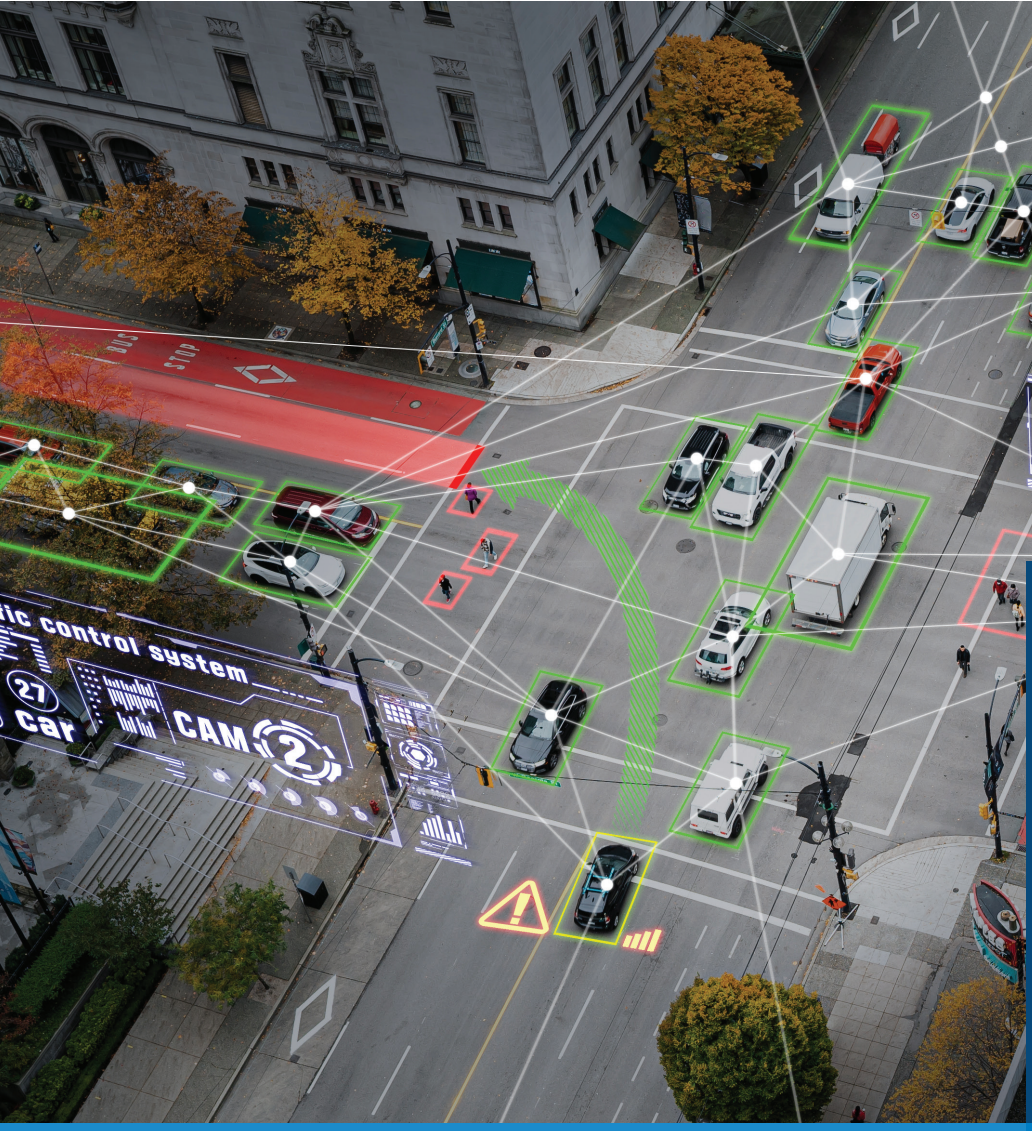

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Editorial

Smart Engagement and Smart Urbanism: Integrating "The Smart" Into Participatory Planning and Community Engagement

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Abstract
The smart city epitomizes a new paradigm shift in urban planning, policy, and cities. Smart cities require and are powered by smart city principles to succeed, including smart technologies, smart infrastructure, and smart governance; however, they also need to engage closely with the citizens who are most affected by the deployment of the smart city and who also embrace the diverse perspectives, experiences, and opportunities of living in smart cities, i.e., smart engagement. What would be forms of collaborative democracy and inclusive citizen participation in smart city planning? To what extent can smart city planning respond and address inequality, justice, and social and digital division? How can we create community-based climate change planning with the smart? What would be a smart community platform that supports smart engagement, and how do cities around the world establish smart city policy and assess the impact on smart engagement? This thematic issue aims to answer these questions by exploring new visions, facets and methods, practices, and tools for enabling smart engagement. Drawing on research from various countries and cities across the world, the contributions bring new prospects of smart engagement and smart urbanism and illuminate how the theory, plan and policy, and practices of smart engagements are binding to the extent of citizen participation and engagement in smart cities.

Keywords
community engagement; inclusive planning; smart engagement; smart governance; smart urbanism

Issue
This editorial is part of the issue "Smart Engagement With Citizens: Integrating "the Smart" Into Inclusive Public Participation and Community Planning" edited by Jin-Kyu Jung (University of Washington) and Jung Eun Kang (Pusan National University).

1. Introduction

Space evolves and always becomes something. The theory of space lays the foundation for us to gain new insights into urban space. The meanings of space are contextualized not only by physical but also by social, cultural, political, historical, and now digital environments of people's everyday experiences. We take a somewhat conscious approach and practice of deciphering urban spaces through back-and-forth negotiations between different conceptualizations to fully reveal and (re-)value urban "spatiality" that might not be so visible from its current outward appearance. Re-imaging urban spatiality requires a creative re-thinking of space, and it is critical or even a pre-requisite for understanding urban transformation like smart cities and smart urbanism.

The smart city discourse represents a new paradigm shift in urban planning and cities. Smart cities require and are powered by smart city principles to succeed, including smart technologies, infrastructure, and governance; however, they also need to engage closely with the citizens in embracing the diverse perspectives, experiences, and opportunities of living in smart cities. Creative engagements/encounters with ordinary citizens are essential for unbinding possibilities of creating inclusive smart communities that enhance citizen participation, providing meaningful educated information, advocating for greater equity in public policies, and ultimately

empowering citizens (Coe et al., 2001; Harvey, 2000; Visvizi & Lytras, 2019; Zukin, 1995).

The smart city discourses often focus on a techno-centered digital solution to urban problems/issues to make cities more responsive, efficient, sustainable, and intelligent. It considers the use of technical or technological infrastructures and interventions as a means to ensure optimum efficiency with regard to urban planning and sustainable development (Goodman et al., 2020; Hollands, 2008; Roche, 2014). However, smart cities can also be built based more on collaborative, democratic approaches in which cities provide access to data and allow citizens to be part of the urban innovation process, thus building city governance through open and participatory people-centric approaches (Cardullo & Kitchin, 2019; Helgason, 2002; Lee & Lee, 2014; O'Grady & O'Hare, 2012). Community engagement and citizen participation are not exclusive to smart cities and smart city planning (Arnstein, 1967; Innes & Booher, 2004; Staeheli, 2005); however, smart cities have shed new light on these concepts and practices by providing new means to enable inclusive public citizen participation in the urban and community planning process. There is a potential for smart engagement to represent the kind of direct democracy and participatory planning that define a vibrant civil society, with citizens engaged as active participants in the inclusive planning process with the ability to connect humans through physical, digital, online, and hybrid engagement.

This thematic issue aims to explore various new visions, facets and methods, practices, and tools of smart engagement, in which smart technologies, infrastructure and governance, and inclusive planning processes foster social inclusion, democratization, communications, and engagements with the citizens. They bind the prospect of smart communities in which citizens are actively involved in designing smart cities as users/consumers, as well as participants and co-producers. This thematic issue also responds to the need to understand how citizen engagement in smart city planning is practiced in different contexts, in particular, drawn from empirical case studies from transnational perspectives and evidence.

2. Overview of the Thematic Issue

The first article by Anderson and Jung (2023) explores alternative possibilities for cooperative, equitable, and participatory forms of smart urbanism grounded in community and place-based resources and priorities. They connect these possibilities to ongoing debates and experiments with commons and commoning in relation to two examples from community organizing in Seattle, Washington, USA—King County Equity Now and The Black Brilliance Research Project. They are gesturing toward more generative open-ended "smart" processes that engage a heterogeneous and *already* existing significant amount of community-embedded and place-based knowledge, capabilities, and institutional capacities, and how these could be central within smart urbanist orientations. They suggest "smart commoning" as a conceptual and processual question rather than a practical or technocratic one and what and how it may afford us, not just a simple critique to the often troubling agendas behind smart urbanism or the gaps between smart ambitions and their implementation, but an effort for thinking deeply about the smart technologies, processes, models, and rules of shared engagement and forms of commitment and resource cultivation that could augment and develop existing urban place-based community knowledge and capacity and social infrastructures. It prompts us to think about how and what smart digital technologies, innovations, and processes can be used to enhance these.

By undertaking an integrative review of the literature and national planning policies across Britain, Charlton et al. (2023) provide an updated narrative around smarter engagement in planning that can recontextualize the meaningful translation of data into decisions via human judgment and knowledge. They present a "digital turn" in the planning systems with the emerging discussions around PlanTech in policy, industry, and research and keenly point out the need for the policy to adopt "phygital" (both digital and physical) methods to ensure high-quality citizen input and to improve their engagement in planning. Their proposed conceptual model for participatory phygital planning identifies seven characteristics of smart engagement (e.g., interoperability, integration, intelligence, inclusion, intentionality, interfaces, and invisibility) and three pillars for smart engagement. (e.g., well-informed residents, well-resourced planners and municipalities, and methods for public participation).

Choo et al. (2023) analyze the various approaches to citizen engagement in South Korea, particularly the living labs. The article identifies the barriers that discourage sustainable citizen engagement and the inclusiveness of smart city plans (SCPs). In South Korea, the Act on the Promotion of Smart City Development and Industry requires all local governments to have an SCP before initiating a smart city project, and more than 20 percent of all cities in Korea have adopted SCPs as of 2022 (The Ministry of Land, Infrastructure, and Transport, 2021). The living lab, as an active approach for citizen participation in urban planning, is widely utilized in South Korea's SCPs; however, Choo et al. argued that most local governments have hitherto only conducted living labs in a limited capacity, for example, only for identifying issues but have never moved up to more participatory planning stages, such as problem-solving and implementation.

Two articles particularly point out a need for more representations of marginalized populations in the planning process. By reviewing planning documents and engagement data from five small cities in the USA, Kashem and Gallo (2023) analyze how racial and ethnic minority communities are participating in the planning process and what kinds of smart community engagement methods are being applied. Shtebunaev et al.

(2023) identify key considerations for planners and smart city practitioners to engage with the youth, specifically teenagers, who are assumed to possess the necessary digital skills; however, they are often overlooked in the participatory planning processes. Their findings show continuous barriers to participation for minority and marginalized populations and the need to provide different modes of public engagement opportunities for a diverse group based on their preferences, including multiple platforms, such as online, radio, newsletters, blogs, and newspapers, and also in various languages. Young people are usually marginalized as not present but as "future" citizens. Teenagers, as "present" citizens, are aware of and perceive digital technologies and smart cities, and they have critical perspectives on smart city models and future smart city visions and aspirations. The engagements with marginalized groups in smart city planning require a proactive and even transformative process that includes diverse voices, allowing alternative conversations about values and visions of smartness in creating future cities.

Devine-Wright and Davies (2023) rightly so warn of uncritical and generic use of concepts like "smart" and "quadruple helix" and how they may become "empty signifiers" (Caprotti & Cowley, 2019) and, in their terms, "rhetorical devices" used by government and academia to promote and legitimate, rather than improve, challenge, and transform existing engagement practices. To understand how citizen engagement in smart initiatives is actually practiced in different contexts and frameworks, this article examines two recently established but contrasting smart districts within the broader Smart Dublin program that explicitly embraces a quadruple helix partnership model among government, academia, and industry. Their findings echo what we see from other articles in this thematic issue that indicates a disjuncture between the goal of creating a meaningful two-way engagement process used to incorporate citizens' voices into SCPs and actions. The residents in Smart Dublin share that the interventions were seen as only lightly addressing the root causes of the issues, as an example of "smart washing." These persistent digital divides can be accentuated during and post-pandemic and may not be considered in the rolling out of digital engagement, which may become barriers to participatory planning.

How can a smart city environment help people to choose healthy walking? The article by E. J. Kim and Gong (2023) analyzes the environmental factors that make people walk healthier, such as greenery, waterfront areas, and low traffic volumes. It demonstrates the use of information technology that collects, analyzes, and represents environmental information in real-time from environmental sensors and the potential of smart technology. A mobile route-finding application is an excellent example of smart technology to promote healthy walking and living.

Park and Fujii (2023) present the second case study of an increasingly adopted citizen-centric living lab methodology based in South Korea. The first living laboratory in the country, the *Seongdaegol* Living Lab, demonstrates active engagement and improved knowledge about community through the participation of the living lab and how it elevates civic pride and creates a more positive attitude toward applying the living lab to smart city development. However, it reminds us that challenges to implementing living labs in SCP still need to be addressed, such as the need for a transparent governance structure, managing diverse stakeholders, keeping participants engaged and motivated during the process, and scalability of solutions.

Y.-K. Kim, Lee, et al. (2023) seek alternative community street lighting by applying the natural surveillance principle of crime prevention through environmental design in a historic community in Busan, South Korea. The article explores the applicability of Relux Pro, a program that identifies the gaps in lighting and simulates the improvement of night lighting in the community. It is a smart visualization tool that can be used for citizen engagement in the participatory planning process, where the communication tools are most effectively used.

Another contribution from Busan, T. H. Kim, Park, et al. (2023) make a strong case for the need to plan climate-smart cities and how consciously planned climate policy can support climate actions to respond to the impacts of climate change. The article focuses on analyzing the gap between heat wave effects and heat wave adaptation policy in municipalities in South Korea. Using a fuzzy analytic hierarchy process, their results suggest the need to establish heat wave adaption policies based on continuous feedback on the predictions of future heat wave effects, acknowledging that adaptation policies have not sufficiently matched the level of heat wave effects closer to the long-term future.

From the city of Odense, Denmark, the final article of the thematic issue by Carstensen and Skow-Petersen (2023) introduces the GPS-tracking project intended to understand marginalized citizens' spatial behaviors and map out their spatial patterns. The perspectives of marginalized citizens, representatives of marginalized citizens, municipal professionals, and city planners are gathered through three separate workshops reflecting the processes and outcomes of the GPS project. Expectedly so, the project's validity, relevance, and applicability are assessed differently by three different participating groups. Although there are limitations, for example, the limited capacity that the GPS maps can provide insights into spatial dynamics and how they can only give time-limited partial snapshots, the project provides us with the potential to create a collaborative platform for trans-disciplinary and cross-sectoral collaboration space that citizens can share their visions of the inclusive city. Although the (smart) technology itself cannot create a holistic picture of the urban problems, the (mapped) space created by the technology proves effective in empowering marginalized citizens: affordance of

smart technology for creating a participatory process and space.

3. Conclusion

A common characteristic of many smart city programs and projects is the reliance on technologies, and they are often considered the foundation of smart cities (e.g., ICTs, sensors, cameras, IoTs, computers, GIS, and maps). Even newer smart technologies are being implemented in new smart city development (e.g., big data, cloud, AI, blockchain, and digital twins). It is essential to understand how these new digital smart technologies and infrastructures become pervasive and interconnected and how they are embedded in urban space and people's everyday life. However, from an urban (planning and geography) perspective, also based on our own experiences of living in the city, we, however, know that cities have a full culture, politics, competing interests, and even wicked problems/tensions (Leszczynski, 2018), and they are complex and ever-evolving, full of interdependent, contingent and relational actors, processes, and relationships. Cities are also challenging to predict and develop in capricious ways. To us, it is a question of "smart urbanism," as the way/mode of life, attitude, values, and patterns of behavior fostered in smart urban life and setting. Smart urbanism enhances citizen engagement and improves how the smart city includes citizens in the policy and planning process, as the selected articles within this thematic issue highlight.

The thematic issue provides evidence of why we need smart city planning based on a more nuanced and relational understanding of cities and generate more questions. How can we proactively re-think our own vision of smart urbanism and smart engagement? For whom and for what purposes should smart cities be developed? Are there benefits for certain populations or areas of the city and not for other people and space? What about significant urban problems left out of traditional smart city models, such as marginalizing communities, failing schools and health systems and jobs, and so on? How can smart cities create more democratic and emancipatory smart governance? Considering several contributions from non-Global North, how can we create equal geography of smart cities across the city, region, and the world through just distribution and implementation of smart city ideologies, practices, and technologies? Different motivations and visions are embedded in other smart city planning and models. Urban imaginations of the future city are continuously realized/materialized.

The contributions in this issue clearly show us that there is a vital role in active and participatory digital citizenship in smart cities. They regard engaging with the citizens living in the city as central to smart city-making. Smart urbanism as a project of "futuring" anticipates socio-spatially (in)equitable cities and produces them. Smart urbanism is an opportunity to sell a desired future centered around digital technologies (Datta, 2019) and control a potentially disorderly future through data-driven technologies. As Elwood (2020) and Leszczynski (2016) suggest, though, we want to approach smart urbanism beyond "hope and fear" framings. There might be time to make a difficult decision, for example, demoting the end goals of "efficiency and optimization" in favor of "meaningful inefficiencies" that favor connection and reflection—the opposite of dominant smart city trends (Halegoua, 2020, p. 148).

Smart engagement values "technology" to make citizens and communities "smart(er)." Yet, it also recognizes the importance of sociality/spatiality, ties, and relationship existing in the community contexts. It is important to continue to think about how these innovative technologies, tools, policies, practices, and visions demonstrated in this thematic issue can facilitate democratic, inclusive, and participatory processes to include (smart) citizens and local communities in the smart city planning and decision-making process. A creative digital engagement with ordinary citizens in their everyday life creates an ideal smart urbanism.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

For a Cooperative "Smart" City Yet to Come: Place-Based Knowledge, Commons, and Prospects for Inclusive Municipal Processes From Seattle, Washington

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Abstract
This article explores possibilities for cooperative, equitable, and participatory forms of smart urbanism. We begin by outlining orientations that emphasize the heterogeneity of economic and urban life and center the capacities and priorities of constituencies that currently are often not well served by urban planning and information-gathering processes. We then further iterate these sensibilities in relation to two examples from community organizing in Seattle, Washington, sketching out a broad sense of how community's and resident's place-based knowledge, experiences, and forms of expertise might be understood as resources that could be integral to processes of urban planning, organization, and potential structural transformation. Finally, we connect these possibilities to ongoing debates and experiments with "commons" and "commoning"—both conceptually and in actually existing urban experiments—to show how serious engagements with place-based knowledge and capacities understood as commons might be made central within "smart" processes that are radically democratic, inclusive, open-ended, and potentially transformative in ways that are distinctive from more top-down models that often merely manage and reproduce status quo urbanisms. Ultimately, the article suggests possibilities for alternative "smart" urbanist orientations, sensibilities, and techno-political applications to emerge in and through open-ended participatory processes grounded in community and place-based resources and priorities.

Keywords
commons and commoning; equity; participatory planning; place-based knowledge; Seattle; smart urbanism

Issue
This article is part of the issue "Smart Engagement With Citizens: Integrating "the Smart" Into Inclusive Public Participation and Community Planning" edited by Jin-Kyu Jung (University of Washington) and Jung Eun Kang (Pusan National University).

1. Introduction: (How) Is An Equitable "Smart" Urbanism Possible?

The questions that animate this article are as follows: (a) What new ways of conceptualizing, engaging, creating, and representing cities, urban spaces, and places, and the relationships within them might be necessary to realize a "smart" orientation that is cooperative, equitable, just, democratic, and potentially transformative and emancipatory for the lives of urban residents—especially those who have historically benefited least from urban and municipal planning processes—and (b) How might taking seriously and thinking with existing place-based knowledge, relations, and capacities such as those evident in countless existing contemporary urban organizing efforts offer both conceptual and practical resources toward these aims? We address these questions in a way that is at once speculative and grounded in deep intellectual and practical respect for resources and activities that already exist in urban spaces and communities. Drawing especially on examples from Seattle, Washington, USA, we highlight how, here and in other cities, there exists already—and often outside official planning or municipal processes—a tremendous amount of community-embedded knowledge and capacity. From asset-based, diverse economies, and post-development perspectives,

we can think of these as variegated place-based social and practical resources on the basis of which different, more equitable, and livable urban futures might be built. As we describe below, in Seattle such place-based resources are already being impactfully leveraged by different communities to make claims on particular spaces and institutions and to assert that these should be invested in and maintained for community benefit under different forms of equitable community control which would further build upon and multiply those same resources. And in this case, the municipality—the city of Seattle—has signaled that it is willing to consider how this might be possible. Though it would require a radical departure from the status quo, the potential exists here for the meaningful pursuit of community-identified priorities and issues—and perhaps broader forms of cooperation and transformation beyond—to emerge in and through different forms of participatory, community-engaged, and democratic planning. While we are critically aware of some of the potential shortcomings and pitfalls in such a proposition, we want to take these possibilities seriously and think in conversation with them, imagining how existing place-based knowledge and capacities could be central and generative within smart urbanist orientations both in Seattle and more broadly.

In the next section, we briefly situate our perspective and scan the smart urbanism literature, seeking points of potential resonance and connection between our framing questions and existing "smart" orientations. We then detail two cases—one involving place-based story-mapping, and the other involving participatory budgeting to rethink public safety—from Seattle wherein both the potentials and some of the challenges of existing efforts to incorporate place-based knowledge and capacities in this manner are fully in evidence. Finally, we consider how notions of "commons" and critical insights from ongoing experiments with participatory processes might point us toward alternative modes of planning, infrastructural development, and investment, and consequently toward more equitable and livable urban futures.

2. Parsing Smart Urbanisms

Let us begin by clarifying some orientations that are central to how we have framed our questions before, from there, unpacking smart urbanist orientations. We are approaching prospects for smart urbanism from what might be termed asset-based, diverse economies, and post-developmental perspectives (e.g., Anderson, 2020; Gibson-Graham, 2007; Gibson-Graham et al., 2013; Mathie et al., 2017). While not monolithic, we understand these perspectives as broadly asking us to consider a series of overlapping questions and propositions: Counter to modes of theorizing, planning, and policy that focus on formations of dominance and/or lack and absence, what might be gained or transformed by focusing on the heterogeneity and fullness—the forms of knowledge, the human capacities, the diverse economic, and cultural activities—that already exists and thrives virtually anywhere there are people? What generative and potentially transformational and sustainable ways of thinking about and understanding economic opportunity, culture, sociality, political organization, and more might be opened up as the result of such a conceptual shift? What might be gained by prioritizing and seeking to cultivate economic diversity alongside and through investments and processes that support heterogeneous forms of cooperation, mutualism, equity, and democratic participation undertaken as part and parcel of ongoing policy and structural iteration and reiteration? While these provocations and the theoretical perspectives that center them emerged in part as critiques of often harmful forms of developmentalism in international and urban contexts of the 20th century, they also seem increasingly urgent for a future likely to be marked by deeply disrupted infrastructures and supply chains, boarders, ecological and political systems, and more, particularly but not only in contexts of climate change and adaptation. For these and other reasons, the questions just posed are not only generative but vital for urban planning. Likewise, considering the "smart" urbanism literature in light of such heterogeneous provocations proves illuminating.

Put succinctly, "smart urbanism" might be understood as an approach to urban planning and governance that seeks to deploy specific technologies and infrastructures—perhaps especially networked digital devices and sensor-based methods—to produce, collect, and analyze a wide variety of data and make decisions, organize structures and resources, and manage urban environments and activities based on that data. While this is a rhetorical oversimplification, thinking with the provocations outlined above we might identify two predominant and contrasting orientations to smart urbanism concepts and practices. The first might be called a technocratic or cybernetics-inspired approach—one that considers a city algorithmically and tends to think in terms of managing and optimizing urban systems and functions using processes wherein many of the desired outcomes are aligned with the current status quo and determined in advance. This technocratic perspective is often closely interwoven with entrepreneurial and neo-liberal ideas of urban development (Greenfield, 2013; Hollands, 2008; Kitchin et al., 2018; Townsend, 2014; Visvizi & Lytras, 2019), and has included visions that imagine urban spaces as blank slates to be materialized and populated in ways that ingrate technologies often developed hand in glove with large corporations like IBM, Cisco, Alphabet, and Microsoft. These smart cities are synonymous with high-tech clusters and knowledge economy-driven urban development wherein corporations often determine how governments should adopt their technological vision and products (Goodspeed, 2015; Hollands, 2008). Many critics have argued that such visions of smart city planning

enact forms of computational and algorithmic governance that surveil and discipline urban inhabitants and that often implement and reinforce inequitable logics of urban development (Kitchin et al., 2015; Shelton & Lodato, 2019). Moreover, many have argued that such corporate-led, technology-centric visions of the smart city feed into neoliberal urbanism—in short, they underwrite forms of privatization, the hollowing out of public goods, and the enrollment of state and municipal institutions in processes of profit-driven growth that create deep inequalities—as they utilize technologies and infrastructures to datafy and commodify all manner of urban metabolisms and circulations in the name of improving efficiencies using new platforms and urban infrastructures (Cardullo & Kitchin, 2019; Kitchin, 2014; Rodgers & Moore, 2018; Wilson, 2018). These critiques of technocratic smart cities orientations are widespread, and we will not linger on them except to echo and underscore that "smart" is often hand in glove with forces that run deeply counter to the spirit of the heterogeneous provocations posed above and run the danger of reducing the rights of urban inhabitants, abetting the commodification of urban life, and foreclosing numerous diverse possibilities for different forms of urban living and organization to sprout, let alone flourish.

Often emerging directly from critiques of more normative technocratic visions, a second "smart" orientation aspires to processes and applications of technology that might tap into, if not necessarily be led by, communities and residents' collective intelligence. We might call this a collaborative and participatory approach, based on a broader vision that embraces more than the efficient management of facilities and services and explicitly promotes the democratic production and exchange of knowledge and human capacities (Barlow & Lévy-Bencheton, 2019; Lampugnani, 2017; Picon, 2015). Such an approach epitomizes a participatory digital turn, emphasizing practices that blur distinctions among production, distribution, and consumption and seeking to facilitate forms of (often digitally enabled) creativity, collaboration, and information sharing, including knowledge-intensive and information-rich user-created content and activities (Battistoni et al., 2022; van der Graff & Ballon, 2019). To be sure, these more participatory, resident-engaged orientations can also serve privatizing and commodifying interests and can deepen structural barriers by treating urban inhabitants as consumers, sources of un- or undercompensated labor, and sources of data to be mined or commodified for profit (Cardullo & Kitchin, 2019). Here too equitable and heterogeneous outcomes are hardly a given, and there is great potential for the opposite. And yet there is something in the potential open-endedness of these more collaborative and participatory orientations that might be productively re-directed in relation to the heterogeneous provocations posed above, especially where sensitized to some of the more heterogeneous qualities of life in urban spaces themselves.

An additional foundational tension that persists in many conceptualizations of smart urbanism concerns innovation (Hajer & Dassen, 2014; Halegoua, 2020; Marvin et al., 2016). In many smart city models, innovation is central. Economic development and growth are imagined to occur in and through the cultivation of creative economies which attract entrepreneurial talent, which will beget further technological innovation, the flourishing of start-up cultures, and further rounds of the same. However, in reality—and in light of the heterogenous provocations above—this is a very narrow approach to innovation and economic cultivation, and one that often does not incorporate many of the most creative and resourceful residents of any city, namely those who have figured out how to persist and thrive even despite historical discrimination, segregation, and other structural-historical barriers (see, e.g., Jung & Anderson, 2017). Indeed, creative, innovation-focused smart implementations can exacerbate already rampant political-economic processes—particularly forms of speculative development connected to increased housing costs and costs of living—that make it harder for many historically disadvantaged and marginalized urban residents to live in, let alone fully participate in and benefit from, the urban forms that emerge.

Following from the above observations, we might also question exactly how—and which—figures of "cities" and "urbanism" conjoin within "smart" formulations. As the above discussion implies, quite different conceptualizations of the urban can underlie different formulations, and these can be very revealing of other tacit orientations or disinclinations within. As in the most high-profile examples like Songdo in Seoul, Korea or Alphabet's Sidewalk Labs in Toronto, Canada, utopian visions of future smart cities often take the form of from-scratch developments where advanced technologies are overlaid on blank city spaces that are then marketed to potential residents as beacons of modern convenience, luxury, and innovative living (McFarlane & Söderström, 2017). In these smart city visions, cities seem to be treated almost as if they are computers—as manageable systems that can be made to act in rational, mechanical, linear, relatively frictionless, and systematic ways and that exist to serve the needs of worker-producer-consumers, all integrated seamlessly with real-time data streams serving the same function. New ways of knowing, seeing, and governing the city are imagined to emerge in and through the integration of thousands of urban sensors, real-time GIS-enabled mapping, and infrastructures for crowdsourced information about urban environments through distributed networks of millions of smartphones. Although such a vision seems rational and promising, it also seems closely aligned with the prerogatives of techno-capitalism and—absent explicit commitments to and prioritization of such principles—unlikely to yield anything resembling equity and solidarity, let alone true innovation or resilience in the spirit of the heterogeneous provocations above.

But different visions are available, offering different sensibilities around what urban spaces and relations are, why they are generative and valuable, and what they could become. A huge aspect of what makes cities exciting, vibrant, and spaces of true innovation is, after all, that they are full of often heterogeneous and contradictory formations of sociality, culture, politics, value, competing interests, and even wicked problems/tensions (Anderson, 2020; Leszczynski, 2018; Tally, 2013). Cities are complex and ever-evolving, full of interdependent actors, processes, relationships, and contingent encounters with and across differences.

In ways resonant with influential strands of urban planning (e.g., Watson, 2013), the best of what we are calling collaborative and participatory orientations to smart urbanism seems to work with, if not amplify and multiply, the heterogeneous aspects of urban life rather than managing them toward outcomes and according to metrics suited merely to narrow notions of efficiency or capitalist value. And from there, it is possible to engage a series of additional questions and experiments in relation to the ways of life, social and political-economic structures, attitudes, values, and more around which urban processes and priorities might be organized. By and for whom and for what purposes should smart cities be shaped? What kinds of inequities and trade-offs are produced through current modes and models? What about significant urban problems that are left out of traditional smart city models, such as rampant socio-spatial inequality, historically marginalized communities' right to the city, struggling institutions such as school and health systems, questions of public safety and criminal justice, or access to affordable housing and living wage jobs, etc.? What kinds of processes, social, material, and information technologies, and—perhaps most crucially—already existing place-based and community-embedded knowledge and capacities could be leveraged as resources to address these questions? Truly addressing these questions might mean demoting the end goals of efficiency and optimization in favor of "meaningful inefficiencies" that facilitate civic connection, study, experimentation, and reflection—the opposite of many dominant smart city orientations (Gordon & Walter, 2016).

What we are gesturing toward here are open-ended "smart" processes that engage and amplify heterogenous and already existing place-based knowledge, community capabilities, and institutional capacities. These are precisely the considerations we ultimately want to get at in relation to "commons." But first, in the next section, we draw on examples from contemporary Seattle to illustrate more vividly community-embedded capacities and resources of the kind we might bear in mind.

3. Examples: Halting Attempts at Place-Based Knowledge Activation

As the above review highlights, there are strands within the literature on smart urbanisms which hold out hope if not explicitly advocate for less technocratic and more participatory, less expert-driven, and more democratic conceptualizations and realizations. Our own ambitions for a more radically heterogeneous, inclusive, equitable, and participatory smart urbanism clearly resonate with these strands of the literature. But upon what foundations might cities and practitioners work to implement such ambitions in practice? And what further steps—both conceptual and practical—might be necessary to move already-existing activities in cities closer to these visions? In this section, we deepen and address those questions drawing on two community organizing-based examples from Seattle: a place and story-mapping initiative and a process of planning for large-scale participatory budgeting.

Our knowledge of the examples described below draws from our participation in an initiative called the People's Geography of Seattle (PGS)—a loose network of community-based artists, storytellers, organizers, and university-based faculty from geography and aligned fields. The PGS originated in 2017 through a set of convenings that aimed to connect practitioners working on anti-displacement and related efforts in response to the rapid development that has dramatically transformed Seattle and the surrounding region over recent years. As Amazon and other major tech corporations have anchored and expanded operations here, the fortunes of the city and region have boomed (US Bureau of Economic Analysis, 2021). Between 2010 and 2020 the population of King County (which includes the cities of Seattle, Bellevue, and numerous smaller municipalities) grew by 338,000 people—an increase of 17% (Gutman & Shapiro, 2021). Many of these transplants are highly educated and highly paid tech-sector workers and contemporary Seattle currently boasts among the highest average rates of education and per-capita income in the United States (King County Office of Economic and Financial Analysis, 2022a, 2022b). At the same time and in direct relation to these changes, Seattle and the region are acutely experiencing crises at intersections among affordability, housing, widening socio-economic inequality, and displacement from what have historically been—because of restrictive covenants, redlining, and other forms of segregation—Black, Pan-Asian, and Indigenous communities adjacent to the urban core (Fynn Bruey, 2019; Seattle Office of Planning and Community Development, 2020). Unprecedented numbers of unhoused people live on the streets while low-income families, the elderly, racial minorities, and other vulnerable populations have been forced to leave the city in high numbers because of skyrocketing housing and living costs. Seattle is routinely at the top of rankings of the "smartest smart cities" in North America (e.g., Locke, 2020)—rankings that evaluate the density of sustainability initiatives, tech start-ups, open data initiatives, and the ability to attract creative and entrepreneurial talent along the lines of the creative development strategy outlined above. Yet—and even despite and in parallel with efforts toward

equity described in more detail below—Seattle has also become one of the least affordable, most inequitable cities in the US.

Attempting to engage a diverse array of participants around the issues above, since its founding in 2017, PGS participants have collaborated on a prototype augmented reality place-based storytelling app (Anderson et al., 2019), supported oral and spatial history by and for historically Black central city communities, and skill-shared with community-based organizations working for place-based equity. It is from these later efforts that we are familiar with the two examples we offer below. In keeping with the broader ethos that animates this article, we must stress that the activities described below were undertaken by community-embedded organizations and not by scholars (including ourselves) or other outside experts. As such, we are engaging these not as research outcomes, but as examples that help us think through how already existing community activities, knowledge, and capacities might intersect—or not—with different orientations to "smart" engagement. There is a great deal to learn from consideration of these examples in these terms.

The first example concerns a regional coalition called King County Equity Now (KCEN). KCEN emerged in 2020 in direct connection with uprisings that rocked cities across the US following the murder of George Floyd. KCEN is a coalition composed of a larger number of (in 2020, the coalition included more than 50) Black-led community-based organizations organizing to achieve equity—in the sense of both justice and ownership stakes—for communities in Seattle and the region. From the start, KCEN aimed to aggregate and amplify already existing community-embedded initiatives to take on decades of inequity and displacement disproportionately affecting Seattle's historically Black communities.

In summer 2020, KCEN put forth a set of demands, subsequently re-framed as equity solutions, which were largely based on initiatives that had already been underway among its membership (KCEN, 2020). These solutions were partly policy and legally oriented (proposing policies against predatory property acquisition and development in historically segregated neighborhoods, terminating contracts between police and schools, and dropping charges against protestors) but predominantly focused on the need for different forms of investment and financial redistribution (turning four parcels of underutilized public land over to community control; establishing a $1 billion anti-gentrification land acquisition fund, roughly 25% of which was to be redistributed from policing budgets) to create opportunities for Black economic development, ownership, and community self-determination. During the summer of 2020, a team of four University of Washington students and two faculty affiliated with the PGS volunteered to help KCEN create story maps that would situate the sites named in the equity solutions. The idea was to use the Environmental Systems Research Institute, Inc. (ESRI) ArcGIS StoryMaps platform to show the location of the parcels and—drawing upon archival and interview-based qualitative information—explicate connections between these specific spaces and deeper social relations and histories within which they were imbricated. This included, on the one hand, histories of forms of segregation experienced by Black communities—specific policies and practices which limited spatial mobility and institutional access. On the other hand, histories of resiliency and resourcefulness in the face of such segregation were also included, especially in relation to specific institutions—a vocational school connected to national Black labor organizing and a senior care facility that had long been under Black community control, for instance—which became particularly important to the community precisely given the constraints of segregation, and whose stories highlighted processes and capacities for Black community-led decision making, institutional organizing, resource provision, and more. This mapping process was also meant to spark additional community-driven and resident-generated data and visualization moving forward, perhaps especially highlighting the deep roots and already existing presence of processes and capacities for cooperative institutional decision-making and management that would be required to successfully realize community control over the parcels named in the demands.

Ultimately, this mapping process did not go farther than an initial prototype, largely because access and proliferation were limited by the privatized and proprietary ESRI platform, and neither community nor university-based collaborators had sufficient bandwidth or resources to identify and mobilize alternatives. Some of the parcels of land in question have since come under community control as hoped, but ambitions for qualitative mapping to inform what might happen from there have remained stunted. Nevertheless, this undertaking is one small example (and there were many others in relation to KCEN and its membership) of existing desires, potentials, and latent capacities for technologies—in this instance qualitative mapping, but one can imagine other technologies for qualitative engagement, participatory archiving, institutional consolidation and administration, and other forms of information gathering and sharing—to be useful as part and parcel of broader strategies for researching and pursuing place-based equity as community controlled institutional and resource management in direct connection with community-identified priorities and drawing directly upon community-embedded capacities.

Our second example emerged in parallel with the contexts of the first. Following directly from the concerted efforts of KCEN and other community-advocacy groups, in the fall of 2020 the Seattle City Council passed a budget that re-allocated funds that had been designated for policing, redirecting them toward an ambitious participatory budgeting process (Russillo, 2020). The city committed $30 million (one of the largest such investments by a US city to date), with $3 million to be

spent over the course of 2020–2021 on a community-led research initiative to generate recommendations for a multi-year participatory budgeting process beyond, all meant to create a participatory pathway for re-imagining public safety and health in collaboration with front line communities. The contract to facilitate this initial work in 2020–2021 was awarded to a research organization called The Black Brilliance Research Project (BBRP), which was at that time directly affiliated with KCEN. The results were complex and controversial, but also highly instructive for anyone considering how best to incorporate community held-knowledge in larger processes of planning, organizing, and potential structural-institutional renovation.

Partly because of the way the city council allocated and administered the funds, partly because of conflicts and tensions that soon emerged within KCEN as a coalition, and partly because this initiative asked the community to create a sweeping vision (some participatory budgeting existed in Seattle, but only at the level of small-scale capital improvements) on a perhaps unrealistically short timeline, the initial round did not go smoothly and did not produce the results it seems many expected. The BBRP undertook a participatory action research (see, e.g., Kindon et al., 2010) process wherein more than 100 paid and 100 volunteer researchers fielded from community organizations were trained, then collaborated to design and undertake interviews, focus groups, questionnaires, case studies, photovoice creation, and story mapping involving more than 1,400 participants from historically segregated and over-policed communities across Seattle. That initial round produced a detailed report (BBRP, 2021) with recommendations and a proposed budget for the next steps. BBRP especially stressed the need for substantial investments in things like publicly supported communication infrastructures, care resources, affordable housing, worker and owner cooperatives, and other public and institutional goods that would not only improve public safety, health, and equity but that researchers concluded would also be necessary before more and broader participatory planning and community-based economic development could take place in a truly equitable way moving forward.

These recommendations were not what many seem to have expected to emerge from the process. Many in the local media painted it as a boondoggle. As the fervor of 2020 subsided, the city ended up largely disregarding the recommendations and cutting ties with the organizations that were involved in the initial round. At the time of writing, the next phases of the larger participatory budgeting process are moving forward and will be facilitated by a Brooklyn, New York-based organization called The Participatory Budgeting Project which was a third-party administrator preferred by BBRP. But there is little information about how the process will unfold or how closely it will attend to BBRP's recommendations.

Several points emerge from these examples in Seattle and speak directly to the discussion of smart urbanism laid out above. First, there is a tremendous amount of community-embedded capacity, place-based knowledge, and community-driven ambition on display in these examples. There are also historical and/or already existing institutional memories and frameworks as well as orientations to collective decision-making and resource provision. Drawing directly on these assets, community-based actors—in this case, especially from Seattle's relatively small but robust Black community—entirely drove the efforts described above, providing the human infrastructure, networks, expertise, and labor. That outcomes diverged from the expectations should not come as a surprise given the degree to which the organizations and actors involved have historically and still do have limited access to power and resources relative to historically powerful and/or status-quo actors and organizations. The learning and insights that emerged from both examples above clearly reflect this.

Moreover, questioning what exactly should or might be expected from such participatory processes is also generative. Reading across much of the reporting on the BBRP process, for instance, it seems what many observers expected was a recommendation that more diverse people should simply be brought into the conversation about how money should best be spent within relatively status quo budget categories, and that a more inclusive undertaking of this process would itself create more equity, accountability, community buy-in, and perhaps some administrative innovation and social capital building (e.g., Gutman, 2021; Oron, 2021; Schofield, 2021). To us, however, that feels like an inhibiting imagination of what a truly path-breaking participatory process could be like. And indeed, what emerged in both cases above was a strong sense that more and different kinds of investments and prioritization would be needed to create the conditions for a more radically democratic and transformational process to unfold in the future. In these respects, these examples underscore much of what we are trying to argue in relation to smart urbanism goals and perspectives: That they might ideally emphasize and seek to facilitate open-ended processes for shaping questions, aims, protocols, and outcomes—rather than presuming these in advance—in collaboration with the knowledge and resources already embedded among residents and communities; that they should prioritize investing in such processes and the community-embedded resources and infrastructures needed (if not already existing) to make them truly equitable and transformational in the long term, even if that presents difficult challenges within shorter time horizons.

One final context worth considering here is the degree to which these community-led initiatives did and did not connect to a number of planning and management initiatives—some explicitly engaging "smart" discourses, others less so—in Seattle during the same period. The city of Seattle and other regional players

have shown serious interest in developing "smart" initiatives that explicitly prioritize collective decision-making through processes that are crowdsourced, tailored to the qualities and needs of already existing people and places, and that integrate the insights of everyday citizens. For instance, Smart Seattle is a collaboration between the City of Seattle, King County, Microsoft, and the University of Washington (Seattle Department of Transportation, 2020) focused on transportation. This initiative has piloted free and publicly available crowdsourcing apps through which residents can provide and benefit from real-time information on changing conditions. It explicitly targets what it calls "equity areas"—spaces with particularly important transit links for commuters trying to navigate the increasing spatial mismatch between the locations of affordable housing and other resources (increasingly on the periphery of the city and region) and good jobs (largely concentrated in or near areas with high housing costs)—for particular attention, investment, and infrastructural development. The Digital Equity Initiative is seeking to ensure that all residents and neighborhoods have access to and know how to utilize information technologies that are increasingly important for accessing information and economic opportunity. That initiative explicitly names potential forms of technologically mediated civic engagement among its priorities. There is also an Innovation Advisory Council intended to facilitate information and technology sharing between the local tech industry and the City to better address ongoing crises of homelessness, affordability, and mobility, alongside services provision, prioritizing racial, social, and spatial justice.

While the effectiveness and impact of the above initiatives are open questions, the city of Seattle is clearly signaling an alignment with many of the values and practices we are trying to advocate for here: Developing processes and technologies that facilitate, crowdsource, freely share, and cede narrative and decision-making power to residents and communities; thinking about equity in relation to technology; making strategic investments in existing places and communities rather than treating "smart" development as an elitist *tabula rasa*; and so forth. So perhaps the gap between what community advocacy and equity groups are calling for and what the City is already pursuing is not insurmountable. At the same time, the impulse seems to be toward facilitating access and inclusion within management frameworks where goals are already known in advance, as opposed to using technologies to facilitate open-ended participatory processes which grow and activate place-based knowledge and capacities to then identify and pursue democratically determined aims, resources, outcomes, and transformations that cannot be known in advance because they have yet to emerge from any truly equitable and well-supported process. Clearly, we would like to push the agendas of planners and "smart" practitioners—especially in avowedly progressive cities like Seattle—toward the latter.

4. Further Discussion: Smart Commoning?

What we have laid out thus far is intended to be suggestive and illustrative. We have offered a broad orientation to smart urbanism, then offered examples to begin suggesting contexts in which such an orientation might be mobilized. To revisit our guiding ambition: We want to consider how mobilizations of "smart" urbanism might engage place-based knowledges and community capacities (such as those evident in instances like those described above) and marshal them toward equitable and participatory planning. We view this as a conceptual and processual question as much as a practical or technocratic one. As such, we now engage an additional set of concepts, specifically around commons and commoning, to add additional nuance to what we have presented above.

At this point, we feel we can make a compelling argument that forms of place-embedded experience, knowledge, and capacity such as we have outlined above constitute and might generatively be treated as forms of "commons." We are not the first to suggest strong potential overlaps between notions of the commons and the more democratic and participatory strands of smart urbanism (see the conclusion of Cardullo & Kitchin, 2019). We wish to elaborate and further consider such overlaps.

"Commons" and "commoning" are old concepts that have gained increasing purchase in different contemporary contexts. In keeping with definitions generally accepted in the commons literature (e.g., Anderson & Huron, 2021; Gidwani, 2013; Linebaugh, 2008; Ostrom, 1990), we understand these concepts as referring, on the one hand, to resources—often but not always material—that are maintained, stewarded, and used collectively (commons), and, on the other hand, the practices—the actual activities, protocols, and ways of acting and relating in mutuality and relation (commoning practices)—that people undertake in relation and in order to maintain particular commons as resources. It is worth noting here that contemporary work on the commons takes place along a spectrum ranging from what might be termed a descriptive-institutionalist approaches—often focused on understanding how shared resources are governed, by which communities of users, according to what rules and protocols, under what conditions and constraints, and so forth—to approaches more closely aligned with critical social theory and critique. We think it useful to consider approaches from across this spectrum in relation to the contexts and questions we have presented thus far.

By virtue of their cooperative character and the collective practices necessary to sustain them, commons are often—but not always—oriented toward at least grappling with, if not necessarily resolving, questions of equity, access, and inclusion. Crucially, where these conditions are not met—in other words, where processes for dealing with these issues are not in place and constantly

re-visited and negotiated—commons can ossify, become privatized, and cease to be commons. Some have suggested that this ethos of constant renegotiation and reiteration means that commons and commoning might be considered among the most potentially transformative and radically egalitarian socio-political ideas available at present (Dardot & Laval, 2019). At a minimum, a descriptive sense of existing commons and the origins, protocols, structures, adaptive capacities, relationships, and so forth that appear in robust examples can be central to understanding institutional, political-economic, resource-related, and even cultural landscapes in particular locations and settings. This is also where we believe notions of commons and commoning could connect decisively with smart urbanism in the ways we have identified.

With the above aspects in mind, what thinking about smart urbanism in relation to commons and commoning affords us is not just another way to critique the often troubling agendas behind smart rhetorics or the gaps between smart ambitions and their implementation, but a conceptualization for thinking deeply and generatively about the technologies, processes, modes and rules of shared engagement, forms of investment and resource cultivation, orientations to data, and so forth that could identify and describe, augment and grow existing urban place-based knowledge, community-embedded capacities, institutional frameworks and relationships, and social infrastructures in relation to and as commons. Moreover, given the crucial importance of open-ended process and constant negotiation within commons, the pairing allows us to speculate about how "smart" approaches could be re-tooled to enliven, support, and sustain organizing and participatory processes, diverse economic and planning activities, collective structures of data ownership and processes of cooperative analysis, and more, among already existing and/or nascent communities of users. Particularly where explicitly connected to goals like equity, racial justice, and/or just climate adaptation, the result could be "smart" uptakes that are participatory, research-oriented, self-reflexive, iterative, adaptive, and deeply transformative, rather than simply perpetuating existing status quo formations, exclusions, and advantages accrued by narrow groups (see Anderson & Huron, 2021; Foster & Iaione, 2022, for further theoretical elaboration of principles upon which such a process might work).

Moreover, as we previously suggested and as the commons literature also confirms, urban spaces themselves are quite distinctive in that they are made up of all kinds of instances of both commons and commons practices (Huron, 2018). In the case of Seattle and some of the examples given above, it is possible to conceptualize a complex interplay between particular commons as resources (in relation to particular parcels of land, public institutions, built structures, and material infrastructures, perhaps particular technologies, public funds, and more) and commons practices that sustain and steward them (social infrastructures, forms of community-embedded and sometimes very place-specific knowledge, forms of labor, care, solidarity, and more). These are clearly domains of urban space and urban life with which smart urbanism is already deeply engaged, only in a "smart commoning" framing such engagements would be driven by notions of equity, inclusiveness, participatory process, and open-ended negotiation and iteration in relation to particular resources and toward community-identified priorities along the lines of what we have outlined above.

To bring these arguments full circle, we could point to numerous examples where communities and municipalities have already started to experiment explicitly with exactly the kinds of engagements we have in mind. Some of the most striking and ambitious examples come from cities where smart approaches have been integrated into progressive "municipalist" political movements which cultivate structures of direct democracy, structured public participation and stewardship, and cooperative ownership in order to confront neoliberalism and create durable, equitable institutional and economic formations that can then be strategically expanded from the municipal scale. For instance, the Calafou Postcapitalist Eco-Industrial District near Barcelona, Spain, aims to surface marginalized, hidden, and alternative economic activities as catalysts for place-based advocacy and policy reform. It promotes a wide range of urban projects from community-managed broadband internet infrastructure—including an open source "Internet of Things" network—to free software cooperatives and spaces for public education and collective reflection (Lynch, 2020). Municipalist experiments ongoing in Barcelona alone—similar experiments are ongoing in many other cities (see, e.g., Morozov & Bria, 2018)—have included the development of an overarching "digital transformation roadmap" based on the idea that citizens should maintain ownership and control of their own data (the initiative includes a "data commons" and co-creation workshops for scaffolding and implementing this vision at the community level) and designed to lay the foundations for broad and equitable participatory bottom-up democratic decision making moving forward, and smaller overlapping undertakings like Guifinet, a decentralized network of community associations that builds and maintains their own extensive public broadband internet infrastructures as part of a broader community-based economic and democratic capacity building strategy (Lynch, 2020). An open-source platform called Decidim (www.decidim.barcelona) allows any citizen of Barcelona to submit their proposals and priorities for budgetary allocations. These examples create new processes for citizens and municipalities to share information, interact, and make collective decisions, forging collective identities and generating, shaping, and sharing resources along the way.

