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Broadening Public Engagement in Spatial Planning through Digital Participatory Mapping: Experiences from Latvia

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Keywords

GIS, participatory mapping, public engagement, spatial planning.

Abstract

Digital participatory mapping is an emerging and largely unexplored practice in Latvia despite its potential to broaden and diversify public engagement processes. This study explores the spectrum of currently used digital participatory mapping tools through select examples from Latvian municipalities. Furthermore, the study examines the citizens' participatory habits and preferences using a small-scale citizen survey and co-design activity. The obtained results allow reflection on the design, functionality, and engagement formats of the existing participatory mapping tools compared to the citizens' expectations.

Introduction

Geographic information systems (GIS) emerged in the 1960s in response to challenges in land use planning [1]. However, significant expansion of GIS use in local governments started in the 1990s, focusing primarily on intraorganizational analytic and decision-making processes [2]. Further advances in GIS and information and communication technologies (ICT) have facilitated the expansion and diversification of GIS applications, including a growing interest in developing participatory mapping methods and tools for generating place-specific knowledge to support plan-making and decision-making [3].

Broadly speaking, participatory mapping refers to using maps as the primary medium to engage people in a dialogue about the world [4], [5]. Participatory mapping is also called geo-participation, meaning the use of spatial tools to involve citizens [6] or a collection of geographical practices with participatory potential [7]. The participatory mapping methods include a spectrum of approaches, from primitive sketch mapping and hardcopy maps with markers or stickers to sophisticated three-dimensional models [5], [8]. GIS enables the capture, storage, analysis, and management of digital spatial or geographic data [5] that has resulted in a range of GIS-based solutions, including public participation GIS (PPGIS), participatory GIS (PGIS), volunteered geographic information systems (VGI), and participatory three-dimensional modeling (P3DM). These solutions are used in urban planning [9], [10], natural resource planning [11], [12], landscape planning [13], crisis management [14], and other fields around the world.

There is no clear distinction between participatory mapping concepts (e.g., PPGIS, PGIS, VGI, crowdsourcing, and others), generating confusion for academics and practitioners alike [7], [15]. Brown & Kyttä [15] have attempted to propose distinguishable characteristics for PPGIS, PGIS, and VGI. However, the practice shows that the distinctions do not always stand up in real-life applications [7], especially since GIS technologies have become accessible not only to expert users but also to citizens, community organizations, and other non-expert actors [2]. Therefore, this study will use Tulloch's definition of PPGIS to define digital participatory mapping as a "field within geographic information science that focuses on ways the public uses various forms of geospatial technologies to participate in public processes,

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such as mapping and decision making" [16]. It will allow encompassing all practices of extraorganizational digital participatory mapping, involving collaborative mapping activities [2].

Overall, participatory mapping or geo-participation promises to enhance public participation in spatial planning [7] by supporting map-based dialogue and data collection [17]. The studies show that PPGIS tools can ensure a relatively large number of voluntary participants at various phases of the planning process and in different planning situations. These tools typically provide functionality for collecting diverse place-based knowledge and supporting interactions among stakeholders [7], [17]. The obtained data can help identify conflicting issues or views early in the planning process to be addressed in follow-up deliberative processes [3], [17], potentially resulting in greater public support of the planning solutions. However, not all PPGIS tools deliver on these promises. There are still many challenges in PPGIS use associated with participatory strategies, representativeness, digital divide, and data collection strategies, to name a few [17], [18]. From a technological and methodological standpoint, the key issues or knowledge gaps are linked with the selection of appropriate participatory mapping methods, adaptation or customization of digital tools for different contexts or user groups, and facilitation of continuous public engagement and interaction throughout the process [5].

These and other issues are especially relevant for post-socialist countries that do not share the same history of public participation in spatial planning and decision-making with Western democracies. The post-socialist societies have started to adopt democratic innovations comparatively recently, and they are still under-researched [19]. There are studies on participatory planning in Poland [20]–[22], the Czech Republic [23], [24], Slovenia, Hungary, Bulgaria, Romania [23], and other contexts, but with limited insights into how these new practices incorporate digital participatory mapping [18], [19], [25]. Moreover, in some post-socialist countries, e.g., Latvia, participatory mapping for spatial planning is mainly unexplored, providing potentially new insights.

Latvian municipalities and planning consultancy companies are working with different GIS solutions, but the incorporation of participatory components in public GIS-based platforms is only beginning to emerge [26]. Some planning agencies or municipalities have succeeded in attracting EU funding that has allowed them to develop or experiment with digital mapping tools in different contexts. However, there are limited insights into how these early experiences have helped to facilitate public engagement or improve spatial planning processes. Therefore, we aim to explore what digital participatory mapping methods and tools are used for spatial planning in Latvian municipalities and how they contribute to public engagement. Moreover, we examine the participatory habits and preferences of citizens to understand how the design and functionality of the existing tools align with their expectations and wishes.

I. Research Design & Methods

The predominantly explorative nature of the study led to choosing a primarily qualitative research design that allowed applying a multi-method approach for data collection and analysis. The research was conducted in three subsequent phases: (1) analysis of the use of digital participatory mapping tools in Latvian municipalities, (2) exploration of participatory habits and preferences of citizens, and (3) co-designing participatory mapping user experience for spatial planning (Fig. 1). The obtained results are first presented separately to illustrate the outcomes of each research phase. We then reflect on the main outcomes to gain additional insights into how the design and functionality of the existing tools align with the expectation of potential users.

