Advisory Today, Co-decisive Tomorrow?

Complementing the Participation Ladder in Smart City Innovation with Institutional Learning Perspectives

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Abstract

The question we explore in this paper is: What are the current constraints and challenges of ladder-based participation models in participatory smart city R&D, and how might learning-oriented approaches offer a complementary perspective? We explore this question through a year-long participant-observation study of a participatory research and development project focused on object recognition technology in public space in Amsterdam. This project not only engaged citizens in shaping urban technology but also challenged the professional, institutional, and political boundaries of what constitutes participation in the smart city. We identified six key developments that emerged during the course of the project and analysed how the participatory process was implemented across them. The results resonate with critical literature on participatory governance in smart cities, particularly the difficulty of sustaining citizen influence in co-decisive roles over time. We argue that the temporal dynamics of influence and institutional uptake observed in this case point to significant opportunities for collaborative and institutional learning in ladder-driven innovation projects.

CCS Concepts

• **Applied computing** → **Computing in government**; • **Social and professional topics** → **Socio-technical systems**; *Codes of ethics*; • **Human-centered computing** → **Participatory design**.

Keywords

smart city, participatory design, participation ladder, institutional learning

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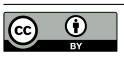

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1 Introduction

In this paper, we examine a participatory design project focused on object recognition technology used in public space in Amsterdam. Like many urban centres, the City of Amsterdam is dedicated to fostering a clean, safe, and liveable environment, using technology to achieve these goals. In particular, the city sees a future role for multi-purpose scanning vehicles to support the work of various internal municipal departments. The city administration's foundational vision behind implementing such technologies in public space is to ensure their responsible use. To achieve this goal, the Department of Digitisation, Innovation & Information has sought to improve the integration of the city's ethical principles[1] by rethinking their approach to procurement and the design of this urban technology. Since the City of Amsterdam is a key partner in a project focused on developing an integrated, value-based, multi-stakeholder design approach for the ethical implementation of smart city technologies[2] we, the authors of this paper, were able to be deeply involved in this process as action and design researchers.

In 2022, the Department of Digitisation, Innovation and Information operationalised its vision through a procurement initiative aimed at acquiring a new camera vehicle equipped with advanced object recognition capabilities for the Department of Monitoring and Enforcement in Public Space. The procurement process explicitly required that the providers of this vehicle engage in a long-term participatory research and development project with other stakeholders. This project included the establishment of a citizen panel in conjunction with four academic partners. A detailed participation plan was developed to ensure robust participation from the citizen panel, working in tandem with academic partners. It was deeply anchored in Arnstein's participation ladder framework [2], since it was based on the municipality's ladder-based participation guide, which outlines various levels of participation outcomes

[1] https://www.amsterdam.nl/innovatie/digitalisering-technologie/data/tada-waarden/
[2] https://humanvaluesforsmartercities.nl/

and influence. The R&D project aimed at the highest levels: co-decisive processes that contribute to voice, making it an example of participatory design within municipal innovation.

The intensive nature of the project and the close involvement of researchers offer a valuable opportunity to examine how the legacy of Arnstein's participation ladder manifests in both the project plan and its execution. This opportunity enables us to scrutinise the emerging challenges of achieving co-decision-making at higher rungs of the participation ladder that truly enhance citizen voice in smart city developments [3, 10]. These insights allow us to investigate further the tendency to depoliticise or overlook issues emerging during the participation process that fall outside the scope of the ladder-based project [26, 27] and, in turn, allow us to explore whether additional theoretical frameworks, such as institutional or collaborative learning, offer valuable opportunities for practical application in addition to a participatory approach based on ladders [4, 5].

Based on these topics, we first provide a more thorough review of related work in the next section, with a particular focus on Arnstein's participation ladder and its relevance to smart city initiatives. This discussion leads to the research question we explore in this paper. In the subsequent Section 3, we dive into the context in which the Department of Digitisation, Innovation & Information decided to embark on this participatory R&D journey. The research approach, described in Section 3, outlines the data collection process and the analysis phases we followed. The participation objectives as described in the participation plan in terms of levels of influence and participation outcomes are summarised in Section 4. In Section 5, these objectives are evaluated based on the realised participation. Finally, in the discussion in Section 6, we reflect on the results of this evaluation in relation to the research question.

2 Related Work – Participatory Smart City Development

This section reviews the growing demand for high-level citizen participation in smart city development, emphasising its democratic and practical significance. It outlines key constraints, including institutional rigidity, tokenistic engagement, and the tendency to depoliticise disruptive input. The review then shifts to learning-based participation models, which treat participation as an iterative, reflexive process involving both citizens and institutions. These approaches offer a promising complement to ladder-based models by enabling bigger institutional change and more responsive urban innovation.

2.1 The Case for High-Rung Participation in Smart City Innovation

Recent scholarship emphasises the need for participatory processes that move beyond consultation toward co-decision making in smart city initiatives. The issue is the technocratic nature of many smart city developments, where citizens are framed as passive data sources rather than active agents in shaping urban futures [3]. Scholars argue that participation at higher rungs of influence is essential not only for democratic legitimacy but also to ensure that technologies respond to situated needs, contested values, and the lived experience of urban inhabitants [10, 28].

This concern is particularly urgent given the risks of reinforcing existing inequalities through data-driven governance. Without meaningful citizen involvement, smart infrastructures can perpetuate governance asymmetries and deepen divides in access, trust, representation, and benefits [11, 24]. Participation, then, should not just be a way to legitimise technologies but become an approach to reframe them: empowering citizens to influence what counts as a problem, what knowledge matters, and whose values are built into digital systems [9, 13].

In this context, co-creation, living labs, and participatory design processes are often positioned as pathways to embed citizen voice at critical junctures of innovation. In particular, where public-private partnerships and commercial platforms shape urban data flows, citizen input into early framing decisions – not just user testing – becomes a democratic necessity [10, 23].

2.2 Barriers to High-Rung Participation in Practice

Despite these ambitions, it remains challenging to structurally integrate the voice of the citizen into decision-making. Institutional inertia, bureaucratic rigidity, and political considerations often restrict the room for manoeuvre. Participation is often limited to early ideation phases, while key strategic and budgetary decisions are predetermined or held beyond public reach [10, 28]. This temporal front-loading limits citizens' ability to shape project trajectories and can turn participation into a symbolic exercise aimed more at legitimation than transformation [13, 26].

The professionalisation of participatory processes further complicates matters. Intermediaries (consultants, designers, or civic tech firms) may act as facilitators but also gatekeepers, mediating what concerns are seen as legitimate and which remain invisible. As Van Zoonen [27] illustrates, such filtering can lead to sanitised forms of engagement that do not accommodate critical perspectives or structural critiques. Participation can become a means of extracting data or behavioural insights, rather than a space for dialogue or disruption [14].

This tendency to depoliticise public engagement is deeply rooted in the logic of smart city governance itself. As Hayes et al. [12] argues, the desire for efficiency and innovation can displace more plural and deliberative forms of governance. When citizen input is subsumed under "solutionism", participatory projects risk reinforcing rather than questioning the technocratic assumptions of smart urbanism.

2.3 When Participation Breaches the Frame

A particularly thorny challenge arises when participatory processes surface issues that exceed the project's original scope. These may include concerns about surveillance, algorithmic bias, environmental justice, or historical grievances; issues that are difficult to resolve within the narrow constraints of a design or pilot project. As Van Twist et al. [26] observes, these moments can serve as instances of "civic disclosure", where latent tensions emerge, and dominant narratives are contested.

However, such disclosures are often managed through mechanisms of containment. Project teams or institutional stakeholders may invoke procedural closure, arguing that concerns have already

been addressed or that new questions fall outside the scope of the project [16, 29]. Van Zoonen [27] documents how prior consultations are sometimes used as shields against renewed scrutiny, especially when ethical or political challenges are raised. These rhetorical strategies effectively signal that the time for deliberation has passed, positioning dissent as disruptive rather than constructive.

Moreover, the pursuit of consensus, often framed as a participatory ideal, can itself be a mechanism of silencing. Building consensus can flatten disagreement, marginalise minority perspectives, and suppress uncomfortable but necessary questions [12, 15]. In smart city contexts, this may result in pressure to remain "on topic", avoid conflict, or focus only on implementable outcomes, at the expense of equity, inclusion, and accountability.

