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Gamification in the Smart City: Insights from Participation and Communication Processes

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1 ABSTRACT

The following paper examines how gamification principles can expand citizen engagement and participatory processes in the Smart City. Smart city data in particular can be communicated excellently via digital media, regardless of location and time, due to the way it is technologically generated, stored and processed. Consequently, it makes sense to develop separate digital visualizations and tools for citizens, which on the one hand explain relevant relationships in a generally understandable way and on the other hand can reduce the high technological complexity. Especially in recent times, new formats of digital citizen participation have been emerging, some of which are specially developed between actors in urban development and media agencies (i.e. ZebraLog, Decidim, etc.). It is not uncommon that also the latest technologies such as VR glasses, digital twins, etc. come to use. But despite all the technological innovation, one of the basic problems of classic participation remains unsolved: The mix of participating citizens does not reflect the diversity of society even remotely. Socioeconomically disadvantaged groups in particular are not sufficiently reached and hence not included; instead, it tends to be the educated middle class that participates "who may be passionate about certain issues and ignore larger issues" (Ampatzidou et al. 2018; Akers 2022). Moreover, digital platforms require the decision to actively access it online. Against the background of this challenge, the two research teams of the Institute for Design Strategies at the University of Applied Sciences and Arts Ostwestfalen-Lippe are trying to link digital Smart City techniques with the potential of gamification by building and testing very simple and analog tools and methods. In these the linked digital data tends to take place much more in the background while the joy of playing with tangible elements could support citizen engagement and behavioural changes in an easier way.

This paper looks at a selection of six applied methods and formats that the team has tested in the public spaces of the medium sized city Detmold, Germany, in a completely or partially analog way in 2024. Topics such as urban planning, data security, mobility, climate change and the Smart City itself were discussed in the formats. The methods tested serve as supplementary elements to online participation and as a further development of classic outreach. Categorizations of gamification elements were reviewed for the analysis. In addition, the methods were classified at different levels of participation according to Cardullo and Kitchin based on Arnstein's work. The paper also takes a critical look at the statement that "Many believe that technological advancements in communication will support a bright new era of political engagement and dialogue" (Green 2020) and that digitalization is therefore the panacea for participation. Furthermore, it has been examined how power imbalances can be countered and a more inviting environment for participatory practices can be achieved.

Keywords: citizen, smart city, gamification, participation, communication

2 INTRODUCTION

In a time of increasing political polarization, environmental and economic changes, the quality of social interaction has become a critical factor in sustainable governance and community resilience. Crucial for a functioning society is public participation because "Through civic participation we become aware of difficulties, social problems and moral questions in society, and are aware that there are possibilities to change and build stronger community ties." (Gudoniene et al. 2021). Likewise, participation is considered to increase the productivity of governments, strengthen citizen satisfaction and promote transparency and trust in politics and administration (Halachmi & Holzer 2010). We follow the definition of participation by Karic and colleagues who describe it as "the involvement and engagement of citizens in planning and decision-making processes at different governance levels." (Karic et al. 2024).

The ladder of participation by Sherry Arnstein, which has been further developed from various perspectives and disciplines in recent decades, forms the basis for the critical examination of the citizen involvement in planning. The concept is based on eight levels, which are corresponding to the extent of citizens' power in determining the final product of a process (Arnstein 1969). At the bottom of the scale are the forms of non-participation ("manipulation" and "therapy"), followed by tokenism ("informing", "consultation" and "placation") and at the highest level citizen power consisting of "partnership", "delegated power" and "citizen control" (ibid.). In 2018, Cardullo and Kitchin specified the forms of participation for use in Smart Cities in a Scaffold structure (Fig. 1). Main contributions to the structure of Arnstein are the addition of "Consumerism" as the second level and expanding the levels by adding description for the corresponding roles, citizen involvement, political discourse/framing and modality (Cardullo & Kitchin 2018).

<table>
<tr><td>Modality</td><td colspan="6">Top-down, Civic Paternalism, Stewardship, Bound-to-succeed</td><td colspan="3">Inclusive, Bottom-up, Collective, Autonomy, Experimental</td></tr>
<tr><td>Political discourse/framing</td><td colspan="2">Stewardship, Technocracy, Paternalism</td><td>Capitalism, Market</td><td colspan="2">Civic Engagement</td><td colspan="2">Participation, Co-Creation</td><td colspan="2">Rights, Social/Political Citizenship, Commons</td></tr>
<tr><td>Citizen Involvement</td><td colspan="2">Steered, Nudged, Controlled</td><td colspan="2">Browse, Consume, Act</td><td>Feedback</td><td>Suggest</td><td>Negotiate, Produce</td><td colspan="2">Ideas, Vision, Leadership, Ownership, Create</td></tr>
<tr><td>Role</td><td colspan="2">Patient, Learner, User, Product, Data-point</td><td>Resident Consumer</td><td>Recipient</td><td>Participant, Tester, Player</td><td>Proposer</td><td>Co-creator</td><td>Decision-maker, Maker</td><td>Leader, Member</td></tr>
<tr><td rowspan="2">Form and Level of Participation</td><td>Manipulation</td><td>Therapy</td><td>Choice</td><td>Informa-tion</td><td>Consulta-tion</td><td>Placation</td><td>Partnership</td><td>Delegated Power</td><td>Citizen Control</td></tr>
<tr><td colspan="2">Non-Participation</td><td>Consume-rism</td><td colspan="3">Tokenism</td><td colspan="3">Citizen Power</td></tr>
</table>

