Augmented Reality-based Data Storytelling for Citizen Participation in Urban Planning

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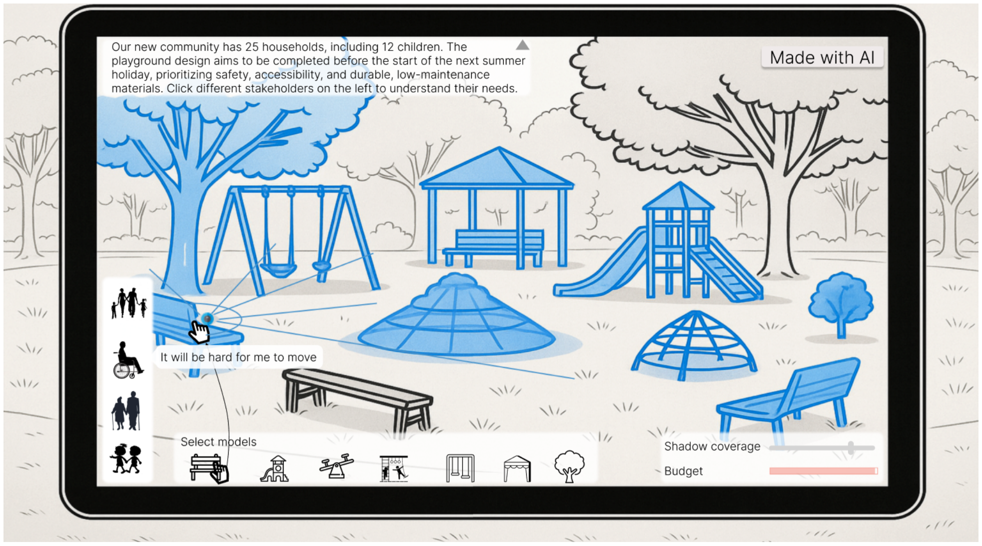

Figure 1: An example of an augmented reality view of a playground design. The 3D models are overlaid on the reality and can be interacted with to simulate different layouts and visualize their impact on the various stakeholders. The image uses AI generation.

Abstract

Citizen participation plays a key role in urban planning by ensuring that the development of cities and communities reflects the actual needs, values, and priorities of the people who live there. It is, however, hindered by rational ignorance: people give up participating because the cost of learning related knowledge is higher than the benefits they can gain. We explore applying augmented reality-based data storytelling to enhance the understanding of urban planning projects, with a focus on small-scale public spaces. This poster introduces this new research topic, proposes an initial set of design requirements, and outlines future research plans.

Index Terms: Data storytelling, augmented reality, urban planning, citizen participation.

1 Introduction

Urban planning ranges from large city-wide projects to small neighborhood-level efforts. Due to its broad economic, social, and environmental impacts, citizens need to be informed about and involved in the design. Past research has highlighted that urban planning is a complex decision-making process that includes addressing practical constraints, adjusting design parameters, and reconciling stakeholder priorities [6]. Consequently, rational ignorance is a common phenomenon in urban planning, where the general public gives up on participating because the perceived cost of learning related knowledge is higher than the benefits of participating [5]. This research explores the potential of combining two techniques to address this challenge: (i) augmented reality for its capability to project tangible visualizations of urban designs in the real world, and (ii) data storytelling to explain abstract knowledge with visualizations and narratives.

Augmented reality (AR) has been considered a promising approach that provides the most direct visuals for in situ understanding of how an urban design interacts with the surrounding environment [16, 12]. Compared with conventional 3D renderings and 2D plans, AR encourages moving freely and observing surroundings. It also has greater scalability to support more complex projects' understanding [10]. However, the primary use of AR in urban planning remains focused on presenting 3D models, such as visualizing alternative building designs or placing predefined objects [12]. Only a few research considered more advanced interactions. For example, Urban Co-builder is a game-based AR tool [4] in which participants play stakeholder roles and collectively design a project. Wang and Lin [15] proposed an "*input-evaluation-feedback*" workflow that allows users to modify abstract indicators (e.g., building coverage, greening rate) and view real-time results.

