Framing Civic Engagement through E-Participation - Towards Immersive Public Decision Making

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Abstract

Citizens increasingly seek greater involvement in public decision-making processes. Emerging technologies, such as augmented (AR) and virtual reality (VR), have the potential to enhance interactions between citizens and administrative bodies. However, public administrations have yet to fully integrate these tools into participatory processes, primarily due to psychological and social barriers. The participation paradox highlights the difficulty of engaging citizens in increasingly complex local processes. While technological advancements offer new opportunities, administrations often struggle to present their concepts in ways that are accessible and comprehensible to citizens. AR and VR offer potential to vividly communicate complex processes and foster engagement in participatory processes through its immersive capabilities. First projects, which use AR and VR to visualize public initiatives fail to embed these technologies into their operational workflows. This working paper proposes a conceptual framework designed to systematize citizen-participation and harness immersive technologies to foster greater transparency, interactivity, and engagement in public administration. The framework aims to streamline participatory processes, reinforcing collaboration between citizens, administrations, and scientific institutions. By bridging this gap, the framework seeks to address current shortcomings and advance the integration of innovative AR/VR technologies into public participation.

Keywords

E-Participation, Digital Engagement, Immersive Technology, Design Thinking, Design Science

1. Introduction

Citizens increasingly seek involvement in public decision-making processes [1], yet governments often struggle to meet these demands effectively. Emerging technologies, particularly immersive technologies such as augmented reality (AR) and virtual reality (VR), offer promising opportunities to enhance the communication and interaction between citizens and public administrations [1][2]. These technologies allow for intuitive and engaging visualizations of e.g. planning concepts, which can support better understanding and more informed participation [3]. A persistent issue in participatory governance is the so-called participation paradox: although citizens are invited to contribute to planning processes, increasing procedural and informational complexity makes meaningful engagement difficult [4]. Public administrations often lack the tools to communicate complex decision-making-processes in a way that is understandable and relevant to citizens [4][5]. Consequently, participation systems frequently fall short in maintaining consistent and meaningful interaction between citizens and authorities.

While immersive technologies have been tested in visualizing public initiatives, few efforts have integrated them into broader participatory frameworks that support administrative decision-making. Most existing literature focuses either on technological capabilities or isolated user experiences, rather than developing comprehensive, operational frameworks for public sector application. To bridge this

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gap, there is a need for a holistic framework that not only leverages the full potential of AR/VR but also aligns with administrative workflows and participatory principles.
Accordingly, this paper addresses the following research question:

RQ1: How can a framework for immersive technologies be conceptualized to enhance citizen participation in administrative planning processes and contribute to more informed decision-making?

In response to this question, this study introduces a conceptual framework for the use of immersive technologies, specifically AR and VR, to enhance citizen participation and support more informed administrative decision-making. Building on insights from existing participation platforms and literature, the proposed framework addresses the lack of structured, transferable approaches that integrate immersive media into participatory processes. The key contribution lies in the development of a design concept that systematizes participation through immersive technologies while remaining adaptable to diverse administrative contexts. The framework is grounded in design science principles and includes actionable steps intended to guide both researchers and practitioners in the implementation of immersive participation platforms.

2. Theoretical Background and Related Work

Virtual reality is defined as a set of technologies that enable individuals to interact optimally in real time using natural senses and skills with 3D-displayed databases [6]. VR technologies that are currently widely available in the consumer market include head-mounted displays (HMDs), creating a virtual environment (VE) for the user's senses, allowing them to feel immersed and interact with virtual objects and representations [7]. HMDs are the most commonly used VR technology, including popular models such as the Apple Vision Pro.

AR encompasses a wide range of devices and technologies. In commercial use, AR applications for mobile phones are prevalent. Since its breakthrough in 2019 through the mobile app Pokémon Go, a variety of location-based AR applications have emerged [8]. Due to improved applicability and reduced development efforts with new frameworks from market-leading companies, AR systems on mobile devices and tablets have become an established and widely accessible technology [9]. AR glasses, such as the Microsoft HoloLens, represent another significant technological advancement, enhancing the user's field of vision spatially, making them particularly impactful for participatory projects [10].

