XR-Supported Communication in Green Urban Projects. Participating in Urban Change through Virtual and Augmented Reality

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1 ABSTRACT

Public participation in urban planning and design processes is becoming increasingly important in European cities to improve transparency, enhance decision-making, and encourage community engegamenent. However, broad and inclusive participation faces a number of significant challenges. Typical participation processes rely on face-to-face interaction and are only able to reach small and non-representative groups of people. To this day, direct means of communication are important because of the high complexity of urban planning and design tasks and the multi-faceted demands on urban spaces, which can hardly be represented in online questionnairs and one-way information campaigns. Additionally, urgent measures to reduce heat in cities and to counteract other negative effects of the climate crisis need to be explained to gain the support of local communities. These challenges are often compounded by low budgets for participation processes and a lack of commitment to a thorough communication strategy.

Over the past few decades, new information and communication technologies have radically changed the way we communicate. The advent of smartphones and the institutionalization of the internet have made it possible to interact with many people simultaneously in real time and at a low cost. Today, powerful mobile devices and the emergence of virtual and augmented reality applications promise new ways to communicate spatial change and to interact with the urban environment. The exploitation of these new technologies to support climate-friendly urban design projects with broad public participation was the declared goal of the Green Living Augmented+virtual ReAlity (GLARA) research and development project. At the heart of the project was the development of the GLARA app, a mobile application that visualizes the spatial and microclimatic effects of urban design projects. Choosing between the virtual and augmented reality modes, users could explore the altered urban space from home or directly in the respective public space. In the latter case, the live image of the mobile phone camera (image of reality) was overlaid with 3D elements like trees, benches and more. This type of vizualisation provided a unique spatial experience of the proposed design project. At the same time, the results of a micro-climate simulation, which shows the effects on surface temperature, perceived temperature, and wind was visualized and made tangible via the app. Last but not least, the application allowed users to provide feedback on the design from anywhere at any time, decoupling participation from the need to be physically present at a specific place and time and allowing a wider range of people to contribute their opinions to the planning process. The GLARA app was combined with a selected set of face-to-face participation tools to form a holisitc participatory planning service for open spaces with green infrastructure.

The full GLARA service was tested in a case study in Vienna's 7th district, Neubau. The local district administration had plans to redesign a narrow residential street in the course of laying new water pipes. The GLARA team accompanied the planning process over a period of one and a half years with a balanced mix of analogue and digital participation tools including the GLARA app. The introduction of a second participation loop based on the preliminary landscape design for the street was a novelty for the administration but was well received by the participating residents. The design was visualized via the app and offered an immersive experience of future spatial change. However, a number of technical and practical challenges remain for future development of the app, including better ways for device localisation, operability on less powerful mobile devices, reducing the effort required to create the 3D visualisations, and further reducing barriers for less tech-savvy populations.

Keywords: Micro Climate Simulation, Resilient Urban Design, Virtual and Augmented Reality, Public Participation, Urban Change

2 PARTICIPATION IN URBAN DESIGN: CHALLENGES AND GOALS

The importance of dialogue and citizen participation in urban planning and design has been increasingly recognized in recent years. In Austria, for example, the cities of Vienna and Graz have developed their own guidelines for citizen participation (MA18 2012; Stadt Graz 2014). In Vienna, the expansion of citizen participation was also anchored in the Smart Climate City Strategy (City of Vienna, 2022).

In order to create a solid knowledge base about the current challenges and restrictions in relation to broad citizen participation, the research team of GLARA (Green Living Augmented+virtual ReAlity)[1] conducted stakeholder interviews and focus group discussions with more than 30 people from the fields of city administration, urban planning, process design and politics. The analysis revealed some main challenges in the conception and implementation of participatory processes today:

- Budgets for participation are often limited while high demands are placed on quality.
- Contemporary approaches only reach a small, non-representative group of people.
- Communicating complex planning requirements and processes is a challenge.
- Participation often takes place at the beginning of the planning process without a follow-up in later stages.
- There is a lack of transparency about the outcomes of participatory processes and their impact on final development proposals.
- There is no standardized way of measuring the success of participatory processes.

In the face of climate change, radical urban transformations will be required in the coming years. The conversion of our cities into resilient and climate-friendly living spaces can be made much more efficient and sustainable if it is supported by a large majority of the population. This can only succeed through the consistent involvement and education of people.

The GLARA participation service aims to provide a low-threshold opportunity to participate in the design of streets and open spaces. It includes a digital component that simulates and visualizes the positive effects of greening and unsealing measures in public space. In the course of the research project presented here, the main challenges were identified, a comprehensive participation service was developed and tested using a real-life case study in Vienna.

