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A PATH TOWARDS CITIZEN-LED PARTICIPATION FOR LOW-CARBON AND AFFORDABLE NEIGHBOURHOOD REGENERATION USING PARTICIPATORY DESIGN DIGITAL TOOLS

Derya Yilmaz[1], Silvia Urra-Uriarte[2], Annie Guerriero[1], Nico Mack[1], Elena Usibiaga-Ferrer[2], Asel Villanueva-Merino[2], and Sylvain Kubicki[1]
[1]Luxembourg Institute of Science and Technology, Esch-sur-Alzette, Luxembourg
[2]TECNALIA, Basque Research and Technology Alliance (BRTA), Derio, Spain

Abstract

The growing literature on citizen empowerment in public decision-making highlights its importance for fairness, acceptance, and urban sustainability. However, achieving extensive citizen participation and effective implementation by local planners remains challenging. To address this, various digital tools have been developed to facilitate collaborative social outcomes. This research reviews existing literature on public participation and participation models. It also evaluates the strengths and weaknesses of participatory design tools. Finally, it presents the functionalities of the participatory urban design tool MUST (Manage Urban Spaces Together), exploring how these functionalities can be extended to support neighborhood regeneration and management in diverse urban contexts.

Introduction

The body of literature evaluating the role of citizens and importance of empowering them to participate in public decisions is growing (Alamoudi et al., 2022). To address challenges related to citizen participation and enhance its implementation by local planners, diverse digital tools and systems for citizen involvement have emerged (Glaas et al., 2020).

Adopting innovative tools and processes can guide urban planners toward achieving fresh, collaborative social outcomes that benefit entire community ecosystems (Horgan & Dimitrijevic, 2019). Citizen involvement not only enhances fairness, relevance, and acceptance, but also contributes to the overall sustainability of urban development (Nunes et al., 2021). According to Dambruch and Krämer (2014), top-down policymaking, which excludes public participation, is increasingly seen as inadequate for managing the complexities of sustainable urban development, especially in smart green cities. Given the complex and interdependent nature of many contemporary issues, there is an urgent need for policymakers, academics, practitioners, and both private and public institutions to engage in collaborative ways of re-envisioning citizen participation in a more bottom-up manner to create sustainable and livable cities (Basak, 2024).

Information and communication technologies (ICTs) offer unprecedented opportunities for enhancing public participation (Preston et al., 2020). ICT methods can be utilized to gather and analyze data to develop urban intelligence capabilities. However, cities are not genuinely leveraging the full potential of ICT to leverage citizen participation (Alamoudi et al., 2022). Furthermore, in municipal planning, citizen participation is a requirement, yet it frequently faces criticism due to its insufficient implementation (Glaas et al., 2020).

According to Horgan & Dimitrijevic (2019), real-life engagement indicates that relationships are developed among stakeholders and organizations via the act of building a consensus in a participatory dialogue. This also reveals that planners and citizens have different perspectives on the role of citizen contributions in planning. Planners interpret comments as primarily providing a more valid representation of the planning context and, to some extent, the needs of citizens. In contrast, citizens would like to play a more active role in regenerating the city (Glaas et al., 2020). Urban regeneration consists of a series of actions aimed at improving the quality of life in cities, which is influenced by a combination of economic, infrastructural, social, hygienic, environmental, safety, political, and cultural factors (Moufid et al., 2024).

Taking these factors into consideration requires both specific expertise and dedicated tools. However, traditional participation methods are often non-digital (Wilson et al., 2019) and result in monotonous, passive participation (Choo et al., 2023). Additionally, computerized tools generally lack interactive engagement (Kodmany, 2001). Therefore, innovative approaches are necessary for citizen engagement. Previous research has shown that Tangible User Interfaces (TUIs) offer advantages over Graphical User Interfaces (GUIs) by stimulating interest, improving cooperation, and enhancing learning (Krestanova et al., 2021). Therefore, this paper examines the potential of a participatory design tool previously developed by the authors using TUI to enhance engagement in collective decision making. It aims to address how participative design functionalities can be adapted to the specific needs of urban regeneration

projects involving citizens and introduces a systematic process to do so.