Fig. 1: Scaffold of smart citizen participation (adapted from Cardullo & Kitchin 2018)

The increasingly implemented Smart City concept, at its core, is defined by the strategic fusion of sophisticated technologies like machine learning or agent based systems and data-driven methodologies across diverse urban sectors (Marukukula et al. 2023). This technological system is intended to address multifaceted urban challenges and, simultaneously, to achieve a more interconnected and efficient urban environment for its inhabitants (Thibault et al. 2021). On the one hand these major transformations have to be accompanied by democratic processes in the society and on the other hand, digitalization offers new promising options for participation technologies and formats. Methods and instruments that evolved in this century are for example crowdfunding and -sourcing, using social media platforms for public purposes, virtual reality visualizations, online surveys and information, hosting events online or e-voting. These methods are becoming increasingly popular for involving stakeholder groups that are otherwise too busy or not interested in existing formats (Ampartidou et al. 2018). Digital tools are used more superficially then traditional settings by citizens, they tend to reduce the citizen power to tokenism (Levenda et al. 2020), "are rooted in stewardship, civic paternalism, and a neoliberal conception of citizenship that prioritizes consumption choice and individual autonomy" (Cardullo & Kitchin 2018) and favor market-oriented technological solutions over solutions from society that are based on common goals (ibid.).

Digital methods do not eliminate the need to address how to reach marginalized groups (Levenda et al. 2020). Moreover, Fredericks states that the understanding of Smart Cities has to evolve to an approach that connects, engages and empowers communities through playful interactions incorporating digital and physical mechanisms (Fredericks 2020). That is why we explore a different approach than the widely used online participatory platforms in this paper. Instead the focus will be on creative implementation of gamification elements in formats on the edge between analog and digital technologies. The term gamification refers to the use of "game elements in nongame contexts" (Deterding et al. 2011). The potentials of gamification in urban planning participation include long-term engagement, inclusion, and empowerment of underrepresented actor groups, as well as more enjoyable participation in general (Ampatzidou et al. 2018). Moreover, they address social values such as joy, agency, and social connection (Altarriba Bertran et al. 2021). Particularly important for effects that go beyond plain information is that gamification can lead to desirable behavioral changes that are supported by emotional experiences (Robson et al. 2015).

The analysed methods are derived from prototypes tested in the mid-sized German city Detmold that currently is facilitating a program of Smart City and data projects funded by the Federal Ministry for Housing, Urban Development and Building called "Modellprojekte Smart City". We understand our tests as a reality check in the wild on the question of which methods and theoretical elements actually work to motivate and raise interest in citizens in the context of Smart City, mobility and climate change mitigation. Special attention was given to the design of the (physical) participatory spaces to offer structures that make

every individual user an equal and (interacting) constituent (Lang 2015). In addition to spatial design, communication and graphic design also played an essential role in the visual communication of content.

3 PRINCIPLES OF GAMIFICATION

Gamification has emerged as a significant approach in various domains, defined as integrating game design elements into non-game contexts to enhance engagement, motivation, and behavioral change (Deterding et al. 2011). While games focus on entertainment, gamification is characterized by a serious purpose like education or behavior changes (Krath et al. 2021). Gamification draws ideas from components of games and applies them to the real environment instead of being a full-featured game (ibid.; Deterding et al. 2011). This chapter explores the theoretical frameworks that inform gamification and examines the principles guiding its application in diverse settings. Because game-related elements are often still loose definitions, we focus on one framework of principles created by Krath et al. in 2021. The researchers ran a systematic literature review about gamification, serious games and game-based learning. Based on 118 different theories mentioned in the meta-review, ten basic principles were derived which help to explain how gamification works (Krath et al. 2021). In later chapters those principles are compared on how participatory methods were implemented within the research project.

Clear and relevant goals. Gamification can transparently illustrate goals and their relevance.

A crucial theoretical framework is Goal-Setting Theory, introduced by Locke and Latham (1990), which emphasizes the significance of clear, specific, and challenging goals in driving motivation and performance. Klein et al. (1999) add that goal-setting increases persistence and performance by providing clear benchmarks. The principle can for example be accomplished by introducing badges, achievements (Gutt et al. 2020) and quests (Klock et al. 2020).

Immediate feedback. Gamification can provide users with direct feedback on their actions.