In *Phase 1*, we explored the current status quo of participatory mapping in Latvian municipalities. We used convenience sampling to identify potentially interesting case studies among Latvian municipalities that would allow exploring the spectrum of currently used digital participatory mapping tools. In each case, we analyzed existing digital participatory mapping tools focusing on their functionality, application for spatial planning or urban management, and engagement format or level (e.g., inform, consult, involve, collaborate, and empower [27]). Additionally, we conducted semi-structured interviews with local planning and GIS experts (Table I) to get further insights into the challenges associated with tool development and implementation. The interview topics covered the development process of locally-used digital participatory mapping tools (from idea to implementation), their usage, maintenance, deficiencies, the potential for broader use in public engagement processes, and others. The questions were adjusted to the expertise of each interviewee before the interview. The obtained data were aggregated and analyzed qualitatively.

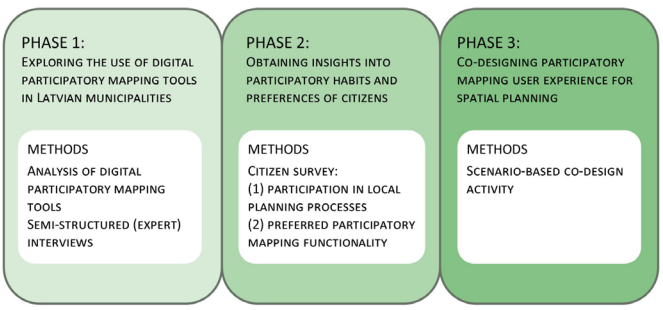


Fig. 1. Research phases and methods [Authors' illustration].

TABLE I

List of Conducted Interviews [Authors' compilation]

Ref. code	Format	Municipality	Expertise
INT_01	In-person meeting	Jūrmala city	Strategic planning, GIS implementation
INT_02	Virtual meeting	Rīga city	Geospatial information
INT_03	Virtual meeting	Mārupe county	Geospatial information
INT_04	Virtual meeting	Kuldīga county	Spatial planning
INT_05	Virtual meeting	Jelgava city	Urban management and GIS
INT_06	E-mail	Jelgava city	GIS
INT_07	Virtual meeting	Daugavpils county	Geospatial information

Phase 2 aimed at obtaining insights into the participatory habits and preferences of citizens. The data was collected using an online citizen survey disseminated via social media (Facebook newsfeed and community groups). The questionnaire was structured in three thematic blocks: (1) demographic data, (2) participation in municipal planning processes, and (3) functionality of participatory mapping tools. It included 22 questions comprised of nine single-choice questions, ten multiple-choice questions, and three open-ended questions. At the end of the questionnaire, the respondents were asked to provide their e-mail addresses to participate in the next research phase – the co-design activity.

170 respondents (112 female and 58 male) filled out the questionnaire. The majority of the respondents (132) were from the Rīga planning region (including 96 from Rīga city). The respondents made up a comparatively small and non-representative sample (Table II). The average respondent was a female aged 25–34 with higher education and living in Rīga. The survey results are presented as indicative trends among the dominant respondent groups, which at least partially describe the habits and preferences of typical participants in the public engagement activities. The acquired data on the preferred participatory mapping functionality was also used to prepare the co-design activity for Phase 3.

Phase 3 was dedicated to co-designing the user interface of a participatory mapping tool. Initially, it was planned as a participatory design workshop with several target groups, but the approach had to be transformed into remote participatory design activity due to the epidemiological restrictions in Spring 2021. It was chosen to develop a scenario-based online worksheet (using the visual collaboration platform Mural) where each participant could develop the preferred user interface of a generic participatory mapping tool.

The chosen scenario was based on a typical spatial planning situation – a public discussion of a detailed plan (a detailed plan is developed in order to implement a particular development proposal, specifying the requirements stated by the spatial plan or the local plan in more detail [28]). It consisted of six steps: (1) user authentication, (2) start page/view, (3) selection of the relevant spatial area, (4) retrieval of information about the detailed plan, (5) adding a suggestion, and (6) getting feedback. At each step, the participants were provided with a brief description, a customizable interface of a mobile application, and a set of user interface elements that could be "dragged and dropped" to create a preferred design solution. The participants were also encouraged to leave comments or suggestions describing their proposed design or adding other important information (e.g., additional features or functions).

Individual access to the online worksheet with task description and video instructions was disseminated among those survey participants who had indicated a wish to participate in the co-design activity. A total of 10 participants (5 male and 5 female, representing two dominant age groups among the survey respondents) filled out the worksheet. The resulting design concept

TABLE II

Overview of Survey Respondents' Age, Education Level, and Occupation [Authors' compilation]

Age		Education		Occupation (multiple-choice)	
<18 yrs.	2	Lower secondary	0	**Employed: government/public sector**	**71**
18–24 yrs.	8	Upper secondary	4	**Employed: private sector**	**74**
25–34 yrs.	**96**	Vocational	6	Self-employed	13
35–44 yrs.	**40**	Unfinished higher	11	Entrepreneur	15
45–54 yrs.	16	**Higher**	**149**	Student	17
55–64 yrs.	8			Unemployed	5
>65 yrs.	0			Other	8

contains aggregated elements and functions selected by most participants (more than a half). Special attention has been paid to the positioning of the elements on the interface and participants' comments that provided more detailed insights into their thought processes.