The paper is structured as follows: Section 2 provides a comprehensive review of the literature on public participation, including its benefits and challenges, various models of public participation, and an analysis of the strengths and weaknesses of public participation tools. Section 3 outlines the research methodology employed in this study. The findings are detailed in Section 4. Finally, the key conclusions and recommendations for future research are presented in the concluding section.

Background

Public participation: Benefits and challenges

Participation is a flexible concept: it can involve a varying number of citizens, with different levels of empowerment, and can take place either on-site or online, for varying durations, and on issues of differing significance (Bobbio, 2019). Participatory culture enhances commitment and user satisfaction in design solutions (Daher et al., 2022). It supports the fulfillment of the UN's Sustainable Development Goals, i.e., reducing inequality and making cities inclusive, safe, resilient, and sustainable (Geekiyanage et al., 2021). Countries that prioritize citizen participation excel in urban project development. Furthermore, citizen participation can enable the implementation of smart cities (Alamoudi et al., 2022). Additionally, successfully involving marginalized groups strengthens local democracy, improves planning, and increases the likelihood of the plan being implemented by aligning it with citizens' perspectives (Glaas et al., 2020). Citizen participation is crucial for inclusive planning and policymaking, as it allows diverse groups to share information, set goals, and allocate resources, thereby creating and spreading new knowledge (Choo et al., 2023). Moreover, participation is often praised for enhancing citizen education, awareness, engagement, government responsiveness, and commitment to implementation (Evans-Cowley & Hollander, 2010).

Although participatory designs aim to include everyone impacted by the policy in question, only a very small fraction of these individuals can participate (Bobbio, 2019; Choo et al., 2023). Traditional methods of citizen participation are often criticized for being exclusionary, insufficient, poorly timed, and merely instrumental (Glaas et al., 2020). Moreover, public participation can be time-consuming and costly, with no guarantee of success. Issues include professional dominance, uncertainty about outcomes, lack of transparency, and empowerment of only certain participants (Daher et al., 2022). Additionally, local governments often find some citizen demands to be personal or irrelevant to smart city planning, making them difficult to implement (Choo et al., 2023).

Public participation models

Several citizen participation models have been developed over the years, with Arnstein's study continuing to attract significant academic interest (Choo et al., 2023) and gaining popularity in policymaking and planning (Preston et al., 2020). In 1969, Arnstein introduced a ladder of citizen participation, illustrating the power dynamics between governments and citizens. This ladder has eight rungs, categorized into three levels: while the first two rungs represent non-participation, the next three rungs represent tokenism, and the final three rungs represent citizen power (Geekiyanage et al., 2021).

The International Association for Public Participation 2 designed the Public Participation Spectrum, which consists of five levels of participation: (1) inform, (2) consult, (3) involve, (4) collaborate, and (5) empower. Promises are made to the public at each level depending on the goals, resources, time frames, and levels of concern (IAP2, 2024). The spectrum is similar to Arnstein's model but uses more neutral labels (Bobbio, 2019).

Choo et al. (2023) organized IAP2 stages into three smart city planning stages. They combined the 'consult' and 'involve' stages due to their similarities and excluded the inform stage due to its lack of active participation. The stages are: (1) Issue Identification, which gathers citizens' opinions to identify urban problems; (2) Problem-Solving, where citizen participation influences the development of solutions and alternatives for regions; and (3) Implementation and Feedback, where citizens become final decision-makers, and the solutions can be modified and refined.

Arnstein's ladder of participation, despite its prominence, has been criticized for oversimplifying the diversity of participatory processes and their goals. The model primarily assesses participation effectiveness based on participants' decision-making power (Bobbio, 2019). Alamoudi et al. (2022) state that the effectiveness of citizen participation strategies varies based on specific conditions and assumptions, meaning not all strategies are suitable for every organization.

Public participation tools: Strengths and weaknesses

Most planning participation methods have traditionally been non-digital, even though the past decade has highlighted the potential for technology to engage more citizens in the planning process (Wilson et al., 2019). As interest in citizen participation in planning grows, opportunities for involvement at various stages using different tools are expanding (Choo et al., 2023). The existing urban planning methods specify a citizen participation system using traditional methods like surveys, information disclosure, listening to residents' opinions, and public hearings (Choo et al., 2023). Al-Kodmany (2001) states that integrating traditional and high-tech tools can create a social learning environment, fostering stakeholder interaction and idea generation. However, traditional tools alone lack advanced analytical and visualization capabilities, while high-tech tools need to better engage the public. The authors recommend using simple, user-friendly computerized methods, investing in

external expertise, and forming partnerships between computer experts and grassroot organizations.