One of the most influential theories in gamification is Self-Determination Theory, initially developed by Deci and Ryan (1985). The use of immediate and constructive feedback further supports this theory by helping individuals track their progress and adjust their efforts accordingly (Locke & Latham 2002). Immediate feedback can be shown through points, levels or a progress bar (Koivisto & Hamari 2019).

Positive reinforcement. Gamification can reward users for their performance and communicate the relevance of their achievements.

Vroom's (1964) Expectancy Theory provides additional insight into gamification by suggesting that individuals are motivated by the expected outcomes of their actions. This theory underscores the importance of designing reward structures in gamification that align with users' expectations and perceived effort-reward relationships. Rewards can be implemented through badges, trophies (Suh et al. 2018) in-game rewards (Berkovsky et al. 2012) or status symbols (Klock et al. 2020; Rapp 2017).

Guided paths. Gamification can nudge users towards the actions necessary for achieving the goals.

As described in the constructivist learning theory, coaching is crucial to successful learning (Krath et al. 2021) and may include supporting learning through motivational prompts, assistance or reflection (Jonassen & Rohrer-Murphy 1999).

Simplified user experience. Gamification systems are usually easy to use and can simplify content.

Gamification can simplify the user experience by dividing complex tasks and topics into shorter and simpler sub-tasks (Simões 2013) and abstracting real-world problems to less complex scenarios supports learning and understanding (Ranchhod et al. 2014). We also add to this point the game-like design of the gamification concept. As Thiel (2017) mentions, a well-thought-out design is an important part of gamification and ease of use and intuition are crucial for the communication of information.

Individual goals. Gamification can allow users to set their own goals.

The goal-contents-theory states that people have different preferences and strategies to pursue intrinsic and extrinsic goals (Ryan & Deci 2017). To support the individual need for autonomy, users should be given the opportunity to set goals for themselves (ibid.). This can be achieved by the integration of leaderboards (Chernbumroong et al. 2017), level bosses (Chen et al. 2019), avatars which illustrate the user´s future (Rapp 2017) or tracking and performance stats (Al-Ramahi et al. 2016).

Adaptive content. Gamification can adapt tasks and complexity to the abilities and knowledge of the user.

Csikszentmihalyi's (1990) Flow Theory further contributes to the understanding of gamification by describing an optimal psychological state of immersion and enjoyment that occurs when an individual's skill level is balanced with the difficulty of a task. In gamification, achieving this flow state requires structuring challenges that progressively adapt to users' skill, knowledge and behavioral level, providing clear objectives and immediate feedback to maintain engagement without causing frustration or boredom (Krath et al. 2021).

Multiple choices. Gamification can allow users to choose between several different options to achieve a certain goal.

According to the situated learning theory, conceptual knowledge can only be acquired by application to real-world scenarios and being embedded in realistic contexts (Brown et al. 1989; Dabbagh & Dass 2013). For learning, personal and environmental experiences and making own decisions based on the context are more important than instruction (Kolb 2015).

Social comparisons. Gamification can allow users to see their peer's performance.

Bandura's (1977) Social Learning Theory highlights the role of observational learning, imitation, and modeling in behavior acquisition. In gamification, leaderboards, social comparison mechanisms, and peer recognition (Christy & Fox 2014; Ding et al. 2020) serve as motivators by allowing users to observe and emulate successful behaviors. The incorporation of social interaction elements enhances engagement, as individuals are more likely to participate actively when they perceive themselves as part of a community (Bandura 1977).

Social norming. Gamification can connect users to support each other and work towards a common goal.

This principle refers to the concept that people have the basic psychological need for relatedness which is shown in the need for conformity and proximity with peers (Ryan & Deci 2017). Using the social comparison mechanisms of social pressure and a common goal can therefore help to reach the educational goals of the gamification (Krath et al. 2021). Social norming can be achieved by forming teams, mastering team challenges, collective voting and social networks (Klock et al. 2020).

The above-mentioned aspects of the study thus offer a good starting point for comparing and evaluating different participation concepts, which will be discussed in more detail below.

4 THE RATIONALE FOR GAMIFICATION IN SMART CITIES

The potentials of gamification in urban planning include long-term engagement, inclusion, and empowerment of underrepresented actor groups, as well as more enjoyable participation in general (Ampatzidou et al. 2018) which increases the motivation to participate (Muehlhaus et al. 2023). Moreover, they address social values such as joy, agency, and social connection (Altarriba Bertran et al. 2021; Bowser et al. 2013). Particularly important for effects that go beyond plain information is that gamification can lead to desirable behavioral changes that are supported by emotional experiences (Robson et al. 2015). This is achieved by illustrating complex urban issues in a more tangible way and using mechanisms of social learning (Ampatzidou et al. 2018). While board games have been specifically developed and used for planning purposes for a long time e.g. the game "Paticipology" where decisions on development challenges, place-making and planning issues get discussed and solutions negotiated and serious games and edutainment like SIM City have gained popularity (Robinson et al. 2021), implementing gamification principles rather than games into urban projects is not that widely applied yet.

