

From administrative tools to place attractiveness: stakeholder cocreation in 3D city mapping for small- and mid-sized cities

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Abstract

Purpose – This study aims to investigate how stakeholder cocreation in 3D city mapping initiatives can extend the role of digital urban platforms beyond administrative efficiency toward the negotiation and enhancement of place attractiveness. Drawing on a participatory case study of Trollhättan, Sweden, the paper explores the needs, expectations and aspirations articulated by diverse stakeholder groups regarding collaborative 3D mapping, and examines how these perspectives, when enacted through cocreation processes, shape and negotiate place attractiveness in small- and mid-sized cities.

Design/methodology/approach – The study adopts an abductive case-study design, integrating the social construction of technology (SCOT) theory, participatory design and place attractiveness research into an analytical framework. Primary data were generated through eight cocreation workshops involving 32 participants across five stakeholder clusters in Trollhättan. Data were analyzed using a three-step thematic coding process of open, axial and selective coding, supported by a coding matrix linking empirical themes to theoretical constructs. The case-study approach enables contextualized understanding of complex socio-technical dynamics in a small- and mid-sized city context.

Findings – The findings show that stakeholders interpret the 3D map not merely as an administrative visualization tool but as an evolving socio-technical platform through which diverse needs, expectations and aspirations are articulated and place attractiveness is negotiated and coproduced. Across six themes, stakeholders articulated diverse expectations related to visualization, usability, data integration, real-time responsiveness, civic dialogue and temporal representation. These interpretations reflect distinct technological frames shaped by stakeholders' institutional roles and lived experiences. The analysis demonstrates that identical technical features acquire multiple meanings, activating different dimensions of place attractiveness. Consequently, collaborative 3D mapping functions as a participatory infrastructure in which urban value is continuously negotiated, extending place attractiveness beyond static representations toward dynamic, socio-technical engagement.

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Originality/value – The study makes three contributions. An integrated analytical framework combining SCOT, participatory design and place attractiveness research is developed to explain how stakeholder cocreation on digital urban platforms shapes multiple dimensions of place attractiveness. Place attractiveness theory is advanced by introducing a temporal dimension, arguing that attractiveness in digital contexts spans past, present and future rather than reflecting present-state evaluations alone. Finally, participation is reframed not as input preceding design decisions, but as an ongoing process in which urban meaning is continuously negotiated within, and partly constituted by, the platform itself.

Keywords Participatory design, 3D city mapping, Digital urban planning, Place attractiveness, Small- and mid-sized cities

Paper type Research paper

1. Introduction

Across European municipalities, the number of so-called “smart cities” that effectively use the latest tools and technologies to solve real-life challenges is increasing (Caragliu *et al.*, 2023). Most smart city studies and initiatives focus on data-driven optimization of urban infrastructure, service delivery and resource management, frequently framed within sustainability and efficiency agendas (Bibri and Krogstie, 2020). These initiatives increasingly involve developing digital twins that integrate real-time data to simulate urban processes. In urban planning and community development, smart cities have often translated into data-driven approaches that use connected sensors and real-time analytics to improve urban services. Within this broader trajectory, the development of 3D city maps has emerged as a tangible entry point for municipalities, providing a visual and data-driven platform that supports internal processes, particularly by streamlining building permit procedures and enhancing visual communication in planning processes (Eriksson and Harrie, 2021). While such applications improve efficiency and provide visually compelling representations of the city, they risk reducing 3D mapping to an inward-looking exercise confined to municipal administration and operational performance.

In this paper, we argue that the potential of 3D maps extends far beyond increasing bureaucratic efficiency or showcasing aesthetically rendered digital replicas of the urban fabric. 3D mapping represents a broader opportunity to reconfigure how municipalities interact with their local environments by inviting other societal actors, businesses, citizens and civic organizations into processes of place cocreation. By mobilizing diverse forms of knowledge and experience, these collaborations can expand the scope of 3D maps from administrative tools to dynamic socio-technical infrastructures (Linkola *et al.*, 2025; Saßmannshausen *et al.*, 2021). In this perspective, 3D mapping emerges not only as a visualization device but also as a novel approach to place management, enabling stakeholders to collaboratively visualize, plan and transform urban spaces into viable and attractive cities.

In the broader place management literature, enhancing place attractiveness has often been linked to interventions such as urban design (Silvennoinen *et al.*, 2022), branding (Garcia Sousa *et al.*, 2025) and cultural events (Bruni and Kompaniets, 2024). While these approaches emphasize the tangible and symbolic aspects of places, they rarely account for the role of digital infrastructures in shaping place attractiveness, particularly through participatory and digitally mediated collaboration. This study addresses this gap by situating 3D mapping within established debates on place management, particularly place attractiveness, and by extending these discussions into the digital domain. We argue that 3D maps, when developed through participatory and socio-technical processes, can serve as platforms for negotiating and coproducing place attractiveness. In this view, attractiveness is not an inherent property of place but a systemic and relational quality that can be collaboratively shaped.

Prior research on digital twins and urban digital infrastructures has largely emphasized their technical capacity to integrate real-time data, simulate urban processes and optimize decision-making (e.g. [Shirowzhan et al., 2020](#); [Ullah et al., 2025](#); [Duan et al., 2025](#)). While this literature advances our understanding of how digital technologies can improve efficiency in urban planning and operations, it is less attentive to the social and governance dimensions that shape the trajectories of such technologies, particularly in early development phases when roles, responsibilities and stakeholder expectations remain unsettled. Moreover, discussions of 3D mapping rarely connect to debates about place attractiveness, even though cocreated digital platforms may contribute not only to operational efficiency but also to strengthening a city's overall appeal to residents, businesses, visitors and other stakeholders.

By engaging with these gaps, this article investigates the case of Trollhättan, Sweden, where a 3D city map initiative illustrates both the opportunities and the municipal challenges of stakeholder involvement. In this case, Trollhättan municipality's Community Building Administration deliberately adopted a participatory approach, inviting businesses, citizens and civic organizations to serve as cocreators in developing and enhancing its 3D mapping infrastructure. Rather than treating the 3D map as a fully developed digital twin, the study conceptualizes it as an evolving socio-technical artifact whose meaning and value are actively negotiated among stakeholders. Drawing on the social construction of technology (SCOT) framework and participatory design approaches, the study illustrates how invited stakeholders articulate their needs and ambitions and how cocreation can link 3D mapping to broader discussions of place attractiveness in small- and mid-sized cities. The study pursues two interrelated aims: it explores the needs, expectations and aspirations articulated by different stakeholders regarding collaborative 3D mapping initiatives, and it examines how these articulated perspectives, when enacted through cocreation processes, shape and negotiate place attractiveness in small- and mid-sized cities.

Small- and mid-sized cities across Europe and beyond grapple with how to implement data-driven innovation with limited resources, involve stakeholders in socio-technical transitions, and ensure that 3D map initiatives contribute not only to administrative efficiency but also to the attractiveness of places. This empirical context is particularly interesting because resource constraints, institutional proximity and limited governance capacity make trade-offs between efficiency, inclusion and competitiveness particularly visible. Although the empirical contribution of this paper is based on a single case study, the insights are also valuable in other contexts. For example, by analyzing Trollhättan's 3D-mapping initiative, the study offers transferable lessons that inform broader debates in urban governance, digital innovation and place attractiveness, particularly in the context of small- and mid-sized cities.

2. Theoretical framework

This section presents the study's conceptual foundation by synthesizing insights from three main perspectives: SCOT, participatory design theory and research on place attractiveness. The objective is to develop an integrated theoretical framework for understanding how 3D mapping can evolve as a socio-technical process that enhances place attractiveness through participatory approaches. The framework emphasizes the interconnections among these perspectives to explain how collaborative technology development can influence urban places and enhance their perceived attractiveness among diverse stakeholder groups. It also positions the study within broader debates on place attractiveness and digital placemaking, acknowledging key questions about governance, stakeholder inclusion and digital mediation. By synthesizing these perspectives, the framework not only guides the empirical analysis but also contributes to

ongoing academic discussions about how places are governed, experienced and strategically positioned.