Digital tools are gaining significant attention in academic research. Toukola and Ahola (2022) reviewed digital tools for stakeholder participation, including building information modeling, games, geographical information systems (GIS), mobile participation, social media, and 3D visualization. They analyzed the benefits and drawbacks for municipalities, contractors, consultants, and citizens. Butt and Li (2012) integrated GIS, groupware, the Web, and other web-based technologies into an online virtual public meeting space to enhance public participation. However, the system has not been tested in real-world scenarios. Wilson et al. (2019) introduced a smartwatch app to facilitate citizen feedback in urban planning. The location-based app encouraged critical thinking about local areas and simplified participation by overcoming barriers like legalistic language and lengthy documents. However, this simplification sometimes resulted in users merely reporting issues instead of envisioning future improvements. Bugs et al. (2010) developed a Web 2.0 PPGIS application for urban planning, which, based on feedback from twenty-two volunteers, was found to be user-friendly and effective for communication. Dambruch and Krämer (2014) created a web-based platform using HTML5 and WebGL, featuring 3D and 2D visualization, model editing, scenario creation, opinion gathering, and more. Despite its capabilities, the platform faced challenges in web application programming, rendering, and object selection in 3D scenes.

Methodology and approach

MUST digital tool for participation in urban planning

This paper elaborates on a digital approach based on the MUST software, which was built upon a participation-based design process framework developed by Daher et al. (2021). The framework consists of three main interactions covering the usual design stages of urban planning. The initial version of MUST leverages the first two interactions, which are (1) problem formulation and objective setting, and (2) dependencies and requirement generation. The current interactions provide delegation, information, and consultation in Arnstein's ladder of participation for the citizens.

MUST relies on a TUI to interact with participating citizens, as this approach engages users by enabling them to gain work experience and skills, providing tactile feedback and a sense of interaction (Krestanova et al., 2021). Studies indicate that TUIs offer greater benefits for learning compared to traditional methods, stimulating interest and improving cooperation (Krestanova et al., 2021). TUIs aim to enhance accessibility and acceptance of computer systems by leveraging human familiarity with physical object manipulation. Unlike GUIs, TUIs convey information through both haptic and topological means, integrating physical and digital elements. MUST is built on top of the TULIP Framework, a Java-based Software Development Tool Kit specifically designed for tangible applications, which has been continuously developed in-house (Luxembourg Institute of Science and Technology) since 2014 (Tobias et al., 2015). From a hardware perspective, TULIP works both with commercially available tangible tables and Do-It-Yourself tables, provided they support the TUIO communication protocol. The TULIP framework has a modular architecture which accommodates several already existing modules that connect to systems from various domains. The separation of content and code is deeply rooted in TULIP's architecture, hence, the bulk of customization required for a given application, like *Scenario* (Figure 1).

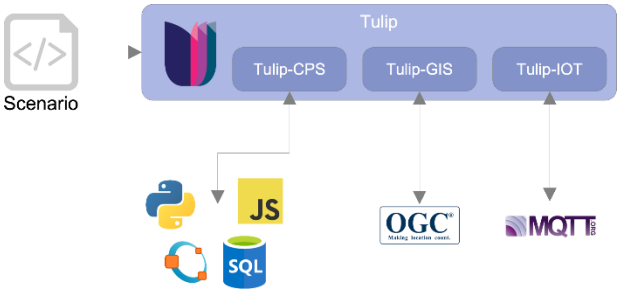

Figure 1: Tulip architecture

The current functionalities of MUST enable citizens to visualize their neighborhood using 2D maps, and analyze various aspects such as mobility, green spaces, noise levels, and services using tangible objects on a tangible table. Subsequently, it allows users to collect citizen requirements in terms of their needs and preferences based on the selected design criteria. Another function provides a diagnosis to the citizens, allowing them to explore the site and identify areas that meet or do not meet their requirements for various programmatic functions. The third function involves generating 3D neighborhood typologies and proposing various urban planning scenarios.

The next section describes the methodology proposed to adapt this tool to the specific participation needs related to urban regeneration.