The approach of gamification assumes particular relevance within the complex landscape of Smart Cities, where the complicated reality of urban infrastructures and data-driven governance models can present barriers to accessibility and may appear disconnected from the daily lives of average citizens (Latifi et al. 2022; Sgueo 2019). The application of gamification in Smart Cities is diverse, spanning numerous urban domains. Thus, in the following a selection of various projects will be presented based in the Smart City context which draw inspiration from the theories and instruments of gamification.

For instance, gamification can be effectively used to encourage pro-environmental behaviors through initiatives such as "Recycle Bank", where people collect points through recycling and can use them to get rewards from local businesses, which demonstrates how reward systems and friendly competitions can incentivize recycling and waste reduction in the US (Marukukula et al. 2023). In the realm of transportation

and mobility, addressing traffic congestion and promoting sustainable transportation choices is a key focus for Smart Cities. Gamified applications, such as "Bike Angels" in New York or gamified ride-sharing apps, can incentivize citizens to utilize public transport, cycling, walking, or carpooling by offering points, discounts, and rewards (ibid.; Sgueo 2019.). With the "Smart Road Sense" game in Italy and carpooling gamification schemes modeled with multi-agent systems people report road and traffic problems, collect points and compare their scores with others (Marukukula et al. 2023). This illustrates how gamification can be used to optimize traffic flow and promote responsible driving behavior (ibid.). Moreover, gamification can enhance citizen preparedness and responsiveness during emergencies. The last gamification examples can educate citizens on safety procedures, emergency protocols, and community support mechanisms (ibid.). Emergency Notification applications redesigned with gamification aim, where the users follow the rules of a typical videogame; users "can get points for sending EN notifications, for accomplishing missions and for attending training courses." (Romano et al. 2016), to improve civic engagement during crises by creating more compelling and informative interfaces for reporting incidents and receiving guidance (ibid.).

The examples show the potential variety in fields of application for gamification in Smart Cities which. In our case, the approaches that can be transferred to topics such as urban climate protection and sustainable mobility are of particular interest, as these are the requirements of the funding line.

5 TESTED METHODOLOGICAL APPROACHES

The focus of the tested methods in the project was on investigating how the above described gamification elements can enhance interaction and engagement among participants. Special emphasis was placed on diversity, real participation, and raising awareness for sustainable mobility and urban resilience. The methods were designed to reach diverse target groups, lower barriers, and promote active participation. This is achieved through multisensory experiences enriched with gamification elements and high-quality design. For each format, a brief profile was created summarizing the essential elements of the respective format.

5.1 Card Game "From A to B"

Description: Participants rethink their mobility habits by using a card game that represents their use of digital tools and modes of transportation (Fig. 2). This workshop invites participants to explore their daily use of digital tools and transportation modes through a card game. Participants describe their day by explaining how they moved from one location or activity to the next, with a particular focus on their choice of transportation and the use of digital tools like a railway transport provider app or a local bus operator app (Fig. 2, r). This process is visually supported by cards that represent each station or mode of transport. The cards are laid out sequentially to create an individual mobility profile, which encourages sharing more information during the conversation and can be added to the profile with pencils. With the participants' consent, the process is filmed or photographed from above, depicting only the hands, to provide a visual documentation of their individual mobility routes. This makes behavioral patterns visible and encourages discussions about alternative transportation concepts. This method was successfully tested at a neighborhood festival in the district Herberhausen and contributes to raising awareness about sustainable mobility options.

Objective: This method addresses key Smart City topics such as sustainable mobility, digital infrastructure, and urban planning. "From A to B" aims to identify barriers to using public transportation, promote alternative mobility options, and inspire behavioral changes towards eco-friendlier transport choices. By making participants more aware of their mobility patterns, the method encourages reflection on how cities can become more sustainable and efficient in terms of transportation.

Gamification Elements: Cooperative interaction, visualization of behavioral patterns, discussion about possibilities for change:

(1) Cooperative Interaction: The card game encourages participants to engage in discussions, share their mobility experiences, and collaborate on identifying patterns and alternative solutions. This fosters a sense of shared learning and collective reflection on sustainable mobility.

(2) Visualization of Behavioral Patterns: The visual representation of each participant's mobility route allows them to see their own behaviors, making abstract mobility choices more tangible and easier to analyze. This dynamic feedback loop sparks self-awareness and discussion about personal mobility habits.

(3) Discussion about Possibilities for Change: By focusing on alternatives to current transportation behaviors, the game creates a space for critical thinking and collaborative dialogue about possible changes in mobility choices, enhancing engagement and promoting sustainable alternatives.