2.4 Participation as Situated Learning

In response to these limitations, a growing number of cases point toward a different model of participation, one that emphasises reflection, mutual learning, and institutional transformation. Rather than treating citizen participation as a one-off consultation or a ladder to climb, these approaches frame participation as an ongoing, adaptive process. They are rooted in traditions of deliberative democracy, science and technology studies, and design research that foreground complexity, ambiguity, and negotiated meaning [4, 5, 20].

A key insight from this body of work is that learning occurs not only among citizens but also within institutions [1, 8, 23, 25]. Participation becomes a way for municipal professionals, designers, and policy actors to reflect on their own assumptions, roles, and constraints. For example, TRANSFORM City Labs created environments where citizens and decision-makers could iteratively explore challenges and solutions, not as fixed endpoints, but as shared learning trajectories [18].

In smart city innovation, such learning-based approaches allow for more open-ended engagements with questions of value, purpose, and equity. The Sharing Cities initiative and related participatory design processes, as described by Crabu and Magaudda [6], exemplify this change: collaborative prototyping is not only about technical testing, but also about constructing shared meaning around what "smart" should entail. Similarly, Hayes et al. [12] and Matos-Castaño et al. [17] show how participatory processes that prioritise dialogue and reflection can challenge institutional path dependencies and produce socially embedded innovation.

In the Netherlands, Ricardo et al. [22] and Salinas et al. [23] document cases where public sector professionals learnt to reframe their roles not as extractors of citizen input, but as participants in processes of uncertainty, negotiation and co-creation. These cases demonstrate that when participation is embedded in learning-rich formats, it can not only alter project outcomes but also influence governance cultures and institutional responsiveness. Importantly, this learning is not limited to interpersonal or cognitive aspects. It is institutional. It involves changes in routines, evaluation frameworks, and organisational mindsets. As Ozkaramanli et al. [19] argue, participation should not be seen as a tool to manage publics, but rather as a method to open up spaces for political, ethical, and epistemic inquiry.

2.5 Laddering and Learning?

The participation ladder has been a foundational metaphor in understanding and organising citizen engagement, but it is increasingly problematic for the complex, politically charged realities of smart city development [4, 5]. Its linear and hierarchical framework tends to obscure the relational, iterative, and contextual dynamics that define meaningful participation in practice. As this review has shown, ladder-based models face significant constraints: institutional rigidities, project-driven timelines, depoliticising tendencies, and a persistent emphasis on consensus and closure.

However, alongside these limitations, there is growing evidence for learning-based approaches that reconceive participation as a space of mutual reflection, institutional change, and situated experimentation. These approaches better reflect the uncertain, contested, and value-laden terrain of smart city innovation. They move us away from technocratic metrics of "influence" and toward a deeper engagement with how participation reshapes roles, assumptions, and capacities over time.

Although Collins and Ison [5] call for "jumping off the ladder", municipalities have strongly adopted ladder-based operationalisations, so perhaps there is a way to combine ladder-based and learning-based approaches. Consequently, the question we explore in this article is:

> What are the current constraints and challenges of ladder-based models of participation in smart city participatory R&D, and how might learning-oriented approaches offer a complementary perspective?

We dive into this question by conducting a case study of the participatory R&D process behind the "Scan Bike", a project with a predefined project scope that not only involved citizens in shaping urban technology, but also challenged the professional, institutional and political boundaries of what counts as participation in the smart city.

3 Participatory R&D Project Context and Research Approach

The description of the context and the characteristics of the participatory R&D project in this section shows, among other things, how carefully and collaboratively it was prepared. Our role in the preparation and as a partner in the multi-stakeholder group collaborating in this project provided the opportunity to be closely involved as action and design researchers. In turn, this enabled us to pursue the research question through intensive data collection and analysis, informed by firsthand observations of the interactions and dynamics within the project.

3.1 Collaborating on Responsible Scanning and Recognition

Like many other cities, Amsterdam is committed to maintaining a clean, safe and liveable environment. To achieve these objectives, the municipality deploys a diverse range of civil servants across multiple departments and utilises various technologies. For example, to address parking congestion, the city uses a parking enforcement vehicle equipped with object recognition technology to identify vehicle licence plates that occupy parking spaces without payment.

One of the key conditions Amsterdam has set when introducing such technologies in public space is to ensure their responsible use[3].

In 2022, the Department of Digitisation, Innovation & Information initiated a procurement process for a new camera vehicle capable of recognising various objects for internal municipal clients. The objective was to more fully integrate the city's ethical values by rethinking its approach to procuring and designing smart city technologies. Specifically, the Computer Vision Team (CVT) developed a tender based on two guiding principles. First, to improve data control, the municipality developed its own machine learning models for object recognition and data obfuscation (e.g., blurring people in images). Second, following the award of the tender, a multi-stakeholder research and development (R&D) trajectory (including a citizen panel) was planned as a core component to ensure that the service would be responsibly designed and implemented [7].[4]

During the procurement process, the CVT engaged several academic partners to embed public values from the outset. The Responsible Sensing Lab[5] – a collaboration between the City of Amsterdam and the Amsterdam Institute for Advanced Metropolitan Solutions – was closely involved. The lab worked in partnership with the Knowledge & Intelligence Design[6] section at Delft University of Technology and the Civic AI Research Lab[7] at the University of Amsterdam. The research project itself was led by the Civic Interaction Design[8] research group at the Amsterdam University of Applied Sciences.

In January 2023, the CVT began developing a participation plan, modelled on the City of Amsterdam's step-by-step guide for participatory projects.[9] The draft plan was refined through several rounds of feedback from the Civic AI Lab and the Civic Interaction Design group. The final version of the participation plan[10] was approved by the responsible alderman in December 2023. In parallel, a public survey was conducted to assess the perspectives of residents on the use of object recognition technologies in the city and to recruit participants for the citizen panel.[11] A total of 862 residents completed the survey, of whom 186 expressed interest in joining the R&D project. The respondents also shared their views on the municipality's use of camera-equipped vehicles for inspecting public spaces.

The 186 interested respondents were subsequently contacted to provide additional demographic and motivational information, including age, gender, district of residence, and reasons for their interest in participating. Ultimately, 48 individuals registered for the R&D project. From this group, 14 participants were selected while ensuring a diverse representation of views, ranging from positive to neutral to critical, as well as variation in city district representation. All selected participants were aged 30 years or older.

In late 2023, the tender was awarded to a company that specialised in bicycle-mounted camera systems. As a result, the city named the new service the "Scan Bike." The project was formally titled Collaborating on Responsible Scanning and Recognition for a Liveable, Clean and Safe City. The R&D project drew on principles from Design Thinking and Agile Software Development, resulting in a structured process involving design sessions, project team sprints and regular demonstration sessions to evaluate results. A backlog was used to document requests, issues and proposed solutions at different stages. Collaboration with the citizen panel and academic partners commenced in February 2024 and ended in February 2025.

3.2 Data Collection and Analysis

The participatory R&D project consisted of 20 sessions, including design workshops, demonstration events, evaluation moments, and explanatory meetings (Figure 1). Most of these sessions were conducted in person, with some held in a hybrid format. Each session generated concrete output, such as presentation slides, annotated flip charts, Miro boards, and monthly newsletters. As involved action and design researchers, we additionally produced field notes based on observations and reflections, covering both the multi-stakeholder sessions and the preparatory meetings. This comprehensive data set enabled a grounded analysis of how the project's realisation aligned with the objectives outlined in the participation plan and how it compared with patterns and concerns identified in the relevant academic literature.

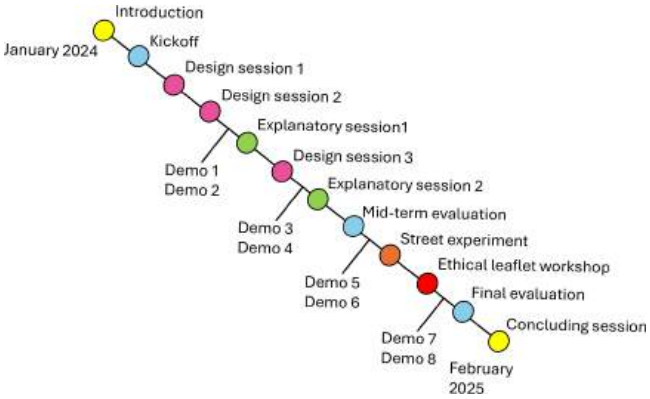


Figure 1: The participatory R&D project comprised 20 sessions, primarily involving the citizen panel, the CVT, and the academic partners. Municipal partners and the scan bike developer occasionally joined. While most sessions were held in person, the demo sessions took place in a hybrid format.