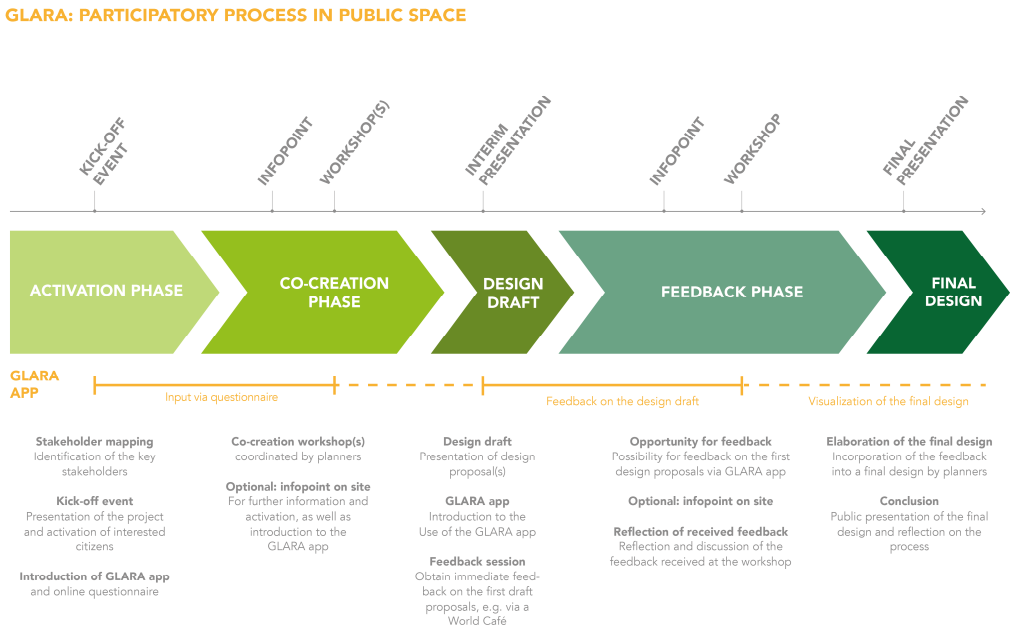

Fig. 1: Schematic process of the GLARA participation service, integrating analogue and digital methods.

[1] The project was funded by the Austrian Federal Ministry of Labour and Economy (BMAW) and carried out as part of the COIN programme line of the Austrian Research Promotion Agency (FFG). Find more information on GLARA here: https://www.glara.info/

3 THE GLARA PARTICIPATION PROCESS

In the GLARA participation service, the close interlinking of proven analogue methods and digital tools is central. A particular focus is on enabling as many people as possible to participate in the process. By removing time and space constraints, the GLARA app facilitates flexible participation as a digital tool in the process. This is supplemented by analogue and low-threshold participation on site to reach groups that would otherwise not have been involved in the process. A key feature of the GLARA process is the public interim presentation of a first design concept to allow feedback and possible changes before the design is finalized.

3.1 Analogue participation methods

The GLARA process is structured into several stages and starts with an activation phase. The goal here is to make users aware of GLARA and to win them over for workshops and for online participation. As a low-threshold method to reach people, a kickoff event (e.g. information evening) should take place. Parallel to this, there should be an online kickoff so that people who cannot join the event are informed. This will be followed by a co-creation phase with workshops (specific target groups or open) and information transfer (online/offline).

The portfolio of analogue methods that can be used is very large (for example, see participatory toolbox in Krebs & Mayr 2023). It should be adapted to the size and local characteristics of the project area. In addition, methods should be used that have proven themselves on site and that the local actors can handle well.

This is a selection of possible analogue participation methods, that have been used in the case study:

- Info points: The participation team meets the local community on the street. They gain the attention of people through placing some urban furniture, a large sign or other visible elements. In this way, qualitative feedback can be obtained right at the place in question and the actual users of the space are encouraged to participate in the design process.
- Workshops: These can be held with specific target groups like local entrepreneurs, children, and elderly people, or be open to all residents and interested stakeholders.
- Walkshops: Joint walk-throughs combined with co-creative methods.
- Information evenings: Large-scale information events that are announced well in advance. Politicians and administrators as well as planners should be present. Small workshop elements (e.g. written feedback with cards, post-it notes, group discussions...) can be integrated.
- Mailboxes: All neighbours receive a letter with a questionnair or feedback card and are encouraged to send it back (free of charge) to the participation team.

3.2 The GLARA app

The GLARA app is the digital component of the GLARA service. It is an innovative native application for iOS and Android that offers a new approach to green planning and its impact on the microclimate by integrating virtual reality (VR) and augmented reality (AR). The app allows for an intuitive understanding of complex issues and invites diverse audiences to explore and discover.

Fig. 2: The GLARA app's AR mode visualizing perceived temperature on a hot summer day in Bernardgasse, Vienna.