A central problem in the interaction between citizens and administrations is the participation paradox. It describes the dilemma between what is contributed and what is received in participation projects [11]. Public administrations may primarily aim to address the needs of citizens. However, involving citizens becomes increasingly challenging due to the rising complexity and effort required at later stages in the participation chain [12]. This creates a discrepancy between the input from administrations, which aim to serve citizens (top-down), and the citizens' capacity to contribute effectively. Current developments in digital participation indicate a shift, evolving from democratically legitimized administrative entities into hubs of democratic and participatory engagement [13]. Two key worst-case scenarios must be considered. The first is the hold-up situation, where progress stalls because two parties cannot reach an agreement over time due to misaligned and escalating requirements. The second is the free-rider problem, where one party, typically the administration, acts independently without adequately involving other stakeholders in critical decisions [14].

Immersive technologies blur the line between the physical and virtual world, which can induce a sense of immersion in users [15]. Immersion can foster engagement with a certain topic and present information in a vivid way [4][16]. Consequently, these technologies offer the potential to highlight complex topics in an engaging manner and involve citizens even at later stages of participation. Public administrations have the potential to reach a large group of interested citizens. However, how the immersive capabilities can be streamlined into an operational process remains an open question [4].

3. Methodology and Data Collection

This study adopts a design science research (DSR) methodology to develop a conceptual framework for applying immersive technologies to foster participatory engagement in public decision-making. The DSR approach follows an iterative process of problem identification, exploration of existing solutions, artifact conceptualization, and preparation for evaluation in future implementation contexts. To establish a foundation for the framework, we conducted an exploratory study of existing AR/VR participation projects within the public sector. The European context was chosen as the primary focus for this exploration due to its strong tradition of promoting civil society participation [17][18] and its continued support for digital innovation through institutional policies and funding programs [19][20][21]. This policy landscape provides a fertile testing ground for emerging technologies, including immersive media, to be embedded in participatory governance structures.

Our initial identification process was conducted through structured desk research. This process yielded a dataset of 133 AR/VR projects implemented across various areas of public administration. To refine this dataset, we applied targeted inclusion criteria: projects were retained if they (1) explicitly aimed to foster citizen participation, and (2) used AR/VR technologies as core tools to support these participatory functions, rather than as peripheral or purely illustrative media. Applying these criteria reduced the dataset to 17 projects, representing approximately 13% of the total identified. Information on both our initial dataset as well as on our currated dataset can be accessed in the following repository: https://tinyurl.com/mw97xmdc
This curated subset serves as the empirical foundation for our framework development, as these cases offer focused insights into the design intentions, implementation strategies, and challenges associated with immersive participation technologies. Importantly, these projects were selected not for their thematic domain but for their participatory orientation, enabling us to analyze broader patterns across contexts. Thematically, the majority of the projects focused on urban planning, where AR/VR is widely applied due to its suitability for visualizing spatial data and its potential to reduce risk in high-stakes environments such as infrastructure development [3]. Four projects, for instance, focused on involving citizens in the planning of public buildings, such as the 5G-CityVisar project, which enables interactive visualization of 3D building models. Other initiatives addressed traffic and smart city planning, utilizing immersive simulations to help citizens understand and provide input on traffic flows and pedestrian movement. Beyond urban planning, several projects explored the creation of immersive participation hubs, such as the GI VR/AR Werkstatt, which supports collaborative ideation and knowledge exchange. Additional applications included participatory services for geodata access, energy system visualization, port development planning, and civic service enhancement—for example, through AR tools that display no-parking zones to improve public compliance.

These diverse examples collectively informed the development of a conceptual framework that seeks to systematize the use of immersive technologies in participatory governance, while remaining adaptable to different administrative domains and use cases.

4. Findings

Although a considerable number of AR/VR participation projects have been identified, only a few have implemented a streamlined and effective participation process using immersive technology, providing clear operational approaches or recommendations. Among the best-researched projects is 'Take-Part', supported by the German Ministry of Education and Research (BMBF). This project provides valuable insights into participatory methods. In Take-Part, two public facilities, the Karlsruhe Zoo and the public hospital in Karlsruhe, were planned and presented to citizens using an experimental participation platform. This platform enables citizens to virtually visit the planned areas and interact with a coordinator regarding the 3D concepts. Fegert et al. [4] integrated an AR/VR-based design science approach within the project, following the Design Science Research in Information Systems (DSRIS) framework by Kuechler and Vaishnavi [22].