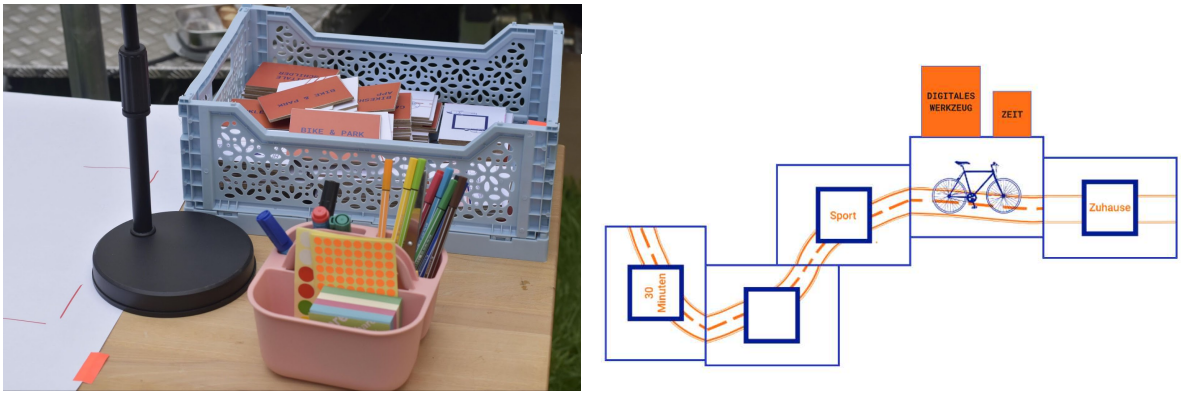

Fig. 2: Crafting materials and example result for “From A to B”

5.2 Model Building “Shape Your Digital/Car-Free City”

Description: A creative format where participants shape their vision of a car-free or digital city. In this interactive format, participants develop their individual vision through playful, engaging questions like “How do you use your phone on the go?” or “How does a car-free city smell?” while using various building materials (e.g., plastic film, wire, cardboard, Fig. 3). The created models are fixed to A3 cardboard and photographed at the end, allowing participants to take personalized postcards with them. This creative approach allows individual future visions to be visualized playfully and discussed afterwards. The questionnaires helped participants structure their ideas, while the photo postcards served as tangible rewards that strengthened engagement. The results of the method were diverse, individual designs and a discussion about future city planning. The interactive environment encouraged exchange, and creative co-creation allowed for a deeper connection to the concepts. In the future, the format should be more flexible in terms of duration and target groups and offered in multiple languages.

Objective: Promote participation, gather ideas and knowledge about digital and car-free cities, and visualize future visions.

Gamification Elements: Creative co-creation, personalized postcards as rewards:

(1) Creative Co-Creation: Participants engage in the collaborative creation of their vision, fostering a sense of ownership and involvement in shaping future urban spaces. The process of co-creating allows participants to see their ideas come to life in a tangible way, fostering greater connection to the activity.

(2) Personalized Postcards as Rewards: The creation of postcards featuring their designs acts as a reward for the participants, providing a tangible artifact that reminds them of their participation and involvement in imagining future cities. These postcards also serve as a form of recognition for their creative input.

Fig. 3: Question-cards, a visitor building their own city at “Shape your Digital/Car-free City” and a result postcard

5.3 Fishing-Game

Description: The fishing game is an interactive activity for Smart City information through playful engagement. As part of the international Parking Day 2024, the parking areas at the central street Rosental in Detmold were transformed into information booths to lounge areas, from clubs, initiatives, and projects. The project space was designed with an exciting, playful, and colorful spatial concept using scaffolding structures

(Fig. 4). Visitors could use wooden fishing rods with magnets to "catch" wooden symbols from a painted pond. These symbols represented different aspects of the Smart City concept and were assigned to corresponding themes in a "Decision-Makers' Corner". The aim of the activity was to actively involve Detmold's residents in learning about key topics such as mobility, saving resources, and social justice. Additionally, the symbols could be taken home as postcards, serving as a reminder of the creative transformation of public space. The fishing game, often known from childhood, is intuitively understood and provides visitors with a lot of fun. The appealing design with organic shapes and bright colors enhances attention and thus participation. Through the playful "fishing", participants engage with topics related to the Smart City and contribute their own ideas. Challenges arise in spatial design and target audience engagement, as the game primarily appeals to children but less so to adults.

Objective: Presenting information in an interesting way and raising awareness of sustainable urban development and Smart City topics.

Gamification Elements: Magnetic fishing game, categorization task, postcards:

(1) Interactive Gameplay: The magnetic fishing rods and symbols offer an engaging and playful interaction. The physicality of fishing creates an immersive experience where participants interact with the environment, leading to greater involvement.

(2) Categorization Task: After catching symbols, participants are tasked with categorizing them into related themes. This task encourages participants to engage cognitively with the different aspects of the Smart City concept, fostering deeper understanding and reflection.

(3) Creative Takeaway: The postcards that participants can take home act as both a reward and a reminder of their engagement, enhancing the emotional connection to the activity and reinforcing the impact of the experience.

