# Cultivating Care: Designing Civic Technologies with Citizens and Governments for Urban Green Maintenance


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## Abstract

Urban green spaces (UGS) are vital for biodiversity and urban quality of life, but face challenges from climate and limited municipal resources. This study investigates how civic engagement can support the maintenance of UGS as well as the role of digital participation tools, such as gamification, augmented reality (AR) and sensor-based feedback, in promoting engagement in smart cities. Through interviews with citizens and administrative officials in six German cities, along with a participatory design workshop, the study surfaces key tensions between informal citizen-led efforts and formal governance structures. While many citizens are willing to contribute to UGS care, they are often hindered by bureaucratic hurdles and unclear responsibilities. Administrations, although supportive of civic participation, frequently lack the capacity to coordinate or sustain it. Our findings reveal that digital technologies hold potential to support long-term participation if embedded in hybrid governance models that align with technological interventions, institutional processes and community practices. This study contributes to HCI and Digital Civics by highlighting administrative constraints even in digitally progressive municipalities, advocating for hybrid approaches combining digital participation platforms with grassroots engagement and institutional flexibility, and discussing the ethics of persuasive design in participatory processes. Through a grounded digital participation concept, we illustrate that civic technologies, when reimagined as mediators of collective care and trust, are crucial for creating sustainable and inclusive urban green infrastructure.





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## CCS Concepts

• **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

## Keywords

smart cities, urban green spaces, participation, technologies, communities

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## 1 Introduction

Urban green spaces (UGS), such as parks, flower beds, roadside plantings, traffic islands, and urban trees, are vital to the livability and ecological health of cities. These spaces provide habitat for various species and improve the quality of urban life through better microclimates and reduced environmental pollutants [57, 60]. Especially during the COVID-19 pandemic, the use of UGS increased significantly [72]. At the same time, urban greenery is facing growing climate-induced stressors, including prolonged drought, escalating urban heat and widespread soil sealing [11, 21, 46, 88].

Municipal administrations are increasingly challenged in maintaining UGS due to human and financial limited resources [77, 92]. This has led to citizens being increasingly involved in upkeep and care tasks. Although some residents already engage in watering trees or planting flowers, these efforts are sporadic and informal, and therefore difficult to monitor and coordinate. This complicates the optimal allocation of city resources [36] and limits the impact of individual actions. In parallel, administrations are testing climate-resilient planting strategies to reduce maintenance needs. However, such strategies can lead to trade-offs, replacing native species and altering the city's landscape and biodiversity [4].

Community-based initiatives such as action days, urban gardening, and UGS sponsorships (as part of public-private partnerships), have emerged in response, aiming to preserve and co-design UGS with public involvement. In German, the meaning of green sponsorship ("Grünpatenschaft") is similar to "adopting" public greenery. However, these shifts also raise critical questions about the redistribution of responsibility between public administrations and citizens. As highlighted by Uittenbroek et al. [87], involving citizens in green maintenance is often framed as "shared responsibility," but this framing can obscure structural limitations in institutional support and capacity. It reflects a broader trend in environmental governance where responsibility for public services is increasingly offloaded to individuals – what scholars call responsibilization. Such dynamics risk overburdening citizens while reinforcing unequal capacities for participation. Worldwide, a large number of digitally supported solutions already exist within the context of UGS.

Alongside app-based platforms like Gießden Kiez [17] and BaumApp Gelsenkirchen [80], there are often (self-organized) communities on social networks and messengers [17]. The app-based platforms use interactive maps on which the tree population is displayed (partly in different colours and symbols based on its status of maintenance) – further information about the trees as well as public water sources and historical data on precipitation can be retrieved. In Northern Ireland, as part of the "Live Here Love Here" campaign, "Adopt A Spot" offers the opportunity to take responsibility for your personal environment – from planting, maintaining wildlife homes and growing food, to litter picks [50]. In the UK and Ireland, "Treeapp" is a sponsor-financed platform that can be used to plant trees worldwide. Various incentive mechanisms, such as calculating one's own carbon footprint, are used to sustainably engage users [31]. In San Francisco, stormwater drains in the urban area can be adopted in order to clean it and thus prevent flooding during heavy rainfall events [69]. The drains are displayed online on an interactive map together with their adoption status. Citizens can register directly online and declare their willingness to adopt a free drain. Many of these projects were initiated by voluntary open government networks (e.g. Code for San Francisco), which are committed to sustainable digital change in politics and administration [19]. However, the actual number of formal sponsorships suggests that current incentive models and participation formats might not be sufficient to support sustained, broad-based engagement [23, 79].

In this context, digital tools are increasingly discussed as a way to foster civic participation in smart cities. Approaches such as gamification, augmented reality (AR), and sensor technologies are seen as promising mechanisms to inform, motivate, and coordinate citizen engagement. However, many such tools are still in experimental stages, and their impact on long-term participation remains unclear.

This study investigates the participatory care of UGS through a multi-perspective approach to explore the feasibility of technological solutions to support green space engagement, particularly through gamification and AR. Building on these insights, we facilitated a collaborative design workshop aimed at developing a digital participation concept for UGS sponsorship.

Our study reveals that although both citizens and administrators are interested in digital solutions, there remains a significant gap in implementation. To address this, a digital participation concept was developed as part of this study. The study further highlighted that smart city participation should not be viewed as a purely technical challenge. Rather, it requires addressing underlying governance structures and rethinking how institutions enable citizen involvement. Digital technologies can support engagement, but only when embedded in transparent, trust-based, and context-sensitive frameworks.

The paper contributes to Human-Computer Interaction (HCI) and Digital Civics by demonstrating how participatory design, grounded in real-world municipal and citizen needs, can inform the development of civic technologies. The proposed digital participation concept incorporates features for incentivization, coordination, and feedback. It emphasizes ease of use, reduced administrative complexity, and long-term engagement. At the same time, our study critically reflects on the limitations of a solutionist approach and highlights the importance of hybrid governance models that combine digital facilitation with institutional and social support.

## 2 Related Work

We define civic engagement as voluntary, individual or collective activities through which citizens participate in the governance, maintenance, or improvement of public issues and spaces. It encompasses both formal and informal actions, including co-creation, advocacy, and community organizing, and goes beyond mere use or education [25, 65, 76]. It has, particularly in the context of digital technologies, been widely studied as a means of fostering public participation in urban governance (e.g. [12, 33, 58]). Research has shown that digital participation tools can enhance democratic engagement, facilitate collective action, and promote transparent decision-making in urban environments [14, 22, 52]. A growing body of literature highlights both the opportunities and challenges associated with integrating citizens into urban maintenance processes, emphasizing the role of co-creation, citizen science, and participatory governance models in addressing urban sustainability challenges [2, 10, 32]. Municipal administrations are responsible for maintaining UGS, yet they increasingly face resource constraints that limit their ability to provide adequate upkeep [1]. As a result, cities are exploring ways to encourage citizen participation in maintaining these spaces.

Harding et al. [17] emphasize that successful civic engagement requires building trusted relationships between citizens and municipal authorities. They argue that while digital technologies can facilitate participation, existing solutions often fail to support long-term engagement, as they predominantly cater to citizen needs while neglecting administrative perspectives. This imbalance presents challenges for the development of sustainable participation models. Furthermore, Olphert and Damodaran [63] highlight the importance of participatory design in e-government initiatives. Their research underscores that actively involving citizens in the development process of digital tools increases adoption rates and enhances long-term engagement. These findings reinforce the need for a collaborative approach that integrates both citizen and municipal perspectives when designing digital participation solutions. However, concerns regarding security, and accessibility remain critical considerations in their implementation [59]. Similar to the findings of Harding et al. [17] our study identifies bureaucratic hurdles

and resource limitations to citizen involvement in urban green maintenance and explores digital solutions to support sponsorship programs while addressing both citizen and administrative needs.

## 2.1 Current Approaches to Urban Green Space Maintenance

UGS contribute significantly to environmental sustainability and urban quality of life by improving air quality, mitigating heat islands, and supporting biodiversity [1, 8]. Traditionally, their maintenance has been a municipal responsibility, often outsourced to private service providers [29]. However, a shift toward participatory governance is emerging, leading to citizen-led initiatives and community-driven projects playing an increasing role [38].

Brazeau-Béliveau and Cloutier [7] examined citizen participation at the micro-community level, focusing on green alley projects in Quebec City. Their study demonstrated that small-scale greening efforts could foster civic engagement and influence urban planning. Cloutier et al. [18] explored do-it-yourself (DIY) adaptation initiatives, illustrating how civic groups can lead urban greening projects to adapt to climate change. The authors discussed the implications of these DIY efforts for broader urban governance, emphasizing that they can reshape how cities respond to environmental challenges. In cities like Utrecht and Aarhus, co-governance models encourage residents to take active roles in UGS development [38].

These studies highlight a broader movement toward integrating community-based formats into UGS maintenance. Nevertheless, sustaining citizen participation requires institutional support, accessible environmental information, and well-structured policy frameworks [8, 89]. Public-private partnerships and sponsorship models are emerging as viable solutions to balance municipal oversight with community involvement, ensuring long-term UGS maintenance. Our paper explores these evolving approaches to UGS maintenance, aiming to understand how participatory formats can be integrated into smart city development.