The obtained generic design concept allowed us to draw tentative conclusions about the expectations and wishes of the potential user group. These were then analyzed comparatively to the existing solutions to obtain insights into similarities and differences that illustrate the need for adaptation or customization of the existing tools.

II. Digital Participatory Mapping Tools: Examples from Latvian Municipalities

A. National Spatial Development Planning Information System

On the national level, the Ministry of Environmental Protection and Regional Development has developed the Spatial development planning information system (SDPIS) – *a structured set of information technologies and databases which ensures the creation, compilation, accumulation, processing, use, and destruction of information required for the development and implementation of spatial development planning documents* [29]. It consists of four components: (1) a central module (tapis.gov.lv) for planning experts supporting the preparation, publication, and upkeep of the planning documents; (2) a regional development indicators module (RDIM) allowing public access to different municipal data sets; (3) publicly available national geospatial information portal (ĢeoLatvija.lv); and (4) e-services on state service portal (Latvija.lv) [30].

Public engagement is ensured through the national geospatial information portal (section "Spatial development planning"). The authenticated users can sign up for spatial planning news for a selected territory. These include notifications about decisions related to different planning documents, public discussion processes, and public hearings or meetings. The portal also provides access to all official documentation and allows viewing land-use zoning in the integrated map browser. When there is an ongoing public discussion process, the authenticated users can submit proposals or suggestions through the portal. The users can submit a written statement with or without selecting a specific location related to the suggestion. Planning experts, in their turn, can view and respond to these suggestions. The research shows that only about 800 citizens have signed up for the news, indicating that people who are not interested in or work with planning issues are unaware of this tool [26].

The SDPIS is essentially a one-stop platform providing access to all available planning documents in Latvia and ensuring uniformity in specifications and visualizations. It allows for easier search and usage of the relevant information. However, the system has limitations regarding public engagement. The proposals and suggestions can be submitted only during the public discussion process. Moreover, there are no options for engagement in

TABLE III
FUNCTIONALITY OF COMMONLY-USED DIGITAL PARTICIPATORY MAPPING TOOLS [AUTHORS' COMPILATION]

Engagement level	Tool	Functionality
Informing	Map browsers	• Viewing different data layers • Viewing different map types
	Geoportals	• Viewing and searching geospatial data sets • Viewing attribute information about objects • Adding data layers from external sources • Data selection and filtering • Layering different data sets and maps • Printing, drawing, or marking points on the map • Viewing metadata (information about data sets)
	3D models	• Viewing three-dimensional spatial visualizations • Simulation and visualization of new plans or projects
Consulting	Crowdsourcing solutions	• Viewing information about a project or plan • Submission of geo-referenced suggestions • Viewing suggestions of other contributors
	Geo-questionnaires	• Creating questionnaires with geospatial components • Linking questionnaire answers to locations on a map by marking points or sketching polygon features
Involving	Interactive mobile & web applications	• Viewing information about a project or plan • Submission of geo-referenced suggestions • Viewing status updates for suggestions • Viewing suggestions of other contributors • Getting feedback from the municipality • Reacting (like/dislike) or commenting on suggestions of other contributors

everyday decision-making and planning processes. The communication is formal, often resulting in a long wait for a response that can be avoided by contacting the municipality directly. Direct communication also provides more options for dialogue and collaboration. Overall, the interviews reaffirmed the primarily formal use of the SDPIS as required by law and its limited role in ensuring public engagement.

B. Local Digital Participatory Mapping Solutions

Latvian municipalities demonstrate a comparatively limited use of participatory mapping solutions for public engagement in spatial planning. The obtained results show that participatory mapping is not an everyday practice among planners due to an implementation gap in adopting existing GIS solutions for participatory planning. Overall, it is possible to distinguish four commonly-used participatory mapping approaches: (1) map browsers and geoportals, (2) 3D models, (3) crowdsourcing solutions and geo-questionnaires, and (4) mobile applications for interactive communication. The identified tools and approaches primarily ensure informing and consulting levels of engagement for spatial planning and urban management (Table III).

The most commonly-used digital mapping solutions in Latvian municipalities are **map browsers and geoportals**. Both solutions are developed to aggregate different data on the municipality and its territory in one system. The objective is to improve the work efficiency of municipal services, ensure data circulation among different departments, and build a basis for the preparation of different cartographic materials, e.g., for spatial planning or data visualization. The difference between a map browser and geoportal lies in its interactivity. Map browsers only allow viewing different data layers and maps, whereas geoportals provide options for dynamic interactions, e.g., data selection and analysis, data upload, and download. The analyzed case studies show that these solutions were initially developed for internal use among municipal experts and departments. However, some municipalities have publicized separate data layers, e.g., the Daugavpils county GIS browser allows viewing different planning documents and thematic maps, municipal statistical data, and information on business activity [31]. In their turn, Kuldīga Development Agency provides an interactive map for viewing municipal spatial plan and adding extra layers like village borders and different base maps with specific information, e.g., areas where it is not allowed to build wind turbines [32]. The available data layers also allow viewing attribute information for individual objects, e.g., area size or zoning code. Rīga, Jūrmala, and Mārupe municipalities have also developed their geoportals based on a similar concept, but they are currently available only for intraorganizational (municipal) use. The main differences among the analyzed examples relate to the complexity and volume of the available data and functionality.