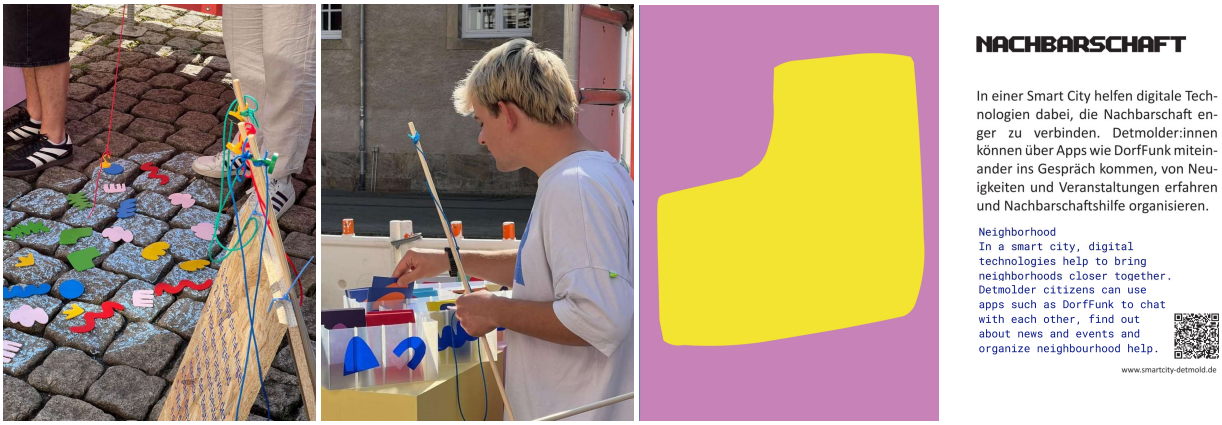

Fig. 4: Visitor at the public Fishing-Game collecting cards with Smart City information, card example "neighborhood"

5.4 Feminist*Parti

Description: The anti-conference "Feminist*Parti", which took place at the university in Detmold, discussed topics of intersectionality in urban contexts of participation. This format deliberately moved away from traditional conference structures and created an inviting and participatory atmosphere with its open room design (Fig. 5). Instead of rigid lectures and hierarchical seating arrangements, different spatial zones were created with open and flexible areas that enabled spontaneous interactions and low-threshold participation. We found that a non-hierarchical spatial arrangement can promote inclusivity, collaboration and active participation by breaking down physical and psychological barriers. This ensures that all participants can equally contribute, are valued and the feeling of shared responsibility is created. The "Feminist*Parti" anti-conference also demonstrated the importance of a well thought-out visual appearance. A consistent and appealing design created clear recognizability, facilitated orientation and visually conveyed the main content of the event. The barrier-free design of the information material and the interactive presentation formats reduced articulation barriers and enabled a low-threshold to interact.

Objective: Testing design approaches for event promotion and the physical space of the interaction, while contentwise discussing intersectional participatory processes.

Gamification Elements: interactive spaces, co-creation zones, spontaneous discussions, and tangible takeaways such as zines and installations.

(1) Playful and Open Interaction Spaces: The spatial concept encouraged spontaneous participation by replacing traditional conference structures with flexible zones, interactive installations, and open co-creation spaces. This made participation feel natural and inviting. Additionally, the event took place in a central, open space – the university foyer – allowing people to join even for just a few minutes.

(2) Collective Challenge & Co-Creation: Participants were encouraged to collaboratively map out intersectional challenges in urban participation through discussion prompts, open discussions, and creative workshop tasks, reinforcing a sense of shared responsibility.

(3) Tangible Insights & Recognition: During the workshops, participants created zines or small installations that they could take home as a keepsake. These also served as a starting point for later presentations and discussions. This approach enhanced engagement and validated their contributions in a playful yet meaningful way.

Fig. 5: Input session and workshop in different spaces at the Feminist*Parti

5.5 Mobil-Map – Detmold Design Week 2024

Description: The prototype employs an interactive, map-based interface controlled via a physical joystick and button in Arcade style. Participants utilize this interface to navigate a virtual urban environment, exploring mobility options for traveling from a designated physical location to any point within the map. Users are presented with the choice between utilizing a car or a bicycle for their virtual journey. Upon selecting a mobility option, the system generates a step-by-step visual routing and provides a detailed comparative analysis of the selected car and bicycle routes, highlighting key differences in distance, cost per kilometer, CO2 emissions, and time (Fig. 6). Following this comparative visualization, users are prompted with a decisional query regarding their potential reconsideration of mobility choices in favor of more sustainable alternatives. Upon submitting their response, the prototype generates a physical receipt summarizing the user's choices and key data points from their interactive experience, providing a tangible artifact of their engagement. The map was mainly programmed and designed by our team, within JavaScript and HTML frameworks and Python for user interaction and data handling. Additional mobility options like walking and taking public transport should be added to the map in the future to show a realistic variety.

Objective: The primary objective of this prototype is to enhance user awareness of diverse mobility options available within an urban environment and to actively promote the consideration and adoption of more sustainable transportation choices.

