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Citizens Meet Climate: A Digital Participation Framework and Prototype for Citizen Climate Action

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Abstract

Achieving climate targets in cities requires the involvement of citizens in policy implementation, collective action, and individual behaviour change. Although digital participation platforms have the potential to enhance citizen engagement in climate action, several barriers remain at the intersection of technology development, science communication, and urban planning, ranging from poor navigation and information overload to disconnection between participation and planning processes. This study develops a framework for designing digital climate action participation, drawing on literature review, analysis of existing digital participation platforms, and prototyping and participatory testing. The framework consists of seven design principles, including valuing local climate knowledge and balancing optimistic and pessimistic climate framings. The framework was applied to design the Citizens meet Climate prototype, a digital participation platform focusing on urban heat. The prototype was tested with mixed audiences, with generally positive and consistent results. Participants reported increased motivation to take climate action, understanding of climate data, and appreciation of local initiatives. However, enabling collective action and community building remains challenging, in part due to the digital medium itself. These insights highlight the importance of not only designing tools to address the particularities of climate change in engaging and understandable ways but also embedding these tools into broader participatory planning approaches that go beyond the digital.

Keywords

citizen empowerment; climate communication; design prototyping; digital participation; participatory planning; public participation

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1. Introduction

Cities worldwide are setting ambitious sustainability targets in response to climate change. Achieving these targets requires a wide range of interventions, many of which need not only public support but also active citizen engagement (Hegger et al., 2017). This includes the adoption of solar panels, renovation and greening of buildings and private outdoor spaces, as well as individual and household behavioural changes (Hansen et al., 2021; Jensen et al., 2021). Because a substantial share of the built environment is residential and privately owned or managed (Kraaijvanger et al., 2023), the success of climate interventions depends on the willingness and ability of citizens to engage in climate action. Increasing awareness about climate change and engaging citizens in addressing climate risks is therefore essential for urban sustainability (Gonçalves, Narendra, & Verma, 2025).

Digital participation is increasingly adopted in urban planning and governance, offering several advantages: participation across time and space, broader and more diverse groups of citizens, and more transparent governance through information exchange between governmental organisations and citizens (Dörk & Monteyne, 2011; Falco & Kleinhans, 2018; Gonçalves et al., 2024; Kleinhans et al., 2022). Yet municipalities often struggle with sustaining engagement, due to several reasons including strict project deadlines, limited resources, and internal structures that hinder cross-sectoral collaboration (Gonçalves, Rocco, et al., 2025). As a result, participation is often limited to incremental actions designed to inform or placate, while planning becomes increasingly reliant on parametric tools like urban digital twins that reduce the city to its volumetric form and exclude citizen perspectives (Rose et al., 2021). At the same time, existing platforms still fail to provide meaningful or empowering experiences for citizens (Gonçalves et al., 2026), reinforcing and creating new challenges for participation, such as lack of trust and participation fatigue (Corbett & Le Dantec, 2018; Gonçalves et al., 2024; Gonçalves, Rocco, et al., 2025).

Moreover, many digital participation tools for urban planning and decision-making, such as Maptionnaire or Decidim, are "generic" platforms—meaning that they are not specifically designed to address climate action. While they are often flexible enough to be adapted to climate-related topics, engaging citizens in climate action requires a tailored approach to how climate is framed (Hegger et al., 2017; O'Neill & Nicholson-Cole, 2009) and what citizens can concretely do about it (Luxon, 2019; Nabi et al., 2018). This is important to avoid climate anxiety and provide an empowering experience where citizens acquire the knowledge, networks, and tools for climate action. In addition, research on climate engagement has largely focused on understanding technology uptake and behavioural change (Hansen et al., 2021; Jensen et al., 2021), rather than enabling citizens to make informed and autonomous choices about how they wish to engage in climate action. This reinforces citizens' perceptions of a limited scope for action, which has been identified as a barrier to citizen engagement (Hegger et al., 2017).

This study examines how digital participation can be designed to empower citizens in climate action. It develops a design framework grounded in a scoping literature review and a systematic analysis of 15 digital platforms designed for citizen engagement. The framework is applied to create Citizens meet Climate (CmC), a prototype of a digital participation platform to empower citizens in climate action. The prototype is iteratively designed and tested through workshops and online surveys, with generally positive and consistent feedback across rounds. The findings show the importance of not only designing digital tools that consider thematic and contextual challenges related to climate change but also embedding such tools within broader governance processes beyond the digital space.

2. Literature Review: Requirements for Engaging and Empowering Citizens in Climate Action

2.1. Participatory Planning and Citizen Empowerment

A key theme in participatory planning literature is the relationship between citizen engagement and empowerment. Citizen engagement can be understood not only as the involvement of citizens in planning processes, but as a process through which citizens develop the capacity, confidence, and opportunities to influence decisions and shape their environments. From this perspective, participation becomes meaningful when it supports different components of empowerment (Zimmerman, 1995). First, empowerment relates to self-efficacy, where citizens perceive that they have the knowledge and capabilities to contribute to change (intrapersonal empowerment). Second, empowerment concerns decision-making capacities, referring to citizens' ability to understand planning processes, navigate institutional contexts, and influence decisions (interactional empowerment). Third, empowerment involves behavioural capacity, where citizens can access resources, support, and opportunities to act autonomously (behavioural empowerment).

Closely linked are questions of how citizen input is valued and used in decisions. While citizen knowledge is increasingly recognised as valuable in planning processes, participation in practice is often reduced to tokenistic exercises rather than meaningfully embedded in decision-making (Monno & Khakee, 2012; Yazar et al., 2025). This disconnect can result from limited implementation capacity and weak integration of participatory activities within planning processes (Gonçalves, Rocco, et al., 2025) and can lead to a lack of trust in public decision-making, disengagement, and participation fatigue (García-Espín & Ganuza, 2017; Jánová et al., 2025). Here, transparent communication about the purpose and influence of citizens is essential to manage expectations and foster honest and meaningful engagement (Gonçalves et al., 2024). In addition, actively recognising the insights and experiences citizens bring to the process can also help to (re)build trust between citizens and decision-makers (Champlin et al., 2022; Gonçalves et al., 2024).