Other examples abound even where political and municipal institutions have not invested in participatory processes. The Hyderabad Urban Lab in Hyderabad,

India, for instance, is supported by donations and foundations to facilitate research by and for urban residents whose livelihoods have historically and continue to be undercut by processes of colonialism, imperialism, and capitalist development (Maringanti, 2020). In this initiative it is residents, working with activists and experts, who produce and interpret data, and not external consultants or professional planners. The knowledge that matters here is that learned by residents and activists living and working in informal settlements, struggling to access basic amenities like housing, water, and sanitation, and organizing for extended municipal services and more equal relationships with municipalities that often hold them at arm's length and disregard their ways of knowing, navigating, and stewarding the urban world. Technology is used to supplement already existing ways of knowing and commitments to urban social transformation. But it is people, relationships, processes, and place-based forms of knowledge and organizing—not techno-capitalist development imperatives—that matter most. This is place-knowledge-intensive smart urbanism that strives to shape technology in the service of collective and cooperative aims around resource access.

There are countless other examples we could highlight. Each would differently underscore the open-ended, process-oriented, and often radically egalitarian sensibilities that attend to commoning practices and the stewardship of resources in common. The point is that attention to, cultivation of, and investment in commons and commoning can lead to both the identification and enhancement of processes and human infrastructures for economic development, solidarity, resiliency, innovation, democracy, and more. This is about much more than integration and access—it is about transforming current structures, deliberatively cultivating and stewarding shared resources, and developing robust modes of cooperative and equitable urban living.

5. Conclusions

Smart urban theorists and practitioners already clearly know that urban residents and communities steward and are in possession of all kinds of potentially valuable and generative place-based knowledge, capacities, and resources and that technologies can be used strategically to tap into these. The question is by and for whom (or what), how, in relation to what technologies, innovations, and processes, and toward what outcomes and futures. We have offered what we simply hope is a provocative perspective, ultimately suggesting that those questions should be addressed via open-ended, just, and participatory processes wherein residents, communities, commons, and commoning practices are invested in and supported in the cooperative pursuit of such answers. The smart urbanisms that emerge from there could well be innovative and transformative in ways all manner of urban inhabitants and actors are only just beginning to imagine.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Phygitally Smarter? A Critically Pragmatic Agenda for Smarter Engagement in British Planning and Beyond

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Abstract
In Britain as elsewhere, planning systems are entering a "digital turn." However, the emerging conversations around PlanTech in policy, industry, and research yield contrasting views about the promises of digital technology and "data-driven" decisions to enhance and embed public participation in the planning system. With faster, data-driven processes capable of engaging more people in more diverse ways, PlanTech offers to revolutionise planning systems. However, empirical evidence demonstrates low citizen trust in government and web-based technologies, democratic and participatory deficits, the complexity of the planning system and its opaque technocratic terminology, multi-layered digital divides, and other socio-technical factors that hinder effective and inclusive public consultations in planning. This article provides a preliminary, high-level research agenda for public consultations across Britain's three nations that centres around a critical pragmatic design, deployment, and evaluation of blended/"phygital" (simultaneously physical and digital) information-rich ecologies of smart engagement. A review of selected national policy in Britain provides initial insight into the emphasis (or lack of) put on the adoption of digital tools within the planning process of each British nation. In doing so, the research sets out a conceptual model that complements existing models for participatory planning by adopting Beyon-Davies' unified conception of information, systems, and technology. The conceptual model presented sets out seven Is of information-rich phygital ecologies and three interdependent "pillars" for smart engagement that enable one to gaze both deeply and broadly into opportunities for smart engagement through and beyond PlanTech.

Keywords
digital participatory platforms; digital planning; e-participation; PlanTech; public consultations

Issue
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1. Introduction

Across Britain as elsewhere, national planning policy encourages a "digital-first" approach to public participation, underpinned by a digital overhaul and a long-standing, continuous reform of the planning system. A chief aim of the current digital revolution is to optimise the delivery of public services by increasing the speed of planning processes and decisions, with a focus on data rather than the current focus on documents (Batty & Yang, 2022; Parker et al., 2018; Wilson & Tewdwr-Jones, 2022). Toward this end, digital engagement is promoted as a means of reaching more people in more diverse ways to integrate citizen input. The overarching aim is to facilitate better and faster processes that lead to "data-driven" decisions and resource optimisation. Notwithstanding, there are clear challenges for such a digital planning system to be simultaneously *effective* (delivering high-quality development in an inclusive, sustainable way) and *efficient* (optimising public value and the speed of delivery through faster decisions). We characterise the current trend toward digital-first

participation to support data-driven decisions as a somewhat narrow form of "smart engagement." Even as digital innovation for public consultations continues to unfold through a wide array of digital methods, neither the national policy guidance nor the academic literature seems to provide any clear definition of what "smart engagement" might be or the way in which digital participation can indeed lead to smarter, better decisions. Rather than seeking scholarly terminological consensus, a critical pragmatic definition would help act on the fact that digital engagement does not a priori lead to better or smarter decisions, and that the complex underpinning factors that do, such as structural conditions that shape access to and the use of digital technologies may call for more radical innovation in the way public consultations are conducted in the current information age of "digital-first" (cf. Commonplace, 2021; Holmes & Burgess, 2022; Royal Town Planning Institute [RTPI], 2020).

Reconceptualising "smart engagement" from a critical pragmatic perspective enables one to convey its potential to better translate data into meaningful knowledge and transactional activities by way of information-rich and "phygital" (simultaneously physical and digital) ecologies. The term "phygital" seems to have been initially coined in the 2010s to describe the rise of e-retail as a complement to in-store shopping practices (Shi et al., 2020). In the realm of community involvement in planning, the practice of engaging citizens in different complementary ways has benefitted from international experimentation and good practice. Current trends in phygital engagement can in part be attributed to the growth in the diversity of both physical and digital engagement technologies, including the historical evolution of mental maps into community GIS and various forms of geoparticipation and 3D participatory modelling (Hjerpe et al., 2018; Pánek, 2016). One can also cite the pioneering work of planning consultancies such as Spacescape in Sweden, or Repérage Urbain in France, among many others, that have creatively combined such in-person methods as exhibition stalls, participatory workshops, and/or site visits with online map-based surveys, which enable information-rich methods such as sociotope mapping (a map-based approach that combines residents' knowledge with the expertise of town planners, urban sociologists, and ecologists; Babelon, 2021; Douay & Prévot, 2015; Rantanen & Kahila, 2009; Ståhle, 2006).

By undertaking an integrative review of academic and industry literature and selected national planning policy across Britain, this article provides an updated narrative around smarter engagement in planning to recontextualise the meaningful translation of data into decisions via human judgement and knowledge. Importantly, the article also addresses the social and ethical challenges with a digital-first approach. Based on the above, we propose a conceptual model for effective smart engagement that adapts the unified conception of information, systems, and technology by Beynon-Davies (2010) to help convey the way in which data and information become simultaneously utilised in and shaped by social activities. The conceptual model is targeted at reflective practitioners, policy-makers, researchers, and activists who wish to identify pragmatic solutions to the observed challenges that a digital-first approach to engagement poses, all the while maintaining a cold, critical look at real, long-term opportunities to do so in a context of continuous planning policy reform.

The article begins by setting out the methodology for the study, before providing a state-of-the-art critical discussion around smart engagement in planning, the issues of concern with a digital-first approach, and a review of principal planning policy documents for each of the three British nations.

2. Methodology

This article provides a conceptual model based on an integrative review of academic and industry literature and a review of high-level British national planning policies (Table 1) that shape opportunities for public consultations. For the academic and industry literature, this study adopted a consistent analysis to identify and present a state-of-the-art discussion of "smart engagement" in planning, while also addressing the social and ethical challenges in a "digital-first" approach. The integrative literature review approach we adopted synthesises and engages critically with key substantive issues in a consistent though non-systematic way to develop a conceptual framework or typology (Snyder, 2019). Potential articles relating to the topics of this study (digital planning, public consultation, digital technologies, etc.) were identified through a scan of existing databases based on these keywords. In doing so, additional keywords and associated terms employed in the initially reviewed literature, relating to the topics of this study were established and used to further search the literature. The approach identified that the term "public consultation" was used interchangeably within the reviewed literature with related terms such as "community engagement," "citizen involvement," "community collaboration," and "public participation," as well as a combination of these terms, amongst others. Likewise, digital technologies for engagement have been referred to as digital participatory platforms (Falco & Kleinhans, 2018), online participatory technologies (Afzalan & Muller, 2018), web-based engagement portals, PlanTech, digital planning, and other tools that facilitate community engagement for data-driven solutions. This exercise highlighted the interchangeability and diversity of terms used within this domain, which itself was mirrored within the reviewed policy documents, and heightens our observation of a lack of any consensual understanding of smart engagement in digital planning.

To further support the proposition of a conceptual model and gain insight into the acknowledgement of

smart engagement within the context of Britain, current, high-level planning policies for each of the three nations (Scotland, England, and Wales) were reviewed. Although produced by distinct national governments, all three planning systems are plan-led and prioritise decisions "in the presumption of sustainable development" through plan-making and development management. The policies selected were the most recent key publications for each country in relation to their national planning policies, allowing for an up-to-date overview of whether and how these discuss aspects of "smart" engagement, as a way to complement the findings established from the integrative literature review. Table 1 provides a descriptive overview of the reviewed policy documents, including their salient features.

3. Smart Engagement in Planning

In Britain as elsewhere, national planning policy encourages a digital-first approach to public participation, underpinned by a digital overhaul of the planning system, as part of a wider context of e-government (Batty & Yang, 2022; Wilson & Tewdwr-Jones, 2022). Concurrently, the practice of public consultations has integrated advances in web 2.0 and 3.0 technologies that have introduced interactive capabilities and analytics, respectively (Anttiroiko, 2021). The stated aim is to enable smarter, data-driven decisions that ensure real community needs are met and thereby avoid emotion-driven or unevidenced judgement in both policy-making and development management (Ministry of Housing, Communities & Local Government, 2020). Depending on the planning context and design quality of the participatory process, commonly mentioned benefits of digital engagement *can* include improved efficiencies in planning processes, and engaging more people in more creative, diverse, and interactive ways in both real-time and asynchronous ways than is typically possible in more traditional, in-person, and paper-based alternatives. Careful consideration of a wide range of socio-technical design parameters (e.g., demographic, organisational, democratic, budgetary, information flow) can therefore help improve the effectiveness of digital engagement and supporting analogue methods as part of an elaborate socio-technical framework (Babelon, 2021; De Filippi & Cocina, 2022; Gil, 2020). The cost of engagement per individual has also been reported as potentially lower for digital public participation than for more "physical" means (Commonplace, 2021; Kahila & Kyttä, 2009). As such, digital engagement technologies, if well designed and managed, promise to provide greater inclusion, creativity and diversity in terms of participants and types of input, such as in delivering co-production and other collaborative forms of policy-making and service delivery (Fung, 2015; Kleinhans et al., 2021). Across Britain, there is a push in national policy to supply more development at pace and of higher quality, alongside key digital, built, and natural infrastructure, except without

Table 1. High-level national planning policy guidance documents that identify opportunities for public consultations.

Policy document	Nation	Salient features
Draft of Scotland 2045: Our Fourth National Planning Framework (NPF4; Scottish Government, 2021)	Scotland	• Strong focus on inclusive placemaking, including region-wide strategies, cultural identity, digital infrastructure, and early engagement in planning
Transforming Places Together (TPT; Scottish Government, 2020)	Scotland	• Comprehensive and engaging policy document that provides a blueprint for a "world-class" integrated digital planning system for Scotland
National Planning Policy Framework (Ministry of Housing, Communities & Local Government, 2021)	England	• Fosters a more streamlined planning process and early engagement in planning for sustainable development
Planning for the Future (PfF; Ministry of Housing, Communities & Local Government, 2020)	England	• Strong focus on improving the efficiency of the planning system through digitisation, and open data to support faster decisions and citizen engagement in planning • Focus on upskilling the planning workforce
Planning Policy Wales (Welsh Government, 2021b)	Wales	• Strong focus on inclusive design, national and regional cultural identity, high-quality placemaking, and digital infrastructure to support businesses and individuals • Encourages early engagement in planning
Future Wales: The National Plan 2040 (Welsh Government, 2021a)	Wales	• Strong focus on regional development and placemaking through the planning system, including national and regional connectivity

the necessary budgets to deliver to expected standards (Parker et al., 2018). For example, a report by RTPI Scotland reveals that gross expenditure to local planning authorities across Scotland has been slashed by 38%, accompanied by a loss of 25% of planning department staff since 2010 (RTPI Scotland, 2022). Clifford (2020) and Wilson and Tewdwr-Jones (2022) indicate that over the last 20 years, resources for non-statutory public consultations have dwindled dramatically, thereby limiting the scope, nature, and diversity of forms of public participation in town planning that local planning authorities can realistically manage. Similar insight is echoed in research led by RTPI (e.g., Bicquelet-Lock & Taylor, 2020; Patterson-Waterston et al., 2020; RTPI Scotland, 2022). Interestingly, this is not to discount the growth over the last 10 years in the use the digital participatory platforms and other digital tools to engage residents across Britain as elsewhere (Babelon, 2021; Falco & Kleinhans, 2018; RTPI, 2020).

In a British context, statutory public participation primarily occurs at two separate though related levels. Citizen input in policymaking helps to shape strategic and local development plans, which in turn shape the criteria for making decisions on individual planning applications, from simple householder applications to large-scale major new development. In the latter, statutory public consultations provide opportunities for residents and stakeholders to comment on and submit "representations" about registered planning applications. Citizen input constitutes one of several essential sources of evidence for planning determination. The extent to which public participation actually shapes planning decisions is a complex, perennial question for which there are as many models for public participation as there are interrelated issues that warrant further investigation, beyond the scope of this article (Arnstein, 1969; Babelon, 2021; Flyvbjerg, 2002; Tewdwr-Jones & Allmendinger, 1998). Although an oversimplification, one can posit that two main positions exist that place public participation either as a means of fostering "consultative" exercises where planners seek feedback from residents without entering into any real dialogue, and, the alternative, more enthusiastic position that highlights the potential for greater "co-production" in policy design and implementation (Healey, 2012; Kleinhans et al., 2021). The debate remains open as to whether "citizen control" retains any currency for contemporary urban planning. The balance may at best point more toward collaboration on any of the many models used to design and evaluate the effectiveness of participatory processes, including their influence on planning processes, which also requires analysts to have a cold critical look at how consultations are effectively wielded by sponsoring organisations beyond the course of single projects (Arnstein, 1969; Carson, 2008; Davis & Andrew, 2018; Fung, 2015). There are dozens, if not hundreds, of models of public participation from which to choose concerning analogue and/or digital participation and different aspects of planning (see Babelon, 2021). However, these largely remain inscribed in just a handful of participatory planning paradigms that either acknowledge or simply disregard non-communicative and less-than-democratic decision-making practices in planning (Flyvbjerg, 2002; Lane, 2005; Rosol, 2015; Swyngedouw, 2005; Tewdwr-Jones & Allmendinger, 1998). Even studies that highlight the consultative role of digital participatory platforms warn of the risk of collecting feedback from citizens in a box-ticking statutory consultation exercise (Kahila-Tani et al., 2019).

Notwithstanding, the current state-of-the-art seems to lie in the deployment of phygital/blended approaches to engage residents, either *iteratively* (sequentially over time, in different phases of planning projects) or *recursively* (where the concurrent use of digital and in-person methods shape each other almost in real-time). Successful hybrid approaches aim to actively reach out to citizens with a genuine concern for diversity, linguistic barriers, democratic deficits, dwindling trust in local government affairs, and digital divides, among other limiting factors addressed in Section 4 (Nabatchi & Leighninger, 2015; RTPI, 2020). Interestingly, non-statutory consultation methods such as urban visioning or prospective consultations about aesthetic preferences can be the first effective step toward engaging residents to integrate citizen input in planning policies such as urban regeneration strategies, master planning, or design guidance (Deakin, 2012; Woods et al., 2019).

4. The Dark Side of Smart Engagement

In his seminal article entitled "The Dark Side of Planning," Flyvbjerg (1996) makes a cogent case for critical realism in planning that echoes other studies that underscore the prevalence of complex, dynamic governance processes. Such processes may appear as less-than-democratic to Habermas-inspired communicative planning advocates who view engagement as the conduct of fair, reasoned dialogue in search of the best common good (Allmendinger & Tewdwr-Jones, 2010; Tewdwr-Jones & Allmendinger, 1998). In Britain, national strategies for digital transformation have followed a digital-first narrative, reflecting the government's aspirations to accelerate economic growth, streamline public services, and become a world leader in digital adoption, notably in the related realms of construction and town planning and related reforms (Cabinet Office, 2020; Department for Digital, Culture, Media & Sport, 2022; Department for Levelling Up, Housing and Communities, 2022; Maltby, 2022). In the current policy-driven push toward digital transformation, critics warn that "blind faith" and optimism in digital technologies risk undermining democratic processes and decisions (Bernholz et al., 2021). At present, national strategies for digital transformation in planning take little account of the wider societal and economic implications of this increasingly rapid push for digital transformation, beyond addressing

digital divides as a matter of upskilling users and rolling out broadband (Holmes & Burgess, 2022). Critically, 1.5 million households across the UK do not have a broadband connection at home, and 21% of internet users have smartphone-only access, which has been shown to limit their access to essential digital-only services such as social housing applications (Holmes & Burgess, 2022; Ofcom, 2022). Unequal access to and use of digital technology and services came to the fore during the Covid-19 pandemic which further excluded already marginalised citizens (Robinson & Johnson, 2021). By extension, digital-first approaches promise to exclude just as much as in-person methods, precisely because they are different in nature and engage different people (Babelon, 2021; Pocewicz et al., 2012). The potential for exclusion has also been investigated by gender, age, race, ethnicity, digital skill, disability, education, and income and related effects of lack of and/or misrepresentations, biases, and unevenly distributed policy outcomes (Bricout et al., 2021; Holmes & Burgess, 2022).

There remain significant ethical risks associated with the exacerbation of existing exclusions, injustices, biases, and prejudices (Afzalan & Muller, 2018). With growing perceptions of digital participatory technologies as novel, exciting, and having limitless potential for more inclusive and efficient engagement, it is increasingly important that the ethical risks, inequalities, practical limitations, and cracks in the current planning system are brought to the forefront of debates around "smart" engagement (Airey & Doughty, 2020; Cardullo & Kitchin, 2019). Analysts warn that the current push in national policy toward systemic digital transformation displays several uncritical if not dysfunctional modus operandi that remain insufficiently addressed in both planning policy and practice (Boland et al., 2022). Such blind spots risk excluding groups of residents and types of engagement input, all the while compromising quality in the built environment, not to mention the risk of jeopardising the democratic imperatives of a well-functioning, equitable, and transparent planning system (Parker & Street, 2018; RTPI, 2020, 2021). These challenges concern: (a) a lack of organisational capacity and readiness at local planning authorities due to skills shortages and constrained budgets for non-statutory public participation, (b) the complexity of combined digital and participatory divides, and (c) low reported levels of citizen trust in government, developers, and the planning system (Batty & Yang, 2022; Boland et al., 2022; Clifford, 2018; Commonplace, 2021; Devlin, 2020; Wilson & Tewdwr-Jones, 2022). Besides, the planning system, both at the policy and development management levels, remains highly technical and unpredictable for all stakeholders involved, including residents (Commonplace, 2021). Most importantly, however, remains the commonly acknowledged (yet critically unassumed) fact that digital, in-person, and physical modes of engagement in public consultations provide unique, irreplaceable engagement "affordances." By their very nature, digital environments such as web-based engagement portals provide a wide range of functionalities that simultaneously constrain and enable the diverse ways in which users interact with them (Kaptelinin & Nardi, 2012). The design of digital engagement technologies should cater for the needs and preferences of different user groups based on level of experience, age, and physical capacity, among other considerations, which can also be adequately considered through well-crafted, creative combinations of in-person and digital methods for engagement (Broberg et al., 2013; Gottwald et al., 2016; Nummi, 2018; Pocewicz et al., 2012; Young et al., 2021). While the need to adopt multiple modes of engagement is commonly acknowledged among planning and engagement professionals, the critical implication is that a dual, blended/phygital approach needs to be well designed, budgeted, and carried out with skill, coordination, and local sensibility to help deliver the best of both approaches and compensate for the worst of each.

Privacy and security risks are also key concerns for so-called "smart" participation, including issues around e-governance (Le Blanc, 2020), the ethics of algorithms and algorithmic decision-making (Tsamados et al., 2021), geoprivacy and geospatial ethics (EthicalGeo, 2021), among other issues. For example, the "self-learning" capacity of algorithms (in the case of neural networks) opens the way to unchecked governance risks as well as oversimplified, binary rule-based decision-making ill-suited for complex decision-making or accurate interpretation of nuanced comments from citizens (Boland et al., 2022; Daniel, 2022; Kitchin et al., 2019).

5. The National Planning Policy Across Britain

With the aim of identifying opportunities and challenges for phygital consultations in development management and policymaking, our research agenda takes stock of a selective list of high-level policy documents (presented in Table 1).

Of all the selected documents, the TPT for Scotland provides the most explicit discussion of how digital transformation can help optimise the planning system on the basis of evidence-based decisions and effective public participation, to improve the quality of places and public value. The TPT policy provides the most comprehensive and detailed strategy for digital planning among the reviewed policy documents. The notion of smart development and placemaking constitutes the red thread behind the TPT's vision. It builds on a backbone of digital technologies for data capture, place management, stakeholder engagement, and public participation. A peculiarity of the TPT is the recurrent use of the term "PlaceTech," which remains undefined but seems to refer to the comprehensive capture and utilisation of locational intelligence for urban analytics to inform planning decisions and foster a culture of digital innovation across local authorities. PlaceTech comes alongside an integrated suite of digital solutions built

around a single planning platform and open data portal. The context for smart engagement is centred around extensive data, information, technological interoperability, and new ways of working and collaborating with key stakeholders and the public. The TPT highlights that the Scottish Government is committed to supporting local planning authorities wishing to pursue smart engagement by providing them with licenses to the smart engagement platform PlaceBuilder, developed by a start-up through a national digital innovation incubator programme. However, in comparison to the clear focus and drive to adopt digital technologies to support planning processes discussed within the TPT, the NPF4 for Scotland mentions little more than the importance of modern digital infrastructure to enable such a comprehensive and integrated digital planning system.

In England, there is little mention of concepts relating to digital planning within the *National Planning Policy Framework*, with the only related mention of digital technologies in the planning process consisting of a single reference acknowledging the need that plans should be available through digital tools to support public engagement. In comparison, the PfF cites the term "PropTech" throughout and provides a clear call for the adoption of digital technologies and open data to make planning services more efficient, inclusive, and consistent, to modernise the planning process. The PfF promotes the need for a digital-first planning process driven by standardised and open data. In England, as well as Scotland, the policy documents, in conjunction with the work of bespoke departments and teams (e.g., the work of DLHUC Digital, Open Digital Planning and Local Digital) identify and set out a requirement to engage with tech and service design companies to develop innovative new approaches to boost efficiencies, improve user experience, and reduce errors and costs, while also supporting local planning authorities to use these innovations to support a new civic engagement process.

In Welsh policy, little mention is made of concepts related to digital planning, "smart engagement," or "PlanTech" beyond building a modern digital infrastructure and securing reliable broadband across the nation. Instead, the policies focus on the highest quality design and sustainable placemaking with community involvement and inclusion at its core, which constitutes a central substantive aim of the reviewed policy documents as well as that of other interlocking policy guidance. The Future Wales national plan cites strategic opportunities for North Wales to become a "smart, resilient and connected region," while the Planning Policy Wales notes the need to "embrace innovative technologies" in supporting several of its policies. However, unlike the reviewed policies for Scotland and England (TPT and PfF, respectively), there is no direct mention of the need to embrace digital technologies to improve citizen engagement and/or planning processes.

The main common denominator for the three nations is that planning is a plan-led system with the presumption of sustainable development. All the reviewed policy documents place a strong focus on digital connectivity, well-designed places and buildings, and opportunities for all to thrive. Across the three nations, the policy address digital divides and exclusion by highlighting the need to improve digital skills and financial support for access to broadband and devices, as well as the value of providing services digitally to dispersed communities. For example, the NPF4 states: "Full benefits will be realised by actively tackling the digital divide by building skills, literacy and learning and addressing the financial barriers to internet access" (Scottish Government, 2021, p. 18). A backbone of digital infrastructure is also highlighted as fostering innovation and supporting businesses. Little mention is made of the more complex, structural effects of marginalisation that prevent many people from engaging effectively online or at all, as discussed here in the literature review. The policy also makes no mention of the need for information-rich ecologies of participation that provide both digital and physical/in-person methods to guarantee high-quality citizen input and improve the capacity for residents to engage in public consultations. The aim, rather, seems to align citizens' capacity with digital-first approaches, rather than the other way around.

Regarding data-driven decisions, the policy documents highlight the importance of collecting, analysing, and interpreting the evidence for specific plans and sites in light of the dynamic national planning policy orientations and community needs, particularly as regards housing supply, infrastructure, and, going forward, decarbonisation of the built environment and climate change adaptation. However, they provide different levels of focus relating to the adoption and application of digital planning tools and processes. Namely, TPT (Scotland) and the PfF (England) provide the strongest call for the need to adopt digital technologies in planning to improve efficiencies, cut costs, and support civic engagement, making direct reference to digital-first approaches and the need to capture and utilise data.

6. A Conceptual Model of Smart Engagement in Planning

Following the integrative literature review we propose a conceptual model that extends Beynon-Davies' (2010) unified conception of information, systems, and technology with seven Is of information-rich "phygital" ecologies, and three interdependent "pillars" for a smart, participatory digital planning system. Established as a result of the literature review, the conceptual model enables us to gaze both deeply and broadly into opportunities for smart engagement through, and beyond, PlanTech, as per the context.

As a result of the study presented, we suggest a heuristic definition of *smart engagement* as the process of involving well-informed residents in a well-resourced digital planning system by way of plural, collaborative

ecologies of participation to translate data into evidence-based decisions that shape and manage places sustainably. The conceptual model presented in Figure 1 elaborates on this definition, with the various parts discussed in greater detail below.

6.1. Beynon-Davies' Unified Conception of Information, Systems, and Technology

To recontextualise the potential for smart engagement to help improve planning processes and decisions in a critical, pragmatic way, we draw upon Beynon-Davies' (2010) unified conception of information, systems, and technology. In his seminal article, Beynon-Davies (2010) explores and extrapolates the relevance of communication artefacts used in the Inka Empire for modern information systems, particularly in reconceptualising the complex socio-technical conditions for meaningful interactions between people. In the proposed unified model, information is portrayed as the bridge between raw data grounded in the physical realm, and knowledge brought to life through social interactions in the activity realm. Information both structures the data from which it derives meaning and is structured by the activities for which this meaning (or "significance") is derived (i.e., "enacted"; Beynon-Davies, 2010). Beynon-Davies (2010, p. 390) writes:

> An information system is considered a special class of communication system, involving the use of signs within patterns of informative acts. As such, an information system is conceived of as a sociotechnical system that utilises a semi-formal "language" (Ågerfalk et al., 2006) mediating between activity systems on the one hand (social patterns of performative acts) and data systems on the other (technological patterns of formative acts).

The proposed framework by Beynon-Davies (Figure 2) is grounded in semiotics, or the study of meaning in social interaction. At its core lies the question: When do objects that act as signs become meaningful, and in which contexts? The Inkan communication coloured knitted threaded artefact studied by Beynon-Davies serves as the form (*forma*) which is both structured by information needs among people and provides the raw material from which communication can take place. For our purposes, the overall framework provides a conceptual basis for the design, conduct, and evaluation of public consultations that actively constitute ecologies of participation.

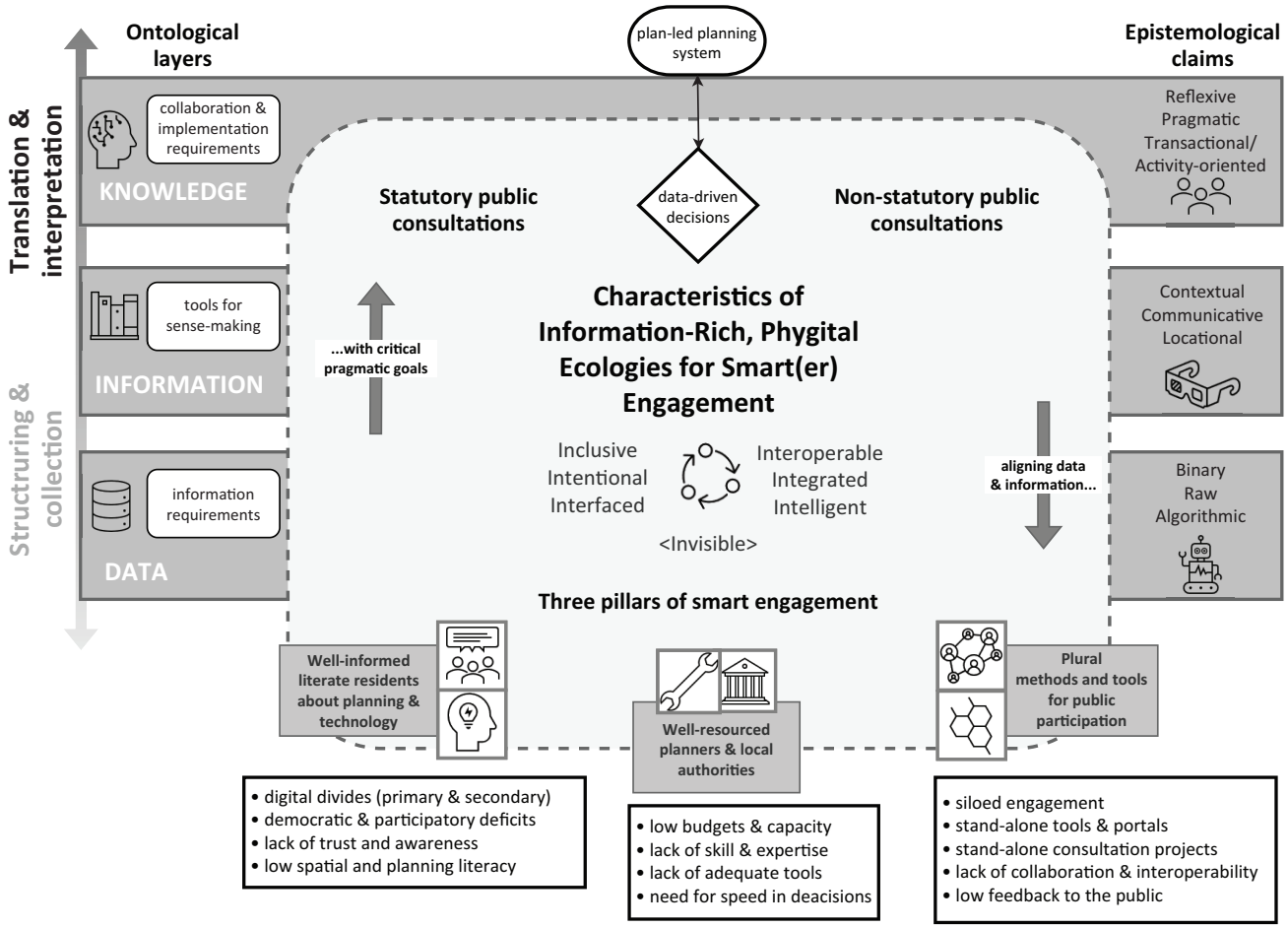

Figure 1. Original conceptual model for effective smart engagement in a digital planning system.

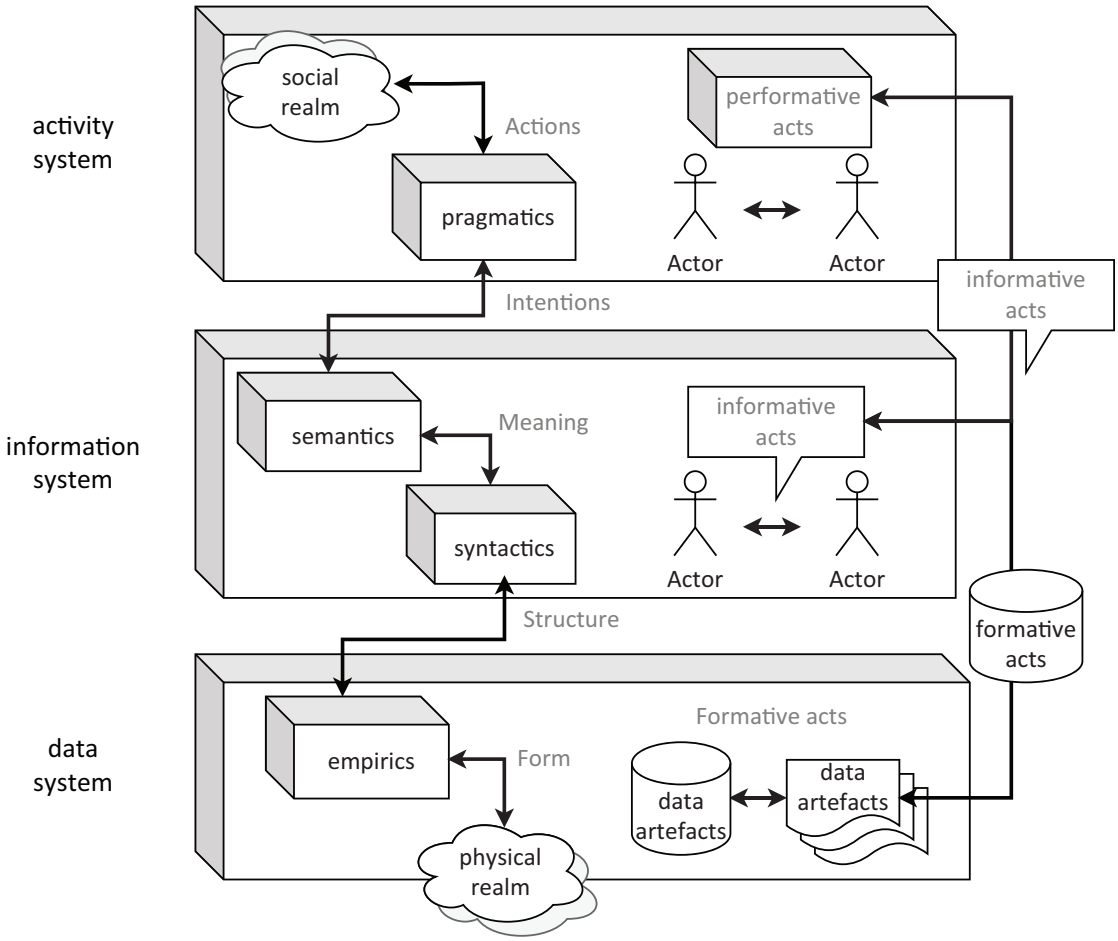

Figure 2. Conceptual framework for the enactment of significance through technology. Source: Adapted from Beynon-Davies (2010, p. 390).

As observed in other studies, citizen participation is seen as a performative activity where identity, motivation, and outcomes are contextual and evolve as they are enacted or "performed" (Turnhout et al., 2010).

6.2. The Seven Is of Smart Engagement

Through our integrative literature review, we can propose seven core characteristics as they relate to smart engagement. Rather than discrete, these characteristics are interdependent and multifaceted, also highlighting their phygital, socio-technical, context-dependent nature (Kitchin et al., 2019). We illustrate each of them with selective quotes from the reviewed national planning policy documents and add further discussion from the reviewed academic and industry literature.

6.2.1. Interoperability

"By focusing on the whole journey through planning, we will be able to develop the interoperability between systems to facilitate a truly digital planning system" (Scottish Government, 2020, p. 57). Interoperability is both technical and process-based as it leverages data and software compatibility through shared standards and workflow integration (Kitchin et al., 2019). The unified approach proposed in the TPT for Scotland outlines one such comprehensive, "end-to-end" suite of digital planning applications, inspired by the ePlanning portal in Singapore. A fully mature data model would enable a unified platform for agile forms of planning that address local community needs proactively as they arise, also called "self-organisation'' (Levine et al., 2021). The challenges comprise organisational, individual, technocratic, and technological factors (Batty & Yang, 2022; Kitchin et al., 2019). Accordingly, the *Engaging for the Future* report by Commonplace (2021, p. 9) recommends the development of interoperability standards so that "local planning authorities can easily work together to ensure that engagement is not limited to their boundaries, when neighbourhoods and infrastructure cross boundaries." Interoperability requirements, therefore, underpin systemic integration.

6.2.2. Integration

"Develop flexibility—Make it easier for planning authorities to integrate new technology within a digital

ecosystem where apps and services can be adopted and reused as components of a flexible, cloud-based, modular platform" (Scottish Government, 2020, p. 19). Building on interoperability, the integration of data, information, and knowledge promises to overcome traditional siloes between intra-organisational departments, organisations, and professions, and between the wider public and planning actors (Batty & Yang, 2022; Kahila-Tani et al., 2019). Integration is also policy-related, as it pertains to sustainable placemaking. For example, the national planning policy for all three nations addresses integration in terms of planning outcomes and cross-policy synergies, including the integration of mixed-use neighbourhoods, transport and blue-green infrastructure, and integrated impact assessments for projects, plans, and policies. These hinge on the appropriate levels and types of data, information, and knowledge (including digital skills) for effective decision-making and collaborative ways of working (Batty & Yang, 2022; Wilson & Tewdwr-Jones, 2022).

Integration also presupposes that the input from smart citizen engagement will help shape the decisions that will in turn (re)shape places (Fung, 2015; Kahila-Tani et al., 2019). PlanTech can utilise data as "dialogue," an iterative, two-way journey featuring continuous data structuring and translation into social interaction and decisions, as mediated by information-rich digital ecosystems (Gil, 2020). Smart engagement technologies can foster dialogue and bridge citizen and professional knowledge about places in powerful ways, particularly if these transcend consensus-based approaches to participation that may be designed to sideline alternative development trajectories and discourses (cf. Akmentina, 2022; Rosol, 2015).

6.2.3. Intelligence

"We will take a radical, digital-first approach to modernise the planning process. This means moving from a process based on documents to a process driven by data" (Ministry of Housing, Communities & Local Government, 2020, p. 21). "Embed a data-driven policy approach where development of policies considers data needs and opportunities at the earliest point, supporting planning policy by continuous monitoring of impact and iterative improvement" (Scottish Government, 2020, p. 52). A smart digital planning system that facilitates "data-driven" or "evidence-based" decision making can be presumed to be "intelligent." Intelligence in planning is simultaneously locational and cross-sectoral to enable collaborative design, management, and effective community involvement for sustainable placemaking. This includes the ability to identify suitable sites for different types of development, quantify housing requirements, and monitor trends through urban analytics, which requires (geo)spatial, digital, and data literacy as well as domain expertise (Kitchin et al., 2019; Parker & Street, 2021; Roche, 2014). Also, interoperability and integration both hinge on an extensive range of computerised codes and algorithms (i.e., artificial intelligence) for partial automation of planning rules or to extract and transpose meaning from citizen input (Hasanzadeh & Fagerholm, 2022; Kitchin et al., 2019). Ultimately, technology enhances human judgement and cannot replace it. Smart engagement requires a professional understanding that citizen input data is in fact living knowledge, which always risks being flattened to one of many data layers in a digital environment (Cardullo & Kitchin, 2019).

6.2.4. Inclusion

> Design is an inclusive process, which can raise public aspirations, reinforce civic pride and create a sense of place and help shape its future. For those proposing new development, early engagement can help to secure public acceptance of new development. (Welsh Government, 2021b, p. 24)

"Value and integrate non-digital interactions—Promote greater digital inclusion and recognise that digital should support professional judgements in planning" (Scottish Government, 2020, p. 19). Smart engagement should be inclusive and diverse by design (RTPI, 2020). Phygital approaches for participation build on the smart use of both digital and in-person participatory methods over the course of planning processes (Babelon, 2021). Accordingly, digital-first approaches to participatory planning cannot be "digital only," lest one should continue to exclude those who are least involved, and potentially most affected by, planning decisions (Commonplace, 2021; RTPI, 2020). Inclusive participation also hinges on the successful integration of citizen input in digital planning systems and evidence-based policy (Cardullo & Kitchin, 2019; Fung, 2015).

6.2.5. Intentionality

> Decisions on where growth will be focused, how places will function, how people will move across regions and wider environmental designations must be shaped by an understanding of cross-boundary issues. This will ensure…that regions do not unintentionally or unnecessarily compete for certain types of development. (Welsh Government, 2021a, p. 104)

Intentionality guides planning. The policy provides a vision augmented by mission statements, orientations, and guiding principles to facilitate opportunities for sustainable placemaking. Well-intentioned smart engagement also incorporates a politics and poetics of "care" and kindness towards end-users, as exemplified also in planners' desire to benefit communities as a popular motivation for joining the profession (Bicquelet-Lock & Taylor, 2020; Forester, 2020). Likewise, a digitally-enabled planning system requires an intentional design to guarantee both efficiency and democratic effectiveness (Batty &

Yang, 2022; Cardullo & Kitchin, 2019). Because decision-making in planning entails trade-offs between competing interests and land uses, intentionality also underpins evidence-based human judgements that transcend binary machinic insights (Kitchin et al., 2019).

6.2.6. Interface(s)

"The technology we implement for a future digital planning system needs to support, and interface with, a full range of capabilities. This integration will allow us to meet the ambitions for transformation and innovation that our strategy outlines" (Scottish Government, 2020, p. 77). "Throughout the planning system, opportunities are available for everyone to engage in local development planning and the development decisions which affect them. Such engagement, undertaken in line with statutory requirements, should be early, collaborative, meaningful and proportionate" (Scottish Government, 2021, p. 70). As related to inclusion, smart engagement through and beyond a digital planning system requires multiple interfaces, both digital and human. We contend that this is best delivered through plural, collaborative ecologies of information-rich environments, ranging from traditional engagement and consultation methods to ideation platforms and data portals that shed light on the opportunities and constraints that affect statutory planning and placemaking. Face-to-face interactions remain vital even as digital-first approaches are adopted and synergies can be achieved through iterative phygital engagement (Babelon, 2021; RTPI, 2020). Within the localism agenda across Britain, community-led planning in the form of local place plans (Wales and Scotland) and neighbourhood plans (England) enable citizens to enhance existing local development plans and strategies by addressing emerging community needs and aspirations, even if these may be under-resourced and non-representative of the communities they work for (Lynn & Wargent, 2017).

6.2.7. Invisibility

> [Deliver a] joined up, holistic and providing an end-to-end service for customers: By this we mean the experience a customer receives when using the planning system is seamless and joined up, regardless of where the underpinning data, policy and systems are derived. (Scottish Government, 2020, p. 41)

System operations may become truly invisible to end-users when seamless and fully integrated. Framed positively, seamlessness can provide a positive user experience and optimise collaboration, community involvement, and workflow integration to improve decisions (Batty & Yang, 2022; Gil, 2020). Conversely, opaque data governance and a technocratic agenda for smart engagement and decision-making can support non-democratic uses of technology and collected data for surveillance and undemocratic purposes (Cardullo & Kitchin, 2019). There are also latent risks of technological vendor lock-ins and lack of visibility about the complex webs of digital solutions providers (Devlin, 2020; Kitchin, 2014). Invisibility not also relates to active surveillance through tracking systems, but also to Foucauldian, panopticon-like modes of embedded rules, conducts of social interaction, and related aspects of distributed social control that operate through cultural norms and narratives. Such norms may include blind faith in the hope that digital-only approaches will foster more inclusive public consultations and lead to smarter, better and faster decisions across the whole planning system (cf. Kitchin et al., 2019; Rosol, 2015; Swyngedouw, 2005).

6.3. Three Pillars for Smart Engagement

To further support the development of the conceptual model for smart engagement, three interdependent "pillars" capturing high-level requirements for a smart, participatory digital planning system can be proposed. Below each pillar resides a selection of fundamental issues that smarter phygital engagement would need to address head-on to bridge the challenges discussed earlier in the article (see Figure 1).

6.3.1. Well-Informed, Literate Residents (Users)

> Work with partners to enable digital participation and inclusion to ensure no one is left behind in a digitally transformed planning system and ensure that people have the skills, confidence and information literacy required to make the most of being online. (Scottish Government, 2020, p. 69)

Primarily, smart engagement needs well-informed users who are literate about the various aspects of digital planning: spatially, civically, digitally, and planning-wise, with awareness of the interrelated domains and technological systems, including basic associated skills, that together would improve users' capacity to engage effectively in a planning system undergoing continuous reform (Babelon, 2021; Commonplace, 2021; Healey, 2012; Hildreth, 2012; Kitchin et al., 2019; Roche, 2014). Such literacy is fundamental to deriving value from the digital and data infrastructures that underpin "smart" placemaking processes (cf. Hildreth, 2012; Kitchin et al., 2021; Roche, 2014). Biased forms of participation, non-participation, and lack of awareness among residents are common signs of misalignment between the alleged aims of an inclusive, planning system on the one hand, and the complex realities of digital and civic divides within communities (Commonplace, 2021; RTPI, 2020).

6.3.2. Well-Resourced Planners and Local Authorities

"We recognise that local planning departments need to have the right people with the right skills, as well as

the necessary resources, to implement these reforms successfully" (Ministry of Housing, Communities & Local Government, 2020, p. 70). Secondly, planners and local authorities need sufficient resources to engage and integrate citizen input in planning workflows and decisions, including staff hours, budgets, skills, and supporting organisational cultures (Babelon, 2021; Boland et al., 2022; Devlin, 2020; Kleinhans et al., 2021; Patterson-Waterston et al., 2020). The technocratic components of PlanTech promise to free up time for planners from automatable tasks to build trust with residents through various forms of engagement, and partake in creative planning activities.

6.3.3. Methods and Tools for Public Participation

> Planning authorities, applicants, key agencies and communities have a responsibility to consult and engage others collaboratively, meaningfully and proportionately. Throughout the planning system, opportunities are available for everyone to engage in local development planning and the development decisions which affect them. (Scottish Government, 2021, p. 70)

Thirdly, plural, hybrid tools and interfaces can facilitate such well-informed and well-resourced interaction and collaboration between planning professionals and residents. Information, while commonly portrayed as the "low-hanging fruit" of public participation, is in fact a fundamental building block of all participatory activities that could characterise smart engagement (Babelon, 2021). Although the British policy remains unclear as to how digital-first approaches could be compensated with in-person methods, it encourages inclusion and collaboration, which presuppose a diverse range of methods and tools to proactively engage different communities. The benefit of deploying diverse engagement methods is to involve different people in ways that are unique to the methods used (Fung, 2015; Pocewicz et al., 2012).

7. Conclusions and Future Research Opportunities

This article has presented a preliminary research agenda and conception of smarter phygital engagement. In the face of a neoliberal, fragmented, and "cash-strapped" planning system where local planning authority planners struggle to implement decisions with a true presumption of sustainable development, as analysts and local authority planners have observed, digital solutions offer to provide a wide range of functionalities, but may not easily facilitate direct dialogue between residents and planners. The literature review highlights the heavy strain experienced by planning professionals and citizens, which reveals fundamental socio-technical cracks in the planning system. At the same time, the selection of reviewed policy documents indicates opportunities and a desire to optimise planning processes and improve the quality of planning outputs (i.e., new development) while engaging more people in more diverse ways via digital public consultations. However, the study has shown that the emphasis given towards the adoption of digital solutions to support the planning system differs across the three British nations. Most notably, Welsh policy makes little reference to a need for such adoption, with the focus instead given towards the requirement to improve the digital infrastructure (broadband). In comparison, while not all of the reviewed policies for England and Scotland discuss digital planning, the PfF (England) and TPT (Scotland) are clear on the need to adopt digital technologies in planning to improve efficiencies, cut costs, and support civic engagement. However, as discussed in the literature, an over-focus on digital-first approaches can be concerning, promising to exclude engagement just as much as in-person methods. While the reviewed policies for all three nations address digital divides and exclusion by highlighting the need to improve digital skills, offering financial support for access to broadband and devices, and providing a sound digital infrastructure, little mention is made of the more complex, structural effects of marginalisation that prevent many people from engaging effectively online or at all, as discussed within the literature review. The policies also make no mention of the need for information-rich ecologies of participation that adopt both digital and physical ("phygital'') methods to guarantee high-quality citizen input and improve the capacity for residents to engage in public consultations. For effective participation to work, both problem-exploration and problem-solving are needed, which would facilitate a critical pragmatic approach in planning without constraining participants' views, understandings, and aspirations. Echoing recent approaches in retail, "omnichannel" approaches to public consultations can—provided the necessary budget, capacity, and willingness to engage and be engaged—help to bridge some of the gaps between the strain in continuous planning reform and the edge(s) of digital participation. To address this opportunity, a conceptual model for participatory phygital planning that adopts Beyon-Davies' unified conception of information, systems, and technology has been proposed. The conceptual model presented sets out seven Is (characteristics) of information-rich phygital ecologies and three interdependent "pillars" for a smart engagement, established as a result of the integrative study presented in this article. The conceptual model enables us to gaze both deeply and broadly into opportunities for current and future phygital approaches to smart engagement in planning. The approach will benefit practitioners, policy-makers, researchers, and activists who seek pragmatic ways of addressing the challenges that digital-first engagement poses for smarter decisions in planning. However, to test this understanding and further develop this preliminary research, it is suggested that longitudinal policy evaluation, industry insight, and empirical academic studies would shed light on whether and how phygital engagement could produce smarter planning practices and decisions.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Citizen Engagement in Smart City Planning: The Case of Living Labs in South Korea

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Abstract
The smart city is recognized as a new city model for inclusive urban planning. Many local governments are making smart city plans to develop new policies that manage urban issues in South Korea. They identify issues through citizen surveys and decide which issues should be managed with priority. Some governments test developed policies based on citizen engagement. Most local governments use the living labs to encourage citizen engagement in smart city plans since these are public spaces where planners engage citizens to develop innovative and inclusive ideas. This study conducted a content analysis of smart city plans of local government. We analyzed the various approaches to the living lab and examined the stage of the planning process it is utilized in. Additionally, we identified the barrier to the living lab by interviewing people who participated in the smart city plan. According to the analysis, a barrier to citizen engagement exists in smart city plans; most citizen engagement is only used when planners develop ideas for setting visions and goals. It implies that citizen engagement occurs at a limited level in smart city plans and may cause planning to be less inclusive. We suggest that citizen engagement should be considered in the whole planning process to improve the inclusiveness of smart city plans and encourage sustainable citizen engagement.

Keywords
citizen engagement; inclusiveness; living lab; local government; smart city plan

Issue
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1. Introduction

Urbanization has improved citizens’ intimacy with cities and made their lives more pleasant, but citizens also face numerous problems with an urban environment, such as sustainability and quality of life issues (Basiri et al., 2017). To address problems, city planners and local governments have tried to design a more sustainable and pleasant city. However, it is questionable whether these efforts have observable effects on citizens or whether these policy efforts are meeting their needs. Additionally, some problems should be addressed through social consensus by synthesizing the opinions of various groups; still, it is questionable whether all these processes have been sufficiently conducted in traditional urban planning. In this regard, local governments have tried to find alternatives to manage urban issues and meet the needs of citizens in urban planning, for which a smart city is a powerful alternative addressing the limitations related to city management and fulfilling citizens’ requirements (Kirimtat et al., 2020).