Gamification Elements: The prototype integrates subtle gamification principles primarily through:

(1) Playful and Nostalgic Exploration: The map-based interface and physical joystick control in Arcade style, pixelated fonts and visualizations, and experience identity offer an engaging and easy to interact means of exploring urban mobility options.

(2) Comparative Feedback and Challenge: The detailed visual comparison of car and bicycle routes serves as a form of immediate feedback, highlighting the trade-offs and potential benefits associated with different choices.

(3) Tangible Reward & Summary: The physical receipt functions as a form of reward or takeaway, providing a tangible summary of the user’s interaction and reinforcing the choices and information presented during the experience.

Fig. 6: Example comparison in the Mobil-map interaction, haptic elements and printer with receipt

5.6 Voting Towers – Neighborhood Festival Herberhausen

Description: This prototype was developed to tangibly demonstrate the concept of data physicalization within a playful and intuitively interactive experience. The core of the prototype consists of physical "voting towers" engineered to register user votes through a ball-drop mechanism (Fig. 7). Utilizing a set of 200 small balls, participants physically cast their votes by balls into the designated tower corresponding to their chosen answer option. Each tower is equipped with integrated sensors capable of detecting ball ingress and automatically tabulating received votes. A networked web interface and server infrastructure are implemented to facilitate real-time data acquisition from the voting towers, aggregate collected data, and generate dynamic visualizations of the voting patterns. The system further incorporates a comparative data layer, enabling direct visualization and contextualization of collected voting results against pre-existing national average datasets for Germany, providing a comparative benchmark for participant responses. The question asked was: "Why are you not using the bike more?" with the given options "I'm already using a lot", "I don't own a bike", "weather", "too exhausting", "safety concerns" and "too long distances". The national data included more options which due to limited number of towers couldn´t be shown.

Objective: The user experience is intentionally designed to be both playful and accessible, simplifying the complex process of data visualization and civic participation into the intuitive act of ball-throwing.

Gamification Elements: While not employing complex game mechanics, the prototype leverages inherent playfulness through:

(1) Physical Interaction and Intuitive Control: The act of physically casting votes by throwing balls into designated towers provides a kinesthetic and inherently engaging form of interaction.

(2) Immediate Visual Feedback and Data Representation: The dynamic visualization of aggregated vote data on the web interface, combined with the physical accumulation of balls within the towers, offers immediate and visually compelling feedback on collective opinion, rendering abstract data sets into concrete and understandable representations.

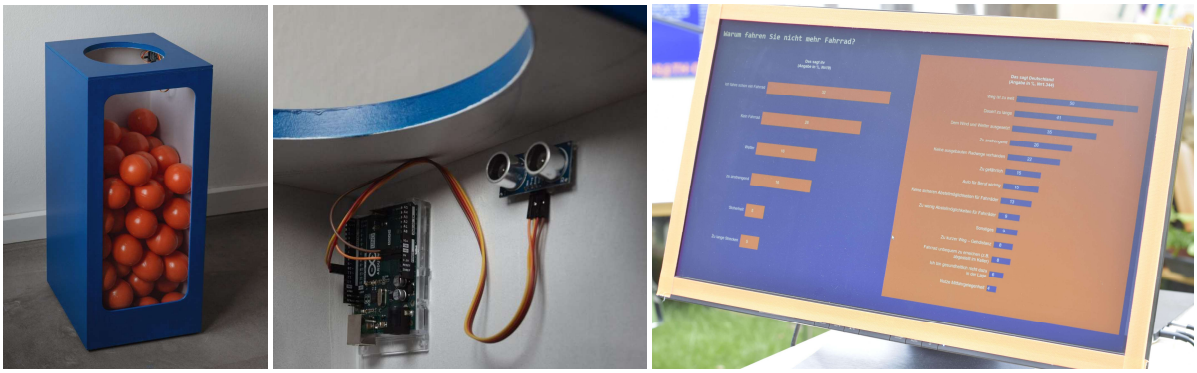

Fig. 7: Voting Towers with sensors and dynamic visualizations.

(3) Comparison and Benchmark (Implicit Challenge): The real-time comparative display of collected data alongside German national averages implicitly introduces an element of benchmark-driven comparison,

subtly prompting users to consider their responses in relation to broader societal trends and collective opinions. While not explicitly competitive, the comparative element introduces a layer of contextual engagement and implicit challenge.

6 FINDINGS AND DISCUSSION: POTENTIAL OF GAMIFICATION IN SMART CITY PROJECTS FOR CITIZEN COMMUNICATION AND PARTICIPATION

To review the newly developed and once tested methods they are brought into comparison on the basis of level of participation (Cardullo & Kitchin 2018) and the principles of gamification (Krath et al. 2018).