Within digital urban planning and emerging discussions around digital twins, participatory platforms are increasingly seen as mechanisms to democratise decision-making and counterbalance technocratic approaches to urban data and modelling (Dawkins & Kitchin, 2025). This raises questions regarding platform governance, including how citizen contributions are collected, acknowledged, communicated, and incorporated into decision-making (Gonçalves, Narendra, & Verma, 2025). Moreover, the effectiveness of digital participation depends on wider conditions, including trust in institutions, awareness of climate issues, access to resources, and digital literacy (Corbett & Le Dantec, 2018; Dörk & Monteyne, 2011; Falco & Kleinhans, 2018; Gonçalves et al., 2024; Gonçalves, Rocco, et al., 2025; Kleinhans et al., 2022). Therefore, digital participation platforms should not be understood as tools for informing or collecting citizen input but as infrastructures that shape relationships between citizens, information, and decision-making processes.

2.2. Climate Action and Science Communication

Climate communication research highlights the importance of how climate change is framed and how climate information and data are communicated. While dramatic representations of climate risks can attract attention, they may also generate fear, anxiety, or feelings of helplessness when not accompanied by clear pathways for action (Hegger et al., 2017; O'Neill & Nicholson-Cole, 2009). Climate communication therefore

requires balancing the communication of risks with opportunities for positive impact, highlighting solutions, success stories, and achievable forms of change (Luxon, 2019; Nabi et al., 2018), as citizens are more likely to engage when they understand how their actions can contribute to meaningful outcomes (Nabi et al., 2018; O'Neill & Nicholson-Cole, 2009). Importantly, climate action can be encouraged through individual behavioural changes, but also collective initiatives and support for broader infrastructural or institutional transformations (Gonçalves, Narendra, & Verma, 2025; Hegger et al., 2017).

Providing credible and clear information influences whether citizens can understand complex climate processes and connect them to their everyday experiences, thus being fundamental to effective climate communication. Climate information should be not only scientifically credible and reliable but also accessible, with visual and interactive representations that help connect technical information to daily concerns of citizens, making complex topics more comprehensible and personally relevant (Nabi et al., 2018; O'Neill & Nicholson-Cole, 2009; Prost et al., 2023; Slingerland & Overdiek, 2023). Local and personal perspectives can strengthen engagement by connecting individual experiences with wider climate processes, supporting place attachment and perceived relevance (O'Neill & Nicholson-Cole, 2009; Scannell & Gifford, 2013).

2.3. Digital Engagement and Human–Computer Interaction

Digital engagement and human–computer interaction research highlights the role of platform design and usability in enabling meaningful engagement. This is important because interactive approaches can make complex climate topics more relatable, particularly when grounded in familiar places and lived experiences (Gonçalves, Rocco, et al., 2025; Slingerland & Overdiek, 2023; Veland et al., 2018). Storytelling, maps, 3D visualisations, and interactive representations can support understanding by making spatial and temporal dimensions of climate change more tangible (Gonçalves et al., 2024; Hanzl, 2007; Sheppard, 2015; Slingerland & Overdiek, 2023; Veland et al., 2018).

In addition, the effectiveness of digital platforms is influenced by platform navigation and interface appeal. Platforms should be intuitive, clearly communicate their purpose, and guide users through complex information and participation processes (Atreja et al., 2018; Gonçalves et al., 2024). Visual appeal, appropriate terminology, and careful management of information load are particularly important for topics such as climate change, which are often perceived as complex or distant from everyday life (Nicholson-Cole, 2005; Slingerland & Overdiek, 2023). Furthermore, interactive features such as gamification, rewards, and engaging visuals can support motivation and sustained participation, particularly among younger audiences (Franken-Champlin, 2019; Gonçalves et al., 2024).

3. Methodology

This study develops a design framework and proof-of-concept for climate action digital participation. Figure 1 illustrates the two-part methodology in this study. Part I (Framework Development) consists of a thematic analysis to derive design principles (DPs). This is based on a literature review and a systematic analysis of 15 existing platforms. Part II (Framework Application) translates the principles into design strategies (DSs) to create CmC—a digital participation platform concept for citizen climate action. The "translation" from DPs to DSs is a *design* step and is necessary to distinguish the framework from its application into a unique prototype. In other words, while the framework and its DPs offer a unique

foundation based on literature and existing participation platforms, the DSs are creative mechanisms to implement the framework into a tangible prototype with a specific goal. In this study, the goal was to empower citizens to take climate action, and the translation from principles to strategies was informed by an empowerment framework (details below). Literature on digital engagement indeed shows that empowerment can be achieved in various ways (Gonçalves et al., 2026; Schneider et al., 2018), which further corroborates the importance of distinguishing principles from strategies.

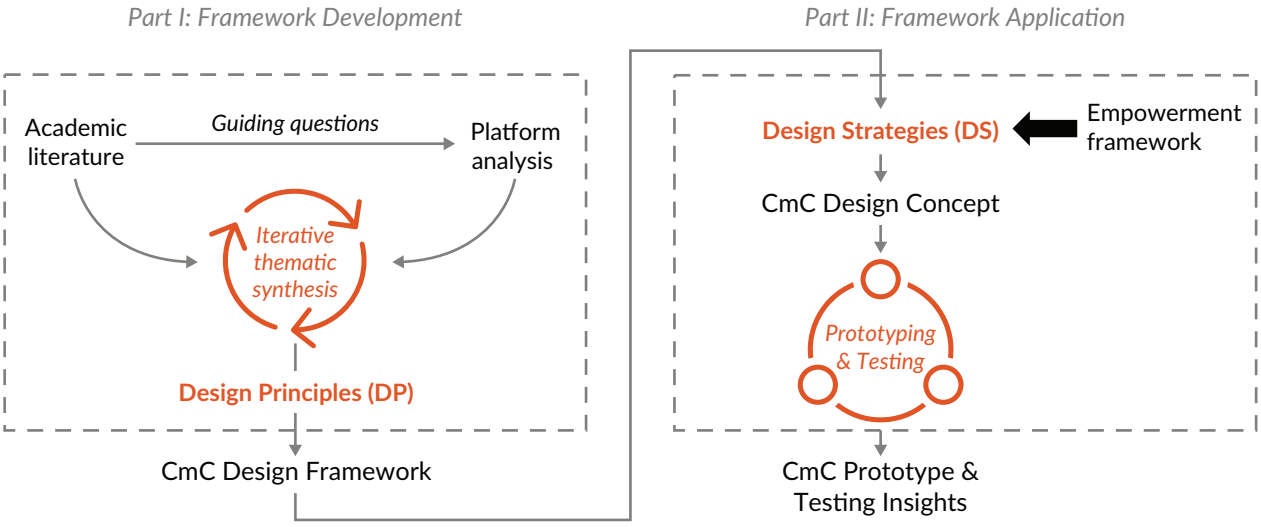


Figure 1. Two-part methodology flowchart.