2.1 Social construction of technology

In exploring the social dimension of 3D mapping in the urban context, the need to acknowledge human factors and the inherent unpredictability of city dynamics is emphasized (Gallotti *et al.*, 2021). If a city ignores its residents' actions, preferences and interpretations, it risks missing a central part of what maps are supposed to represent and enable. Despite scholarly emphasis on the social dimension in 3D mapping, practitioners have been slow to integrate this perspective into planning processes (Eilola *et al.*, 2023). This study draws on SCOT theory, which recognizes technological applications as socially constructed, shaped by the interactions and interpretations of various social groups (Bijker *et al.*, 1987).

This theoretical perspective offers a flexible framework for understanding municipal 3D mapping in the urban context, highlighting the need to acknowledge both technological and nontechnical factors, such as human collaboration, in developing 3D maps to enhance place attractiveness. Its relevance in this context rests on three interrelated dimensions. First, SCOT theory emphasizes the importance of identifying and engaging relevant social groups whose interpretations shape technological trajectories (Adade and de Vries, 2023). In urban development, 3D mapping creates opportunities for cocreation among diverse actors, extending beyond SCOT's original categories of users and producers (Pinch and Bijker, 1984). For example, 3D platforms enable urban planners, architects and engineers to simulate changes in infrastructure and human activity (Hämäläinen, 2020), while also facilitating citizen participation through shared experiences and localized knowledge (De Franco and Moroni, 2023; Hämäläinen, 2020; Schrotter and Hürzeler, 2020).

Another dimension concerns *interpretative flexibility*, a core element of SCOT (Bijker *et al.*, 1987), which helps explain how different stakeholder groups ascribe divergent meanings to 3D platforms. For instance, property developers may primarily regard them as visualization tools, whereas residents may experience them as instruments for participatory planning. At the same time, limited digital literacy among certain groups may complicate engagement, influencing both participation and design processes. Finally, the notion of technological frames (Bijker, 1995) captures the shared cognitive schemata through which social groups interpret and interact with technology (Klein and Kleinman, 2002). These frames shape perceptions of opportunities, constraints and potential applications of 3D maps and, in turn, inform development decisions that may enhance place attractiveness.

While the SCOT approach has been criticized for insufficient attention to intergroup dynamics (Klein and Kleinman, 2002), its premise that technologies are shaped by social processes remains compelling. It highlights how identifying and engaging relevant stakeholder groups in cocreation processes can enable contextual adaptation and responsiveness to local needs while also making differences in interpretation visible. Nevertheless, the SCOT perspective does not offer specific methods for structuring stakeholder participation.

Building on these SCOT principles, several implications for implementing 3D mapping can be anticipated. The interpretative flexibility of visualization technologies suggests that different stakeholder groups will likely attribute distinct meanings to identical technical capabilities, necessitating adaptive interface design. The emphasis on relevant social groups also implies that effective 3D platforms need to accommodate situated user needs and varying digital competencies to ensure meaningful participation across diverse urban actors. SCOT provides an explanatory foundation for understanding why place attractiveness cannot be treated as a fixed outcome of technological implementation but must instead be analyzed as an ongoing socio-technical negotiation.

2.2 Participatory design

In exploring the governance dimension of 3D mapping, participatory design theory is integrated into the analytical framework to provide concrete strategies for inclusive stakeholder engagement in 3D-mapping processes (e.g. influenced by [Cumbo and Selwyn, 2022](#)). In keeping with [Meijer and Bolívar \(2016\)](#), the underlying assumption is that three dimensions are central to the success of digital innovation: technology, human engagement and governance. In complex urban settings, governance becomes critical for enabling social inclusion and participatory design through technological solutions. Municipal strategies and support are crucial to enabling urban governance that increasingly emphasizes transparency, accountability and collaboration ([Diaz-Sarachaga, 2025](#)).

Despite increased interest in smart digital platforms, 3D-mapping adoption remains limited in urban contexts because of high costs, technical complexity and governance uncertainties ([Najafi et al., 2024](#)). [Meijer and Bolívar's \(2016\)](#) framework highlights the need for socio-technical integration, competence assessment and political navigation in such initiatives. Institutional arrangements, including formal regulations and organizational structures, can either facilitate or constrain stakeholder involvement. To ensure multi-stakeholder collaboration as a core governance mechanism, inclusive technical solutions are needed ([Broccardo et al., 2019](#); [Najafi et al., 2023](#); [White et al., 2021](#)), along with a fundamental understanding of how governance mediates engagement. Furthermore, knowledge management within municipalities is pivotal. Robust mechanisms are needed to establish to collect, integrate and apply knowledge from various sources ([Meijer and Bolívar, 2016](#)). Although data may be fragmented or ambiguous, it still needs to support stakeholder understanding and contextual relevance ([Damgrave et al., 2023](#)). A flexible 3D-mapping approach can accommodate multiple perspectives and thereby foster more informed decision-making.

Participatory design and digital participation research suggest that technology-enabled initiatives, such as 3D mapping, should facilitate ongoing dialogue between stakeholders and municipal authorities, moving beyond one-way information provision toward more interactive forms of civic engagement ([Wilson et al., 2019](#)). In addition, the theory's emphasis on contextual adaptation implies that 3D platforms should integrate local community resources and services to support everyday urban navigation and decision-making.

2.3 Place attractiveness

Place attractiveness is best understood as a socially constructed, contextually negotiated outcome of interactions among people, technology and place (e.g. [Kavaratzis and Kalandides, 2015](#)). It refers not only to a city's capacity to draw and retain residents, businesses and visitors but also to the broader sociocultural, economic and symbolic qualities that make urban environments livable, competitive and resilient (e.g. [Zenker and Braun, 2017](#)). Rather than an objective property or a technically optimizable quality, attractiveness emerges as a relational, situated evaluation that varies across stakeholder groups and evolves over time. Assessments of attractiveness are shaped not only by the rational evaluation of functional attributes but also by emotional ties and subjective identification with the place ([Zenker and Petersen, 2014](#)). However, these assessments may diverge; what increases competitiveness for one group may reduce everyday livability for another. In this regard, 3D mapping can serve as a mediating interface that shapes how places are perceived, experienced and valued. A map integrating real-time data on public transportation, green spaces and cultural events not only provides functional information but also helps shape and reframe residents' and visitors' perceptions of a city's accessibility and vibrancy ([Liang et al., 2022](#); [Tu et al., 2020](#)). Still, digital representations may also simplify, filter or privilege certain aspects of place over others.

Despite rapid technological development and growing interest in digital platforms for urban planning, empirical research linking tools such as 3D maps to place attractiveness remains scarce (Marchesani *et al.*, 2026). Prior studies predominantly emphasize sustainability, livability and data integration (Luo *et al.*, 2025; Villanueva-Merino *et al.*, 2024), while research on smart city initiatives also shows that digital infrastructures may enhance attractiveness by fostering tourism (Romão *et al.*, 2018) and supporting innovation ecosystems (Kummitha, 2018). Still, these studies rarely address how digital platforms might influence stakeholders' perceptions of urban attractiveness or how such perceptions are negotiated within planning processes.

This gap reflects a broader theoretical shift toward relational interpretations of place attractiveness, positioning attractiveness as an emerging property shaped by stakeholders' practices, needs and experiences within the place (Hooijen, 2021; Niedomysl, 2010). This understanding further highlights the multiscalar nature of attractiveness and its temporal fluidity, formed by everyday practices as much as by strategic positioning. In line with Zenker and Braun (2017), different stakeholder groups construct place-related meanings differently, making attractiveness fragmented rather than unified. This recognition has raised concerns that professional and administrative interpretations of attractiveness routinely overshadow user-based or civic perspectives (Hidman, 2018; Alberola, 2024), as institutionally positioned actors, such as planners, developers and municipal administrators, disproportionately shape dominant definitions of what constitutes an "attractive" place (Lysgård and Cruickshank, 2013). Still, institutional coordination is necessary to translate dispersed preferences into coherent development trajectories, suggesting that tensions between strategic direction and civic input are not inherently dysfunctional but structurally embedded.

These dynamics underscore an insider/outsider distinction that is political rather than geographical. Insiders are those with institutional authority to define attractiveness, while outsiders experience its consequences, often without agency or the opportunity to shape its content. This distinction is particularly important when designing digital platforms intended to serve multiple publics. The risk is that they reproduce the very asymmetries they aim to mitigate. This challenge is especially acute in small- and mid-sized cities, which often lack the governance resources of metropolitan centers to manage conflicting views yet must nonetheless compete to attract residents, talent, investment and tourism (Lysgård and Cruickshank, 2013; Mabillard *et al.*, 2023). Accordingly, place attractiveness is not only socially constructed but also constructed under unequal conditions, raising critical questions about which voices are embedded in digital representations of the city.