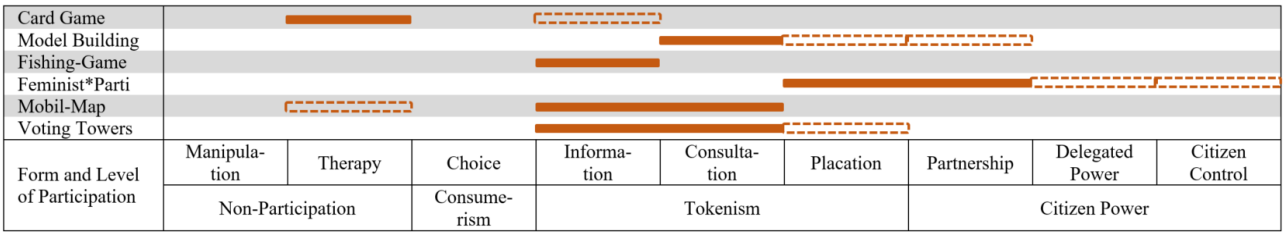

Fig. 8: Level of participation based on the scaffold of smart citizen participation by Cardullo & Kitchin 2018. (dotted = can potentially be used for …)

Looking at the scaffold of participation reveals that our methods focus on data collection (included in "Therapy"), communication and information instead of the higher levels of participatory practices (Fig. 8) which is in line with the distribution of methods carried out by cities (Levenda et al. 2020). This has to do with the fact that the method exploration is part of a research project testing creative information formats and improving outreach to diverse citizen groups. No specific power or budget is therefore allocated to self-organised citizen projects. While this is a specific problem of research in this field, it also reflects a bigger issue in digital participation: technological advancements cannot introduce a "new era of political engagement and dialogue" because the challenges lie in the limitations of power, politics and public motivation (Green 2020). In general the research team can confirm what Thiel (2017) stated: the best way to engage people in urban governance activities is to show that the people in power are listening to citizens input and make it part of their policies. While developing methods for information and outreach is essential, tokenism and power imbalances can only be prevented by transparently sharing from the start what can be achieved and decided by the citizens in the participatory process. This might require a shift in mindset within the administration and politics which again would be part of a wider societal turn.

	Clear and relevant goals	Immediate feedback	Positive reinforcement	Guided paths	Simplified user experience	Individual goals	Adaptive content	Multiple choices	Social comparisons	Social norming
Card Game					•				•	
Model Building	•		•		•		•	•	•	
Fishing-Game			•		•					
Feminist*Parti					•				•	•
Mobil-Map	•	•	•	•	•	•		•	•	
Voting Towers	•	•			•				•	•

Fig. 9: Analysis based on gamification principles by Krath et al. 2019

The analysis of the gamification principles shows that many of the methods fulfill the simplified user experience (Fig. 9) which is due to the emphasis on design and simplifying complex topics. Furthermore, social comparison is found in five of the methods, mainly because of the setting in social and public settings. Unsurprisingly, the Mobil-Map fulfilled the most gamification principles. It also represents the method which had the highest digital development need and hence was closest to an actual (serious) game. User feedback from the applications indicated a positive effect on attracting attention in open participatory formats and the rewards in the different methods particularly promise an improved long-term engagement with the topics presented in the workshops. Detailed feedback by citizens has to be studied in future events including structured monitoring through e.g. questionnaires.

For all methods it has to be said that they were solely developed for the specific event by the research team and included many time resources for content development, coding, printing and especially achieving a high-quality design which included special recognition of the event setting and creating an open and inclusive space where the participation could happen. This reveals a discrepancy between creating new and exciting

participatory methods and what public institutions could often actually achieve with their given resources. Specific skills regarding gamification, design, accessibility etc. are needed in the staff from the public side, especially in comparison to the usual town hall meeting with a slide-presentation or online-publication of information. Due to these reasons real playful urban technology has stayed in research and arts till now and remains unusual in real-world Smart Cities (Altarriba Bertran 2021; Ampatzidou et al. 2018). Moreover, a focus of the described methods was to provide accessibility in color choice, font choice, easy language and offering different languages which did not reflect in the gamification comparison. In the future gamification principles in regard to participation processes should integrate these elements.

7 CONCLUSION

This paper explored how gamification principles are and can be part of participatory processes in Smart Cities. We found that while the studied methods fulfill several gamification principles (Fig. 9) it does not automatically result in perfect participation or that more principles equal better interaction. Creating a surprising and interactive design for the specific context seems to be more important because the most pressing problem is currently the outreach to a representative section of the citizens. We concluded from our results that using gamification can help to fulfill this aim but also entails a need for more budget, time and human resources for the development. Therefore, future research should address these issues by providing guidance or a toolbox for easily implementing engaging participation in public administrations, even in smaller cities with less resources. Furthermore, different methods using gamification e.g. with design probes should be studied in greater detail and should gain importance rather than implementing online-participatory platforms everywhere without questioning their benefits within a diverse society. Indeed, a mix of different digital and analog methods seems to create a robust and useful participatory environment (Akers 2022).

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