Another informing tool is **3D urban models** that provide three-dimensional spatial visualization of the natural and built environment. These models are gaining popularity in spatial planning, as they allow visual simulation of different development scenarios. 3D urban models help assess how the proposed buildings fit into the existing urban environment and communicate the expected changes in a more comprehensible way for non-expert audiences. These models can be an integral component of a geoportal, but they are typically developed as separate tools due to large data volume that can slow down other services.

Among the analyzed case studies, only Daugavpils county has developed a 3D model [33] under the umbrella of the Interreg project "Trans-form", aimed at revitalizing degraded territories. The model allows viewing a three-dimensional model of four industrial areas, measuring distances, comparing changes, and preparing visual materials. In this case, the model is aimed at a specific target group – entrepreneurs and potential investors interested in the sustainable development of these areas [34].

Overall, tools like map browsers, geoportals, and 3D urban models do not facilitate active participation but ensure the most basic engagement level – informing. It allows citizens to view or obtain information about their local environment and helps to stay up to date with different planning and development processes. Moreover, access to visualized information often facilitates a better understanding of the local context or proposed planning solutions leading to informed participation.

When going beyond the informing level, some municipalities have used GIS-based **crowdsourcing solutions** to collect suggestions or ideas from citizens. One such solution – terGIS – has been developed by a planning consultancy company Metrum Ltd. and used in three different municipalities (Jūrmala, Kuldīga, and Rīga). It was first used to display citizen suggestions and their status during the spatial plan amendment process in Jūrmala [35]. Later, the terGIS was developed to allow submitting new suggestions or ideas directly through the web platform using a simple form. This version was used in Kuldīga during the preparation of the local plan for the old town area [36]. The latest terGIS version, used for crowdsourcing ideas for a local plan in Rīga (Riga Technical University campus area in Ķīpsala [37]), incorporates more data layers, categorization of suggestions, and new functionality allowing to vote and comment on collected ideas that are already characteristics of interactive web applications. Although the terGIS tool has evolved and improved over time, it has limited functionality primarily aimed at consulting – collecting suggestions and obtaining feedback for a specific planning project. Moreover, the

suggestions are submitted as free-form written messages that complicate the data processing and analysis.

For consulting purposes, some municipalities have also tried using **geo-questionnaires** that allow integrating geospatial components with a typical question-answer process. The case studies revealed two instances where the Esri ArcGIS Survey123 tool was used for citizen engagement. One was in Kuldīga county, where citizens were invited to submit suggestions for the new strategic planning documents using the ArcGIS Survey123 questionnaire [38]. In this case, the questionnaire mimicked a simplified suggestion submission form without taking advantage of the geospatial component or more structured geospatial data collection options. Therefore, its application resembles crowdsourcing solutions for idea collection.

A different approach was used in the Interreg project "Land-Sea-Act", which aimed to find ways to balance national interest for wind energy production at sea with coastal community interests and tourism development. In this case, Baltic Environmental Forum (*Baltijas Vides Forums*) employed geo-questionnaires (1) to collect data on locations in the Southwestern Kurzeme coastal area that are considered important for tourism and recreation and (2) to assess identified landscape units in the same area based on four different landscape qualities [39]. Both geo-questionnaires used a fully or partially structured data collection approach to obtain information that is comparatively easy to analyze. Moreover, the results of these questionnaires and other studies were fed into a geoportal (map explorer) that displayed project outcomes using textual descriptions, interactive maps, and dashboards that are updated in real-time [40]. Such an approach ensures greater transparency of the project outputs and provides access to easy-to-understand information that can be used by different stakeholders.

Finally, several municipalities use **interactive mobile and/or web participatory mapping applications** for two-way communication with citizens. These solutions typically allow to submit real-time reports on problems in the urban environment, view submissions of other users, and follow the report's status. For example, Jelgava municipality has developed a geoportal integrating an interactive problem-reporting map linked with the municipal operative information center [41]. This way, the municipal services can respond quickly, ensuring feedback and facilitating good communications practice. The application is primarily used for urban management, but it can also be adapted for citizen engagement in spatial planning. Similar solutions are also used in Daugavpils and Valmiera municipalities that have developed mobile applications with integrated problem-reporting maps. Mobile applications typically have a broader spectrum of functionalities (e.g., newsfeed, event calendar, and offers), and they can become a one-stop information and communication solution with the municipality for smartphone users. It supports different engagement levels (informing, consulting, and involving) and can be adapted for various uses.

III. Development and Implementation Challenges of Participatory Mapping Solutions

The interviews with municipal experts revealed several challenges they faced when developing and implementing digital participatory mapping solutions. First of all, there are technological or practical challenges like data availability, data quality, data protection, systems' complexity, and design. Second, there are also user-related challenges, e.g., competencies and digital skills of user groups. Finally, there is an overarching challenge of facilitating changes in thinking and dominant practices among citizens, municipal experts, and decision-makers.

No mapping solution can function without an adequate database or content. Therefore, data availability and quality are crucial challenges when developing a new solution. Initially, it is important to identify, prioritize, and categorize the available data sets based on planned usage (internal or public). If developing a public platform, another issue is data protection following the existing legal requirements. No less importance should be given to regular data updating to ensure the long-term usability of the developed tool. Essentially, any successful solution is continuously maintained, updated, and improved to ensure up-to-date information and expansion of its usability.