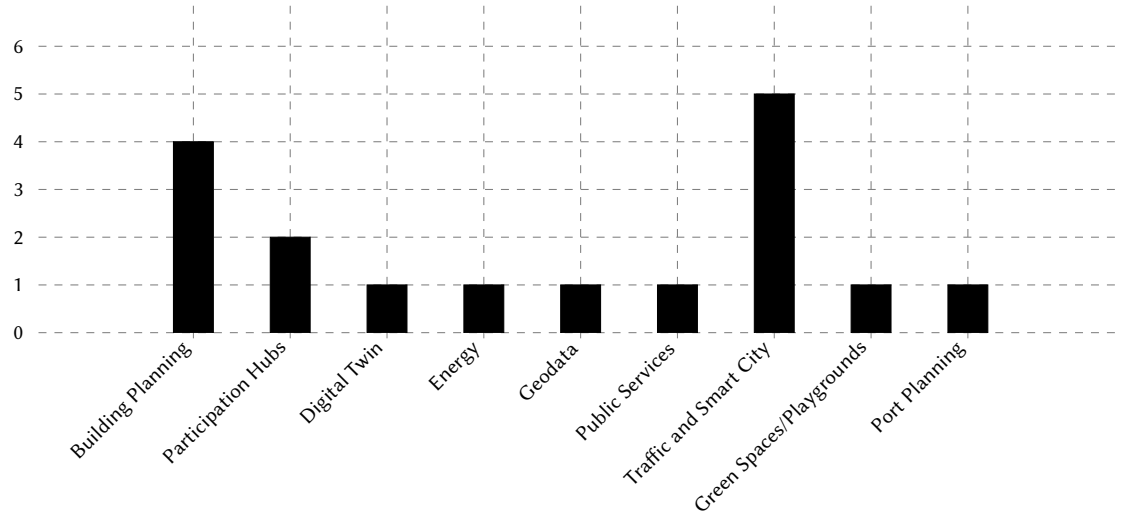

Figure 1: Thematic Distribution of AR/VR Participation Projects in our Dataset.

Current public participation projects primarily use VR in experimental settings to explore the potential of the technology. One major issue with many AR/VR initiatives is the high entry barrier faced by technologically inexperienced municipalities and communities [4]. These technologies are in a transitional phase for public use, and, much like early mobile phones, developing customized applications remains a complex process. Public institutions must recognize the potential of these technologies and develop new methods for rapidly presenting services and 3D drafts to the public. A key challenge is the need for public administrations to hire IT experts who can effectively integrate AR/VR software into existing IT infrastructures. A promising solution may lie in user-friendly low-code platforms, which could enable public employees without programming knowledge to present concepts to citizens [23]. An Low-Code environment is a tool that helps build, launch, and manage apps quickly using easy-to-use, high-level programming. It supports user interfaces, workflows, and data handling [24][25]. The Take-Part project also utilizes a low-code environment as the foundation for its design science approach. This setup offers customization potential, allowing projects to be easily uploaded and contextually placed within urban areas, where citizens can provide feedback based on their daily experiences [4]. Despite the promising initial approaches in AR/VR participation initiatives, significant challenges remain. Public AR and VR platforms often suffer from design flaws, many of which arise from inexperience and the direct adaptation of concepts from related fields, such as mobile apps or participation websites. These platforms also lack agility and effective feedback mechanisms, hindering the exchange of perspectives between citizens and project coordinators. Recent projects continue to struggle with balancing creative engagement (e.g. the Take-Part project) with the complexity of detailed planning processes. For example, the Vision 5G project illustrates how citizens are typically not involved until the final stages, which can lead to frustration. Consequently, current projects fall short in addressing the participation paradox [26]. To advance public participation using AR/VR technologies, a flexible framework that builds on existing platforms and structures the engagement process is urgently needed [4].

5. Framework Design and Discussion

The conceptual framework presented here is grounded in the analysis of 17 AR/VR-based public sector projects. Our findings indicate that most projects focus on isolated participation stages, often limited to visualization or ideation, without connecting them into a coherent participation flow. These patterns revealed a gap in current practice and shaped the need for an integrated, full-cycle participation framework.