To reflect on the research question in light of the related work, we needed to evaluate the participation objectives by comparing them with the actual realisation of participation. This analysis required the following steps.

(a) *Summary of the participation plan:* We began by reviewing the participation plan and its underlying guidelines. We extracted and summarised the plan's core objectives, categorising them into distinct focus areas. For each focus area, we

[3] https://www.amsterdam.nl/innovatie/agenda-digitale-stad/
[4] https://s2c.mercell.com/today/34506
[5] https://responsiblesensinglab.org
[6] https://www.tudelft.nl/io/over-io/afdelingen/sustainable-design-engineering/kind
[7] https://www.civic-ai.nl
[8] https://civicinteractiondesign.com/
[9] https://p.amsterdam.nl/stappenplan/inleiding
[10] https://open.amsterdam/woo-zoeken/detail/ad4a4184-c113-44b2-8f3d-32a4dbe1ad44
[11] https://onderzoek.amsterdam.nl/publicatie/enquete-cameras-openbare-ruimte

documented the intended participation outcomes and levels of influence.

(b) *Identification of key developments:* We then identified and described the key developments along which the project was organised. We distinguished between a preparatory phase, subsequent thematic developments and an ongoing evaluation, mapping each development to its corresponding focus area(s) based on their stated aims and objectives.

(c) *Reconstruction of key developments:* We analysed the realisation of the participatory R&D process along these key developments in three iterative rounds using MaxQDA, a qualitative analysis software tool. In an initial exploratory round, we organised all available data relevant to each key development into corresponding folders. In a second round, we applied a participatory lens and a learning lens to identify data fragments that could serve as meaningful building blocks for a narrative reconstruction. In the third and final round, three researchers collaboratively developed a detailed chronological account of each development, drawing on these curated fragments to trace the participatory dynamics over time.

(d) *Evaluation of key developments:* We conducted a collaborative interpretative comparison between the intended and realised forms of participation. For each key development, we assessed how the observed participatory dynamics related to the planned participation outcomes and levels of influence. We also documented learning moments that emerged throughout the process to enable reflection in the subsequent step.

(e) *Reflection:* Finally, we reflected on the evaluation results in relation to the research question. This reflection was conducted in two stages: first, by connecting the findings to documented challenges in the existing literature; second, by applying a learning-oriented lens to assess broader implications. Both reflections were developed through ongoing discussions among the authors.

We present the results of step a in Section 4, step b–d in Section 5 and step e in Section 6.

4 The Participation Plan for the 'Scan Bike'

This section describes the participation plan (see Table 1 for an overview), which will be compared with its realisation in Section 5.

4.1 Focus Areas and Participation Ladder: Outcomes and Levels of Influence

The participation plan outlines how the City of Amsterdam can independently develop various measures to respect the fundamental rights and wishes of its citizens.[12] Although the municipality is committed to this goal, it acknowledges that it can never fully capture all the wishes and demands of its residents. To better align the image recognition system with citizen values, a multi-stakeholder group will collaborate on an R&D project aimed at "professionalising" the image recognition system (p. 5). The main objective of this collaboration is to ensure that the deployment of the image recognition system better respects the fundamental rights and interests of citizens. Ultimately, this initiative seeks to provide Amsterdam residents with greater insight into how the municipality uses technology.

The participation plan outlines three focus areas for Amsterdam residents to engage in:

- Service Improvement (Focus Area 1): "How the image recognition system should be deployed, including the collection and anonymisation of data from public spaces, and what steps should be taken to improve it. The case that will be used for this purpose is the recognition of construction waste containers on vulnerable quay walls."
- New Use Cases (Focus Area 2): "Whether other objects or situations, in addition to recognising construction waste containers, would be valuable for Amsterdam residents to identify in public spaces, and ensuring that the municipality actively addresses these."
- Evaluation of the Collaboration (Focus Area 3): "Actively evaluating how the collaboration with other parties is going, identifying improvement areas, and reflecting on the lessons learnt from this cooperation."[13]

The topics included in the planned participation process cover how Amsterdam residents perceive scanning vehicles and public space surveillance, their awareness and preferences for image recognition technology, and their expectations for transparency, anonymisation and fairness. They also address communication strategies, potential citizen access to collected data, and mechanisms for objection and accountability.

In the plan, the municipality excludes other topics such as the necessity and permissibility of scanning public space, developing image recognition algorithms, and processing data in Microsoft Azure, which have been sufficiently examined through external advice and prior decisions. It views further discussion on these topics as a distraction from the primary goal of the participation process: improving the image recognition system.

According to the participation policy guidelines titled Participation Outcomes and Levels of Influence,[14] the participation plan begins by outlining the intended participation outcomes, followed by an explanation of the levels of influence within the participation process.

Based on Figure 2, the levels of influence (1, 2, 3, and 4) and the participation outcomes (A, B, and D) covered in the participation plan are summarised in the next sections. The outcome 'Ownership' (C) was not part of the plan.

4.2 Focus Area 1: Improvement of the Service

In the participation plan, Service Improvement (Focus Area 1) encompasses two participation outcomes and four levels of influence (see Figure 2).

Quality (Outcome B) is summarised as "Allowing knowledge, expertise, and experience (collective wisdom) to be contributed,

[12] https://open.amsterdam/woo-zoeken/detail/ad4a4184-c113-44b2-8f3d-32a4dbe1ad44

[13] https://open.amsterdam/woo-zoeken/detail/ad4a4184-c113-44b2-8f3d-32a4dbe1ad44, p. 5

[14] https://p.amsterdam.nl/stappenplan/uploads/attachments/clysv3ny300sj01plwvhimbj4-participatiedoelen-en-mate-van-invloed-1.pdf

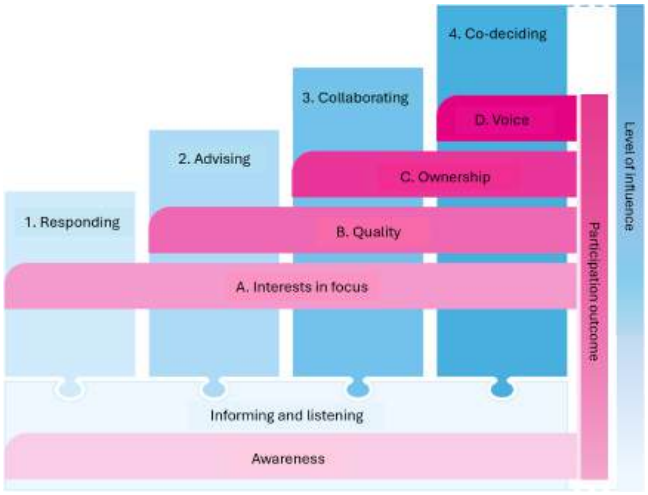


Figure 2: The participation ladder from Amsterdam's participation policy guidelines, illustrating four ascending levels of citizen influence (1. Responding, 2. Advising, 3. Collaborating, 4. Co-deciding) and their corresponding participation outcomes (A. Interests in focus, B. Quality, C. Ownership, D. Voice). The diagram illustrates how higher levels of participation yield progressively more substantive outcomes, built upon foundational layers of informing and listening, as well as awareness. The visual structure demonstrates the relationship between the degree of citizen influence and the nature of participation outcomes achieved.

improving the content and quality of the project or policy" (p. 6). The R&D project is regarded as an opportunity where "something tangible can be done with input from the collaborating parties" (p. 7) to improve the scan bike service for the current use case.

A prerequisite for this outcome, as described in the plan, is Interests in Focus (Outcome A), summarised as "Exploring and investigating perspectives, interests, and needs on both sides regarding the task at hand, fostering understanding of each other's viewpoints and establishing legitimacy for the choices made" (p. 6). This outcome is further elaborated as the CVT's aim "to develop a deeper understanding of the wishes and interests of residents" (p. 6).