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A main feature of GLARA's participatory process is providing easily understandable 3D models of the area, including the results of microclimate simulations. All are used in the app to visualize the proposed design as well as its impact on the area's microclimate. The most important factors for the perception of the environment - perceived temperature, surface temperature and wind speed - become visible as 3D overlays and can be intuitively understood by the public. A tutorial guides users and provides an overview of all features. The GLARA app marks an important step in bringing digital and analogue participation together and offers new opportunities to make green planning and its impact on the microclimate tangible.

Main functions include:

- Augmented reality: AR is a computer-based extension of the perception of reality. With the GLARA app, residents are able to immerse themselves in and move around the 3D environment with a smartphone or tablet in hand. The app uses the device's gyroscope and accelerometer sensors to track the user's movements and provide an immersive experience. On the screen, the live image from the phone's camera (a representation of reality) is overlaid with 3D elements. For example, people can walk through "bubbles" that visualize the perceived temperature on a hot summer day, or get an impression of the future of the alley with planning scenarios.
- Virtual reality: allows for an experience at any time and from anywhere. Similar to a computer game, 3D models with all relevant elements (buildings, street surfaces, furniture, plants, ...) can be explored. Users can switch between the status quo and the design, and see the effects of the redesign on the microclimate in the area. Thus, even people who cannot be there physically can get an impression of the planned changes through the app.
- Switching between different scenarios allows for comparison between the current situation and the proposed plans, as well as projected future scenarios (i.e. simulated temperature for 2050 or 2080, including the effects of the fully grown vegetation).
- Exploring the different climate parameters with the click of a button. Parameters are shown as 3D representations.
- Microclimate education: information about each parameter as well as the general microclimate situation in the area.
- Participation tools (in-app survey, picture based feedback tool).

4 CASE STUDY BERNARDGASSE

The GLARA participation service was tested in an urban regeneration project in the 7th district of Vienna. Due to the renewal of the water pipes, extensive construction works have to be carried out in one of the district's residential streets, Bernardgasse. The district mayor wanted to involve citizens in the design process and agreed to test GLARA as a new innovative tool for civic engagement.

4.1 Participation process Bernardgasse

The process was initiatied by a stakeholder mapping to identify relevant target groups and local actors. All residents were informed about the project through direct mail, additionally public awareness was raised through posters, flyers, and other media.

The first participation phase (October 14th to November 7th, 2021) focused on general challenges and ideas for the redesign of the street. Applied methods included an information evening with an interactive workshop part, questionnaires, on-site info points, and the use of the GLARA app. Emotional Mapping and Goals-Grid Analysis were used for qualitative feedback during the workshop. The survey assessed the current situation in Bernardgasse and design preferences of the citizens. The on-site info points helped to promote the use of the GLARA app and to test the AR mode in the street. In this phase, the app visualized the current micro-climatic conditions in the street and offered the opportunity for feedback through the integrated questionnaire. Moreover, the snapshot tool allowed participants to take pictures in the street, rate the situation and give comments for improvement. The results of the first participation phase were published in a comprehensive report and communicated to the landscape planners that won the design tender (GLARA, 2021).

Based on the citizen's feedback, technical framework conditions, and spatial planning strategies, a modular design concept was developed and discussed in the second participation phase (June 22nd to July 10th, 2022). Similar to the first stage, residents and entrepreneurs were invited to join an information event and workshop to provide feedback. On a large plan, stickers were used to indicate preferences for various functions and design modules. The GLARA app was used during a guided walk and at the on-site info points. The AR and VR modes visualized the design proposal and the simulated micro-climatic conditions, showing improvements where green elements, trees and impervious surfaces were proposed (see Fig. 3). Through the app, people could view the design remotely and provide their feedback via the online questionnaire. The results of the second participation phase were summarized and published in a report (GLARA, 2022). They substantially influenced the final design outcome that was presented in a concluding event in June 2023.

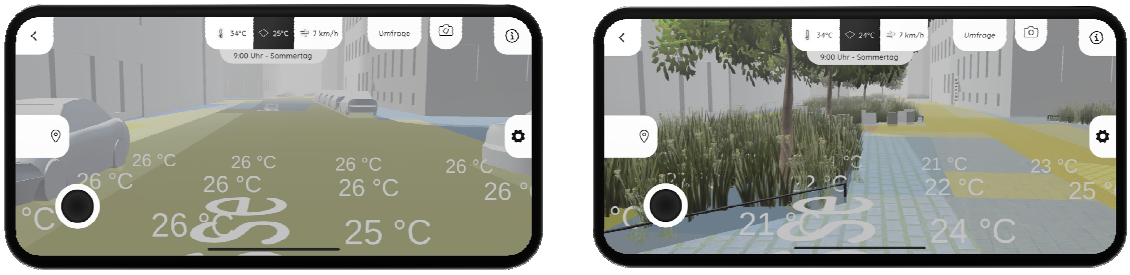

Fig. 3: The GLARA app's VR mode showing the status quo and design proposal with surface temperature for Bernardgasse, Vienna.