Empowerment was operationalised into the prototype based on Zimmerman's model of three-component empowerment (Zimmerman, 1995). The intrapersonal component refers to self-efficacy, perceived competence, and mastery—how people believe they can influence a given context—and was operationalised as "widening citizens' perceived scope of climate action." The interactional component refers to awareness/knowledge of systems and processes—how people understand choices available to them to achieve certain goals within a given context—and was operationalised as "making citizens feel connected to each other and aware of their context." The behavioural component describes actions people take to exert control in the context—how people take action to acquire resources and make change—and was operationalised as "providing knowledge and tools for citizens to achieve positive and concrete impact." The prototype was iteratively evaluated and improved in three rounds of testing with 58 participants in total. Details about both Parts I and II are provided next.

3.1. Framework Development

First, a scoping literature review was conducted at the intersection of participatory planning, digital engagement and human–computer interaction, and climate action and science communication (Section 2). The review was not intended to be systematic or exhaustive, as it aimed to identify key themes and existing concepts at the intersection of these fields (Figure 2a). These themes formed the basis for a set of guiding questions used to assess existing digital platforms (Figure 2b).

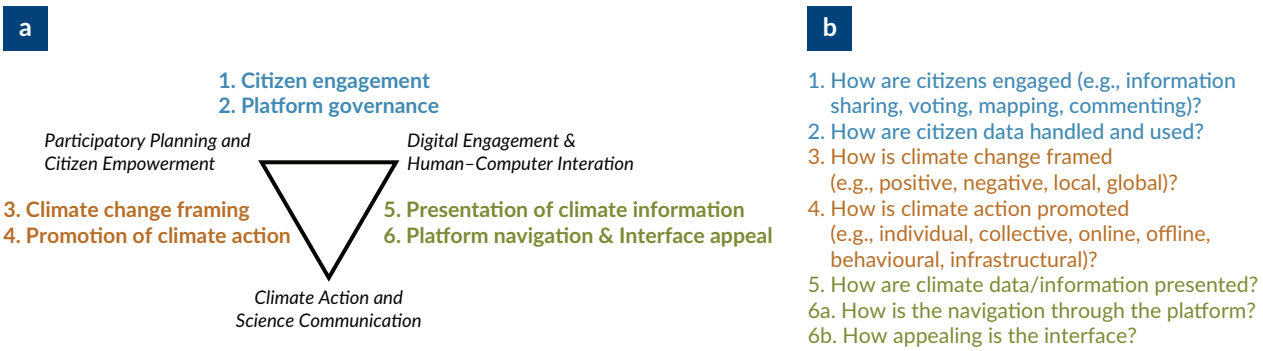


Figure 2. Scoping review: (a) key themes derived from the literature; (b) guiding questions for the platform analysis.

An initial desk review identified only three platforms specifically designed for climate engagement. We therefore expanded the sample to include "generic" participation platforms, in the sense that they are not climate-specific. This additional selection was informed by literature (Gonçalves et al., 2024) and additional desk research. In total, 15 platforms were analysed and are described in the Supplementary Material (Part A). The selection was intended to capture a broad range of engagement mechanisms, interaction modalities, and communication approaches relevant to the study.

During the platform analysis, we found that platforms consistently fit within three categories: climate-oriented platforms (mostly awareness), flexible participation platforms (mostly consultation but adaptable to climate action), and civic reporting platforms (not adaptable to climate action), and no substantially new platform types emerged. At this stage, the platform sample was considered sufficiently diverse to support the analysis. We acknowledge that additional platforms exist and could have been included; however, the selected sample provides a broad perspective on current digital engagement practices and was considered adequate for informing the development of DPs, since it was also informed by literature.

Each platform was evaluated against the themes identified in the literature review. The findings from the platform analysis were then combined with the literature through an iterative thematic synthesis. Rather than synthesising descriptive themes from the literature alone, this process aimed to derive normative DPs by integrating theoretical insights with practical observations from existing platforms. The DPs form the design framework in this study and provide foundational guidelines that help creators make consistent and effective choices when designing digital climate action participation.

3.2. Framework Application

3.2.1. Prototyping Approach

The framework application includes the prototyping and testing of the CmC prototype. Prototyping supports communication and learning between designers and potential users by setting early versions of design artefacts into the world, triggering critical thoughts and experiences that can inform the next prototype (Jaskiewicz, 2022). The CmC prototype links empowerment to the design framework through three sub-goals: widening citizens' perceived scope of climate action (intrapersonal component), making citizens

feel connected to each other and aware of their context (interactional component), and providing knowledge and tools for citizens to achieve positive and concrete impact (behavioural component). These goals are operationalised through an interaction design approach based on user journeys (Stolterman & Wiberg, 2010). A user journey can be seen as a scenario-based sequence of the steps that a user (citizens in this case) takes to accomplish a high-level goal. The prototype is designed around a "climate story," where citizens follow the journey of a persona who is affected by climate change. The story is localised and evolves over long periods, where climate impacts become more (or less) severe. The role of citizen climate action is highlighted by showing how climate impacts change when the persona in the story takes action in relation to climate change. More details are provided in Section 4.

To create a realistic and localised climate story for the prototype, a specific context and climate condition were defined. The context selected was the cities of Delft, Rotterdam, and Amsterdam, in the Netherlands. The personas and user journeys are the same for all cities as they are two of the key design elements in our framework (more in Section 4), but the story is contextualised in each city using local spatial markers. In terms of climate conditions, climate data and scenarios by the Dutch Meteorological Institute (Koninklijk Nederlands Meteorologisch Instituut) show that summers will be hotter and drier, and the winters warmer and wetter. Since heatwaves are becoming more frequent in temperate regions like the Netherlands (Ahmed et al., 2026), it was decided to focus on such a scenario for the prototype. The impacts of extreme heat during heatwaves are illustrated through the urban heat island (UHI) effect, health stress, drought, subsidence, and biodiversity loss, while greening and water interventions appear as heat stress mitigators.