Rooted in this discussion, 3D mapping can be theorized not merely as a technical artifact but as an urban interface through which place attractiveness is negotiated, stabilized, contested or reconfigured. Central to this theorization is understanding place attractiveness not as a sum of discrete attributes but as a systemic quality that emerges from the interplay among the functional, social, economic and symbolic elements of a city (Boisen *et al.*, 2018; Kavatzis and Kalandides, 2015). No single element or actor can produce attractiveness on its own. Rather, it is the coherence and coordination among these elements and among the stakeholders who shape and experience them that determine whether a place is perceived as viable, desirable and worth engaging with.

A useful contrast here is between placemaking and place attractiveness. Placemaking emphasizes participatory processes through which communities transform public spaces into meaningful places (Cilliers and Timmermans, 2014), whereas place attractiveness focuses on how places are evaluated and chosen within broader socioeconomic fields, often tied to branding and intercity competitiveness (Boisen *et al.*, 2018). These perspectives increasingly intersect in place branding research, where residents and other stakeholders are recognized as

active cocreators of place identity rather than passive recipients of official descriptions of place (Kavaratzis and Kalandides, 2015). Both perspectives underscore that attractiveness is collectively produced, contested and contingent on whose knowledge, experience and visions of the city are incorporated into the process. Positioned at this intersection, 3D mapping functions simultaneously as a participatory platform for shared meaning-making and as a tool for strategic urban competitiveness, an inherent duality that raises critical questions about whose visions of attractiveness become inscribed in the digital platform.

Zenker and Braun's (2017) resident-oriented place brand equity approach provides a multidimensional analytical framework for examining these processes (see also Zenker, 2011). According to this framework, place attractiveness encompasses four interrelated dimensions: *the functional*, *the sociocultural*, *the economic* and *the symbolic-emotional*. In the context of 3D mapping, the functional dimension concerns spatial legibility and service access, the sociocultural dimension concerns participation and inclusion, the economic dimension concerns investment visibility and business ecosystems and the symbolic-emotional dimension concerns memory, identity and attachment. These dimensions are not fixed categories but analytical constructs that structure how stakeholder evaluations of place are articulated and interpreted. Each dimension should be regarded as socially produced and continuously renegotiated, reflecting the interpretative flexibility central to SCOT. Without deliberate governance mechanisms to balance these dimensions, 3D mapping platforms risk privileging institutionally dominant framings of attractiveness over civic and experiential ones, thereby reinforcing the asymmetries this study seeks to examine.

2.4 *Toward an integrated framework for 3D mapping*

By embedding place attractiveness within the conceptual framework alongside SCOT and participatory design, this study positions 3D mapping not only as a technical innovation or a fixed administrative tool for municipal efficiency but also as an evolving interface through which urban meaning, governance and competitiveness can be actively coproduced. The integrated framework provides a situated and reflexive foundation for understanding 3D mapping as a socio-technical infrastructure.

The SCOT perspective highlights how technologies are socially constructed and shaped by the interpretations and negotiations of diverse stakeholder groups. It also highlights the interpretative flexibility of digital platforms and shows how different social groups assign values, expectations and purposes to the same platform. The participatory design perspective offers practical methods and concrete strategies for embedding various stakeholder groups in design processes. It emphasizes the need for municipal governance structures that foster dialogue, inclusion and adaptive solutions in developing digital platforms that accommodate and acknowledge varied perspectives rather than privileging a single administrative view. Place attractiveness research adds a complementary focus on the multidimensional value of urban environments, including functional, social, economic and symbolic dimensions, and how digital platforms can mediate, represent and enhance these dimensions. Furthermore, this perspective foregrounds the stakes of digital mediation and ongoing negotiation, addressing questions of who shapes representations of place, who benefits from them, and who gets to define what makes a place desirable or worth investing in.

This integrated approach also helps explain how digital urban technologies intersect with local political dynamics and stakeholders' place identities. Through the SCOT perspective, it becomes clear that different stakeholder groups attach distinct, at times competing, meanings to the same platform and the place it represents. Participatory design provides guidance for municipalities in navigating these differences, offering practical methods for structuring inclusive, dialogic processes. Place attractiveness research, in turn, clarifies why these

negotiations matter, how managing them may help shape a desirable place and influence investment trajectories and how cities can be positioned in increasingly competitive environments. In this sense, 3D mapping becomes not only a means for visualizing data or supporting administrative planning but also a space where multiple, contested visions of a place are negotiated in real time.

The framework is especially relevant for small- and mid-sized cities in understanding how 3D mapping initiatives and platforms may carry functional, social, economic and symbolic significance, enhancing place attractiveness. In this context, digital platforms not only signal modernization but also responsiveness to community needs, wants and lived experiences, becoming part of how local governments communicate legitimacy, inclusion and strategic direction. Approaching 3D mapping as a dynamic convergence point between technological possibilities and place-based aspirations highlights its potential to foster more efficient municipal planning and support civic engagement. This integrated perspective connects urban innovation to political legitimacy and inclusivity, expanding the role of digital tools from data instruments to participatory infrastructures. This is particularly pertinent in small- and mid-sized cities, where digital tools are often under-resourced but carry high symbolic weight in signaling modernity, inclusion and responsiveness.

Although many challenges in urban 3D mapping remain subject to further examination, this literature review highlights the importance of a human-centered, socio-technical and governance-embedded approach. This approach recognizes that digital platforms do not merely reflect existing urban realities but also help shape them, technically, symbolically and politically. By integrating the main conceptual perspectives, the framework facilitates anticipating, understanding and addressing interpretative differences and practical trade-offs that emerge in urban 3D mapping cocreation processes, particularly in small- and mid-sized cities. Ultimately, conceptualizing 3D mapping as part of a broader place development and branding strategy enables a more analytically integrated understanding of its societal role and the challenges that follow. This approach moves the conversation beyond municipal efficiency and the smartness of a digital platform toward meaning, belonging and participation, qualities that are increasingly vital in shaping inclusive and resilient urban futures.

3. Methodology

Building on the theoretical synthesis, empirical insights are gained by examining Trollhättan's ongoing 3D mapping initiative. Adopting an abductive case-study research design (Dubois and Gadde, 2002), the study explores the theoretical constructs of the social dimension (Bijker *et al.*, 1987), the governance dimension (Meijer and Bolívar, 2016) and place attractiveness (Zenker and Braun, 2017) within the empirical context of the city of Trollhättan. In line with the overarching theme of stakeholder engagement and participatory design identified in the literature review, primary data were generated through a series of interactive and iterative workshops involving diverse stakeholder groups in Trollhättan. The workshops were designed to elicit stakeholders' interpretations, expectations and envisioned applications of Trollhättan's 3D map and its potential to support municipal development and enhance place attractiveness.

Focusing on the early-stage development of the 3D map platform, the study examines how stakeholder interpretations shape socio-technical trajectories before institutional stabilization (in accordance with Bijker, 1995). This phase is particularly important because it captures the technology's interpretative flexibility, offering actionable insights for municipal decision-makers in further developing the platform and the participatory initiative to avoid privileging certain interpretations over others. As Dubois and Gadde (2002) emphasize, abductive case studies are especially well suited to analyzing emerging and complex phenomena, where

theory and empirical findings coevolve in a dynamic interplay. In this study, the abductive logic enabled continuous movement between theoretical constructs (SCOT, participatory governance and relational place attractiveness) and empirical observations from the workshops.

Given the specific governance dynamics of a mid-sized city such as Trollhättan, the case-study methodology also enables a deeper understanding of how participatory design principles materialize within this institutional, political and spatial context. Small- and mid-sized cities provide analytically rich environments where resource constraints, localized knowledge and close institutional proximity make stakeholder interactions especially visible and consequential. While Trollhättan shares such challenges with many European municipalities, the findings cannot be generalized statistically. However, this single case study offers transferable insights that may inform comparative studies and initiatives across cities of different sizes and governance systems.

3.1 *The case of Trollhättan's 3D map*

Trollhättan is a medium-sized city on the west coast of Sweden with a long industrial history that, in recent decades, has been reshaped into a hub for innovation and technology. Like many other mid-sized cities, Trollhättan continuously seeks to strengthen its place attractiveness and competitiveness. This ambition is guided by two key municipal strategies: the establishment strategy (Trollhättans Stad, 2022), which emphasizes sustainable urban development and partnerships across the public, private and civic sectors and the digitalization strategy (Trollhättans Stad, 2020), which envisions a well-connected, innovative and inclusive digital environment.