## 2.2 Civic Engagement in Urban Green Spaces

Civic engagement plays a pivotal role in sustaining UGS, as active participation from citizens can lead to improved maintenance and social cohesion [43]. Research has demonstrated that communities involved in such initiatives report higher levels of satisfaction and a stronger sense of ownership over their local environments [90]. Laage-Thomsen and Blok [49] investigated urban gardening, beekeeping, and other community-based initiatives, showing how these activities contribute to civic engagement and urban sustainability. The authors highlighted the socio-material politics involved in these civic modes of greening, providing insights into how different groups and their modes of engagement impact urban spaces. Similar values of sustainability, locality, and grassroots participation have also been explored in other domains such as food resource sharing, fairness-oriented community practices, and prefigurative design approaches [26–28].

However, formalizing citizen-led initiatives poses significant challenges. Sarzynski [70] analysed various forms of public participation in climate adaptation, emphasizing the importance of civic capacity in engaging citizens for urban planning. The paper noted that cities often face resource constraints and bureaucratic hurdles when attempting to formalize citizen-led UGS maintenance. Despite these obstacles, informal civic engagement remains a vital element in urban sustainability, as grassroots efforts contribute to adaptive and context-sensitive urban greening strategies [49].

In this context, our paper examines the role of civic engagement in maintaining UGS, focusing on how citizen-led efforts can contribute to sustainability and community building.

## 2.3 Technological Innovations in the Context of Smart Cities

Smart cities are increasingly relying on digital technologies to improve urban environments, enhance efficiency, and foster citizen engagement. Technologies like AR, sensor networks, data-driven solutions and design approaches such as gamification have emerged as essential tools in urban planning and UGS management, enabling smarter, more sustainable urban environments (e.g. [37, 41, 42, 94]). These technologies can play a supportive role in streamlining UGS maintenance and fostering citizen participation in environmental stewardship [75]. However, the degree and nature of public involvement vary across use cases and should not be conflated.

For instance, the augmented watering can [41], which was initially developed as a concept through participatory action research [81] at an urban city farm [41], was later expanded into an interactive system as part of the "The Talking Plants" project [42], where plants could "talk" to visitors: This system was intended to allow visitors to interactively explore plant-specific knowledge and cultural practices based on the community's collective knowledge of plant cultivation. While such interventions promote environmental education and local identity-building, their direct impact on decision-making or policy processes remains limited and exploratory in scope.

A more structurally integrated use of technology is illustrated by the URBAN GreenUP project l. [86] supported by the European Union's Horizon 2020 programme. This project examined nature-based solutions like green roofs and urban gardens, to improve air quality, reduce the urban heat island effect, and promote sustainable development in Izmir, Türkiye. It highlighted, that digital tools not only optimized green infrastructure performance (e.g., reducing the urban heat island effect and improving air quality) but also supported civic participation through structured public consultation processes. Such projects demonstrate a closer alignment between technology deployment and participatory urban governance.

Furthermore, digital technologies can also facilitate better communication between local governments and citizens, improving the efficiency of UGS management. Cities use integrated platforms where residents can report issues, share feedback, and collaborate on UGS development [47]. These platforms, often combined with GIS and data analytics, enable real-time monitoring and help municipalities align UGS with community needs. By fostering participatory governance, these technologies empower citizens to actively contribute to decision-making and improve resource allocation for UGS maintenance.

Our paper examines the impact of technological innovations on smart cities and on how gamification and plant recognition can be integrated into digital participation concepts to promote civic engagement and streamline UGS maintenance. However, while

these technologies offer promising avenues, their actual impact on civic engagement and UGS maintenance must be assessed with careful attention to context, scope, and scale of implementation.

## 2.4 Challenges in Formalizing Citizen-Led Initiatives

One of the significant challenges in formalizing citizen-led UGS maintenance is the complex administrative and legal framework required to transition from informal engagement to structured partnerships. Converting these efforts into institutionalized programs often involves navigating bureaucratic hurdles, resource constraints, and legal complexities [70]. Public administrations must draft formal agreements, ensure regulatory compliance, and develop monitoring mechanisms, which can discourage citizens from engaging in official sponsorships [9].

Brazeau-Béliveau and Cloutier [7] explored relationships between citizens and local administrations, highlighting that formal agreements with citizens often impose disproportionate administrative burdens, thereby necessitating process simplification to enhance structured civic participation. Mattijssen et al. [56] state that logistical challenges, such as a lack of dedicated funding, personnel, and resources, further hinder the institutionalization of citizen-led initiatives, making it difficult for cities to sustain long-term engagement in community-driven projects. Even when local governments provide financial or material support, disparities in access to funding can result in unequal participation, where well-organized and resourced communities benefit more than marginalized groups [30]. This raises concerns about inclusivity in participatory urban greening efforts.

Furthermore, maintaining citizen motivation over time is a challenge. While many community-led projects start with enthusiasm, sustaining engagement requires ongoing support, incentives, and recognition from municipal authorities [62]. Without clear benefits or institutional backing, citizen participation can diminish, leading to abandoned or poorly maintained UGS.

Our contribution relates to this research field by examining the challenges in formalizing citizen-led initiatives and identifying opportunities to streamline administrative processes to encourage more structured civic engagement in UGS maintenance.

## 2.5 Factors Influencing Citizen Participation

Rewards and recognition were identified as personal incentives for engaging in official sponsorships of UGS by Brazeau-Béliveau and Cloutier [7]. The authors noted that while financial incentives were mentioned less frequently, social recognition and environmental protection were motivating factors for some participants. However, various barriers can deter potential participants, such as a lack of time, resources, and information about official sponsorship opportunities. Addressing these barriers is essential for promoting greater citizen participation in UGS maintenance.

Gamification, which can be described as “the use of game design elements in non-game contexts” [24] also offers potential for increasing engagement in participatory urban planning processes [16, 20, 71]. Gamification can be used to engage citizens in civic activities such as park planning and urban repair projects [20, 71]. It makes public participation more interactive and enjoyable by incorporating game-like elements and immersive experiences [20, 71].

Thiel [85] investigated the impact of game elements on civic engagement, suggesting that gamification can motivate citizens to participate in civic activities by creating a sense of community through points, badges, and competition. Gamification frameworks like the one presented by Sharma and Prasad [74] employs these game mechanics to motivate energy conservation and sustainable behaviour, integrating smart technology for real-time monitoring and offering financial incentives to enhance user engagement and community collaboration. Romano et al. [67] explored the use of gamification in emergency management within smart cities, incorporating game elements to improve civic engagement in emergency notification systems.

While feedback systems and gamification are frequently promoted as effective tools to foster sustainable behaviour, critics in Sustainable HCI have raised concerns about the assumptions these systems embed. Strengers [82] critiques the way eco-feedback systems often centre on an abstract, rational, and calculative user – what she terms ”Resource Man” – who is expected to respond to data and incentives in a linear, goal-oriented way. Such models risk ignoring the emotional, social, and cultural dimensions of everyday life that shape sustainable action.

Our paper investigates the factors that influence citizen participation in maintaining UGS, focusing on motivations and barriers. By understanding these factors, the research aims to inform the design of digital participation concepts that align with citizens’ needs and preferences, promoting greater and long-term civic engagement in UGS.

# 3 Study Objective

UGS are vital assets for ecological health and urban quality of life, yet they face increasing challenges due to climate change, urbanization, and limited municipal resources. This study aims to explore how the collaborative maintenance of UGS between citizens and municipal administrations can be strengthened through digitally supported forms of participation. The focus is exclusively on publicly managed UGS, such as street trees, parks, and roadside plantings, for which local municipalities retain formal responsibility. While citizen participation was encouraged, these spaces remained under municipal governance, and no community ownership or autonomous funding structures were in place.

As sponsorships were frequently assumed by older adults in the past, particular emphasis was placed on exploring ways to motivate younger citizens to take on such roles as well. Therefore, we focus particularly on the potential of emerging technologies, such as gamification and AR, to create engaging, long-term digital participation formats for UGS sponsorships. The design-oriented methodology presented in the following chapter is guided by the following research questions:

- How can long-term engagement in UGS sponsorships be fostered and new, especially younger participants encouraged?
- What role can emerging digital technologies play in improving participatory practices and community support?
- How can transparency, collaboration and trust be improved between citizens and administrations?