Methodology for defining participation needs in urban regeneration projects

This study is conducted as part of the Horizon-Europe-funded REGEN project, which aims to regenerate neighborhoods towards a low-carbon, inclusive, and affordable built environment. The project will be implemented on four demonstration sites: Beckerich in Luxembourg, Laredo in Spain, Dublin in Ireland, and Milan in Italy. The current study focuses on the Laredo demo site to demonstrate how MUST will be updated to address the specific needs of the municipality. Figure 2

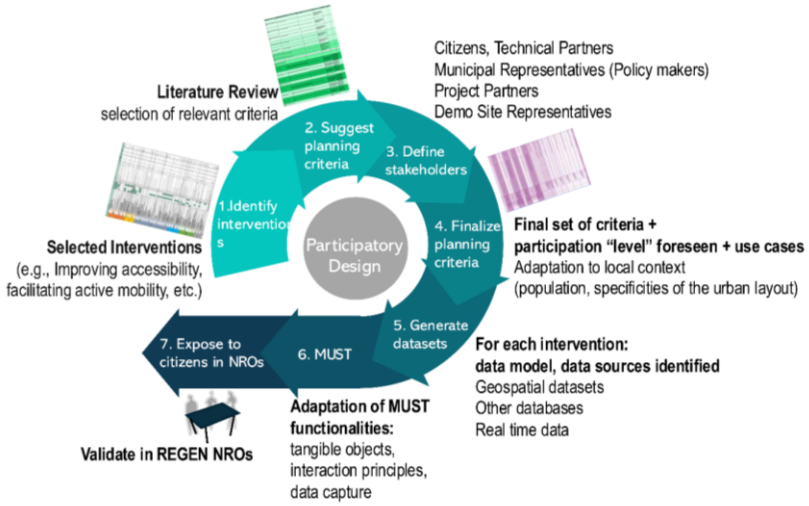

Figure 2: Methodology to define participation needs (Authors own work)

illustrates the methodology for defining participation needs, which comprises seven steps. The initial phase involves identifying neighborhood regeneration interventions. Currently, 49 initiatives are categorized into 7 domains and 18 subdomains, and their applicability to the four demo sites has been assessed. The second stage entails a preliminary analysis of participatory urban planning examples from a literature review, aimed at understanding public involvement approaches in similar European contexts and developing alternative citizen engagement strategies in the urban planning process. The third step involves defining the relevant stakeholders for the process, including technical staff and demo site representatives. The fourth task focuses on collecting partner requirements for the application of MUST at specific demo sites and finalizing the criteria for participatory urban planning through interviews. The subsequent step involves generating the necessary datasets and deciding on the best tools to adapt MUST to the current needs of the neighborhoods. The following phase includes the adaptation of MUST functionalities to the final set of criteria using identified data models and sources. The final step involves gathering feedback from citizens at the neighborhood regeneration offices (NROs).

Case study: Laredo demo site

Laredo is a prominent tourist destination on the Cantabrian coast, renowned for its expansive and scenic shoreline (Figure 3). The urban structure of Laredo is divided into three distinct zones: (i) the historic core, known as La Puebla Vieja, (ii) the newer suburban developments, and (iii) the extension of these suburbs toward El Puntal. The REGEN demonstration project will be implemented in La Puebla Vieja, the oldest sector of the town, which was designated a Historic-Artistic Site in 1971 due to its historical significance and architectural heritage.

The old town consists of a network of narrow streets lined with grand residences dating from the 16th to 18th centuries. As of 2025, La Puebla Vieja has a population of 851 inhabitants. This district has been experiencing a steady population decline, attributed in part to challenges related to accessibility and habitability posed by the existing urban fabric and the built environment. In response, the municipality of Laredo has been actively developing a strategy for the regeneration of its historic center to preserve its cultural character and improve livability.

The topography of the old town is complex, with one of the main access roads acting as a physical barrier that disrupts connectivity within the neighborhood and blocks pedestrian mobility. These conditions contribute to the isolation of La Puebla Vieja from the rest of the town and hinder commercial activity along its primary marketplace street. The situation poses particular difficulties for older individuals, as well as for people with reduced mobility or disabilities. Addressing these challenges requires systematic monitoring to analyze pedestrian movement and identify key obstacles, alongside the development of improved accessibility solutions, including urban mobility infrastructure. However, as a designated

Figure 3: Aerial picture of the Laredo demo site

Historic-Artistic Site, Laredo's old town is subject to stringent heritage protection regulations (PLANEAMIENTO VIGENTE, n.d.), which may impose constraints on the scale and nature of interventions at both the neighborhood and building levels. Additionally, these regulations define limitations on permissible land uses within the historic district. In this context and aligned with REGEN project, several interventions have been identified to foster the urban regeneration of "La Puebla Vieja, as detailed in the following section.