3.2.2. Prototype Testing

Three rounds of testing were conducted with a total of 58 anonymous participants. Details about each round are presented in the Supplementary Material (Tables B1 and B2). Participants were asked to evaluate a series of statements through questionnaires (Table B3 in the Supplementary Material), with the option of leaving open comments. The questions provide insights into the three empowerment components: intrapersonal (perceptions of feeling heard and relevant), interactional (perceptions of increased awareness, sense of community, and trust in governance), and behavioural (perceptions of acquiring tools and knowledge; Table B4 in the Supplementary Material). We emphasise that empowerment is a complex, multidimensional process that cannot be directly measured through a small set of questionnaire items in an experimental/prototype setting. Rather than attempting to quantify empowerment itself, we use the empowerment framework to ground our design process in established theory. The questionnaire thus only provides indicative insights into participants' perceptions related to the framework's three components.

In the first round, a low-fidelity prototype was created in paper format. It consists of seven printed pages, including manual pop-up elements to simulate the interactivity of digital platforms. This testing round was designed primarily as an initial proof-of-concept to gather in-depth feedback. For this reason, the number of participants was kept small and involved students and researchers with expertise in the design of digital platforms and/or urban challenges. The session can thus be seen as a semi-expert-based testing. Participants ($N_1 = 7$) responded to the questionnaire and were invited to analyse and give feedback on each of the seven pages of the paper prototype. The feedback was therefore extensive. The paper format hinders the evaluation of certain aspects of platform navigation and appeal, forcing participants to focus intentionally on the general concept, which was the goal of this evaluation round.

In the second round, a first version of a digital prototype (mid-fidelity) was created using the software Figma to simulate the user interface of the CmC platform. Digitalising the prototype was a logical step towards the final goal of designing a digital platform. Looking like a real platform, the digital prototype enabled the evaluation of navigation and interface interaction aspects. It was tested with 22 participants ($N_2 = 22$) through an online questionnaire and an open discussion at the end of the workshop, which were recorded as field notes.

In the last round, a second version of the digital prototype (mid-fidelity) was created, improving on the feedback gathered previously. This prototype was tested by 29 participants through an online questionnaire ($N_3 = 29$) in three different settings, allowing for more diverse feedback: (a) workshop ($N_{3a} = 4$), (b) online survey ($N_{3b} = 12$), and (c) community festival ($N_{3c} = 13$).

4. Results

This section has three parts: (a) the design framework and how it was implemented into the CmC prototype; (b) the prototyping results, focusing on how participants perceived the prototype and what modifications were made across testing rounds; and (c) the empowerment results, focusing on how participants' perceptions connect to the three empowerment components.

4.1. Design Framework and CmC Prototype

Table 1 presents the resulting design framework (expanded version in Table D1, Supplementary Material). It consists of seven DPs: balanced use of negative and positive framings; valorisation of citizen knowledge and lived experiences; promotion of awareness and sense of efficacy both individually and collectively; grounding in local and personal perspectives; clear, credible, and reliable information; appealing and engaging interfaces and communication; and transparent and clear participatory processes. The principles emerged from an iterative process between analysing literature and existing platforms.

Table 1. Design framework (expanded version in Table D1, Supplementary Material).

DP	Description and examples of how to implement the DP based on the platform analysis
DP1: Balanced use of negative and positive framings	Participation in climate action should combine realistic depictions of impacts with hopeful narratives, best practices, and success stories. This balanced framing encourages action and sustained involvement and avoids climate anxiety. Examples: Storytelling, scenarios, success stories
DP2: Valorisation of citizen knowledge and lived experiences	Participation in climate action should build on citizens' lived experiences and contextual knowledge. Platforms should provide diverse ways for people to contribute insights. Examples: Open comments, pictures
DP3: Promotion of awareness and sense of efficacy both individually and collectively	Participation in climate action should strengthen citizens' belief that their actions matter, which motivates both individual and collective engagement. Community-building features and recognition of positive behaviour further reinforce a shared sense of impact and responsibility. Examples: Educational material, tutorials, community-building mechanisms

Table 1. (Cont.) Design framework (expanded version in Table D1, Supplementary Material).

DP	Description and examples of how to implement the DP based on the platform analysis
DP4: Grounding in local and personal perspectives	Participation in climate action should be grounded in local contexts to increase relevance, linking global phenomena to daily life. Personal and place-based perspectives enhance emotional resonance and perceived relevance. Examples: Storytelling, local landmarks
DP5: Clear, credible, and reliable information	Participation in climate action should be accessible, transparent, and based on credible scientific information, which builds trust and supports informed decision-making. Examples: Guided debate, open data, educational material
DP6: Appealing and engaging interfaces and communication	Participation in climate action should be visually consistent, interactive, and emotionally engaging to spark curiosity and keep citizens engaged. Examples: Consistent visual language, gamification, storytelling
DP7: Transparent and clear participatory processes	Participation in climate action should provide clear communication about roles, responsibilities, and decision-making processes, which helps citizens understand how their contributions are used and what outcomes they can expect. Transparency and clarity also foster long-term engagement and confidence. Examples: "About us" page, consent form, data and privacy statements

Specifically, the literature review provided key themes and guiding questions for analysing existing platforms (Figure 2a). This analysis identified four limitations (details in the Supplementary Material, Part C): disconnection between climate data and personal experience, complex navigation and lack of intuitive design, information overload, and limited opportunities for climate action. The principles were inductively developed to address these limitations. For example, the disconnection between climate data and personal experience is addressed by the principles of "DP4: Grounding in local and personal perspectives" and "DP5: Clear, credible, and reliable information." These DPs are based on both literature (Section 2.2) and the platform analysis and include concrete examples of how they can be implemented. For instance, "DP1: Balanced use of negative and positive framings" is well established in the literature (Section 2.2) and has been implemented in the platform Ambrogio & Gaia through storytelling. To implement the framework into the design of the CmC prototype, the DPs in Table 2 were combined into DSs that are linked to the three empowerment components (Zimmerman, 1995): intrapersonal, interactional, and behavioural (Figure 3).

To leverage storytelling and contextualised personal narratives (DS1), the prototype uses locally grounded stories and personalised experiences to connect climate impacts and climate action to citizens' everyday lives (DP4), while balancing realistic risks with hopeful and action-oriented narratives (DP1). Storytelling makes the platform more engaging and easier to follow despite the complex topic and the use of technical climate data (DP6). The prototype follows the journey of a person seeking a "cool" place in the city during an extreme heat day. Through this storyline, the platform illustrates current climate impacts, explores future scenarios using local spatial markers, and presents opportunities for climate action. This temporal framing balances realistic challenges with hopeful perspectives (DP1), aiming to foster a sense of efficacy (DP3).