4.2 Feedback on the GLARA service

The case study in Bernardgasse was used to test the GLARA participation service and app in a real planning process and to collect feedback for further improvement of the service and methods. Overall, the participation was quite satisfactory. Out of the approximately 650 immediate residents in the street, 130 people attended the evening events and 160 participated at the on-site info points. In total, there were 280 responses to the questionnaire. The response rate was at 26 % in the first participation phase which is very high in comparison to other participation processes.The GLARA app recorded about 300 downloads throughout the whole process.

Participants were predominantly middle-aged residents with above-average education, as is often the case in participation processes. However, this may also be related to the general population composition in the 7th district that has a majority middle-class progressive population with a high level of education. The mix of digital and analogue methods however, has proven successful in addressing people with limited time budgets like parents or working people. The on-site participation was an integral element that established contact with people who could not attend the large events and was very well received.

In the course of the second participation phase, participants were also asked about their assessment of the process and the GLARA app. With 82 %, the participation process was rated positively by the majority of those surveyed. In personal communication, participants emphasized that the process has led to improved communication and new contacts and initiatives within the neighbourhood. This was also confirmed by the GLARA survey, in which 81 % stated that they knew more about the needs and problems of the residents and visitors of Bernardgasse after the participation process. At 56 %, a majority of app users in the survey also stated that they knew more about the effect of greening in the city after using the app. The most important result, however, is the satisfaction of the participants and residents with the final design. According to the GLARA questionnaire, 85 % like the presented vision of a green, traffic-calmed Bernardgasse.

5 REFLECTIONS AND LEARNINGS: TOWARDS MORE INCLUSIVE PARTICIPATION?

Civic engagement involves actors with different interests, with or without previous knowledge of urban planning processes. Therefore, the complex contents of planning must be well prepared and communicated simply and clearly. Visualization is considered key for successful communication and participation, as it provides participants with a shared basis for decision making. Virtual and augmented reality tools offer new

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possibilities for visualizing a wide variety of data. They enable planners, policymakers and other stakeholders to experience and better understand the intended changes in the built environment and to identify potential conflicts before a development is implemented in practice (Tomkins and Lange 2020). In this context, GLARA presents the design proposals in a transparent and neutral way. The design is not exaggerated and "pretty" as is often the case with architectural renderings. The GLARA representation remains minimalist and concentrates on the essential and relevant factors of equipment, spatial distribution, microclimate, green and blue infrastructure. The GLARA app can thus empower citizens to give informed feedback on their preferences and help to make strategic urban planning decisions that are comprehensible for everyone.

Beyond the visualization of the design proposal, GLARA integrates and presents microlimatic simulations as well as a KPI-based evaluation and climate resilience analysis. GLARA is therefore particularly suitable for planning with a special focus on climate change adaptation and the construction of green infrastructure. In the case study, the GLARA app strongly supported the transfer of knowledge of climate data to the residents. It demonstrates how VR/AR tools can contribute to increasing the transparency and acceptance of climate mitigation and adaptation options among private actors and to improve the decision-making basis for politicians and planners (Othengrafen et al., 2023).

In the GLARA service, digital and analogue formats complemented each other in a meaningful manner. While digital tools can address new target groups that have been neglected so far through playful approaches and innovative forms of knowledge transfer, a holistic participatory process should also offer space and time for discussions in analogue formats. The tightly meshed, accompanying analogue formats also make key technologies such as AR and VR usable for people with a low affinity for technology. The low-threshold formats such as info points or online questionnairs ensure that all stakeholders can easily contribute their opinions.

In general, AR/VR tools have the potential to increase people’s motivation to participate in planning processes by introducing innovative ways of visualization and playful means of interaction. At the same time, the acceptance of AR as a visualization and participation tool has, thus far, been rather low compared to analogue participation formats (Othengrafen et al., 2023, p. 62). The use of digital tools is still a barrier for those who are less comfortable with the use of smartphones or tablets. Moreover, the usability of high quality XR visualisations on all digital devices is still a technical challenge and representations have to be simplified to allow availability for all. These barriers, however, will diminish in the future with technical progress and higher rates of digital natives.

While the research team was confronted with technical challenges and limitations, there were also numerous ideas and approaches for even more interactive, inclusive and exciting ways to use VR/AR in planning and participation. An important question that arose in this context was how XR technologies could be used accross all planning phases, show planning options and enable a more dynamic exchange with local stakeholders. These issues will have to be addressed in the future where VR and AR applications will be applied in planning and participation processes more often and more effectively.

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