The processes underneath these outcomes are on four levels of influence. Advising (Level 2) is summarised as "Amsterdam residents advise the municipality and share useful ideas or suggestions" (p. 9). Their opinions, for example, whether images are sufficiently anonymised, will be discussed with all involved parties.

Collaborating (Level 3) – also called co-creation in the plan – is summarised as "Amsterdam residents and the municipality work together as equal partners on the policy or project" (pp. 8–9). This level is described as a multi-stakeholder collaboration in which "problems, wishes, requirements, solutions, and measures are jointly defined" (p. 9).

Co-deciding (Level 4) is summarised as "Amsterdam residents decide on a policy or a project within the framework. Equal partners" (p. 10). This level is described as having an equal vote in determining which insights and solutions are most important and should be prioritised.

Finally, Responding (Level 1) is summarised as: "Amsterdam residents give an opinion or reaction to a proposal of the municipality" (p. 10). The plan states that a broader group of Amsterdam residents beyond the citizen panel would potentially be involved in responding to proposals.

4.3 Focus Area 2: New Use Cases

New Use Cases (Focus Area 2) is described in the participation plan as an interplay between a participation outcome and a level of influence (see Figure 2).

Voice (Outcome D) is described as "Promoting the democratic process; Amsterdam residents can have a say in decisions about their living environment" (p. 7). The plan mainly concerns the citizen panel's potential ideas about detecting additional or different objects or situations. To make participation meaningful, the municipality outlines its intention to implement these ideas, provided that there is sufficient alignment with the municipality's objectives and responsibilities. If these ideas do "not align with current municipal policy or ambitions, further discussions will be held with the designated director or department head" (p. 8).

This Voice, related to New Use Cases, manifests itself through Co-deciding (Level 4), which is introduced as "Amsterdam residents decide on policy or project within the framework. Equal partners" (p. 10). Just as with Co-deciding related to Service Improvement (Focus Area 1), "the involved Amsterdam residents will have the same opportunity to contribute ideas and an equal 'vote' in determining which matters are most important and should be prioritised" (p. 10). Strong preferences for new or alternative applications are said to be "brought to the attention of the responsible administrator to realise them" (p. 8).

4.4 Focus Area 3: Evaluating the Collaboration

Evaluation of the Collaboration (Focus Area 3) related to New Use Cases and Service Improvement was not included in the description of participation outcomes, levels of influence, or other aspects of the participation plan. However, three evaluation sessions were interwoven into the series of other sessions in the actual R&D project.

5 Participation: Realisation and Evaluation

In the following subsections, each key development is briefly described and evaluated against the planned ladder-based approach, with an eye on learning moments for the CVT. Section 5.7 concludes with an overall assessment of the findings through a participation-ladder lens, based on the summary of the key developments presented in Table 2.

5.1 Key Development 1: Identifying Themes to Work On

5.1.1 Description. During the launch of the project and the subsequent first design session, participating citizens, civil servants, and researchers explored what they found important for Amsterdam as a digital city. They created collages (see Figure 3) with value cards and images, discussed them in groups, and distilled their insights

Table 1: Summary of the Participation Plan's Focus Areas, Intended Outcomes, and Levels of Influence.

Focus Area	Intended Outcomes	Intended Levels of Influence
1. Service improvement	*A. Interests in Focus:* Exploring and investigating perspectives, interests, and needs on both sides; fostering understanding and establishing legitimacy for choices. *B. Quality:* Allowing knowledge, expertise, and experience to be contributed, improving content and quality of the project.	*1. Responding:* Citizens give opinions or reactions to municipal proposals (broader group beyond panel). *2. Advising:* Citizens advise the municipality and share useful ideas or suggestions. *3. Collaborating:* Citizens and municipality work together as equal partners; problems, wishes, requirements, solutions jointly defined. *4. Co-deciding:* Citizens have equal vote in determining which insights and solutions are most important and should be prioritised.
2. New use cases	*D. Voice:* Promoting the democratic process; citizens can have a say in decisions about their living environment. Ideas to be implemented, provided they align with municipal objectives and responsibilities.	*4. Co-deciding:* Citizens have equal opportunity to contribute ideas and equal vote in determining priorities. Strong preferences brought to the responsible administrator's attention.
3. Evaluation of the collaboration	Not described in terms of participation outcomes in the plan.	Not described in terms of levels of influence in the plan. Three evaluation sessions were interwoven into the R&D project.

Figure 3: One of the collaborative collages that responded to the question of what participants considered important for the digital city of the future. Participants worked with images from magazines and with value cards (such as "Efficiency", "Fairness" and "Freedom") generated from municipal policy documents.

into a collective mind map. A second exercise used four steps in the operational process of the scan bike, from encountering it on the street to public enforcement following up, to identify key concerns in each. The participants placed emojis on flipcharts with these steps and explained their reactions by identifying key issues and preliminary solutions, which were collected on four other flipcharts. Dot voting[15] helped refine these into four themes: data minimisation, transparency, control over technology, and human dimension. This key development established the initial collaborative basis and agenda for the R&D process and directly shaped the topics addressed in the following key developments.

5.1.2 Evaluation. Although still early in the R&D project, this key development shows that higher levels of influence were present, as described in the participation plan (Section 4). The design session was creative and collaborative, and the dot voting, for example, illustrates a co-decisive process. Furthermore, the reactions to the steps in the operational process clearly functioned as advice.

Similarly, this key development also contributed to the expected outcomes of participation. The panel's interests became clear, contributing to the outcome Interests in Focus (Outcome A), and the first ideas were collected to improve the quality of the scan bike service (Outcome B). Especially in the focus area of New Use Cases, the goal was to enable a strong citizen voice in developments affecting their living environment (Outcome D). The citizen panel's input acknowledged the need for this goal. Their discussions even extended beyond new use cases of object recognition to more fundamental concerns, such as influencing partially automated decisions and preventing data linkage across databases.

For the first time, the CVT became aware that concerns had arisen that exceeded the original scope of the participation plan, indicating broader issues surrounding future public space technologies. These concerns were particularly related to control over technology and the human dimension, both of which resulted in key developments that will be revisited in the following sections. First,

[15] https://designthinking-methods.de/en/3Ideenfindung/dotmocracy.html

we will cover key developments in data minimisation and transparency, both of which aim to improve the service, as described in Section 4.2.

5.2 Key Development 2: Implementing Data Minimisation

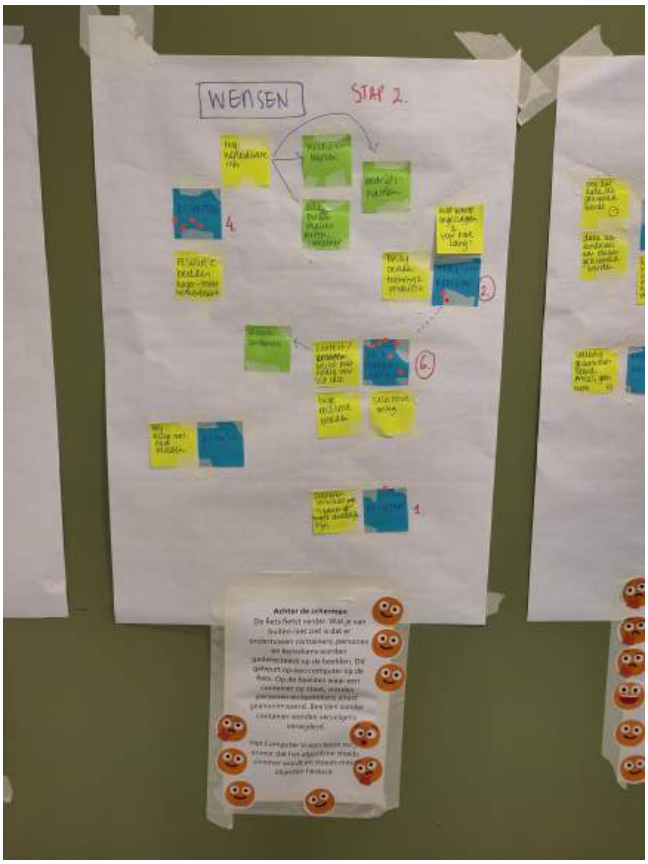


Figure 4: One of the four flip charts from the first design session illustrates how the theme of data minimisation, later developed as key development 2, was identified. Participants used emojis to react to details of the operational process in which containers and people were recognised in the collected images and subsequently blurred or removed. From these reactions, wishes (yellow), concerns (blue), and solutions (green) were gathered and discussed. In the final step, dot voting revealed data minimisation as the most important concern.