To address this gap, we turn to Design Science as a methodological foundation for developing such

a framework. In the context of public participation, Design Science can bridge different perspectives and enable knowledge transfer between scientific scholars and political agents while developing a functional system for day-to-day operations. Within the context of participatory governance, three main stakeholder groups must be considered: citizens, administrations, and scientific researchers. Balancing the expectations and requirements of these groups is a complex task. For instance, the Stuttgart 21 protests revealed the critical need for transparent citizen communication in public infrastructure projects [5]. Research, in turn, gains insights into civic engagement patterns that may inform future participatory approaches.

The DSRIS framework by Kuechler and Vaishnavi [22] offers a methodological framework comprising of five iterative stages: problem awareness, suggestion, development, evaluation, and conclusion. Design Science emphasizes generating scientifically grounded artifacts through repeatable, evaluative processes. However, public sector applications present specific challenges. These include the high coordination effort required by central institutions and the difficulty of sustaining multi-cycle processes among citizens and administrators who often expect fast, tangible outcomes [27]. Additionally, participation systems must mitigate governance dilemmas such as free-riding or hold-up scenarios [14], making adaptability and resilience key design considerations.

To address the limitations of Design Science in dynamic participatory contexts, we integrate Design Thinking as a complementary methodology. Design Thinking introduces a human-centered, agile process that aligns well with early-stage ideation, rapid prototyping, and iterative user feedback. Its five-phase structure, empathize, define, ideate, prototype, and test, mirrors the fluidity of civic participation processes and facilitates continual engagement with end users [28]. Design Thinking and Design Science were selected for their complementary characteristics: the former prioritizes practical usability and responsiveness, while the latter ensures conceptual depth and methodological rigor. Although integrating both approaches is complex, particularly in the public sector where agility is constrained by regulation, we propose an architecture where Design Thinking guides interaction and iteration, and Design Science supports evaluation and structured learning.

With these core elements defined, we now present a more detailed description of the central components. A key aspect of Design Thinking is storytelling, which facilitates idea development through stakeholder interaction. Storytelling inspires participants and provides concrete details that help visualize the context [29]. Presenting continuous feedback is challenging and can fail due to increasing complexity [14]. To mitigate this, structured feedback rounds help refine ideas. Each step in the process generates artifacts that document agreements between stakeholders and organizations. Agile processes are slowly being integrated into public administration, but agility also requires flexibility, which often conflicts with rigid administrative procedures [30]. Public institutions differ from private-sector organizations due to legal restrictions and data privacy concerns [31].

Therefore, we propose a framework that simplifies administrative processes and serves as an interaction layer over existing planning procedures. The proposed platform establishes an agile innovation process based on the Design Thinking paradigm. The central technological concept is an immersive ITech-room, where ideas are generated and presented. The concept of the ITech-room is connected to the participation platform and can function as a physical participation station in public development areas. These stations may be placed in urban centers, transportation hubs, or locations requiring citizen involvement in planning public facilities.

The framework comprises of six central views. In the empathize view, the system provides tools to clarify the scope and context of the problem. The goal is to understand the current situation of a participation project and to establish a shared baseline. An AR/VR system can bring this context to life and create a common understanding of the existing field conditions. The immersive environment includes functionalities for visualizing real-world conditions and for integrating 3D scans.

In the define view, citizens and administrators move from shared understanding to clear problem definition in a given participation context. Virtual tools allow both parties to highlight critical pain points directly in the 3D artifact. Additionally, all annotations made in the virtual environment are compiled into a central document, helping to narrow down and prioritize key issues. Each party provides a response document summarizing the main concerns within the design space.

In the ideation view, participants may generate ideas with divergent and convergent idea generation functionalities. Ideas can be placed on top of the 3D-artefact of the design view to enhance the problem space with possible solutions. This view contains two phases. In the first phase, citizens and administrations receive the chance to generate divergent ideas. In the second phase, the ideas are narrowed down to a limited number of alternatives [32].

After the ideation phase, ideas are selected through a structured voting process. The administration predefines the number of voting iterations. Citizens and administrations vote for five ideas from a pool of generated ideas. After voting, a discussion phase is initiated to exchange arguments. A second voting round follows, narrowing the options to one to three ideas.