**Table 1: Overview of interview sessions of the study**

| ID | Interview location | Contact established | Persons | Gender | Age | Age 2 | Length (minutes) |
|---|---|---|---|---|---|---|---|
| P1 | City center | on street | 2 | F/M | 62 | 71 | 38 |
| P2 | City center | on street | 1 | F | 18 | | 36 |
| P3 | University | via contacts | 1 | M | 62 | | 40 |
| P4 | Private home | via contacts | 2 | F/M | 65 | 72 | 49 |
| P5 | Phone | via survey | 1 | F | 57 | | 39 |
| P6 | Phone | via survey | 1 | M | 53 | | 89 |
| P7 | Phone | via survey | 1 | M | 50 | | 51 |
| P8 | University | via survey | 1 | M | 59 | | 66 |
| P9 | Private home | via survey | 1 | M | 80 | | 50 |
| P10 | Phone | via survey | 1 | M | 82 | | 32 |
| P11 | Phone | via survey | 1 | F | 61 | | 40 |
| P12 | Phone | via contacts | 1 | M | 66 | | 50 |
| P13 | Phone | via contacts | 1 | M | 38 | | 41 |
| P14 | University | via contacts | 1 | F | 76 | | 52 |
| P15 | Office | via contacts | 1 | M | 64 | | 60 |
| P16 | City park | via contacts | 1 | F | 23 | | 30 |
| P17 | City park | via contacts | 1 | F | 21 | | 30 |
| P18 | University | via contacts | 2 | F/F | 30 | 25 | 37 |
| A1 | Office | via email | 1 | M | 48 | | 88 |
| A2 | Phone | via email | 1 | F | 61 | | 87 |
| A3 | Online meeting | via email | 1 | M | 62 | | 144 |
| A4 | Phone | via email | 1 | F | 44 | | 73 |
| A5 | Written | via email | 1 | F | 30 | | - |

These questions shape our empirical and design activities and form the basis for the participatory development of a digital engagement concept that addresses both citizen and administrative needs.

## 4 Method and Sample

In order to initiate a design process [40] for a digitally supported participatory approach for UGS, semi-structured interviews were conducted in six cities, primarily in the Lower Rhine region of North Rhine-Westphalia, Germany, with citizens as well as managers from the green space departments of the municipal administrations. The aim was to conduct a comprehensive empirical investigation of social practice and attitudes to UGS. It also served as an instrument for identifying the perceived challenges and opportunities as well as the requirements and needs of the stakeholders. The interview guidelines developed were influenced by previous research and explicitly included several questions on technology in general, gamification and AR.

For the citizens' perspective, participants were recruited both randomly on the street and systematically using voluntary contact details from the 2021 climate survey of a cooperating city as well as private contacts via cooperating organizations. This was done in line with data protection regulations. The interviews with citizens ran from July to November 2023 and involved a total of 18 interview sessions (P1 to P18) with an average length of around 46 minutes. Eleven were interviewed in person and seven by phone. There was also a balanced ratio of male and female participants as shown in Table 1.

Various cities were asked by email for their administrative perspective. Their interview period lasted from January 2024 to April 2024. Five city representatives were interviewed – four from North Rhine-Westphalia (A1 to 4) with an average interview time of around 98 minutes and one city from Rhineland-Palatinate as written interview (A5).

The semi-structured interviews were recorded, transcribed, coded and manually analysed based on the thematic analysis by Braun and Clarke [6]. The resulting themes were then presented at the design workshop. The participants agreed to the collection and processing of their personal interview data. For the analysis of the transcripts, all information that could lead to the identification of the participants was changed or removed from the text. Using the software MaxQDA, more than 1,200 relevant text passages from the interviews were marked and assigned to a coding system consisting of around 120 codes and subcodes. The passages marked in this way were grouped into 12 categories for the citizen perspective and 11 categories for the administrative perspective. The interview guides were also used to form the categories. The categories could be summarized into two respectively three themes (see Chapters 5.1 and 5.2).

The interview results were then manually condensed and prepared on several slides in a PowerPoint presentation for a design workshop using the prior categories. The design workshop is based on the design sprint by Knapp et al. [45]. The group work phase,

**Table 2: Overview of participants of the design workshop**

| ID | Organisation | Profession / Role | Gender |
|---|---|---|---|
| W1 | University | Research assistant for eGovernment / Facilitator | M |
| W2 | University | Professor for Environmental Assessment | F |
| W3 | University | Professor for Operations & Innovation Management | F |
| W4 | Private | Pensioner | M |
| W5 | Private | Bank trainee | F |
| W6 | Private | Kindergarten manager | F |
| W7 | Public administration | Green space manager | F |
| W8 | Public administration | Green space manager | F |
| W9 | Public administration | Green space manager | F |
| W10 | Public administration | Green space manager | F |

which normally takes two days in a design sprint, was reduced to half a day (9 am to 2 pm, including two short breaks). This was due to time constraints resulting from the fact that workshop participants were volunteers with no financial compensation. The reduction was achieved by replacing the live expert interviews with the prepared slides from the interviews before and by preparing or shortening design thinking activities such as the mapping (user journey) and Lightning Demos. In a design sprint, the Lightning Demos method is essential and employed to identify existing solutions/approaches by having participants compile a list of inspiring products and services from diverse fields within a short timeframe [45, 78]. Each collection is then briefly presented to all participants by the individual. This method encourages innovative thinking beyond one's own industry, facilitating the discovery of creative ideas and exemplary designs for the later development of solution sketches.

The accompanying presentation also included the sprint questions and the long-term goal for a design sprint, which were visible on a second screen during the whole workshop. The long-term goal of the workshop aims to define the overall vision that the team wants to achieve and ensure alignment towards a common outcome. Sprint questions identify potential challenges and uncertainties and guide the team through the workshop activities. Both the long-term goal and the sprint questions were formulated in line with the study's objective (see Chapter 3).

The design workshop took place in February 2025 at a university in North Rhine-Westphalia, Germany. It was attended by 10 participants (see Table 2). These included three university employees, three citizens and four members of the public administration. With the exception of two university employees, the participants had previously taken part in the semi-structured interview.

During the workshop, the notes and sketches created by the participants were photographed for documentation purposes. There was no audio or video recording of the workshop. After the workshop, the photos and observations were used to create a digital representation of all work steps and contents of the design workshop in a text document.

# 5 Findings

This chapter presents the interviews results, differentiated into citizen and administrative perspectives. Both perspectives in Chapter 5.1 and 5.2 have a particular focus on technology, AR and gamification. The results from the design workshop are then followed in Chapter 5.3, with a particular focus on the storyboard, which serves as a design proposal for a digital participation concept for UGS sponsorships.

## 5.1 Citizens' Perspective on Participatory Maintenance of Urban Green Spaces

UGS are frequently associated by participants with quality of life, well-being and an attractive cityscape. All participants were generally satisfied with the UGS in their cities. Nevertheless, a lack of maintenance of UGS was frequently criticized, as it impairs road safety in some cases due to overgrown vegetation (4). In addition, UGS are often littered or demolished. Examples of the loss of UGS for new buildings were also mentioned. Overall, participants would like to see more greenery in the form of trees and flowers, and better maintenance.

Participants referred to a range of urban green elements during the interviews, from regularly watered street trees to newly established biodiversity zones or paid sponsorships. While the former were often seen as standard maintenance, the latter were interpreted as more experimental, time-limited or event-driven, with unclear guidelines for participation or success. Almost half of the participants have already engaged in various forms of unofficial sponsorships for UGS (e.g. watering trees, mowing lawns). A few (5) initiated their own green projects, like creating special meadows for insects. Citizens also experienced negative outcomes, such as unofficial plantings that were unintentionally destroyed by the city's public service providers, as this statement shows: "[...] because I just knew I was going on vacation [...] I also put a note saying: please don't cover it with mulch [...] I also wrote that I would take care of it myself. Well, but nobody cared about that either. And then the seeds I had – they just didn't come out." (P7). The main reasons stated against taking on an official UGS sponsorship were a lack of time and other priorities such as interviewees' own gardens, work, or family. In addition, there was often a lack of information about the availability of such an official offer. Furthermore, previous greening initiatives were often short-lived or no longer exist for a variety of reasons (P8, P10 and P14). The water supply for irrigation was also a stated problem, especially

for UGS that are further away from the residential buildings of the participants (P4, P8, P14 and P18).

*5.1.1 Incentives and Target Groups for an Official Sponsorship.* Rewards and recognition were mentioned by participants as a personal incentive to take on an official sponsorship of UGS. Some were also motivated by environmental protection and their ecological awareness (4). Financial (3) and social incentives (3) were mentioned. The opportunity to be creative and contribute to the design of UGS was emphasized by two participants, motivated by this thought: "[people] often drive past there [. . .] and then you [can] say, look, I planted that myself, and then other people say: it looks really cool" (P16).

When asked about the target groups cities should focus on, respondents frequently mentioned schools, kindergartens, older people, local residents, and community organizations as suitable candidates for UGS sponsorships. Additionally, when asked about potential barriers, participants shared their thoughts on factors that might prevent these groups from taking on sponsorship roles. The lack of social appreciation of UGS, such as wilful littering and destruction, was mentioned, which was explained by problems with education or training by parents and teachers in younger age, as well as the social status: "the lower the social status, the less interested they are in such things" (P9).