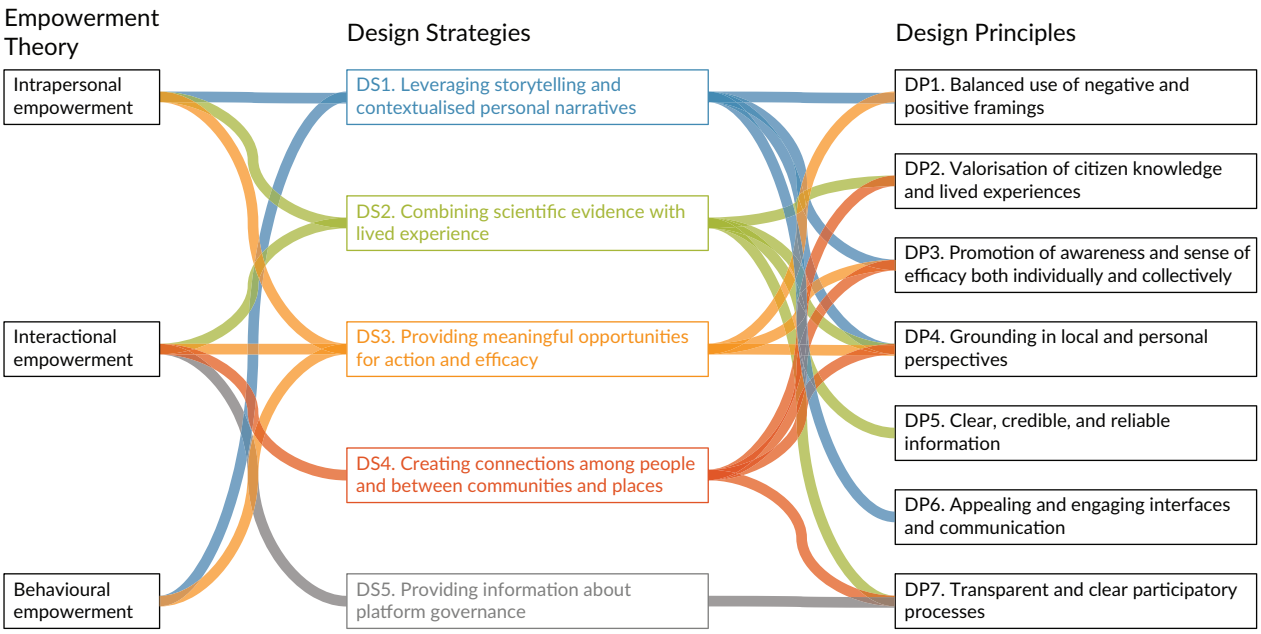


Figure 3. Alignment across empowerment theory, design strategies, and design principles.

Three different stories were developed and linked to a persona (a young adult, a family with children, and a middle-aged person) and perceived effectiveness (from not being able to take climate action to being very active). Citizens follow different journeys based on the persona they selected and the perceived self-efficacy they indicate. The personas are gender-neutral and correspond to different demographic groups with different living conditions. Both user journeys and personas were chosen for being generally applicable and were meant as proof of concept rather than being exhaustive or representative of the local context. Focusing on a persona rather than a story in which citizens themselves are the protagonists helps them to suspend their personal judgement about climate change in favour of exploring the data and empathising with others (DP3). This also helps to cope with climate anxiety, creating distance between the platform user and the story.

To integrate scientific evidence with lived experience (DS2), the prototype combines scientific data with citizens' local knowledge and personal accounts, making complex climate issues tangible and contextually relevant (DP2 and DP4), but also trustworthy (DP7). For example, citizens are presented with a UHI map in relation to green and blue areas to show the importance of these areas in reducing the UHI effect. The amount of scientific information is carefully balanced, with details being provided without overwhelming citizens (DP5).

To enable meaningful opportunities for action and efficacy (DS3), the prototype provides pathways for individual and collective engagement, including personalised practical tools/tips and community features. It also offers an explicit call for action. Citizens are presented with options for taking climate action, which are based on the persona chosen and the self-efficacy indicated. For example, a low sense of efficacy will lead to educational material and low-cost do-it-yourself (DIY) actions, while a high sense of self-efficacy will lead to solutions which require more time and effort (DP3). This aligns the "call to action" with diverse life realities (DP4). Importantly, the option is directed at the persona they have chosen and not at citizens themselves, fostering a sense of efficacy but avoiding climate anxiety (DP1 and DP3). Each option takes citizens to external websites where they can find information about the action selected.

To foster connections between communities and place (DS4), the prototype provides mechanisms that link citizens to one another and to their local environment through shared stories, spatial landmarks, and representations of local impacts. In several instances, citizens are asked to express their opinions about a specific topic. For example, citizens are asked about places they go during heat waves (DP2). Suggestions from other people are also presented to create a sense of collectiveness (DP3), also showing that their opinions are stored and shared with other people (DP7). In addition, all elements of the story are localised, including heat maps at the city level and climate scenarios based on local landmarks (DP4).

Finally, regarding transparency and clarity of platform governance (DS5), the prototype is envisioned as a tool for individual and collective empowerment, potentially independent of governmental control (DP7). The reason lies in the fact that much of the reviewed literature conceptualises digital participation platforms primarily as intermediaries between citizens and (local) government. In this regard, Linders (2012) describes the category of "Do-It-Yourself Government," in which citizens self-organise and manage everyday activities, potentially with facilitative support from public authorities, but not necessarily. From this perspective, several governance configurations would be possible for the CmC platform, as explained later.

4.2. Prototyping Results: Design Insights

The first testing round (R1) was designed primarily as an initial proof of core elements and purposely involved a small group of participants ($N_1 = 7$). The feedback was generally positive, with most statements perceived positively (Tables E1 and E2 in the Supplementary Material). Participants considered aspects related to climate data presentation and platform navigation and appeal particularly positive, despite the paper-based format. However, participants' responses indicate that the prototype failed to convey the importance of their inputs or that these inputs would be considered in decisions (see lower agreement in Table E2 in the Supplementary Material). In their comments (Table E1 in the Supplementary Material), participants noted that the prototype did not ask explicitly for their opinion. Another point was the failure to create a sense of community, as participants did not feel connected to other citizens.