The complexity and design of the developed solutions are linked to two main user-related challenges: (1) the competencies and skills of municipal experts and (2) the existing digital divide in society. When developing and implementing participatory mapping solutions, the municipality has to engage experts with relevant knowledge and competencies and ensure the training of internal system users. The continuous maintenance and update of such solutions require skilled human resources that not every municipality in Latvia has or can afford. Furthermore, there is still a digital divide among different social groups. Specifically, not all citizens have adequate digital skills or access to technologies. It results in a spectrum of potential users from a complete beginner to advanced or expert level. Therefore, the mapping tool requires a simple, user-friendly, and intuitive design that is easy to perceive and understand by all user groups while maintaining the options for more complex functionality. This aspect is crucial for public engagement tools to avoid the exclusion of potential users due to poor design or lack of skills.

Finally, the interviewed municipal experts repeatedly pointed out that a lot of time and work is invested in explaining and educating their colleagues on the

advantages and benefits GIS-based solutions can bring to everyday work, like data processing, data visualization, and citizen engagement. It requires a shift in thinking and planning practice on the municipal level and subsequent work with society to make these tools integral to everyday practice.

The interviewees also proceeded to provide some suggestions for tackling the abovementioned challenges. For example, they suggested an intervention on the national level to provide unified guidelines and regulations on implementing digital mapping solutions and data usability. Moreover, there is a lack of unified data templates or sets that municipalities could integrate into their systems. Instead, the data comes in different formats or with diverse database structures requiring preliminary data conversion or processing, often using additional software.

For those municipalities that have not implemented participatory mapping solutions, it would be helpful to provide a handbook with basic technical or practical guidelines. According to the interviewees, it should include potential data sources, define primary data layers or sets, and describe guidelines for setting up a database. Furthermore, it is necessary to provide a minimum licensing package and paid training for municipal experts to ensure the availability of skilled personnel. The interviewees also thought there was a need for national support in setting up a joint geoportal. The existing national geospatial information system currently does not include the same functionality as municipal geoportals. Moreover, it is primarily used due to mandatory legal requirements regardless of the usability issues.

IV. Participatory Habits and Preferences of Citizens

The limited use of participatory mapping solutions for public engagement has to be viewed in the context of the participatory habits and preferences of citizens. The survey results of 170 respondents primarily reveal opinions of socially and economically active citizens that are easily engaged digitally (in this case, via social media) and at least partially represent typical participants in the public engagement activities.

The survey results show that respondents obtain information about the activities and current events in their municipality, primarily from municipal social networking sites (Fig. 2). Approximately half of the respondents also use municipal websites or get information from their friends, relatives, or colleagues. A surprisingly small number of respondents obtain information about planning processes from the national geospatial portal (Geolatvija.lv) despite the possibility of signing up for direct notifications. Admittedly, the respondent recruitment method can explain the preference for social media. In comparison, a study from 2017 shows that citizens usually obtain information about events and services provided by Rīga municipality from relatives, friends, or acquaintances (53 %), online news portals (52 %), social networking sites (42 %), TV (39 %), radio (32 %), and municipal (specialized) websites (29 %) [42]. It suggests a comparatively lower use of social media as an information source despite the increasing usage of social networking sites by community organizations and municipalities.

The respondents were also asked whether they knew how to get involved in spatial planning. A comparatively small portion of the respondents indicated that they know and use the existing participatory opportunities (Fig. 3). More than a third of respondents said that they know about the participatory opportunities but choose not to participate, while another third of the respondents do not know how to get involved but wishes to do so. These results indicate that there is a societal group that could potentially get involved but lacks information. It suggests that municipalities have not provided sufficient information about participatory opportunities or used communication channels that are not reaching the specific audience.

When asked about the participation formats, approximately half of the respondents indicated that they have never gotten involved in any participatory activities (Fig. 4). Among the other half of the respondents, the most popular formats were citizen surveys and public

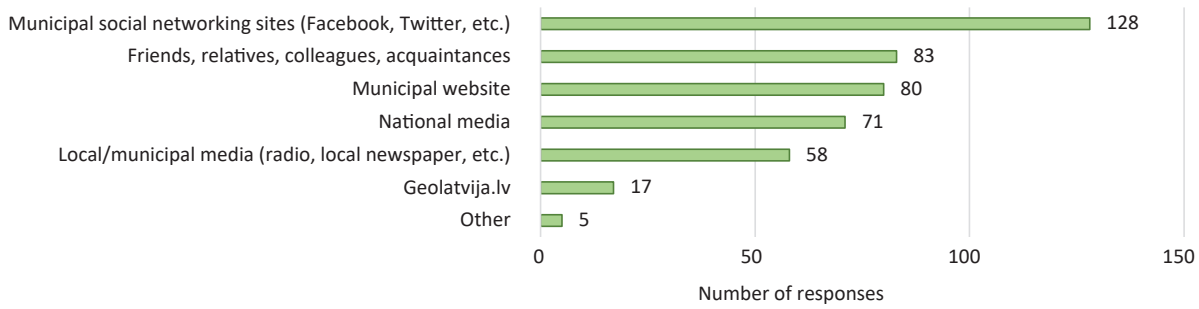


Fig. 2. Overview of the answers to the question "Where do you get information about municipal activities and current issues?" [Authors' illustration].