A smart city is a new model for contributing to cities’ sustainability and managing the problems that modern cities face (Bibri & Krogstie, 2017; Kirimtat et al., 2020). The smart city is generally conceptualized as an innovative city that uses information and communication technologies (ICT) and other means to improve the quality of life, efficiency of urban operations and services, and competitiveness of the city (International Telecommunication Union, 2014). For urban management, a

smart city is considered a city that monitors and integrates conditions of all its critical infrastructure, optimizes its resources, plans its preventive maintenance activities, and monitors security aspects while maximizing services to the citizens (Hall et al., 2009). Additionally, a smart city means smarter urban areas made by investments in human and social capital and traditional and modern (ICT) communication infrastructure which fuel sustainable economic growth and high quality of life, with a wise management of natural resources (Caragliu et al., 2013). Moreover, the smart city can induce citizen participation in addressing controvertible issues through innovative communication technologies such as e-participation or e-government (Conroy & Evans-Cowley, 2006; Zheng, 2017), so these cities have an advantage in using citizen participation for urban management (Tadili & Fasly, 2019). Therefore, urban planners are expecting smart cities to address the challenges faced by conventional urban planning efforts since a smart city is not only built on an intelligent combination of endowments and self-decisive activities but also pursues sustainable growth and high-quality of life through participatory governance of citizens (Caragliu et al., 2013; Chourabi et al., 2012; Giffinger et al., 2007).

Regardless of the type or ideal of a city, it is essential to ensure that governments and planners respond to the needs and demands of citizens to solve city problems (Fung, 2015). Therefore, using citizen participation is considered the hallmark of effective democratic governance (Barber, 2003; Teorell, 2006; Verba et al., 1995), which can be well utilized in the smart city. Considering the purpose of a smart city, which is to solve the city problems experienced by citizens, citizen participation is an essential element in smart city plans (SCPs), and local governments are exploring possibilities to let their citizens participate through new interaction platforms (Coleman & Blumler, 2009). As a new method for promoting close interaction with grassroots initiatives (Buscher et al., 2010), the living labs are being actively used in numerous city planning initiatives, including SCPs. A living lab aims to stimulate an inclusive and collaborative system for shaping smart cities (Bifulco et al., 2017; Santonen et al., 2017). SCPs induce citizen participation in living labs to identify main issues and propose smart city strategies. For example, Amsterdam has tried to use citizen participation to develop smart city solutions, strategies, and services by encouraging citizens to provide feedback for services and advancement processes. Likewise, although the maturity of citizen participation differs from representative cases such as Amsterdam, most cities also use citizen participation to identify planning issues and establish SCPs in South Korea.

The differences between citizen participation levels using living labs in smart cities may be attributed to differences in the perception of whether it is beneficial. The dominant orthodoxy surrounding citizen participation in city planning states that citizens play a crucial role in smart cities regarding their participation in governance (Meijer & Bolívar, 2016; Przeybilovicz et al., 2022; Webster & Leleux, 2018). Przeybilovicz et al. (2022) argue that citizens or communities are the city components that make smart city initiatives responsive and balance the needs of different stakeholders for inclusive planning. However, other scholars skeptical of citizen participation in the planning process point out that it is necessary to discuss the conditions that justify citizen participation costs instead of simply putting blind faith in its positive aspects (Barnes et al., 2003; Michels & De Graaf, 2010). The skeptics also question whether its cost is economically reasonable and, more fundamentally, whether it is genuinely in the common interest of all citizens. However, despite this debate, there is a consensus that involving a wider variety of actors in the planning process based on citizen participation is significant for inclusive planning. For better citizen participation, it is necessary to review the limitations faced by citizen participation and find ways to improve them. While the focus is slowly shifting from "smart technologies" toward "smart citizens," citizen participation needs to be induced and the traditional top-down approach should be connected with a grassroots or bottom-up approach (Baccarne et al., 2014). In other words, it is necessary to build and operate smart cities with the active participation of "smart" citizens who are passionate about citizen participation at the center, rather than being centered on smart technology. This change is apparent in that the municipality's paradigm shift emphasizes citizens' contributions over its predecessor's tech-driven design (Angelidou, 2017). In this regard, this study analyzes local SCPs to identify how living labs are used in them as a citizen participation tool and examines the stages in which living labs are mainly applied. We also conduct a thematic analysis of the barriers and limitations of utilizing living labs for citizen participation in the SCPs.

2. Citizen Participation in the Planning Process

2.1. Citizen Participation in Urban Planning

Unlike when urban planning was the exclusive domain of planners and local governments, it has recently been changing to reflect inclusive opinions through the participation of various stakeholders, including citizens. As the interest and importance of citizen participation in the planning process increase, the conditions for citizens to participate in various stages of this process through various tools are also expanding. It has received interest ever since Arnstein (1969) presented the "ladder of citizen participation" study in academic fields (Konsti-Laakso & Rantala, 2018). Arnstein's (1969) classic highlighted the importance of citizen participation in various fields, especially in urban planning where inclusive opinions on a single objective such as the quality of citizens' lives are important.

Citizen participation is essential in inclusive policymaking because it is a strategy that allows non-

stakeholder groups to participate in sharing information, setting goals and policies, and deciding how to allocate tax resources (Konsti-Laakso & Rantala, 2018). Additionally, citizen participation has become routine and an expected feature of public policy-making such as urban planning, because of its implication for the right way to inclusive planning (Bingham et al., 2005). It tends to be applied in urban planning based on its purposes: identifying and collecting data, establishing legitimacy for the planning effort, and addressing the moral and ethical commitment of planners to ensure that those who are the most affected by a given decision have a hand in making it, developing robustness by bringing the widest possible set of views to the table (Seltzer & Mahmoudi, 2013). In other words, citizen participation can contribute to creating new knowledge and perspective and diffusing knowledge to other stakeholder groups (Konsti-Laakso & Rantala, 2018; Tritter & McCallum, 2006).

According to the above argument of citizen participation, we can assume that citizen participation will be more powerfully valuable for the urban planning process because urban planning is the comprehensive process of policy-making that derives a joint and inclusive agreement from different values for the same space. Regarding citizen participation in urban planning, IAP2 (2018) classifies the level of citizen participation into five stages: information, consult, involve, collaborate, and empower. In the "information" stage, citizen participation aims to provide information to help citizens understand problems, alternatives, and solutions in passive steps by providing data and building websites. In the "consult" stage, planners try to get feedback for decision-making through hearings, surveys, and public meetings based on citizen participation. Further, citizens directly participate in the planning process in the "involve" stage by utilizing workshops, discussions, and votes. In the "collaborate" stage, citizens earnestly work with policymakers in each aspect of the decision, including developing alternatives and identifying preferred solutions. Lastly, citizens make a final decision through citizen juries and referendums in the "empower" stage. Recently, most planners have been trying to apply citizen participation at a level like involve, collaborate, and empower stage, away from the information and consult stages, which can be attributed to recognizing the limitation of traditional citizen participation methods (Innes & Booher, 2004). In other words, traditional methods such as hearings, comment procedures, and reviews, are organized to satisfy legal requirements, not to cause learning and provide space for new ideas to emerge (Innes & Booher, 2004; Konsti-Laakso & Rantala, 2018).

There is a tendency for the application of citizen participation to be more potent in innovative urban models like SCPs, and the above efforts are prominently marked there. Unlike traditional urban planning, there is a tendency for lots of projects to be implemented based on the citizens' needs, with them actively participating in the planning process of the smart city. The reason for this is that citizen participation is the key challenge to developing a smart city project since the main objective of the smart city is to improve the quality of citizens' lives (Tadili & Fasly, 2019). The development of innovative communications technologies, such as ICT, also contributes to inducing better citizen participation in the smart city (Zheng, 2017). Using technology, they can access various information and share content with ease. They can also participate in the planning process without restrictions on space in the city. This technological improvement in the convenience of citizen participation through this technological leap promotes participation in line with the recognition of the importance of citizen participation in smart cities.

Although a participatory environment sufficiently supports citizen participation in the urban planning process, why are only a few citizens involved in the planning? Empirical evidence suggests that relatively few citizens participate when given the opportunity (Rydin & Pennington, 2000) and it has led to an interest in the issue of who will participate under what circumstances (Wandersman & Giamartino, 1980). Parker and Murray (2012) argue that if people do not get involved, it is not enough for planners to blame this on apathy. They also note that although improving relevant knowledge and awareness of the citizens' motives should be supported, interest in them is too negligible (Parker & Murray, 2012). Regarding the limitations of inducing citizen participation, developing the human capacity, like cities' social capital, is recognized as the basic ingredient in urban planning (Angelidou, 2017). Citizens' knowledge of the region helps make policies (Baker et al., 2007; Li et al., 2020) and local members' continued efforts to diagnose problems and make solutions are more likely to form a basis for a city to be resilient (Mahdavinejad & Amini, 2011). Therefore, it is noted that not only environmental improvement mentioned above but also educational measures to improve the awareness of society and interest in urban planning are essential for enhancing citizens' motivation to participate.

2.2. Living Lab: A Citizen Participation Tool in Urban Planning

The importance of citizen participation has been espoused in planning for decades. To this end, the existing urban planning stipulated a citizen participation system using tools such as surveys, disclosure of information, listening to residents' opinions, and public hearings (Greater London Authority, 2004; The City of New York, 2021). Although citizen participation has become a common practice in the field of urban planning, the related studies highlight a slender influence on the actual planning process (Backlund & Mantysalo, 2010; Beresford & Hoban, 2005). One of the reasons identified is the inadequate and uncomfortable methodology, such as public

hearings and written statements (Innes & Booher, 2004; Kingston, 2007). There is also doubt about whether the information collected through citizen participation influences the planning outcomes (Koontz & Thomas, 2006). That is, such a traditional method for citizen participation usually may end with monotonous and passive participation. Recognizing the limitation of traditional tools for citizen participation, planners and local governments have recently been trying to use citizen participation in the planning process, aiming to establish plans that can reflect the various demands of citizens, breaking away from the top-down method. They are also making an effort to develop the city as a laboratory to generate innovative solutions (Juujärvi & Pesso, 2013), an approach that aligns with the living lab concept.

The living lab is in line with an innovative change in urban planning related to citizen participation as mentioned above. A living lab is an appropriate tool for citizen participation in urban planning, which is a concept of user-centered, open innovation ecosystems based on a systematic user co-creation approach in public–private–people partnerships, integrating research and innovation processes in real-life communities and settings (European Network of Living Labs, n.d.). In the living lab, the public–private–people partnership structure, interactions between public, private, and people act as a core competency of citizen participation (Kuronen et al., 2010). Participants are given the same status as existing innovative entities (public, private) and expand the scope of cooperation between subjects to enhance the continuity of citizen participation. These can enhance user participation in the activities occurring in living labs (Seong & Park, 2015) and expand cooperation with existing entities to accelerate development. The living lab also functions as a method to embody and solve the problems experienced by residents by operating on a bottom-up governance basis (Kuronen et al., 2010), unlike other citizen participation tools. In this way, living labs can effectively identify the problems felt by citizens and develop field-oriented alternatives by collecting opinions from various stakeholders. Living lab's characteristic allows citizens to learn about pending issues in the region where citizens live, away from existing passive participation. In other words, there has been a notable shift from passive user feedback to a more active approach based on users' involvement (Cardullo et al., 2018). The characteristic of the living lab has established itself as an effective tool to achieve the purpose of citizen participation in urban planning.

Although the usage of living labs has positive effects in encouraging meaningful citizen participation in the planning process, why do only a few local governments adopt it? Moreover, why do some local governments hesitate to use living labs for citizen participation? First, the difficulty of organizing the participants for the operation of living labs is the representative reason. Empirical evidence already suggests that relatively few citizens participate when given the opportunity (Rydin & Pennington, 2000). Furthermore, as mentioned before, the skeptical need to discuss the conditions that justify citizen participation costs instead of simply putting blind faith in its positive aspects (Barnes et al., 2003; Michels & De Graaf, 2010) may hinder the adoption of living labs for citizen participation. This study initiated the identification of these problems and tried to analyze the barriers to the usage of living labs and present suggestions for addressing them based on semi-structured interviews about SCPs in South Korea.

3. Method

3.1. Data

This study aims to analyze how citizen participation is performed under SCPs and identify barriers and suggestions to living labs in SCPs. In South Korea, the Act on the Promotion of Smart City Development and Industry states that local governments need to establish an SCP first before starting a smart city project (The Ministry of Land, Infrastructure, and Transport, 2021). As of September 2022, out of a total of 229 cities, 45 cities including most of the metropolitan areas, such as Seoul, Incheon, and Gyeonggi, have adopted SCPs. According to the law, the contents of SCPs must include the basic directions, goals, and strategies of smart city construction while taking into consideration the characteristics and current situation of the region. In most regions, citizen participation is actively used for the analysis of local characteristics and developing strategies through surveys, living labs, or other tools. This study targeted those 45 cities that adopted SCPs to analyze what stage of the planning process citizen participation is utilized in SCPs, using contents analysis of SCPs. Additionally, this study conducted thematic analysis through semi-structured interviews with public officers working for smart cities and living labs to derive the barriers and suggestions for future living labs.

3.2. Contents Analysis

Prior to analyzing the detailed contents of SCPs regarding citizen participation, we classified it into three stages: Issue Identification, Problem-Solving, and Implementation and Feedback. For smart cities, citizens can take a role in discovering necessary urban services as democratic participants, and as creators who directly participate in problem-solving with local governments or users who create better services by providing solution execution and feedback (Callahan, 2007; Simonofski et al., 2017, 2019). Considering the role of citizens and active participation in SCPs, we re-organized the five traditional citizen participation stages in urban planning by IAP2 into three stages for SCPs, combining some stages with similar characteristics like "consult" and "involve" or excluding "information" stage that do not show more active participation (Figure 1).

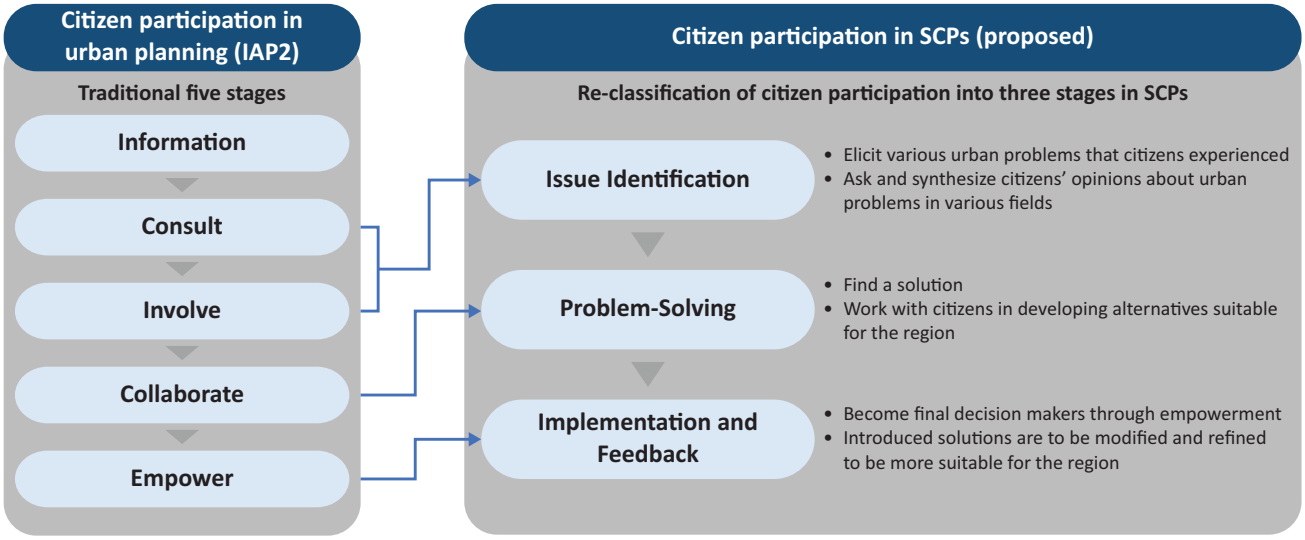


Figure 1. A framework of re-organization of citizen participation in SCPs.

First is Issue Identification, which is a process that listens to citizens' opinions and elicits various urban problems. At the beginning of smart city planning, there is a need to ask and synthesize citizens' opinions about regional problems they suffered in various fields. The second stage, Problem-Solving, aims to solve the problems derived through the first stage, going through the process of finding a solution. In this process, citizen participation affects the development of alternatives suitable for the region. In executing the solution in the community, citizens become final decision makers which can be linked to the third stage, Implementation and Feedback. At this stage, the introduced solutions are to be modified and refined to be more suitable for the region. This study classified 45 local SCPs according to the above citizen participation stage presented in each plan, analyzed the citizen participation tools mainly used in each stage, and further reconstructed the local SCPs centering on the stage of citizen participation in which the living lab is used. To this end, we conducted a content analysis of SCPs, including not only citizen participation that had already been implemented in the actual planning process, but also future citizen participation planned in the smart city service solution and monitoring stage.

3.3. Interview Protocol

We used the semi-structured interview to collect data regarding the barriers to living labs for SCPs and suggestions for improvements. Interviews were conducted over the phone or in writing because face-to-face interviews were limited due to the Covid-19 pandemic restrictions. We recruited interview participants considering the type of each SCP depending on the citizen participation stage of the living lab. Five public officials who experienced living lab for SCPs or were in charge of SCPs participated in interviews from August 26, 2022, to September 6, 2022. Four interviewees, whose participants' codes were from A to D, were each from regions using living labs at the intermediate level of citizen participation. Interviewee E was from a city which did not use a living lab for SCP but had established the SCP five years ago. Interviewee A worked for an SCP, and B was in charge of overall work related to the smart city, including living labs. Interviewee C worked on establishing smart city services, and D was in charge of the smart city challenge project and related works. Using open-ended questions, we asked the interviewees about their experience of using citizen participation in establishing local SCPs, the pre-requisite and barriers to the living lab for SCPs, and some suggestions for future living labs. Lastly, participants answered the effect of living lab and citizen participation for SCPs and the suitable citizen participation stage for living lab in SCPs. Additionally, common questions set in advance were amended or added in response to the respondents' experiences with the living lab and citizen participation. Figure 2 describes the fundamental questions of the interview.

We conducted a thematic analysis based on the interview responses using MAXQDA software which is a qualitative data analysis tool. Thematic analysis is a helpful method for understanding the perspective of different interview participants and emphasizing their similarities or differences (Nowell et al., 2017; Shahab et al., 2021). We first color-coded the responses in accordance with their contents and keywords, with selected sentences and paragraphs serving as each coding segment. Then, we categorized the primary responses (coding segments) into the following seven groups: purpose, prior citizen participation experience, management procedure for the living lab, barriers, outcomes, suggestions, and planned implementation of the living lab. Next, we gathered and structured the responses in accordance with the code to look for patterns and linkages. Finally, we identified four barriers to living labs and provided recommendations for the future.

Part 1	**The experience using citizen participation in establishing SCPs**
	1.1. Did you use citizen participation in the establishment of SCPs this time?
	1.2. What is the purpose of citizen participation? And at which stage did you engage citizens?
	1.3. What is the citizen participation tool, and why do you use that tool?
	1.4. Have you ever conducted citizen participation for other plans?
	1.5. Which tool did you use? Was it helpful for this SCP establishment?
Part 2	**Living lab implementation, barriers, and improvements**
	2.1. Why did you decide to conduct a living lab for the SCP?
	2.2. In addition to the issue identification stage, are you planning to use the living lab in other citizen engagement stages or policies?
	2.3. Was there any pre-requisite before conducting a living lab?
	2.4. What are the barriers to living labs?
	2.5. Do you think that civic engagement was successful through the living lab?
	2.6. What are the advantages or effects of the living lab in terms of the perspective of citizen engagement?
	2.7. If you will use the living lab later again, what would you like to improve on the living lab?
Part 3	**Significance of the use of living lab (citizen participation) in SCPs**
	3.1. Was citizen engagement active? Who led the citizen engagement process?
	3.2. Do you think the citizens' opinions were fully reflected in the planning process by utilizing the living lab or other citizen engagement tools?
	3.3. Which of the three citizen engagement stages are the most suitable for using a living lab?

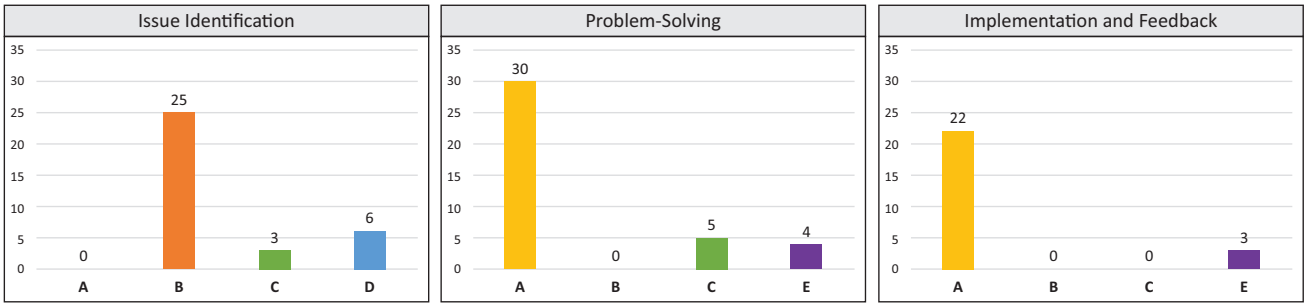
Figure 2. Semi-structured interview questions.

4. Analysis

4.1. Citizen Participation in Smart City Plans

The type of citizen participation in most SCPs can be divided into three stages, namely Issue Identification, Problem-Solving, and Implementation And Feedback. Figure 3 describes the percentage of local SCPs using citizen participation.

Issue Identification searches the local problems for a set of visions, goals, objectives, and strategies of SCPs, which many local governments traditionally have used as surveys and public hearings. Overall, six local governments used only surveys in this stage, while living labs were also actively used by 25 local governments in this stage. Problem-Solving is the second stage that prepares alternatives for how to solve the local issues derived from Issue Identification. In this stage, 30 local governments used only living labs and nine governments used an online platform or digital participation governance including idea competition, advisory, and others. Implementation and Feedback applies the solution derived in the prior two stages to the region and gathers feedback. In this stage, 22 local governments use living labs and only three use civic mapping or online platforms. This indicates that fewer than half of local governments are delegating initiatives to individuals, with local governments still overseeing the majority of planning processes. Many cities employ a variety of techniques to promote citizen participation, but few are used beyond the Issue Identification phase. Living labs, in contrast, are extensively used across all three stages, making them appealing alternatives for allowing citizens to take part in smart city initiatives and have more control over the planning process. Further, we analyzed how the living lab is working as a citizen participation method in SCPs and confirmed whether it is effective to engage citizens in smart city planning in Section 4.2.



* A: Living lab only, B: Living lab + Survey, C: Living lab + Others, D: Survey only, E: Others (idea competition, advisory online platform, SNS, etc.).

Figure 3. The percentage of local SCPs using citizen participation tools in the three stages. Notes: A—living lab only; B—living lab and survey; C—living lab and others (idea competition, advisory online platform, SNS, etc.); D—survey only; E—others.

4.2. Analysis of the Use of Living Lab in Smart City Plans

Based on the three citizen participation stages, we divided local SCPs into four types in terms of the usage of living labs, as shown in Table 1.

Out of 45 SCPs, five were excluded because they did not follow the common format of SCPs, were not approved by the Ministry of Land, Infrastructure, and Transport, or were established before the relevant law was enacted. Of the remaining 40 local governments, 15% did not use living labs in SCPs, which correspond to Type A. Most of them used surveys to identify the local issues or identify the needs of citizens by analyzing civil complaint data and using digital governors. Type B, on the other hand, utilized living labs and is further subdivided into three sub-types based on the extent of use. Overall, 10% of local governments are classified as Type B1, using living labs only in Issue Identification. They all used surveys and living labs to identify local problems and other tools such as online platforms or digital twins to make a new place to communicate with citizens in the planning process. Type B2 includes 27.5% of local SCPs, which are three metropolitan and six medium-sized cities in two provinces. As they held living labs three to four times, the participants took a pre-education about SCPs and living labs in the first session as they might not know what a smart city and a living lab are. Subsequently, citizens gather to share local problems for the environment, transportation, safety, healthcare, and so on, synthesize similar problems into one theme, and decide how to solve the problems in two or three rounds. Although Type B2 governments receive ideas from citizens, there is a limit in that it does not give citizens the authority to make detailed decisions or give feedback continuously through monitoring. Type B3 gives citizens more opportunities to solve problems and monitor implementation than Type B2. Type B3 represents 47.5%, with 10 metropolitan cities and many districts in Seoul but only one rural area. They plan to work with citizens to test solutions and evaluate them with the help of citizens as well. Additionally, some local governments like Gangseo-gu in Seoul have partnered with businesses, local stores, and citizens to demonstrate a smart order application that allows visually impaired people to easily visit and place an order. Other governments also make partnerships with universities so that citizens can continue to participate in living labs and testing projects.

4.3. For a Future Living Lab in Smart City Plans: Barriers and Suggestions

Unlike other citizen participation tools, living labs are widely utilized for identifying issues to giving feedback in SCPs, which is a relatively high level of citizen participation like Implementation and Feedback. However, most local governments have hitherto only conducted living labs for Issue Identification and Problem-Solving or do not use them; thus, we looked at why local governments are hesitant to apply living labs as a citizen participation tool in the planning process. To this end, we reveal the barriers to living labs based on the interview responses in terms of participant composition, low smart

Table 1. Type of living labs.

Type		Degree of citizen participation using living labs	Stage of citizen participation using living labs			Number of SCPs (%)
			Issue Identification	Problem-Solving	Implementation and Feedback	
A	A	Very low				6 cities (15%)
B	B1	Low	✓			4 cities (10%)
	B2	Intermediate	✓	✓		11 cities (27.5%)
	B3	High	✓	✓	✓	19 cities (47.5%)

city awareness, rewards, and the discrepancy between living labs and actual plans. Further, we provide suggestions and improvements for upcoming smart city living labs.

4.3.1. The Gap Between the Opinions From the Living Lab and Actual Smart City Planning Reflection

First of all, the gap in objectives and expectations about SCPs between citizens and local governments can be a barrier in the living lab of the smart city. It is also related to the possibility of reflecting citizens' ideas in the SCPs. In other words, the practical impossibility of realizing the services desired by citizens causes a discrepancy between the demands of citizens and the plans. Regarding this issue, Interviewee C mentioned:

> It is impossible to implement all the policies that citizens want. Even if solutions are necessary for real life, it takes a budget from installation to maintenance and monitoring, so we cannot do everything in the region, and it takes much time to coordinate them.

In fact, the gaps might be attributed to the tendency of citizens to prioritize personal interests over the public goods of SCPs—let us suppose that only policies that are technically impossible to implement or that take forever to realize are presented for establishing plans; further, if the contents of plans represent the interests of particular classes or citizens. There is a risk that citizens' ideas will not be sufficiently adopted in the plans. Even if it is adopted, the plan may turn into a plan to pursue specific interests rather than a plan for the public interest of citizens.

4.3.2. Lack of Knowledge and Awareness

Regarding the above issues, some interviewees noted the reason is that living lab participants lack knowledge and have low awareness about smart cities and living labs. Unlike in recent years when discussions on smart cities have been relatively active, there was insufficient discussion or publicity about smart cities at the time SCPs were established. One of the interviewees mentioned that "more than 90% of citizens who responded to surveys about smart cities said they do not know the smart city." The concept is difficult to understand and vague and is challenging for citizens to recognize the smart city since any outcomes or visible effects are insignificant. Furthermore, the lack of knowledge about the smart city harms implementing living labs and finding local issues or in-need policies. According to Interviewees A and E, "citizens typically chose services they desire even if they are unrelated to a smart city, focusing mainly on the 'field' of policies like transportation, healthcare, and safety." Additionally, Interviewee D said it was hard to decide on a smart city service solution due to the lack of knowledge about smart cities.

In this regard, utilizing pre-education or seminars on the smart city and living labs would be helpful to improve the level of awareness and knowledge of citizens. Interviewee A responded that providing basic education about smart cities and living labs is needed. Interviewee B also mentioned that facilitators and experts should play an important role in delivering relevant information and recognizing the smart city concept when operating a living lab. Further, Interviewee A suggested that an online platform can be useful in inducing more citizens' participation in the living lab of SCPs because it can eliminate the spatial constraint of participation. Therefore, it will be effective to develop online content via YouTube, including the general contents of the smart city and living lab, in order to enhance knowledge and awareness. Alternatively, public officials and planners can conduct pre-living labs with facilitators and experts to set basic directions and goals for living labs before implementing multiple living labs with citizens.

4.3.3. Limitation of Participant Composition and Recruitment

It is challenging to recruit living lab participants, and there is not enough diversity in the composition of participants. The number of citizens who can participate in living labs is limited, therefore the number of participants who represent the region is significant for determining the validity and reliability of using the outcomes of living labs for planning and policymaking. In fact, some citizens prioritize personal interests over public goods. For example, Interviewee B mentioned:

> The living lab seems effective only when people from various classes or backgrounds participate. Otherwise, if residents already live in the same neighborhood and know each other well, it will be difficult to coordinate and control a conflict of interest among them. So, the living lab will likely fail or be delayed.

Another issue is that because of time and space limitations, the participants' makeup does not reflect the region's population. Interviewee B said:

> Considering the personnel of public officials and consulting companies who operate it, most living labs are operated during the daytime on weekdays, and therefore the number of citizens who can participate is inevitably limited. Further, overall recruiting living lab participants did not go well.

Therefore, the diversity and representation of living lab participants must be guaranteed to obtain high-quality living lab results.

To overcome the issue of participant composition and recruitment, living lab organizers can consider recruiting experts with knowledge in the smart city service field or living lab. Interviewee B responded:

> Let's suppose residents, experts, and other stakeholders such as business operators, public officials, and planners are involved together in the living lab. In that case, the living lab can proceed in a way that can solve problems or conflict factors that may arise within the living lab.

Moreover, it is necessary to expand opportunities so that more diverse residents can participate in living labs without time and space limitations by utilizing various ICT technologies such as smartphone applications or online platforms.

4.3.4. Lack of Sustainability of Rewarding System for Citizen Participation

Planners and local governments also confront the issue of rewards for participating in the planning process. Although local governments recognize the importance of rewards for living lab participants, there is insufficient legal evidence to provide incentives to participants, and there is not enough budget to execute them. According to Interviewee A, "it is often difficult for public institutions to give cash to the public, and the legal basis for a reward for those who participate in a planning and decision-making process like the living lab is still insufficient." Such a restriction of rewards may not be proper for the citizens who participate in living labs, even if the whole objective of their participation is not about money. Moreover, the behavior of local governments encouraging citizen participation by depending on non-repudiable rewards such as money may not be sustainable for SCPs.

Therefore, planners and local governments have to provide various types of rewards based on legal standards for incentivizing the participants in the planning process. Regarding this, Interviewee C mentioned that "reward systems such as management of an innovative technology project or project leaders are being considered, in addition to providing local gift cards." Alternatively, it is also possible to grant qualifications such as project manager or committee for the entire process of planning, implementation, and monitoring of the proposed smart city projects through living labs, or rewards such as certificates and awards from local governments. For a suitable living lab, the active participation of citizens from various backgrounds and demographic characteristics should be prioritized. However, considering the time and effort required for a living lab, there will be few citizens participating in a living lab with a strong will to solve local problems. Therefore, citizens should receive reasonable rewards for participating in the living lab by establishing appropriate legal and institutional grounds, such as local ordinances accompanied by local governments.

5. Conclusions

According to the results of this study, most cities in South Korea use living labs for citizen participation in the planning process and local governments are aware that living labs for inducing citizen participation in SCPs are better than other measures. Nevertheless, most cities still only use living labs for the Issue Identification stage and are planning to expand to the Problem-Solving and Implementation and Feedback stages. For this reason, we identified what discourages them from applying living lab in the planning process of SCPs and what factors would improve the living lab environment. First, the gap between the results collected through citizen participation and the actual contents of the SCP can hinder sustainable citizen participation. However, from the local government's viewpoint, some citizens' demands tend to be personal or unnecessary to SCP, and those tend to be impossible to implement in the city. Despite this, gaps exist in the planning process and both the planners and local governments need to address them, because as the gaps deepen, citizens may lose their motivation to participate. Second, there was little awareness of the concept of "smart city," so there is a limit to inducing citizens to participate in SCPs. As a result, the organizers of living labs for SCPs can influence the results of citizen participation in the planning process. Third, public officers find it difficult to identify diverse members of living labs in each region because there are not enough residents who can participate in living labs. According to their experience, if diverse members participate, the results tend to be in the public interest; however, if a particular group or a small number of participants participate in living labs, the results tend to be biased toward personal issues not related to the smart city. Lastly, regarding economic feasibility, living labs can face cost problems that the skeptics pointed out (Barnes et al., 2003; Michels & De Graaf, 2010). Public officers shared concerns that encouraging citizen participation based on living labs would be less efficient in the process of SCPs.

Although barriers and limitations exist, there are solutions as well. First, not only citizens but also experts with expertise in smart cities should be included as indispensable members. Experts can suggest the correct directions for a smart city and play a role in coordinating decision-making among members of a living lab so that the results are in the public interest. Improving citizens' knowledge related to smart cities can also be the base for inducing citizen participation in SCPs. Second, local governments should improve residents' awareness about smart cities and living labs through various policies such as education, campaign, and public hearing, and actively utilize online platforms such as YouTube and Instagram to improve awareness among the younger generation about urban planning. As a result, planners will easily organize living labs and gather more diverse opinions through more participation of citizens who are interested in smart cities. Finally, despite the economic skepticism regarding citizen participation in SCPs, planners should provide incentives for participants to be swayed, such as a legal basis to support compensation for participants. In other words, reasonable reward standards for

time spent and costs incurred by citizens must be prepared according to local governments' financial conditions. However, planners and local governments should move away from the attitude of simply relying on only incentives or rewards for citizen participation to improve the sustainability of participation in the planning process. Living labs are a clear way to provide solutions for urban problems and have powerful advantages that can connect the local government and citizens. Additionally, it can be effective in harmonizing the traditional top-down planning structure and grassroots planning bottom-up structure of SCPs (Baccarne et al., 2014). Therefore, it is necessary that local governments efficiently address barriers to maximize the above advantages of citizen participation using living labs. We can ensure that inclusive SCPs may be possible when such limitations are effectively addressed, and SCPs utilize citizen participation suitable to local circumstances.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Smart Engagement in Small Cities: Exploring Minority Participation in Planning

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Abstract
Smart engagement approaches are now widely applied in community planning processes. However, there continues to be a lack of representation from marginalized groups such as racial/ethnic minorities in planning processes. In this study, we explore what smart community engagement methods are being applied by small cities in the U.S., and how minority communities are participating in the planning process with those engagement methods. We analyzed planning documents and public engagement data from five small cities located in different regions of the U.S. with varying levels of minority populations. We evaluated the planning processes of the study cities, specifically comprehensive planning, and what smart community engagement tools they have applied. Our study shows that smart engagements are performed primarily through community surveys and online outreach initiatives. Despite adopting these approaches, most cities received lower participation from minority populations compared to non-Hispanic Whites. Cities with higher participation rates provided more engagement opportunities and conducted targeted community events and surveys to reach out to minority and low-income communities. From this study, we conclude that cities should apply varied methods for community engagement and should not rely solely on smart approaches to engage with minority communities. For cities to increase their overall civic participation, including those underrepresented, smart engagement approaches should be supported by targeted public events and outreach activities.

Keywords
community engagement; small cities; smart city; urban planning

Issue
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1. Introduction

Community engagement is an integral component of any planning process that allows planners to know people’s vision for their community and learn from the perspectives of the citizens. Since the 1960s’ turn in planning by the advocacy planners (Clavel, 1994), public participation is now widely applied in the planning process. Participatory planning targets to create a process that is inclusive, allows consensus building, learning from local knowledge, and helps mobilize community action (Afzalan & Muller, 2018; Quick & Feldman, 2011). But traditional participatory planning process based on community meetings faces the problems of unequal participation from different population groups and entails a high cost of time and resources (Bamberg, 2013; Hoang, 2021). Considering the limitations of public meetings that cannot effectively inform citizens about complex urban issues, planners are increasingly adopting new web-based smart techniques to better engage citizens in planning (Evans-Cowley & Hollander, 2010). Smart engagement approaches can provide greater knowledge, commitment, and satisfaction level compared to traditional public meetings (Conroy & Gordon, 2004). Social media and internet technology also exert a positive influence on political participation (Bañales et al., 2020;

Weber et al., 2003). However, in some cases, they may fail to receive an adequate response from the community (W. Williamson & Ruming, 2020), and may lead to "token participation" by merely educating citizens to accept decisions that have already been made (Evans-Cowley & Hollander, 2010).

Lower participation from ethnic/racial minority communities is always a concern for planners (Hoang, 2021). Cultural differences, distrust in the government, lack of incentives, poor advertisement, inconvenient location and time of public meetings are some of the reasons for lower engagement from minority communities (Kapoor, 2001; Martinez-Cosio, 2006; Michelson, 2001; Quick & Feldman, 2011). While the use of web-based smart engagement approaches can help to overcome some of these barriers (Afzalan & Muller, 2018), there are concerns about "digital divide" or unequal access to digital services and knowledge of information technology among disadvantaged groups (Deng et al., 2015; Kashem et al., 2021; Praharaj et al., 2017). The level of access and usage to social media and digital services may also vary by race/ethnicity, income, or age (Bañales et al., 2020; Larsson & Grönlund, 2016). Despite these concerns about smart engagement approaches, cities worldwide are using them at different levels for their planning process. There is yet to be a comprehensive study that looks at whether smart engagement approaches have any positive influence on minority engagement compared to traditional participatory planning processes. We explored this question through case studies of five small cities across the U.S. By analyzing their methods of public participation and how successful they were in reaching out to minority communities, we evaluated the efficacy of smart engagement and identified methods of participation that may encourage more minority participation.

2. Smart Engagement Approaches to Planning

With the broader availability of internet technology, most cities worldwide are now thriving to become a "smart city" that promises to bring techno-centered digital solutions to urban problems (Cardullo & Kitchin, 2019; Hollands, 2008). Besides bringing embedded systems and sensor technology that may provide a safer and energy-efficient environment (Angelidou & Psaltoglou, 2017; O'Grady & O'Hare, 2012), smart cities also have the potential to transform urban governance that is a more participatory bottom-up process (Coe et al., 2001; Hollands, 2008). Smart technologies can blend the advantages of a face-to-face discussion with the scale and convenience of modern communication technology (Carpini et al., 2004), which may allow creating a citizen-centered approach to city governance. However, there are also critiques that smart cities can enable overly technocratic top-down governance that serve the interests of states and corporations more than the citizens (Cardullo & Kitchin, 2019; Kitchin, 2016). Instead of producing a more progressive and inclusive process for decision-making, smart cities can become a high-tech variation of "entrepreneurial cities" (Harvey, 1989; Hollands, 2008).

Despite the critiques of smart city initiatives, smart approaches for community engagement in the planning process are now widely applied. Smart approaches can include any method of public participation that relies on web technology and allows active or passive interaction of a large number of people with the planning process (Angelidou et al., 2017; Evans-Cowley & Hollander, 2010; Horgan & Dimitrijević, 2019). Brabham (2009, p. 243) argues that this smart approach of community engagement "enables us to harness collective intellect among a population in ways face-to-face planning meetings cannot." Such digital communication networks can help us crowdsource the public participation process to mobilize citizens and produce plans through a democratic process (Brabham, 2009). Besides making the planning documents and processes publicly available and getting direct input from the community, the use of social media is another aspect of smart engagements. W. Williamson and Ruming (2020) investigated the use of social media during the preparation of district plans in Sydney, Australia. Although they found a low per capita response rate, other studies have shown that social media has reached the lives of young adults from many racial and socioeconomic backgrounds (Duggan & Brenner, 2013). Social media is shown to provide new opportunities for minority young adults to read and share news and voice their political perspectives (Bañales et al., 2020).

Smart engagement usually goes beyond giving access to data or using social media to interact with the community. Smart city discourse also focuses on creating a "citizen-centric" city that is more responsive to community needs. However, Cardullo and Kitchin (2019, p. 1), through their study on smart city initiatives in Dublin, Ireland, argue that such "citizen-centric" initiatives "prioritize market-led solutions to urban issues, rather than being grounded in civil, social and political rights and the common good." They suggested that city administrations should be seeking to shift as many of their initiatives as possible up the ladder of citizen participation (Arnstein, 1969) towards citizen engagement and citizen power to create a truly "citizen-centric" smart city. As Bañales et al. (2020) highlighted, such engagement and empowerment of the citizen are even more crucial for minority communities. However, there is yet to have any comprehensive study that investigates minority engagement in the planning process, particularly when cities are adopting different smart engagement approaches.

3. Community Engagement in Planning

Community engagement is considered as an integral component of any planning process. It requires involving community members in all stages, from initial visioning to final plan development, typically through consultation

and collaboration (Arnstein, 1969). This emphasis on community engagement came through a transition within planning practice and theory, from the early conception of planning as a highly technocratic practice to one where planning is meant to be responsive to the needs of citizens (Healey, 1996). The benefits of community engagement or public participation in planning processes are now widely documented (Brabham, 2009; Innes & Booher, 2018; W. Williamson & Ruming, 2020).

Community engagement allows adding expert knowledge and local knowledge to the plan and makes the planning process more informed about public narratives. It can be considered a logical extension of the democratic process in more local, direct, and deliberative ways (Michel Pimbert, 2001). Involving the local community in the planning process also ensures that the plan will be widely accepted by its future users (Burby, 2003; Fiskaa, 2005; Miraftab, 2003). Dialogue with the local citizens and learning about their lived experiences allow planners to gather enough details and facts about local issues (Watson, 2003). It is a process of creation and diffusion of new knowledge about the community that can affect planning process at all stages (Hanna, 2000). In some cases, it was found that the inclusion of non-expert knowledge collected through community participation helped planners discover creative solutions for specific local contexts (Van Herzele, 2004).

Community engagement may not provide the expected outcomes all the time. It can turn out to be a costly and ineffective if not properly designed considering the local context (Irvin & Stansbury, 2004; Nance & Ortolano, 2007). High-level participation can also increase conflict among disputing parties and slow down the decision-making process (Brody, 2003). Simple participation in the planning process may also not ensure inclusion in the decision-making. Quick and Feldman (2011) particularly highlighted this distinction between participation and inclusion. They argued that while participatory practices enrich the input received, "enhancing inclusive practices builds the capacity of the community to implement the decisions and tackle related issues" (Quick & Feldman, 2011, p. 274). Efforts should be taken to make the planning process more inclusive for the target community, that would empower them to engage in an ongoing stream of issues. It is particularly challenging for minority communities who are already having a lower level of participation in the planning process. The following section elaborates on the challenges of reaching out to minority populations.

4. Minority Participation in the Planning Process

Minority populations, particularly Black and Hispanic people, have a contentious relationship with the U.S. political system due to systematic racial/ethnic marginalization (Bañales et al., 2020). Racist immigration policies and voting practices (Durst, 2018; Misra et al., 2021) have contributed to this distrust in the political system and thereby assumed to have contributed to racial disparities in public meeting participation at the local level (Hoang, 2021). Although there is yet to have systematic research analyzing minority participation throughout the planning process, studies have explored public meeting attendance of minorities to gauge their participation in urban decision-making (Hoang, 2021; A. R. Williamson & Scicchitano, 2014). A recent study by Hoang (2021) utilizing nationally representative data did not find racial/ethnic group differences in public meeting participation but found differences among the economically vulnerable. Several other studies found that public meeting participants usually tend to be older, male, and possessing higher levels of education and income than the general public (Carr & Halvorsen, 2001; McComas, 2001). However, public meetings are only one method of community engagement through which minorities can participate in the planning process. More empirical research needs to be done, and this current study is an attempt at it.

Efforts to increase community involvement among minorities have not been successful due to various reasons. Hispanic communities with a large share of undocumented immigrants can have limited community engagement (Munier et al., 2015) as concerns of legal status may raise fear and trust issues towards city officials. Even community members that are born in the U.S. limit their interactions with the local government due to a lack of trust and racial profiling (Michelson, 2001). Minimal English skills and a lack of knowledge about governing processes may also prevent them from engaging in planning events (Martinez-Cosio, 2006). Through interviewing planning practitioners, Sen (2008) identified several reasons that may keep members from low-income and minority communities from participating in a public process: lack of perceived relevancy, use of technical jargon in meetings, inaccessible meeting places, inconvenient meeting time, busy work schedule, lack of child-care access, absence of translation in the native language, etc. Targeted events for selected groups and ensuring appropriate representation are also important to encourage minority participation (Fung, 2006).

Prior studies have underscored the links between community engagement and the political efficacy of a population group (Abramson & Aldrich, 1982; Hoang, 2021). Bañales et al. (2020, p. 176) explored it further by applying critical consciousness (CC) theory, "a framework that explains marginalized groups' pathways to civic/political engagement." CC framework argues that a person's civic engagement is influenced by their perceptions of societal inequities (critical reflection) and their political efficacy (i.e., beliefs about one's ability to initiate social change; Diemer et al., 2017). Bañales et al. (2020) examined the ways CC processes are related to sociopolitical action and social media engagement of Hispanic and Black American young adults. From this study, they concluded that stimulating critical reflection on societal inequality has the potential to increase the civic

engagement of Hispanic and Black young adults. They argued for teach-ins, intergroup dialogues, and social media campaigns to stimulate critical reflection among these young adults.

It is projected that in the U.S., racial and ethnic minority groups will outnumber non-Hispanic Whites in 2045 (Frey, 2018). Considering this expected demographic shift, planners should be more diligent now in encouraging minority participation in the planning process (Kashem et al., 2016). While smart engagement approaches may make it easier to quickly reach out to the whole community (as discussed in Section 2), planners need to be aware whether minority populations are effectively participating through these approaches.

5. Study Method

For this study, we selected five small cities from different regions in the U.S. We considered cities with 50,000 to 100,000 residents as "small cities" since it is between the 2010 Metropolitan Statistical Area (MSA) definition followed by the U.S. Census (areas with an urbanized area of minimum 50,000 population; Office of Management and Budget, 2010) and the 2020 updated standard for MSA (minimum 100,000 population; Office of Management and Budget, 2021). The reason for selecting smaller cities is that smaller cities usually have a limited planning workforce and may have limited capacity to deploy any smart public engagement method for plan preparation. Besides the size of the city, we considered demographic composition and availability of planning documents with race/ethnicity information of public engagement. To select cities from different regions, we explored the U.S. ethnicity map created by Frey (2019) and shortlisted cities with different levels of race/ethnicity distribution. Demographic data of the cities were collected from the 2020 decennial census available through Census QuickFacts (U.S. Census, 2020).

After shortlisting cities from different regions, we searched for cities that had adopted a comprehensive plan between 2010 and 2020 and provided detailed race/ethnicity data of their public engagement activities. The planning documents were found by searching the city's planning department websites. Once the final plan documents were found, the next step was to look through the documents to find any information on public participation and documentation of race/ethnicity breakdown of participants. This process eliminated many cities for different reasons—they either did not have a comprehensive plan between 2010 to 2020, did not have any documentation of public participation, and/or did not document racial/ethnicity data of public engagement events. The locations of the selected study cities are shown in Figure 1.

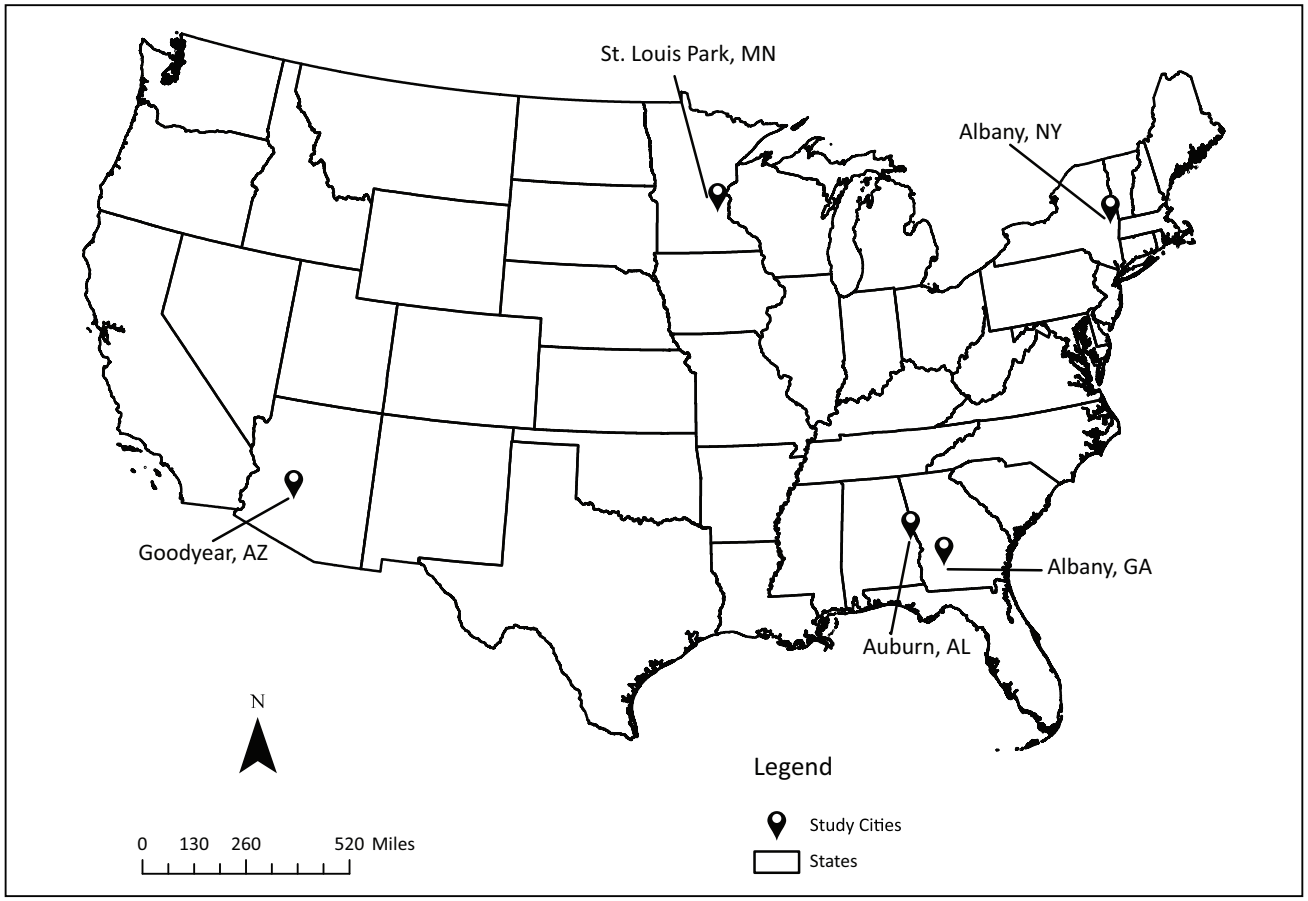

Figure 1. Location of the study cities in contiguous U.S.