5.2.1 Description. Data minimisation was the first theme to be further developed (see Figure 4). In advance of the second design session, the project team studied citizens' concerns about data overcollection and misuse in various operational steps of the scan bike. In the session itself, mixed groups of citizens, CVT members, researchers, and the scan bike developer reflected on their feelings and values about the data. Using images and value cards, they discussed and articulated concerns such as privacy, justice, and sustainability. After discussing how to minimise data in various operational steps, the participants conceived solutions using the Crazy 8s method[16] and pitched their ideas. Based on these pitches, concrete concepts were developed in groups that were then prioritised.

The CVT used these results to define four potential data minimisation scenarios, from blurring only personal data on the images (Scenario A) to sharing only GPS data (Scenario D) of the recognised construction waste container. After real-life testing, Scenario A remained the default, but the CVT committed to using Scenario D as a starting point for future negotiations with internal clients. In addition, a request from the Department of Monitoring and Enforcement in Public Space to expand the number of images of construction waste containers was denied to honour the priorities of the citizen panel.

5.2.2 Evaluation. In the early phases of developing data minimisation, the project enabled collaborative and co-decisive participation, as intended, related to Service Improvement (Focus Area 1) in the participation plan (Section 4.2). The design session included joint exploration of concepts, iterative refinement, and prioritisation through dot voting. Ethical concerns were translated into four scenarios, such as the principle of collecting only strictly necessary data. This process involved both the citizen panel and municipal staff in reflective design work, marking a meaningful form of collaboration that supported quality improvement (Outcome B) and helped the CVT become aware of the panel's interests (Outcome A), both intended outcomes of the Service Improvement focus area.

However, during later implementation stages, the influence of enforcement officers from the Department of Monitoring and Enforcement in Public Space started to grow. Their prioritisation of efficiency and operational feasibility led the CVT to adopt the most data-intensive solution, despite citizen preferences for the opposite. This decision introduced a tension: Although the early stages reflected higher participation levels, the eventual decision resembled a more advisory model.

Interestingly, the CVT demonstrated genuine engagement with several learning outcomes. The denial of the request for more images illustrates this. Furthermore, retaining the least data-intensive solution (scenario D) as a default option for future use cases across other departments demonstrates that the CVT intends to give the citizen panel's priorities influence beyond the project's temporal scope.

5.3 Key Development 3: Exploring Transparency

5.3.1 Description. This development aimed to design the physical scan bike in a way that makes its function legible and trustworthy in public space. During a demo session, a service blueprint was used to identify touchpoints for interaction and transparency. In a subsequent design workshop, citizens, CVT members, researchers, and the scan bike developer explored their own design ideas, assessed them against selected values, and refined them based on peer feedback. They also discussed five design criteria – transparency,

[16] https://designthinking-methods.de/en/3Ideenfindung/crazy-8.html

legibility, relatability, contestability, and actionability – and developed concepts for three prototypes: the scan bike as municipal infrastructure, as an enforcement tool, and as a point of contact (see Figure 5).

These were tested in three street locations with both spontaneous and invited participants, yielding six key insights. These ranged from the importance of visual cues when the bike is stationary, to how limited municipal communication fuels suspicion and false assumptions. Residents of Amsterdam provided concrete suggestions to improve the visibility and accessibility of the bike, especially online. Although some measures were adopted (e.g., a digital flyer and better website communication), more fundamental requests, such as clarifying the rationale behind use cases, remained unaddressed.

5.3.2 Evaluation. Initially, the design workshop demonstrated strong collaborative and co-decision-making processes, as intended in the participation plan for Service Improvement (Focus Area 1, cf. Section 4.2). However, follow-up discussions focused on individual responses and advice, rather than collective decision-making. The CVT decided to adopt lightweight information-provision strategies (e.g., website updates, business cards for the scan bike riders) without re-engaging the citizen panel in a co-decision-making way. This adoption was viewed as an experiment that could be improved based on the learnings gained beyond the project's temporal scope. The pressure to finalise outputs may have been influenced by the project's approaching end.

In summary, the participatory dynamics shifted from an initial influence at the top of the ladder to a more advisory role, as institutional feasibility determined what was ultimately taken forward. This narrowing helped maintain a focus on interests (Outcome A) and service quality (Outcome B), both of which are outcomes related to the Service Improvement focus area in the participation plan.

5.4 Key Development 4: Controlling Technology

5.4.1 Description. This development, related to the focus area of new use cases in the participation plan, responded to citizens' desire for more influence over the design and governance of smart city technology. Two central questions emerged: how to shape future object recognition use cases and how to influence municipal decision-making.

The first question was addressed in a demo session, where the citizen panel prioritised a predefined list of new use cases for object recognition and reflected on which personal characteristics should be prioritised for blurring in future services. Regarding the prioritisation of recognising new objects (see Figure 6), the CVT committed to taking the panel's priorities into account when implementing new scan bike applications. The first expansion of bike applications was the recognition of mobile toilets and scaffolding without permits for the Department of Monitoring & Enforcement in Public Space. This application was not among the top-priority items: waste (e.g., illegal dumping and litter), followed by rainwater nuisance (e.g., clogged street drains), and defective traffic assets (e.g., a broken traffic light).

In relation to the second question, the CVT organised explanatory sessions on municipal decision-making and the role of advisory

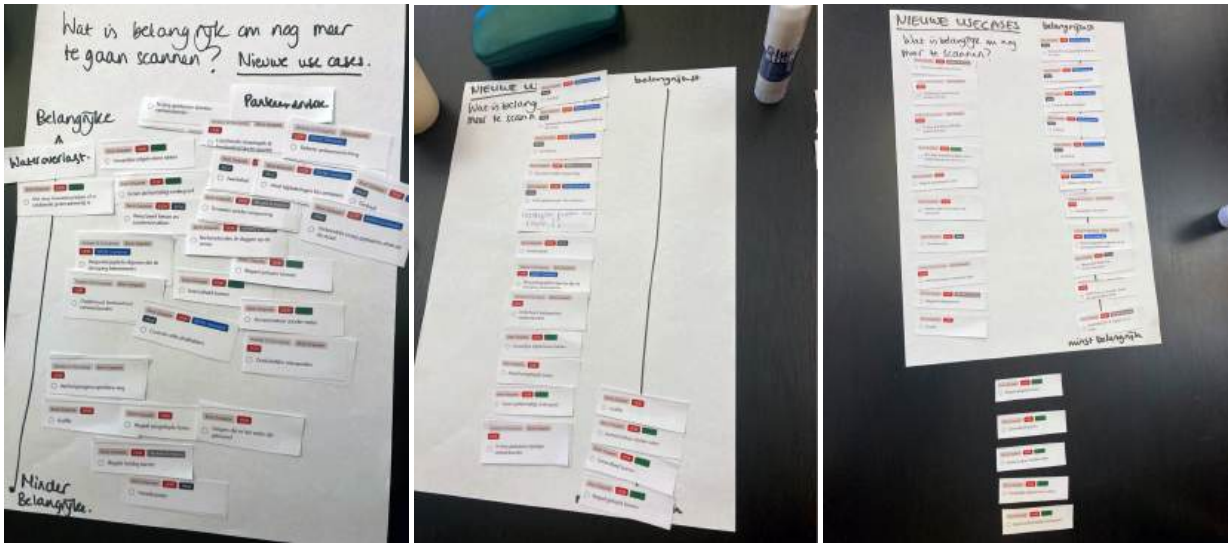
Figure 5: This image shows one of the three prototypes that was used during the street experiment while exploring transparency (KD3). The emphasis in the design of this prototype was on communicating its enforcement character. A second prototype emphasised its general function as a scan bike and a third on its affordances to interact with the bike rider. Image ©Michiel Landeweerd.

letters in it. For the request to expand the scan bike with the ability to recognise mobile toilets and scaffolding, the CVT decided to experiment with a citizen section in the advisory letter on this expansion. This letter, based on input from an 'ethical leaflet workshop'[17] (see Figure 7) involving the citizen panel and CVT, was approved by the city's executive and forwarded to the council.