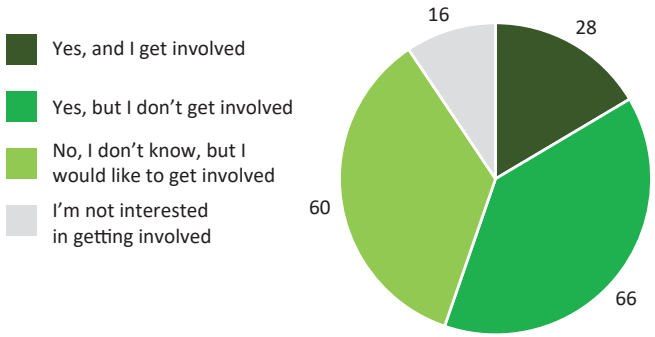


Fig. 3. Overview of the answers to question "Do you know how to get involved in municipal planning processes?" [Authors' illustration].

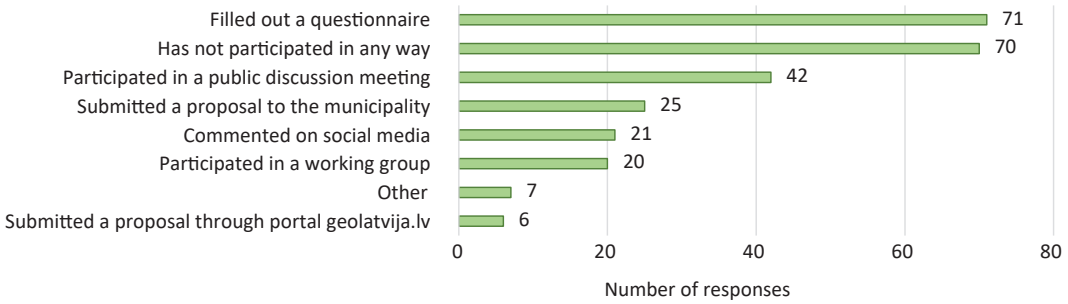


Fig. 4. Overview of the answers to the question "In what way have you participated in planning your city or neighborhood?" [Authors' illustration].

discussion meetings. These are two very different approaches – an easy question-answer process that ensures anonymity and does not take up much time or resources versus an in-person event that typically requires travel and considerable time investment (In pre-pandemic situation). However, the data shows that these are two of the most popular participatory methods used by Latvian municipalities [26], which explains their prevalence among the responses. The comparatively higher preference for citizen surveys could suggest a greater interest in simple and convenient participation formats. Moreover, most of the respondents said that they would be interested in online or online and in-person participation formats indicating an unexplored potential of digital engagement methods.

The next step was to explore respondents' familiarity with map-based digital tools. The results show that most respondents use map-based applications regularly, with a general preference for Google Maps. Admittedly, the Google Maps application is an integral component of Android-based smart devices; therefore, citizens have developed a habit of using it. Also, the application is visually and functionally very simple. The standard base map is not satiated with different elements. It is easy to read and incorporates different points of attraction or landmarks. Additionally, Google Maps provides a good search engine, street view options, several base map types, and more advanced options for experienced users. Finally, the application ensures global coverage in different languages facilitating wide usage.

Respondents were further asked questions about the preferred functionality of a generic participatory mapping tool. The results reveal demand for functionality enabling four primary user operations: (1) getting information, (2) expressing an opinion, (3) communicating, and (4) collaborating (Fig. 5).

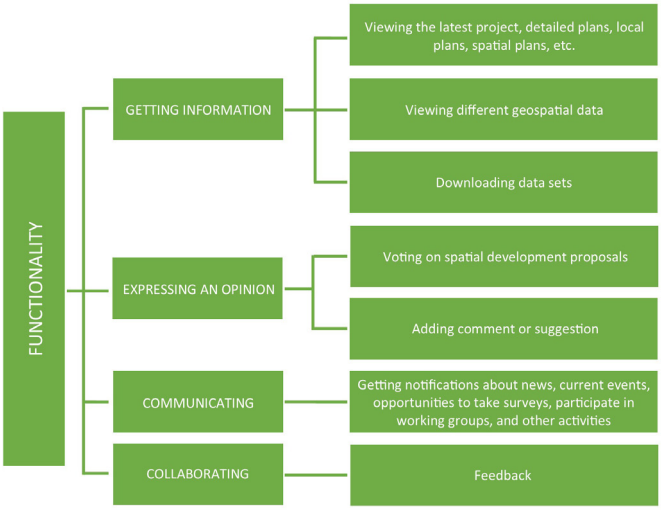


Fig. 5. Overview of the preferred digital participatory mapping tool functionality [Authors' illustration].