In order for the target groups to take on a sponsorship, the interviewees stated that "communication and support structures" (e.g. in the form of specialised personnel, training offers) would have to be created by the city and that early investments would have to be made in education at schools. In addition, the interviewees stated that there should be more investment in general advertising and awareness-raising work for such sponsorships for UGS and the freedom to develop them (scope for creativity) should be highlighted by the cities. If the requirements are met, the target groups can be motivated by financial incentives and the provision of resources (e.g. water, tools) as suggested by P5, P9 and P18. Successful sponsorships as best practice, rewards, acknowledgements and competitions (with others) were also mentioned as potentially effective incentives.

Engagement in UGS fosters positive social effects, such as enhanced social integration, community strength, and increased private activities beyond sponsorship, reinforcing neighbourhood self-identification, as this statement shows: "If the neighbour is [working at the green space], and [you] see that, you automatically start a conversation: Oh, that looks great! Shall I help out for a moment?" (P18).

*5.1.2 Technological Attitude.* The citizens that participated in the interviews were also asked about the use of digital technologies in green sponsorships. They did not necessarily focus on technical feasibility. The most common responses were sensors (9) that measure moisture and soil conditions, automatic irrigation and digital applications. Tools, a public maintenance dashboard (2) and localizable water points (2) were also mentioned more frequently.

When it comes to the specific use of gamification in green sponsorships, the "competition" and the collection of points (in various forms in each case) clearly stand out. Collecting awards, badges or rewards was also mentioned. There was great interest in the use of AR to plan UGS with virtual support (e.g. planting guidance) and to preview the desired target state (7) – "so that the imagination is supported" (P13). When participants were asked to combine gamification and AR, the idea of a "simulation game" with area planning (5) was mentioned. This game would also include the simulation of animals and especially insects to educate about ecological interconnections. AR-supported collections of urban design ideas including competitions (4) were also mentioned: "people design [the actual state of] a certain area, [. . .] and the best design idea wins" (P13). In addition, AR could be used for rating of UGS (to obtain points/badges) and for geo-referenced activities that might be visually linked to reality via QR codes or GPS, as in geocaching.

In summary, the interviews with citizens indicate that UGS are highly valued, but that there are still concerns about littering and maintenance. Informal maintenance activities such as watering, cleaning and planting are widespread. Barriers to formal engagement include lack of time, lack of information and perceived administrative complexity. Suggestions made for improvement include financial and social incentives, better communication, and education.

## 5.2 Administrative Perspective on Participatory Maintenance of Urban Green Spaces

Urban green space (UGS) management varies, with many cities outsourcing maintenance tasks to contractors or municipal service providers (e.g. as a public-law institution or as an in-house operation). In some cases, limited personnel resources are compensated by modern and more efficient machines. In general, the interviewed cities tend to have little in-house staff, which is mostly engaged in planning, monitoring and coordinating (outsourced) activities. Climate change adds further challenges: drought threatens new plantings, while wet summers increase growth and maintenance needs. Invasive species like Japanese knotweed require extensive control. Particularly in the case of new outsourced plantings, watering has now been contractually secured for several years in some cities, yet extreme temperatures make daily watering difficult to prioritize: "I can actually prevent drought damage if I am informed early enough. [. . .] we have [an offline] list and in the end, people drive around, and we know exactly what needs to be watered [. . .]" (A1). In addition, the administrations are increasingly experimenting with climate-resistant greenery (e.g. trees and bushes) when planting new ones – a process which, according to the interviewees, is long and requires an exchange of experience with other cities. However, a tension exists between resilient plant choices and public expectations: "We have lots of plants like this Lonicera everywhere. [...] it's an [...] evergreen, very robust ground cover. When I show it, everyone knows it." (A1) Perennial plantings are visually more attractive alternatives for citizens, but have to be pruned in winter, leaving blank open spaces. Maintenance is also prioritized in central areas to enhance appeal for tourists and visitors: "[...] the city centre or in the so-called "parlour" [...] is maintained differently than somewhere on the outskirts or in the industrial area [...]" (A3).

*5.2.1 Technological Use.* The administrations use various technologies and systems for task management and planning. Internal communication takes place via personal meetings, telephone and e-mail. Trees are inventoried and geo-referenced in so-called tree registers – specialized information systems with trees on a map

and their meta information with further linked data, e.g. history of inspections (4). The register is also used for legal documentation for safety purposes. Some cities also record UGS in a register. There have also been attempts and plans to introduce further information and planning systems that, for example, digitally integrate executing employees or provide information on planting. One city is running a project to introduce a tree donation portal where citizens can support new tree plantings with small financial contributions.

Regular external communication towards and from citizens takes place via service hotlines, emails and websites. The use of mobile reporting apps was also highlighted (2), which are generally well received by citizens.

*5.2.2 Experiences with Participatory Care of Urban Green Spaces.* The cities have shown themselves to be open to civic involvement in the maintenance of UGS. Citizens are encouraged to help directly via calls in the newspaper or online and through smaller events. However, the initial contact for many volunteer care activities is made by citizens who want to take care of nearby UGS. In particular, older people or people with a lot of free time during the day were named as a target group – provided that the UGS is located near the private residential area. Young families with children, political parties and associations/communities are in focus as well. One interview further highlighted the dichotomy between the city's active approach to individual citizens and the potentially negative impression of wanting to pass on administrative tasks to citizens.

As soon as contact has been established between the administration and the citizen, a kind of "agreement process" usually follows. This includes the individual examination, consultation and support of the UGS requested by the citizen. Some cities do not require formal agreements to sponsor the irrigation of trees. They also hand out the corresponding refillable water bags for free, which slowly release water to the roots of the tree. Written agreements are often made for the landscaping of tree beds, which then also regulate cost-free initial planting by the city. Citizens are then responsible for subsequent care as the following statement shows: "We had, I'll say, an approach whereby we as the city paid for the planting. And it was then the people's job to maintain these plants, keep them alive, water them, remove weeds and so on" (A3). However, it often happens that the cities send the application forms to citizens and only about half of the application forms are answered (A1), which indicates a formal threshold for citizens. Even incentives, especially monetary ones, are difficult to provide, as this statement indicates: "The contractors offer this [the maintenance of the UGS] so cheaply" (A2). Incentives for citizens such as cinema vouchers would be more expensive than the contractors.

Cities are already trying to recognize the commitment of citizens, for example by thanking them (anonymously) in the newspaper or inviting them to events, e.g. for sharing experiences. One city also considered to mark the adopted UGS with signs, but this was not desired by the caretakers: "In fact, little labels should be added. That would also be an idea for showing appreciation. This bed is maintained by someone. However, many people didn't want that." (A1) – they are primarily motivated by how the greenery enhances the appearance of the space in front of their house. The long-term commitment of citizens was also described as challenging. Some people suddenly stop their engagement without any feedback to the administration. In addition, the following statement shows that in isolated cases committed citizens caused other problems "from garden gnomes to the edging with chain-link fences and so on [...], because [other] people then [...] approached us [the city]: You can't allow that, it doesn't look right in a public space" (A3).

Even if the administrative effort for the official sponsorships may be uneconomical, the interviews show that the cities are doing their best to fulfil the citizens' needs. For the cities, a sponsorship is seen as successful, for example, when "[. . .] the optical condition has improved [. . .]" (A1) and "[. . .] the citizens identify with the plant bed in front of their front door [. . .]" (A3). However, if sponsorships of UGS become more popular, the cities are concerned about a lack of personnel and financial resources to manage them (3).

*5.2.3 Interest and Potential of Digital Technologies for Enhancing Citizen Engagement.* In order to increase civic engagement in the area of green spaces, the cities were also asked about the use of technology in green sponsorships and their attitude towards it. In addition to the wish "We would like to automate more (e.g. with public maps, which areas [UGS] are available [for sponsorship])" (A5), the utilization of sensors to measure soil moisture was mentioned (3), as exemplified by this statement: "[. . .] this is enough for me to supervise and control the irrigation when I have sensors on random trees" (A2). There is also an interest in making the data from the sensors publicly accessible to citizens. "[. . .] we also talked about the possibility that if people or citizens could see the tree in front of their house, there would be a traffic light system and it would turn red, that they could see it on the internet" (A2). However, the existing watering bags for trees are highlighted as a simple and effective countermeasure against drought in summer.

The interviews also provided examples of gamification applications such as "talking" trees and tracking of irrigations with public recognition. A kind of collection album for urban trees was also proposed, with a public ranking of who has photographed more trees. Points could also be collected by citizens for biodiverse and long-maintained flower beds in green spaces. Some cities proposed prizes, award ceremonies or honours by official representatives as a reward.

Most city administrations, however, mentioned the possibility of using AR to virtually plan and experience UGS. This would enable citizens to select suitable plantings in advance and simulate them using AR. The result is a kind of "preview" function that shows how the planting on the green space will look over time. Citizens can see the effects on shape and biodiversity before they take action in reality. "The individual planting periods, i.e. spring, summer, autumn, winter, could actually force a decision by the carers" (A1). AR could also provide guidance, as the following statement suggests: "What are the location requirements for this plant? Do I need to water it a lot? Water it a little? Does it need a high pH value or a low pH value? Does it need sandy soil or peaty soil? These are questions that arise. Because everyone asks themselves, why is my plant doing well or not so well?" (A2).