Table 1 lists the selected five cities, their population size in 2020, and the plan documents reviewed. Table 2 shows the distribution of major race/ethnicity in these five cities. Two cities have a significant share of Black or African American population (Albany, Georgia and Albany, New York), and one city has a significant share of Hispanic population (Goodyear, Arizona). The reason for selecting cities with different levels of the minority population is to evaluate whether there is any significant difference in minority public participation depending on where they are in the U.S.

Planning documents from the study cities were reviewed to identify the public engagement mechanisms they applied and what efforts they have taken to reach out to the minority populations. The key focus of this review was to identify what kinds of smart engagement techniques they have applied and what is the race/ethnicity distribution of the participants in their planning process. Race/ethnicity data of the whole population in each city for their corresponding year of the plan preparation was collected from the census and American Community Survey (ACS). Race/ethnicity distribution of the population is compared with that of the plan participants to evaluate how much the planning activities were able to reach out to the minority populations. The study cities are briefly discussed in the following sections.

5.1. Auburn, Alabama

The city of Auburn is located in Lee County of Alabama. It is the largest city in eastern Alabama. The population of the city was 76,143 people in 2020. Auburn has a high share of the Black or African American population (17.6%), but the non-Hispanic White population (68.9%) is the majority, like most other cities in Alabama. The city of Auburn adopted its comprehensive plan, CompPlan 2030, in 2011. The planning process for CompPlan 2030 began in early 2008, and it serves as a general policy guide for future community improvements and decision making. This plan provides the basic framework for land use, transportation, natural systems, other public services, and community improvements (City of Auburn, 2011). It was further updated and adopted in 2018.

5.2. Goodyear, Arizona

The city of Goodyear, Arizona, is a city in Maricopa County. It is a suburb of Phoenix. In 2020, the population of this city was 95,294. This city is selected for this study due to its size, location, and demographic composition (46% minority population). The city of Goodyear adopted the Goodyear 2025 General Plan in 2014 as a roadmap to the future growth. This General Plan is the community vision that also outlines the overall fundamental strategy, community goals, objectives, policies, and action items (City of Goodyear, 2014).

5.3. Albany, Georgia

The city of Albany, Georgia, made to our selected five cities due to having a majority-minority demographic, where about 75% population is Black or African American. This city, located in Dougherty County of Georgia, had a population of 69,647 in 2020. The City of Albany and Dougherty County developed the Comprehensive Plan 2026 to guide the growth of their community. It is a part of their ongoing planning process that seeks to ensure the provision of adequate facilities and services to support anticipated growth (City of Albany & Dougherty County, 2016).

Table 1. Study cities and the reviewed planning projects.

City	State	Population size in 2020 (U.S. Census, 2020)	Planning projects	Year of adoption
Auburn	Alabama	76,143	CompPlan 2030	2011
Goodyear	Arizona	95,294	2025 General Plan	2014
Albany	Georgia	69,647	Comprehensive Plan 2026	2016
St. Louis Park	Minnesota	50,010	2040 Comprehensive Plan	2019
Albany	New York	99,224	Albany 2030 Comprehensive Plan	2012

Table 2. Distribution of major race/ethnicity in the study cities.

City	Black or African American alone	Hispanic or Latino	White alone, not Hispanic or Latino
Auburn, AL	17.6%	3.4%	68.9%
Goodyear, AZ	7.2%	29.0%	54.3%
Albany, GA	74.9%	2.5%	20.1%
St. Louis Park, MN	5.9%	4.9%	79.9%
Albany, NY	29.0%	10.1%	49.8%

Source: U.S. Census (2020).

5.4. St. Louis Park, Minnesota

The city of St. Louis Park is in Hennepin County of Minnesota. It is a suburb west of Minneapolis. It had a population of about 50,000 in 2020. It is a typical midwestern city with a majority White population (about 80%), and only 6% Black/African American and 5% Hispanic population. The City of St. Louis Park developed the 2040 Comprehensive Plan and adopted it in 2019. This plan sets forth the policies and programs to govern future land use, transportation, public facilities, economic development, and housing in St. Louis Park (City of St. Louis Park, 2019).

5.5. Albany, New York

The city of Albany, New York was selected as one of the five study cities considering its comparatively higher concentration of minority population (about 50% of the total population). This city adopted a comprehensive plan (Albany 2030 Comprehensive Plan) in 2012 and provided detailed documentation of its public participation process along with the racial/ethnic distribution of participants. Albany is also the capital of the state of New York and had a population of about 99,000 in 2020. Albany 2030 Comprehensive Plan is the city's first comprehensive plan, and it documents the city's Vision for the future and reflects the residents' values and priorities (City of Albany NY, 2012).

6. Study Findings and Discussion

6.1. Public Engagement Techniques

All five study cities have taken various public engagement techniques for preparing their comprehensive plans. Table 3 shows the public outreach and engagement approaches taken by each of the study cities. The applications of smart engagement approaches vary significantly from city to city. All cities have used their city website or created separate planning websites to post plan updates and request community feedback or comments. Most of the cities also had some form of social media presence, either to quickly interact with the community (in Albany, New York) or to broadcast public meetings (in St. Louis Park, Minnesota). Some of the cities also used interactive engagement websites (Goodyear, Arizona and Albany, New York) or online mapping tools (St. Louis Park, Minnesota). Direct community input came primarily through community/citizen surveys for all cities. However, the survey approaches varied between mail surveys (Auburn, Alabama and Goodyear, Arizona), online surveys (St. Louis Park, Minnesota and Albany, New York), or a mix of online and in-person surveys (Albany, Georgia). Engagement techniques applied by each of the cities are elaborated below.

For Auburn, Alabama, input from the public, external stakeholders, and City staff was a key aspect of the development of their CompPlan 2030. They organized a series of public meetings at different locations in Auburn to gather input from the public. They promoted public meetings through emails, promotional posters, public service announcements, event notices on radio and online, and social media (City of Auburn, 2011). The Auburn Citizen Survey of 2010 and a dynamic GIS-based application on the CompPlan website were the sources of public input for this plan. ETC Institute, a firm specializing in market research for local governments, administered the citizen survey through a mail survey of Auburn residents (ETC Institute, 2010). Besides this citizen survey, the City sent surveys to nearly 100 stakeholder organizations to solicit their input regarding issues and needs in their areas of expertise.

For the 2025 General Plan of Goodyear, Arizona, public participation approaches consisted of Getting Arizona Involved in Neighborhoods (GAIN) Community

Table 3. Public outreach and participation methods applied by the study cities.

Auburn, AL	Goodyear, AZ	Albany, GA	St. Louis Park, MN	Albany, NY
Public meetings	Community Festivals	Kick-off meeting/visioning session	Neighborhood planning workshops	Community forums
Public service announcements	Visioning workshop	Focus group	Town Hall meetings (in-person and online)	Stakeholder roundtables
Event notices on radio and online	Open house meetings	Mayor of the day	City website	Micro-meetings
Community survey	Mobile community	Public hearings	Community survey	Speed planning
CompPlan website	Advisory forum meetings	Media strategies	Social media	Stoop surveys
Social media	Small business summit	Community survey	Online mapping tool (Social Pinpoint)	Walk-shops
	Youth involvement	Plan website		Community drop-ins
	Citizen survey			Community group meetings
	Interactive engagement website (Goodyear Connects)			Online surveys
				Interactive website and social media

Festival, visioning workshop, open house meetings, mobile community meetings, Goodyear Connects, development advisory forum meetings, Fall Festival (GAIN), small business summit, youth involvement, citizen survey, and community meetings (City of Goodyear, 2014). To guide public participation in the planning process, they adopted a Public Participation Plan in 2012. This plan identified the public participation activities to maximize community involvement in creating the goals and policies for the General Plan. They used the National Citizen Survey, conducted by the National Research Center Inc (2015), which provided an affordable and easy way to receive residents' opinions on local issues.

The City of Albany and Dougherty County, Georgia, tried to include citizens of all ages in their planning process for Comprehensive Plan 2026. Albany's comprehensive plan committee used different participation techniques such as a community survey, kick-off meeting/visioning session, focus group, mayor of the day, media strategies, public hearings, and a website (City of Albany & Dougherty County, 2016). They distributed the community survey both online and in-person soliciting citizen opinion on local issues. The survey was available on the Southwest Georgia Regional Commission website and was publicized through local media outlets, focus group meetings, and postcards with a link to the survey (City of Albany & Dougherty County, 2016).

2040 Comprehensive Planning project of St. Louis Park, Minnesota, adopted a community engagement approach consisting of a Fall and Spring plan. The fall activities consisted of neighborhood planning workshops and a community survey, and in the spring, they conducted another community survey (City of St. Louis Park, 2019). They organized four workshops that aimed to cover the city's seven neighborhood planning areas and all 35 neighborhoods. The online survey in the fall attracted almost 1,100 participants, while the spring survey attracted 2,150 participants. There was an online mapping tool added in coordination with the community survey to gather feedback on the proposed land use plan. The online mapping tool was called Social Pinpoint, where users were asked to review the land-use change areas and mark where they can support the change, have concerns, or have ideas (City of St. Louis Park, 2018).

The Albany 2030 Comprehensive planning project of the City of Albany, New York, applied various techniques to engage with the public. Their public outreach techniques included branding and promotion, community forums, interactive website and social media, stakeholder roundtables, micro-meetings, speed planning, Stoop surveys, walk-shops, community drop-ins, online surveys, community group meetings, and a final town hall forum (City of Albany NY, 2012). Their outreach process began in 2009, designed to engage all community members and regional partners in developing a vision for the future. They developed an Outreach Strategic Plan that began with a situation analysis to identify "hard-to-reach" populations and key messages that should be relayed throughout the Albany 2030 planning process (City of Albany NY, 2012).

The city of Albany, New York, considered social media as a key component of the public engagement plan. They used web technology to get higher interest and participation from young professionals and those who rely on instant communication. The interactive website provided outreach, feedback, and information-sharing options. The share option provided an online survey as a quick way to give feedback to the community forums in which hundreds of surveys were completed. The city also set up a Facebook page, Twitter account, and LinkedIn group to allow for feedback and a constant open line of communication (City of Albany NY, 2012). The social media accounts were used regularly to send out reminders and announcements, launch discussions, and provide feedback on inquiries regarding Albany 2030 topics.

6.2. Minority Participation in the Planning Process

As discussed in the previous section, all five study cities have applied different mechanisms to increase the participation of their citizens during the planning process. The application of smart engagement approaches (i.e., planning websites, social media, interactive maps, online surveys, etc.) varied from city to city. To evaluate minority participation in the planning process, we had to rely on their survey data reports since no other planning documents reported the race/ethnicity distribution of participants in public meetings or community events. This is a limitation of this study, but we can also argue that if the smart engagement approaches successfully reached out to everyone, we should see equal response rates from all population groups. Hence, evaluating the survey response rates can be an alternative way to identify whether those smart engagement approaches are helping to encourage overall minority participation in the planning process.

The surveys performed for each planning project in the studied cities were very similar. The main topics were quality of life, city services, amenities, development, and demographics. Evaluating the survey questionnaires, we did not find any question biases that may affect minority participation. The questions asked were conducted in a way that allowed all respondents to answer the questions without feeling discouraged or racially profiled. Although there were demographic questions, respondents were allowed to skip or not answer the questions.

We compared the distribution of three major races/ethnicities (White, Black, and Hispanics) within the total population and among the survey respondents to evaluate if there are low response rates from the minority groups (primarily Black and Hispanics) as found in prior studies (Carr & Halvorsen, 2001; A. R. Williamson & Scicchitano, 2014). For race/ethnicity distribution, we collected data from the Census and ACS of the survey years. While compiling this data, we encountered

difficulty with how planning documents report race and ethnicity. Some cities reported them together with all races (e.g., Auburn and St. Louis Park), while others reported them separately. Therefore, we collected race/ethnicity data from the Census or ACS (depending on the survey years) in a similar fashion for each city to make them comparable.

Table 4 shows the summary of our findings. Lower participation rates of minority groups (i.e., Black and Hispanics) compared to Whites is evident in all the study cities (except for Stoop Survey in Albany, New York) despite the variations in their location and demographic composition. In Auburn, Alabama, the Black/African American population constituted 14% of responses, while they are 16.4% of the total population. On the other hand, the White population had a much higher response than the total population (81% respondents for 73.5% of the population). Goodyear, Arizona showed a similar pattern, but they had significantly lower participation from the Hispanic population (with a −7.6% points difference). Hispanic/Latino ethnicity is the fastest-growing population in the U.S. (Frey, 2019), so such a low response from this group should be concerning. Albany, Georgia, despite having Black/African American population as the majority, received a significantly lower response from this group (−12.8% points difference). St. Louis Park already had a low minority population compared to other cities, but they also experienced lower responses from both Black and Hispanic populations (−4.3 and -3.1% points differences respectively). While these low response rates from minority populations can be addressed by appropriate weighting for statistical analysis, this consistent pattern indicates the inefficacy of the methods employed by the cities to ensure equal participation from minority groups.

Findings from Albany, New York, warrant further discussion. In addition to online surveys, social media engagement, and community forums, they conducted Stoop Survey to engage hard-to-reach populations (i.e., low-income, minority neighborhoods; City of Albany NY, 2012). They conducted online surveys at several stages but did not report the race/ethnicity distribution of the respondents. They reported that information for Community Forum and Stoop Survey participants. Observing lower responses from minority groups in both community forum and online survey, they conducted Stoop Surveys in targeted areas. Stoop Survey involves walking around underrepresented neighborhoods with paper surveys and surveying citizens encountered on their front stoops or on the sidewalk (City of Albany NY, 2012). Through this approach, the City of Albany planning team was able to collect more responses from Black/African American populations, compensating the low response/participation in the community forum and online survey. The diverse engagement methods employed by this city, as discussed in the previous section, have also helped them gain a better response from minority groups.

These findings show that there are many ways and methods in which cities try to get their community members involved in the planning process. Besides community surveys, they used social media, community forums/meetings, workshops, and city/community events. The methods that helped reach out to the community at large are social media and planning websites. As discussed in the previous section, different cities used social media platforms differently. Albany, New York, used multiple social media platforms and tried to create a more accessible communication channel with the community. St. Louis Park, Minnesota, conducted Facebook Live Townhall meetings, and all other cities have some form of social media presence. All cities also provided either static or interactive maps of their plans online for public comment. Despite all these various methods of engagement, all cities received comparatively lower response rates from the minority populations, as usually found in community meetings (Carr & Halvorsen, 2001; McComas, 2001). Only Albany, New York, was able to reach out to the low-income and minority communities through their stoop survey approach. It indicates that cities should not rely solely on smart approaches for public participation. Any online survey or social media engagement should be supported by targeted community events and surveys (like the stoop survey approach in Albany, New York) to encourage better minority participation in the planning process.

7. Conclusion

Effective community participation and advocacy process provide legitimacy to a good plan (Baer, 1997). Planners are now more aware of the importance of community engagement in the planning process. As we found through this study, community engagement techniques vary significantly from city to city. Exploring the distinctive ways people have been participating in the planning process and taking a closer look at how minorities have been involved will help determine the ways to improve participation from minority communities. Prior studies have identified various reasons for lower participation from minority and low-income communities (Kapoor, 2001; Sen, 2008). Smart engagement approaches based on web technology could be effective in reaching out to minority groups (Afzalan & Muller, 2018; Evans-Cowley & Hollander, 2010). However, we found through this study that these new approaches of community engagement are failing to overcome the limitations faced by traditional approaches like community meetings and public hearings. Planners should complement these smart approaches with targeted community-specific approaches to ensure greater participation from minority communities. The Stoop Survey technique applied by the City of Albany, New York, is an example of such an approach.

Community members can participate in the planning process through different modes of public

Table 4. Race/ethnicity distribution of population (during survey years) vs. survey respondents.

		Black/African American			Hispanic			White		
Study Cities	Survey year	Survey respondents (%)	Pop. (%)	Diff. in % points	Survey respondents (%)	Pop. (%)	Diff. in % points	Survey respondents (%)	Pop. (%)	Diff. in % points
*Auburn, AL	2010	14%	16.4%	**–2.4**	2%	2.9%	**–0.9**	81%	73.5%	**7.5**
**Goodyear, AZ	2015	6%	8.9%	**–2.9**	20%	27.6%	**–7.6**	79%	75.2%	**3.8**
**Albany, GA	2015	55.6%	68.4%	**–12.8**	3.4%	2.6%	**0.8**	43.1%	26.2%	**16.9**
*St. Louis Park, MN	2018	1.5%	5.8%	**–4.3**	1.8%	4.9%	**–3.1**	91.7%	79.9%	**11.8**
*Albany, NY	Community Forums (2010)	28%	29.1%	**–1.1**	2%	8.6%	**–6.6**	57%	54%	**3**
	Stoop Survey (2010)	59%	29.1%	**29.9**	2%	8.6%	**–6.6**	18%	54%	**–36**

Notes: * Reported Hispanic population together with races, ** Reported Hispanic population separately. Sources: Race/ethnicity data sources for Auburn, AL and Albany, NY is U.S. Census (2010); for Goodyear, AZ and Albany, GA, race/ethnicity data was collected from U.S. Census (2018; ACS 5-year estimate); and for St. Louis Park, MN it was collected from U.S. Census (2021; ACS 5-year estimate), considering the mid-years of 5-year estimates (i.e., 2015 and 2018 respectively).

engagement. Planners should note the preferred engagement approaches for different ages, gender, and races/ethnicity and prepare a public participation plan accordingly. Based on the findings of this study, we recommend that cities increase their number and methods for community engagement that can help reach out to all population groups. To maximize and increase overall civic participation, including those underrepresented, the community engagement process should have multiple open public events at different locations and times. In addition, people should be informed on all platforms, such as online, radio, newsletters, newspapers, blogs, and local tv channels. The information should also be distributed in multiple languages. In addition to providing information in the languages of the target communities, making sure there is someone who can speak in that language is important for increasing minority engagement.

One of the major limitations of this study is that we relied mainly on survey responses, as reported in the planning documents. The other community engagement mechanisms throughout the planning processes did not collect demographic data; therefore, we could not analyze the complete community engagement minorities had in the planning process. Since prior studies have explored minority engagement in public meetings (Hoang, 2021; McComas, 2001), we attempted to cover the broad spectrum of engagement methods with a particular focus on smart approaches. Future studies can expand it further by conducting an ethnographic study of a planning process or analyzing video/zoom recordings of community meetings. As the discourse on smart cities and smart citizen engagement is gaining momentum, there should be a more critical analysis of how to increase minority participation in the planning process.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Planning the Smart City With Young People: Teenagers' Perceptions, Values and Visions of Smartness

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Abstract
Young people are often seen as "future citizens" and therefore relegated to a back seat in the planning process, awaiting their coming of age. Recent digital transformations in planning have brought new consultation processes but also created a digital divide and conflicting agendas. This article engages with youth, specifically teenagers, a heterogenous community stuck between childhood and adulthood, assumed to possess the necessary digital skills, but usually overlooked in participatory planning processes. This article will examine the case study cities of Manchester, Birmingham, Valencia, and Sofia, where 121 teenagers between 15 and 19 years of age have been interviewed in relation to their awareness and perceptions of digital technologies and smart cities. It focuses on critically examining young people's perceptions and values towards the smart city. Using the smart city wheel as an engagement and discussion tool, the article presents teenagers' critique of smart city models and future city visions. The article categorises common threads and values that this demographic has espoused and presents cautionary tales relating to awareness and skills development in this age group. Throughout the interviews and surveys, young people in all four case studies have reported strong affiliations to specific modes of inhabiting the city and values that they would like to see reflected in any future visions. The article identifies key considerations for planners and smart city practitioners when engaging young people in the creation of future city visions.

Keywords
city visions; participation; smart cities; teenagers; urban planning; young people

Issue
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1. Introduction

The smart city is the next iteration in a long series of utopias concerning the city to the present day (Angelidou, 2015). At the core of any utopian world is the desire for reconciliation between humans and the natural world. What the debate and practice about smart cities tend to promote is the sustainability and citizen-friendly credentials of digital optimisation in the city (Girardi & Temporelli, 2017); yet the validity of such claims remains largely contested. Yigitcanlar et al. (2018) are critical not of the concept itself but the framework in which smart cities operate, as in their view the failure of both sustainable and smart urbanism is bounded by their performance within an anthropocentric practice. Hollands (2008) stressed that progressive smart cities need to be founded on the needs of the people inhabiting them instead of uncritically promoting the role of IT as a panacea, which has led to a range of critiques of the smart city. Smart cities as a largely technocratic idea have permeated the visioning process not only in local municipalities but on national and international levels. The adoption of "smart city" aspirations in the European context was largely driven by the European Commission's agenda and the European Marketplace for Smart Cities (Neirotti et al., 2014). Translated into the national context, specific frameworks were created to fund the digitalisation of cities and their integration into the new "knowledge

economy." Smart city concepts have made their way into the renewed Horizon Europe, heading one of the five missions on 100 climate-neutral and smart cities by 2030 (European Commission, 2022a). A rather more critical approach has been adopted by the UN-Habitat which has developed a flagship programme on people-centred smart cities (UN-Habitat, 2022), which, while attempting to critique the concept, establishes it firmly as a future city vision on the international stage.

Meadows (1994) writes about visions as the most important part of the policy process, yet she suggests that we are deprived of meaningful discussions not only in the policy process but also in society at large. Meadows stresses that sharing visions with others is essential: Only a shared vision can be a responsible one. Smart city strategies as visions of the future are rarely discussed in the public realm. The failed Sidewalks project in Toronto Quays (Bozikovic, 2022) is an example of the contradictions which a smart city vision can encounter when put to the test. The project faced scrutiny by the public and community actors, which eventually led to its withdrawal. Smart city visions bear similarities to science fiction novels—grounded in realism and technocratic approaches but subservient to current political and economic narratives, casting aside the alternatives possible under a more open and community-led approach. Smart city visions based on current politico-economic realities often glance over the non-rational human and fail to accommodate alternative imaginations of the future. Future city visions should address the issues of climate change and citizen participation to be truly transformational, considering not only the human-centric factors but also the flora and fauna which inhabit the city, a sentiment echoed by the youth climate strike movement (Gorman, 2021). Yigitcanlar et al. (2018) advocate a post-anthropocentric smart city which prioritises a long-lost way of thinking about our habitats—as parts of the natural world.

Communities, and in particular, historically marginalised members of society are often sidelined in the visioning process. Adopting the viewpoint of youth, as one such demographic, can help us to test the validity of smart city planning and start questioning top-down future visions. In the urban debate, youth have been a diverse, complex, and elusive demographic often taken to mean children and adolescents. The hypothesised benefits of involving youth in the planning process (Frank, 2006) have rarely materialised as meaningful inclusion has been low on the priorities list. However, changes brought about by digital technologies have made consulting youths much more practicable. Digital transformations have also brought the so-called digital divide (Stratigea et al., 2015) and young people have become one of the prime targets of educational programmes by state actors to upskill them in preparation to become smart citizens. Innovative ways of consulting are becoming commonplace, such as utilising place-based education (Heffez & Bornstein, 2016), virtual and augmented reality tools (Argo et al., 2016) as well as large online multiplayer games (Potts et al., 2017).

Within the human-centric smart city approach we can find overlooked actors who possess the power of imagination needed to shift the debate. We need to more closely examine how youth's perceptions and participation in urban life relate to a post-anthropocentric world, where the gaps of knowledge are, and how can youth be seen to drive action which respects the intergenerational contract of sustainable development. Young people are aware that their futures are uncertain—we can see them organising in emergent movements across the world—but what values do young people hold when considering the smart city? Can we imagine the future of our cities together with youth and what would it look like?

2. The Human-Centred Smart City

In the Global North, authors critical of the smart city straddle a wide range of disciplines such as urban sociology, architecture, urbanism, and media studies (Greenfield, 2013; Hollands, 2015; Marvin et al., 2015; McFarlane & Söderström, 2017). The smart city is seen as a construct of the corporate in the public realm, striving towards which in the long term could exclude citizens from participating meaningfully in urban life. Academics adopting this viewpoint seek to unpick critical aspects of future cities which the predominant smart city rhetoric tends to obfuscate or omit, such as sustainability (Cugurullo, 2018), gendered cities (Datta, 2015), power dynamics (Klauser et al., 2014), branding strategies (Söderström et al., 2014), and citizen participation in the process (Stratigea et al., 2015). This contrasts with the more technological approach which attempts to view the city from the perspective of urban analytics (Caragliu & Del Bo, 2019) and the "embedded" approach which aims to conceptualise the inner workings of cities in their digital transition and is situated in disciplines such as public administration, urban studies, and the built environment (Cardullo & Kitchin, 2018).

Lack of participation from the public in the creation of the "smart city" has been a crucial issue since the emergence of the field (Vanolo, 2016). Sassen (2011) is concerned that the randomness of a city, the elements of serendipity that create urban life are under threat by the highly technical visions of algorithmic controls. Greenfield (2013) addresses the threats to diversity in the smart city, driven by algorithms which prioritise financial profit, optimisation of public services, and energy consumption and which suppress inefficiencies. A key concern is the ability of people to perform citizenship in an urban arena where the power balance is shifted and the urban experience is highly controlled. The right to the smart city (Willis, 2019) has emerged as a contested debate, occupying the realm of digital technologies; however, it follows in a long tradition of urban innovation displacing and disenfranchising

citizens. The four powers which shape our cities as seen by Zukin (2010) in her analysis of development dynamics in processes of gentrification remain largely in charge in the smart city too: the economic power of capital, the state, the media, and consumer taste. Mattern (2017) discusses a similar interplay of forces shaping the city in the 21st century, in a digital age where cities have become both a marketplace for technologies and a product. Local governments have largely started to address such critiques. There is an observable shift towards citizen participation in smart city governance and strategies, progressing from contestation and acceptance to collaboration (Przeybilovicz et al., 2022).

The role of youth in participating in and developing city visions is currently largely absorbed by overarching theories of citizen and community engagement. This is a reflection of the underdeveloped theoretical field in urban planning literature concerning the inclusion of children and young people. More than two decades ago, Simpson (1997) called for a fundamental rethinking in the way we design and plan cities to include children and youth; however, little progress has been made. Youth-focused planning case studies such as Growing Up Boulder (Derr & Kovács, 2017) exemplify the practical and contextual aspect of working with young people and the need for further theorisation. Botchwey et al. (2019) examine youth-focused planning case studies in order to situate young people in one of the more established theoretical models—the ladder of citizen participation (Arnstein, 1969). There is a distinct gap in the literature in establishing the role of young people (Peacock et al., 2020), in particular teenagers, within smart cities. Barriers to their inclusion have been identified. Masucci et al. (2019) expose a conundrum as young people who are usually open to digital advances do not recognise emergent technologies working for the benefit of their communities. Cohen et al. (2016) recognise the role that young people can play in bottom-up approaches to the smart city. Costa et al. (2020) stress the positive role that ICT can play in involving teenagers in placemaking processes but warn about the potential challenges of ownership, privacy, and surveillance. Gamification approaches to e-participation in planning such as the use of Minecraft (Rexhepi et al., 2018) also provide new avenues for empowerment and engagement, promising a power shift towards youth. While these studies evaluate specific aspects of the concept of digitalisation and smart cities in relation to young people, they do not examine the validity or alignment with the demographic's values. If smart cities are becoming a dominant paradigm in municipal vision-making, it is important to understand what youth, traditionally under-represented in decision-making, think of the concept.

3. Methodology

This study is part of a wider project examining the perceptions and awareness of young people in regard to urban planning, future city visions and smart cities within the European context. To understand the phenomenon of youth inclusion and their positionality within the planning of future smart cities, a mixed methods approach was selected allowing for diverse data points to be interpreted in a narrative format. This approach suited the open exploration of an under-researched phenomenon. Druckman (2005) discusses that focused case studies are often performed in an inductive-emic tradition that allows for inventiveness at all stages of the research. This flexibility has suited the research questions as there are few existing studies describing and evaluating smart city developments from the youth lens. The method allowed for the role of the context to be emphasized in the studies; however, by its definition, it provides for limited generalisation and theorisation, instead building up the knowledge base concerning youth inclusion.

Focused case studies compare a small number of similar cases matched on all but a few variables. The project was concerned with the development of smart cities in Europe and picked three national contexts where research could be conducted in the respective native language—England, Spain, and Bulgaria. The three countries straddled the East–West divide within Europe. Three cities of each national context were selected due to their comparability in population size with Birmingham, the host city of the research and the primary case study. The process of selection was undertaken after examining all large urban settlements with over 100,000 population in each of the countries and selecting the ones covered by local authorities which possess a smart city strategy or vision, which included youth-focused goals. The four case studies were Birmingham and Manchester in England, Sofia in Bulgaria, and Valencia in Spain. The cities also carried similarities in that they are all within the European context of developed democracies, had largely aligned legislation (divergences have since occurred due to Brexit), and were all classified as beta cities by The Globalization and World Cities Research Network (2018) rankings. However, there are significant differences which have been contextualised in the analysis, such as the different political systems, relative affluence, planning systems, youth policies, level of engagement with "smart city" rhetoric, and cultural and demographic differences. The Birmingham and Manchester examples provide the best baseline for comparison, with the Valencia and Sofia examples providing a wider European contextualisation of the emergent themes. A wider screening of top-down visions was undertaken to understand the policy aspects in the three countries examined and their overlap with youth goals. A summary of the four case studies is presented in Table 1, demonstrating the narrow prism through which young people are considered within respective smart city strategies, predominantly as a future workforce to be developed and placated.

Once the broader lens through which young people are acknowledged in their city's smart vision had

Table 1. A summary of youth goals occurring in the case studies' smart city visions: Digital Birmingham Strategy (2019), Manchester Smart City Programme (Manchester City Council, 2019), Valencia Smart City (2019), and Sofia Strategy for Smart Specialization (Sofia Municipality, 2019).

Theme	Youth Goals	City
Economy	Focus on career development Young people seen as future workforce	Manchester and Sofia
Economy	Focus on youth as talent development, support growth, and retention	Sofia
Education	Focus on introduction of STE(A)M fields into teaching and schools	Valencia and Sofia
Education	Focus on upskilling and training through further education	Sofia
Citizenship	Focus on overcoming the digital divide and social exclusion	Birmingham
Innovation	Focus on youth entrepreneurship and digital incubators	Sofia
Culture	Focus on creative industries as potential youth employment	Manchester and Sofia
Health	Focus on sports provision for youth	Valencia
Spatial	Focus on physical infrastructure for youth	Valencia

Notes: All information was retrieved in March 2019; the analysis of the cities' smart visions was undertaken in Spring 2019; STE(A)M stands for science, technology, engineering, art (including architecture), and mathematics.

been identified, a bottom-up primary data collection was undertaken. The specific demographic which was approached was teenagers aged between 15 and 19. Teens in this group are in a transitional stage of their development into adulthood, acquiring citizenship rights and undergoing significant physiological and social transformations. This group has largely been categorised as "hard to reach" in planning practice. A transient and diverse community, in the European context the percentage of young people is on the decline resulting in societal pressures and economic disbalance. The case studies approach aimed to uncover broad themes within this demographic when smart city planning is concerned. Morse (2000) suggests that for shallower case studies adopting an inductive approach a larger sample size might be required; an indicative n = 30 was the goal of recruitment in each city. Figures 1 and 2 present a profile of the participants.

Semi-structured interviews formed the main part of the primary research within the case study of Sofia, but

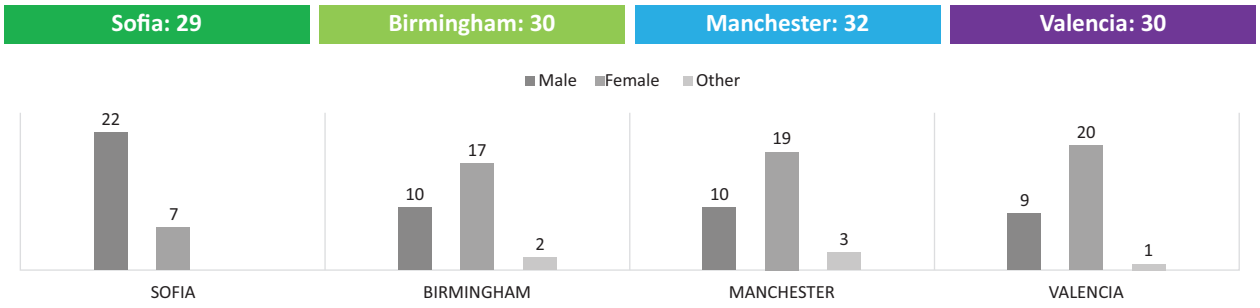

Figure 1. Breakdown of participants by sample size and gender.

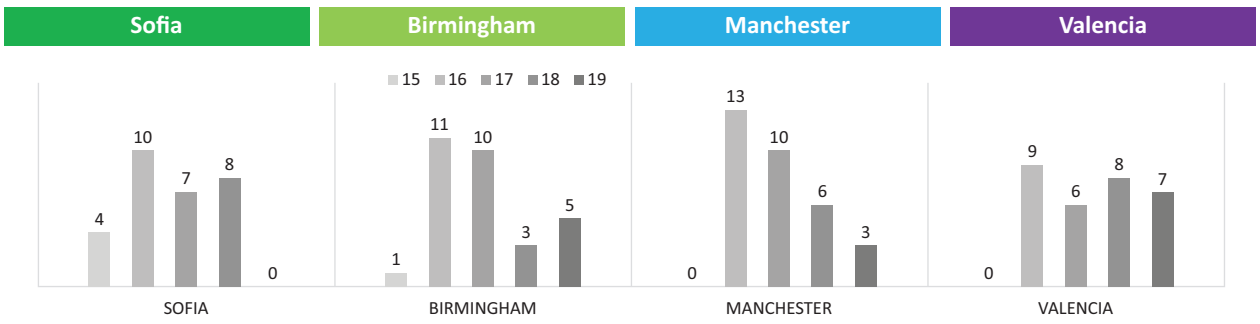

Figure 2. Breakdown of participants by age.

the approach was later adapted to an online survey and social media research in the case studies of Birmingham, Manchester, and Valencia due to pandemic restrictions. In Sofia, participants were recruited through secondary schools' administration and after-school English language classes. Interviews took place in person during the winter of 2019 and 2020, within school settings, for up to 30 minutes. As the Covid-19 pandemic occurred in the middle of the data collection, participants in the remaining three cities were recruited online throughout winter 2020 and spring 2021, primarily via Instagram and Twitter. Participants were approached through direct messaging and presented with a link to a detailed online survey. Contrasts were observed: In the post-pandemic conditions, 15-year-olds were harder to recruit due to the need for parental permission; additionally online recruitment attracted more females.

Semi-structured interviews and online surveys were able to uncover how young people perceive the planning system, the concept of smart cities, and how they value it. The design of the interviews and survey questionnaire focused on three main areas: urban planning, technology and the smart city, and citizen participation. The questionnaire consisted of approximately 30 questions across all seven sections. Figure 3 provides an overview of the sequential survey design and thematic focus. Both interviews and online surveys followed the same structure.

There were limitations to the research. The primary data collection took place from 2019 to 2021, with the implication that the research had to cope with pandemic conditions and their potential influences on perceptions and values. Examining the target demographic of 15- to 19-year-olds also meant that one could not expect young people at that age in mainland Europe to be bilingual nor feel confident in answering questions in English. Linguistic and cultural differences were key to understanding the perceptions towards urban planning and smart cities. The research was conducted in the respective native language and then coded and analysed in English.

Ethical considerations when working with young people are significant and require re-centring in the digital domain. The recruitment and interview processes reaffirmed the experience of encountering "slippages"—moments of ambiguous nature but with no clear ethical implications, as described by Cutting and Peacock (2021). The pre-pandemic data collection in Sofia generally followed the traditional approach to recruitment and interviews with youth, following institutional ethical approval, recruiting participants through negotiations with gatekeepers (such as schoolteachers and after-school clubs) first and being present on site when interviewing the young people in either individual or group settings. Due to the pandemic limitations, however, the remaining samples were collected employing a digital methodology. Participants were recruited via social media and incentives were provided in the form of charity donations. Even though a revised institutional ethical approval was obtained, some key ethical fuzzy boundaries emerged. Gatekeepers shifted from persons of influence and authority to platform owners and friends' networks. The boundary between a researcher and participant was also blurred as two-way feedback was much easier to establish over social media platforms such as Instagram. Equally, recruitment was much more time intensive as social media approaches require audience building, branding and advertising, the development of incentives, and the generation of a public conversation. Building trust in the digital domain was challenging, both on the side of participants who often ignored invitations to take part and on the side of the researcher with respect to the identity of participants. Self-verification of age was one such issue, as a suspicious spike in responses from over 16-year-olds was observed, avoiding the required parental consent procedures for 15-year-olds. It is important to note that the digital approach to data collection revealed issues which would present themselves in digital youth participation processes within urban planning practice.

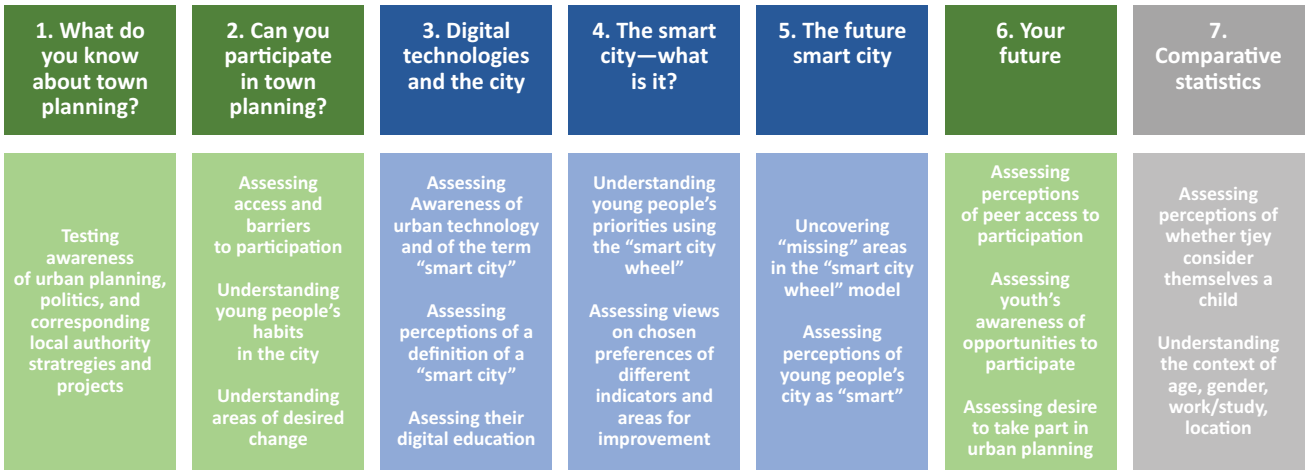

Figure 3. Example interview and survey structure. Note: This article focuses on the results and discussions covered in themes 3–5 of this figure, in blue.

4. The Smart City Wheel as a Method of Engagement

To approach the smart city debate with young people, a framework had to be adopted which was relatively accessible to explain and dissect. One of the more influential smart city models has been the smart city wheel (Cohen, 2018), widely quoted by city authorities and smart city consultants, and widely referenced in research on cities across the world: Dubai (Virtudes et al., 2017), Guadalajara (Mexico; Ceballos & Larios, 2016), and the EU CITYKeys project (Bosch et al., 2017).

The wheel is a graphical representation of key areas of progress and indicators. The wheel is based on the methodology developed by Giffinger et al. (2007) at the European Smart Cities research group at the Centre of Regional Science of Vienna University of Technology. The project European Smart Cities 4.0 (https://smart-cities.eu) led by Giffinger benchmarked the progress of European cities towards smartness and achieved wide publicity, including influencing the European Commission's early image and idea of the smart city. The methodology was later adopted by the smart city wheel, developed by Cohen (2018). The wheel covers six areas and 18 indicators claiming to present a holistic strategy towards becoming a smart city.

The wheel was presented to the participants in both a complete and a broken-down form to elicit responses (Figure 4). The wheel presented a useful framework focusing young people's understanding on the possibilities and domains of the city in which technological advances are considered. It visualised the description of the smart city concept and allowed for the evaluation of aspects of their respective cities which might have been overlooked when smart technologies are considered. Young people were asked to first identify their top priorities from the outer circle of indicators and then to select one area of focus from the inner six where they would like to see technological advances in their city. Finally, teenagers were asked to consider what elements might be missing from the model. Once reflections were collected, the research applied analysis approaches developed from grounded theory. The data was analysed using inductive thematic analysis where codes emerged from the text. The analysis then compared the emergent themes across all four case studies. This article presents the overarching results and conclusions.

5. Young People's Ability to Engage in the Smart City

New technologies broadly under the guise of the term "plantech" (planning and technology) have revolutionised the ways in which public participation takes place (Alizadeh, 2017). The availability of urban data online provides new tools and avenues for consulting citizens. However, digital participation can often be passive, therefore the design of the tools needs to be considered in detail (Bizjak, 2012). Emerging plantech and smart city tools demonstrate that higher engagement levels with young people can be achieved, as reported by private companies such as Commonplace (2019). Digitalisation is promoting the enfranchisement of a wider population in the planning process, in particular young people. Digital methods should, therefore, consider youth's different needs, skills, and values. There is a risk that we transplant the same biases existing in physical consultation methods to online ones. Digitalisation allows for youth

Figure 4. Smart city wheel as presented to youth. Note: On the left is the complete wheel and on the right is the broken-up version. Source: Authors' work based on Cohen (2018).

to engage in the planning conversation but can as easily constrain the diversity of ideas and opinions. It is also crucial to understand the validity of the general assumption that generations who have grown up with the internet would by default be more willing and able to engage with new technologies. The points above have a direct impact on the confidence of young people to take part in the future smart city.

When asked, most young people knew little about urban planning and conflated politicians with professionals. This was observed across all cultural aspects. It is an important context for any future engagement in the digital realm which fails to first educate youth about urban planning. The permeation of digital technologies in the urban realm also proved hard to assess for teenagers. Overwhelmingly, the interviewees had difficulties naming urban tech examples beyond technologies that were close to their everyday life (Table 2). The predominant three examples in every city were broadly consistent with the comment of a 17-year-old female from South Birmingham: "Phones, computers, smartwatches."

There were detailed attempts at unpeeling the urban environment, and a 17-year-old male in Sofia exemplified the thought process observed in most responses: "The stop signs, uh, I don't know if it's with the traffic lights, where it's pressed to turn green, if it's for something like that. I guess some cameras, the traffic police, something like that." This indicates a lack of critical engagement with technology in the urban realm, apart from awareness of some transport-based urban technologies, which scored higher in the mainland European context.

Indeed, when asked if they possess the necessary digital skills to be better equipped in the future, responses were unequivocally negative as seen in Figure 5. Young people do not yet believe that they have the expertise to be "smart citizens." There was a significant confusion between their self-reported knowledge, desire to take part in planning, and understanding of available opportunities. A 17-year-old male in Sofia responded: "I'm not qualified for that, and I think there are people who would do it much better than me." Another 16-year-old male in Sofia responded: "Maybe again, we're not mature enough for that [participating in urban planning]." As Himmel et al. (2014) suggest, urban challenges connected with planning and future city visions need to be incorporated into school-level education in order to provide a deeper understanding of systems thinking and causal links.

Similar difficulties were encountered when asked how digital technologies can help better engage young people in urban planning. A sizeable minority in all four contexts struggled to name any suggestions, particularly in the Bulgarian case. However, clear themes emerged which were considered priorities: increased accessibility and use of municipalities' websites, better digital advertising to inform about future developments, better use of social media by stakeholders, involvement of youth in digital simulations and games in order to communicate changes in cities, and facilitation of online workshops, events, and surveys. Young people were cautious of digitalisation as far as it allowed meaningful engagement and for their voices to be heard. Lack of access to information and awareness of what is happening in the city was also widely reported, and digital technologies were seen as a potential solution if equitable engagement platforms were established. As one 18-year-old male from North Manchester reports: "This survey is the only information I have come across regarding this topic."

Table 2. Urban technologies: Youth's top five choices across the four case studies in order of number of responses.

Birmingham	Manchester	Sofia	Valencia
Smart Phones (17)	Smartphones (21)	Digital screens (17)	Smartphones (16)
Laptop (13)	Laptop (14)	Smartphones (6)	Transport tech (6)
Personal computer (10)	Tablet (11)	Metro barriers (6)	Tablets (6)
Social media (7)	Personal computers (7)	Traffic lights (5)	Personal computers (5)
Wearable tech (6)	Digital billboards (5)	e-Scooters (5)	"I don't know any" (5)

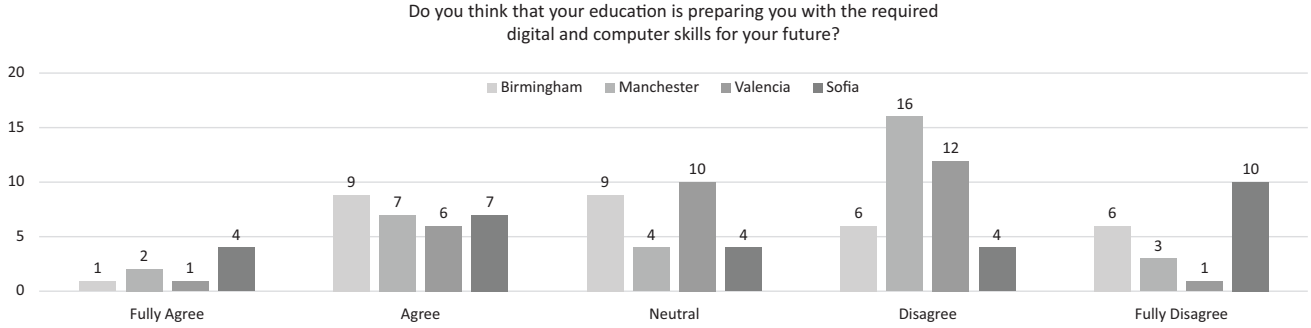

Figure 5. Self-assessment of digital and computer skills education.

6. Teenagers' Priorities in the Smart City

In his book *Smart City Citizenship*, Calzada (2020) proposes a fifth helix in the multi-stakeholder framework of innovation in the smart city—the social helix including activists, entrepreneurs, and assemblers. As a demographic often lacking a firm basis in the other four domains—public, private, academia, and civic society—some young people have gravitated to the social domain, adopting the mantle of activists as seen in the climate movement (Gorman, 2021). However, youth are not a homogenous group. It is key therefore to understand what are the visions that diverse teenagers have for the future and whether they differ from those that municipalities prioritise.

Young people were presented with a definition of the smart city adopted by the European Commission (2022b). More than 70% of youth interviewed in each case study indicated that they would very much like to live in such a city, indicating an openness to the concept as a vision of the future. However, critical evaluations emerged, especially centred around the need for smart city visions to acknowledge human interactions, tackle inequality, and address sustainability in a holistic way. When asked to reflect on the survey and consider if their city was a smart one, the Bulgarian youth were most negatively predisposed, followed by the Spanish. In England, young people were more likely to indicate that they are not sure whether their city was a smart one. This could reflect attitudes across the population in terms of their future roles and opportunities in their cities or reflect the politico-economic distinction between the three countries or the adoption of technology in day-to-day life.

A preferential analysis of the smart city wheel was undertaken where young people were asked to rank the aspects of the model that they value most. Figure 6 presents the comparison in priorities. There were clear overarching preferences in all four contexts, where young people generally prioritised smart people and smart living first, followed by smart environment as the top three overarching themes to which they would like resources to be allocated. Contextual factors then drove the prevalence of economy, governance, and transport; however, in all cities, they were superseded by human-centred themes. In Sofia, economy and governance were strongly represented themes, demonstrating the awareness of young people of ongoing national debates as a country with turbulent politics and a smaller economy.

When granular preferences of the indicators (the outer circle of the smart city wheel) were analysed, the four cities become more diverse in their priorities (Table 3). In Birmingham, themes of safety, culture, creativity, happiness, well-being, and education dominated. In Manchester, while similar to Birmingham in the dominant themes, a much stronger emphasis emerged in areas of green energy and clean transport. In Sofia, health was much more pronounced than in the other three cities. Drivers such as education, safety, creativity, and culture were still well represented, but similarly to Manchester, green energy and clean transport were also strongly preferred. Valencia emerged as the most people-centred city among young people. Issues of education and inclusivity dominated the debate. Economic issues were also strongly represented, as well as issues of sustainability and green planning.

There were clear cross-cutting trends, mainly in priorities such as education and safety that appeared in the top five preferences across all four cities. Issues of liveability and people-centric smart cities were top of the agenda in all of the case studies. In Birmingham, desires

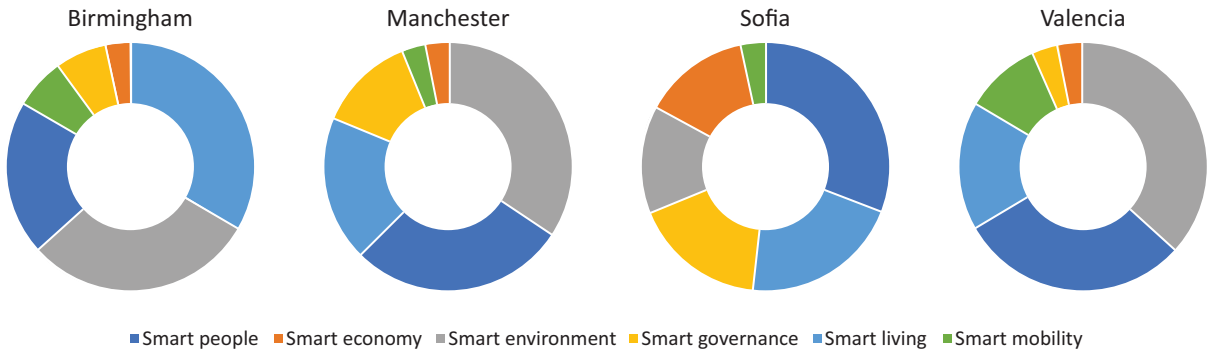

Figure 6. Areas of the smart city where technological improvements should be a priority according to young people.

Table 3. Smart city indicators: Youth's top five priorities across the four case studies.