Within this strategic framework, the municipality's planning and construction offices developed a 3D map of the city. Initially, the platform was primarily used as an internal tool to increase efficiency and transparency in urban planning and building permit processes. Its internal success is evidenced by Trollhättan's top ranking in the National Lead Time Index 2025, a nationwide benchmark of planning and building processes, where the municipality was recognized as the overall national winner across all categories (Initiativet Bygg i Tid, Byggföretagen and Fastighetsägarna, 2025). This recognition underscores the platform's role in streamlining administrative processes and strengthening procedural predictability.

However, municipal leaders have long recognized that the 3D map had potential far beyond internal efficiency. While effective as an administrative instrument, the platform was still perceived as overly inward-looking and underutilized its potential as a collaborative and participatory resource. In particular, challenges remained in involving external stakeholders in platform development and ensuring that the 3D map addressed diverse urban needs. To address this gap, the municipality invited researchers from University West to design and facilitate workshops with diverse stakeholders, thereby creating structured opportunities to explore how the 3D map could evolve into a more inclusive socio-technical platform.

In its current form, Trollhättan's 3D map is a geospatial visualization platform that represents building volumes with sufficient detail to support urban planning processes such as shadow analysis and spatial assessment. The platform integrates elevation models, aerial imagery, municipal GIS data and planning information, with updates provided periodically based on the data source. While it does not yet include real-time data streaming or advanced simulation capabilities, its technical architecture enables further expansion. The platform is, therefore, conceptualized not as a finalized digital twin but as an evolving socio-technical artifact whose meaning and functionality remain open to negotiation among stakeholders.

3.2 Workshop design and data collection

A qualitative, iterative approach was used to explore how different stakeholder groups interpret Trollhättan's evolving 3D map and its potential. Workshops were designed as structured, participatory encounters that encouraged reflection, interaction and cocreation among stakeholders. Data were collected between autumn 2023 and early 2024.

The study began in October 2023, when the developers of Trollhättan's 3D map presented a pilot version of the platform to the research team. At the request of the Trollhättan municipality, which sought structured stakeholder input to inform subsequent platform development, the research team was invited to design and conduct a series of workshops. Following consultations with municipal representatives and an initial kickoff meeting, where the platform and its intended development were introduced by the developers, a set of participatory workshops was designed and tested with students at University West. These initial sessions both refined the workshop format and generated valuable insights into the perspectives of a stakeholder group representing permanent, temporary and prospective residents. Students were central to the study because of their technological openness and demographic importance in Trollhättan, where they account for approximately 15% of the city's population ([Trollhättans Stad, 2016](#)).

Building on these pilot workshops, four additional sessions were held in January and February 2024 with other strategically identified stakeholder groups. A stakeholder mapping process guided participant selection, using criteria of relevance to geospatial data applications, potential impact on or interest in place attractiveness, organizational diversity and availability. The resulting clusters were real estate and service industry actors, given their role in interpreting and communicating place value; startups and entrepreneurs, as potential innovators and economic drivers; logistics and transport professionals, given the platform's planning capabilities; and nonprofit organizations, to capture community and civic-engagement perspectives. In total, eight workshops involving 32 participants were conducted (see [Table 1](#)). Given the early developmental stage of the 3D platform and in line with case-study logic emphasizing analytical generalization ([Yin, 2018](#)), the number of participants was considered sufficient to generate rich, information-powerful data aligned with the study's exploratory aims ([Malterud et al., 2016](#)).

Each workshop was cofacilitated by representatives from University West and the City of Trollhättan and designed to elicit participants' views on both opportunities and challenges associated with the 3D map. Sessions began with a visual and oral presentation of the platform's current functions and envisioned development, ensuring a shared baseline of understanding. Participants were then encouraged to reflect on potential enhancements,

Table 1. Workshop overview

Workshop ID, date	Cluster	No. of participants	Informant ID	Duration
1, 23-11-30	Residents, students, University West	4	1:1–1:4	25 min
2, 23-11-30	Residents, students, University West	5	2:1–2:5	27 min
3, 23-11-30	Residents, students, University West	4	3:1–3:4	27 min
4, 23-11-30	Residents, students, University West	8	4:1–4:8	25 min
5, 24-01-23	Real estate industry, service industry	2	5:1–5:2	1 h 34 min
6, 24-01-30	Startups and entrepreneurs	4	6:1–6:4	1 h 24 min
7, 24-02-13	Logistics and transport industry	2	7:1–7:2	1 h 32 min
8, 24-02-20	Nonprofit organizations	3	8:1–8:3	1 h 15 min

Source(s): Authors' own work

discuss how the platform could meet their needs, and consider its role in strengthening the city's attractiveness for diverse stakeholder groups. All workshops were audio-recorded, transcribed and supplemented with detailed field notes. Participation was voluntary and based on informed consent. Written information was provided in line with the Swedish Research Council's ethical guidelines, covering the study's purpose, anonymity and GDPR rights. Data handling followed University West's regulations and a formal data management plan to ensure secure storage, controlled access and research integrity.

The SCOT perspective guided the workshop design by prompting interview questions about how different stakeholder groups interpret the 3D map's potential uses, meanings and limitations. Specific attention was paid to identifying relevant social groups, their technological frames and their interpretative flexibility regarding 3D map applications. During the workshops, the facilitators explicitly explored how different actors envisioned the technology's role, the problems it might solve and their preferred design directions. In other words, participatory design theory was operationalized through the workshop structure itself, positioning participants as co-designers rather than passive respondents. Each session included hands-on platform interaction, collaborative visioning exercises and iterative feedback loops. Participants were invited to critique, modify and reimagine the platform's functionality.

3.3 Data analysis

Each workshop followed a structured participatory design protocol to progressively build understanding of 3D-map perceptions and possibilities. The workshops were interconnected through three analytical phases: an exploration phase (student workshops) to identify initial possibilities and challenges, a sectoral engagement phase (industry-specific workshops) to gather specialized insights and a synthesis phase (cross-cutting analysis) to identify convergent themes. This tiered approach enabled both depth in discussions within stakeholder groups and breadth in mapping interpretations and suggestions across diverse perspectives, directly supporting the development of the 3D map to include more advanced features inherent to digital platforms and the subsequent analysis of how different stakeholders may envision the 3D map's potential contribution to enhanced place attractiveness.

The analysis of the transcribed workshop data used an abductive approach to thematic analysis, moving iteratively between empirical data and theoretical concepts to identify meaningful patterns (Timmermans and Tavory, 2012; Braun and Clarke, 2006). This methodological approach was particularly appropriate for this study, as it facilitates the discovery of unanticipated insights from diverse stakeholder perspectives while enabling analysis guided by the theoretical framework that combines SCOT theory with participatory design principles and a relational interpretation of place attractiveness.

All researchers were involved throughout the coding process, and interpretations were continuously discussed and negotiated until agreement was reached. The analytical process unfolded in three iterative phases. During open coding, data segments were identified and labeled according to how stakeholders interpreted the 3D map's potential uses, meanings and limitations. This phase was guided by attentiveness to both the interpretative flexibility emphasized in SCOT and the user-centered design priorities inherent in participatory design theory. Labels were kept close to participants' own language and concerns: for instance, a real estate professional's remark about showing clients how sunlight changes around a property was coded as *functional visualization for decision support*; a student's suggestion about seeing which cafés or cultural spaces were nearby was coded as *everyday place navigation*; and a logistics actor's interest in simulating transport flows through the city was coded as *operational planning support*. Statements expressing a desire to trace how a

neighborhood had changed over time were labeled *temporal place memory*, while comments about wanting to add local knowledge or community information to the map were coded as *civic data integration*.

In the subsequent axial coding phase, relationships among initial codes were identified and consolidated into broader conceptual categories, reflecting how stakeholder interpretations connect to collaborative design processes and dimensions of place attractiveness. Attention was paid here to patterns of convergence and divergence across stakeholder groups, noting, for example, that while professional actors tended to articulate concrete functional requirements, students and civic actors more often expressed aspirational and identity-oriented visions for the platform.