Regeneration activities in Laredo

This section outlines the planned regeneration activities in Laredo. Table 1 presents an overview of the proposed neighborhood regeneration interventions.

Table 1: Neighborhood interventions domain and subdomains in Laredo

Domains	Sub Domains
Built environment	Improve building performance
	Improve the quality of digital infrastructures
	Conserve building stock
Energy systems	Reduce energy use in communities
	Provide sustainable energy sources
Mobility and transport	Facilitate active mobility
	Improve urban accessibility
AFOLU	Greener and healthier urban spaces
	Cultural ecosystem services
Green industry	Foster lower emission tourism
Transversal	Neighborhood regeneration office

In the built environment, efforts will focus on improving building performance through retrofitting, planning, and construction, enhancing digital infrastructure quality, and conserving the existing building stock. Energy system interventions aim to reduce energy use in communities and provide sustainable energy sources. Mobility and transport initiatives will facilitate active mobility and improve urban physical accessibility. In the AFOLU (Agriculture, Forestry, and Other Land Use) sector, the focus will be on creating greener and healthier urban spaces and enhancing cultural ecosystem services. Lastly, the green industry will foster lower emission tourism, contributing to a more sustainable and vibrant old town. A neighborhood regeneration office will be established at the demonstration sites to facilitate the regeneration of the neighborhoods. This office will also serve as a physical space to promote the use of participatory tools by residents and other stakeholders.

Application of the proposed methodology

Selection of relevant criteria through literature review

Following the identification of interventions, a selection of literature sources has been chosen to identify relevant criteria (Step 2). Coates et al. (2013) examined citizen participation in district planning in Freiburg, Germany, through Forum Vauban, illustrating how participatory planning can have distinct goals from those of the city and propose various uses, such as community centers, locally owned restaurants, and public plazas. Nello-Deakin et al. (2024) investigated preferences and perceptions regarding the pedestrianization of multiple streets in a Barcelona district. Porto developed a model using GIS and multi-criteria analysis to enhance the pedestrian network, analyzing street connectivity and factors influencing walkability, such as slope, green spaces, and land use (European Commission, 2016). Pérez-delHoyo et al. (2021) created an urban accessibility monitoring system comprising a mobile application for citizens to report accessibility issues and a web console for local government management. Table 2 provides an overview of these studies. Analyzing these studies facilitated the understanding of public involvement approaches in various European contexts and the development of alternative citizen engagement strategies for the next stage.

Table 2: Relevant criteria through literature review

Author	**Location**	**Relevant Criteria**
Coates et al. (2013)	Freiburg, Germany	Different building use
Nello-Deakin et al. (2024)	Barcelona, Spain	Preferences, perceptions regarding pedestrianization
European Commission (2016)	Porto, Portugal	Analysis of street connectivity, factors influencing walkability
Pérez-delHoyo et al. (2021)	Sweden, Spain, Canada, Australia	Reports on accessibility issues

Following this stage, interviews were conducted with project and technical partners. Researchers specialized in living lab deployment, design thinking, citizen science, and participation technology design supervised the process. In addition, as four demonstration sites are being considered, all of them involved local stakeholders, including consultants responsible for organizing engagement activities locally, representatives from the municipalities involved, and other experts relevant for the specific regeneration interventions considered. These interviews determined the final set of criteria,

participation levels, and use cases, as detailed in the following section.

Final set of criteria & participation level & use cases

From the interventions selected for implementation in the Laredo demo case, those related to mobility (in Table 1) have been chosen to test how MUST functionalities can be extended. The final steps 4, 5, 6 are summarized with use case diagrams, and examples are provided in the next subsections in Figures 4, 5, 6, and 7.