The interviewed cities also mentioned possible applications of gamification and AR in combination. For example, in the form of city walks (3) where users can obtain more information on recognised trees and animals and collect points at the same time. In addition, potential is seen with existing outdoor activities, as the

following statement shows: „The link between geocaching to find the [adopted] areas in addition to an evaluation and a ranking list is really hot stuff" (A1).

Alongside the possible applications, the use of smartphones can be disruptive when working on the UGS. Gloves must be removed for using the device. Furthermore, the device itself must be held or put down during the work. There are also doubts as to whether the younger generation will be motivated to take action after the virtual (playful) part, with interview partners questioning if they will also "get their hands dirty" (A2).

The interview findings highlight several challenges and interests within the administration. They struggle with climate-induced maintenance issues and resource constraints when it comes to UGS, while efforts to formalize citizen involvement are hampered by bureaucratic overhead. There's interest in technological solutions like moisture sensors and AR, but scepticism remains about long-term citizen commitment and digital adoption.

## 5.3 Design Workshop on a Digital Participation Concept for Urban Green Spaces

A design workshop was conducted to develop a digital participation concept for the maintenance of UGS. As described in Chapter 4, an accompanying presentation was used to guide the participants through the workshop and work towards a common goal. During the first workshop activity, the presentation of the interview insights (the perspective of citizens and administrations), participants were asked to formulate a series of How Might We (HMW) questions focused on improving UGS sponsorships and integrating digital solutions. A central question that emerged was, "How can we address poor site conditions?" This included specific challenges such as polluted existing flower beds and tree pits, as well as the potential for water-permeable designs in urban areas.

Another important aspect was communication – how long-term and meaningful UGS sponsorships can be promoted and supported. Interest was also expressed in digital solutions such as dashboards, which led to the discussion of how best to combine UGS sponsorships with digitalization.

Additionally, other digital possibilities were discussed, such as how to present lost places (as examples of rich biodiversity) online and how to implement sensors in soils to gather relevant data. There were also other questions, especially regarding how to integrate the care of UGS into the education sector and how to inspire the younger audience – specifically children and teenagers – to engage with green initiatives (existing and new ones).

The core question that ran through the workshop discussions was how to make sponsorships interesting across the city and what incentives can be created for this purpose. This was accompanied by inquiries about how to reward engagement and how to attract interested parties to green sponsorships. These topics were met with great interest and numerous ideas from participants, providing a solid foundation for future actions and strategies.

*5.3.1 Inspiring Real-World Examples.* The workshop participants collected and pitched several real-world examples during the Lightning Demos, which served as a basis for the subsequent development of solution sketches (see Chapter 4). The individual Lightning Demos have been placed in a coherent context below for a better presentation:

**Free tree planting initiatives**, such as those carried out in several cities, are designed to increase the public's general interest in nature. **Information boards** explaining the difference between plants and weeds can also generate interest and provide information about the maintenance of UGS and the availability of sponsorships. A **social media** campaign for UGS sponsorships, combined with the possibility of taking on a sponsorship with one click, can significantly increase interest and reduce the formal hurdles. These different approaches offer effective ways to encourage participation in UGS sponsorships and raise awareness of the importance of nature and the environment.

There were also examples of digitally supported experiences with UGS. An appealing approach could be the integration of gaming and activity in urban green sponsorships, inspired by **Pokémon Go**, where geo-referenced virtual Pokéstops or battle arenas of the game could be placed at locations of real trees or plants. Furthermore, **nature trails** can be expanded to provide comprehensive information on meadows, trees, and industrial nature, supplemented by fact-based content and digital treasure hunts to enhance participant interest and knowledge. **Tree trails** in particular could be modernized by developing an app based on the city's digital tree register.

Beyond this, examples were also presented that focus on the social aspects. **Community gardens** with restricted access, can allow schools to use harvested produce in the school cafeteria, offering both ecological and educational benefits. At the same time, **competitions** in the area of UGS sponsorships, in which schools or kindergartens design UGS, can be promoted with incentives such as ice cream vouchers or trophies. **Do-it-yourself project work** in general is popular and offers a practical approach promoting UGS sponsorships. Moreover, **team-building days** can be combined with social actions to achieve communal goals, such as cleaning playgrounds or garden maintenance in urban parks.

The **integration of game elements** in which the maintenance of UGS is linked to rewards, e.g. in virtual animal farm games, represents another innovative possibility. This could be complemented by incorporating **educational videos** about nature to enhance environmental awareness.

*5.3.2 Solution Sketches.* Based on the insights gained from the interviews, HMW questions, Lightning Demos and the workshop discussions, participants were asked to sketch their own solution design for UGS sponsorships. In total, seven designs were developed and subsequently presented during the workshop (see Figure 1). Finally, the designs were subjected to a voting process using sticky dots. This chapter provides a summary of the designs, with a more detailed description of the design that received the most votes.

The solution sketch "**Experiencing Nature**" (#1) outlines a concept to promote nature knowledge and interactivity along a nature trail. A key component are information boards, which display the plant's name (both common and Latin), accompanied by photos for visual identification. These boards also offer interactive elements such as questions and answers that can be used for games or point collection, along with interesting facts in a "Did you know?"-format. Flora Incognita, a standalone mobile application designed


**Figure 1: Collage of the solution sketches**

by researchers to help users identify plant species using their smartphones and image recognition, is integrated into the concept to facilitate plant identification and provide additional information on aspects such as occurrence, care, and protection status. QR codes on the boards link to an app that shows a database and locations of other boards. The concept also envisions integration into guided tours and educational settings like a "Green Classroom" to enhance the learning experience. The integration of existing initiatives was very positively highlighted in the rating of the sketch. It should be noted, however, that this concept sketch does not lead to an increase in civic engagement as defined in this paper. Educational offerings are valuable in raising awareness and fostering long-term engagement potential, but they do not in themselves constitute civic engagement unless they are tied to participatory processes or community-driven initiatives.

The "**Happy Tree – Happy Me**" (#2) sketch outlines an interactive approach to engaging with trees. It begins with photographing trees, followed by a short explanatory video (maximum 60 seconds) that identifies the tree and explains its background and needs. Users are encouraged to visit multiple trees to earn achievements. When a user waters a tree, a video illustrates the impact of watering on the tree. The watering information is recorded to prevent overwatering, and an alert system notifies users when a tree urgently needs water, especially during hot weather. Additionally, users receive regular updates on trees they (frequently) visited before, including optional photos by other users. This solution sketch earned the most overall votes by the workshop participants.

The "**Tree Learning Path**" (#3) sketch proposes an interactive app that provides information about trees and plants in parks and public spaces, utilizing the city's tree register. It includes a competitive element where users can track their scores and receive positive feedback through badges or levels. The concept is integrated into educational frameworks across schools, vocational training, and universities. It also connects with regional initiatives like International Garden Exhibition (IGA) 2027. Users are encouraged to visit multiple trees to earn achievements, and data collected is shared back with the community. Communication focuses on embedding the concept within educational programs. In particular, the interlinking with existing initiatives was rated very positively by the workshop participants.

The "**Ka-Li Go**" (#4) sketch outlines an app-based engagement strategy for community involvement in UGS. The app provides location tracking and a photo function for users to report damage, adopt UGS, or use a recognition tool to identify and learn about plants. Users can upload photos of their adopted and improved UGS and also take part in competitions. Furthermore, a digital camera filter provides visual examples of potential improvements for UGS, while animations especially engage children. Users can collect points for various activities, which can be redeemed for gifts and benefits. Especially the second two features were rated higher in the workshop.

An **untitled solution sketch** (#5) outlines a strategy to promote UGS sponsorships through digital engagement and community involvement. It begins with a social media campaign featuring visually appealing images, encouraging users to participate by clicking a "join" button. The button directs users to a website with detailed information and a dedicated section for sponsorships. Here, individuals can enter their personal details and select specific areas like flower beds or tree pits from a digital register. Participants choose a sponsorship duration and receive notifications before the term ends, as well as holiday greetings and an annual thank you. Once a sponsorship is confirmed, participants receive a confirmation mail with contact information, tips and support. Additional support may include installing hydrants, providing replacement plants, supplying mulch, or replacing topsoil to facilitate maintenance efforts. In particular, the selection of the duration of maintenance received a lot of positive feedback from the workshop participants.