Through selective coding, these categories were refined into six cross-cutting themes that represent significant mechanisms through which collaborative 3D mapping could enhance place attractiveness: enhanced visualization, situated user experience, integration of community resources, real-time data responsiveness, interactive citizen dialogue and temporal layering. A theme was retained if it appeared across at least two stakeholder clusters and could be linked to one or more theoretical constructs. To systematically map these connections, a coding matrix was used to link each theme to aspects of interpretative flexibility, participatory codesign, dimensions of place attractiveness and governance considerations. This matrix served as an analytical bridge between empirical patterns and the theoretical framework, ensuring conceptual coherence across the analysis and subsequent discussion.

4. Key findings and discussion

In this section, the six cross-cutting themes that emerged from the analysis are presented and discussed. Each theme is structured to show how it manifests across stakeholder groups, how it aligns with the SCOT perspective and participatory design theory, and how it relates to the relational and multidimensional understanding of place attractiveness outlined in the theoretical framework. The section concludes by synthesizing the themes into three interconnected theoretical mechanisms, highlighting both the potential and the tensions involved in framing 3D maps as socio-technical infrastructures for enhancing place attractiveness.

4.1 Enhanced visualization

This theme demonstrates how stakeholders attach divergent meanings to the same 3D visualization capability, illustrating both interpretative flexibility and unequal influence over platform development.

Enhanced visualization emerged as a shared priority across all stakeholder groups, yet with distinct interpretations reflecting their roles, interests and degrees of influence over platform development. Professional stakeholder groups expressed clear functional orientations. For real estate professionals, visualization was primarily seen as a client-oriented decision support tool: “The ability to show clients exactly how a property relates to its surroundings, including how sunlight changes throughout the day, would significantly improve the ability to match properties with client needs” (Informant 5:1). Logistics professionals framed it as an infrastructural layer for operational efficiency: “We currently spend a lot of time manually searching Google Maps and using AI to find suitable locations. A comprehensive digital twin would streamline this process considerably” (Informant 7:1), positioning the 3D map not only as a planning aid but also as a platform for infrastructural foresight.

Students, by contrast, engaged with visualization through an experiential lens: “It would be great to walk through the city virtually before even moving here ... to get a feeling for the

place” (Informant 2:4). Unlike the professional groups, students linked visualization not to organizational strategy but to subjective experience, emotional connection and belonging.

SCOT’s concept of interpretative flexibility (Bijker, 1995) is directly illustrated here: a single technological capability takes on different meanings depending on stakeholders’ technological frames (Klein and Kleinman, 2002), shaped by how groups are positioned in relation to the technology – as implementers, cocreators or imagined users. Rather than representing a fixed functionality, the visualization feature becomes socially differentiated, refracted through distinct institutional logics and experiential orientations. In Trollhättan’s case, the platform remains in a phase where meanings are still negotiated and competing visions coexist, indicating that stabilization has not yet privileged one dominant interpretation over others. From a participatory design perspective, this underscores the need for iterative, inclusive processes that enable different user groups to articulate, revise and reconcile their expectations. As Cumbo and Selwyn (2022) argue, participatory systems must accommodate situated knowledge while balancing tensions among personalization, standardization and scalability, tensions that surfaced clearly in the workshops but remained structurally unresolved.

In terms of place attractiveness, visualization serves as a multidimensional attractor. Consistent with multidimensional understandings of place attractiveness (e.g. Zenker, 2011; Zenker and Petersen, 2014), it strengthens functional qualities, such as spatial legibility for logistics; social-cultural qualities, such as orientation and belonging for prospective residents; and symbolic qualities tied to identity and attachment. Notably, symbolic and affective meanings were expressed less frequently by institutionally powerful actors, indicating that without deliberate governance support, these dimensions risk marginalization during platform development.

4.2 *Situated user experience*

This theme demonstrates how accessibility and personalization create tensions between democratic inclusion and differentiated professional needs, directly tapping into the recognized tension between simplicity and personalization as opposing design features in 3D map development.

Situated user experience reflects how stakeholders differ in their expectations, competencies and capacities to use and reimagine the 3D map. Students and nonprofit actors emphasized simplicity and low-threshold access as prerequisites for meaningful participation. As one student put it: “It needs to be accessible and easy to navigate, especially for people who aren’t tech-savvy. That’s the only way everyone can get involved” (Informant 3:1), while a nonprofit representative added: “3D maps don’t need to be technically advanced or ‘pretty’. They just must be user-friendly and accessible” (Informant 8:1). Students also expressed a desire for adaptive functionality: “Users should be able to create personalized profiles or life-cycle-based maps to receive information tailored to their current life situations” (Informant 2:1).

Professional actors articulated more strategic visions. Entrepreneurs envisioned differentiated access models: “The interface needs to be intuitive enough for casual users while still offering depth for business applications, perhaps through a tiered access system” (Informant 6:4) and saw potential in location-based targeting: “You could use it for geographically targeted offers like shops or cafés promoting themselves to nearby users” (Informant 6:4). Real estate professionals also called for content customization: “Buyers have vastly different priorities. Young families want to know about schools and playgrounds, while others might prioritize proximity to restaurants or public transport. Allowing them to

customize what information they see would make the platform much more valuable” (Informant 5:1).

These divergent expectations reveal that accessibility is not merely a matter of user-friendliness but also of resource allocation, market positioning and value extraction. Interpretative flexibility (Bijker, 1995) is evident again: the same features, such as accessibility, usability and customization, take on fundamentally different meanings depending on users’ institutional contexts. Participatory design theory emphasizes designing *with* users rather than *for* them, but, as Cumbo and Selwyn (2022) note, not all groups have equal capacity to influence that evolution. The workshops illustrate that stakeholders differ in their capacity to articulate technically actionable demands. The participatory paradox is thus visible here: inclusive intentions coexist with structural asymmetries that shape which visions are expressed confidently and which remain speculative. Implementing accessibility and personalization ultimately requires governance choices about interface structures, data flows and role management, decisions that determine who can access what, under what conditions and for whose benefit, reflecting the tensions between openness and control within participatory technology design. Meijer and Bolívar (2016) highlight the importance of addressing these questions and tensions, as they directly shape a system’s legitimacy and long-term viability.

In terms of place attractiveness, situated user experience supports both the social-cultural and functional dimensions in Zenker and Braun’s (2017) framework. Accessibility signals institutional openness and responsiveness, while personalization enhances the individual’s capacity to navigate urban space in ways that resonate with personal needs. When a platform reflects a user’s circumstances, it can also foster affective resonance, thereby supporting attachment, recognition and belonging as subtle yet powerful contributors to place attractiveness.

4.3 Integration of community resources

This theme shows how stakeholders define community resources differently based on institutional frames, shaping what becomes visible and valuable in developing the 3D map.

Despite variations in specific content demands, all stakeholder groups expected the platform to function as a layered information infrastructure that reflects and coordinates everyday urban life. However, what counts as relevant community data differed markedly by institutional logic. Real estate actors emphasized commercial amenities: “We would want to include data on schools, exercise trails, and playgrounds. It’s what buyers ask about before anything else” (Informant 5:1), framing community resources as tools for spatial legibility and investment decision-making. Entrepreneurs focused on business intelligence: “We want to see what’s around [...] cafés, stores, pricing levels [...] basically, how lively and functional the area is” (Informant 6:4), treating community resources as market intelligence rather than residential amenities. Nonprofit actors prioritized civic engagement: “Having all sports facilities mapped with capacity, facilities and upcoming events would make it much easier for our members and visitors to engage with what’s going on in the city” (Informant 8:2), constructing community resources through a civic-engagement frame oriented toward belonging and social cohesion.

These divergent interpretations confirm SCOT’s concept of relevant social groups (Pinch and Bijker, 1984), as each stakeholder cluster constructs community resources through its institutional position and relationship to place. The platform becomes a site where competing definitions of “community value” are negotiated rather than simply aggregated; thus, the 3D map must be open to contextual adaptation, aligning with participatory design principles that emphasize iterative cocreation and the accommodation of diverse user realities (Cumbo and Selwyn, 2022). Yet this flexibility must be balanced with data availability, interoperability

and platform manageability. Integrating diverse community data requires data-sharing agreements, technical interoperability and cross-sector coordination, which Meijer and Bolívar (2016) identify as a core governance challenge in urban digital innovation. Without these institutional arrangements, integration risks remaining fragmented or symbolic rather than structurally embedded in platform architecture.