These mobility interventions include: (1) integrating retail and other economic activities (e.g., tourism) into the urban core to enhance active mobility; (2) fostering and prioritizing pedestrian walkability to reduce vehicle use; (3) managing mobility behavior (pedestrian, motorized, transportation) to address carrying capacity and human traffic; and (4) deploying accessible pathways for older people and people with disabilities. Based on these interventions, the following adaptations are suggested for MUST.

Integrating retail and other economic activities (e.g., tourism) into the urban core to enhance active mobility

A comprehensive 2D map detailing the current landscape of retail stores, businesses, and available spaces, including both public and private areas such as stores and bars, will be created. The map will be enhanced with photographic documentation.

- **Stakeholder Engagement** will enable collaboration with citizens and key stakeholders, including business associations, to identify the types of shops or services that are lacking and determine optimal locations for these establishments.
- **Market Simulation** will allow simulations to be conducted to assess the potential impact of introducing local or artisan markets into specific areas, aiming to enhance the visibility and patronage of existing businesses within the neighborhood.
- **Space Identification** will support the identification of vacant spaces and stores to foster entrepreneurship, particularly within Cultural and Creative Industries (CCI), ensuring alignment with the cultural heritage of the demo site.

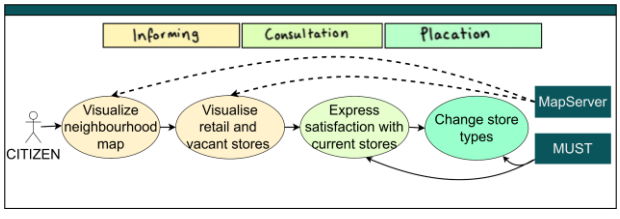

Figure 4: Use case diagram for integrating public participation into economic activities

Foster and prioritize pedestrian walkability to avoid vehicle use

The streets will be presented on a 2D map that can be combined with street photos to identify pedestrian routes within the neighborhood and can be extended to nearby landmarks. These routes will be quantified in kilometers and analyzed for their health benefits.

- **Route Identification** through participation entails mapping out pedestrian routes within the neighborhood and to key destinations, translating these routes into kilometers.
- **Health Metrics** will evaluate the health benefits of these routes as an indicator, by calculating the:
  - Difficulty Grade: Assess the difficulty level based on individual capacities.
  - Caloric Expenditure: Estimate the calories burned during the walk.
  - Step Count: Determine the number of steps taken.
- **Activity Options** will provide various options based on activity type (walking or running) and speed, offering tailored recommendations for different fitness levels.

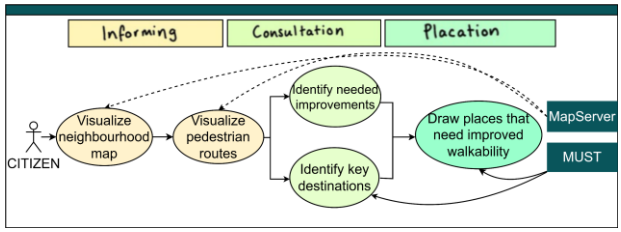

Figure 5: Use case diagram for integrating public participation to enhance walkability

Manage mobility behavior to address the carrying capacity and human traffic

A 2D map will present the data gathered by pedestrian/vehicle counters.

- **Usage Visualization** will analyze and visualize street usage data at different times of the week, assessing the impact of weather conditions and public events on street usage.
- **Public Information** will be leveraged by educating citizens on the advantages and disadvantages of people and vehicle counting, highlighting its relevance in urban planning.
- **Citizen Feedback** will be collected by engaging with citizens to identify issues related to street usage and gathering insights on how people and vehicle counting data can be utilized to improve urban planning.

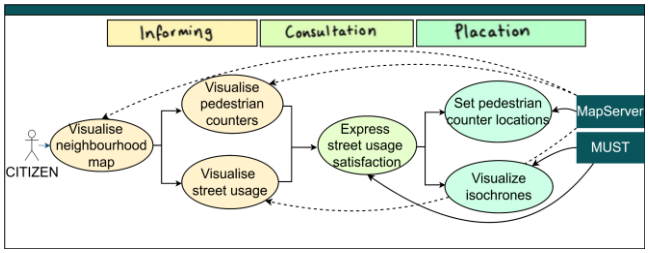

Figure 6: Use case diagram for integrating public participation to enhance street usage

Deploy accessible pathways for older people and people with disabilities

For this intervention, the presentation of the streets on a 2D map will be combined with street photos.