**Untitled solution sketch** (#6) involves an app-based approach. Users start by identifying their location to see if they're on municipal land and provide personal details and choose plants based on aspects like size and season. The app evaluates site conditions (e.g. sunlight, soil moisture). Tips are provided for e.g. planting,

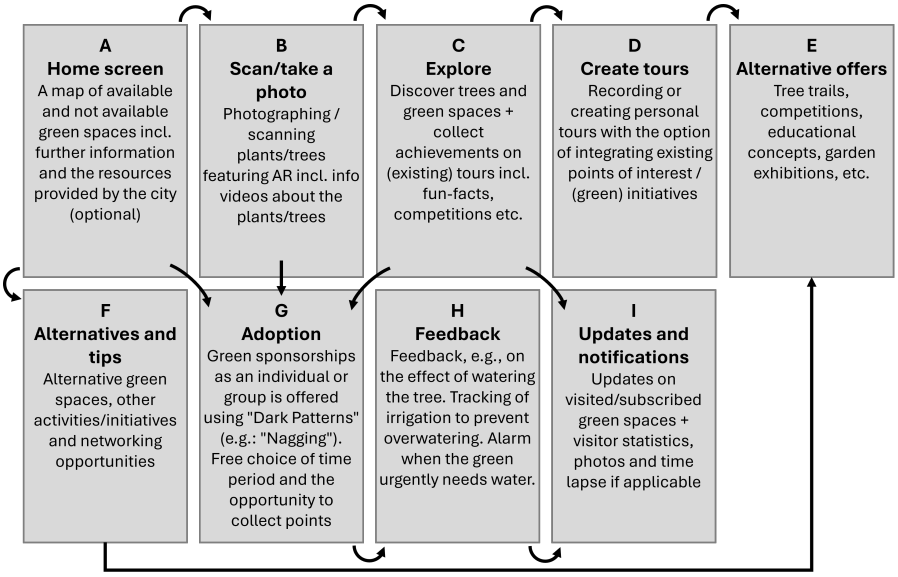


**Figure 2: Overview of the scenes on the storyboard**

fertilizing, watering. Users can earn points, set goals, receive reminders, and access tips and background information to enhance their sponsorship. In this drawing, workshop participants particularly appreciated the support in the plant-selection.

The last solution sketch "**Green Space Go**" addresses younger generations (#7). The app identifies usable UGS that require care. It includes features for identifying or registering trees and plants through a plant book that uses photos to determine species. Users receive species information and care tips, can collect species to earn medals, initiate individual or group sponsorships, and engage with the community through a question feature. In this sketch, the option of taking on an individual/group sponsorship was rated particularly positively, as was the question feature.

*5.3.3 Proposed Digital Participation Concept for Smart Cities.* Storyboarding in the design sprint is a collaborative process taking place at the end of the group work phase in the workshop to develop a visual representation of the UX [45]. The team outlines the user journey in the form of scenes that a user goes through. The scenes represent the most important interactions and critical moments of the UX. The aim is to create a clear understanding of the planned UX, which serves as the basis for the prototype development. The storyboard begins with the best voted design from the solution sketches and also combines other features from the other sketches. Its components and features are placed in the respective scenes/steps. Intermediate interaction scenes are collaboratively filled with available ideas and concepts, e.g. from the previous phases of the design sprint. This storyboard consists of a total of nine scenes, as shown in the following overview (Figure 2). Arrows are displayed between the scenes to highlight the direction of the various navigation flows, enabling users to use the app flexibly. The storyboard shown in Figure 2 is a refined digital representation of the original storyboard that was developed with the participants during the workshop. For this article, some scenes from the storyboard were created as mock-ups to visualize them (see Figure 3 and Figure 4).

The entry point is "Home screen" (Scene A), which can be reached via a social media post, for example. The home screen shows a digital map that lists available UGS and plants in need of care. It also shows locally available resources (e.g. tools, water), which are optionally provided by the city or third parties. In addition, the map displays areas that are not suitable or available for sponsorship and gives reasons for this. Another function is the statistical analysis of the views of the respective UGS for authorities in the background. If there is a high level of interest in unsuitable areas, the municipality could take measures to make them available. In case UGS are not suitable, the home screen provides suggestions for exploring alternatives (Scene F) as well as other activities and offers opportunities to connect with other (green) initiatives (Scene E).

The navigation bar of the app refers to an AR-based function for scanning plants and trees, which is also linked to available UGS. This feature described in Scene B (see Figure 2) helps users to identify the type of plants and trees and learn more about its requirements. This is supported by entertaining explanatory videos of maximum 60 seconds on the various plants in front of the user. If the user is still interested in exploring their surroundings, they can search for other UGS in their area (Scene C). The exploration can be done with the app on one's own, via prepared tours by other users, or via linking to external third-party initiatives such as city tours or school education programs. Users receive achievements (badges) for their exploration. Using a filter, interesting points or "showcase projects" can be located on the map. In addition, fun facts about the UGS will be presented with an entertaining animated light bulb as a symbol, like the Duolingo owl. Users can upload photos of the UGS they visit, as well as rate and comment on them as shown in Scene A (see Figure 3). The interaction and corresponding data are

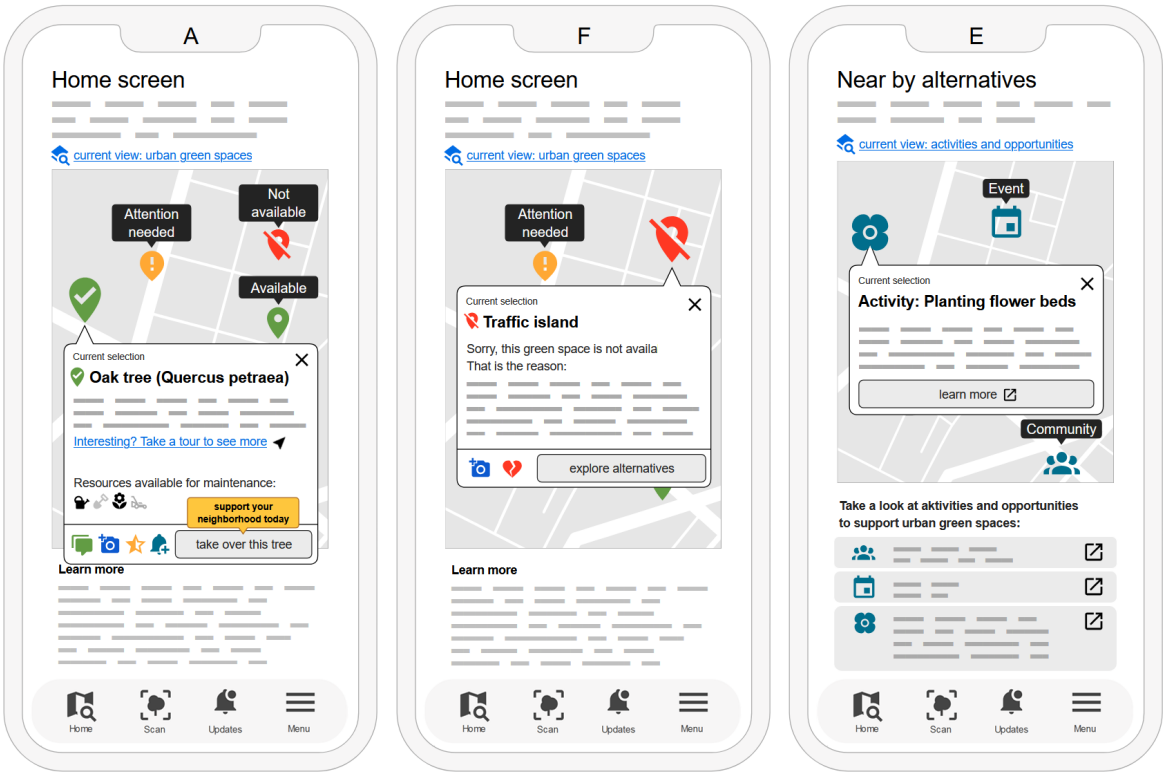


**Figure 3: Mockup of Scene A, F, and E of the storyboard**

further used in Scene I "Updates and Notifications" (see Figure 4). Users will also have the option of recording/creating and sharing their own tours (Scene D). Points of interest (POI), other third-party offers or (green) initiatives can be integrated into these tours (Scene E). Leaderboards and various types of competitions between users, as well as the ability to build collections and earn badges, require further development, but have the potential to further enrich the experience and ensure long-term commitment.

All the interaction paths described above finally come together in Scene G. The user can switch to this view at any time to adopt an available UGS. The workshop participants were in favour that the app should use design patterns in such a way that it nudges the user to adopt a UGS. This includes that the user is led to a decision through manipulation as known as dark design patterns [35]. Moreover, the presented concept only requires very few entries and confirmations to take on a sponsorship. The user must specify at least how long the sponsorship should last and whether the maintenance is done as an individual or as a group. Group sponsorships are primarily intended for companies, schools and clubs to promote social connections and a sense of community. During the sponsorship, points can be collected for rewards or benefits.

On special occasions (e.g. anniversaries, ending the sponsorship), the sponsors receive a reminder with thank you. The user receives feedback, e.g. on the effect of watering the tree. The effect of the sponsorship is shown in Scene H. They can also use the app to track when and how much they have watered to avoid overwatering and ensure that resources are used efficiently. An alarm function also notifies the user when the greenery urgently needs water. This can be the case, for example, if there is a prolonged drought.

Updates and notifications are displayed in Scene I of the storyboard (see Figure 4). In this view, users receive updates on visited or subscribed UGS, can access visitor statistics, uploaded photos and, if applicable, the photo timelapse. This collected information can be viewed by both the sponsors and the people who just use the app to discover UGS. Most importantly, however, the feedback offers the sponsor incentives to motivate them in the long term.