Birmingham	Manchester	Sofia	Valencia
Safe city	Education	Healthy city	Education
Education	Safe city	Safe city	Inclusive city
Inclusive city	Green energy	Education	Safe city
Creative city	Inclusive city	Green energy	Green energy
Green planning	Clean transport	Creative city	Entrepreneurial city

for a safe and green city were one of the main justifications for how young people selected their preferences. A 16-year-old female from North Birmingham stated: "Future urban development needs to be green and innovative to fight the growing threat of climate change and global warming, and in doing this it will help public health, the economy, and transport." In Manchester, awareness and concern for inclusivity, tolerance, and multiculturalism emerged as strong themes in the justification of responses. A 16-year-old female from West Manchester elaborated: "I picked the three from the outer circle because we are facing significant divisions in the population. As much as technological advancement is good, we cannot forget and leave behind core human principles and needs." In Valencia, preoccupation with climate change was the main reason quoted for the selection of priorities. There was also a strong indication of a more proactive approach, as young people indicated that those were priorities they were working on or wanted to change in their city. A 17-year-old non-binary person from North Valencia explained: "I feel that not enough measures are being taken to combat climate change." In Sofia, young people were acutely aware of the economic reality of the proposed smart city visions and how it might affect them. A 17-year-old male from South Sofia responded: "Everyone's economic capabilities are different, so the definition of a smart city changes depending on the people." There was also awareness of the political campaigns—part of the Sofia mayoral election—that were in progress during late 2019 when some of the data was collected. In the Eastern-European context, teenagers' long-term visions for their city were related significantly to their plans to stay in the city they grew up in. A majority of the participants reported societal or parental pressures to emigrate to study and live abroad dictating their choices, uncertain whether they could take part in the planning of the future city. Such trend did not emerge strongly in the three Western-European cities, even if individuals indicated that they will be moving out of their home city for higher education purposes.

Once priorities of the existing model were uncovered, participants were asked to point to aspects from their life which are not represented in the smart city wheel. A broken-up model was presented as a visual prompt (Figure 2). Most of the participants struggled to name an area that was missing in their city. In Sofia, students put on the spot within the school settings where the interviews were taking place struggled to name areas which were missing; this was not observed in the other three case studies, with online surveys appearing to present a better opportunity for reflection. Ultimately, across all contexts, a rich sample of topics emerged. Cultural change and personal and political will to implement innovative projects were identified as key to the success of smart cities. A post-anthropocentric understanding also emerged, with some young people naming animal welfare and non-human species' wellbeing as key considerations missing from the model. Some young people struggled with the lack of concrete definitions of the "smart city" scope and themes and suggested that those were open to misuse. An interesting contrast was observed. Whereas a post-capitalist sentiment emerged in most answers with issues of togetherness, community, political activism, affordability, and care for vulnerable populations all named as key to any future visions, an alternative narrative of consumerism was presented in some answers with ideas such as smart shopping presented. Cultural activities, art, and creativity were also clearly identified as essential to the future city and desire for even stronger integration across all themes of the smart city model was exposed. Equality, equity, diversity, and inclusivity were all issues which were felt to be missing from the smart city model, reflecting the fear of young people that institutional biases will be replicated in the digital domain. Sport and active populations were other issues which were felt to be not strongly represented in the model. Table 4 shows the key themes identified in each city.

The answers of young people broadly point to a desire for the collective imagining of alternative visions of the future which are not constrained to the techno-politico-economic origin of the smart city wheel. As observed in the Youth 4 Climate Strike actions (Gorman, 2021), young people are acutely aware of the challenges humanity faces and are willing to contest our collective acceptance of visions and strategies based on a faulty system which ultimately has caused our precarious situation.

7. Conclusions

A better translation of young people's needs must be incorporated into future city visions. Reaching teenagers in smart city planning needs to be a proactive process and involve them in the priority phase in a holistic manner—both in person and digitally. As demonstrated, digital participation raised new issues in terms of ethics and accessibility. The transition towards human-centred smart cities needs to be accompanied by a transformational process in policy-making and vision setting. Including diverse voices in this process is the key to reflecting wider values within society. In the case of teenagers, we need to acknowledge that there are barriers to education, participation, information, and critical skills that need to be overcome in order to achieve meaningful inclusion. Young people can help broaden the horizons of what the future city can be and allow alternative conversations to take place within the policy realm.

Teenagers are intrigued and attracted by the prospect of living in a smart city; however, they are able to critically examine the concept against a socio-economic and political landscape. Future city visions, whether a smart city strategy or a local plan, need to be examined in relation to their long-term sustainability if they are to capture the imagination of young people. There is a general lack of knowledge of the terminology

Table 4. Youth identified aspects missing in the smart city model.

Area	Birmingham	Manchester	Sofia	Valencia
Community	Smart socialisation Vulnerable people Youth empowerment Homelessness Smart community	Sense of community Vulnerable people Smart communities Youth spaces Social action	Citizens' motivation Ethics and morals Religion	Intercultural city Ageing population Right to the city Social exclusion Political inclusion
Culture	Enriched arts	Art and creativity		Language and culture
Education	Access to education Smart knowledge		Life-long education	
Affordability	Affordable housing Affordability	Affordability Lower living costs		
Economy	Independent businesses Unemployment	Independent business Labour relations		Modern infrastructure
Consumerism	Smart consumerism Smart shopping			Smart consumerism
Health	Sport and fitness	Mental health		Clean city
Services	Smart public facilities			Security
Sustainability			Animal welfare Non-human focus	Circular economy Ecological Focus
Governance			Implementation plan Concrete definitions Cross-theme integration	Progress monitoring Implementation
Regional			Regional disparities	Smart regions
Politics		Tackling racism	Political will	

Note: Each theme represents one individual's opinion.

and processes of policymaking and planning; however, there is a good overall level of awareness of key problems in their cities. There are overarching trends in the prioritisation of smart city indicators. Young people want to see most resources in areas connected with urban living, people-centric, and environmentally smart cities. Young people hold values which are community and society-driven, identifying areas within the smart city model that are concerned with the wider environment, a sense of justice and fairness, and post-anthropocentric views. The omission of such issues in current models reflects the underlying ideology of "smart city" projects, which needs to be challenged. Political will and leadership are key to securing the trust of young people. Planners can rely on this demographic to present competing visions of the future and challenge policymakers.

Youth engagement in urban planning and smart city visioning is largely an under-researched area worth exploring further. Comparison with the post-pandemic condition in the city will be necessary to understand whether the pandemic has not only changed young people's priorities but also their confidence in their ability to make contributions to their city. The political landscape has also changed in each of the case studies, which might influence young people's attitudes. Further qualitative research in the four cities is needed to fully understand the reasoning behind some of the cultural and contextual trends. The online methodology can be easily adapted by local governments considering the development of future visions and a wider sample of teenagers engaged. In the smart city domain, understanding what models and processes of developing the smart city can incorporate the priorities and the areas identified by young people can prove transformational in envisioning a post-anthropocentric vision for the future city.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

What Role for Citizens? Evolving Engagement in Quadruple Helix Smart District Initiatives

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Abstract
Globally, smart city initiatives are becoming increasingly ubiquitous elements of complex, sociotechnical urban systems. While there is general agreement that cities cannot be smart without citizen involvement, the motivations, means, and mechanisms for engaging citizens remain contested. In response, this article asks what the role of citizens is in two recently established smart districts within the wider Smart Dublin programme: Smart Sandyford, a business district, and Smart Balbriggan, a town north of Dublin with Ireland's most ethnically diverse and youthful population. Using multiple methods (online and in-person interviews, site visits, a focus group, and participant observation), this article specifically examines how the "quadruple helix," a popular concept within innovation studies and one that is adopted in promotional materials by Dublin's emerging smart districts, is used by key actors as an overarching framing device for activities. It finds that, to date, the quadruple helix concept is being applied simplistically and uncritically, without attention to pre-existing and persistent patterns of uneven power and influence between the different actors involved. As such it risks inhibiting rather than supporting meaningful citizen engagement for smart and sustainable places that both smart districts articulate as a key driver of their activities.

Keywords
citizen engagement; Dublin; hackathon; Ireland; quadruple helix; smart cities; smart districts

Issue
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1. Introduction

Globally, the prefix "smart" is a powerful rhetorical and legitimating device for catalysing and lending coherence to a variety of practices (Caprotti & Cowley, 2019). It is increasingly appended to geographical spaces, such as cities and, to a lesser extent, towns, districts, and rural areas, by local authorities keen to attract investment for technical data-driven solutions to pressing (and often highly normative) societal challenges such as climate change, urban regeneration, air quality, and transportation (Baykurt & Raetzsch, 2020). However, these complex, sociotechnical "smart" responses have not led to unambiguously positive outcomes for citizens (Clark, 2020). As a result, there is an increasing need to understand how and to what extent, the citizens most affected by the social problems which these smart responses are purporting to address, are being engaged in decisions about their design and deployment. With scholars, such as Cardullo and Kitchin (2019) providing conceptual frameworks of engagement approaches in smart cities, what is needed now is more empirical data and an understanding of how citizen engagement in smart initiatives is actually practised in different contexts to test these frameworks. This means moving beyond a hierarchical ranking of methods alone (e.g., the scaffolding) to a greater understanding of how methods of engagement led by smart district initiatives are situated

within particular place-based contexts and wider political spaces (Chantry, 2022). In response, this article asks what the role of citizens is in emerging smart districts in Dublin, adding novel empirical insights to an expanding data bank of smart cities in practice.

Broadly, critics have argued that smart city developments have tended to be associated with top-down, technocratic, instrumental processes that serve the interest of states and businesses rather than citizens (Kitchin, 2014; Sadowski, 2019). Research indicates that people tend to be designed out of smart futures with citizen participation largely rhetorical; a way to legitimise technological solutions that support private interests and entrepreneurial modes of governance (Cardullo & Kitchin, 2019; Fitzgerald & Davies, 2022). Moving beyond a simple, dichotomous, top-down versus bottom-up view of actors, recent scholarship argues for a more fluid, interstitial positioning of actors that acknowledges that actors can, and do, occupy multiple and shifting roles over time (Burns & Welker, 2022) including active non-engagement (Soutar et al., 2022).

According to the All Ireland Smart Cities Forum (n.d.), a collaboration between Maynooth University and local authorities in Northern Ireland and the Republic of Ireland, eight cities across the island of Ireland are currently designated as smart including the capital, Dublin. Within the local authority-led Smart Dublin programme there are five smart districts, the first of which, Smart Docklands, was launched in 2018. Since then, the Smart Dublin programme has expanded to include: Smart DCU—a university campus; Smart D8—a health and well-being district; Smart Sandyford—a business district; Smart Dún Laoghaire—a coastal "climate" district; and Smart Balbriggan—a coastal town referred to as Ireland's first smart "community" district. All of the districts within the Smart Dublin programme state that they apply the quadruple helix innovation systems conceptual framework as a means for four stakeholder groups—government, academia, industry and citizens—to co-produce smart city projects (Nguyen & Marques, 2021).

Originating in innovation studies, the quadruple helix is a popular model used to describe the involvement of these four main actors in smart city projects: local authorities, academics, companies, and citizens (Carayannis & Campbell, 2009). While widely used as a proxy for familiar concepts of engagement, participation, and partnership, few initiatives that evoke the concept explicitly articulate where, how, and why certain stakeholders should be "involved" at various stages in smart city developments (Paskaleva et al., 2021). Rather than a criticism of the quadruple helix model per se, for there is considerable complexity to the original concept within innovation studies (see Carayannis & Campbell, 2009), this is instead a criticism of how it has been adopted and utilised in smart city initiatives.

Of course, implementation deficits are not the sole preserve of smart city developments. The challenge of creating and enacting meaningful participation, and in particular public or citizen engagement, has long preoccupied academic and policy practitioners in a range of fields (Hügel & Davies, 2020), with fundamental issues of democratic legitimacy, participation, and representation at their core (Avril & Neem, 2014). In particular, matters of deliberation and inclusion have been central concerns of urban actors, activists, and academics for decades (Malkopoulou & Hill, 2018). Many of these debates revolve around polarised readings of social theories of power and knowledge. For example, in the 1990s, the collaborative turn in urban planning reached out to Habermasian ideal speech situations, which call for extended deliberative democracy and emphasise communicative rationality. However, scholars responded with Foucauldian readings of knowledge-power which emphasise that there are no neutral spaces devoid of power relations (Tewdwr-Jones & Allmendinger, 1998). Tackling this polarisation led to the emergence of blended frameworks that sought to recognise the unavoidable, if fluid, nature of power relations in particular places. Examples range from attending to the power, politics, and partnerships in the state-led initiation of sustainable communities using place-based actor-network theory (Davies, 2002) to the development of new heuristics aiming to assess multiple and diverse spaces of citizen engagement beyond those normally considered; what Chantry (2022) refers to as post-political spaces of engagement. This is an important step theoretically because such framings—while normatively supporting the consensus view that citizens must be part of planning, enacting and inhabiting smart initiative spaces—do not accept that smart cities are depoliticised spaces.

Building on and extending previous research examining smart city engagement processes, in this article, we explore how citizens are being accommodated and involved in two emerging and contrasting Smart Dublin districts that explicitly embrace a quadruple helix partnership model, Smart Sandyford and Smart Balbriggan. In the first instance, this article sets out the research context by describing the socio-historical development of smart districts. Then, it outlines the methodological approach adopted to explore smart citizen engagement, with a focus on the perceived roles and responsibilities of citizens from the perspective of other quadruple helix stakeholders, as well as outlining the mechanisms of citizen engagement practice. Finally, the article concludes with recommendations for engendering meaningful citizen engagement.

1.1. The Research Context

The research focuses on stakeholders' views of citizen engagement within two contrasting, early-stage smart city districts initiated in 2020—Smart Sandyford and Smart Balbriggan—that differ in terms of how citizen engagement has been practised.

1.1.1. Smart Sandyford

Situated to the south of Dublin city within the Dún Laoghaire-Rathdown County Council (DLRCC) municipality, Smart Sandyford is synonymous with the area known as Sandyford Business District (see Figure 1). Prior to the Covid-19 pandemic in 2020, approximately 26,000 people commuted daily into the district to work in one of more than 1,000 companies including global technology providers. Around 5,000 people reside in the district, with most housed in high-rise apartment blocks rented from property developers (Power, 2021).

Launched on February 27th, 2020, a day before the first case of Covid-19 was recorded in Ireland, Smart Sandyford was described as a "smart business district" test bed, a partnership between the local authority (DLRCC), academics funded by the Science Foundation Ireland Enable Research Programme and the business community, represented by members of the Sandyford Business Improvement District, a volunteer-led organisation funded through a compulsory business levy (Smart Sandyford, 2020). Despite just these three key stakeholders being stated as partners, the district formally articulates its development pathway as that of a quadruple helix (Smart Sandyford, 2020). This raises a number of questions that form the focus of this article: Where are the citizens and what role are they envisaged to play in the smart district?

Workshops with business representatives prior to the launch of Smart Sandyford identified improved

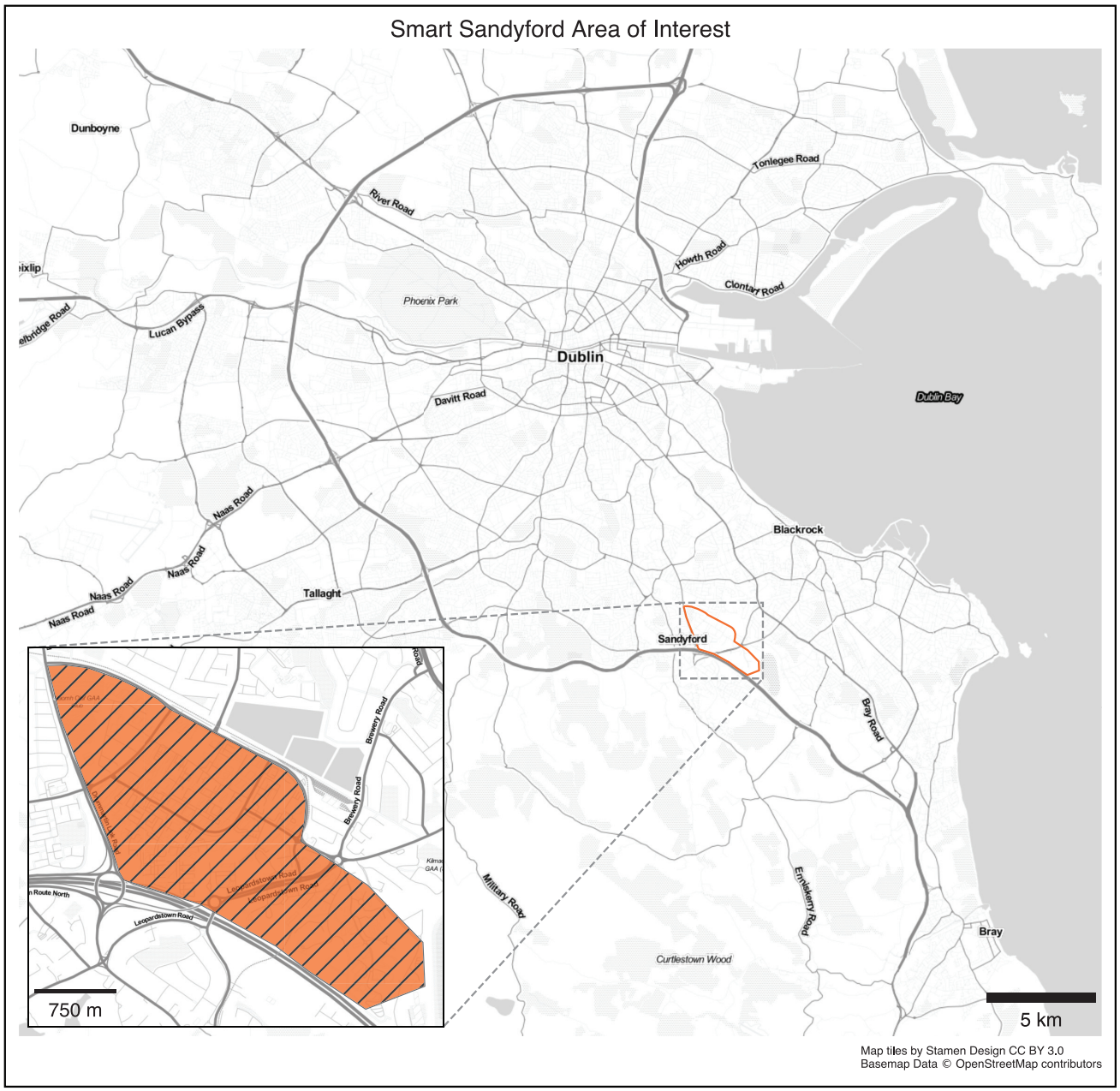

Figure 1. The location of Smart Sandyford. Map designed by Stephan Hügel.

liveability and placemaking as key challenges for the district. However, the projects that emerged in Smart Sandyford focused primarily on mobility, a trend that can be traced back to DLRCC's first Smarter Travel Community established in the Sandyford Business District in 2010 (DLRCC consultation hub; Sandyford Smarter Travel). Examples of Smart Sandyford mobility projects to date include the installation of a "smart" bench at a bus stop (powered by solar energy and hosting USB charging ports, wireless charging points, electrical sockets, an air compressor, and cycle maintenance equipment), the loan of e-bikes to health workers during the pandemic, and an eCargo bike leasing scheme for local businesses. In essence, the needs of the local business community, represented by the Sandyford Business Improvement District, were prioritised (Sandyford Business District, n.d.).

In late 2021, online presentations led by the Smart Sandyford project manager started to shift from a focus on projects delivered within the Smart Sandyford district to projects within the wider area of Dún Laoghaire. Whilst legacy reference was still made to Smart Sandyford within the text of the Smart Dublin website until summer 2022, Smart Sandyford as a separate smart district ceased to exist in late 2021.

1.1.2. Smart Balbriggan

Situated on the east coast, north of Dublin (see Figure 2), Balbriggan is Ireland's most youthful and ethnically diverse town, home to approximately 25,000 people, of whom 11% classify themselves as Black or Black Irish (MacNamee, 2020). In the last 20 years, rapid population growth has been matched by a proliferation of new housing estates built on the edge of the town with limited facilities or amenities ("Balbriggan population set to grow to 25,000," 2000). According to a local Fianna Fáil councillor, a lack of facilities and reductions in the number of Gardaí (police) in Balbriggan, has fed local concerns about violent, place-based, "Eircode [postcode] wars" (Foy, 2020) attributed to young men who have been negatively represented in traditional and social media as "lawless thugs," "gangs," or "feral rats" (Berry, 2020). However, Fingal Communities Against Racism has argued that these narratives are part of a deliberate misinformation campaign by the far-right to problematise diversity within Balbriggan (Phelan, 2021).

Balbriggan has embarked on a programme of urban redevelopment, the *Our Balbriggan 2019–2025 Rejuvenation Plan* commonly abbreviated to *Our Balbriggan*. Estimated to cost €33.9M, *Our Balbriggan* is partially funded through the local authority, Fingal County Council (FCC), participating in EU programmes (for example, the European Urban Regeneration Fund and the EU's Sustainable Integrated Urban Development iPlace project, URBACT). The *Our Balbriggan* plan was informed by a public survey designed by FCC and administered online for a statutory consultation period of three weeks in 2018. The survey was completed by 4,000 people—approximately a quarter of Balbriggan residents—and lauded in the local and national press as a "historic community engagement" (Manning, 2020). Described as "a citizens" assembly for urban regeneration" (Hilliard, 2019), *Our Balbriggan*'s approach to citizen engagement was predicted to become "a model for towns around the country" ("Balbriggan plan one year on," 2020).

In June 2020, FCC launched Smart Balbriggan, Ireland's first Smart District town, as a digital adjunct to the Our Balbriggan programme. According to the initiative website:

> Community is at the heart of Smart Balbriggan, with residents invited to participate in the design and implementation of the programme through workshops, events, surveys and focus groups. From developing a 3D model of the Harbour Redevelopment to facilitate community consultations, to supporting citizen science projects, Smart Balbriggan strives to deliver tangible, positive outcomes for local residents. (Smart Dublin, n.d.)

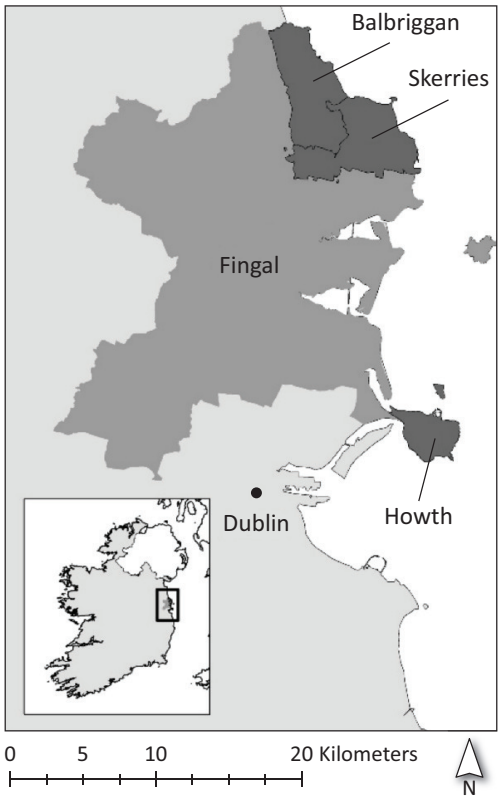

Figure 2. The location of Smart Balbriggan. Source: Dalla Pria et al. (2022, p. 164).

2. Methods

Ethical approval for the research was provided by Trinity College Dublin. Site visits were made to both locations.

A total of 30 people participated in research interviews. Due to Covid-19 restrictions, 26 semi-structured interviews were conducted online and in person to allow for comparability but also flexibility, allowing participants to articulate their experiences in their own words (Devine-Wright, 2020; Hoggart et al., 2014). There were 15 interviews conducted in Smart Sandyford—four industry actors, five academics, five government actors, and one civil society actor. In Balbriggan, 11 interviews were conducted—one industry actor, two academics, three government, and five civil society actors as well as an in-person focus group with four members of a civil society group.

Participants were selected using a snowball method initiated through an introduction by the smart district project manager in each location. The snowball method was sustained through interviewees recommending other people to interview and continued until all those recommended had been approached for an interview. The interview and focus group used a protocol that included questions exploring how respondents understood the term "smart," how the quadruple helix was understood and actioned within each district, how engagement was comprehended, and how citizen engagement was practised. In October 2021, the first author joined a hybrid hackathon in Smart Balbriggan commissioned by FCC and attended by 11 people.

With the prior permission of the participants, an audio-visual recording of each interview was created using Microsoft Teams and transcribed using VTT software. Transcripts were subject to reflexive thematic analysis (Braun & Clarke, 2019) as a means to identify rationalities associated with the quadruple helix and citizen engagement practices. The next section interrogates stakeholder responses to these topics and presents key observations from participation in the hackathon.

3. Results

This section presents the results derived from interviews exploring the core concepts of the quadruple helix and engagement practices to better understand the perceived roles and responsibilities of citizens in both smart districts, Smart Sandyford and Smart Balbriggan. Four key findings are detailed here: an uncritical application of the quadruple helix, an instrumental and predominantly extractive logic driving citizen engagement, superficial treatment of engagement in practice, and leading to engagement being seen as primarily a box-ticking exercise.

3.1. Uncritical Use of the Quadruple Helix

The Smart Dublin website described the quadruple helix as a "novel approach" that "helps ensure that a diversity of perspectives, experiences and voices are part of each district programme—essential ingredients for impactful innovation" (Smart Dublin, n.d.). However, although frequently referred to during online presentations, the term quadruple helix was typically used to describe an unstructured "coming together" (Academic, Smart Balbriggan) of government (local and national), citizens, business, and academia. For example, responses included statements like, "[w]e use that quadruple helix" (Government, Smart Balbriggan) and:

> We try and engage with four 4.5 slash 5 actors, main actors…central government as well as local government, citizens, academia, and industry so when I say demonstrating value, its value from the perspective of those stakeholders…value to a local government stakeholder that'll probably ultimately improve citizen's lives. (Government, Smart Sandyford)

As such, the quadruple helix was used only as a rhetorical device to describe broad stakeholder groups, without interrogating the criteria for ascribing membership. It was not used as an operational framework. Nor was the composition of the four stakeholder groups detailed. In each location, the views of citizens were seen to be those derived from previous events, networks, and processes, such as the Public Participation Network in Smart Sandyford, or the *Our Balbriggan* survey in Balbriggan. No attention was paid to the state of relations between the four stakeholder groups or to patterns of historical participation, power, and influence.

3.2. Instrumental and Extractive Logic

3.2.1. Smart Sandyford

A variety of factors were cited for the limited engagement with local residents in Smart Sandyford, including structural factors such as the design of residences (large apartment complexes) and associated access rights, as well as temporal issues associated with the Covid-19 restrictions that were evolving over the time period of the fieldwork. As one actor said:

> I think our approach to citizen engagement has been a little bit sporadic….I just find that no matter who you're engaging with, citizens or otherwise, always have to figure out what's in it for me? And that's hard to do sometimes with the citizens. And I think that's why previous interactions have just turned into the kind of an airing, 'Tell us your challenges…just shout them out.' Which maybe is not 'robust citizen engagement.' (Government, Smart Sandyford)

Additionally, residents in the area were described by respondents as "very disparate" (Civil society, Smart Sandyford), multicultural, unorganised, transient, and, as a result, difficult to engage with. As the area is not a socio-economically deprived district, there are few active public sector-led community groups or services, although there was anecdotal evidence of emergent

self-organised activities relating to particular nationalities and religious affiliations. However, the housing mix (predominantly apartments) and the lack of local social provisions such as playgroups, community centres, schools, and green spaces shape the household mix in the area and lead to transience when household sizes grow. This means the expectations, concerns, and experiences of those living in the district are largely invisible to other actors in the Helix: "There's no-one really talking for them on their behalf, and so even to try and engage them and get surveys out of them, it's quite difficult actually" (Civil society, Smart Sandyford).

The challenges of engagement outlined above created an instrumental and extractive rather than deliberative logic to involving civil society. This combined with the focus on issues that had technical "smart" solutions were seen as an explanation, and a justification, for the lack of meaningful citizen engagement since the launch of the initiative:

> [We are proposing to use] lots of sensor data from the embedded stuff that's in roads…lots of drone data…lots of cell mobile phone data that we're going to use to see where people travel to and from….I'm not sure if even you could call that engagement, but it's collecting of information. (Academic, Smart Sandyford)

Faced with the need to secure the cooperation and permission of landlords, as well as tenants, to site sensors in residences and additional delays associated with the Covid-19 pandemic, academics "just gave up on that pilot…we were hoping that the situation would change, but then it never happened" (Academic, Smart Sandyford). Then quietly and without ceremony, plans for citizen science projects and smart projects more generally within Sandyford, were abandoned.

3.2.2. Smart Balbriggan

According to the lead of Smart Balbriggan, the community is at the heart of Smart Balbriggan. Indeed, they stated that "the theme which we have gone in [with] is around community involvement and participation" (Government, Smart Balbriggan). In practice, this was equated with residents being "invited to participate in the design and implementation of the programme through workshops, events, surveys and focus groups" (Smart Dublin, n.d.). FCC invited those who had attended the online launch of Smart Balbriggan to participate in an online community survey in July and August 2020 (Fingal Consult, 2020). The submissions were considered by members of the Smart Balbriggan Steering Committee which had been established by FCC with representatives from the local authority, businesses, academia, and two people identified as being from the community. The committee then came up with the Smart Balbriggan Programme Framework which has three strategic priorities that reproduce pillars within the existing *Our Balbriggan* strategy: community building, job creation and economic growth, and improved services and public realm. These were linked to five programme objectives listed on a Trello board for openness and transparency.

Despite goals for Smart Balbriggan engagement to be "inclusive, accessible and reflect an ongoing two-way community conversation" (Smart Dublin, n.d.), the mechanisms for engagement were articulated as extractive—a way to mine potential:

> So there is what I'd consider to be a weakness around the fact that on the one hand, we have this very strong narrative, like a defining feature, but on the other hand, we are still grappling with bringing [youth] voice to the fore in a meaningful way….I think with the Smart Balbriggan it gives us more of an opportunity to go directly into schools, to use technology in a more creative way, to look at means of storytelling, music, I mean creativity of which there's bags of in this town and really *mine that whole potential* there. (Government, Smart Balbriggan, emphasis added)

3.3. Smart Washing

Smart Balbriggan's second programme objective was to "enhance citizen engagement and community building" and three related actions were specified: "to create opportunities for all citizens to get involved in Smart projects"(e.g., via the Smart Balbriggan hackathon activity); "to improve communications and decision-making using new and existing technology" (e.g., an interactive, online open data 3D model to showcase Our Balbriggan public realm projects funded through the 2020 Public Service Innovation Fund); and "to explore tech solutions to tackle anti-social behaviour" (e.g., via digital light art installations; Smart Dublin, n.d.). However, during interviews these interventions were seen as only lightly addressing the symptoms not the root causes of the issues faced by the community in Balbriggan:

> I was looking at the smart thing, it was just like facial [superficial] beauty, nothing deep and that is so sad because this is the second consultation I'm aware of that is ongoing for the Balbriggan area and it's still not listening to what the people truly need. (Civil society, Smart Balbriggan)

There were concerns among civil society interviewees that there was a fundamental lack of understanding amongst Balbriggan residents of what is meant by "smart" (and therefore by association with the Smart Balbriggan initiative) and how this might be relevant to the everyday challenges they face:

> I think people don't understand what Smart Balbriggan is. And I think the language around it can be quite difficult. People assume that it's just you

> know, Wi-Fi, it's broadband, it's connectivity. They don't understand how that can be used by attaching it to a bin, you know when a bin is full, it can you know, highlight something, or if something is missing off a pole it can highlight that. That they don't get all of that. Or how we can connect as a community through smart. I mean, they did a hackathon, people hadn't a clue, no more [never mind] myself….Unless you're digitally minded, it's not going to appeal to the ordinary person. (Civil society, Smart Balbriggan)

3.4. Tick-Box Engagement

It is clear that much of the work programme for Smart Balbriggan dealt with the insights gained from previous consultation exercises and particularly online surveys. This raises important questions about how inclusive such mechanisms can be, given the persistent digital divide within Irish society and specifically amongst the residents of Balbriggan; a digital divide that was accentuated during the Covid-19 pandemic (McGowran, 2022). As one interviewee argued:

> The old-fashioned communication systems should not be dropped altogether with the assumption that people will use social media. Older folk don't use social media at all…a lot is by word-of-mouth or leaflet in the door or something like that. Now what I am asking for is a notice board at the Town Hall, at the library. (Civil society, Smart Balbriggan)

After being interviewed for this article, the lead of a local charity catering to the elderly took it upon themselves to design and distribute a survey of access to and literacy regarding technology amongst 60 of their clients of whom 18 completed the survey. Of those who completed the survey, one-third did not have internet access at home and relied on other people to access a range of services including paying bills, accessing medical services, finding jobs, shopping online, or checking death notices.

Nonetheless, the focus on digital engagement continued as actions were rolled out. The online launch of Smart Balbriggan included an introduction to The Changing Face of Balbriggan Citizen Engagement Hackathon organised by What The Hack, a recently established company commissioned by FCC to deliver two hackathons, one with schools in Balbriggan and a hybrid, one-day, resident-facing event, as part of their citizen engagement commitment. The event took place on a Saturday from 9 am to 5 pm on October 16 of 2021, online and in Balbriggan's only hotel. The event was funded through FCC's involvement in the European iPlace Project. According to What The Hack's introductory material for participants given out at the event, the aim of the hackathon was two-fold: to produce a "brilliant solution" for an issue in Balbriggan and for participants to gain "a whole host of new skills."

However, the public event was less productive, with few participants and even fewer Balbriggan residents taking part. Interview responses indicated a disjuncture between the goal of achieving high levels of meaningful two-way engagement and the processes used to incorporate citizen preferences into plans and actions in Smart Balbriggan. The amount of time and level of technical skill required to join the event was high, especially for those joining online. Most of the participants had an existing background in software design or technology development: "We did the Community Hackathon. I know you were there. Bit of a disaster, but sure, it was something" (Government, Smart Balbriggan).

4. Discussion

While the emergence of these districts during a global pandemic may partially explain the trajectory of citizen engagement during the period of study, insights can be drawn about how to rectify some of the limitations of the current approach and improve the robustness of citizen engagement in smart districts in Ireland and beyond. Table 1 summarises the four limitations identified in interview transcripts from each of the Smart Districts: uncritical use of the quadruple helix, extractive logic, "smart-washing," and "tick-box" engagement.

Whilst academics and government representatives in both districts referred to the quadruple helix as a foundation for action, and acknowledged a need to involve citizens, there was no clear or systematic strategy for how to ensure inclusive involvement, or how to respond in a transparent way to the outcomes of that involvement. The way in which citizens were conceptualised and engaged failed to accommodate diverse, often marginalised, groups such as community associations, non-profit organisations, ad-hoc task groups, or groups with different digital practices, for example, elderly people. This issue is not new, or particularly unique to smart initiatives, but pervades efforts to embed participation in planning and public policy more generally (Davies, 2001, 2002; Hügel & Davies, 2020). Overall, deployment of the quadruple helix in this way perpetuated existing power differentials between groups by prioritising the role of local authorities, academics, and businesses and relegating citizen engagement (Tewdwr-Jones & Wilson, 2022), whilst also seeking to frame the smart district as an apolitical intervention (Chantry, 2022). For example, the Balbriggan hackathon was sponsored by FCC which commissioned the delivery agents, framed the event aims, provided the space, and chose the mentors.

In this sense, the quadruple helix was used as a rhetorical device that paid lip service to the presence of broad stakeholder groups and failed to detail how multiple, changing actor positions could be accommodated. There was no indication of any challenge to the appropriateness or legitimacy of the Quadruple Helix or any alternative ways to represent actors, their roles, or their responsibilities (Nguyen & Marques, 2021; Nguyen et al.,

Table 1. Results and recommendations for promoting citizen engagement activities within Smart Districts.

Theme	Example(s)	Recommendation(s)
Uncritical use of quadruple helix	"Each district would have the [quadruple helix] framework…local government, citizens, business, and academia all coming together" (Academic, Smart Balbriggan). "We use that [quadruple helix]" (Government, Smart Balbriggan).	Focus on diversity, inclusiveness, and power relations Work with local representatives to identify relevant stakeholders. Develop criteria for ascribing membership and acknowledge that stakeholders can hold multiple affiliations. Include intermediaries and actors with temporary and/or ambiguous roles. Pay attention to historical participation, power, and influence.
Instrumental and extractive logic	"[We concentrate on] the districts where they have a kind of already-made community that we can tap into" (Local government, Smart Sandyford). "I'm not sure if even you could call [mobile phone, drone, and embedded sensor data] engagement, but it's collecting of information" (Academic, Smart Sandyford).	Deliberative logic Provide adequate finance, time, and personnel resources to co-design, refine, and deliver projects. Develop mechanisms to give local communities control over resources, actions, decision-making, and data.
Smart-washing	"I was looking at the smart thing, it was just like facial beauty, nothing deep" (Community A, Smart Balbriggan). "The smart space [is] a kind of promotional tool" (Community B, Smart Balbriggan). "Smart initiatives that I've seen around the globe, they always kind of feel like they're scratching the surface" (Academic, Smart Balbriggan).	Smarter approach Identify specific local concerns, as well as regional and national concerns. Develop mutual trust within and between smart district actors to create the bedrock for collaborative and meaningful engagement. Incorporate identified needs into a coherent, meaningful, and deployable strategy.
Tick-box engagement	"'Tell us your challenges,' just shout them out" (Local government, Smart Sandyford). "It needs transparency like where does it go into the community? Or how did those decisions unfold?" (Community C, Smart Balbriggan)	Citizen engagement as a process Involve citizens as early as possible in the design and delivery of engagement activities. Use a range of engagement strategies and methods including cultural and creative events alongside formal workshops and meetings. Co-develop, resource, and deploy an iterative monitoring and evaluation strategy.

2022). Instead of problematising the quadruple helix, "the citizens," who could not be identified or mobilised were re-constituted as "the problem," as being "techno-phobic," "backward," and "old school." Such a deficit framing of the citizen has been widely critiqued, not least because it overlooks how structural factors such as poverty or cognitive capacity constrain willingness and ability to engage (Soutar et al., 2022).

Critics of the quadruple helix suggest that the concept could be improved by diversifying and increasing actor types, for example, including intermediaries, such as social entrepreneurs, in a penta helix (Calzada & Cowie, 2017). However, as the survey run by the local charity demonstrated, interstitial actors, such as intermediaries, do not wait passively to be consulted by other quadruple helix stakeholders, they can have

multiple roles and strategically mobilise these, e.g., as a researcher and a charity actor, collecting data and representing practices that are reflective of the community and its members (Burns & Welker, 2022). Rather than being strategic or systematised, the dominant mode of citizen engagement in both smart districts was reactive and opportunistic, running the risk of being located at the lowest part of Cardullo and Kitchin's (2019) scaffold for participation, that of being tokenistic and paternalistic. Citizen engagement was persistently framed according to an extractive rather than deliberative logic, albeit in different ways in the two places.

While there are similarities between the two district's framings and actions, there are also differences. Smart Sandyford did not, for a range of social and temporal reasons, conduct any novel citizen engagement in its short-lived existence. Smart Balbriggan was explicit in its use of "smart" citizen engagement methods—such as online surveys and hackathons. However, the level and diversity of engagement these mechanisms produced raises questions about the "undisputed aptness" (Engelbert et al., 2019, p. 351) of digitally enabled engagement methods amongst digitally divided populations. More than this, adopting business-driven, Dragon's Den style discourse and practices during the hackathon whereby citizens were allocated into teams that they did not choose, presented with digital technologies that they were required to use without prior training, and asked to identify solutions to specific problems that were then judged by an external panel of "experts" in a compressed timeframe, undermined the value of local knowledge. The framing of the event encouraged competition and provided little in the way of legitimacy for any outcomes produced. Consequently, it is not only the computational logic that constrains and curtails citizens' rights to identify, contest, or reject smart solutions, both in Dublin and beyond (Halpern & Mitchell, 2022) but also the lack of space for collaborative deliberation.

The results of the analysis of citizen engagement in the emerging smart districts outlined above raise a number of key issues. Within the Republic of Ireland and Europe more widely, badging initiatives as "smart" can be an effective branding tool for the promotion of an area and a way to secure funding for collaborative activities between academic research, business, and government. However, if citizens are themselves not also meaningfully engaged, it is questionable whether discrete, locally embedded, technically enhanced smart projects are either appropriate for, or capable of, addressing complex, place-based and systemic challenges such as climate change or urban regeneration without intentionally, or unintentionally, causing negative outcomes for the citizens most affected (Clark, 2020).

5. Conclusions

Whilst it is acknowledged that going beyond case studies in smart city research is needed (Miller et al., 2021), the focus on case studies is still valuable for learning when smart urban initiatives, like those considered in this article, are emergent or short-lived. Both the smart districts examined in this article were run on limited budgets and with few human resources. Without strategic funding and substantive resources, it is hard to go beyond already existing activities. Therefore, an opportunistic approach prevails with programmes and activities designed to fit funding availability rather than address needs identified by citizens. The uncritical articulation and generic use of concepts such as smart and quadruple helix then become "empty signifiers" (Caprotti & Cowley, 2019); rhetorical devices used by government, industry, and academia to discuss, resource, and legitimate, rather than challenge or transform, existing engagement practices. Such concerns are not restricted to Ireland. Elsewhere, debates are ongoing about whether the prefix "smart" should be replaced by terms such as "community" or "connected." However, as this article shows, words alone are insufficient to address the wicked problems being faced.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

The Smart City and Healthy Walking: An Environmental Comparison Between Healthy and the Shortest Route Choices

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Abstract
Walking is a means of health promotion, which is one of the main features of smart cities. A smart city's built environment can help people choose a healthy walking route instead of the shortest one. Our study investigated which environmental factors pedestrians who select healthy routes prefer and favored environmental factors in pedestrian navigation mobile applications. Survey data were collected from 164 residents in Daegu, South Korea, from October 12 to October 25, 2022. *t* and chi-square tests were used to compare perceptual differences between the healthy route and the shortest route preference groups. The results indicate that 56.7% of respondents preferred a healthy walking route over the shortest route. Pedestrians who chose the healthy route preferred to have less noise and more greenery along their commute and feel safer from traffic accidents and crimes than those who chose the shortest route. Moreover, people who favored healthy routes also considered the following environmental factors in pedestrian navigation mobile applications: (a) greenery and waterfront areas, (b) low traffic volume, and (c) safety from traffic accidents and crimes. The results suggest that urban planning and design policies support healthier and more active walking in smart cities.

Keywords
built environment; healthy walking; mobile applications; pedestrian navigation; smart city; walking route

Issue
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1. Introduction

Several studies have suggested that the built environment plays an important role in promoting walking behaviors (Hillnhütter, 2022; Panter et al., 2019; Sallis et al., 2009). Environments with more mixed land use, greenery, and less heat exposure facilitate increased walking (Basu et al., 2022; Taleai & Yameqani, 2018). People living in communities with good pedestrian amenities such as sidewalks and benches are more likely to walk than those living in other areas. Therefore, urban planners and designers are attempting to create an attractive and high-quality environment that will encourage pedestrians to walk (Rodríguez et al., 2009).

Understanding the environmental conditions that people want to walk in can help create a pedestrian-friendly built environment (Handy et al., 2006). Many researchers have investigated the walking routes chosen by pedestrians in their neighborhood environments to understand their preferred built environmental conditions. A majority of pedestrians tend to choose the shortest route to their destination (Borgers & Timmermans, 2005). However, this is not always the most preferred characteristic in walking route choice (Guo & Loo, 2013). Pedestrians are likely to choose a safe route to avoid crime or traffic accidents even if it means they need to take a detour to reach their destination (Bhowmick et al., 2021; Lee & Lee, 2021). Moreover, despite the extra distance, pedestrians may opt for a comfortable route with extensive greenery and fine views (Koh & Wong, 2013). In addition, sometimes people choose routes other than the shortest route to avoid certain obstacles, such as

crosswalks or stairs (Guo & Ferreira, 2008; Olszewski & Wibowo, 2005). Based on this evidence, it is expected that active walking can be encouraged when pedestrians are provided their preferred built environments.

Recent studies have suggested that smart cities, which are attracting attention as a new urban planning paradigm in the 21st century, can improve walking quality and promote active walking (Jabbari et al., 2022; Line et al., 2011; Moreno et al., 2021). Visvizi et al. (2021) argued that information and communication technologies (ICT)-based systems in smart cities (e.g., sensor-based systems that adjust traffic lights according to the walking speed) have the potential to improve walking quality. Conticelli et al. (2018) also mentioned that applying ICT technology to pedestrian route planning and design would enable people to walk more and increase pedestrian satisfaction. In this context, a healthy walking route has been suggested as an element to improve smart cities (Novack et al., 2018; Pimpinella et al., 2019). Existing navigation services, such as Google Maps, provide routes based on the shortest distance and walking time (Siriaraya et al., 2020). However, recent technology can guide pedestrians to the optimal route by reflecting the built environmental conditions they prefer (Conticelli et al., 2018).

Pimpinella et al. (2019) proposed a routing system called Smart Urban Routing for Flesta-IoT for urban pedestrians and cyclists. The healthy routes offered by the system required an average of 10% longer walking time than the shortest route searched by Google Maps but had 25% less exposure to carbon monoxide. Novack et al. (2018) proposed a system that finds the most appropriate route when pedestrians select the factors they prefer for green areas (e.g., parks and trees), meeting places (e.g., cafes, restaurants, and shops), and quiet streets (e.g., less traffic volume). While the routes suggested by the system were slightly longer than the shortest routes, they were observed to be more social, comfortable, and quiet. Wakamiya et al. (2019) proposed a system that recommends a pleasant route with extensive greenery and pleasant views. Several studies have suggested systems that recommend shaded and cool routes on hot days (Deilami et al., 2020; Monreal et al., 2016; Rußig & Bruns, 2017). Regarding pedestrian safety, Pang et al. (2019) designed the safest PATH, an application that guides pedestrians to the safest routes with a lower risk of becoming a victim of crime. Similarly, Mishra et al. (2021) proposed a safe route design technique in light of the recent Covid-19 pandemic that enables pedestrians to bypass areas that would make them vulnerable to infection. Gani et al. (2019) proposed a system that suggests the optimal route by considering the presence of crosswalks or curbs, which are barriers to walking.

With the development of smart technology, pedestrian navigation mobile applications are actively being developed that allow pedestrians to navigate healthy walking routes in urban environments (Fonseca et al., 2021; Novack et al., 2018). To develop healthy ambulation into a major means of promoting people's health in smart cities, it is essential to understand pedestrians' perceptions and needs. Specifically, it is necessary to identify the environmental factors are key to inducing pedestrians to take healthier routes. In addition, when pedestrian navigation mobile applications that guide pedestrians to healthy routes are commercialized, the environmental factors and functions required by pedestrians must be identified. Therefore, this study aims to investigate the environmental factors preferred by pedestrians who choose healthy routes and to examine their preferred route search functions in mobile applications.

2. Materials and Methods

2.1. Study Area

This study covers the Ayang Bridge and its surrounding neighborhood in the Dong-gu region in Daegu, South Korea. This neighborhood is rich in green areas and has good access to the Geumho River; therefore, it has good environmental conditions for this study design. As shown in Figure 1, the starting point of the route (origin) is the Dong-gu Health Center and the arrival point (destination) is the Ayanggyo intersection. The red-colored route (1.1 km) is the shortest path found on Google Maps, whereas the green route (1.3 km) is the healthy route defined in this study. A healthy route requires walking a greater distance to reach the destination than the shortest route but has less traffic and better access to greenery and rivers.

2.2. Data

To compare people's perceptions between the healthy and the shortest walking routes, this study employed survey data generated from a large project (the Healthy Walking Project). The study was approved by the institutional review board of the research team and conducted from October 12–25, 2022, and all participants were aged 18 years or older. The survey was designed to ask participants to report their demographics and individual characteristics and their perceptions of walking route choice, walking behavior, attitudes toward health, preferred environmental factors in walking route choice, and preferred functions in pedestrian navigation mobile applications. The survey was conducted on residents living around the study areas of Ayang Bridge, and the data was used of 164 people who answered all the questions.

With regard to demographics and individual characteristics, this study used age, gender, car ownership, neighborhood residence duration, and the degree of familiarity with the neighborhood. For the walking route choice, we included the choice of walking route (the shortest route and healthy route) and satisfaction with the chosen walking route. Participants were shown Figure 1 and were asked to choose a walking route for

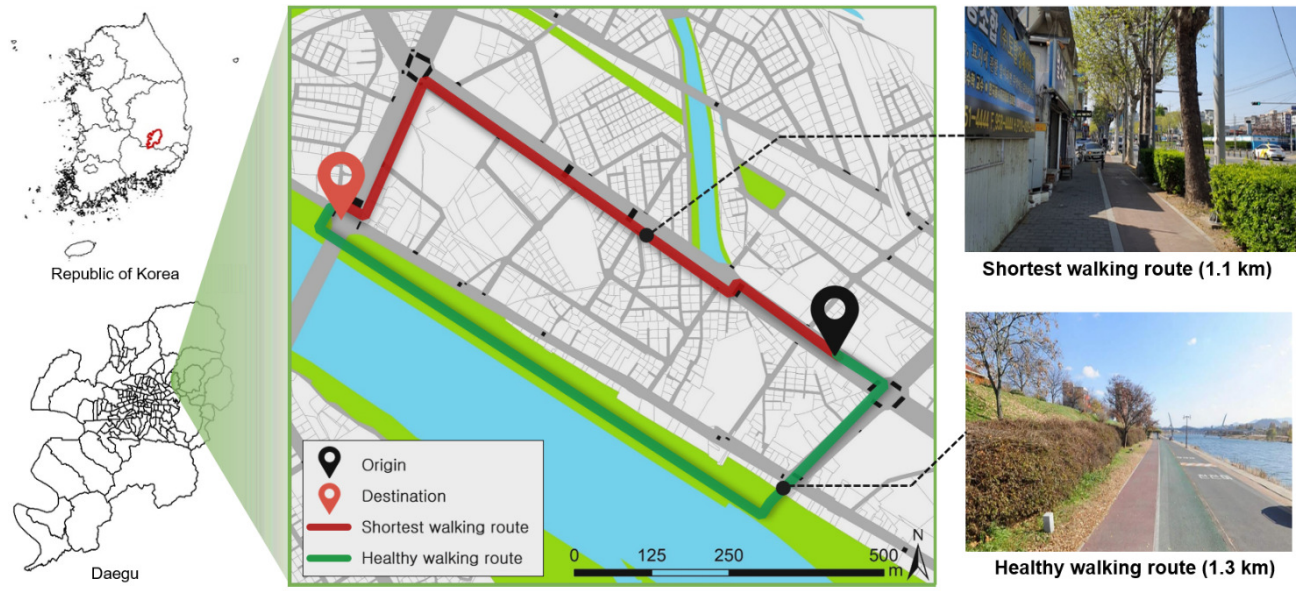


Figure 1. Study area and route setting.

leisure purposes. Satisfaction with the selected walking route was measured on a scale of 1 to 10 points.