The 3D map was envisioned across stakeholder groups not merely as a spatial visualization tool but as a dynamic, socially embedded system that enhances orientation, supports decision-making and strengthens place identity. This theme contributes to multiple dimensions of place attractiveness (e.g. Zenker, 2011; Zenker and Petersen, 2014): functionally, by enhancing spatial legibility and decision-making capacity through the integration of community data; economically, by supporting market transparency and entrepreneurial positioning; socially and culturally, by strengthening civic participation and community coordination; and symbolically, by rendering visible which aspects of urban life are considered worthy of representation, thereby shaping collective urban place identity. As such, the 3D map operates as a socio-technical boundary object that maintains coherence across user groups while accommodating divergent interpretations of community value.

4.4 Real-time data responsiveness

This theme demonstrates how real-time functionality is framed as convenience, coordination or commercial intelligence, further highlighting that the same technical feature takes on different meanings across stakeholder groups.

Across all groups, real-time responsiveness was consistently framed as desirable, albeit for divergent reasons. Students emphasized everyday navigation: “Real-time data on traffic flows, parking availability, and weather conditions would really help when planning your day” (Informant 3:1), positioning real-time information as enhancing personal autonomy and quality of life in daily navigation. For logistics professionals, real-time data served operational coordination: “We need access to current data on transport route accessibility and infrastructure status” (Informant 7:1), positioning the 3D map less as a user interface and more as an infrastructural backbone for multiscalar planning. Entrepreneurs focused on behavioral analytics: “Understanding which streets have the highest foot traffic at different times of day would help us decide where to place vendors and how to target marketing activities” (Informant 6:3), envisioning a market intelligence frame in which real-time data becomes strategic business information.

Although real-time functionality is technically uniform, its meaning spans time-saving utility, logistical infrastructure, and competitive market intelligence. The same infrastructural capability is thus strategically reframed across stakeholder groups, embedded in distinct institutional priorities and operational rationalities. The design of real-time features, therefore, cannot assume a universal user profile; instead, it needs to accommodate multiple institutional logics and practical needs. Governance implications are embedded within this theme, even when stakeholders do not explicitly mention them. The expectation of seamless, real-time data access implies institutional arrangements for data ownership, management and sharing between municipal systems and private data providers, as well as clear policies on accountability and data quality. Without such arrangements, the promise of responsiveness risks becoming uneven, with some groups better positioned to benefit than others.

In terms of place attractiveness, real-time responsiveness strengthens both the functional and social-cultural dimensions (Zenker, 2011; Zenker and Braun, 2017). Real-time data enhances the platform’s utility as a decision-making aid across scales, from personal navigation to organizational logistics, and supports temporal awareness and everyday orientation. From a relational perspective, responsiveness shapes how stakeholders evaluate

the city's reliability, accessibility and dynamism over time. Rather than being merely a technical feature, it signals an aspiration toward a more temporally responsive and coordinated urban interface.

4.5 *Interactive citizen dialogue*

This theme highlights strong stakeholder interest in dialogic and participatory urban governance through the 3D map platform.

Across all stakeholder groups, an aspiration emerged for the 3D map to function not merely as an informational platform but as a medium for interactive civic engagement and two-way dialogue. This vision extended beyond traditional public consultation toward a more continuous, responsive communicative infrastructure between municipalities and diverse urban actors. Students associated the platform with direct civic influence: "It would be great if you could submit suggestions directly in the platform. Like if you had an idea for improving a public space or wanted to ask a question about a project" (Informant 2:4), reflecting a democratic participation technological frame in which value derives from enabling civic agency rather than passive observation. Entrepreneurs emphasized strategic responsiveness: "Inviting Trollhättan's residents to a dialogue on urban development can create a tool relevant to their needs" (Informant 6:2), positioning dialogue as a mechanism for market adaptation and stakeholder alignment. Real estate professionals highlighted the platform's potential to facilitate planning transparency: "[...] showing how a new housing project might change the area could open up better dialogue with potential buyers, especially if the process is ongoing and visual" (field notes), framing dialogue as a mechanism for reducing transaction uncertainty and building client trust. For nonprofit actors, the communicative function was tied to accountability: "People don't usually know about decisions until it's too late. If we could follow projects in real-time and comment, more people would care" (Informant 8:2), reflecting a civic transparency frame in which dialogue democratizes access to information.

The diversity of these technological frames again confirms interpretative flexibility (Bijker, 1995) and underscores the importance of engaging with relevant social groups that have fundamentally different relationships to civic participation and institutional power (Pinch and Bijker, 1984). From a governance standpoint, for dialogue to be more than symbolic, mechanisms need to translate citizen input into institutional action, which requires organizational capacity for responsiveness, knowledge management, and cross-departmental coordination, a core challenge in urban digital innovation identified by Meijer and Bolívar (2016).

The implications for place attractiveness are particularly strong in the social-cultural and symbolic dimensions (Zenker and Braun, 2017). A platform that fosters dialogue does not merely represent the city; it helps construct it as a shared, participatory project, fostering a sense of ownership, belonging and emotional investment. By creating visible channels for civic engagement, the platform can also enhance trust in municipal governance, an important component of place-based legitimacy and attractiveness.

4.6 *Temporal place representation*

This theme illustrates how stakeholders envision 3D mapping as a representation of the past, present and future, thereby extending place attractiveness temporally.

While 3D maps are often seen as representations of current urban conditions, stakeholders articulated a broader temporal ambition, envisioning the platform as a layered system that supports retrospective analysis, present-day decision-making and forward-looking planning. Real estate actors expressed particular interest in historical layers: "Adding historical layers

to the map so users could see older images of neighborhoods and properties would be great, especially for buyers interested in renovation or who care about the identity of a place” (Informant 6:4), with one adding that “this could be operationalized through geo-tagged images from the city’s archive to recreate how Trollhättan looked at different times in the past,” reflecting a heritage-value technological frame in which temporal data mobilizes urban history as an asset for property attractiveness and place attachment. Entrepreneurs and planners focused on future-oriented affordances: “Being able to toggle between current reality, historical views and plans would create a powerful narrative about the city’s evolution” (Informant 6:1), reflecting a strategic development frame in which temporal visualization enables long-term planning and investment alignment.

SCOT helps make sense of these divergent temporal engagements: technologies acquire meaning not only through present-day use but also through retrospective reinterpretation and anticipatory projection. Stakeholders thus construct not only the immediate meanings of the 3D map but also its temporal trajectory, the representation of historical information, the interpretation of current conditions and the visualization of future scenarios. Temporal visualization becomes a contested socio-technical practice that encodes power, memory and aspiration into the urban interface. Participatory design resonates with this ambition, as features of historical reconstruction and scenario planning shape how users relate to the city and imagine their roles in shaping its future, extending [Cumbo and Selwyn’s \(2022\)](#) emphasis on contextual adaptation across temporal as well as spatial dimensions.

From a governance perspective, the inclusion of historical and future data layers raises substantive questions: whose histories are represented, which futures are considered plausible, and who determines the boundaries between vision and speculation. These are deeply political questions tied to legitimacy and strategic agenda-setting, requiring deliberate governance mechanisms that are transparent, participatory and reflexive, reflecting [Meijer and Bolívar’s \(2016\)](#) knowledge management challenges.

This theme contributes particularly to the symbolic-emotional and functional dimensions of place attractiveness ([Zenker, 2011](#); [Zenker and Braun, 2017](#)). Symbolically, the capacity to visualize urban evolution fosters an emotional connection to place through continuity and transformation. Functionally, it enhances users’ capacity to make sense of spatial change, understand planning rationales and anticipate future developments, supporting not only more informed navigation of the city but also more reflective engagement with its identity, legacy and imagined future. From a relational perspective, temporal layering reinforces the idea that attractiveness is not static but continuously reinterpreted over time.

4.7 From an administrative tool to a collaborative place attractiveness

Synthesizing these six cross-cutting themes through the SCOT perspective and participatory design reveals how stakeholder cocreation systematically transforms 3D mapping from an administrative tool into a multidimensional platform for place attractiveness. Rather than merely reflecting preexisting urban qualities, the platform becomes a socio-technical arena where urban value is negotiated, prioritized and potentially institutionalized. This transformation operates through three interconnected theoretical mechanisms, as identified in the analysis:

- (1) Interpretative flexibility as multidimensional enhancement: stakeholder diversity generates competing yet potentially complementary pathways through which multidimensional urban appeal is articulated, prioritized and established within the same technical infrastructure.