In terms of data communication, urban design is unique in that it requires explaining how people can interact with the space, as well as considering the underlying economic, environmental, and social factors. Data storytelling brings new opportunities to communicate information in an engaging and comprehensible manner by combining data visualization and narrative techniques [8, 7]. Taking neighborhood playground design as an example, through AR, visualizations of planned facilities are overlaid onto the real site (see Figure 1). Narratives first explain the context, like how different user groups might interact with the space. Users can then explore the design from different stakeholder perspectives. For example, selecting the parent view reveals sightlines extending from each bench, showing how much of the play area is visible. Under trees and shade structures, shaded zones are marked. Users can add, remove, and reposition models, and the affected metrics will be updated, such as costs. When a design affects other users, for instance, the density of facilities is too high to ensure wheelchair access, an

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avatar representing that stakeholder would express their concerns.

Despite promising, AR-based data storytelling is still in an early stage [13]. Past research mainly explored where the physical space is not semantically related to the represented data [13], and augmented visualization in short-form videos [14]. **This research starts addressing the research gap by focusing on small-scale public space design.** This poster focuses on design requirements and leaves the implementation and evaluation for the future.

2 Design Requirements

The design requirements are drawn from the literature in citizen participation, urban planning, and data storytelling.

Link design choices to effects on lives. Public space designs often involve professional indicators that are hard for non-experts to understand [15]. Therefore, narratives should be explicit about how different design choices affect their lives.

Facilitate mutual understanding among stakeholders. Public space design affects diverse users, such as parents, children, drivers, and pedestrians, and often requires negotiation and compromise among stakeholders [1]. Narratives should help foster empathy and mutual understanding by clarifying who the relevant stakeholders are and highlighting how different design choices impact their needs and experiences.

Visualize people and activities concretely. Extending the previous considerations, visualizations of the benefits and costs of design alternatives should represent how people would be affected by planning decisions in a concrete and relatable way. Similar to the idea of Anthropographics [9], which uses depictions of persons to help audiences connect with people behind data, AR-based data storytelling for explaining public space designs should show concrete visions of people's activities within the space.

Integrate abstract and concrete visualizations. In addition to concrete visuals of 3D buildings and human activities, the data story should also consider abstract metrics, such as budgets, noise levels, and air pollution. Effective visualizations should integrate both types of representations and show the connections between abstract data metrics and concrete public space designs.

Support interactive exploration of design alternatives. Allowing users to manipulate 3D models and key design parameters (e.g., greening rate) enables comparison of alternatives and helps them express their priorities [16, 15]. To support this, both the visualizations and associated narratives should update dynamically to reflect the consequences of each change.

Apply the martini glass narrative structure. Narrative structures affect comprehension, information retention, and engagement [3, 17]. Synthesizing previous considerations, the data storytelling should explain the urban design context (e.g., concerned parties, design choices, and constraints) and allow for interactive exploration of alternatives. The martini glass structure [11], which begins with a focused, linear narrative and transitions into open-ended exploration, provides a suitable framework.

3 Future Research Plan

The next research plan mainly consists of two stages. First, the design decisions should be concretized and implemented based on those design considerations in real-life applications. Second, evaluations will be conducted to assess if the AR-based data storytelling approaches enhance understanding and encourage participation. Finally, we plan to investigate the two major open visualization questions in the research context. First, the poster does not discuss earlier stages in the planning involving identifying community needs [2]. One question is how to support the general public in generating personalized visions for a space design in AR visualizations, even just low-fidelity ones. Another question concerns collaboration. Beyond individual understanding, how might interactive visualizations support experts and citizens jointly explore trade-offs while accommodating different levels of expertise and priorities? Finally, the project does not directly address the common perception of a power imbalance between citizens and planning authorities. It remains an open question whether data visualizations, which have the potential to demonstrate how public input is considered, can facilitate trust-building between officials and the public.

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