For walking behavior, we considered the number of walking days per week and the average number of walking minutes for both recreation and transportation. Participants answered the question "How many days have you walked for more than 10 minutes for recreation/transportation purposes in the past week?" with the range from "not walking (0 days)" to "7 days." They also answered the question "How may minutes does it take on average to walk for recreation/transportation purposes?" in the range between "less than 10 minutes" and "more than 60 minutes."

Three attitudes toward health variables were considered: preference for walking to prevent chronic diseases, preference for walking to relieve stress and depression, and preference for walking to promote quality of life. For the preferred environmental factors for walking route choice, we used four categories (accessibility, convenience, pleasantness, and safety) and 11 types of corresponding variables. The corresponding variables used for each category were as follows: (a) accessibility: distance to destination; (b) convenience: flat terrain, presence of street amenities such as benches, and presence of retail stores; (c) pleasantness: low noise level, good air quality, presence of greenery and waterfront areas, and presence of tree shade; and (d) safety: low level of traffic speed and presence of traffic safety facilities, presence of crime prevention facilities (e.g., CCTV, streetlights), and environment with less contact with people. To measure participants' opinions, we used a 5-point Likert scale.

For the preferred environmental factors in pedestrian navigation mobile applications, we used 12 options, such as street connectivity, noise level, and greenery. By examining these items, we try to examine what factors should be considered in the development of pedestrian navigation mobile applications. The 12 options were constructed with reference to previous studies, and participants could choose one or more options without limiting the number.

In particular, for the preferred environmental factors, this study tried to compare people's perceptions from the survey with geographic information system (GIS)-measured environmental conditions. In other words, this study attempted to verify whether there was a difference between subjectively measured and objectively measured variables. For example, if we tried to compare in between the two groups (the shortest vs. healthy route) for the variable "presence of greenery and waterfront areas," the normalized difference vegetation index (NDVI) and the percentage of route length adjacent to the river could be employed for the objectively measured variables.

2.3. Analytical Methods

The analytical methods used in this study are as follows. First, participants were divided into two groups based on route selection (the shortest route vs. healthy route), and compared whether there were differences in individual characteristics and environmental perceptions. The *t* and chi-square tests were used to compare group differences between the shortest route and the healthy route. The *t*-test was used for continuous variables (i.e., satisfaction with the chosen walking route, weekly minutes of walking), whereas the chi-square test was employed for the ordinal scale of variables. Second, this study compared subjectively measured and objectively measured environmental conditions between the shortest route and healthy route groups. GIS software was used to capture the objectively measured environmental conditions. Third, this study investigated the preference of routing

application functions in pedestrian-preferred environments, and the frequency bar charts were used. SPSS 26 and ArcGIS 10.5 were employed for this study.

3. Results

3.1. Differences in Walking Choice Between the Shortest Route and the Healthy Route by t *and Chi-Square Tests*

Table 1 shows the differences in demographics and individual characteristics and perceptions between the group that chose the shortest route and the group that chose the healthier route. Of the respondents, 71 (43.2%) chose the shortest route and 93 (56.7%) chose the healthy route. All variables from the demographics and individual characteristics (i.e., age, gender, car ownership, resident period, and familiarity with a neighborhood) of the two groups were not significantly different.

For walking route choice and walking behavior, the *t*-test was used due to the continuous variables. The satisfaction level with the selected walking route was found to be significantly higher in the group that chose the healthy route than in the group that selected the shortest route ($p < 0.001$). From the survey items, the number of days walked per week was multiplied by the average walking time to calculate the weekly minutes of walking. There were no significant mean differences in the total weekly minutes of walking for both recreation and transportation between the two groups (i.e., the shortest route vs. healthy route).

For an efficient chi-square test, the variables measured by the 5-point Likert scale in the survey were

Table 1. Comparison of individual characteristics and perceptions between healthy and the shortest route choices using *t* and chi-square tests.

Class	Variable		Measure	Shortest route (*N* = 71)	Healthy route (*N* = 93)	*p* *
				Count (%)	Count (%)	
Demographic/ Individual characteristics	Age		19 or younger	6 (8.5)	8 (8.6)	0.209
			20–29	22 (31.0)	31 (33.3)	
			30–39	16 (22.5)	16 (17.2)	
			40–49	6 (8.5)	16 (17.2)	
			50–59	12 (16.9)	19 (20.4)	
			60 or older	9 (12.7)	3 (3.2)	
	Gender		Male	25 (35.2)	29 (31.2)	0.586
			Female	46 (64.8)	64 (68.8)	
	Car ownership		Yes	35 (49.3)	40 (43.0)	0.423
			No	36 (50.7)	53 (57.0)	
	Period of residence in the neighborhood		Less than 1 year	13 (18.3)	13 (14.0)	0.742
			1–5	26 (36.6)	29 (31.2)	
			6–10	12 (16.9)	18 (19.4)	
			11–15	7 (9.9)	9 (9.7)	
			More than 16 years	13 (18.3)	24 (25.8)	
	Familiarity with the neighborhood		Not familiar	6 (8.5)	7 (7.5)	0.455
			Average	20 (28.2)	14 (15.1)	
			Familiar	45 (63.4)	72 (77.4)	
				Mean (SD)	Mean (SD)	
Walking route choice	Satisfaction with selected walking route		Continuous: 1 (dissatisfied)—10 (satisfied)	6.5 (1.8)	8.9 (1.3)	< 0.001 ***
Walking behavior	Recreation walk	Total weekly minutes of walking for recreation	Continuous: minutes	115.8 (92.4)	126.6 (113.2)	0.510
	Transportation walk	Total weekly minutes of walking for commuting and to retail services	Continuous: minutes	142.2 (111.7)	141.3 (111.0)	0.960

Table 1. (Cont.) Comparison of individual characteristics and perceptions between healthy and the shortest route choices using *t* and chi-square tests.

Class	Variable		Measure	Shortest route (*N* = 71)	Healthy route (*N* = 93)	*p* *
				Count (%)	Count (%)	
Attitude toward health	Preference for walking to prevent chronic diseases		Disagree	4 (5.6)	1 (1.1)	< 0.001 ***
			Neither agree nor disagree	21 (29.6)	8 (8.6)	
			Agree	46 (64.8)	84 (90.3)	
	Preference for walking to relieve stress and depression		Disagree	3 (4.2)	2 (2.2)	0.009 ***
			Neither agree nor disagree	13 (18.3)	4 (4.3)	
			Agree	55 (77.5)	87 (93.5)	
	Preference for walking to promote quality of life		Disagree	2 (2.8)	2 (2.2)	0.005 ***
			Neither agree nor disagree	23 (32.4)	11 (11.8)	
			Agree	46 (64.8)	80 (86.0)	
Preferred environmental factors in walking route choice	Accessibility	Distance to destination	Not important	3 (4.2)	8 (8.6)	0.479
			Average	13 (18.3)	19 (20.4)	
			Important	55 (77.5)	66 (71.0)	
	Convenience	Flat terrain	Not important	7 (9.9)	4 (4.3)	0.232
			Average	14 (19.7)	14 (15.1)	
			Important	50 (70.4)	75 (80.6)	
		Presence of street amenities such as benches	Not important	17 (23.9)	20 (21.5)	0.808
			Average	21 (29.6)	25 (26.9)	
			Important	33 (46.5)	48 (51.6)	
		Presence of retail stores	Not important	15 (21.1)	24 (25.8)	0.713
			Average	23 (32.4)	31 (33.3)	
			Important	33 (46.5)	38 (40.9)	
	Pleasantness	Low noise level	Not important	12(16.9)	5 (5.4)	0.034 **
			Average	11 (15.5)	11 (11.8)	
			Important	48 (67.6)	77 (82.8)	
		Good air quality	Not important	4 (5.6)	6 (6.5)	0.178
			Average	12 (16.9)	7 (7.5)	
			Important	55 (77.5)	80 (86.0)	
		Presence of greenery and waterfront areas	Not important	6(8.5)	3 (3.2)	< 0.001 ***
			Average	22 (31.0)	6 (6.5)	
			Important	43 (60.6)	84 (90.3)	
		Presence of tree shade	Not important	3 (4.2)	2 (2.2)	0.519
			Average	14 (19.7)	14 (15.1)	
			Important	54 (76.1)	77 (82.8)	
	Safety	Low level of traffic speed and presence of traffic safety facilities	Not important	4 (5.6)	1 (1.1)	0.083 *
			Average	10 (14.1)	7 (7.5)	
			Important	57 (80.3)	85 (91.4)	
		Presence of crime prevention facilities (e.g., CCTV, streetlights)	Not important	6 (8.5)	1 (1.1)	0.059 *
			Average	6 (8.5)	11 (11.8)	
			Important	59 (83.1)	81 (87.1)	
		Environment with less contact with people	Not important	8 (11.3)	17 (18.3)	0.365
			Average	26 (36.6)	27 (29.0)	
			Important	37 (43.3)	49 (52.7)	

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

converted into a 3-point Likert scale. For all three variables derived from the attitude toward health, the group that selected a healthy route showed significantly higher levels of perception, while the group who chose a healthy route showed higher levels of preference for walking to prevent chronic disease ($p < 0.001$), to relieve stress and depression ($p = 0.009$), and to promote quality of life ($p = 0.005$) than the group that chose the shortest route. Approximately 64.8% of the shortest route choice group and 90.3% of the healthy route choice group agreed that they preferred walking to prevent chronic disease, which was the most statistically different perception across the groups.

From the preferred environmental factors in walking route choice, four variables were statistically different between the two groups (shortest route vs. healthy route). There were significantly different perceptions of pleasantness, including a low level of noise and the presence of greenery and waterfront areas. Approximately 67.6% of the shortest route choice group and 82.8% of the healthy route choice group agreed that they consider the lower noise level when selecting a walking route ($p = 0.034$). Similarly, the healthy route group was more likely to consider the presence of greenery and waterfront areas than the shortest route group, at the 0.001 level of significance (90.3% vs. 60.6%).

There was also a statistically significant difference in the perception of environmental safety between the two groups. It was found that the group that chose a healthy route considered the lower level of traffic speed, presence of traffic safety facilities ($p = 0.083$), and presence of crime prevention facilities (e.g., CCTV, streetlights; $p = 0.059$) more than the group that chose the shortest route.

3.2. Comparison of Subjectively and Objectively Measured Environmental Conditions Between the Shortest Route and the Healthy Route Groups

As shown in Table 1, pleasantness and safety were important environmental factors for those who chose the healthy route. Specifically, respondents who elected for a healthy route had a greater preference for greenery and waterfront areas, a lower traffic speed, traffic safety facilities, and more crime prevention facilities than those who chose the shortest route. As objectively measured variables, we used the NDVI and the ratio of contact with waterfront for the presence of greenery and waterfront areas, while the ratio of arterial roads and the number of streetlights were used for low traffic speed, traffic safety facilities, and crime prevention facilities, respectively. NDVI is a popular index for vegetation, with higher values indicating greener vegetation conditions (Candiago et al., 2015; Pettorelli et al., 2005). We used the Landsat-8 OLI scene from July 1, 2022, from the United States Geological Survey website (https://earthexplorer.usgs.gov). Data on waterfronts and arterial roads were obtained from the National Spatial Data Infrastructure Portal (2022) and streetlight data were obtained from the D-data hub (2022).

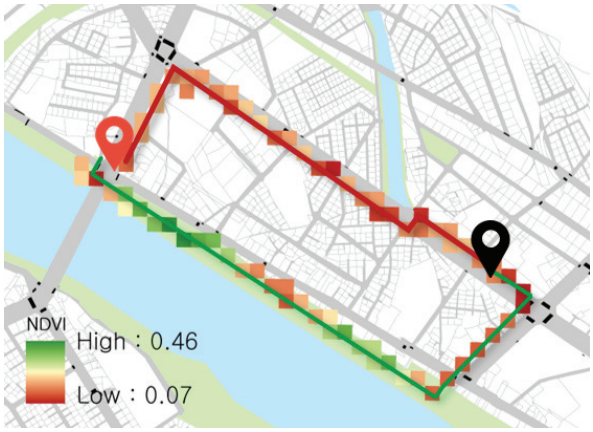
The results using the objectively measured variables are shown in Tables 2 and 3. The average NDVI (ranging from −1 [no vegetation] to 1 [green vegetation]) of the healthy route and the shortest route was 0.25 and

Table 2. Comparison of subjectively and objectively measured environmental conditions between the shortest route and healthy route groups.

Subjectively measured variables from the survey				Objectively measured variables using GIS		
Variable		Descriptive statistics		Measure	Descriptive statistics	
		Shortest route	Healthy route		Shortest route	Healthy route
Presence of greenery and waterfront areas	Not important (%)	8.5	3.2	NDVI (ranging from −1 to 1)	0.16	0.25
	Average (%)	31.0	6.5			
	Important (%)	60.6	90.3	Ratio of contact with waterfront (%)	0.00	68.95
Low level of traffic speed and presence of traffic safety facilities	Not important (%)	5.6	1.1	Ratio of arterial road (%)	100.00	28.46
	Average (%)	14.1	7.5			
	Important (%)	80.3	91.4			
Presence of crime prevention facilities	Not important (%)	8.5	1.1	Number of streetlights (n/km)	21.10	22.80
	Average (%)	8.5	11.8			
	Important (%)	83.1	87.1			

Table 3. Environmental conditions of objectively measured variables using GIS.

Pleasantness



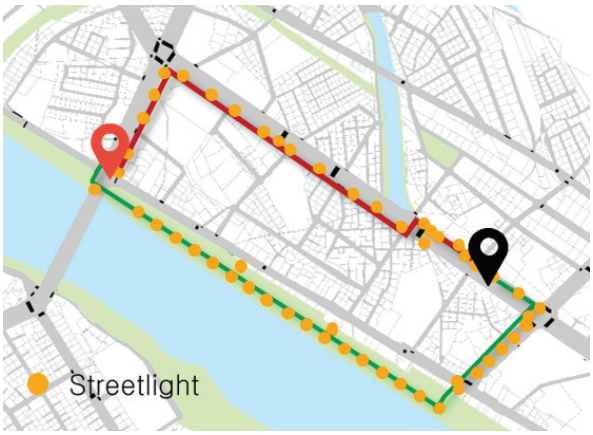
NDVI (ranging from –1 to 1)

Route	Mean (SD)	Min	Max
Shortest route	0.16 (0.04)	0.07	0.27
Healthy route	0.25 (0.11)	0.08	0.46

Ratio of contact with waterfront (%)

Route	Total length	Length with waterfront	Ratio of waterfront
Shortest route	1,090 m	0 m	0%
Healthy route	1,272 m	877 m	68.95%

Safety



Ratio of arterial road (%)

Route	Total length	Length with arterial road	Ratio of arterial road
Shortest route	1,090 m	1,090 m	100%
Healthy route	1,272 m	362 m	27.46%

Number of streetlights (n/km)

Route	Total length	Number of streetlights	n per km
Shortest route	1,090 m	23	21.10
Healthy route	1,272 m	29	22.80

0.16, respectively, demonstrating that the greenery level of the healthy route was better than that of the shortest route. Healthy routes accounted for approximately 69% of the rate of contact with the waterfront, so much of the route could be walked along the river, but the shortest route did not align with the waterfront. For the arterial road ratio, only about 28% of the healthy route was on the arterial road, while the shortest route fully followed the arterial road. This showed that the pedestrians who chose the healthy route were relatively safer from vehicular incidents than those who chose the shortest route. As for the number of streetlights, there was no significant

difference in the number of streetlights at approximately 22 per km for the healthy route and 21 per km for the shortest route.

3.3. Preferred Environmental Factors in Pedestrian Navigation Mobile Applications

This study also sought to investigate routing application functions in pedestrian-preferred environments. The participants were able to choose from among multiple selections with 12 environmental factors. A total of 527 samples were selected from 164 participants, with an average of 3.2 environmental factors selected per person. Figure 2 shows the preferred pedestrian navigation functions for mobile applications. The most preferred environmental factor was "greenery and waterfront areas," accounting for 14.6% of the total. The ratios for "low traffic volume" and "safety from traffic accidents and crimes" were 14.2% and 13.7%, respectively.

Figure 3 shows the preferred environmental factors by classifying the participants who chose the healthy and shortest routes. The rate of choosing "greenery and waterfront areas" was the highest at 19.3% in the healthy route selection group, but only 8.9% in the shortest route selection group, which only ranked 6th. In other words, those who chose the healthy route were most

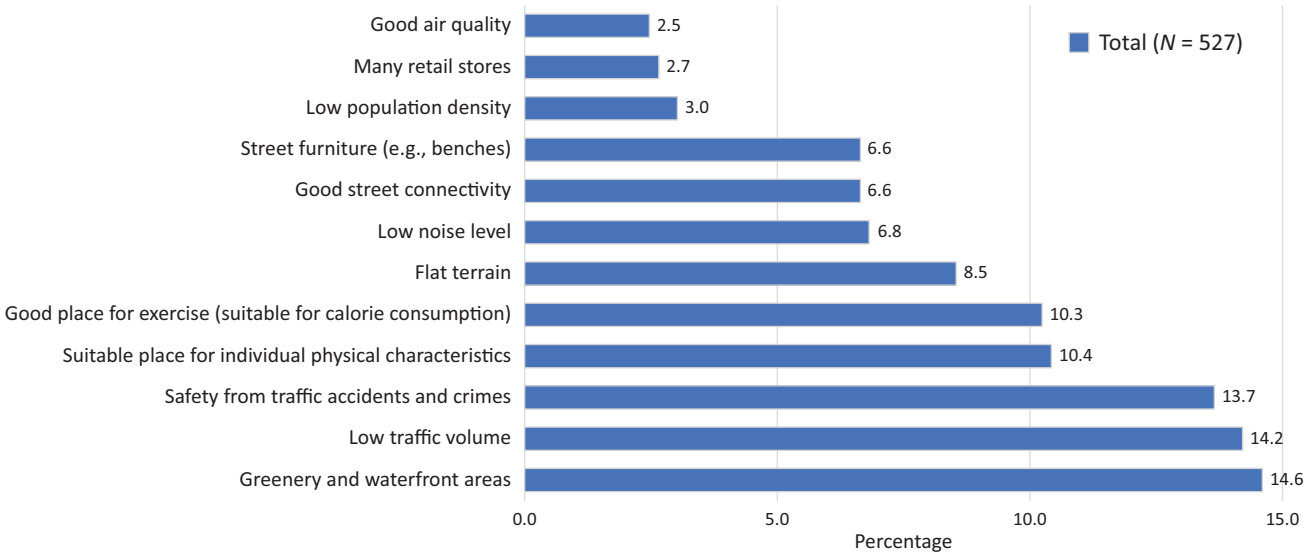


Figure 2. Preferred environmental factors in pedestrian navigation mobile application for the total sample.

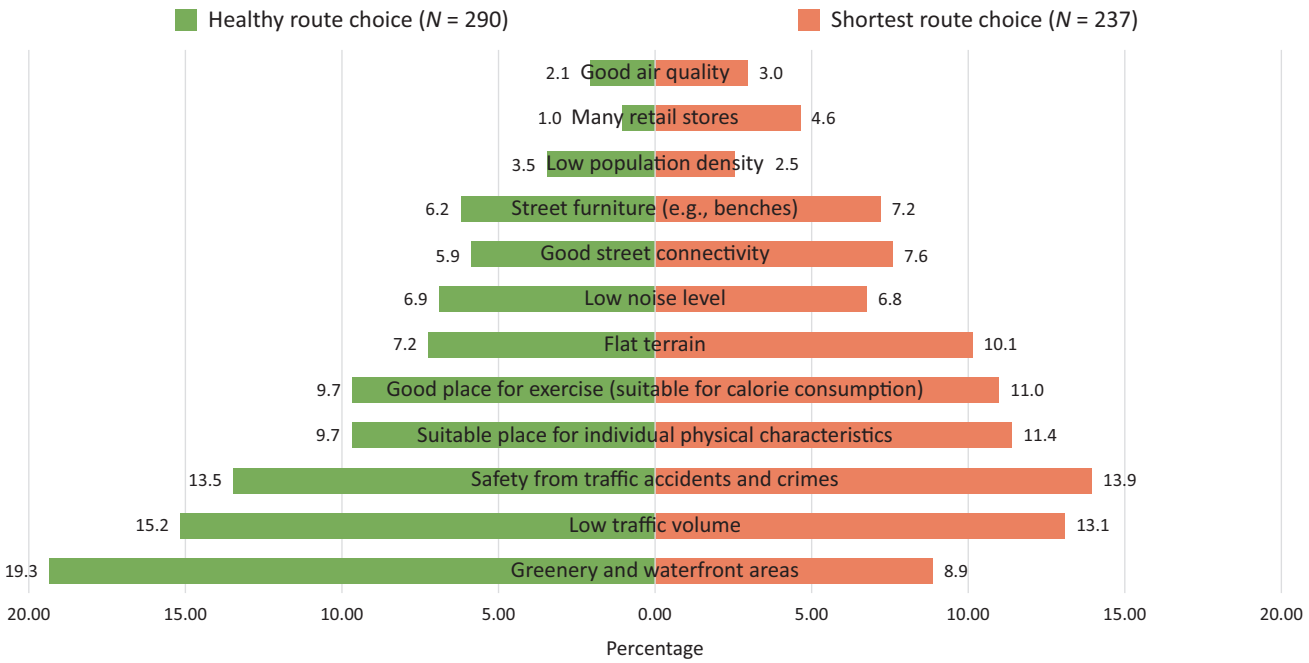


Figure 3. Preferred environmental factors in pedestrian navigation mobile application of the subsamples (the shortest route group vs. healthy route group).

interested in having pleasant environmental conditions while those who chose the shortest route were most interested in safety.

4. Discussion

Smart cities are increasingly recognized as important for creating sustainable and livable environments. The smart city environment can help people choose a healthy walking route. In this study, participants" walking route choices were investigated by setting the shortest route and the healthy route. Moreover, we compared the preferred environmental factors and pedestrian navigation application functions for the two groups. Approximately 56.7% of participants chose the healthy route and were more satisfied with it. Those who chose the healthy route had a higher health awareness and considered it to be more important in terms of the pleasantness and safety of the environment. In addition, those who chose a healthy route preferred having pleasant environmental conditions (e.g., greenery and waterfront areas, low traffic volume) as a pedestrian navigation mobile application function.

Based on the findings of this study, several observations can be made. First, we found that pedestrians were likely to choose healthy routes (more pleasant and safer routes), even if they took more time. This shows that a pedestrian navigation mobile application that guides people to healthy walking routes can be a useful and effective means of promoting citizens' health in smart cities. With the development of technology, walking route search systems that consider various environmental conditions have been developed (Conticelli et al., 2018). Recently, with the technological advancements of various mobile devices, such as smartphones and smartwatches, it has become easier to implement healthy walking using mobile applications (Rodrigues et al., 2019). Therefore, more attention to develop a system that searches for a healthy route and active support for related research are required.

Second, we found consistency between subjectively measured and objectively measured preferred environmental conditions among those who chose healthy route. According to the results, those who chose the healthy route placed more importance on the following environmental conditions than those who chose the shortest route: presence of greenery and waterfront areas, low level of traffic speed, and presence of traffic safety facilities. When measuring a healthy route using GIS, it had more greenery and more contact with the waterfront than the shortest route. In addition, there were much fewer sections facing arterial roads with heavy traffic. This study found that the objectively measured variables using GIS could explain the subjectively measured perceptions of pedestrians. Therefore, using both subjectively and objectively measured variables in these empirical studies can be an important approach to increase research validity.

Third, we found that the environmental conditions with rich in greenery and waterfront areas, and safe from cars and crime were important factors in promoting healthy walking. The environmental factors that people who chose a healthy route considered important and actually wanted to be guided in the pedestrian navigation mobile applications were the environmental conditions rich in greenery and safety. Several previous studies have shown that green and blue spaces are important factors in improving people's physical activity and health conditions (Gaikwad & Shinde, 2019; Lee et al., 2015; Vert et al., 2020). In addition, some studies have reported that people walk more and engage more in physical activity in areas with low crime rates and safe from car accidents (Oyeyemi et al., 2012; Rees-Punia et al., 2018). Therefore, this study could support the results of previous studies and showed that a pleasant and safe environment can encourage pedestrians to walk longer. Urban planners and policy makers can promote people's walking by providing green and blue areas, and safe streets in their neighborhoods. Moreover, the pedestrian navigation mobile application will help to promote healthy and active walking by providing a function that meets the needs of pedestrians (i.e., a function that guides a pleasant and safe environment).

Fourth, there is a need for information technology that collects, analyzes, and provides environmental information in real time so that people can effectively use pedestrian navigation mobile applications. Environmental sensors can measure various types of data such as noise, airborne pollen, floating population, and traffic volume in real time, as well as air pollutants such as PM_{10}, $PM_{2.5}$, CO, NO_2, and O_3 (Rußig & Bruns, 2017). In addition, it is possible to collect image and video data from streets using CCTV. A large amount of real-time big data collected from sensors and monitors can be utilized to search for healthy walking routes with the help of various technologies, such as ICT and ubiquitous technology (Cardozo et al., 2015; Nallur et al., 2015; Papageorgiou et al., 2020). For this, it is necessary to establish sensors and an ICT-based network infrastructure that can record and measure various detailed data in urban environments.

This study has several limitations, and directions for future research to address them are as follows. First, it investigated the route selection of participants for a specific area. Future studies can examine many case areas of various environments (e.g., high-density areas with buildings vs. low-density areas with open spaces). Second, it is difficult to generalize people's route selection results because the survey was conducted only during a specific period. Therefore, additional research is needed on which routes pedestrians choose for leisure under various environmental conditions such as season, weather, and time of day. Third, this study compared individual characteristics and perceptions of the environment between the two groups using *t* and chi-square tests. Some multivariate analyses, such as the spatial

regression model and multi-level regression approach, can be employed to examine the association between environmental factors and walking selection in future studies. Finally, this study examined the functions preferred by people in pedestrian navigation mobile applications. When the application is commercialized in the future, it is expected allow for more diverse and in-depth studies using the data produced. For example, it would be possible to compare objective environmental conditions, people's perceptions of the environment, and their health status using real-time data between those who practice healthy walking and those who do not.

5. Conclusions

Encouraging walking is an essential requirement for creating a healthy city and is line with the UN's sustainable development goals (Cerin et al., 2022; Visvizi et al., 2021). The smart city, a new urban planning paradigm, contributes to improving neighborhood walkability (Conticelli et al., 2018). In this context, this study investigates the environmental factors that make people walk healthier in smart cities. The results revealed that the participants in this study tended to choose routes with comfortable and safe environmental conditions, even if this meant that they had to walk longer distances. In addition, they expressed a desire to find a pleasant and safe route by using pedestrian navigation mobile applications. Accordingly, urban planners are trying to create a pleasant and safe environment that promotes healthy walking. This study can be employed to suggest urban planning and design policies that support healthier and more active walking in smart cities.

Acknowledgments

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Civic Engagement in a Citizen-Led Living Lab for Smart Cities: Evidence From South Korea

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Abstract
Smart cities have emerged in the hope of solving growing urban problems. In addition, unlike past citizen participation in tokenism, new technologies in smart cities have shed light on creating cities with high levels of civic engagement. However, contrary to expectations, technology-centric smart city development has resulted in a lack of opportunities for citizen participation. Consequently, smart cities are increasingly adopting a citizen-centric living lab methodology. Previous research on living labs has emphasized the significance of civic engagement and the potential as a collaborative platform for governments, businesses, and citizens. However, keeping individuals engaged and motivated during the living lab process might be challenging. This study examined the significance of citizens' active participation and determined the elements that influence the level of participation in a living lab. In this study, the first citizen-led living laboratory in South Korea was selected as the subject of a case study. An empirical analytic approach was adopted and a survey was conducted among living lab participants regarding their level of participation and the sociocultural elements that may impact it. Our findings revealed that living lab activities were associated with enhanced civic self-esteem and positive attitudes toward smart cities. Moreover, they display the socioeconomic elements that influence the degree of participation. This study offers evidence that living lab activities encourage citizen engagement by giving participants a sense of empowerment during the co-creation process with multiple stakeholders, boosting civic competency through learning activities, and improving a sense of community ownership.

Keywords
civic engagement; living labs; participatory approach; smart city; urban planning

Issue
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1. Introduction

Cities are heading toward the critical point caused by continuous urbanization and global climate change. According to a United Nations (2018) report, the global urban population is expected to reach 68% by 2050, and urban problems will worsen accordingly. The crisis caused by urbanization and global issues that may occur in cities is complicated to solve using only one approach. Various stakeholders and diverse political, societal, and economic issues are intertwined in the context of urban problems. Therefore, it is an urgent but burdensome problem for governments to take responsibility for solving urban issues. In the context of rising urbanization and new urban challenges, smart cities have emerged as a response to these problems and opportunities to reduce the anticipated complexities and expenses accompanying future urbanization (Albino et al., 2015). However, it was pointed out that technology-oriented urban development at the time of the smart city introduction caused a lack of citizen participation (Lim et al., 2018). According to a survey on cooperation with stakeholders

in smart city development, 65% of respondents indicated that the lack of political consensus among stakeholders was an obstacle to the success of smart city governance (Capgemini Research Institute, 2020). In addition, technocratic smart city development has led to a paucity of essential elements in terms of social sustainability, such as empowerment, participation, and inclusion (Bouzguenda et al., 2019; Cardullo & Kitchin, 2019; Merritt et al., 2021). The World Bank report on smart cities proposes using the living lab approach as a test bed for the cooperative activities of governments, businesses, and citizens in the planning stage for new infrastructure and government services (World Bank, 2016). In addition, the European Commission highlighted the priority of living lab methodology for innovation activities in smart cities in 2006 (Cardullo et al., 2018). Urban living labs experimenting with smart city innovation have been active in Europe (Baccarne et al., 2014).

Changes in the urban environment due to the advent of smart cities provide new opportunities for citizens to participate in politics (Pritchard & Gabrys, 2016). For example, ICT in smart cities is expected to overcome the time and physical constraints limiting factors for citizen participation (Baraniewicz-Kotasińska, 2022). The infrastructure using ICT in a smart city raises expectations that it will contribute to creating a more progressive city that prioritizes citizens' interests, going beyond the tokenism level of citizen participation in the past urban development process (Arnstein, 2019; De Lange & De Waal, 2013; Hollands, 2008). The expanded citizen participation services of smart cities can be the key to their success in a way that ensures an increase in citizens' quality of life with a people-centered approach to urban innovation. Understanding the needs of citizens in the wave of new technological innovations applied to infrastructure is essential to create a citizen-centered smart city.

Recently, the development of smart cities has been consistent, as reflected in the conceptualization and implementation of living labs. According to recent research, the concept of smart cities has gained significant attention and momentum in recent years, with a focus on the integration of technology and innovation to address urban challenges and improve the quality of life of citizens (Al-Nasrawi et al., 2016; Kitchin, 2015; Nam & Pardo, 2011). Consequently, living labs have emerged as a promising approach for developing smart cities, offering a platform for co-creation and collaboration among government, industry, academia, and citizens (Eade, 1997; Falco & Kleinhans, 2018; Liedtke et al., 2012). The literature has established a close association between implementing urban living labs and developing smart cities (Greve et al., 2021; Huang & Thomas, 2021). Urban living labs provide a collaborative platform for co-creating and co-designing technology-based solutions for urban environments, involving the participation of residents, the government, and the private sector. Through such a participatory approach, individuals can actively engage in designing and implementing smart city initiatives, potentially leading to more inclusive and sustainable solutions. Citizens, researchers, and policymakers have been experimenting with living labs, an open and citizen-centric approach to tackling persistent urban challenges. The European Network of Living Labs states that "living lab methodology is user-centered [and consists of] open innovation ecosystems based on a systematic user co-creation approach in public-private-people partnerships, integrating research and innovation processes in real-life communities and settings" (Steen & van Bueren, 2017). The living lab originates from technological innovation but has emerged as a new citizen participation platform for social innovation in many studies (Brock et al., 2019; Cardullo et al., 2018; Leminen et al., 2017). Previous studies on living labs have emphasized the importance of citizen participation (Baccarne et al., 2014; Cardullo et al., 2018; Cellina et al., 2019; Kareborn & Stahlbrost, 2009; Leminen et al., 2017). The living lab is a concept in which citizens participate in co-creation and innovation processes with stakeholders to create public good for society (Siljanoska, 2020). In addition, learning and participation in the living lab create an inclusive environment and encourage changes in citizens' behavior (Huang & Thomas, 2021; Leminen et al., 2015).

Developing a smart city involves implementing various solutions, projects, and initiatives to enhance urban systems and services' efficiency, sustainability, and inclusivity (Brock et al., 2019). These solutions can range from smart transportation systems and energy grids to digital services and platforms for citizen engagement and governance (Sweeting et al., 2022). However, it is essential to note that the development of a smart city is not limited to the implementation of discrete solutions but instead requires a holistic and strategic approach that considers the complexity and interdependence of urban systems and stakeholders (Hollands, 2008; Nam & Pardo, 2011; Sweeting et al., 2022). Figure 1 illustrates the process of implementing an inclusive smart city by stakeholders, such as people, governments, companies, and research institutes, through multiple living lab projects. The process begins with empowering citizens more than other stakeholders in the co-creation process. Then, each entity conducts various living lab projects to achieve its purpose, and iterative feedback is provided. As citizens' repeated feedback and multiple living lab results are deployed as new services and infrastructure of the smart city, citizens' needs can be reflected in approaching an inclusive smart city where no one is left behind.

Through the living lab project, the government will have the opportunity to attain the legitimacy of policy implementation, companies will obtain business opportunities or test beds for new products, and citizens will have the chance to reflect on their own needs or their community's. Thus, new infrastructure, citizen services, and devices that are not technology-oriented but are citizen friendly will be created in smart cities. In addition, citizens confront the information given in a specific project during the co-creation process with stakeholders within

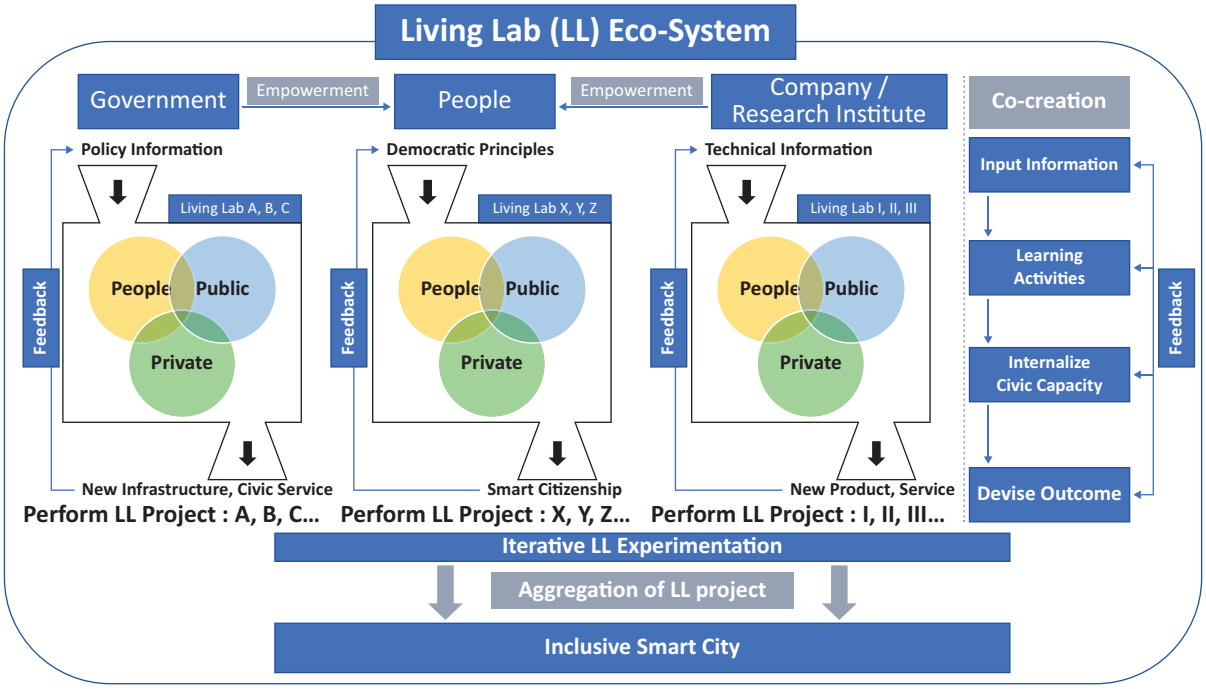

Figure 1. Living lab's eco-system and the smart city.

the living lab. By learning information and internalizing it into their knowledge, they can enhance their competency to enjoy the new smart city service fully. In other words, smart citizenship is nurtured through the learning process in a living lab (Callari et al., 2019).

Many studies have been conducted on the effects of citizen participation and learning in a living lab. Civic engagement and learning within a living lab refers to the process by which policy and technical information to achieve project tasks is internalized into the capacity of participating citizens through the activities of the living lab (de Hoop et al., 2021; de Witte et al., 2021; Huang & Thomas, 2021; Mastelic et al., 2015; Park & Fujii, 2022; Seo, 2002). Prior research generally confirms the importance of citizen participation in the living lab (Barata et al., 2017; Campailla & Titley, 2019; Leminen et al., 2015, 2017). Simultaneously, challenges exist in retaining participants and maintaining their motivation for an extended period (Habibipour et al., 2018; Lievens et al., 2014; Schmidthuber et al., 2019).

A previous study (Jones, 2007) defined citizen participation as government and local authorities' inclusion of people in the formal decision-making process. Living labs prioritize co-creating solutions to urban problems and fostering innovation through the active participation of stakeholders, particularly citizens, in the decision-making process (Barata et al., 2017). Consequently, the efficacy of living lab initiatives is primarily contingent upon the citizens' voluntary engagement and participation level, as their feedback is a vital aspect of the co-creation process (Falco & Kleinhans, 2018). Studies have examined the degree of participation in citizen engagement in urban planning and smart city development (Cardullo & Kitchin, 2019; Puskás et al., 2021). In empirical studies on factors influencing civic participation, various socioeconomic factors such as gender, educational background, and average annual salary have been identified as influential (Noguchi-Shinohara et al., 2020; Schlozman et al., 1994). Moreover, the number of family members, environmental policies, and political tendencies are also significant factors (Muddiman et al., 2019). In this study, we explored the importance of citizens' active engagement and identified the factors affecting their level of participation in a living lab to induce active civic engagement.

1.1. Seongdaegol Living Lab

The Seongdaegol Living Lab (SLL) started as a community of local mothers to establish a children's library in 2010. It became Korea's first citizen-led living lab in 2015 (Figure 2). While establishing and operating a small library in the village, the library became a hub for local mothers' exchange activities, and a local community for public purposes was formed. After the Fukushima nuclear accident in Japan in 2011, the community operating a library started an energy-saving movement for children's future and became interested in renewable energy. At that time, the Seoul Metropolitan Government started the "One Less Nuclear Power Plant" initiative. It promoted a policy to replace nuclear with solar power (Gunderson & Yun, 2021).

Along with the local government's policies, the village movement changed into a self-sufficient energy movement. In addition, the energy transition movement began in earnest after the selection for the Energy Independent Village Support Project of the Seoul Metropolitan Government. Since then, the citizen-led

energy independence movement has received attention domestic and international attention, receiving several awards. The energy movement of Seongdaegol Village introduced the living lab methodology in 2015. In the initial living lab, the university, research institute, and local government participated in the co-creation process.

Consequently, mini-solar panels suitable for collective housing in urban areas were produced, and financial products were developed in conjunction with local credit unions to increase the penetration rate. The successful experiences of these citizen-led living lab movements were extended to attempt to establish a local virtual power plant and received the central government's attention (Seongdaegol Village, 2020). According to an interview with the founder, SLL spontaneously started as a village movement. Participants refer to each other as "village researchers," taking pride in being local problem-solving experts. Therefore, the selection of topics and the composition of educational programs within the living lab should be made by participants rather than external experts or local government officials. Above all, the founder emphasized the importance of empowerment for citizens. The co-creation process of living labs can only work properly when ordinary people in the village feel equal to experts with doctoral degrees or government officials with administrative authority.

1.2. Questionnaire Description

Table 1 illustrates the questionnaire aimed to identify the demographic and socioeconomic factors of the participants and their relationship with the improvement of civic participation. Despite recognizing socioeconomic factors as critical determinants of civic participation in current empirical research, few studies examine the role of family dynamics in influencing individual participation in civic activities (Muddiman et al., 2019). Additionally, the absence of empirical studies that consider accessibility to living labs and environmental and political factors has been noted in the literature. It is unclear whether these factors were adequately accounted for in previous studies. Therefore, the decision to consider variables for selection was based on the unique demographics of the SLL participant group, which consisted solely of residents of Seongdaegol Village and initially began as a group of mothers working to establish a children's library. As a living lab with the long-term goal of addressing climate change, considering these factors was deemed essential in the variable selection process. Due to the pandemic, the survey was conducted online from December 30, 2021, to March 5, 2022. The questionnaire was distributed to almost 100 participants via the social media of the SLL participants with the founder's permission. The survey was targeted only to those who had participated in the living lab project as SLL members, and questionnaires were sent randomly among those participants. Insufficient responses were excluded, and 30 completed questionnaires were collected and used for analysis.

1.3. Statistical Analyses

Descriptive statistics were calculated for all demographic characteristics and responses, including means with standard deviations for continuous variables and frequencies and percentages for categorical variables. To explore the importance of civic engagement, we asked participants to respond to (1) the elevation of civic pride through living lab participation and (2) their attitudes toward applying a living lab to smart city development, with scores ranging from 1 to 5. The scores of the three groups according to engagement levels (low, medium, and high) were compared using Wilcoxon rank-sum tests. Wilcoxon signed-rank tests compared possible factors affecting participation. A quantitative research methodology such as regression analysis could be employed to comprehend the characteristics of living labs. Before conducting the regression analysis, the data needed to be normally distributed. However, in our case, the data did not fulfill this requirement. The objective of this study was to conduct a comparative analysis of the factors associated with the level of participation. Therefore, we conducted a comparative analysis using the Wilcoxon rank-sum and Wilcoxon signed-rank tests in conjunction with descriptive statistics to examine the differences between various factors. All statistical analyses were performed using R software (version 4.1.1; R Foundation for Statistical Computing,

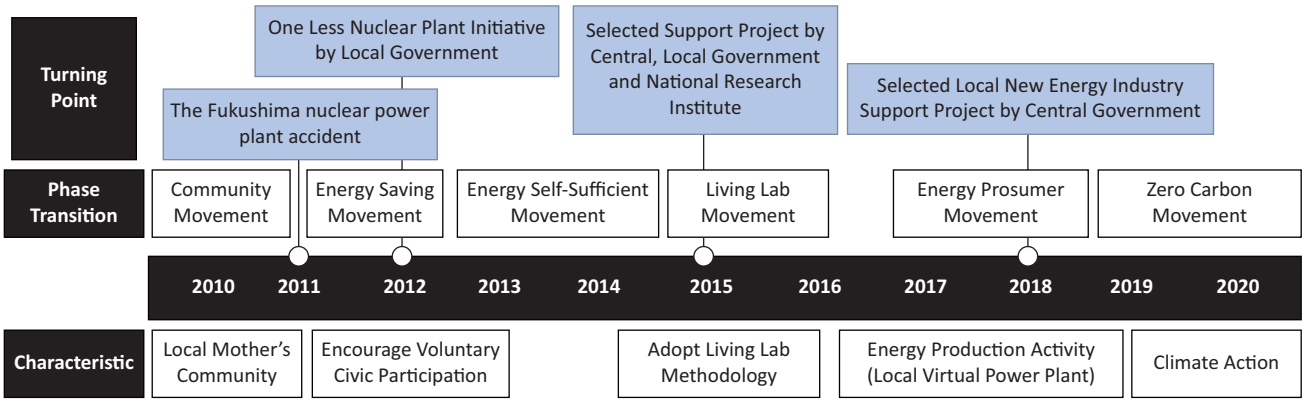

Figure 2. Timeline of SSL activities.

Table 1. Survey questionnaire.

	Question	Answer
1	How would you rate your level of participation in the SLL activities?	1 (Very passive) to 5 (Very active)
2	After participating in the SLL's activities, I felt proud of being a resident.	1 (Strongly disagree) to 5 (Strongly agree)
3	Do you believe developing smart cities will thrive using the living lab methodology?	1 (Strongly disagree) to 5 (Strongly agree)
4	How many members are in your household, including you?	( ) persons
5	How would you rate your level of civic engagement in the village through SLL activities?	Low/Medium/High
6	What is your sex?	Male/Female
7	What is your highest level of education?	Elementary/Middle/High/Undergraduate/Grad.
8	What is your occupation?	Housewife/Salaried Worker/Self-employed/No occupation/Student
9	What is your average annual income?	< USD 15,800/< USD 31,600/< USD 47,400/< USD 63,200/≥ USD 63,200
10	How do you travel to the SLL from home?	Bicycle/Car/Public Transportation/Walking
11	How long does it often take to travel from home to the SLL?	( ) min.
12	How long have you been a resident of Seongdaegol?	( ) years
13	How long have you been participating in SLL's activities?	( ) years
14	What is the most important for improving participants' motivation?	Contribution to village development/Interest in social issues such as energy and climate change/Interest in village activities and community engagement/Personal interest in photovoltaic technology/Recommendations from others
15	What would you say your political inclination is?	Conservative/Outsider Right/Neutral/Outsider Left/Progressive
16	How likely are you to support environmental policies?	Conservative/Outsider Right/Neutral/Outsider Left/Progressive

http://www.R-project.org). All p-values were two-sided, and statistical significance was set at $p < 0.05$.

2. Results

A survey was conducted to identify variables within the living lab that may be associated with civic engagement. Table 2 shows the variables used to explore the research questions of this study, such as socioeconomic background factors, participation level scores, self-esteem improvement, attitudes toward introducing the living lab methodology to smart city development, participation motives, political tendencies, and environmental policy tendencies. The proportion of women and self-employed people among SLL participants is relatively high, presumed to be attributable to its foundation as a gathering of local mothers and its location near an old traditional market.

The active engagement group showed a higher mean score (4.75) in the elevation of civic pride through living lab participation than the low (4.1; $p = 0.0244$) and medium (4.08; $p = 0.0568$) groups (see Figure 3a). Among the three groups, participants who actively engaged in the living lab had the highest mean score (4.62) on their positive attitudes toward applying the living lab to smart city development. The scores of participants in the high engagement group were significantly higher than those in the low engagement group (4.00; $p = 0.0306$) and medium engagement group (3.58; $p = 0.0113$), while there was no significant difference in scores between the low and medium engagement groups ($p = 0.26$; see Figure 3b).

Figure 4 shows the participation scores by sex, number of family members, education level, types of jobs, and average annual family income. We observed an increasing trend in participation scores as the number of

Table 2. Descriptive statistics.

Participants (n = 30)	
Participation Score	
Mean (SD)	3.8 (1.0)
Civic Pride	
Mean (SD)	4.3 (0.7)
Attitude Toward Smart City	
Mean (SD)	4 (0.8)
Number of Family Members	
Mean (SD)	3.5 (1.1)
Civic Engagement	
Low	10 (33.3%)
Medium	12 (40.0%)
High	8 (26.7%)
Sex	
Male	12 (40.0%)
Female	18 (60.0%)
Education Level	
Middle	2 (6.7%)
High	10 (33.3%)
University	17 (56.7%)
Grad. or higher	1 (3.3%)
Job	
Housewife	6 (20%)
No occupation	1 (3.3%)
Salaried Worker	9 (30.0%)
Self-employed	10 (33.3%)
Student	4 (13.3%)
Income (Annual)	
< USD 15,800 (KRW 20 Mil.)	14 (46.7%)
< USD 31,600 (KRW 40 Mil.)	3 (10%)
< USD 47,400 (KRW 60 Mil.)	5 (16.7%)
< USD 63,200 (KRW 80 Mil.)	6 (20.0%)
≥ USD 63,200 (KRW 80 Mil.)	2 (6.7%)
Transportation	
Bicycle	2 (6.7%)
Car	1 (3.3%)
Public Transportation	6 (20.0%)
Walking	21 (70.0%)
Travel Time	
< 10 min.	10 (33.3%)
< 30 min.	16 (53.3%)
≥ 30 min.	4 (13.3%)
Residence Period	
< 10 yrs.	14 (46.7%)
< 20 yrs.	9 (30.0%)
< 30 yrs.	4 (13.3%)
< 40 yrs.	2 (6.7%)
≥ 40 yrs.	1 (3.3%)
Participation Period	
< 3 yrs.	17 (56.7%)
≥ 3 yrs.	13 (43.3%)

Table 2. (Cont.) Descriptive statistics.

Motivation	
Contribution to village development	4 (13.3%)
Interest in social issues such as energy and climate change	14 (46.7%)
Interest in village activities and community engagement	6 (20.0%)
Personal interest in photovoltaic technology	4 (13.3%)
Recommendations from others	2 (6.7%)
Political Inclinations	
Conservative	2 (6.7%)
Outsider Left	22 (73.3%)
Progressive Left	6 (20.0%)
Environmental Policy Inclinations	
Outsider Left	21 (70.0%)
Progressive Left	9 (30.0%)

family members and education level increased, yet none showed statistical significance. Sex, types of jobs, and average annual income were not significantly associated with participation levels.

The variables with potential associations with participation levels are presented in Figure 5. The mean participation level score of the walking group (4.09) was significantly higher than that of the public transportation group (3.00; $p = 0.0493$; see Figure 5a). However, no significant relationship was observed between the participation score, the travel time to visit the living lab site (see Figure 5b), and the period of village residence (see Figure 5c). In addition, we observed that the participation score of the group that participated in the living lab for more than three years was higher than that of the group with less than three years (see Figure 5d).

No significant relationship was detected between participation scores and motivation (see Figure 6a). However, participation levels differed significantly according to the participants' political (see Figure 6b) and environmental policy inclinations (see Figure 6c).