- (2) Participatory design as governance innovation: stakeholder diversity requires governance arrangements capable of mediating discursive asymmetries and preventing the institutional consolidation of narrowly professionalized interpretations of attractiveness.
- (3) Temporal extension of place attractiveness: stakeholders conceptualize attractiveness as spanning past–present–future, thereby extending place attractiveness theory beyond present-state evaluations toward digitally mediated temporal engagement.

Integrating these mechanisms shows how a socio-technical infrastructure, such as a 3D map, can harbor competing interpretations and support diverse uses, while also strengthening the functional, social, economic and symbolic dimensions of place attractiveness, as conceptualized in multidimensional place branding research. The synthesis also introduces a temporal dimension and acknowledges inherent risks related to discursive asymmetries and potential institutional prioritization in platform design and development.

4.7.1 Mechanism 1: interpretative flexibility as multidimensional enhancement. The systematic application of Bijker's (1995) concept of interpretative flexibility across all themes shows that identical technical capabilities acquire multiple meanings for different stakeholders, depending on the technological frames they inhabit (Klein and Kleinman, 2002). For example, themes such as enhanced visualization and real-time data responsiveness operate within distinct technological frames: commercial and market intelligence (real estate professionals and entrepreneurs), operational (logistics professionals) and experiential-emotional (students). These frames do not merely coexist; they map onto and activate different dimensions of place attractiveness (Zenker and Braun, 2017), for example, the functional dimension (operational coordination and reliability frames), the social-cultural dimension (navigation and temporal awareness frames), the economic dimension (investment and commerce frames) and the symbolic dimension (identity and belonging frames). This pattern suggests that place attractiveness enhancement occurs not through single-dimension targeting but through curating interpretative multiplicity, allowing diverse stakeholder frames to coexist on the same platform without fragmenting the user experience.

4.7.2 Mechanism 2: participatory design as governance innovation. The analysis reveals that participatory design theory's core principles of iterative, user-driven development generate not only implications for designing 3D mapping technology but also structural governance transformations. For example, the theme of situated user experience demonstrates the need for adaptive inclusivity frameworks that balance democratic access (students and nonprofits) with differentiated functionality (entrepreneurs/real estate), challenging traditional either/or approaches to inclusive design. Also, interactive citizen dialogue emphasizes the demand for communicative democracy infrastructure that transforms a platform's functions from information delivery to an infrastructure for bidirectional civic engagement (including, e.g. feedback capture and response loops). These capacities align with the knowledge-management and cross-boundary coordination mechanisms highlighted by, for example, Meijer and Bolívar (2016).

These findings extend participatory design theory by showing how digital platform initiatives in cities necessitate governance innovation, creating processes, roles and data policies that can capture and sustain multiple technological frames simultaneously while maintaining platform coherence.

4.7.3 Mechanism 3: temporal extension of place attractiveness. Stakeholders conceptualized the 3D map as a temporally layered interface that integrates historical memory, present conditions and future scenarios. The theme of temporal place representation reveals demands for historical visualization (real estate professionals) and future scenario

modeling (entrepreneurs and planners), extending the dimensions of place attractiveness beyond static, present-focused characteristics toward temporally responsive and participatory forms of engagement. This suggests that Zenker and Braun's (2017) symbolic-emotional dimension can be theoretically refined by expanding its temporal scope to include both historical memory and future imagination as constitutive elements of place appeal.

Consequently, place attractiveness should be theorized and operationalized as temporal engagement rather than solely as a present-state representation, addressing an underdeveloped dimension in current place attractiveness research and practice, yet one that is receiving increasing attention in the broader place management literature.

4.7.4 Discursive asymmetries and design tensions. Analysis of the empirical data and synthesis of the six cross-cutting themes revealed a consistent discursive asymmetry in how stakeholders expressed their perceptions of the 3D map and its potential. Across all themes, professional stakeholders and institutional actors (real estate, logistics and entrepreneurs) articulated concrete ideas and recommendations for the platform, suggesting what the 3D map platform "could do" or "should do." students (residents) and civic actors, by contrast, offered more aspirational contributions, posing questions and discussing possibilities rather than advocating direct development proposals.

Such discursive asymmetry reflects stakeholders' institutional positions, indicating that some groups may have greater authority than others and, thus, greater capacity to shape the 3D-map platform's future direction. Professional actors speak from within organizational mandates and frame the platform through existing workflows and sectoral needs. Students and civic actors, by contrast, engage with the 3D map as prospective or potential users, offering more speculative, future-oriented ideas. Their input is less tied to established routines and more reflective of different temporal and functional relationships with the technology. These differences illustrate how technological frames are conditioned not only by interests but also by institutional proximity to implementation and decision-making. This asymmetry highlights insider/outsider dynamics that need to be considered to avoid privileging solely professional and/or administrative perspectives in municipal technology innovation and place attractiveness initiatives (Hidman, 2018; Nedomysl, 2010). Here, insider/outsider does not refer to residency status but to differential capacity to define and institutionalize particular visions of attractiveness. In small- and mid-sized cities, where governance structures are often closely networked and resource-constrained, such asymmetries may be amplified. The risk is not necessarily deliberate exclusion but the gradual normalization of professionally articulated priorities as default design directions.

An example of how discursive asymmetries and uneven prioritization could play a central role in designing and developing 3D map platforms is the tension between simplicity and personalization. For example, noninstitutional actors (residents and nonprofit organizations) expressed a desire for broad inclusion and simple, easily navigable features. While these stakeholders also advocate for personalization opportunities, professional actors (real estate, entrepreneurs and logistics) demand personalization and contextual adaptation that require advanced technical solutions and design mechanisms that easily overshadow simple navigation features and democratic inclusion. Successful 3D map development in small- and mid-sized cities, therefore, depends on governance arrangements capable of recognizing and mediating asymmetries and design tensions, ensuring that interpretative multiplicity is maintained rather than narrowed during platform stabilization.

The analysis demonstrates that collaborative 3D mapping's contribution to place attractiveness operates through integrated stakeholder cocreation processes that enable diverse interpretations to coexist and mutually reinforce urban appeal. For small- and mid-sized cities, platform success depends less on technical sophistication than on governance

capacities to accommodate interpretative flexibility while maintaining institutional coherence. By foregrounding discursive asymmetries, the framework underscores that 3D mapping platforms function as evolving socio-technical arenas in which competing visions of the city are negotiated, stabilized and institutionalized over time.

Overall, the findings challenge conventional assumptions about digital urban infrastructure by showing how participatory processes generate mechanisms of place attractiveness that extend beyond current theoretical conceptualizations, requiring municipalities to view platforms as evolving socio-technical systems rather than fixed technical solutions. See a summary of the findings in [Table 2](#).

These theoretical mechanisms provide the foundation for understanding how municipalities can practically implement collaborative 3D mapping to enhance place attractiveness, as discussed in the following section.

5. Conclusions and contributions

This study set out to explore the needs, expectations and aspirations articulated by different stakeholders regarding collaborative 3D mapping initiatives and examine how these perspectives, when enacted through cocreation processes, shape and negotiate place attractiveness in small- and mid-sized cities. Across the workshops, stakeholders envisioned 3D mapping as more than an administrative tool, encompassing broader socio-relational aspirations that challenge conventional 3D mapping assumptions and align with previous critiques of overly technical framings of urban digital systems ([Hämäläinen, 2020](#); [Schrotter and Hürzeler, 2020](#)). Various stakeholders articulated needs that consistently transcend narrow technical requirements, emphasizing experiential, symbolic, relational and governance-oriented functions, consistent with contemporary research on place attractiveness as a multidimensional and socially produced phenomenon ([Zenker and Petersen, 2014](#); [Hidman, 2018](#)).

The six identified cross-cutting themes reveal how stakeholder interpretations shape technological meaning and the articulation of place attractiveness, and how identical platform features are interpreted differently depending on stakeholders' roles and lived experiences. The findings show that 3D mapping acquires meaning not only through technical configuration but also through ongoing socio-institutional negotiation, interpretative flexibility and divergent technological frames ([Klein and Kleinman, 2002](#)). Opportunities for enhanced place attractiveness thus emerge not as a predefined outcome of technological implementation but as a negotiated and institutionally mediated effect of socio-technical interaction.