5.4.2 Evaluation. Activities related to New Use Cases (Focus Area 2) in the participation plan (Section 4.3) were expected to promote the voice of the citizen panel (Outcome D) through co-decision making (Level 4). However, the explicit intention in the plan to implement their ideas was not followed up on, and how their intended "equal vote" played out remained unclear. Although the process for new use cases gave citizens a co-decision-making role in shaping priorities, it also revealed the limitations of their influence, especially when the request for an expansion deviated from their priorities. This lack of follow-up reduces citizens' initial co-decisive role to an advisory one. This role contributes to the CVT having citizen interests in focus (Outcome A), which, in turn, enables the CVT to improve service quality (Outcome B).

On the other hand, the CVT committed to follow up on both priority lists (new use cases and blurring of characteristics) in the future, which illustrates the willingness to take the interests of the citizen panel seriously. Together with the effort to expand the advisory letter with a citizen section, this highlighted the opportunity for participants to contribute to both operational and strategic aspects of innovation.

[17] https://openresearch.amsterdam/nl/page/109569/trainers-ethische-bijsluiter



(a) Flip chart 1 **(b) Flip chart 2** **(c) Flip chart 3**

Figure 6: These flip charts a–c show how three individual members of the citizen panel prioritised a predefined list of potential objects for future recognition. The list was based on the pre-project survey (see Section 3.1) and existing nuisance reports. Among the items were "Uneven pavement", "Temporary traffic signs left in place too long", "Terraces without a permit" and "Assessing whether an area contains sufficient green space". The individual priority lists were collected by the CVT, which committed to act on the collective results.

5.5 Key Development 5: Protecting the Human Dimension

5.5.1 Description. Throughout the project, fundamental concerns were raised regarding smart city developments (see, for example, Figure 7). These were most prominently voiced by the citizen panel in the advisory letter on the scan bike's expansion. The letter outlined four key concerns: function creep, data accumulation, citizen disengagement, and asymmetry in municipal innovation investments. Although the CVT acknowledged these points in its response to the advisory letter, it reframed them as manageable within existing protocols and municipal decision-making structures, rather than as grounds for institutional change.

For example, one concern was the institutional bias toward enforcement over citizen service. The panel warned against prioritising the use of technology to detect and punish at the expense of support and service. They claimed that placing greater emphasis on improving the latter could reduce the need for some enforcement efforts. Rather than acknowledging this imbalance, the CVT's response largely deflected the critique by emphasising that improving citizen services was the responsibility of the Department of Monitoring & Enforcement in Public Space. Although technically correct, this response illustrated the limits of institutional responsiveness and reinforced a technocratic orientation.

5.5.2 Evaluation. This key development was expected to promote the voice of the citizen panel (Outcome D) through co-decision making (Level 4), both of which are central to New Use Cases (Focus Area 2, cf. Section 4.3).

The key development introduced a more pronounced political and agonistic tone to the process. The concerns of the citizen panel intersected with debates on surveillance and civic responsibility. However, framing these concerns as external to the project's technical goals limited their acceptance. This key development exemplifies how deeper values and longer-term risks are often surfaced but not structurally addressed in participatory innovation. Although citizens co-decided on the ethical content of the advisory letter, their influence remained mostly advisory.

However, the advisory letter created a precedent. The act of framing citizen perspectives for a political audience in the city council briefly connected administrative, executive, and democratic domains. Although no city council member chose to deliberate on the letter, its public visibility in the official council documents leaves open a future avenue for voice. In this way, it embodied a tension: the letter was structurally advisory, yet temporally open-ended: participation today may still yield political impact tomorrow.

5.6 Key Development 6: Assessing the Collaboration

5.6.1 Description. The sixth development focused on evaluating the overall collaboration. This evaluation was done through an opening session on expectations, a midterm evaluation, and a final reflective dialogue (see Figure 8). During the opening session, citizens raised questions about decision-making processes, complaint procedures, and the handling of disagreements. The midterm evaluation focused on identifying which practices to continue, add, or eliminate. The participants praised the creativity and openness of

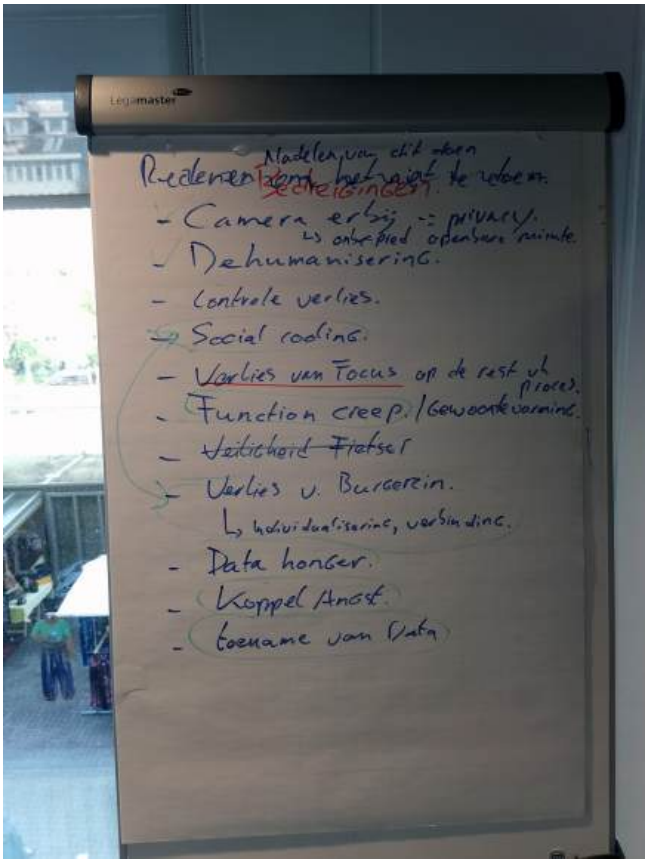


Figure 7: One of the flip charts created during an 'ethical leaflet workshop' on extending the scan bike service with the capability to recognise unpermitted mobile toilets and scaffolding. The chart captures a set of risks identified by the citizen panel, including "social cooling", "function creep", "loss of control", and "data hunger". Several of these concerns later reappeared in the advisory letter to the city council discussed in Key Development 4: Controlling Technology.

the sessions, as well as the presence of diverse stakeholders. Suggestions included more low-tech testing, earlier participation in the process, and greater transparency about decision-making authority. The participants also called for more attention to diversity and collaboration with critical civic organisations.

The final evaluation revealed tensions between the formal scope of the project and the participants' expectations. Many felt the process was too late-stage to allow for real collaboration and co-decisions. Although the participation plan was clear, it had not been co-designed, and some citizens felt it steered them into a consulting role. Although trust developed between the citizen panel and individual CVT members, concerns remained about the broader institution's commitment to ethics and transparency.

Reflections included calls to clarify from the outset whether citizens were involved as advisors or co-decision-makers. Others warned that when citizens become too embedded, they risk losing their critical stance. However, many appreciated the opportunity and believed that their presence had made a difference, even if indirectly. This final key development underscored that meaningful participation requires sustained attention not only to content but also to clarity of process, timing, and institutional receptivity.

5.6.2 Evaluation. Although Evaluating the Collaboration (Focus Area 3) was not described in terms of participatory objectives (see Section 4.4), it demonstrated strong collaboration (Level 3) and mutual understanding of interests (Outcome A). The evaluation workshops were candid and respectful, and the citizens directly contributed to the development of participation principles and practical recommendations. These contributions led to internal reflections within the CVT and intended adjustments to future participatory planning. The participants appreciated the openness of the CVT and noted a climate of trust.

However, this trust sometimes came at the cost of critical distance. Some panel members felt they had become overly loyal to the CVT's framing and goals, acting more as consultants than collaborators or co-deciders. Others expressed a desire to influence upstream decisions: shaping the participation format, defining the problem, and engaging with broader ethical questions. These desires were not met. Instead, the project remained constrained to the original scope of the R&D project, which supported collaborative improvement but not institutional transformation.

5.7 Overall Evaluation of the Results

Three patterns emerge from the evaluation of the six key developments, which are summarised in Table 2.