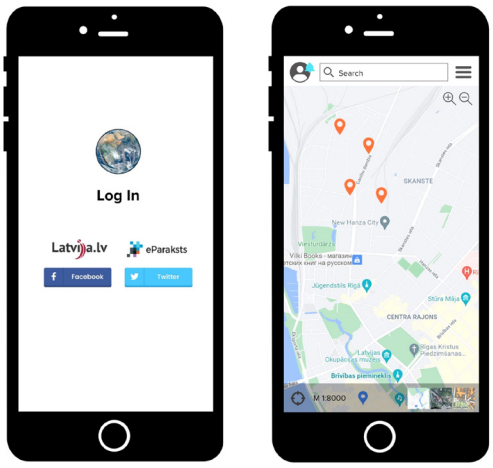
The respondents indicated a wish to view available geospatial data sets and planning-related data in one place. Moreover, they expect to be able to download the data for other uses. Another important aspect is the option to express an opinion on current issues by voting on specific proposals or submitting their comments or suggestions. Additionally, the respondents see a need for direct communication with the municipality. They would prefer to receive notifications about news and current issues and have an option to send messages to the municipality. Finally, the respondents wish to receive feedback, which is an important step in ensuring continuous participation, as it provides acknowledgment of the importance and value of the contribution in addressing local issues.

V. User-Friendly Participatory Mapping Tool: A Design Concept

The citizen survey suggested the preferred functionality, but it did not explain how it would translate into a participatory mapping tool or engagement in a real-life planning situation. Therefore, a scenario-based co-design activity was carried out with a small group of participants to develop a design concept for a generic participatory mapping tool. Based on similar approaches used in developing other ICT solutions, it allows exploring the user experience of a target audience. The results demonstrate a simple and convenient design concept aimed at a positive user experience.

User authentication. Most information and functionality should be accessible to any user without authentication. However, the users must create an account or log in using an existing account in another platform to express an opinion – add a comment or suggestion about a spatial development project. The results show a preference for official authentication options, e.g., using state service portal Latvija.lv, electronic signature eParaksts, or social media profiles (Fig. 6 (a)).

Start page/view. The start page or home page of the participatory mapping tool uses a base map that is simple and easy to read without specific symbols that are found, e.g., in topographic maps. The example in Fig. 6 (b) uses Google Maps as a base map, but it can be any other similar product. There is a user profile icon in the left upper corner that displays a notifications symbol if there are new announcements pertaining to the user. The tool also incorporates search and zoom functionalities displayed in the upper part of the screen together with the menu. By clicking on the menu, it is possible to access available data layers, e.g., educational institutions or playgrounds. The menu also allows launching other options, e.g., an area selection tool. Finally, the menu can contain other information or functions that the developer wishes to integrate into the tool.



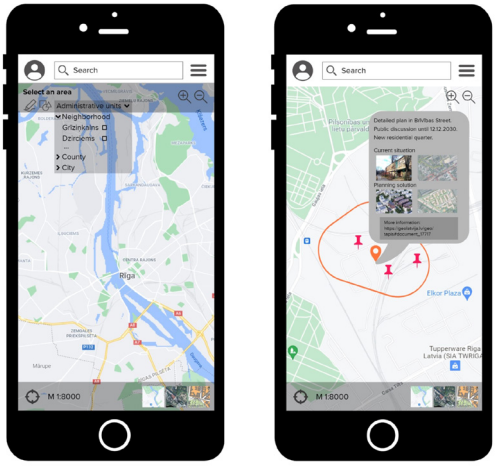
(a) User authentication (b) Start page

Fig. 6. Design concept of a participatory mapping tool: (a) user authentication page and (b) start page/view [Authors' illustration].

A semi-transparent bar is displayed at the bottom of the screen. It shows the map's scale, the 'find your current location on the map' tool, and other available base map types. On the map, the orange markers display places with ongoing planning projects. The user can access more information by clicking on the marker. The chosen icons or markers are shaped similarly to those used in the map browsers indicated by the respondents. It ensures that the design will seem familiar, and the users will be able to navigate it intuitively.

Selection of the relevant spatial area. The survey respondents wished to receive notifications about planning projects or engagement activities in the specific (selected) spatial area(s) – those relevant or interesting to them. Therefore, the participatory mapping tool provides authenticated users with an option to select such areas. The functionality is launched from the main menu that activates a pop-up menu bar with selection tools. The user can choose from the existing administrative units or demarcate a specific area with a drawing tool or polygon. It ensures that the user can select either a municipality or a specific part of the municipality that is smaller than any administrative unit. Additionally, it is important to display a search function that allows users to find a specific address, object, or their location on the map. The design concept example (Fig. 7 (a)) uses Rīga as a demonstrative case with integrated neighborhood units. In other municipalities, the selection field of administrative units would display locally-adapted areas.

Retrieval of information about a detailed plan. When a user receives a notification about a new development project or public discussion process, the tool allows clicking on the notification to find the specific location on the map. The user should also be able to access the exact location from the start page. It displays a borderline of



(a) Area selection (b) Information retrieval

Fig. 7. Design concept of a participatory mapping tool: (a) selection of an area and (b) information retrieval about a plan or a project [Authors' illustration].

(a) Adding a suggestion (b) Getting feedback

Fig. 8. Design concept of a participatory mapping tool: (a) adding a suggestion and (b) getting feedback [Authors' illustration].

the area with an icon in the center (Fig. 7 (b), the orange markers). When clicking on the icon, the tool opens a pop-up window with a brief description of the proposed planning solution, including the address, public discussion period (dates), information about the proposed solution outlining the most significant changes, and a link to complete information package in the national geospatial information portal (geolatvija.lv). The descriptive information is complemented with visual material, e.g., photographs of the existing situation, visualizations of the proposed changes, 3D models, sketches, and other graphic material that facilitate understanding of the proposed planning solution. The participants also expressed a wish to access the information about the land-use zoning, ideally combined with the 3D model of the planning solution. The land-use zoning map for the specific area could be activated using the toolbar at the bottom of the screen. Additionally, the user can also see pins (the pink markers) that show locations about which other users have already submitted suggestions or comments. It is possible to click on each one to view the opinions.