The findings suggest that participatory and socio-technical approaches to 3D mapping enable these platforms to function as arenas where place attractiveness is shaped and redefined. The findings also substantiate this claim by showing how identical technical features acquire multiple meanings that collectively extend the urban value of the platform. For example, enhanced visualization may increase functional clarity (from a logistics perspective), cognitive orientation (as perceived by students and other residents) and symbolic attachment (among visitors and prospective residents). Interactive citizen dialogue contributes to social attractiveness by supporting trust and participation ([Zenker and Petersen, 2014](#)). Thus, rather than serving as a static representation of urban space, 3D platforms emerge as socio-technical infrastructures through which place attractiveness is continuously negotiated, enacted and reproduced.

5.1 Theoretical contributions

The central theoretical contribution of this study is an integrated framework that brings together SCOT, participatory design theory and place attractiveness research to explain how

Table 2. Summary of key findings: cross-cutting themes, stakeholder frames and implications for place attractiveness

Cross-cutting theme	Dominant stakeholder interpretations	SCOT and participatory design implications	Dimensions of place attractiveness activated
Enhanced visualization	<i>Professionals:</i> decision support, infrastructural efficiency <i>Students and nonprofsts:</i> experiential understanding, emotional connection, sense of belonging	Strong <i>interpretative flexibility</i> ; one technical feature holds multiple meanings depending on technological frames and institutional positioning. Lack of stabilization highlights need for inclusive, iterative participatory design to prevent dominance of professional frames	<i>Functional:</i> spatial legibility, efficiency <i>Social-cultural:</i> orientation, belonging <i>Symbolic:</i> identity, attachment
Situated user experience	<i>Professionals:</i> personalization, tiered access, strategic targeting <i>Students and nonprofsts:</i> simplicity, accessibility, low-threshold entry	Reveals <i>participatory paradox</i> ; inclusive intentions coexist with unequal capacity to articulate and institutionalize demands Governance choices determine whose usability needs are prioritized	<i>Functional:</i> navigation, usability <i>Social-cultural:</i> recognition, inclusion <i>Affective:</i> personal resonance with place
Integration of community resources	<i>Professionals:</i> amenities for investment decisions, market intelligence, vitality indicators <i>Students and nonprofsts:</i> civic infrastructure, community engagement	Illustrates <i>relevant social groups</i> constructing “community value” differently Platform becomes a boundary object requiring governance mechanisms for data sharing, interoperability and coordination	<i>Functional:</i> decision-making capacity <i>Economic:</i> market transparency <i>Social-cultural:</i> civic participation <i>Symbolic:</i> what is rendered visible as “the community”
Real-time data responsiveness	<i>Professionals:</i> operational coordination, behavioral analytics, competitive intelligence <i>Students and nonprofsts:</i> everyday convenience and autonomy	Same <i>functionality reframed</i> across institutional logics Raises implicit governance issues (data ownership, quality, access), affecting who benefits from responsiveness	<i>Functional:</i> reliability, coordination <i>Social-cultural:</i> temporal awareness, everyday orientation
Interactive citizen dialogue	<i>Professionals:</i> trust-building, strategic responsiveness <i>Students and nonprofsts:</i> direct civic influence, transparency and accountability	Confirms <i>interpretative flexibility</i> and exposes need for <i>institutional response capacity</i> ; without feedback loops, participation risks becoming symbolic	<i>Social-cultural:</i> belonging, trust <i>Symbolic:</i> city as shared, participatory project
Temporal place representation	<i>Professionals:</i> historical layers, heritage value, future scenarios, strategic visioning <i>Students and nonprofsts:</i> visualization opportunities	<i>Extends SCOT temporally:</i> technologies gain meaning through memory and anticipation Raises political questions about whose histories and futures are visualized	<i>Symbolic:</i> continuity, identity, place attractiveness as evolving over time <i>Functional:</i> sensemaking, anticipation

Source(s): Authors’ own work

stakeholder cocreation on urban digital platforms simultaneously shapes and negotiates multiple dimensions of place attractiveness. By mobilizing and extending SCOT's concept of interpretative flexibility (Bijker, 1995) into digital planning contexts, the framework shows that identical technical capabilities can acquire divergent meanings depending on stakeholders' institutional roles and technological frames (Klein and Kleinman, 2002). Rather than treating interpretative multiplicity as a temporary instability to be resolved, the study conceptualizes it as a generative mechanism through which multidimensional urban attractiveness is articulated, prioritized and stabilized. In doing so, the framework repositions 3D mapping from a technical planning instrument to a socio-technical infrastructure through which urban attractiveness is actively coproduced and selectively institutionalized.

The framework further advances participatory design theory in urban governance contexts by identifying the governance conditions required to sustain inclusive digital cocreation. The findings show that meaningful participation depends on institutional arrangements that address unequal discursive authority, varying digital literacy and the structural risk that civic perspectives are overshadowed by professionally articulated frames. This more firmly connects participatory design to place management scholarship on insider/outsider tensions (Hidman, 2018; Lysgård and Cruickshank, 2013; Cumbo and Selwyn, 2022) and positions governance innovation as a precondition for sustaining interpretative plurality rather than merely facilitating consultation.

Perhaps the most distinctive contribution concerns place attractiveness research itself. Current frameworks, including the resident-oriented approach (Zenker and Braun, 2017), tend to emphasize present-state evaluations of place rather than explicitly theorizing its temporal mediation. The empirical findings challenge this assumption: stakeholders consistently conceptualize attractiveness as inherently temporal, with historical visualization fostering memory and symbolic attachment and future scenario modeling supporting strategic identification and anticipatory investment. The findings demonstrate that interpretative flexibility in digital place platforms also operates temporally (cf. Liang *et al.*, 2022; Tu *et al.*, 2020), referring to the capacity of digital platforms to mediate and connect past, present and future urban perspectives, in ways that deepen rather than merely represent place identity (Kavaratzis and Kalandides, 2015), and argue that the symbolic-emotional dimension of place attractiveness requires expansion to encompass this temporal dynamic.

5.2 Implications for place management

The study has important implications for urban place management and digital placemaking initiatives, especially in small- and mid-sized cities. To operationalize the study's findings, municipalities need to address not only technology design strategies but also explicit governance cocreation models:

- Role and access model that supports interpretative multiplicity, enabling differentiated public, practitioner and administrative views and interpretations without fragmenting the system. This aligns with SCOT's emphasis on relevant social groups shaping technological meaning (Pinch and Bijker, 1984).
- Data stewardship frameworks for ownership, quality, update frequency and openness, supporting both real-time data responsiveness and temporal layers (as in, e.g. Najafi *et al.*, 2023; Damgrave *et al.*, 2023).
- A structured participation pipeline that supports processes to capture stakeholder feedback and inform municipal decision-making, ensuring engagement is substantive

rather than symbolic (Meijer and Bolívar, 2016), acknowledging potential discursive power asymmetries and balancing insider/outsider perspectives.

- Cross-departmental coordination, bringing together product owners, data stewards and community liaisons to align technical and civic logics (as in, e.g. Broccardo *et al.*, 2019; White *et al.*, 2021).
- An evaluation model linking design features and cocreation processes to place attractiveness outcomes (functional, social, economic and symbolic), using measurable indicators such as orientation success, trust, heritage engagement and investment to assess these outcomes (Zenker and Braun, 2017).

Although these governance principles are grounded in the empirical context of Trollhättan, the single case study design demonstrates how analytically rich insights into socio-technical negotiation processes can yield transferable lessons for similar digitalization initiatives in small- and mid-sized cities. Future research may further refine and test these principles across diverse governance settings and comparative contexts. Beyond the Trollhättan case, the study contributes to a growing body of research on how digital urban platforms restructure the conditions of place cocreation in ways that analog placemaking processes cannot replicate. Whereas non-digital participatory formats produce place meanings sequentially and through bounded encounters (cf. Cilliers and Timmermans, 2014; Saßmannshausen *et al.*, 2021), digital platforms embed competing stakeholder framings simultaneously and persistently within a shared infrastructure. This structural difference calls for a reframing of how place attractiveness theory conceptualizes participation: not as input preceding design decisions, but as an ongoing process in which urban meaning is continuously negotiated within, and partly constituted by, the platform itself. Future research could also further explore the participatory paradox identified in this study, particularly how increased opportunities for engagement through digital platforms may simultaneously enable and constrain meaningful stakeholder participation.

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