- **Storytelling Engagement** will facilitate an activity in which older adults describe their experiences traveling from their homes to an existing service, such as a health center.
- **Barrier Identification** will take the form of collaboration, where participants will identify barriers encountered along the routes that make them inaccessible.
- **Pathway Analysis** will conduct a co-diagnosis with the neighbors of the most frequently used pathways by older adults: from home to market, from home to health center, from home to civic center, from home to sports center, and others.
- **Citizen Collaboration** will enable researchers to work with citizens to determine the necessary interventions to improve these pathways, ensuring they are age friendly.

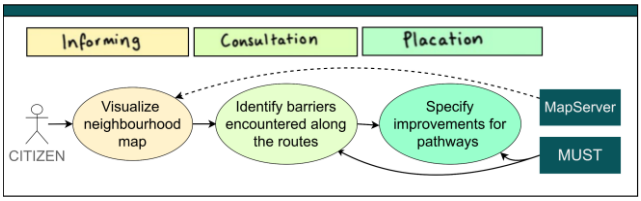

Figure 7: Use case diagram to integrate public participation into the deployment of accessible pathways

Discussion

This study introduces a digital and innovative approach to citizen participation, contrasting with traditional methods like surveys, public hearings, and information disclosure. By employing MUST, a participatory urban planning tool for neighborhood regeneration that utilizes a TUI and tangible objects, the study aims to address the limitations of traditional participation methods, such as monotonous engagement. It seeks to attract interest, enhance cooperation, and improve learning outcomes.

The proposed tool can support the development of sustainable cities, enhance citizen awareness and education, and facilitate the creation and dissemination of new knowledge between local governments and citizens by engaging citizens in the urban regeneration process.

The proposed tool will address the limitations of previous studies, such as those by Butt and Li (2012), which were not tested in real-world scenarios. By exposing MUST to NROs at four different demo sites, it will be possible to gather feedback from various user profiles on the effectiveness of participatory planning tools relying on TUIs.

Additionally, unlike digital participation tools that merely permit issues related to specific locations to be reported (Wilson et al., 2019), the tool will enable citizens to suggest optimal locations for stores, provide routes to key destinations that are tailored to their fitness levels, and collect citizen ideas to improve pathways.

Conclusions

This study has introduced an interactive participatory urban planning tool (MUST) designed to enhance citizen engagement in neighborhood regeneration across various urban contexts on TUI. The study first outlined a methodology to identify participation needs and implement technological solutions within a digital tool, considering its existing functionalities. Subsequently, the engagement of citizens in the urban planning process was examined through the lens of mobility interventions in Laredo, Spain, a town subject to stringent heritage protection regulations. The current study demonstrated how four mobility interventions could be supported in a digital participatory design tool to engage citizens, considering the stages of informing, consultation, and placation in Arnstein's ladder of citizen participation.

As development is ongoing, the tool will be updated to enable various functionalities using geospatial datasets and real-time data. Later, the software will be tested with target end-users in NROs. Their feedback will enable improvement loops that will contribute to refining: 1) the scenario of urban regeneration, and 2) the set of functionalities of the MUST application. Future research can explore how the methodology could be improved for effective citizen engagement in diverse contexts. Additionally, the benefits and challenges of using digital tools in public participation will be assessed once our prototypes are deployed, with a view to improving participatory planning processes.

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References

Alamoudi, A. K., Abidoye, R. B., & Lam, T. Y. M. (2022). The impact of stakeholders' management measures on citizens' participation level in implementing smart sustainable cities. Sustainability, 14(24), pp.16617.

Al-Kodmany, K. (2001). Visualization tools and methods for participatory planning and design. Journal of Urban Technology, 8(2), pp. 1–37.

Basak, O. (2024). Envisioning just and democratic citizen participation in urban planning and governance. Available at: https://www.isocarp-institute.org/ (Accessed: 5 October 2024).

Bobbio, L. (2019). Designing effective public participation. Policy and Society, 38(1), pp. 41–57.

Bugs, G., Granell, C., Fonts, O., Huerta, J., & Painho, M. (2010). An assessment of Public Participation GIS and Web 2.0 technologies in urban planning practice in Canela, Brazil. Cities, 27(3), pp.172–181.