In addition, in their detailed comments, participants noted the storyline as "too linear" and expressed a desire for greater interactivity and personalisation, including more diverse user pathways and a stronger visual identity. Many also found it difficult to position their climate stance among the three available options (Figure 4a). Although the data presented through heat maps and diagrams (Figure 4b) were considered clear and informative, participants noted that they did not evoke an emotional response. Personal consequences of heat waves were considered not sufficiently articulated. The climate action opportunities suggested were generally well received; however, participants highlighted the importance of clearer information about the expected impact and the level of effort required for these actions. They also suggested categorising the options by type (for example, DIY measures versus government subsidies).



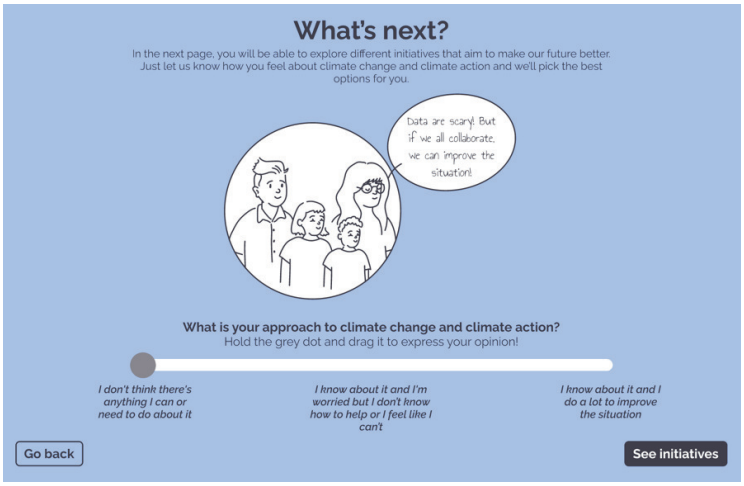
Figure 4. Paper prototype: (a) persona and climate position options; (b) UHI map linking scientific data to personal experience.

In the second testing round (R2), the paper prototype was developed into a digital prototype, already considering the feedback from R1. Details can be found in the Supplementary Material (Part E). Key modifications included the use of affective language and real-life examples in the storyline to make climate impacts more tangible and easier to understand. For example, instead of presenting climate data through graphs or numbers, the prototype now shows AI-generated pictures and collages of how popular places in the city will look in 2050 and 2085 due to climate change (Figure 5c). These images were generated based on the scenarios and climate data described by the Dutch Meteorological Institute. Additionally, to strengthen connections between citizens, a map with "cool" locations is included, picturing locations suggested by other citizens, including nicknames, comments, and pictures (Figure 5b). Citizens are invited to see the comments of others and leave their own suggestions.

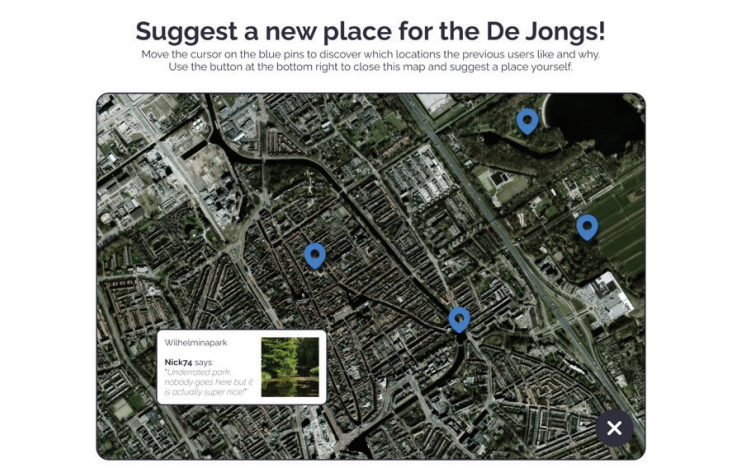
The "call to action" section is also expanded with more climate action options, divided into three categories (learn and discover, build and DIY, and online and offline communities) and rated based on price, effort level, climate impact, and social value. This way, citizens can explore a wide range of options based on extra

information. In addition, it is now explicitly communicated that the choices at the beginning (persona and climate position) are to customise the experience on the platform (Figure 5a). A slider is used for citizens to indicate their climate position instead of a multiple-choice question in the paper version (Figure 5a vs. Figure 4a).

a



b



c

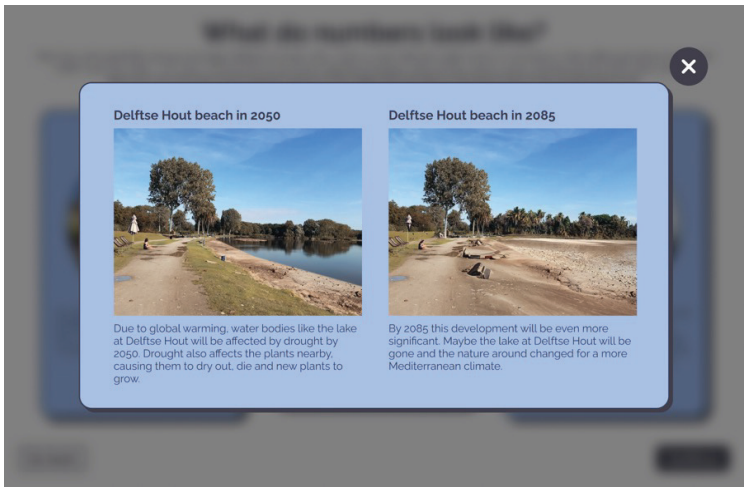


Figure 5. Digital prototype (Version 1): (a) climate positioning slider; (b) "cool" map showing interactions between platform users; (c) data-informed scenarios making climate impacts more tangible.

The new prototype was tested in a workshop (Table B1 in the Supplementary Material) with generally positive feedback. Although results cannot be directly compared to R1 due to the different prototype version, as well as size and type of audience, participants perceived more positively the statements related to their input and opinions being relevant and that the prototype conveys a sense of community and connects them to other users (Table E4 in the Supplementary Material). In line with results in R1, the data presentation and platform navigation and appeal were regarded very positively, and participants described the presentation of climate risk data such as the heat scenarios as engaging and accessible (Table E3 in the Supplementary Material).