3. Discussion

First, according to our findings, the higher the level of participation, the greater the resident's self-esteem while observing the region's development through living lab activities. According to a study on the change of citizens through living lab activities, they help improve the citizens' knowledge (Huang & Thomas, 2021; Siljanoska, 2020). In addition, in the co-creation process with stakeholders holding different opinions, such as other citizens,

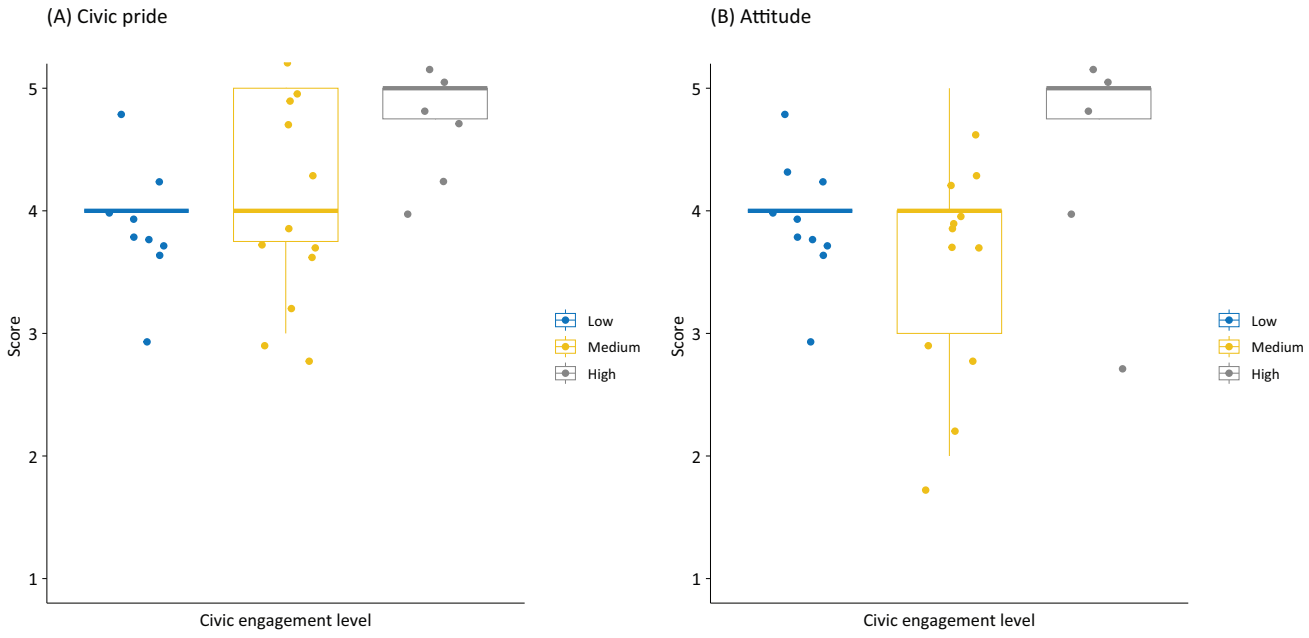

Figure 3. Scores of (a) elevation of civic pride through the living lab participation and (b) participants' attitude toward applying living lab to smart city development by civic engagement levels (low, medium, and high).

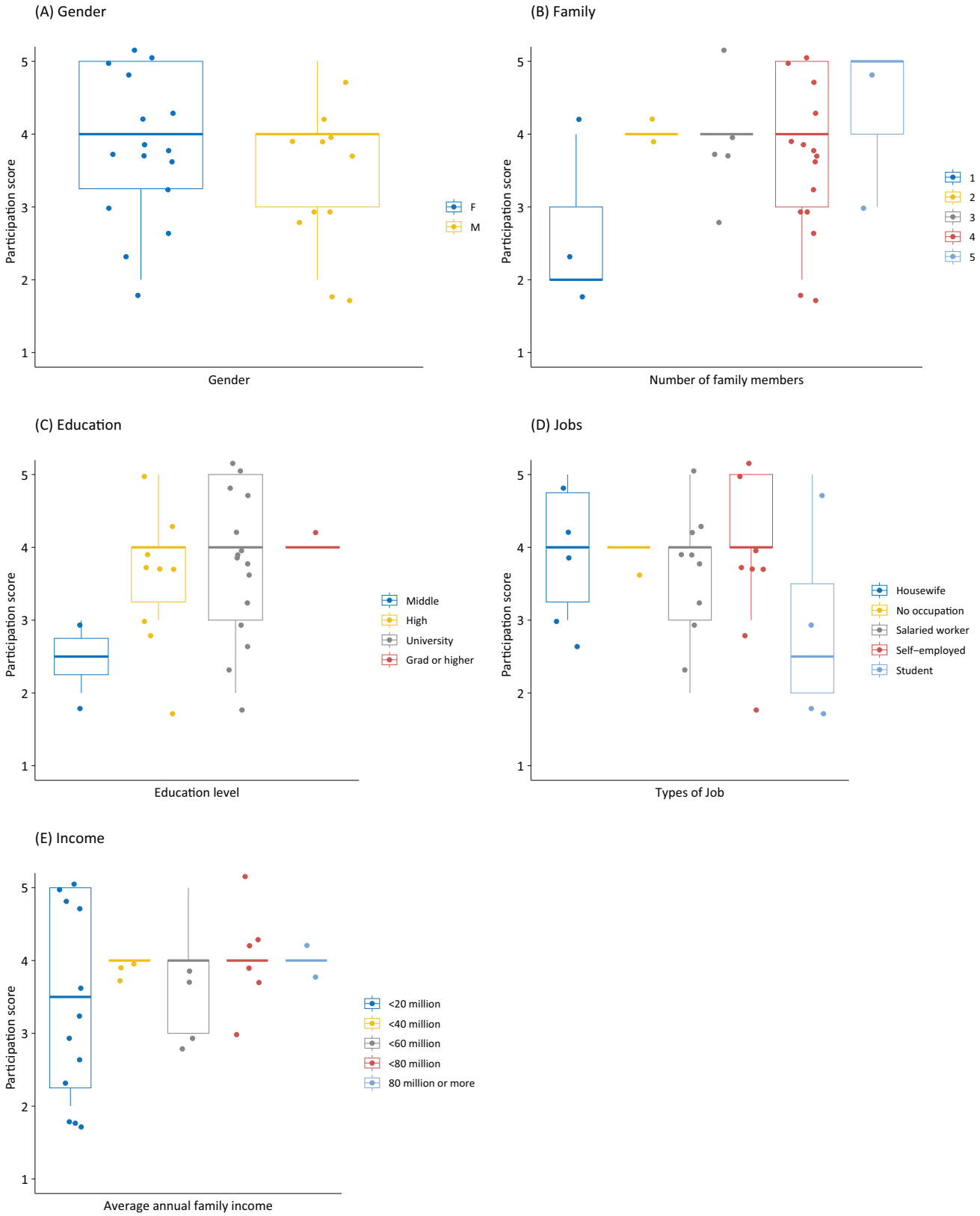

Figure 4. Participation scores by participants' demographic characteristics and socioeconomic status: (a) sex, (b) number of family members, (c) education level, (d) types of jobs, and (e) average annual income.

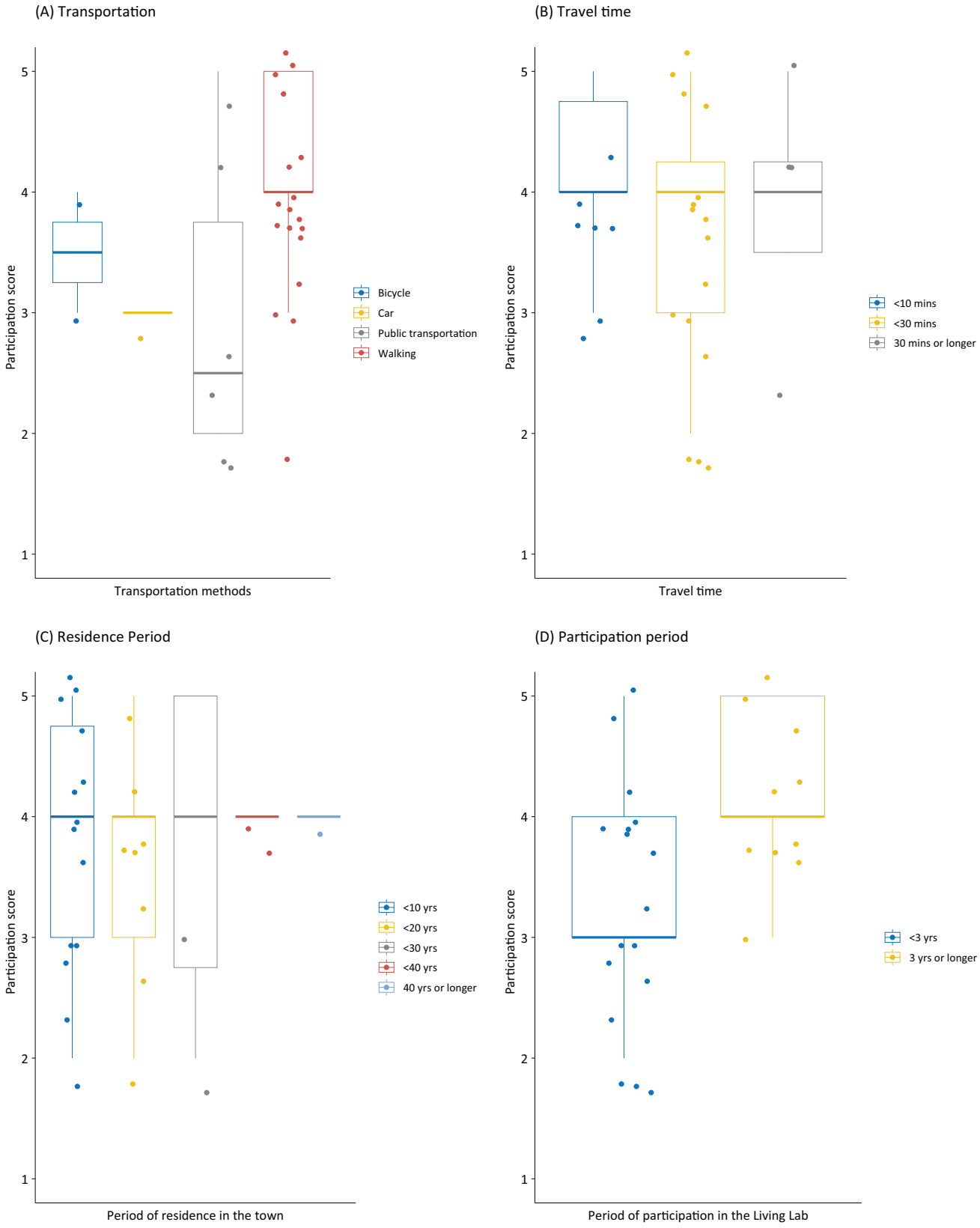

Figure 5. Participation scores by (a) transportation, (b) travel time, (c) residence period, and (d) participation period.

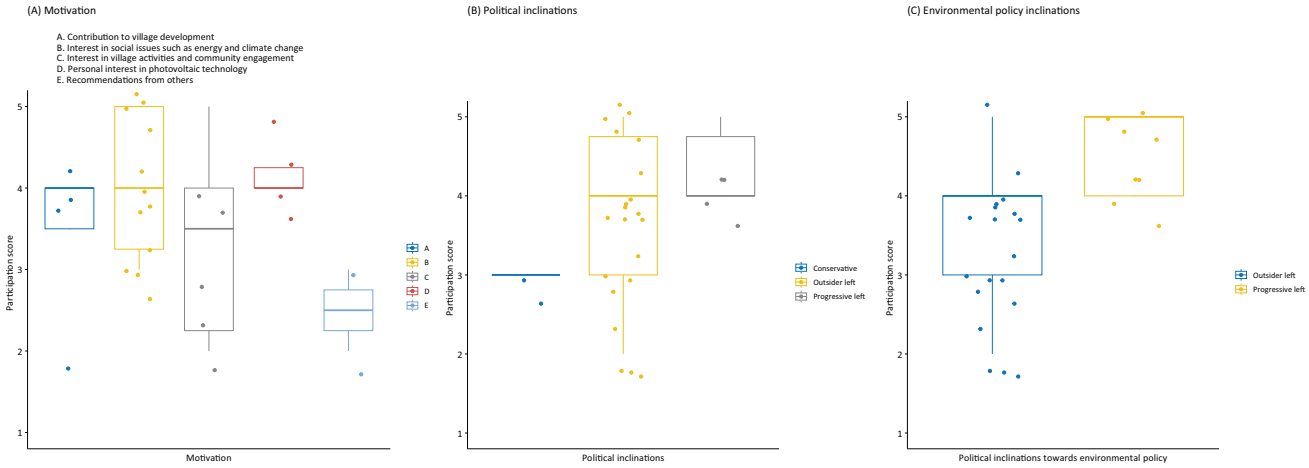

Figure 6. Participation scores by (a) motivation, (b) political inclinations, and (c) environmental policy inclinations.

government officials, and corporations, they experience democratic values and internalize citizenship (Cardullo et al., 2018; Sørensen & Torfing, 2011). The improvement of knowledge through living lab activities and the empowerment of citizens experienced in democratic procedures lead to an improvement in self-esteem. Furthermore, there is an effect of increasing pride by contributing to developing policies and infrastructure for the village and community.

Second, those who actively participated in the living lab (those with a high level of participation) thought that applying the living lab methodology to smart city development would be effective. SLL had experience in urban regeneration projects, such as housing retrofit projects and mini photovoltaic panel projects. However, no living lab experiments were performed on topics related directly to smart cities. However, the group that actively participated in the living lab would have felt the efficacy of user empowerment through the living lab as compared to the lower group (Eade, 1997). The results suggest that groups highly involved in living lab activities have positive expectations for their potential as platforms for effective civic engagement in smart cities (Leminen et al., 2017).

Third, we investigated whether the socioeconomic background of the living lab participants affected their participation. Although their socioeconomic variables were not statistically significant, the participation score of the group with many family members was higher than that of a single family. In general, a notion exists that it is advantageous for single families to have spare time to participate in social activities. Hence, their participation rate can be high (Ruseski et al., 2011). In contrast, SLL started with mothers' gatherings, and some children were found to participate in cultural events and local activities held in the living lab with their mothers. As suggested by a study on the relationship between civic participation and participation of family members (Muddiman et al., 2019), the number of family members likely showed this trend in the socioeconomic background due to the origin of SLL. Although no statistical significance was found, the participant recruitment stage should be considered when attempting a living lab experiment in the urban planning project of family-sized housing complexes.

Fourth, the convenience of transportation and the period of participation in the living lab were identified as factors affecting the association with participation levels in a living lab. The participation level was significantly higher for the group visiting on foot than that using public transportation. Whether this was due to the physical proximity of walking or a personal preference cannot be determined. However, this result may suggest one of the factors to consider when increasing citizen participation when securing a base for living lab activities. In addition, the fact that the participation rate of the group with more than three years of participation was higher than that of the group with less than three years of participation suggests that efforts to prevent the dropout of living lab participants will be necessary to ensure active participation (Habibipour et al., 2018).

Fifth, contrary to expectations, we found no association between participation level and motivation. Various studies have shown that economic incentives are needed. Moreover, emotional satisfaction, such as that derived from contributing to regional development, is vital to motivating participation in the living lab (Antikainen & Vaataja, 2010; Leminen et al., 2015; Lievens et al., 2014). However, no statistical significance was found between the participants' motivation factors and participation levels in this study. Interestingly, our findings suggest that political and environmental policy inclination factors are associated with active participation. Generally, a sense of public contribution and personal interest, including economic gain, is recognized as a motivating factor. This finding is worth highlighting in terms of suggesting the possibility of another external factor beyond the sense of public contribution or personnel interest among the motivating factors for active participation in a living lab. The SLL experimented

with introducing solar power generation to villages for environmental protection and to respond to global climate change.

Regarding political stance and global climate change, studies suggest that a difference exists between right-wing and left-wing supporters (understanding political bias in belief in climate change, understanding and countering the motivated roots of climate change denial, and overcoming skepticism with education, interacting influences of worldview and climate change). Concerning political orientation, a statistically significant difference was found in participation between the progressive left and the conservative group. A statistically significant difference was observed in participation between the progressive left and conservative groups in environmental policy support tendency. The SLL does not disclose its political orientation publicly. However, they are mainly engaged in activities related to sustainable energy, zero-carbon movement, and climate action. According to existing research, organizations involved in climate action may be politically progressive by the general public (Mortoja & Yigitcanlar, 2022; Wong-Parodi & Feygina, 2020). This result suggests that active civic engagement can be elicited by sharing respondents' political inclinations or inclinations toward specific policies and the vision pursued by living labs.

These findings provide insights for governments promoting citizen participation in smart city development by introducing the living lab methodology. However, it may raise debate that respondents' political or environmental policy inclination showed a significant difference in the level of participation. In other words, if political and environmental tendencies have an exclusionary effect that limits the diversity of participants, this may contradict the value of living labs that pursue diversity. Studies on the homogeneity and heterogeneity in the composition of living lab participants are controversial. In the case of a type led by a corporation (utilizer-driven) or government (provider-driven), efficiency is often emphasized to meet the deadline for investment or policy implementation (Leminen, 2015; Schuurman et al., 2013). It has also been argued that selective inclusion and exclusion can be considered according to the background knowledge of the participants in a living lab experiment (Veeckman & Graaf, 2015). Since a city is not a place where only people with homogeneous tendencies live, applying the living lab to urban development requires a careful approach to possible bias. In particular, smart cities and all urban development projects cause personal economic losses and benefits. Research shows that problematic situations may arise when a person whose individual interests are affected participates actively in a civic group addressing their concerns (Cardullo & Kitchin, 2019).

4. Conclusion

This study explored the importance of civic engagement and sought possible factors affecting participation. We observed that active engagement elevated civic pride in their town through participation in living labs. In addition, those who actively participated were found to have a more positive attitude toward applying the living lab to smart city development. The empirical analysis also demonstrated that the visiting method, participation period, political, and environmental policy inclinations have a statistically significant effect on active engagement.

Existing studies suggest that higher citizen participation improves the quality of life of a community and contributes to the realization of an inclusive community (Baum et al., 2000). This study also found that participating in living lab activities can lead to a positive experience of community development and a more favorable attitude toward applying the living lab approach to smart cities. The standard socioeconomic model suggests that education and income levels positively relate to civic participation (Dowse et al., 1973). In this study, the degree of participation in the living lab was found to have a significant effect on the number of family members, mode of transportation, and participation period, among socioeconomic backgrounds. The relationship between the number of family members and participation level is due to the origin of the SLL as a mother's group and the fact that some children participated in cultural events and local activities held in the living lab with their mothers. This finding aligns with those of a study that revealed the effect of family solidarity on the improvement of civic participation (Muddiman et al., 2019). It suggests that involving family members in the living lab process may be an essential factor in driving active participation.

Furthermore, the more time and economic resources required for participation, the less likely an individual is to engage in the process (Schlozman et al., 1994). High participation in SLL also affected walking accessibility. Because living lab projects are usually regional rather than national, a study comparing accessibility factors with living labs of different scales should be considered in the future. Unlike the motivating factors of public contributions and personal interest, the influence of political and environmental tendencies was a significant factor in improving participation. It has been well established that political efficacy plays a significant role in determining an individual's level of participation in civic engagement and politics (Beeghley, 1986). While the SLL does not explicitly endorse any particular political party or ideology, it has been perceived as having progressive tendencies because of its activism against nuclear power plants and its efforts to address climate change. The results of this study suggest that shared political beliefs or a vision, including the living lab, may enhance participation.

The findings of this study provide insight into the government's implementation plan to incorporate the living lab approach in smart city development. Attempts to apply the living lab approach to the development of smart cities have been made transnationally over the past few years (Baccarne et al., 2014). The background

of this trend is that the government has incentives to introduce living labs into urban development, especially smart city development. For city governments, the living lab approach is effective in overcoming excessive bureaucracy and risk-averse attitudes and gaining legitimacy for government policy as a platform for civic engagement (Sørensen & Torfing, 2011). Above all, citizen-led living labs, such as SSL, enable more active citizen participation and ensure the sustainability of government policies (Eskelinen et al., 2015). Notably, in terms of urban planning, few cases exist where civic participation is reflected as an actual citizen control stage. Civic participation is often used as a tool to obtain political payoffs rather than citizen empowerment (Arnstein, 2019; Willis & Nold, 2022). A high-level transfer of empowerment to citizens in urban planning policies is feasible when civil society has sufficient organizational and technical capacities (Willems et al., 2017). From this perspective, to reach the "citizen control" stage, the highest on the participation ladder, strengthening citizenship is as important as the willingness of the government to transfer authority. Finally, activities in the living lab encourage citizen participation by providing an experience of empowerment in the co-creation process with various stakeholders, increasing civic competence through learning activities, and enhancing the sense of ownership of the village. This study proposes the potential of a living lab as a platform that can evolve the existing smart city into a smarter city with smart people.

Our study has several significant limitations. In the real world, considerable variation exists in context-based regional distinctions and sociocultural variations to implement the living lab experiment (de Hoop et al., 2021; Leminen et al., 2017; Overdiek & Genova, 2021). Furthermore, the heterogeneity of objectives and strategies of introducing the living lab methodology, different contexts underlying the background, and various unexpected feedback lead to diverse outcomes (Giang et al., 2018). For this reason, reaching a consensus on a universal definition of the impact and function of living labs is challenging. This study attempted to explore a citizen-led living lab located in Korea, which began with their introduction. This process may also be influenced by the sociocultural background and locality of the community where SLL is located. Furthermore, living lab research literature has highlighted the challenges associated with data collection, including the potential for bias in survey responses due to a pro-living ab methodological inclination among respondents (Dekker et al., 2021).

Studies have shown that living labs can facilitate the co-creation of solutions to urban problems, foster citizen engagement and empowerment, and enhance the sustainability and inclusivity of smart city initiatives (Overdiek & Genova, 2021). However, challenges and limitations to implementing living labs in smart cities remain, such as the need for transparent governance structures, management of diverse stakeholders, and scalability and transferability of solutions (Habibipour et al., 2018; Nam & Pardo, 2011). Therefore, policymakers and practitioners should carefully consider the potential and limitations of living labs in the context of smart city development and adopt a holistic and participatory approach to ensure the success and impact of such initiatives (Baccarne et al., 2014; Cellina et al., 2019). This study presents meaningful implications for civic engagement through the living lab in the smart city development planning stage.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Natural Surveillance for Crime and Traffic Accidents: Simulating Improvements of Street Lighting in an Older Community

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Abstract
This study aimed to plan an alternative for community street lighting in an older community by simulating illuminance improvements. We applied the natural surveillance principle of crime prevention through environmental design to an older community in Busan Metropolitan City in South Korea. We conducted four field investigations to identify lighting sources and measure their illuminance and heights. Using the Relux Pro program, the gaps in lighting were identified and alternative plans for improvement for night lighting were simulated. Narrow alleys and houses were sources of light disruption and lighting blind spots. We determined the location and type of lighting within the community and considered the continuity necessary to meet natural surveillance standards in alternative settings. We considered visibility, facial recognition, the risk of traffic accidents, and other variables (i.e., lamp type). Our results confirmed that the community's average horizontal illuminance met the requirement of the Korean Agency for Technology and Standards and the minimal illuminance criterion of the International Commission on Illumination in all community lighting spaces—which was improved by about 2.2% to 85.7% compared to the previous situation. The results of this study are meaningful in that they present an effective planning support tool using simulation methods to establish community street lighting alternatives and determine their suitability.

Keywords
Busan; facial recognition; illuminance; natural surveillance; Relux Pro; street lighting; walkability

Issue
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1. Introduction

Walkability is important in community planning. Community walkability creates various social effects, such as social interaction enhancements, community interests, and invigoration for local businesses. Personal health promotion, such as reducing the risk of obesity and preventing chronic diseases, is another benefit (Chen & Zhou, 2016; Lund, 2002, 2003; Osama & Sayed, 2017). The quality of community walkability is determined by various factors, such as the subjective quality of the walking environment, access to parks, public open spaces, environment for bicycles, access to retail stores, and safety (Clifton et al., 2007; Lund, 2002, 2003; Sugiyama et al., 2014).

The elements constituting community walkability can be divided into two main categories: the physical environment, which comprises the community as related to the ability to walk, and safety of walking. Existing studies on walkability have focused on communities' physical environments (Oakes, 2004; Riggs, 2014). Those studies discuss how communities' environmental factors exert a major influence on walkability, even after considering related individual socioeconomic characteristics and preferences (Cao et al., 2009; McCormack et al., 2012; Norman et al., 2013). Regarding safety, previous walkability studies have examined the risk of crime and traffic accidents, both of which threaten pedestrian safety, but which are approached differently. Newman (1973) suggested that discussions related to crime must be

examined through the crime prevention through environmental design principle, while discussions related to traffic accidents should focus on the relationship between pedestrian accidents and environmental conditions (Kim & Park, 2017; Lee & Lee, 2019; Woo & Yu, 2017).

Discussions regarding crime prevention through environmental design related to crime focus on three conditions that increase pedestrians' fear of crime: darkness, disorder, and being alone in a threatening situation (Painter, 1996). Darkness is related to visibility in a walking environment, which is linked to fear because facial recognition of people and objects is reduced. Even after considering that fear originates from various levels of individual psychological factors, a basic requirement of the physical environment to resolve fear is to secure visibility with nocturnal street lighting (Kyttä et al., 2014; Nasar et al., 1993). In a nighttime walking environment, factors like adding CCTV, police patrolling, and increasing lighting enable natural surveillance and make people feel safer (Armitage et al., 2011; Marzbali et al., 2012; Welsh & Farrington, 2008).

Discussions related to traffic accidents focus on physical environmental factors that create a high risk of accidents. Regarding walkability, many pedestrian traffic accidents occur in residential areas and about 50% occur on community roads (Park et al., 2020). The higher the ratio of commercial areas, the higher the risk of traffic accidents while walking (Ukkusuri et al., 2012); wider roads and higher speed limits are also associated with increased risks of pedestrian traffic accidents (Chen & Zhou, 2016). The higher the density of intersections and public transportation in a region, the more pedestrian safety is threatened (Dumbaugh & Li, 2010; Woo & Yu, 2017). An increased ratio of sidewalks separated from roads is associated with a higher risk of pedestrian traffic accidents and a lower level of damages from accidents (Osama & Sayed, 2017; Woo & Yu, 2017). The brightness of lighting on the road in communities increases visibility for both drivers and pedestrians, thereby reducing traffic accidents, while having no light at night decreases the distance at which drivers can recognize a subject, increasing the risk of traffic accidents (Park & Byeon, 2012).

Street lighting at night is required to create a physically walkable environment that increases the safety of pedestrians in respect of both crime and traffic accidents. Visibility increases concomitantly with the level of luminosity, which also increases safety perceptions (Blöbaum & Hunecke, 2005; Boyce et al., 2000). Street lighting enables natural surveillance by facilitating facial recognition and is key to walking safely in a nighttime environment (Kim & Park, 2017). Street lighting can be measured using illuminance and the minimum illuminance required for pedestrians' safety varies according to the surrounding conditions and lighting class. The Commission Internationale de l'Eclairage's (2010) presents requirements for facial recognition per lighting class. In Korea, the Korean Agency for Technology and Standards (KATS) suggests a lighting standard for roads—Korea Standard Association (KS A) 3701—according to traffic volumes and area characteristics (residential or commercial; KATS, 2019).

The studies on community walkability mentioned above focused on various environmental requirements for walkability but are limited because they did not discuss the safety of the walking process at the community level. Safety from crime or traffic accidents must be ensured for pedestrian walkability in communities. In older communities, narrow alleys, mixed roads for pedestrians and cars, illegal parking, and restrictions on installing street lighting reduce safety. Therefore, this study started with the following research question: What alternative plan for street lighting can increase visibility in communities, and what is its effect regarding basic requirements for improving walkability in an older community?

The scope of studies on smart cities varies. The spectrum is wide, ranging from technical applications for smart cities, to smart tools that can make existing plans more effective. Existing planning processes for establishing community alternatives focus primarily on how participatory processes can be designed and how opinions can be constructed. In terms of the tool that communicates most effectively with citizens, many cases favor participatory planning techniques, and studies discussing the use of visualized simulation tools are scarce. Visualized results of alternatives and ideas discussed by citizens during the participatory process can raise the discussion level during said process, and possible changes in these communities can only be imagined. This study explores the applicability of Relux Pro as a smart tool that can be used when engaging citizens in the planning process.

This study aimed to use a simulation to derive an alternative plan for street lighting that could improve nocturnal safety in an older community. The target area was the community around Bongrae Elementary School in Yeongju-dong, Jung-gu, in the Busan Metropolitan City (BMC). This community is a typical example of older communities in Korea that were formed since the 1920s, and still exist. Narrow roads, dated infrastructure, and increased traffic volumes have impaired walkability in the community. Issues related to pedestrian safety at night were raised during a workshop with community residents in June 2021, and this study was initiated based on the need for residents to plan alternatives to reduce the risk of crime and traffic accidents. From August 3 to 14, 2021, four field investigations assessed the status of the community's street lighting. The community was then divided into six zones and, considering visibility, facial recognition, and traffic accident risks, an alternative plan was derived according to the standard of installing similar lamps for consistency with the surrounding street lighting. Finally, to determine the plan's effectiveness, simulations were conducted with the existing status and the improved status under the alternative plan, using Relux Pro to evaluate whether the required illuminance for safety had been met.

2. Materials and Methods

2.1. Study Area

The area studied was the community around Bongrae Elementary School located in Yeongju-dong, Jung-gu, BMC, in South Korea (Figure 1). BMC began to develop with the opening of the port in 1876. During the Korean War, the population increased rapidly, and naturally occurring dwellings with insufficient infrastructure formed around hilly areas. Currently, urban decline is continuing, concomitant with a continual population exodus and an increase in the number of vacant houses (Kamata & Kang, 2021). This community is representative of old town communities in BMC. It was established in the 1920s and grew over time, many of its residents being refugees from the Korean War. The community's characteristics include many narrow alleys and outdated buildings, as well as various facilities such as public offices (e.g., the Yeongju 1-dong Community Center), religious facilities, hospitals, and local markets, all in proximity of Bongrae Elementary School. Vehicle and pedestrian roads are mixed, and illegal parking frequent occurs because of a lack of parking facilities.

The community's biggest concern is children's safety regarding traffic accidents. Residential and commercial facilities have many entrances and exits, and the consequent high risk of traffic accidents to children is exacerbated by illegal parking and mixed road usage. The roads are narrow and complex, creating many areas with lighting blind spots, and installing adequate lighting would be challenging. Although streetlights are installed, the level of brightness throughout the area is not the same, with some sections having many dark areas. Natural surveillance in the community is difficult and leads to the possibility of being exposed to various risks, such as crime and traffic accidents.

2.2. Data

To understand the current conditions related to street lighting in the study area, we conducted four field studies from August 3 to August 14, 2021. The location of street lighting, illuminance, height of the light source, number of streetlights in the community, and types of lamps were identified. The investigations were conducted between 20:00 and 22:00, using a TES-1330A illuminometer and a Murray laser rangefinder D-35. Measurements were performed four times for each streetlight, and the luminous (lm) was calculated using the mean of the values. The location of street lighting was investigated based on road lines.

2.3. Simulation Methods: Relux Pro

Relux Pro is a software program produced by Relux Informatik AG, which is used for simulation analysis of street lighting in communities (Kim & Park, 2017). This

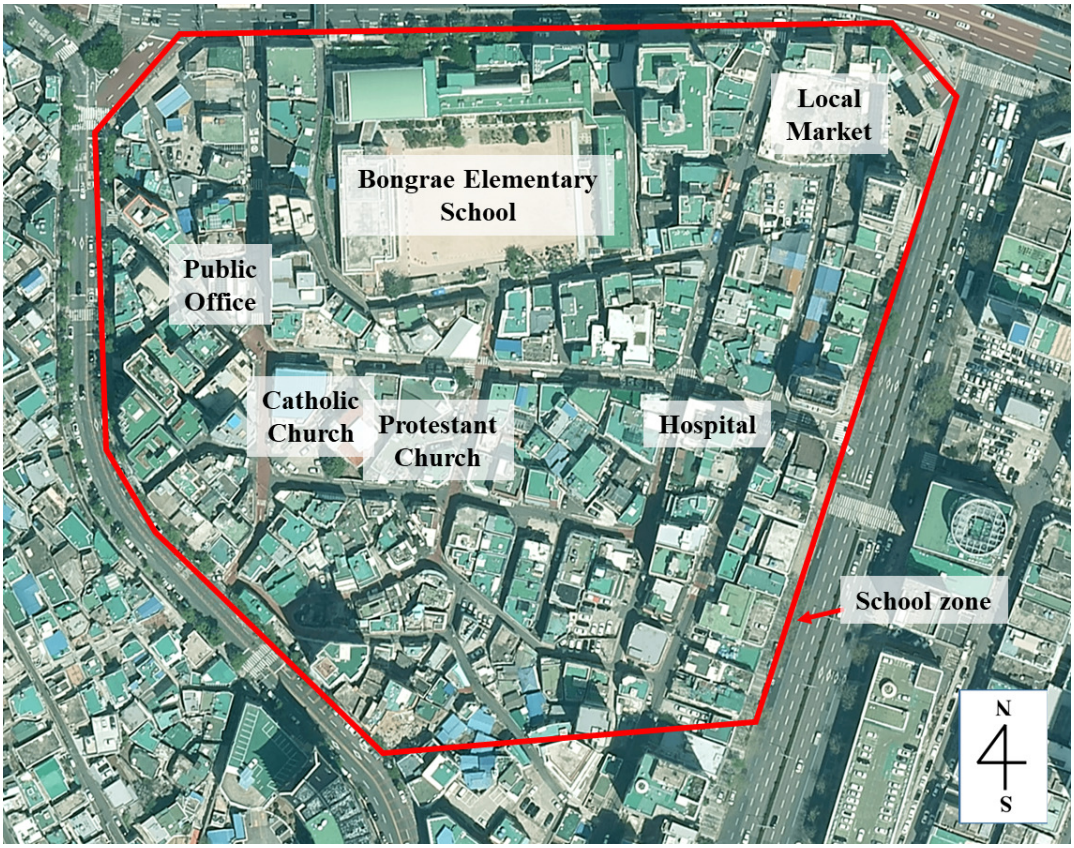

Figure 1. Study area.

study used Relux Pro to compare the current conditions with conditions after the development of an improvement plan. First, a base map of the research target area was required for the simulation. The numerical topographic map provided by the National Geographic Information Institute was used as the base map. The height buildings' floors were set at 3 m and the pilot part was the number of floors. Facilities on the roof of a building were considered an additional floor. The data on street lighting collected through the actual measurements were applied to the base map. Lamps providing street lighting were matched in Relux Pro by utilizing the lumen level and lamp type of each streetlight, and Philips Digi Street BGP671 and BGP760 were applied.

3. Results

3.1. Current Street Lighting Status

The current status of street lighting in the study area is shown in Figure 2 and Table 1. There were 74 streetlights in total. The average height of installed streetlights was 5.37 m and the average illuminance was 122.83 lx. The average luminosity was 3233.17 lm. The site under study was demarcated into six zones based on the main street and the central facility, Bongrae Elementary School, to facilitate the determination of the illuminance in the study area. Zone A contained 15 streetlights, Zone B had 13, Zone C had eight, Zone D had nine, Zone E had 21, and Zone F had eight. Zone F was the brightest and Zone E the darkest.

3.2. Alternatives to Improve Street Lighting for Community Safety

Four factors (visibility, facial recognition, traffic accident risk, and others), were used in this study to derive a natural surveillance alternative through street lighting (Table 2). Common alternatives were applied to all zones. First, the new street lighting took the height of the existing street lighting into account but installed it at 3–5 m above ground level. Visibility was set at 3–5 m, considering the BMC Nightscape Guideline's (BMC, 2020) installation standard of 3 m, and the average installed streetlight height of 5.37 m in the surveyed study area. Second, recognizing pedestrians became possible by applying KS A 3701 (KATS, 2019). It should be borne in mind that drivers should be able to see pedestrians, and that facial recognition between pedestrians also depends on the levels of road lighting, pedestrian traffic, and land use. This study applied the standards of KS A 3701, considering the characteristics of each zone. Third, in consideration of illegal parking and mixed-use roads, pedestrians and drivers could identify all movable obstacles on the road. To consider the traffic accident risk, each zone's characteristics were identified prior to deciding the new location of streetlights according to the standards of KS A 3701 (KATS, 2019). Fourth, similarity with the lighting of the surrounding area was maintained. Regarding the consistency of street lighting in

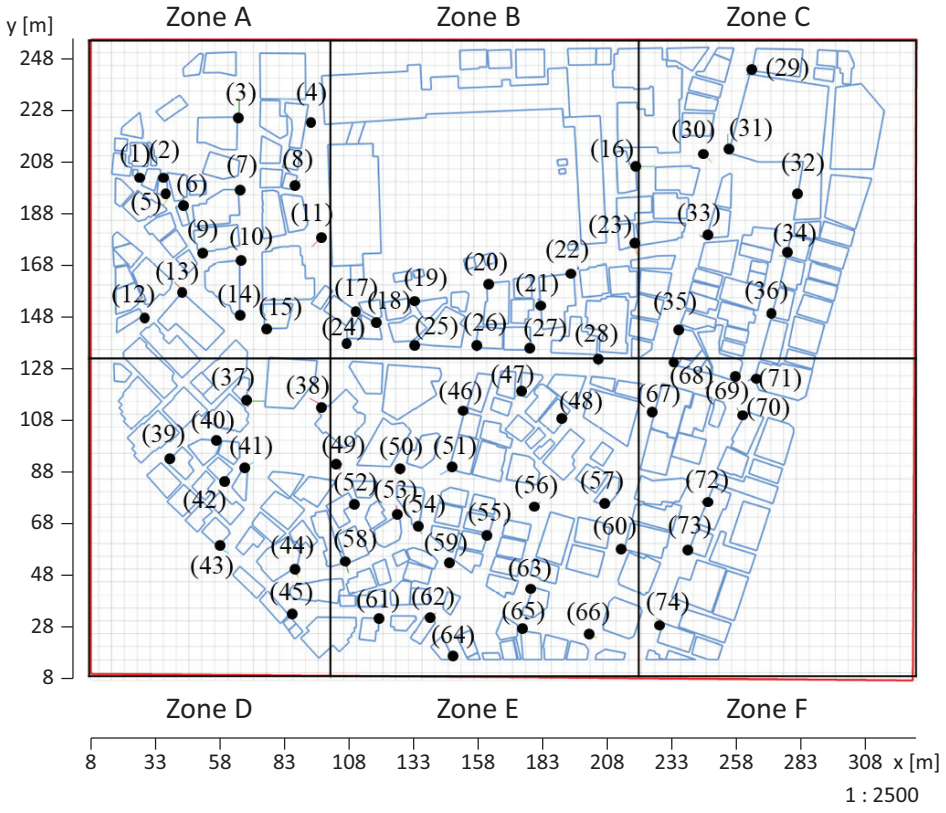

Figure 2. Current street lighting. Note: Black points indicate current street lighting.

Table 1. Lighting conditions.

Zone	Number of lights	Illuminance of lighting (lx)	Height (m)	Luminous (lm)	Zone	Number of lights	Illuminance of lighting (lx)	Height (m)	Luminous (lm)
A	1	27.8	7.3	1,478.8	D	37	148.0	6.3	5,781.3
	2	116.5	4.0	1,887.4		38	41.0	6.3	1,627.3
	3	100.5	7.3	5,392.4		39	324.8	3.4	3,754.1
	4	118.5	4.2	2,040.9		40	147.8	4.6	3,126.4
	5	78.5	5.6	2,483.8		41	53.0	7.6	3,081.5
	6	171.5	3.3	1,896.0		42	105.8	4.4	2,047.3
	7	174.0	6.2	6,742.6		43	54.5	6.9	2,557.3
	8	146.0	3.7	1,971.8		44	181.0	4.2	3,231.0
	9	172.3	3.5	2,050.2		45	75.8	4.8	1,763.5
	10	133.8	4.2	2,359.4	E	46	115.3	5.2	3,056.7
	11	67.5	5.2	1,842.8		47	114.8	3.9	1,700.9
	12	65.3	4.1	1,070.3		48	223.3	3.1	2,076.8
	13	225.3	5.3	6,267.7		49	65.0	7.9	4,056.7
	14	154.5	6.8	7,091.6		50	57.8	7.6	3,313.7
	15	147.8	5.6	4,592.2		51	155.5	5.8	5,231.0
B	16	485.0	2.5	2,970.9		52	373.8	2.9	3,035.8
	17	210.8	3.4	2,400.6		53	113.8	4.3	2,127.8
	18	138.3	3.6	1,791.7		54	48.0	5.4	1,386.8
	19	40.5	6.7	1,804.5		55	156.5	4.1	2,567.0
	20	106.0	5.3	3,005.7		56	59.5	5.0	1,472.7
	21	56.3	7.1	2,815.6		57	24.3	7.7	1,437.8
	22	157.5	4.3	2,912.2		58	53.3	5.1	1,398.6
	23	174.0	3.6	2,255.0		59	145.3	4.8	3,311.8
	24	150.5	6.2	5,785.2		60	56.5	5.4	1,647.5
	25	211.5	5.4	6,053.7		61	120.8	5.0	3,018.8
	26	121.0	6.7	5,350.9		62	71.8	5.0	1,758.1
	27	92.3	4.3	1,725.6		63	61.3	5.3	1,704.3
	28	107.3	6.6	4,636.5		64	125.8	5.0	3,112.4
C	29	205.8	5.6	6,510.1		65	106.8	4.2	1,905.6
	30	112.8	4.7	2,490.6		66	64.3	6.0	2,332.3
	31	189.8	5.7	6,219.2	F	67	67.3	4.8	1,549.4
	32	21.8	9.1	1,791.2		68	220.5	6.2	8,476.0
	33	93.0	5.4	2,737.0		69	186.3	6.3	7,451.0
	34	106.0	4.3	1,914.6		70	101.8	5.8	3,452.4
	35	132.5	5.6	4,192.4		71	70.3	6.1	2,614.0
	36	61.0	5.2	1,617.9		72	143.8	5.8	4,794.2
						73	96.0	6.5	3,993.8
						74	76.3	7.4	4,119.2

Note: lm = illuminance of lighting × height^2.

the area, the new streetlights reflected characteristics similar to the existing lamps, which leads to community improvement through the installation of additional streetlights rather than adjusting the community's brightness and color.

Next, in applying new street lighting, each zone's characteristics, such as visibility, facial recognition, traffic accident risks, and others, were considered. When determining the location of new street lighting in each zone, characteristics such as the outer wall of the buildings were used in all zones. In Zone E, it was possible to install some telephone poles. Facial recognition became possible in the spaces where new streetlights had been installed. Narrow alleyways and vacant lots should be considered in Zone A; schools in Zone B; parking lots and vacant lots in Zone C; parking lots, vacant lots, and narrow alleys in Zone D; and narrow alleys in Zone F. Considering the space for each zone, the average illuminance at the ground level required by KS A 3701 (KATS, 2019) should be 3 lx. Next, the risk for traffic accidents should be gauged, given the road junction in Zone A, school in Zone B, commercial facility in Zone C, parking lot and vacant lot in Zone D, entrance and exit in Zone E, and road junction in Zone F, to identify movable objects for both pedestrians and drivers.

Figure 3 shows the alternative plan where new street lighting is applied according to the criteria in Table 2. In Zone A, eight new streetlights, using the outer wall of

Table 2. Natural surveillance alternatives through street lighting.

		Characteristics of each zone					
Category	Common alternatives	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F
Visibility	Install 3–5 m from the ground surface	Use of building outer walls	Use of building outer walls	Use of building outer walls	Use of building outer walls	Use of building outer walls and installation of telephone poles	Use of building walls
Facial recognition	Apply KS A 3701 (KATS, 2019) to enable pedestrian recognition	Narrow alley, vacant lot	School	Parking lot and vacant lot	Parking lot, vacant lot, narrow alley	Narrow alley, vacant lot	Narrow alley
Risk for traffic accident	Identify all movable objects in consideration of illegal parking and mixed-use roads (pedestrians, drivers) based on KS A 3701	Road junction	School	Commercial facility	Parking lot and vacant lot	Entrance and exit	Road junction
Others	Keep lighting similar to that of the surrounding area: 6.7–41W LED lamps	—	—	—	—	—	—

Note: According to KATS (2019), the requirement of average horizontal illuminance (ground level) is 3 lx (low traffic volume and residential area) for the study area.

the building, were introduced. N1 and N2 were installed in the dark vacant lot; N3, N4, N5, N6, and N7 in narrow alleys; and N8 was installed in the road junction. Six new lights were installed in Zone B, using the outer wall of the building. To increase the brightness around the school, lights were installed in an area that had been a blind spot along the nearby road. Zone C received six new streetlights; five were newly installed using the exterior wall of the building, and another one was added to improve the existing street lighting. N16 and N18 were applied to eliminate blind spots in parking lots and vacant lots around the local market, which is a commercial facility, and N15, N17, N19, N20, and N21 were applied to secure visibility in areas where illegal parking of commercial facilities occurred. In Zone D, five new streetlights were installed, using the exterior wall of the building. N22, N25, and N26 were installed to improve blind spots in narrow alleys. N23 and N24 were installed to eliminate blind spots in parking and vacant lots around two religious facilities. Zone E included narrow alleys, vacant lots, and entrances and exits to residential facilities. N28, N29, N31, N36, N37, and N38 were applied to eliminate blind spots in narrow alleys; N27, N30, N40, and N41 to improve blind spots in the vacant lot; and N32, N33, N34, N35 (improving existing street lightings), N39, and N42 to secure the visibility at entrances and exits. Zone F had five streetlights installed to improve blind spots at narrow alleys and road junctions. N44, N45, N46, and N47 were applied to improve blind spots in narrow alleys, and N43 improved visibility at the road junction.

3.3. Simulation of Street Lighting

Table 3 and Figure 4 present the simulation results, employing Relux Pro to examine the illuminance according to the street lighting of the study area and to compare the status quo with the improved status. Table 3 shows the degree of illuminance in all areas and lighting areas. First, the average illuminance of the current status in the study areas was 0.97 lx in all areas and 2.85 lx in illumined areas, i.e., falling short of KS A 3701's standard of 3 lx (KATS, 2019). The average illuminance for each zone in all areas was lower than 3 lx, and only Zones A and F in the illumined areas met KS A 3701's (KATS, 2019) requirement.

The average illuminance after the alternative plan was applied is presented in Figure 3. The average illuminance was improved by 55.7% at 1.51 lx for all areas, and

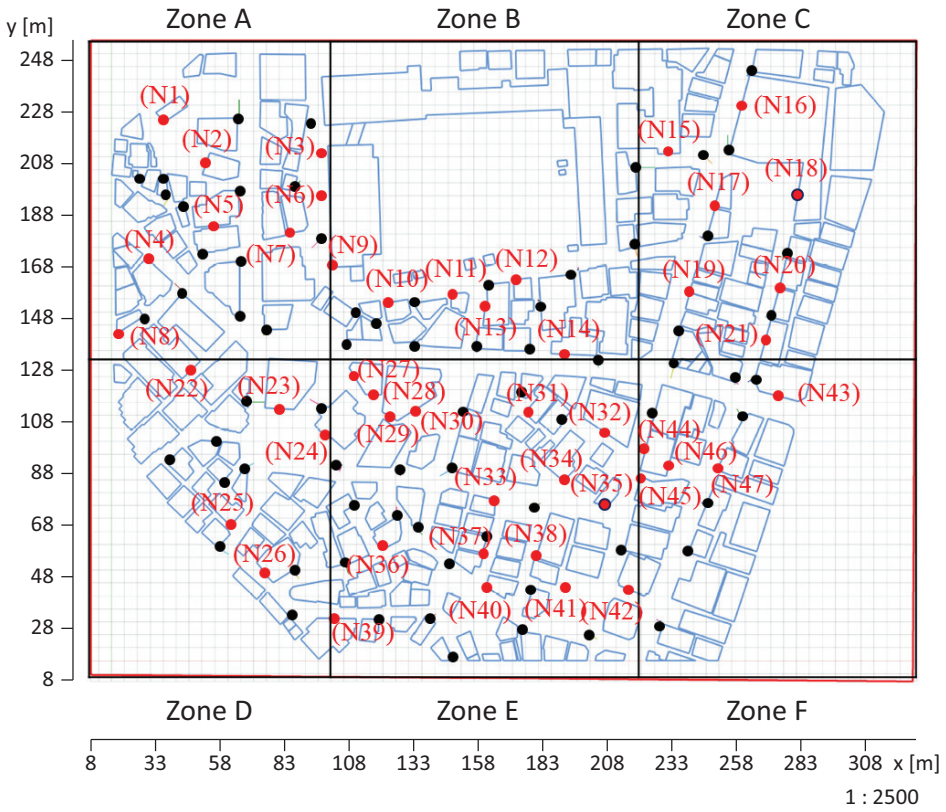

Figure 3. Alternative plan for improving the street lighting. Notes: Black points indicate current streetlights; red points indicate new streetlights with new locations; a red point with a black circle means improved street lighting in the current location.

by 28.5% at 3.66 lx for the illumined areas, meeting the requirements of KS A 3701 (KATS, 2019). Improvements for each zone ranged from 2.2% to 85.7%, with a particularly high improvement in Zone E. The latter zone included many blind spots in narrow alleys, vacant lots, and entrances and exits. In the whole area, illuminance was 1.63 lx, which was improved by 107.2%, indicating that most of the existing blind spots had been improved. Zone C's illuminance was 0.44 lx based on all areas, which showed a 30.1% improvement. When based on the lighting area, it became 1.42 lx, an improvement of 2.2%. The degree of improvement in Zone C was relatively low because there were almost no narrow alleys, and improvements were centered at parking lots, vacant lots, and commercial facilities. In Zones B and D, improvements were slightly lower than the requirements of KS A 3701 (KATS, 2019). In Zone B, the installation of new street lighting was limited due to school facilities. There were also some alleys that were too narrow to install lighting, which limited the improvement. In Zone D, there were restrictions on new street lighting in the vacant lot in terms of vehicle traffic and parking lot use, as well as a limitation to installing street lighting because of narrow alleys.

Table 3 and Figure 4 present the simulation results using Relux Pro to examine the illuminance according to the street lighting of the study area, and to compare the current and improved statuses. Table 3 shows the degree of illuminance in all areas and lighting areas. First, the average illuminance of the study area's current status was 0.97 lx in all areas, and 2.85 lx in the illumined areas. This did not meet the standard of 3 lx of KS A 3701 (KATS, 2019). The average illuminance for each zone in all areas was lower than 3 lx, and only Zones A and F in the lighting areas met the prescribed requirements (KATS, 2019).

Figure 4 shows a simulation map, depicting the illuminance of the study area in the current status and improved status, respectively. In the current status, disconnected lighting was noted in areas of roads and alleys. In Zone A, the disconnected lighting areas were at vacant lots and road junctions, and in Zone B, although existing streetlights had been installed, the range was limited, causing disconnected lighting areas. In Zone C, disconnected lighting occurred in the middle of the vacant lot, parking lot, and roads. In Zone D, disconnected lighting areas appeared in parking lots and vacant lots. In Zone E, there were disconnected lighting areas around narrow alleys. In Zone F, disconnected lighting occurred at road junctions. The simulation of the improved status shows the effect of the alternative plan (Figure 3), which was constructed as per the items suggested in Table 2. First, the disconnected lighting areas were improved at roads, vacant lots, parking lots, and entrances and exits in all areas. In addition, even without ambient light from surrounding buildings, the minimum horizontal illuminance of 1.0 lx (Commission Internationale de l'Eclairage, 2010)

Table 3. Changes of zones' illuminance of street lighting at ground level.