Several key developments (particularly 2, 3, and 4) show how participation travelled through different rungs of the municipal participation ladder over time. The early phases featured moments of strong collaboration and even co-decision, with equal votes in identifying themes, developing solutions, and prioritising outputs. These collectively prioritised outcomes effectively narrowed the decision space of the CVT, while the department retained the final authority to make the decision. Consequently, participation oscillated between co-decisive, collaborative, and advisory modes (i.e., between levels 4, 3, and 2).

However, the advisory level of influence was not necessarily the endpoint, as a second pattern concerns how the implementation of the learnings in key developments 2, 4 and 5 was postponed beyond the project's temporal frame. Throughout the R&D project, the CVT committed to continuing several citizen priorities, such as archiving the least data-intensive scenario as a future baseline and incorporating citizen perspectives into future advisory letters. These commitments imply that participatory influence can potentially extend beyond the immediate project cycle.

In this project, focused on the design of the scan bike and its data processing, participation proved to be inherently political. In several key developments (particularly 1, 5, and 6), citizens raised fundamental concerns that reached beyond the project's predefined thematic scope. The advisory letter, for instance, raised questions about function creep and citizen disengagement, while the final evaluation called for greater influence on upstream decisions regarding problem definition and ethical challenges.

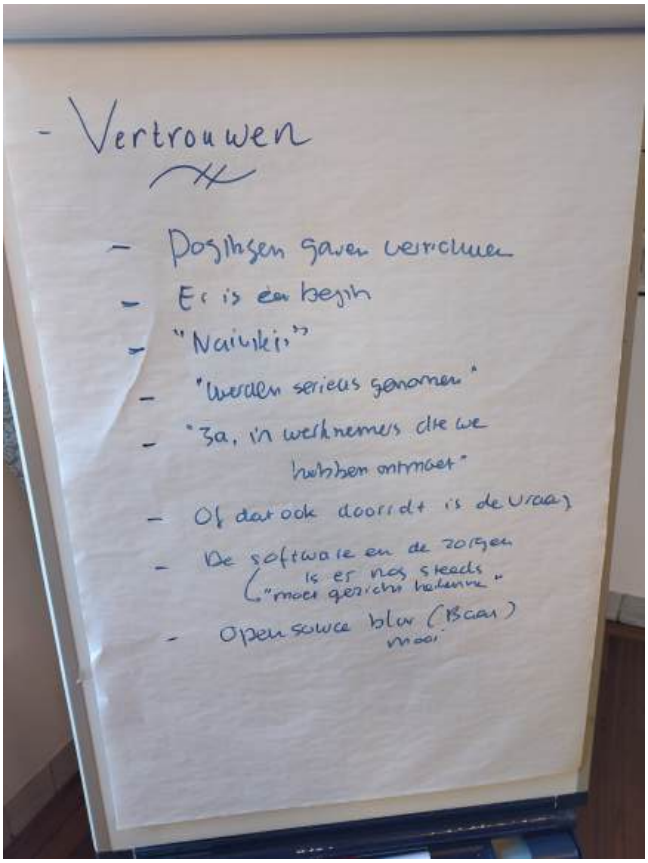


Figure 8: During the final evaluation, several themes were discussed, including "Trust", "Collaboration", "Expectations", "Ethics", "Understandability", "Engagement" and "Responsible innovation?". This flip chart presents core statements when discussing "Trust". The citizen panel felt "taken seriously" which contributed to "trust in the CVT members". Although this was seen as "a start", the "concerns [were] still there", as the municipality was still perceived as "naive" regarding the use of technology that, for example, "must first recognise faces" in order to blur them.

Together, these three patterns illustrate how participatory ambition interacts with institutional boundaries and political contestation. The following section returns to the implications of these observations in light of the research question.

6 Discussion and Conclusions

Our evaluation reveals a common pattern: early co-decisive processes narrowed over time into more advisory forms of influence (see Figure 9). However, influence may still be exercised indirectly through responsible professionalisation of the scan bike and the potential political uptake of deeper concerns. These findings return us to the central question: What are the current challenges and constraints of ladder-based participation in smart city R&D, and how might learning-oriented approaches offer a complementary perspective?

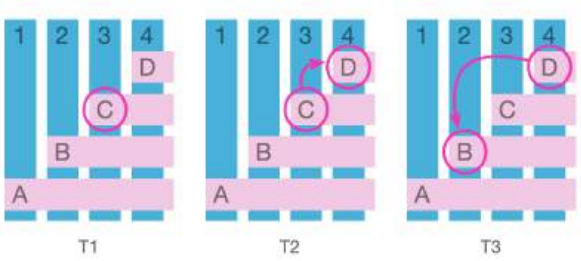


Figure 9: An illustration of how levels of influence change over time. In this typical case, at time T1, citizens collaborate (e.g., through a co-design workshop). At T2, they've moved up to co-deciding, e.g. dot-voting to prioritise the results at T1. Finally, at T3, they've descended to advising, because their priorities at T2 play a secondary role in the decisions by the CVT in interaction with the Department of Monitoring and Enforcement in Public Space.

Returning to the related work discussed in Section 2, we first demonstrate how the observed challenges align with documented difficulties in achieving influence at the higher levels of participation. Additionally, these patterns align with the broader institutional and political dynamics characteristic of smart city innovation. In what follows, we argue that the temporal dynamics of influence and institutional uptake observed in this case point to significant opportunities for collaborative and institutional learning in ladder-based participatory innovation projects.

6.1 Acknowledging the Challenges Higher Up the Ladder

The evaluation results align with critical literature on participatory governance in smart cities, particularly the challenge of sustaining citizen influence in co-decision-making roles over time. As Van Twist et al. [26] notes, participation often operates within bounded institutional expectations, which gradually reassert themselves as projects transition from ideation to implementation. This was evident in the scan bike project: While the early stages enabled meaningful co-creation and ethical exploration, later phases saw a shift towards more technocratic and efficiency-driven priorities. The inclusion of operational experts, particularly from enforcement departments, played a decisive role in shaping outcomes, echoing Van Twist et al. [26]'s observation that expert authority can subtly crowd out more exploratory or dissenting perspectives.

A similar dynamic played out in the citizen panel's advisory letter, where the effort to reach a unified message constrained the articulation of divergent viewpoints. Although the advisory process included disagreement and doubt, the institutional logic of formal decision-making encouraged consensus. This observation is consistent with the claim by Van Zoonen [27] that consensus-seeking, although framed as a participatory virtue, can function as a discursive closure mechanism. Once a participatory message is formalised, it becomes easier for institutions to invoke it as evidence of responsiveness, even if underlying concerns remain unaddressed. The presence of conflicting discourses between collaborative openness and procedural closure was also marked linguistically. Phrases

Table 2: Summary of participation realisation across six key developments. Early stages often achieved collaborative and co-decisive participation as planned, but implementation phases shifted toward advisory influence due to institutional constraints, operational priorities, and temporal pressures. The CVT demonstrated learning through commitments to apply citizen priorities in future use cases and experiments with novel governance formats.

KD	Key Development	Realized Participation	Comparison to Initial Aims
1	Identifying Themes to Work On	Collaborative and co-decisive (dot voting, collective mapping). Reactions to operational steps functioned as advice.	Aligned with plan. Contributed to interests in focus and quality improvement outcomes. Concerns exceeded original thematic scope, pointing to broader smart city issues.
2	Implementing Data Minimisation	Early: collaborative and co-decisive (joint exploration, iterative refinement, prioritisation). Later: advisory (CVT adopted most data-intensive solution despite citizen preferences).	Early phases aligned with plan. Implementation became advisory due to enforcement officers' efficiency priorities. CVT learning shown through denying request for more images and committing to least data-intensive scenario for future.
3	Exploring Transparency	Initially: collaborative and co-decisive (three design iterations). Follow-up: advisory (lightweight strategies adopted without re-engaging panel).	Shifted from high-ladder influence to advisory role as institutional feasibility determined outcomes. Approaching project end influenced dynamics. Maintained focus on interests and service quality.
4	Controlling Technology	Co-decisive in shaping priorities. Advisory in implementation (first expansion deviated from priorities). Novel format: citizen section in advisory letter.	Expected voice through co-decision-making, but implementation intention unclear. Initial co-decisive role rendered advisory. CVT commitment to follow priority lists in future shows temporal extension beyond project.
5	Protecting the Human Dimension	Mostly advisory. Citizens raised broader ethical issues (function creep, data accumulation, disengagement, innovation asymmetry). CVT reframed as manageable within existing protocols.	Structurally advisory despite political tone. Deeper values surfaced, but not structurally addressed. Advisory letter created precedent connecting administrative, executive, and democratic domains – potential for future political impact.
6	Assessing the Collaboration	Strong collaboration. Candid evaluation workshops with direct contributions to participation principles and practical recommendations. Led to internal CVT reflections and future planning adjustments.	Trust sometimes reduced critical distance – panel members felt like consultants rather than co-decision-makers. Desire to influence upstream decisions unmet. R&D framing supported collaborative improvement, not institutional transformation.