Butt, M. A., & Li, S. (2012). Developing a web-based, collaborative PPGIS prototype to support public participation. Applied Geomatics, 4, pp.197–215.

Choo, M., Choi, Y. W., Yoon, H., Bae, S. Bin, & Yoon, D. K. (2023). Citizen engagement in smart city planning: The case of living labs in South Korea. Urban Planning, 8(2), pp. 32–43.

Coates, G.J. (2013). The sustainable urban district of Vauban in Freiburg, Germany. International Journal of Design & Nature and Ecodynamics, 8(4), pp.265-286.

Daher, E., Kubicki, S., & Pak, B. (2022). How lay people design interior architecture layouts in virtual, augmented, drawing and physical reality. In: Proceedings of the International Conference on Education and Research in Computer Aided Architectural Design in Europe. Ghent, Belgium.

Daher, E., Maktabifard, M., Kubicki, S., Decorme, R., Pak, B. and Desmaris, R. (2021). Tools for citizen engagement in urban planning. Holistic Approach for Decision Making Towards Designing Smart Cities, pp.115-145.

Dambruch, J., & Krämer, M. (2014). Leveraging public participation in urban planning with 3D web technology. In: Proceedings of the 19th International ACM Conference on 3D Web Technologies. Vancouver, Canada.

European Commission. (2016). Developing a model to improve pedestrian infrastructure in Porto (Portugal). Available at: https://urban-mobility-observatory. transport.ec.europa.eu/(Accessed:3 January 2025).

Evans-Cowley, J., & Hollander, J. (2010). The new generation of public participation: Internet-based participation tools. Planning Practice and Research, 25(3), pp. 397–408.

Horgan, D., & Dimitrijevic, B. (2019). Frameworks for citizens participation in planning: From conversational to smart tools. Sustainable Cities and Society,48, pp.101550.

Geekiyanage, D., Fernando, T., & Keraminiyage, K. (2021). Mapping participatory methods in the urban development process: A systematic review and case-based evidence analysis. Sustainability, 13 (16), pp.8992.

Glaas, E., Hjerpe, M., Karlson, M., & Neset, T. S. (2020). Visualization for citizen participation: User perceptions on a mainstreamed online participatory tool and its usefulness for climate change planning. Sustainability, 12(2), pp.705.

Krestanova, A., Cerny, M., & Augustynek, M. (2021). Review: Development and technical design of tangible user interfaces in wide-field areas of application. Sensors, 21(13), pp.4258.

Moufid, O., Praharaj, S., & Oulidi, H. J. (2024). Digital technologies in urban regeneration: A systematic review of literature. Journal of Urban Management.

Nello-Deakin, S., Vallvé, C.S. & Akinci, Z.S. (2024). Who's afraid of pedestrianization? Residents' perceptions and preferences on street transformation. Habitat International, 150, pp.103117.

Nunes, N., Björner, E., & Hilding-Hamann, K. E. (2021). Guidelines for citizen engagement and the co-creation of nature-based solutions: Living knowledge in the URBiNAT project. Sustainability, 13(23), pp.13378.

Pérez-delHoyo, R., Andújar-Montoya, M. D., Mora, H., Gilart-Iglesias, V., & Mollá-Sirvent, R. A. (2021). Participatory management to improve accessibility in consolidated urban environments. Sustainability, 13 (15), pp. 8323.

Planeamiento Vigente. (n.d.). Available at: https:// www. laredo.es/09/planeamiento_vigente.pdf (Accessed: 04 February 2025).

Preston, S., Mazhar, M. U., & Bull, R. (2020). Citizen engagement for co-creating low carbon smart cities: Practical lessons from Nottingham city council in the UK. Energies, 13(24), pp.6615.

Tobias, E., Maquil, V., & Latour, T. (2015). TULIP: A widget-based software framework for tangible tabletop interfaces. In: Proceedings of the 7th ACM SIGCHI Symposium on Engineering Interactive Computing Systems. Duisburg, Germany.

Toukola, S., & Ahola, T. (2022). Digital tools for stakeholder participation in urban development projects. Project Leadership and Society, 3, pp.100053.

Wilson, A., Tewdwr-Jones, M., & Comber, R. (2019). Urban planning, public participation and digital technology: App development as a method of generating citizen involvement in local planning processes. Environment and Planning B: Urban Analytics and City Science, 46(2), pp. 286–302.