## 6 Discussion

This study examined how digital technologies might support civic participation in the maintenance of UGS, revealing both enthusiasm for digital tools and the structural barriers that limit their effectiveness. While citizens and administrations showed interest in platforms that could coordinate and motivate participation (through gamification, AR, and sensor-based planning) our findings suggest that participation is not primarily a technical challenge, but a social, institutional, and ethical one. However, civic participation in public service provision – particularly in sustainability and urban green maintenance – must also be understood through the lens of responsibilization. As highlighted by Uittenbroek et al. [87], local governments often invoke shared responsibility rhetorically, but in practice, they may shift responsibility for structural problems onto citizens without adequate support or authority. These dynamic risks reinforcing unequal capacities for participation and masking underfunded or fragmented institutional systems. In what

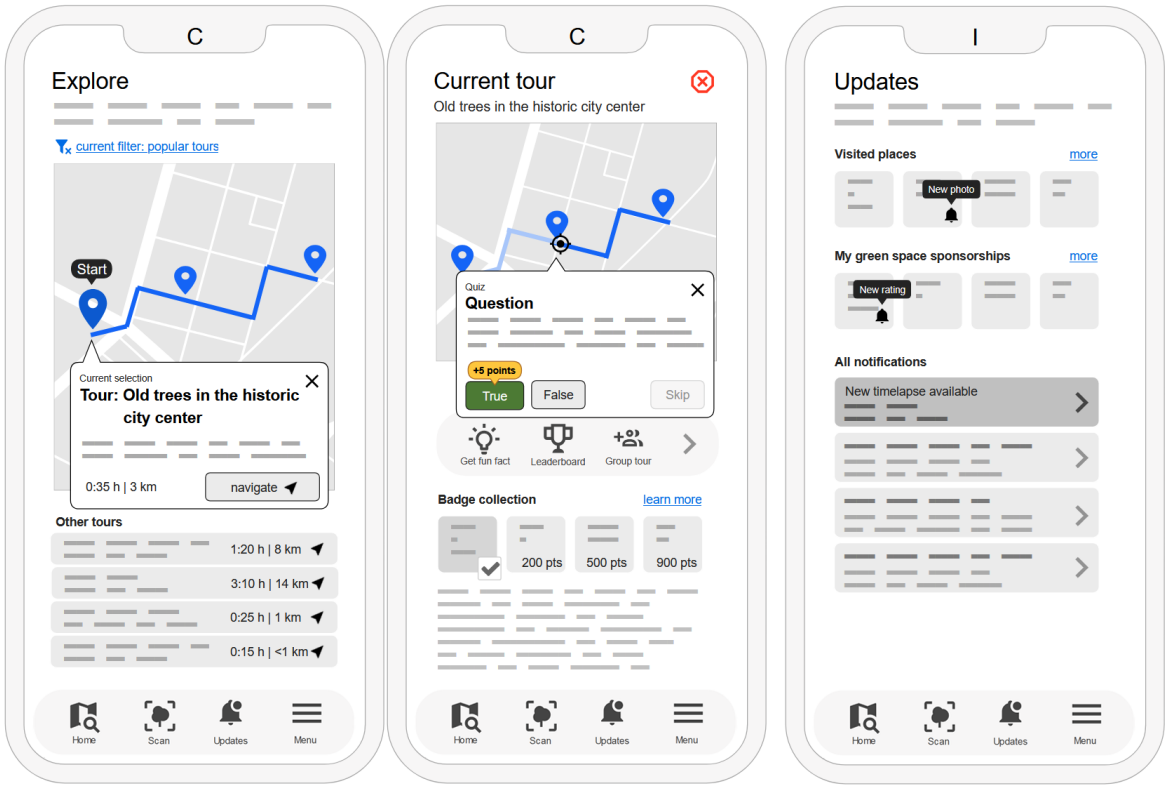


**Figure 4: Mockup of Scene C and I of the storyboard**

follows, we reflect on the implications of persuasive design techniques, bureaucratic infrastructures, and governance models for participatory maintenance. We argue for a reorientation of civic technology design, away from solutionist framings and toward long-term, care-centred approaches that integrate digital participation with social recognition, institutional accountability, and community integration.

## 6.1 Ethical Considerations and Next Steps in our Participatory Design Process

The storyboard appears promising, but we are concerned about dark patterns subtly manipulating users into sponsorships. These techniques might boost short-term engagement but raise issues of consent and autonomy. We will hold workshops to discuss design choices, past dark pattern use, and alternatives. The ethical debate on using persuasive design for social good continues, with some seeing benefits [15] and others viewing it as limiting autonomy [55].

Chou [15] frames this tension within the concepts of white hat gamification (e.g., by addressing core drives such as ”epic meaning and calling” or ”development and accomplishment”) and black hat gamification (by addressing core drives such as ”unpredictability and curiosity” or ”scarcity and impatience”), suggesting that a balanced approach could lead to increased engagement [15].

To navigate these tensions, our next steps include gathering feedback on the developed storyboard and promoting transparency around various motivational design techniques, including dark patterns [34, 35, 55], white and black hat gamification [15], implicit and explicit gamification [15], meaningful gamification [61], and nudging [13, 84]. By empowering participants with this kind of knowledge, we aim to enable them to make more informed design decisions as demonstrated in [54, 91], where similar approaches have already led to successful designs. This process is also planned to include co-creating click prototypes and empowering users to create their own designs. Based on these designs, we are going to develop a functional version for initial testing and further design iterations. In the long term, we aim to conduct a longitudinal study to examine how our application influences community practices and how it is “appropriated” as part of the technical infrastructure [51, 64].

This study was explicitly designed to explore technological solutions to foster participation in UGS maintenance. Our interviews with citizens and administrations focused on the potential of gamification and AR as engagement mechanisms, while our design workshop aimed at developing a broader digital solution that incorporated these elements without relying solely on them. This solutionist approach provided valuable insights into the technological implications of digital participation. However, the process also revealed the limitations of digital platforms as stand-alone solutions to civic engagement challenges in smart cities. Baumer and Silberman [3] emphasize the importance of asking whether technology is appropriate in the first place. Their notion of “the implication not to

design" invites HCI researchers to reflect on how digital interventions may oversimplify complex governance problems and obscure deeper structural issues that may be better addressed through non-technological means. Our findings echo Jensen et al. [39], who argue that solutionist framings risk neglecting the social and institutional infrastructures necessary for collective care. Their critique underscores the need for civic technologies to move beyond efficiency and individual action, toward fostering durable practices of collaboration and shared responsibility.

In an earlier work Strengers [83] questions whether persuasive sustainability technologies reinforce neoliberal ideals of individual responsibility. She calls for design approaches that move beyond data-centric interventions and instead engage with domestic routines, affective practices, and social relations. This critique resonates with our own findings, which suggest that digital tools like gamification and AR may fall short when they neglect the relational and institutional context in which civic participation occurs.

Designing ethical and inclusive civic technologies also means addressing broader issues of accessibility, inclusivity, and trust. Future development must ensure that digital tools cater to diverse demographics, including elderly citizens and those with limited access to digital infrastructure. Transparency in user interactions must be prioritized to respect user agency, and data generated through sensors and participation must be handled responsibly to uphold public trust.

As Roemmich et al. [66] argue, techno-solutionist approaches – such as those seen in Emotion AI – can institutionalize surveillance, shift responsibility onto individuals, and marginalize those in most need of care. Their critique reminds us that civic technologies can not only fall short of fostering participation but can actively erode trust and reinforce systemic injustices if designed without consent, contextual sensitivity, or ethical rigor.

While ethical and inclusive design is essential for building trust and fostering meaningful participation, it cannot be separated from the broader institutional and procedural contexts in which civic technologies operate. Our participatory design process has shown that even well-intentioned and thoughtfully designed digital tools face limitations when confronted with entrenched bureaucratic structures, resource constraints, and fragmented responsibilities. In the following sections, we shift focus from questions of design ethics and user autonomy to the institutional realities that shape civic participation. We examine how administrative barriers, governance models, and the underlying infrastructures of public service provision critically affect the success of participatory initiatives in UGS maintenance – and why digital solutions alone are not enough to empower sustained civic engagement.

## 6.2 From Bureaucratic Burden to Civic Empowerment: Rethinking Digital Participation in Green Space Maintenance

Our findings show that UGS are widely associated with quality of life, well-being, and an attractive cityscape. While citizens express general satisfaction with existing UGS, concerns regarding insufficient maintenance persist. Many individuals already engage in informal care, yet formal sponsorships remain rare due to time constraints, lack of information, and bureaucratic hurdles. Moreover, administrative support for such initiatives is often limited by budgetary and resource constraints. These barriers are often compounded by perceptions of institutional neglect or weak administrative support.

A key concern emerging from the study is the perception of responsibility transfer – citizens may view UGS sponsorships as an attempt by municipalities to offload their duties. This concern is reinforced by the challenge that while administrations acknowledge their resource constraints and the need for civic participation, they often lack the resources to effectively support and manage such participation. As a result, citizens who are willing to engage in UGS maintenance may find themselves facing administrative hurdles, unclear responsibilities, or a lack of necessary resources, making their participation less effective or even discouraging them from engaging altogether.

