Shipley & Utz, 2012). In the light of the restrictions imposed by the COVID-19 pandemic, traditional methods of collecting spatial data and consulting people are no longer available, leading to a pressing need for alternatives. Denwood, Huck, and Lindley (2022a) explores a combined approach called, "Paper2GIS", which allows for manual mapping on printed maps to be digitized into GIS data using a QR code and a SIFT algorithm (Lowe 2004). In this context, participants would be contacted by post and asked to map places on a printed A3 map that was later digitized. This would allow reducing the digital divide faced by some demographic groups, while maintaining a certain data quality standard through digitization.

6. Conclusion

The framework used in this study indicates how certain components of a PPGIS process, such as the tool, participants, and institutions involved, can determine its effective adoption in practice. The results show that while any of the 15 examined types of barriers can benefit or hinder the process, engagement within the tool dimension, trust and willingness of the participants, and institutional culture are critical factors and should be prioritized. As technology advances, so do PPGIS alternatives, which can be more engaging and easier to use and analyze. This, in turn, will contribute to a number of success stories that can be incorporated into practice. However, the success stories alone are not enough for the successful adoption of PPGIS because even in organizations that embrace public participation on a formal level, the engagement structure is often dependent on the practitioners' drive and willingness. Therefore, the role of practitioners should be extended to awaken the need for knowledge among politicians and decision-makers. This advocacy in addition to institutional champions and the aforementioned success stories may be the formula that makes PPGIS a standard practice in spatial planning. Nonetheless, it is important to consider that PPGIS is only part of the puzzle of effective public participation. It is not meant to be "the solution" but rather one of the

many pieces of a holistic solution that can hopefully complement the shortcomings of existing practices.

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