Nevertheless, in their extensive open feedback, participants identified several areas for improvement (Table E3 in the Supplementary Material). Many noted that the storyline did not reconnect with the selected persona at the end of the journey. This created confusion regarding the final "call to action"—it was not clear that the call to action was the end of the story. In addition, the proposed climate action opportunities were well received, especially those connected to local initiatives. Others raised concerns that certain proposed solutions were too costly and therefore not accessible to all population groups. They also expressed interest in more collective approaches to climate action, as well as options for immediate action and opportunities related to climate activism beyond the digital environment. More opportunities to share opinions, ask questions, leave comments, and exchange information with other citizens were requested. Finally, participants noted that the purpose of interacting with the platform was not clear. The platform's owners or organisers were not explicitly identified, leading to concerns about transparency and platform governance. Participants were also uncertain about how their input would be used in the planning process, which leads to challenges in expectation management and trust building.

The third round (R3) continued developing the digital version of the prototype based on the feedback from R2. In summary, personalisation features were refined while maintaining the original structure. The "call to action" at the end of the user journey is more explicitly directed to the platform user rather than being part of the persona story (Figure 6c), showing the story has a clear ending. In addition, the prototype now asks citizens to specify whether they own or rent their home just before the call to action, which determines what options are presented to them, ensuring that these options reflect citizens' living situations and are therefore more relevant and actionable. The future scenarios were also further developed (Figures 6a and 6b). While the overall structure remains the same, the storyline now follows the persona over time more consistently, illustrating how climate impacts evolve, how the persona becomes involved in climate action over the years, and how transformative this can be (Figure 6b). This adjustment strengthens narrative coherence and addresses feedback regarding the lack of reconnection with the persona at the end of the journey.

The second version of the digital prototype was subsequently tested with a broader audience (Table B1 in the Supplementary Material), allowing for more diverse feedback. The feedback was also generally positive. Participants generally agreed with statements related to their input and opinions being relevant, similar to R2, which shows that the design improvements were effective. However, most participants disagreed with statements related to a sense of community and being connected to other users, although no major changes were made in this aspect from R2 to R3. A potential reason for this is that the setting in R3 was less personal compared to R2, which was conducted in a workshop setting that provides a sense of togetherness. Nevertheless, it indicates that creating a sense of community may require going beyond the digital into hybrid formats. This round also asked participants who they would trust more as "owner" or "manager" of such a platform, to which they indicated the greatest trust in the municipality or a neighbourhood initiative,

rather than an individual citizen or a private company. Finally, open comments in R3 were less extensive compared to R1 and R2, possibly due to the different setting (online survey and a community festival where people have less time compared to the dedicated workshops in R1 and R2). The few minor improvements suggested are documented in the Supplementary Material (Part E).

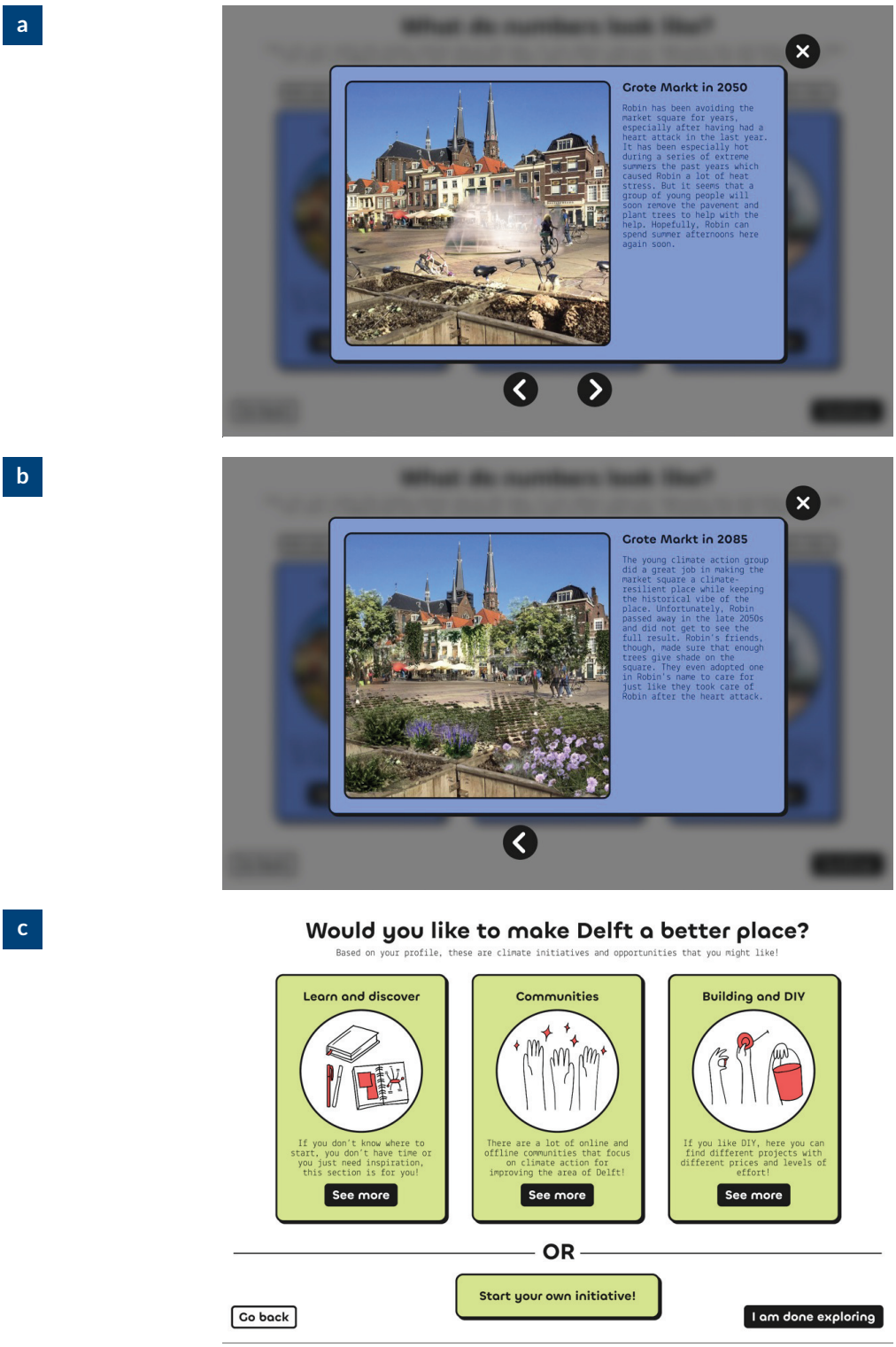


Figure 6. Digital prototype (Version 2): (a–b) future scenarios; (c) call to action.