such as "we have listened and will act on it" illustrate a shift toward institutional reassurance, which, as Van Zoonen [27] argues, serves to neutralise contestation by reframing critical input as advice rather than challenge. Despite the project's self-positioning as a co-creative R&D trajectory, it remained structurally constrained by procedural and service-improvement logics, particularly in its final stages. This tension raises a broader institutional question: why frame participation in terms of ownership or co-decision if the project's governance structures cannot sustain such influence? As Ricardo et al. [21] argues, the gap between participatory promise and institutional capacity can erode trust, especially when participants experience influence as symbolic rather than substantive. Although shifting influence over time is not inherently problematic, it requires transparency and careful management of expectations. In the scan bike project, initial openness may have unintentionally created expectations that later stages could not meet.

Despite this, the project yielded a wide range of insights on surveillance, legitimacy, and service framing that were neither dismissed nor fully carried forward. This observation underscores the limitations of relying solely on influence-based models such as the participation ladder. As Collins and Ison [5] suggest, a learning-based perspective better captures how participatory processes can generate institutional reflexivity, even when direct influence is limited. In this light, the scan bike case is less a failure of co-decision-making than a missed opportunity to institutionalise learning. It can be seen as a site where valuable knowledge was generated, but not systematically mobilised.

6.2 Complementing the Ladder with a Learning Approach

The scan bike case illustrates both the potential and the limits of participatory R&D within municipal innovation, particularly after the institutional decision to professionalise the scan bike as a multi-purpose service. Although the early phases offered genuine opportunities for collaboration and reflection, structural and procedural constraints ultimately shaped the extent of citizen influence. These constraints were not only organisational; they were also temporal, discursive, and epistemic.

The first implication concerns the alignment between participatory ambition and institutional follow-up. Although early documents invoked high levels of influence, such as co-decision making and shared ownership, these were not carried through into implementation. Ricardo et al. [21] highlights the need for greater realism

in participatory framing: when deep influence is not institutionally feasible, setting clear boundaries and managing expectations becomes essential for ensuring trust and integrity.

Second, the project underscores the importance of institutional responsiveness to ethical and political concerns. Participants raised questions about surveillance, legitimacy, and the human dimension of enforcement, but the city often reframed these as impractical or outside of the project's scope. This response reflects a familiar pattern in smart city innovation, where complexity is often reduced in the interest of administrative manageability (Van Twist et al. [26], Van Zoonen [27]). However, as Ozkaramanli et al. [19] argue, participation should be understood not merely as a means to collect preferences, but as a generative space for political, ethical, and epistemic inquiry – particularly when technologies reshape foundational citizen-state relations.

Third, the case illustrates the importance of actively negotiating the balance between expert and lay knowledge. In the later stages, the project was steered by experts whose priorities, such as operational efficiency, shaped the final decisions. Although these contributions were practically grounded, they shifted the balance away from the values raised earlier by citizens. A more robust process would make such epistemic tensions explicit and subject to reflection, rather than allowing one knowledge regime to silently displace another [12, 26].

Fourth, this case supports a shift in perspective from participation as influence to participation as a means of institutional learning. Participatory processes, particularly when embedded in iterative and exploratory formats, can generate institutional reflection even if the immediate outcomes are modest. For example, the Sharing Cities initiative and related collaborative prototyping efforts illustrate how co-design can facilitate shifts in how "smartness" is socially constructed Crabu and Magaudda [6]. Similarly, in the scan bike project, the CVT began to internalise more reflexive practices, reconsidering assumptions and participatory roles. These shifts align with Salinas et al. [23] and Matos-Castaño et al. [17], which demonstrate that institutional actors can learn to adopt roles as co-learners rather than gatekeepers, particularly when faced with uncertainty or disagreement.

Moreover, as Rattay et al. [20] argue, institutional learning in design work depends on critically engaging with the imaginaries that shape participation from the outset. These imaginaries predetermine what kind of futures are seen as desirable and who is imagined to benefit from them. In the scan bike case, certain imaginaries driven by values such as efficiency, cleanliness, and safety were institutionally dominant. In contrast, more critical values, around care, rights, and resistance, were surfaced but less integrated. Viewing participation through a learning lens helps reveal not only how institutions act but also how they think and adapt, as well as how those underlying frameworks might evolve.

Finally, participation should be understood in terms that extend beyond the project cycle. In this case, the citizen panel's advisory letter briefly disrupted standard governance routines, linking administrative, executive, and political domains. Although it did not generate immediate political change, it established a precedent for connecting participatory insight with democratic debate: a slow-building form of institutional change also visible in the City Labs model [18]. As Salinas et al. [23] note, anticipatory innovation benefits from treating speculative interventions not as isolated critiques, but as learning moments that can seed future institutional transformation.

Together, these insights support the case for complementing ladder-based participation models with perspectives from collaborative and institutional learning. Where the ladder emphasises levels of influence, learning-oriented approaches emphasise reflection, mutual understanding, and the evolution of institutional capacities. In this light, the scan bike project does not simply fall short of its participatory goals – it demonstrates how learning occurs even when influence is limited, and how such learning can be leveraged beyond the end of the project for more grounded, pluralistic, and responsive innovation practices in the future.

6.3 Transferability: Amsterdam's technological and participatory infrastructure

Our findings should be understood in the context of the particular organisational and policy landscape of Amsterdam. In recent years, the city has shifted its approach to technology procurement toward greater in-house development capacity. The municipality has made deliberate choices to develop its own machine learning models and algorithmic applications, rather than relying exclusively on market solutions, which enables greater data control and alignment with public values.[18] This internal capacity facilitates iterative adjustment of systems based on feedback from participants, whereas cities relying on external vendors face longer procurement cycles and less flexibility to incorporate such feedback mid-project. Additionally, Amsterdam has institutionalised citizen participation as a mandatory component of policy development. Since 2020, all policy proposals submitted to city executive bodies must include a participation paragraph documenting how citizens were involved in the policy-making process.[19] This mandate creates organisational accountability for participation that may be lacking in contexts where participation remains discretionary. It also makes it easier to justify the allocation of resources to citizen engagement, allowing the city to draw on existing infrastructure and expertise for activities such as participant recruitment. These characteristics, the capacity for in-house technology development and the institutionalisation of participation, facilitated the participatory and iterative practices that we observed in this study. Cities lacking comparable technical infrastructure or formal participation requirements may face different challenges when implementing similar approaches, potentially limiting the direct transferability of our findings.

6.4 Concluding Remarks

This paper investigated the tensions between participatory ambition and institutional capacity in smart city R&D through a detailed case study of the design and development of object recognition technology. Observing six thematic developments over the course of one year, we found that while citizens achieved meaningful collaboration early on, their influence was consistently reduced during the implementation phase. However, this apparent descent down the participation ladder revealed a more nuanced dynamic: institutional learning and future-oriented commitments that suggest

[18] https://www.rekenkamer.amsterdam.nl/onderzoek/algoritmen/
[19] https://www.rekenkamer.amsterdam.nl/onderzoek/participatieparagraaf/

participatory impact unfolds across longer timescales than those of single projects. Our analysis supports complementing ladder-based approaches with learning frameworks that recognise how advisory participation today can establish precedents and institutional reflexivity for more responsive governance tomorrow.

Declaration of AI Use

The authors utilised AI-assisted tools, including Writefull, ChatGPT, and Grammarly, solely for copyediting and proofreading of the manuscript text. All original content, ideas, analysis, and conclusions were developed and written by the authors. No AI tools were used in the generation of research ideas, data analysis, or the creation of substantive content.

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