The literature underscores the necessity of reducing bureaucratic hurdles to ease civic involvement [31]. As Addas [1] highlights, participatory urban planning and greater citizen awareness are vital to successful green infrastructure in smart cities. Furthermore, prior research by Harding et al. [39] emphasizes that trust-building between citizens and local authorities is crucial for effective civic engagement. Transparent communication and reciprocal recognition are essential to framing green sponsorships not as substitute for public services, but as collaborative effort grounded in mutual care. The study by Rossitto et al. [68] underscores this point by showing how technologies, when narrowly designed for productivity, can inadvertently undermine the social relationships and care work essential to sustainable civic engagement.

Instead of framing digital participation as a technical problem, this study reframes it as a governance and civic trust issue that requires both institutional commitment and infrastructural support to enable meaningful and sustained participation. While digital tools can facilitate coordination, visibility and engagement, they must be accompanied by clear, well-structured administrative processes that ensure participants receive the necessary guidance, resources, and recognition for their efforts, with digital tools acting as a mediator of care and collaboration rather than a simple solution that is replacing institutional responsibility.

## 6.3 Smart Cities Without Smart Engagement? The Hidden Role of Bureaucracy in Digital Participation

One of the most pressing challenges identified in the study is the administrative burden associated with formal sponsorship programs. This presents a paradox: municipalities acknowledge that civic participation is essential to addressing their resource constraints, yet they often lack the necessary capacity to adequately support and manage such engagement. As a result, despite the recognized benefits of citizen involvement, the very structures that should enable participation can instead create additional barriers. Without adequate administrative capacity, even well-intentioned initiatives risk being unsustainable or underutilized. Bureaucratic complexity discourages citizens from engaging, and even when participation increases, municipalities lack the capacity to effectively manage sponsorships.

This study highlights a key challenge: while smart cities emphasize digital participation, bureaucratic inefficiencies and rigid administrative structures can hinder civic engagement. The study suggests that successful digital participation requires not just technological solutions, but a restructuring of administrative workflows to support grassroots efforts.

To address this paradox, digital participation models must prioritize process simplification and automation, ensuring that municipalities can support citizen engagement without overwhelming administrative workloads. This requires a careful balance between reducing bureaucratic barriers and maintaining the necessary oversight and coordination to ensure participation remains meaningful and sustainable. This aligns with Jensen et al.'s [44] argument that civic technologies must be designed not only to reduce friction but to actively support care infrastructures and long-term collective engagement. They caution against narrow definitions of 'smartness' that prioritize administrative efficiency over social repair. Similarly, Harding et al. [39] emphasize that civic tech design must engage with the needs and constraints of both citizens and civic authorities, suggesting that lowering barriers for participation also requires reducing administrative complexity and fostering trusted relationships. Literature on urban green infrastructure further reinforces the importance of citizen participation and equitable access in UGS planning, highlighting the value of inclusive and collaborative approaches [1]. Potential solutions include:

- Digitally mediated agreements – automated sponsorship registration with minimal bureaucratic requirements.
- Transparent resource tracking – interactive dashboards displaying available municipal resources and real-time sponsorship status.
- Hybrid participation models – leveraging community-based coordination mechanisms to distribute responsibility beyond city administrations.

By critiquing the smart city narrative that assumes technology alone can solve governance problems, this study argues that successful digital participation must be supported by institutional adaptation and reform, not just citizen engagement strategies. This aligns with Manzini's [53] call to move beyond narrow, product-centric approaches to design. In his view, civic engagement should not be framed as a solvable design problem but as a process of social innovation, requiring enabling infrastructures, ongoing adaptation, and shared ownership rather than predefined digital solutions.

While design approaches such as gamification, and digital innovations such as AR, and sensor-based tracking can facilitate participation, we argue that they remain ineffective without addressing deeper structural issues in administrative workflows, policy design, and resource allocation. Our findings reveal that municipalities often struggle with the scalability of digital solutions due to bureaucratic inefficiencies, raising the need for more integrated and flexible governance models. To ensure sustainable civic engagement, digital participation initiatives must be embedded within transparent, well-supported institutional frameworks that prioritize long-term citizen involvement over short-term technological fixes.

As Rossitto et al. [68] highlight, digital technologies introduced into community-led initiatives often overshadow existing caring practices, prioritizing efficiency over relational work. They warn that sociotechnical interventions can result in anti-designs – solutions that unintentionally disrupt the social fabric of community initiatives when they ignore the interpersonal labor that sustains them. This supports our finding that unless administrative workflows are restructured to accommodate and support social relations, digital participation efforts risk weakening rather than strengthening engagement. Adding to that, the use of gamification and AR raises questions of power and appropriateness. Who defines what is "engaging", and whose practices are prioritized in these designs? Furthermore, integrating AR into urban spaces reveals how digital overlays can influence perception and promote particular ideas about "ideal" green spaces. We acknowledge that a simple, low-barrier tool, such as a well-maintained public website or printed signage, may sometimes be more equitable, affordable, and sufficient. Our design choices aimed to experiment within the design space, not prescribe AR or gamification as defaults.

## 6.4 Enhancing Long-Term Engagement and Community Integration

While improving administrative workflows and fostering institutional trust are crucial, our study also reveals that structural support alone is not enough to ensure lasting engagement. Many sponsorship initiatives begin with enthusiasm but dissolve over time, often due to a lack of sustained motivation or integration into community life. This highlights that successful civic participation must be supported not only institutionally but also socially and emotionally. A recurring theme in both citizen and administrative perspectives is the short-lived nature of sponsorships. To address this challenge, our study suggests several strategies to foster long-term commitment:

- Regular updates and feedback loops – participants should receive continuous information on their sponsorship's impact to maintain motivation.
- Community-driven initiatives – integrating sponsorships with local organizations, schools, and clubs can reinforce engagement through social ties and collective responsibility.
- Recognition mechanisms beyond digital rewards: while gamification elements (e.g., badges, points) are useful, non-digital incentives such as public acknowledgment in local newspapers or community events may be equally effective.
- Personalization of sponsorships: allowing participants to choose flexible commitment levels (e.g., short-term vs. long-term sponsorships) could accommodate diverse participation preferences.

## 6.5 Contributions to HCI and Civic Tech

This study contributes to HCI and Digital Civics by providing insights into how digital tools mediate participatory urban maintenance by exposing the interplay between administrative constraints, technological interventions, and community engagement dynamics. Specifically, this study identifies (1) the persistence of bureaucratic hurdles that limit effective engagement despite interest in digital solutions from administrations, (2) the necessity of hybrid governance models that integrate digital tools with institutional and grassroots efforts to create more sustainable engagement pathways, and (3)

the conditional effectiveness of gamification and AR, which require contextual alignment with social and administrative structures to meaningfully support civic participation in UGS maintenance. Our work resonates with recent calls in HCI to reimagine civic technologies as enablers of collective care rather than instruments of individual empowerment or institutional efficiency [44].

This study contributes to HCI and Digital Civics by advancing the understanding of how digital tools can – and cannot – foster participatory maintenance of UGS. Through in-depth interviews, a participatory design workshop, and the development of a digital participation concept, we show how civic engagement is shaped not only by user-facing technologies like gamification or AR, but also by underlying institutional realities such as administrative burden, fragmented responsibilities, and limited trust between citizens and governments. Our findings surface critical tensions between informal practices and formal governance structures, revealing the persistent bureaucratic hurdles that hinder engagement even when digital solutions are welcomed by both citizens and administrations.

Beyond these empirical insights, our study makes three key conceptual contributions. First, we argue for hybrid governance models that integrate digital participation with institutional and community infrastructures, moving beyond individualistic or purely technical framings. Second, we extend debates on persuasive design ethics by showing how motivational techniques (e.g., nudging, gamification) must be negotiated openly within participatory processes to avoid undermining autonomy. Third, we contribute to HCI's infrastructuring discourse by highlighting how digital participation must be embedded in long-term care infrastructures – including administrative workflows, social ties, and community practices – to ensure sustained and equitable engagement. Taken together, our work responds to recent calls to reimagine civic technologies not as tools of efficiency or control, but as mediators of collective care and social repair [44].

## 7 Conclusion

This study demonstrates that enabling meaningful civic engagement in UGS maintenance requires more than digital interventions – it demands institutional flexibility, ethical sensitivity, and sustained social support. While digital tools such as gamification, AR, and sensor technologies offer promising avenues for participation, their impact hinges on how well they are embedded within broader governance frameworks and community life.

Looking ahead, we see opportunities for future research to explore how civic technologies can support not only participation, but long-term relationships of care between citizens, institutions, and urban nature. This includes deepening participatory design processes, experimenting with hybrid analogue-digital infrastructures, and addressing questions of inclusion, accessibility, and trust. By taking seriously the lived realities of both citizens and administrators, HCI can help shape civic technologies that are not only smart, but also just, situated, and collectively owned.

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