These ideas may be further developed in the prototyping phase. When the administration is confident with a prototype, it starts an evaluation phase for this prototype, to verify the impact with the citizens [33]. The most promising virtual prototypes are continuously refined in the evaluation phase. This phase integrates the ideation and presentation functions from previous stages, adapting them to a feedback-oriented context. Both stakeholders, citizens and administrators, have the opportunity to assess a concept before it enters production. The evaluation process continues until the project's completion, with virtual representations being regularly updated.

During prototyping, ideas can be developed using a toolbox containing 3D models. This allows citizens and administrators to collaboratively create virtual environments with basic interactive elements, such as weather effects, traffic sounds, and simple logic functions. The implementation can build upon existing SDKs and software frameworks to ensure compatibility and ease of use.

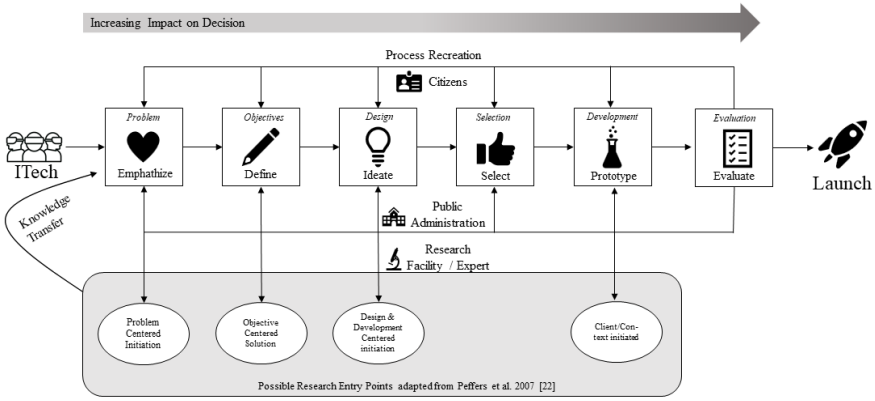

Figure 2: Conceptual Framework rooted in Design Thinking Process.

For scientific institutions, four key entry points are considered to refine the participation process. The extent to which insights can be integrated into the process may be discussed between partners. Scientific contributions can follow Peffers et al. (2007) by adopting a problem-centered approach to better understand specific participation challenges [34]. Subsequently, objective-centered solutions can be explored to address these challenges effectively. In terms of prototype development, the design and development phase can be supported by scientifically backed methods. Finally, client- and context-driven prototype development can be enhanced through continuous observation and iterative refinement based on citizen feedback.

6. Conclusion

This paper presents an effort aimed at conceptualizing a framework for the use of immersive technologies to enhance citizen participation and support informed administrative decision-making. Grounded in a design science approach, the framework builds on insights from existing AR/VR-based participation projects and proposes a structured, yet adaptable, design concept. The resulting model outlines granular,

actionable steps for integrating immersive technologies into participatory processes, with the goal of making these processes more transparent, engaging, and responsive.

At this stage, the framework remains conceptual and exploratory. While it is informed by a systematic review of existing projects, it has not yet undergone empirical validation. To advance this research, a critical next step involves the pilot deployment of the proposed framework in a real-world, controlled setting. Such a pilot would allow for the evaluation of the framework's usability, effectiveness, and adaptability in practical administrative contexts. Close collaboration with public institutions will be essential to establish appropriate testing environments.

Given the central role of immersive interaction in shaping participatory experiences, co-development with citizens is vital to ensure that the framework aligns with the expectations and needs of its intended users. This includes iterative prototyping and continuous citizen feedback throughout the development and testing phases. Importantly, the framework is not intended to replace existing planning procedures but to complement them. Future development will require the creation of robust interfaces to integrate administrative systems and data sources seamlessly into the participatory process.

In addition to legal and organizational considerations, the technical setup must be outlined in detail before implementation. This includes developing a data framework encompassing the structures, formats, and quality standards required for platform integration. Furthermore, we will explore partnerships with GovTech startups and venture clients. These startups bring an inherently agile mindset, and lessons learned from this initiative could inform other agile projects in the public sector. Finally, a modular approach to platform design may encourage divergent thinking in participation strategies, helping to address challenges without relying on the same paradigms that created them. This separation could promote innovative solutions and broader applicability across diverse public-sector initiatives.

Declaration on Generative AI

During the preparation of this work, the authors used Grammarly, DeepL, and ChatGPT in order to: Grammar and spelling check, Paraphrase and reword. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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