4.3. Prototyping Results: Empowerment Insights

Table 2 presents the level of participants' agreement across statements that represent the three dimensions of empowerment. We stress that these results do not aim to measure empowerment or compare it across testing rounds but to provide additional insights into how participants perceived the prototype. Table 2 shows that intrapersonal empowerment increased consistently across the three rounds. The proportion of participants who felt that their input and opinions were heard or important increased from 29% in R1 to 50% in R2 and 62% in R3. Similarly, agreement that their input and opinions would be considered increased from 14% to 45% and 55%, respectively.

Behavioural empowerment remained relatively strong. Agreement that participants had the necessary tools to engage in climate action increased from 57% in R1 to 82% in R2, before declining slightly to 72% in R3. The perceived relevance and usefulness of the climate information presented remained high across all rounds (86%, 95%, and 83%). The slightly lower levels in R3 are interesting, as they refer to a broader group of participants compared to student and academic groups in R1 and R2, showing that climate information is not exclusive to expert or highly educated audiences.

Finally, interactional empowerment showed more mixed results. Awareness of climate action opportunities increased from 86% in R1 to 95% in R2 but declined to 69% in R3. A similar pattern was observed for awareness of climate risks and impacts (86%, 95%, and 55%). This is again interesting given the non-expert audience, as mentioned above. Perceptions of data and privacy protection remained relatively positive, although these also declined in R3 (86%, 91%, and 69%). The most persistent limitation was the sense of community: Only 29% of participants in R1, 64% in R2, and 28% in R3 felt connected to other users and part of a community. This is consistent with qualitative feedback highlighting limited connection to other users and the selected persona.

Table 2. Insights into empowerment. The results represent the percentage of participants who agree, somewhat agree, or strongly agree with the statement (full results in the Supplementary Material, Part E).

Empowerment component	Statement	Level of agreement		
		R1 ($N_1 = 7$)	R2 ($N_2 = 22$)	R3 ($N_3 = 29$)
Intrapersonal	I feel that my input and opinions are heard/important	29%	50%	62%
	I feel that my input and opinions will be considered	14%	45%	55%
Interactional	I feel I know more about climate action opportunities around me	86%	95%	69%
	I feel connected to other users and part of a community	29%	64%	28%
	I feel I know more about climate risks and impacts	86%	95%	55%
	I feel my data and privacy are protected	86%	91%	69%
Behavioural	I feel I have the necessary tools to engage in climate action	57%	82%	72%
	The climate information/data presented is relevant/useful	86%	95%	83%

5. Conclusion and Discussion

This study examined how digital participation can be designed to improve citizens' perceptions about their role in climate action. A design framework was developed and applied in the prototyping of CmC, a digital participation platform for citizen climate action. The framework offers clear design strategies and principles that can be used by planning organisations and community initiatives to structure citizen engagement around local climate issues. Citizens' contributions can then be synthesised to inform the planning and implementation of context-sensitive climate action.

The prototype was iteratively tested with 58 participants. Results show the prototype was strongest in climate awareness and individual capacity to act. Participants felt that their voices mattered, that their input would be considered by platform managers, and that they had access to relevant information and tools for climate action. This is reflected by relatively higher levels of intrapersonal and behavioural empowerment. Community building and clarity around governance and ownership remained challenging, as reflected in the lower levels of interpersonal empowerment. This may partly reflect the digital medium itself, which provides only limited opportunities for interpersonal and place-based connection. It may also relate to the use of personas: While personas create distance between participants and the climate narrative, allowing them to explore data and perspectives without directly confronting their own climate position, this distance may simultaneously limit perceptions of community and place connection. These findings suggest that digital participation can support individual empowerment, but collective action may be more challenging through a digital platform alone. They also point to a tension within the design framework: Creating sufficient distance to avoid climate anxiety may come at the expense of creating the personal and social connections that support collective action.

Building on these findings, we identify three directions for further development that address the limitations of this study. First, while our study used personas and city landmarks that are relevant to a city-wide citizenry, this limited our ability to assess how the platform might resonate with specific place-based groups. This was further restricted by our predominantly student and academic sample. Future work should explore how participation and platform design can be more strongly grounded in specific places and population groups, as a more granular place-based approach may further strengthen relevance, identification, and sense of community (Prost et al., 2023; Scannell & Gifford, 2013).

Second, digital participation should provide clearer pathways towards long-term collective action. Peer-to-peer connections enable collective learning, foster shared responsibility, and potentially strengthen collective responses to climate challenges (Gonçalves et al., 2026; Nasi et al., 2024; Slingerland & Overdiek, 2023). Moreover, empowerment is unlikely to be achieved through a single digital intervention (Champlin et al., 2024; Gonçalves et al., 2026), as citizens differ in their circumstances, prior engagement, and climate knowledge. Going beyond the digital was out of the scope of this study, but our results indicate that community building is challenging through digital platforms alone. Additionally, climate action requires sustained and long-term collaboration rather than isolated interventions (Hügel & Davies, 2020). Our prototype primarily supported participants in understanding local climate risks, reflecting on different perspectives, and identifying opportunities for climate action. It therefore aimed to increase participants' perceived capacity to engage in climate action; further research should explore whether participants effectively engage in climate action after using the prototype.

Third, digital participation should be embedded within locally relevant planning and governance processes. In our study, participants recurrently expressed concern about platform governance and the use of citizen-generated data, highlighting the importance of the institutional context and planning process surrounding digital tools (Franken-Champlin, 2019). Attention should thus be given to the "soft infrastructure" of people, practices, and institutional arrangements that shape how platforms are designed, used, and governed (Cardullo & Kitchin, 2019; Champlin et al., 2026; Hueske et al., 2023).

Participation in climate action planning thus necessitates new ways of interfacing with and across multiple digital and non-digital spaces where experimentation and democracy at the small scale meet long-range planning (DiSalvo et al., 2009; Pelzer et al., 2021). This study has contributed a starting point with a novel design framework for digital climate action participation, answering a growing call for non-volumetric, feminist gazes on the city (Rose, 2025).

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Conflict of Interests

The authors declare no conflict of interests.

LLMs Disclosure

During the preparation of this manuscript, the authors used Grammarly for basic proofreading, spelling, and grammar checks. After using this tool, the authors reviewed and edited all suggestions manually and take full responsibility for the content of this work.

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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