Adding a suggestion. If an authenticated user wants to add a suggestion or comment, he/she can access the relevant function from the main menu. It will activate a grey toolbar underneath the search field (Fig. 8 (a)). The toolbar provides three options for marking an object on the map – point, line, or polygon. It ensures that users can be as precise as possible in selecting an object (e.g., a building, a street, or a block). When a user has marked an object on the map, it opens a pop-up window to write a suggestion or comment and add other materials, e.g., an image or a document. The user completes the task by pressing the 'Submit' button at the bottom of the pop-up window. The successfully submitted suggestions are displayed on the map as a pink pin icon (the icon is grey while the user writes their suggestion).

Getting feedback. The tool provides several feedback options (Fig. 8(b)). The users can easily trace the status of their comments or suggestions based on the color of the pin icon on the map. The newly submitted suggestions are shown as pink icons that change the color to blue when the municipality starts reviewing the suggestion. It turns green when the municipality has provided feedback. When clicking on the green pin, a pop-up window will show the suggestion, including descriptive text and any other submitted material. The municipal feedback shows as a highlighted comment placed directly underneath the original suggestion. The survey respondents emphasized the importance of getting feedback from the municipality; therefore, it is prioritized and highlighted among other comments.

The contributors can also receive feedback from other authenticated users either as a like/dislike vote or comment. The voting allows the municipality to see the overall support for individual contributions. The users can also vote on each other's comments extending the feedback loop beyond the original contribution. All the information about status changes of the original contribution or interactions appears as a notification symbol on the profile icon in the upper left corner of the screen. The response from the municipality is delivered not only in the form of a comment but also as a direct message to the contributor.

The suggested design concept primarily emphasizes simplicity and an intuitive user experience that can be adapted for both mobile and web applications. Each step is based on the start page view allowing one to perform basic functions, e.g., search, switch between base maps, or determine one's location. Exploring other engagement scenarios could reveal a need for additional functions or

options. These should be integrated and displayed visibly and understandably to an average user who typically would choose the functions shown on the screen.

The design elements (symbols, icons, pop-up windows) and colors shown in the sample design concept can be adjusted. However, each element has to be simple and noticeable, while ensuring that the application's overall design is clean and easily perceptible. The most important elements indicating the next steps or providing primary feedback should be highlighted (e.g., with color) so that users do not have to guess or search for what they are supposed to do and can easily accomplish the desired action.

VI. Discussion

The obtained generic design concept allows drawing tentative conclusions about the expectations and wishes of citizens as the end-users of the proposed generic participatory mapping tool. The users expect (1) familiar, simple, uncluttered, and intuitive design; (2) diverse functionality that allows using one tool for different purposes and provides integration with other (external) services; and (3) different engagement and interaction formats. By comparing these expectations with already existing tools used in Latvian municipalities, we discuss the main similarities and differences.

The design of the generic participatory mapping tool is simple and intuitive, which is achieved mainly through the use of familiar design elements chosen by the end-users. Although most existing tools incorporate similar design elements (e.g., simple base maps from other services), they rarely ensure an intuitive user experience, especially for inexperienced users. It could be mitigated through customization and improvement of the initial design based on user feedback or use patterns. However, such an approach poses challenges for those municipalities that have developed their tools within EU-funded projects and lack resources for further tool development. In rare cases (e.g., terGIS), we have observed gradual improvements in the design and functionality, but there is still room for further enhancements and simplifications.

The current practice shows that existing participatory mapping tools are predominantly employed for one planning project or provision of one primary function (e.g., problem reporting, informing, or idea collection). It creates challenges for the end-users required to navigate different tools and services. A step in a different direction are municipal mobile applications that provide various functions, including participatory mapping options, but those are not yet employed for public engagement in spatial planning. In contrast, the citizens expect diverse functionality that would allow using one tool for different purposes – getting information, expressing opinions, communicating, and collaborating. The proposed design concept demonstrates such a multifunctional solution that would allow employing one participatory mapping tool for different purposes or projects. However, it requires further exploration of other typical planning scenarios (e.g., public engagement in strategy development) to assess its applicability in different planning situations.

The use of one solution with diverse functionality allows ensuring a continuous public engagement process (as opposed to project-based or irregular involvement). Nevertheless, such a participatory mapping solution still has its limitations. We explored only one planning scenario that anticipated reactive engagement to an ongoing government-led planning process characteristic of top-down approaches. Moreover, although the proposed generic participatory mapping tool envisages different communication and interaction formats, it does not facilitate bottom-up engagement. Therefore, future studies should address other proactive or citizen-led engagement scenarios to explore the potential applicability of participatory mapping tools for citizen empowerment.

Finally, we want to emphasize that developing a multifunctional participatory mapping tool is complex and expensive. Therefore, there has to be an agreement among decision-makers and planners on development and implementation objectives. It only makes sense to invest time and resources in development when the tool is foreseen to be fully integrated with the everyday planning processes and used regularly. Alternatively, the municipalities should choose one of the existing and adaptable services for short-term or project-based usage.

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