		Illuminance in all areas (ground level, lx)				Illuminance in lighting area (ground level, lx)			
	Zone	Average	Max	Min	Standard deviation	Average	Max	Min	Standard deviation
Current status	A	1.45	24.50	0.00	3.44	3.44	24.50	0.10	5.87
	B	1.12	23.10	0.00	3.15	2.58	23.10	0.10	4.37
	C	0.34	9.20	0.00	1.34	1.39	9.20	0.10	2.43
	D	1.12	14.10	0.00	2.32	1.78	14.10	0.10	2.72
	E	0.79	18.20	0.00	2.60	2.42	18.20	0.10	4.10
	F	0.99	26.00	0.00	4.09	5.46	06.00	0.10	8.23
	Total	0.97	26.00	0.00	3.12	2.85	26.00	0.10	4.65
Improved status	A	1.95 (34.0%)	25.40 (3.7%)	0.00 (none)	4.88 (16.9%)	4.08 (18.3%)	25.40 (3.7%)	0.10 (0.0%)	6.42 (9.4%)
	B	1.48 (31.9%)	23.10 (0.0%)	0.00 (none)	3.37 (6.9%)	2.87 (11.2%)	23.10 (0.0%)	0.10 (0.0%)	4.24 (–2.8%)
	C	0.44 (30.1%)	9.20 (0.0%)	0.00 (none)	1.49 (11.0%)	1.42 (2.2%)	9.20 (0.0%)	0.10 (0.0%)	2.39 (–1.4%)
	D	1.77 (58.7%)	14.30 (1.4%)	0.00 (none)	2.76 (19.3%)	2.58 (44.5%)	14.30 (1.4%)	0.10 (0.0%)	3.01 (10.7%)
	E	1.63 (107.2%)	29.20 (60.4%)	0.00 (none)	4.61 (77.7%)	4.49 (85.7%)	29.20 (60.4%)	0.10 (0.0%)	6.84 (66.9%)
	F	1.78 (78.9%)	27.20 (4.6%)	0.00 (none)	5.42 (32.3%)	6.52 (19.3%)	27.20 (4.6%)	0.10 (0.0%)	8.76 (6.4%)
	Total	1.51 (55.7%)	29.20 (12.3%)	0.00 (none)	3.98 (27.4%)	3.66 (28.5%)	29.20 (12.3%)	0.10 (0.0%)	5.41 (16.4%)

Note: The numbers in parenthesis show growth rate.

was reached, which is the level at which both pedestrians and drivers can identify objects in a neighborhood (P4) when there is little pedestrian and cycling traffic at night. This means that facial recognition in the study area and responses to traffic accident risks are possible if two out of 74 currently installed lights are improved and 45 new streetlights are added—a total of 119 streetlights.

4. Conclusions

This study suggested an alternative plan for street lighting to improve pedestrian safety in an older community near Bongrae Elementary School in Yeongju-dong, Jung-gu, BMC, and compared the illuminance of the current and improved status through a simulation exercise. The target area had many narrow alleys and problems related to vacant lots, parking lots, and illegal parking, all of which limited visibility at night. The existing 74 streetlights did not meet the illuminance requirements for safe walkability in the target area. The target area was divided into six zones, and the common alternative was derived based on the categories of visibility, facial recognition, traffic accident risk, and other factors. The alternative plan was derived from the characteristics of each zone. Two of the existing streetlights were improved, and 45 new ones were installed, resulting in a total of 119 streetlights. As a result, the average illuminance in lighting areas improved from 6.9% to 77.3%, and the average illuminance in all areas improved from 30.1% to 107.2%. This means that the lighting areas increased in all zones, enabling facial recognition and reducing the risk of traffic accidents.

This study has three limitations. First, it did not consider the effects of buildings and signboards attached to buildings in the illuminance simulation. Light generated from buildings and signboards attached to buildings also increases the visibility of pedestrian environments. These factors were excluded from this study because the time and forms were not constant. When examining the effect of street lighting at a specific time, it is necessary to consider these types of lights. Second, this study did not reflect the presence of slopes in some buildings and roads in the target area. This was difficult to do because the target area was an older community, meaning that the land had an irregular shape with complicated slopes. To compensate for this, the direction and location of the lamps were reflected in the alternative plan, based on the field studies' results and in consideration of the minimization of blind spots. Nevertheless, blind spots due to slopes can still occur. Third, partial or total redevelopment is required to completely solve the community-related problems raised in this study, such

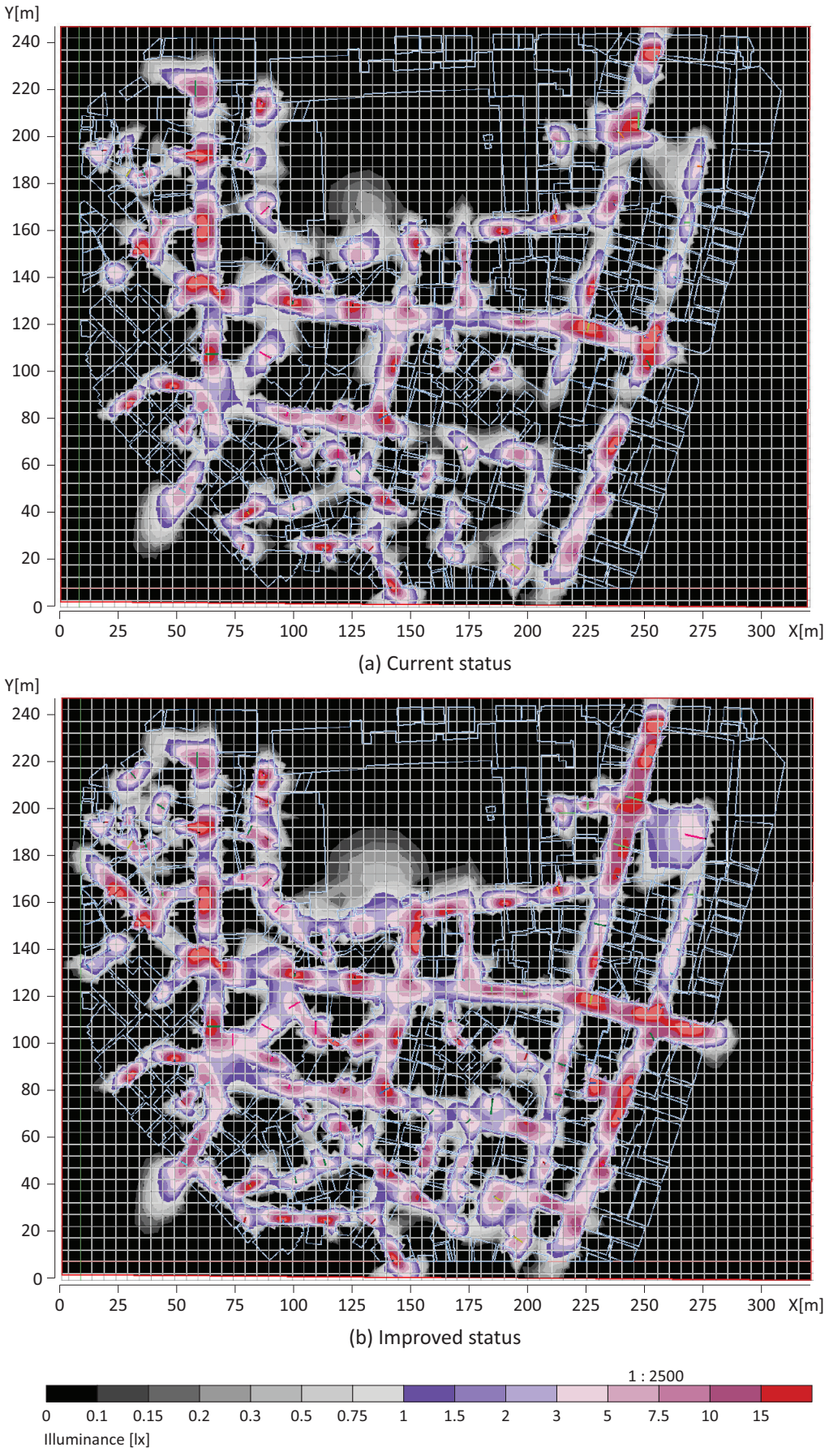

Figure 4. Changes of illuminance of street lighting at ground level.

as illegal parking, narrow pedestrian pathways, and the absence of sidewalks. In this study, street lighting is a limited alternative to address problems raised by communities where it is not easy to apply partial or total redevelopment. Street lighting cannot solve these fundamental problems. Community pedestrian safety requires many factors (e.g., surveillance cameras, police patrols, bollards, speed bumps, etc.) that can more directly affect safety. However, street lighting is a prerequisite for the safety of pedestrians in the community. If there is no street lighting, the effectiveness of any other solutions will be limited. Although this study only highlights the example of one community, it is meaningful in that street lighting is the most basic nighttime safety infrastructure that exists in any community.

The implications of the study findings are as follows: First, this study focused on the safety of the walking process, which is a requirement for walkability. It specifically focused on improving street lighting to secure visibility at night. Public infrastructure in communities is important to increase walkability. Still, if walking safety is not secured, people will prefer other modes of transportation over walking, even for short distances. Therefore, street lighting is a prerequisite for walkability and a way to reduce the risks of crime and traffic accidents. In the case of older communities composed of irregular streets, there is a high probability for lighting blind spots during walking, and street lighting needs to be actively considered in renewal plans for these communities. Second, this study compared the target area's current status and improved status through an illuminance simulation, and suggested the degree of improvement that can be achieved. This result can be used to decide where lamps can be installed to improve a community's street lighting. It can also be used as a planning tool that can locate blind spots through simulation and, when combined with field results, can identify optimal points for improvement.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Gap Analysis Between the Level of Heat Wave Adaptation Policy and Heat Wave Effects in South Korean Municipalities

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Abstract
This study aims to analyze the gap between the level of heat wave adaptation policies and heat wave effects in South Korean municipalities. First, the types of industries in municipalities were classified using factor analysis and cluster analysis. Second, the level of heat wave adaptation policy in the municipalities was assessed using a fuzzy analytic hierarchy process analysis. Third, the gap between the level of heat wave adaptation policy and the heat wave effect was analyzed. The results show that the heat wave adaptation policies were established in accordance with the heat wave effects to at least some degree. However, closer to the long-term future (2095), the policies have not sufficiently matched the level of heat wave effects. The proportion of municipalities with insufficient levels of heat wave adaptation policies against the heat wave effects was higher among urban-type municipalities. The analysis results suggest two policy implications. First, the heat wave adaptation policies of municipalities should be established through continuous feedback on the predictions of future heat wave effects. Second, urban-type municipalities should strengthen their planning authority and competence by securing a professional workforce and budgets for the establishment of heat wave adaptation policies.

Keywords
adaptation policy; climate change; gap analysis; heat wave; local government; municipal policies; South Korea

Issue
This article is part of the issue “Smart Engagement With Citizens: Integrating “the Smart” Into Inclusive Public Participation and Community Planning” edited by Jin-Kyu Jung (University of Washington) and Jung Eun Kang (Pusan National University).

1. Introduction

The fifth report of the Intergovernmental Panel on Climate Change confirms that climate change due to the rising average global temperature is clear (Intergovernmental Panel on Climate Change, 2014, 2021). In fact, numerous studies have demonstrated the various effects of climate change, such as heat waves, heavy rains, and typhoons. Among the effects of climate change, the damage caused by heat waves is especially detrimental to South Korea (Korea Environment Institute, 2014).

During the past 100 years (ca. 1911–2010), the annual average temperature of Korea has increased by 1.8 °C, which is much higher than the global average of 0.75 °C. Moreover, the average temperature of the Korean Peninsula is predicted to increase by 2.6–4.8 °C by the end of the 21st century (ca. 2071–2100) compared to the average temperature of the past few decades (ca. 1971–2000), and the number of heat wave days is predicted to increase from 9.2 days per year on average to approximately 18.9–56.7 days by the end of the 21st century (National Institute of Meteorological Sciences, 2012).

Climate change impacts such as heat waves that threaten human survival are critical environmental problems. Some studies have emphasized that urban sustainability through smart cities is necessary to manage climate-related problems (Angelidou et al., 2018; Choi & Song, 2023).

In an attempt to respond to the effects of climate change—including heat waves—the United Nations Framework Convention on Climate Change has emphasized the importance of adaptation as well as mitigation; since then, the UK, Australia, the US, and other countries have begun to enact laws related to climate change adaptation and have implemented adaptation plans. These legal institutional frameworks play a crucial role in responding to global climate change (Wilson, 2006).

To strategically prepare for the effects of climate change, South Korea established the Framework Act on Low Carbon Green Growth, in which Article 48 of this act and Article 38 of the enforcement decree of this act prescribe the establishment and enforcement of adaptation measures for climate change. At the national level, the South Korean government established the First National Climate Change Adaptation Plan (ca. 2011–2015) in 2010, the Second National Climate Change Adaptation Plan (ca. 2016–2020) in 2015, and the Third National Climate Change Adaptation Plan (ca. 2021–2025) in 2020.

To efficiently and effectively respond to the impacts of climate change, it is essential to strengthen adaptive capacity. In addition, climate change adaptation measures, which are being repeatedly established, must be developed into effective and long-term relevant policies. Therefore, to move toward a city with effective and efficient policies, decision-making support through more scientific and diverse methods is needed. Climate change impacts occur on an international scale, but damages occur on a regional and city level, so it should be possible to reflect various conditions in cities that directly and closely affect citizens. Therefore, it is essential to analyze regional capabilities for climate change from the perspective of securing urban sustainability and preparing smart countermeasures. The derived evaluation results can improve the citizens' awareness of climate change, which is actually affected, and enhance the capacity of residents, such as increased participation in countermeasures.

The existing studies on climate change adaptation at the municipality scale are mainly focused on the assessment of vulnerabilities for the establishment of adaptation policies (Evariste et al., 2018; Prudent et al., 2016), awareness surveys (Cobbinah & Anane, 2016; Shameem et al., 2015), and policy prioritization (Lee et al., 2014; Ndamani & Watanabe, 2017). They are all about preliminary planning for policy formulation and studies on post-assessment of already-formulated adaptation policies are insufficient.

In general, policy assessments are classified into content, implementation, and impact assessment (Brownson et al., 2009). For systematic policy assessment, step-by-step assessments of each component are necessary, but adaptation policies are characterized by the difficulty of monitoring in the implementation stage as well as uncertain policy effects and the long-term manifestation of effects in the impact stage (Füssel & Klein, 2006). Furthermore, since the initial municipality climate change adaptation policies are not scheduled to be implemented until 2020, there are limited ways to carry out implementation and impact assessments at this time.

Therefore, this study focuses on content assessment for the municipalities' climate change adaptation policies. First of all, among the event representing various climate changes, the heat wave, which has recently become stronger in frequency and intensity in Korea, was targeted in this study. The analysis used a gap analysis methodology that can examine the difference between impact and policy. For detailed analysis, the types of local governments were classified according to regional characteristics and used for evaluation. To evaluate the impact of heat waves, future impacts according to climate change scenarios were used, and for policies, regional gaps were analyzed using the policies of the local government. The analysis of the gap was intended to derive many implications, such as presenting the current and future status and direction for a response.

2. Materials and Methods

The gap analysis was carried out broadly in three stages. The analysis flow and method of each analysis stage are shown in Figure 1.

First, the types of industries in municipalities were classified based on the industrial characteristics using factor and cluster analysis.

Second, the heat wave adaptation policy level was assessed. To do this, a list of sectors and response areas were derived by building an inventory of heat wave adaptation policies, and the importance weights of the sectors and response areas by municipality type were derived through a fuzzy analytic hierarchy process (AHP) analysis. The policy level was then assessed using the number of projects, project budgets, and importance weights.

Third, the gap between the policy level and heat wave effects was analyzed. The gap analysis was conducted in two ways: a gap analysis by municipality type using Kendall's concordance coefficient and a gap analysis by municipality.

2.1. Classification of Municipalities

Before the classification of administrative district types, basic local governments, which are the spatial scope of this study, mean *si*/*gun*/*gu*, which are the basic administrative units of Korea and can be said to be similar to counties in the US. There are no exact equivalent administrative units to the Korean *si*/*gun*/*gu* system in the US.

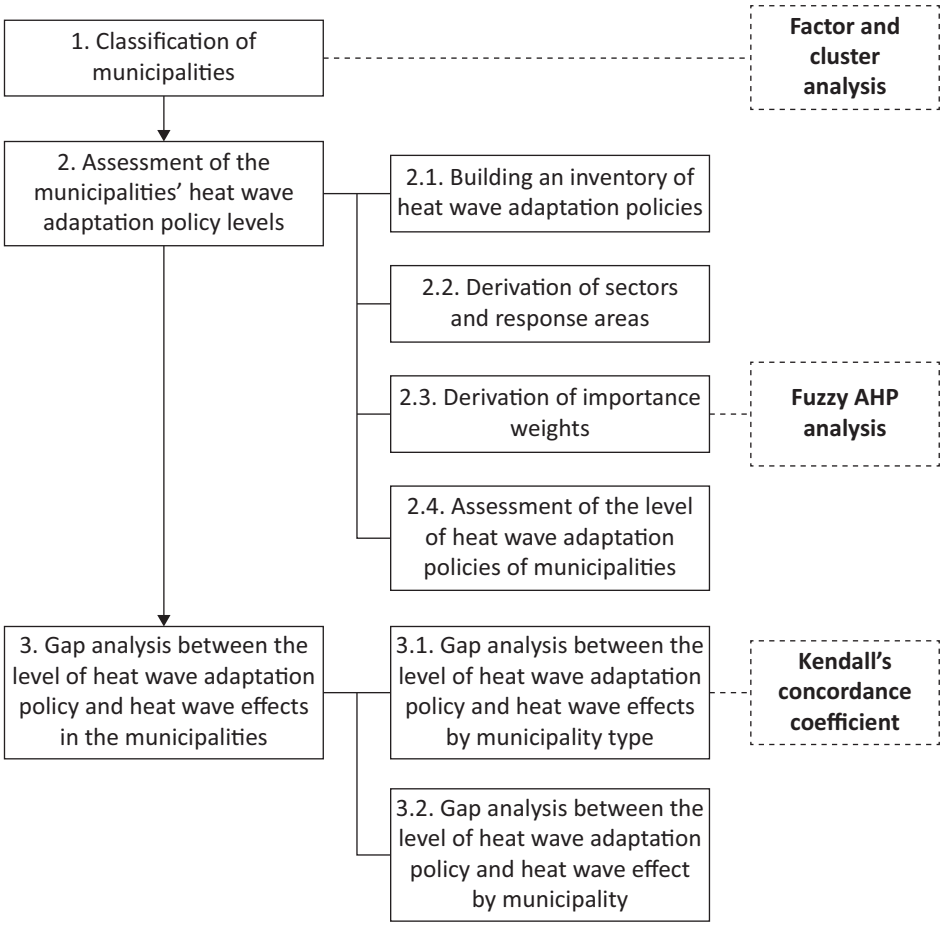

Figure 1. The flow of this study.

However, counties in the US are similar to Korean *si* in that they are the primary unit of local government, responsible for providing many essential services to residents, including law enforcement and education.

The administrative unit is the basic unit for decision-making such as finance, administration, and policy in each region, and is the subject of the detailed implementation plan for climate change adaptation measures used in this study. Therefore, in this study, the spatial scope of the study, such as the impact of heat waves and the level of policies, is based on the local government.

The social ripple effects of heat waves mainly affect the agriculture, livestock, fishery, and forestry industries, leading to economic damages such as coastal aquaculture animal mortalities, the spread of alien species, and livestock mortalities (Korea Environment Institute, 2014). In order to cope with these damages, municipalities are establishing detailed implementation plans for climate change adaptation measures around the components that require the prevention and management of properties or personal injuries. In particular, they are establishing adaptation plans for the primary industry, which is in the public goods sector and the main adaptation plans differ depending on the industrial characteristics of each region. Therefore, in order to assess the level of heat wave adaptation policies by reflecting the characteristics of municipalities, the municipalities need to be classified in accordance with their primary industries.

First of all, municipalities can be broadly classified into urban and rural municipalities. Urban municipalities are centered on secondary and tertiary industries, whereas rural municipalities are centered on primary industries. Thus, these two types of municipalities have significant differences in their industrial characteristics. In order to distinguish between them, the population size of the municipalities was used as the classification criterion. For urban municipalities, the criterion for large cities prescribed by Article 198 ("recognition of exceptions for large cities") of the Local Autonomy Act was referenced. Thus, every autonomous district that belongs to a metropolitan city or a special city, or every city with a population of at least 500,000 people was classified as "urban," while the other municipalities were classified as "rural" (Table 1).

The rural municipalities can be classified further by their primary industry characteristics: mountain types (centered on forestry and livestock industries) or farming and fishing types (centered on agriculture and fisheries). For this classification process, the growing stock volume and livestock count were selected to represent the characteristics of the forestry and livestock industries in the mountain-type municipalities, and the rice

Table 1. Selection of variables for the classification of municipalities.

Type		Variables
Urban		Every autonomous district that belongs to a metropolitan city or a special city, or every city with a population of at least 500,000 people
Rural	Mountain	The livestock count The growing stock volume
	Farming and fishing	The rice field area The field area The fish farm area

field, field, and fishery farm areas were selected to represent the agriculture and fishery industries in the farming-and-fishing-type municipalities. In addition, factor analysis and cluster analysis were performed to characterize municipalities with similar industrial characteristics.

The livestock count, growing stock volume, rice field area, field area, and fish farm area data were constructed for the South Korean municipalities nationwide based on the Korean Statistical Information Service. The reference year was set as 2015 for data acquisition.

2.2. Assessment of the Municipalities' Heat Wave Adaptation Policy Levels

In this study, the assessment goal was whether municipalities actively acquired budgets and explored projects to meet the heat wave adaptation policy goal to evaluate the policy level. Accordingly, the policy project budget and the number of policy projects were selected to assess the level of the heat wave adaptation policies. In addition, considering that the importance of the sector and response areas of the heat wave adaptation policies may vary by the industrial characteristics of the municipalities, the importance weights of sectors and response areas were reflected by municipality type (Table 2).

The data on the project budget, number of projects, and importance of each sector and response area were constructed largely in three steps.

Firstly, an inventory of climate change adaptation policies was built by collecting reports about the detailed implementation plans from municipalities around the country, which they are required to submit to the Korea Adaptation Center for Climate Change. The establishment and maintenance of detailed implementation plans for climate change adaptation measures by the local government are established every five years, and each local government has a different period. This study used the inventory made based on the plan submitted and established in 2018.

An inventory of climate change adaptation policies was constructed for all projects from the 156 municipalities that were confirmed to have established detailed implementation plans. In these plans, a total of 10 sectors were identified: health, disasters/accidents, agriculture, forestry, marine/fisheries, water management, ecosystem, climate change monitoring and forecasting, adaptive industry/energy, and education promotion and international cooperation. Thus, the inventory of climate change adaptation policies was divided into 10 sectors, and the budget amount of each detailed project was included.

Secondly, from this inventory, the sectors and response areas of heat wave-related adaptation policies were derived. Before doing this, the heat wave-related adaptation projects were separated from the total climate change inventory. Next, sectors and response areas were derived by grouping similarly detailed projects and reviewing them through three expert meetings. Through this process, 24 response areas in six sectors were finally derived, as shown in Figure 2.

Thirdly, data about project budgets and the number of projects were constructed for the sectors and response areas. The sums of the detailed project budgets and the number of projects were calculated for each sector and response area of municipalities' heat wave adaptation policies that had been previously determined and converted into variables. To derive the importance weight of each sector and response area, a fuzzy AHP analysis was carried out.

The AHP analysis method, which was developed by Saaty (1980), is mainly used for prioritization in complex decision-making problems, but it involves the ambiguity or uncertainty inherent in the evaluator's language or thoughts. Recently, to overcome this problem, the fuzzy AHP analysis method, which was developed

Table 2. Selection of variables for assessing the level of the heat wave adaptation policies.

Variables	Description
Project budget	Assessment criterion for efforts to acquire project budgets
Number of budgets	Assessment criterion for efforts to explore projects
Importance of each sector and response area	Importance weight for the sector and response area by type of municipality

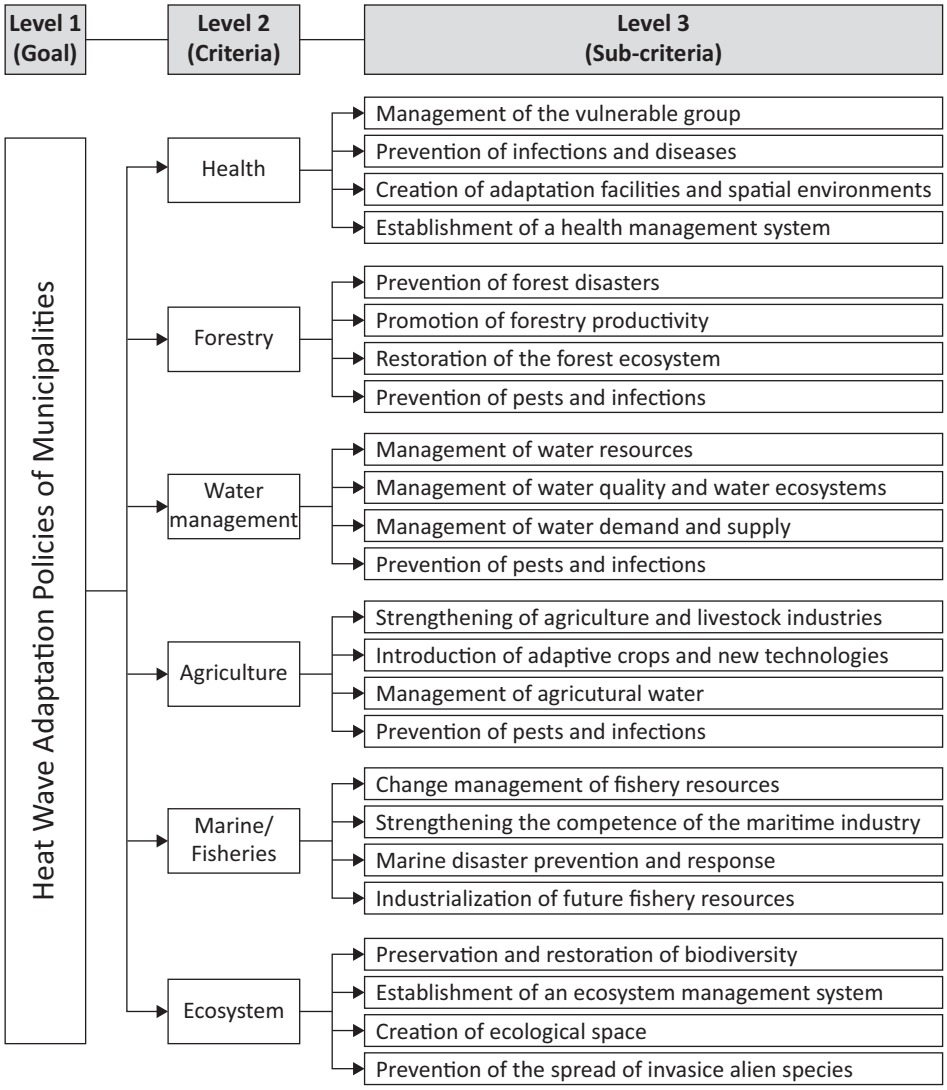

Figure 2. The sectors and response areas of heat wave policy.

by van Laarhoven and Pedrycz (1983), has often been applied. The fuzzy AHP analysis method is different from the conventional AHP method in that the data used in the computation process are not normal numbers but fuzzy numbers. A fuzzy number is a value converted from the result of a pairwise comparison in order to deal with the uncertainty and ambiguity inherent in human judgment. For fuzzy numbers, the triangular fuzzy number is generally used. A triangular fuzzy number is composed of three parameters (a_1, a_2, a_3), and the function is defined as Equation 1, where a_1 and a_3 are the lower and upper limits of the triangular fuzzy number, respectively:

$$\mu_A(x) = \begin{bmatrix} y_a^L(x) = \dfrac{x - a_1}{a_2 - a_1}, \; a_1 \le x \le a_2 \\ y_a^R(x) = \dfrac{x - a_3}{a_2 - a_3}, \; a_2 \le x \le a_3 \\ 0, \text{ otherwise} \end{bmatrix} \quad (1)$$

To calculate the level of heat wave adaptation policies of the municipalities, the assessment model was established as in Equation 2 below using the project budget, number of projects, and importance of the sector and response area, which were selected as the quantitative variables. The sum of the unit project budgets and the sum of the number of unit projects for each response area were normalized to values of 0 and 1, respectively:

$$\text{Assessment score of the level of heat wave adaptation policies of municipalities} = \sum_{j=1}^{m} \left(\sum_{i=1}^{n} B_i \times N_i \times W_i \right) \times K_j, \quad (2)$$

where m is the number of sectors, n is the number of response areas, K is the importance weight for each sector, B is the sum of the unit project budgets for each response area, N is the sum of the number of unit projects for each response area, and W is the importance weight for each response area.

2.3. Gap Analysis Between the Level of Heat Wave Adaptation Policy and Heat Wave Effects in the Municipalities

The gap analysis between the heat wave adaptation policy level and heat wave effects was divided into gap analysis by municipality type using Kendall's concordance coefficient and gap analysis by the municipality. In addition, the number of heat wave days for each local government was used as an impact indicator for the heat wave effect in the analysis.

First, to analyze the gap between the level of heat wave adaptation policy and heat wave effects by the type of municipality, the correlation between the analysis results for the level of municipalities' heat wave adaptation policies and the heat wave effect level was analyzed using Kendall's concordance coefficient. Kendall's concordance coefficient indicates the correlation of assessments when multiple assessors evaluate the same sample. In this study, the level of heat wave adaptation policies and the heat wave effects are not the same, but, assuming that the ideal heat wave adaptation policy is established when these two levels are identical, the correlation between the assessment results of the two samples was analyzed. The equation for calculating Kendall's concordance coefficient for this purpose is as follows:

$$\text{Kendall's concordance coefficient} = \frac{S}{12K^2\left(N^3 - N\right)}, \quad (3)$$

where S is the mean deviation for each ordinal scale, K is the number of assessors, and N is the number of assessment subjects.

For the gap analysis between the level of heat wave adaptation policy and heat wave effect by municipality, the difference in the scores between the previously derived level of heat wave adaptation policy and the number of heat wave days for each municipality was analyzed.

The heat wave effect variable, the number of heat wave days based on the number of days in which the daily maximum temperature is 33 °C or higher was selected. These data were established based on the RCP (representative concentration pathways) 8.5 scenario provided by the Korea Meteorological Administration. The reference years were set as 2015, 2035, 2055, 2075, and 2095. Since long-term future predictions involve large variability, the cumulative mean value of 10 years was estimated in order to consider this variability. For example, the mean value for the period from 2011 to 2020 was selected as the representative value for 2015.

3. Results

3.1. Classification of Municipalities

There were 229 classified municipalities across the country. First, for Level 1, they were classified into urban and rural types based on the population size. Every district that belongs to a metropolitan city or special city or every city with a population of at least 500,000 people was classified as urban, and the others were classified as rural. Next, for Level 2, in order to reflect the characteristics of the primary industries, the rural municipalities were classified into mountain type or farming and fishing type through factor analysis and cluster analysis using the variables for classification. The factor analysis was performed first using the characteristic variables of the primary rural industries after standardizing the variables so that variables with different units could be compared. For the rotation method, the varimax method was used, which is an orthogonal rotation of the factor axes.

As a result of the factor analysis, as shown in Table 3, the KMO value was determined to be 0.622, which is greater than 0.5, and Bartlett's sphericity test was also significant ($p < 0.001$). Thus, the variables used in the factor analysis are appropriate for our purposes.

From the result of the rotated component matrix, as shown in Table 4, the field area, fishery farm area, and rice field area are classified as Component 1 (*farming and*

Table 3. Results of KMO and Bartlett's test for the characteristic variables of the primary rural industry.

KMO measure of sampling adequacy		0.622
Bartlett's sphericity test	Approximate chi-square	82.123
	Degree of freedom	10
	Probability of significance	0.000

Table 4. Result of the rotated component matrix for the characteristic variables of the primary rural industry.

	Components	
	1	2
Standardizing score (the field area)	0.822	−0.013
Standardizing score (the fish farm area)	0.715	0.099
Standardizing score (the rice field area)	0.614	−0.381
Standardizing score (the livestock count)	0.213	0.796
Standardizing score (the growing stock volume)	−0.437	0.649

Notes: Factor extraction method—primary component analysis; rotation method—varimax with Kaiser normalization.

fishing type), while the livestock count and growing stock volume are classified as Component 2 (*mountain type*).

The municipalities were classified into the farming and fishing type or the mountain type by performing a cluster analysis using the components derived from the factor analysis. For the cluster analysis, the *K*-mean cluster analysis method was used.

As a result of the cluster analysis, as shown in Table 5, Cluster 1 was classified as the farming and fishing type, and Cluster 2 was classified as the mountain type. Thus, 229 municipalities were classified into 84 urban, 58 mountain, and 87 farming and fishing municipalities.

Among them, 156 municipalities, which were confirmed to have established detailed implementation plans for climate change adaptation measures, were reclassified. Finally, as shown in Figure 3, they were classified into 58 urban, 42 mountain, and 56 farming and fishing municipalities.

3.2. Assessment of the Level of Heat Wave Adaptation Policies of Municipalities

The importance of each sector and response area of the heat wave adaptation policies is expected to appear differently depending on the industrial characteristics of the municipalities. Thus, the weights were derived for each type of municipality classified above. To derive the weights of the sector and response area by municipality type, the fuzzy AHP analysis was performed through a survey of experts related to climate change adaptation. The relative importance of the sectors and response areas for the fuzzy AHP analysis was evaluated using the pairwise comparison scale based on the nine-point Likert scale, which is described in Table 6.

The expert survey was conducted through an e-mail request between 10 November and 30 November 2017. The survey request was sent to 234 persons in total,

Table 5. Cluster analysis results for the characteristic variables of the primary rural industries.

	Clusters	
	1	2
Component 1	**0.31828**	−0.47742
Component 2	−0.52919	**0.79378**

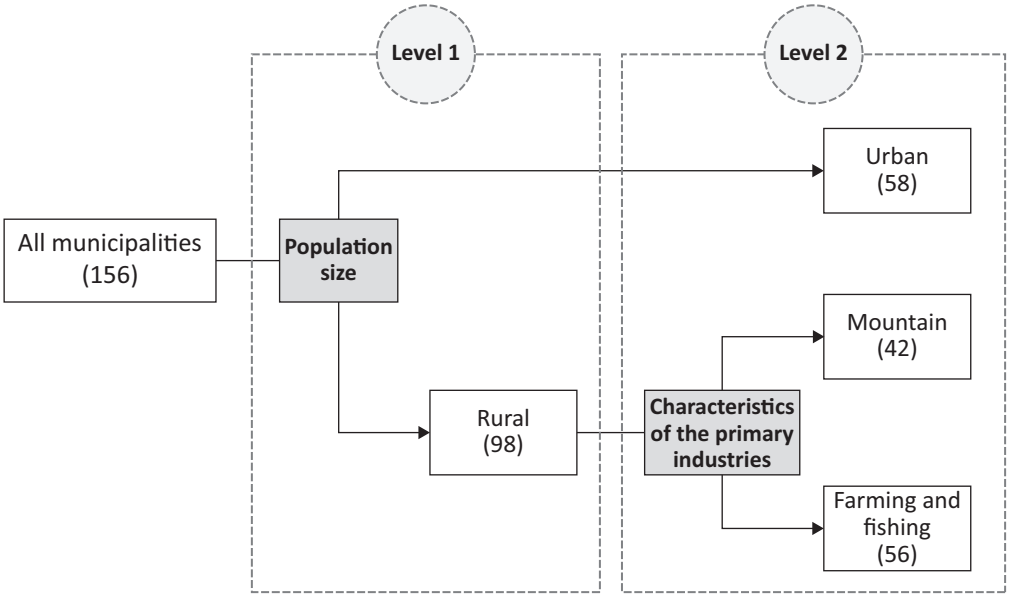

Figure 3. Result of classification of municipalities.

Table 6. Description of the scale of pairwise comparison.

Importance intensity	Description
9	Absolute importance of one element over another
7	Demonstrated importance of one element over another
5	Strong importance of one element over another
3	Weak importance of one element over another
1	Equal importance of both elements
2, 4, 6, and 8	Intermediate values between two adjacent judgments

and 50 of them responded, with a return rate of 23.4%. The fuzzy AHP analysis was performed using 37 of the 50 returned survey questionnaires, excluding 13 questionnaires that did not answer some questions or were inconsistent. The general criterion for consistency is a consistency ratio (CR) of less than 0.1, but, in this survey, the criterion for CR was lowered to 0.2 to consider the relatively high number of questions. This is also consistent with the assertion of Saaty and Kearns (1985) that consistency be maintained even when the CR is less than 0.2.

Based on the results of the fuzzy AHP analysis, the importance weights of sectors and response areas by municipality type were derived as shown in Table 7.

3.3. Gap Analysis Between the Level of Heat Wave Adaptation Policy and Heat Wave Effects in the Municipalities

To analyze the gap between the level of heat wave adaptation policy and heat wave effect by the municipality type, an analysis of Kendall's concordance coefficient was performed, which requires ordered data. Thus, the scores for the level of heat wave adaptation policies and the number of heat wave days derived above were graded to convert them from continuous data to ordered data. For this grading, the uniform interval method was used based on the corresponding year. However, although it is easy to find the distribution of a group with the uniform interval method, there is a concern that it may be distorted by the ideal and extreme values. Thus, the ideal and extreme values were removed before grading and the grades were divided into seven steps in total. After removing the ideal and extreme values, Kendall's concordance coefficient was analyzed for a total of 143 municipalities (Table 8).

The analysis results show that the concordance coefficient between the level of heat wave adaptation policy and the heat wave effect for all municipalities and each municipality type tends to decrease as the heat effect time moves further into the future. For all municipalities, the concordance coefficient was significant at every heat wave effect time ($p < 0.05$), and the concordance coefficient tends to decrease as the heat wave effect time moves further into the future. For the urban municipalities, the concordance coefficient was significant at every heat wave effect time except for 2095 ($p < 0.05$), and the concordance coefficient tended to decrease as the heat wave effect time moved further into the future. For the mountain municipalities, the concordance coefficient was significant at every heat wave effect time ($p < 0.05$), and the concordance coefficient tended to decrease in general as the heat wave effect time moved further into the future, although it increased in 2055. For the farming and fishing municipalities, the concordance coefficient was significant at every heat wave effect time except for 2095 ($p < 0.05$), and the

Table 7. Importance of the sector and response areas of heat wave adaptation policies by municipality type.

Type	Sector	Importance	Response areas	Importance
Urban	Health	0.371	Management of the vulnerable group	0.350
			Prevention of infections and diseases	0.248
			Creation of adaptation facilities and spatial environments	0.209
			Establishment of a health management system	0.242
	Forestry	0.127	Prevention of forest disasters	0.363
			Promotion of forestry productivity	0.161
			Restoration of the forest ecosystem	0.237
			Prevention of pests and infections	0.279
	Water management	0.240	Management of water resources	0.198
			Management of water quality and water ecosystems	0.210
			Management of water demand and supply	0.365
			Maintenance of water and sewage	0.262
	Agriculture	0.102	Strengthening of agriculture and livestock industries	0.203
			Introduction of adaptive crops and new technologies	0.297
			Management of agricultural water	0.227
			Prevention of pests and infections	0.315
	Marine/fisheries	0.083	Change management of fishery resources	0.275
			Strengthening the competence of the maritime industry	0.202
			Marine disaster prevention and response	0.297
			Industrialization of future fishery resources	0.259
	Ecosystem	0.127	Preservation and restoration of biodiversity	0.250
			Establishment of an ecosystem management system	0.249
			Creation of ecological space	0.305
			Prevention of the spread of invasive alien species	0.237

Table 7. (Cont.) Importance of the sector and response areas of heat wave adaptation policies by municipality type.

Type	Sector	Importance	Response areas	Importance
Mountain	Health	0.221	Management of the vulnerable group	0.313
			Prevention of infections and diseases	0.360
			Creation of adaptation facilities and spatial environments	0.162
			Establishment of a health management system	0.210
	Forestry	0.284	Prevention of forest disasters	0.380
			Promotion of forestry productivity	0.203
			Restoration of the forest ecosystem	0.182
			Prevention of pests and infections	0.270
	Water management	0.190	Management of water resources	0.413
			Management of water quality and water ecosystems	0.222
			Management of water demand and supply	0.238
			Maintenance of water and sewage	0.182
	Agriculture	0.132	Strengthening of agriculture and livestock industries	0.227
			Introduction of adaptive crops and new technologies	0.271
			Management of agricultural water	0.221
			Prevention of pests and infections	0.324
	Marine/fisheries	0.061	Change management of fishery resources	0.288
			Strengthening the competence of the maritime industry	0.223
			Marine disaster prevention and response	0.271
			Industrialization of future fishery resources	0.244
	Ecosystem	0.165	Preservation and restoration of biodiversity	0.392
			Establishment of an ecosystem management system	0.224
			Creation of ecological space	0.128
			Prevention of the spread of invasive alien species	0.296
Farming and Fishing	Health	0.249	Management of the vulnerable group	0.321
			Prevention of infections and diseases	0.321
			Creation of adaptation facilities and spatial environments	0.173
			Establishment of a health management system	0.228
	Forestry	0.099	Prevention of forest disasters	0.336
			Promotion of forestry productivity	0.176
			Restoration of the forest ecosystem	0.217
			Prevention of pests and infections	0.312
	Water management	0.179	Management of water resources	0.409
			Management of water quality and water ecosystems	0.184
			Management of water demand and supply	0.269
			Maintenance of water and sewage	0.187
	Agriculture	0.238	Strengthening of agriculture and livestock industries	0.240
			Introduction of adaptive crops and new technologies	0.187
			Management of agricultural water	0.305
			Prevention of pests and infections	0.303
	Marine/fisheries	0.141	Change management of fishery resources	0.208
			Strengthening the competence of the maritime industry	0.268
			Marine disaster prevention and response	0.361
			Industrialization of future fishery resources	0.205
	Ecosystem	0.152	Preservation and restoration of biodiversity	0.329
			Establishment of an ecosystem management system	0.216
			Creation of ecological space	0.158
			Prevention of the spread of invasive alien species	0.338

Table 8. Analysis results of Kendall's concordance coefficient between the level of heat wave adaptation policy and the heat wave effect by municipality type.

Type	Sample size	Result	2015	2035	2055	2075	2095
All	143	Kendall's *W*	0.515	0.488	0.404	0.134	0.028
		Approximate probability of significance	0.000	0.000	0.000	0.000	0.045
Urban	56	Kendall's *W*	0.137	0.137	0.126	0.080	0.010
		Approximate probability of significance	0.006	0.006	0.008	0.035	0.446
Mountain	35	Kendall's *W*	0.488	0.488	0.541	0.357	0.333
		Approximate probability of significance	0.000	0.000	0.000	0.000	0.001
Farming and fishing	52	Kendall's *W*	0.501	0.428	0.448	0.124	0.057
		Approximate probability of significance	0.000	0.000	0.000	0.011	0.086

concordance coefficient tended to decrease in general as the heat wave effect time moved further into the future, although it also increased in 2055.

To analyze the gap between the level of heat wave adaptation policy and heat wave effect by the municipality, the difference in the scores derived above between the level of heat wave adaptation policy and the number of heat wave days (score of heat wave adaptation policy–heat wave effect score) was analyzed. To do this, each score was normalized to a value of 0–1.

The analysis results are outlined in Figure 4. The dashed part indicates municipalities whose heat wave effect scores are higher than the score of the heat wave adaptation policy, and the light-colored part indicates the municipalities whose heat wave adaptation policy scores are higher than the heat wave effect scores. The former can be regarded as those whose current heat wave adaptation policies are insufficient relative to the heat wave effects. These municipalities are summarized by municipality type in Table 9. The municipalities

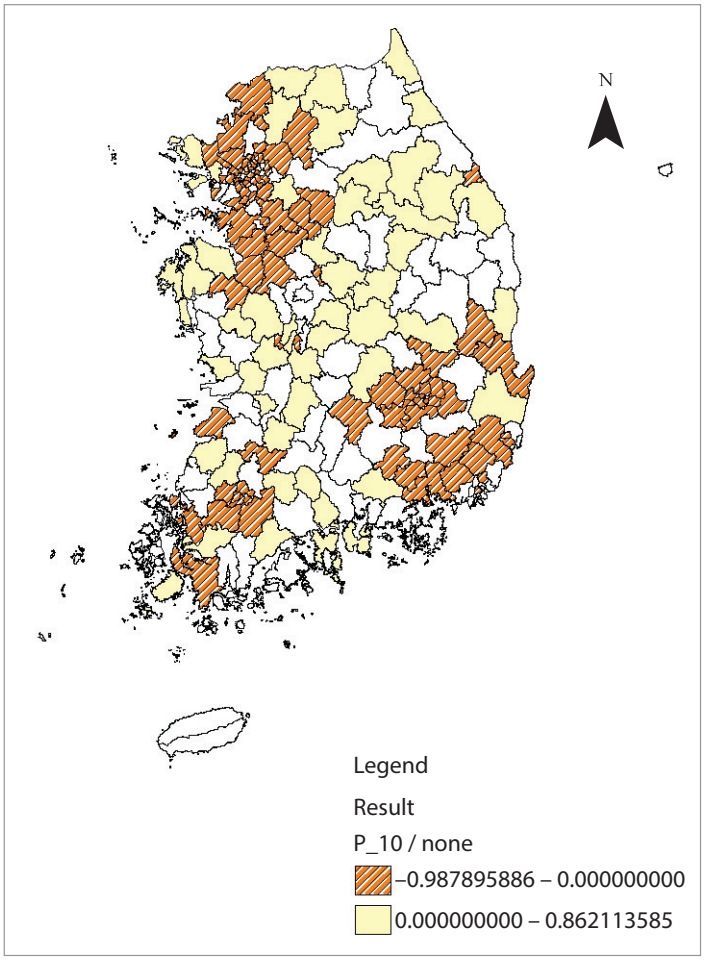

Figure 4. Result of the gap analysis between the level of heat wave adaptation policy and heat wave effects by municipality.

Table 9. Ratios of municipalities with insufficient levels of heat wave adaptation policies compared to the heat wave effects by municipality type.

Type of municipality	Total number	Number of insufficient municipalities	Ratio of insufficient municipalities (%)
Urban	56	51	91.07
Mountain	35	11	31.42
Farming and fishing	52	28	53.84
All	143	90	62.93

with insufficient heat wave adaptation policies consist of 51 urban types, 11 mountain types, and 29 farming and fishing types. Proportionally, urban municipalities had the highest ratio of insufficient heat wave adaptation policy levels (91.07%), followed by farming and fishing municipalities (53.84%) and mountain municipalities (31.42%).

4. Discussion

The gap analysis results between the level of heat wave adaptation policy and heat wave effect by municipality type showed that Kendall's concordance coefficient was significant and tended to decrease as the heat wave effect time advanced further into the future. Significant concordance means securing the validity of the evaluation model of the municipality's heat wave adaptation policy. At the same time, it means that the municipalities acquired the project budget and discovered the proper project in accordance with the effect of the heat wave at the decision-making and policy establishment step. Furthermore, the fact that the concordance coefficient decreases as the heat wave effect time moves further into the future means that the degree of concordance between the level of heat wave adaptation policy and the future heat wave effect decreases.

By municipality type, the urban type showed a relatively low concordance coefficient. This seems to be because factors other than the heat wave effect are reflected when the heat wave adaptation policies are established in urban-type municipalities. Residents in cities have more diverse ages and economic levels than do those in farming and fishing villages and mountain areas. Therefore, in the event of a heat wave, the damages appear differently depending on the social, economic, and demographic characteristics of the city. The concordance coefficient may be low because this vulnerability of cities affected the establishment of heat wave adaptation policies.

When the difference between the score of the heat wave adaptation policies and the heat wave effect score was analyzed for the gap analysis by municipality, 90 of 143 municipalities showed an insufficient level of heat wave adaptation policy compared to the heat wave effect.

By municipality type, the urban type showed a relatively high ratio of municipalities with insufficient heat wave adaptation policies. Of the 51 urban-type municipalities with insufficient heat wave adaptation policies, 40 were autonomous districts in administrative units. A *gu* district is an autonomous district that belongs to a metropolitan city or a special city. Under the current laws of South Korea, these autonomous units have the same status as cities (*si*) and counties (*gun*) that belong to a province (*do*), but they have considerable limitations in planning authority, manpower, and budget (Yang et al., 2015). Consequently, there is a tendency for the metropolitan city and special city to take the lead in planning, and the autonomous districts only take charge of simple projects. This tendency appears to be related to the number and budget of projects for heat wave adaptation policies, resulting in a low level of heat wave adaptation policy compared to the heat wave effect. Another possible reason is that cities do not need to establish adaptation policies related to costly infrastructure because the proportion of primary industries is low.

5. Conclusions

This study aimed to analyze the gap between the level of heat wave adaptation policy and the heat wave effect in South Korean municipalities. For this purpose, this study was conducted largely in three steps. First, the types of industries in the municipalities were classified considering their industrial characteristics using factor analysis and cluster analysis. Second, the level of heat wave adaptation policy in the municipalities was assessed. To do this, a list of sectors and response areas were derived by building an inventory of heat wave adaptation policies, and the importance weights of the sectors and response areas by municipality type were derived through a fuzzy AHP analysis. Then, the level of heat wave adaptation policies by municipality type was assessed using the number of projects, project budgets, and importance weights. Third, the gap between the level of heat wave adaptation policy and the heat wave effect was analyzed. The gap analysis was conducted in two ways: a gap analysis by municipality type using Kendall's concordance coefficient and a gap analysis by municipality.

The analysis results can be largely summarized in two parts. First, the heat wave adaptation policies were established in accordance with the heat wave effects to some degree, and the extent of concordance decreased as the time of the heat wave effect was moved further into the future. Second, the number of municipalities that have insufficient heat wave adaptation policies against heat

wave effects was 90 out of 143. The proportion of municipalities with insufficient levels of heat wave adaptation policy against heat wave effects was higher among urban-type municipalities.

The analysis results suggest policy implications. First, the heat wave adaptation policies of municipalities should be established through continuous feedback on the predictions of future heat wave effects. Second, urban-type municipalities should strengthen their planning authority and competence by securing a professional workforce and budgets for the establishment of heat wave adaptation policies.

On the other hand, this study has limitations in that the assessment of heat wave adaptation policies reflected only quantitative variables, such as the number of projects and project budgets, and did not reflect the competence and perception of the civil servants carrying out the projects. Furthermore, a total policy assessment was not carried out because the implementation process, which is critical in adaptation policies, was not assessed. Therefore, comprehensive policy assessments need to be carried out that include the policy implementation process and results once the implementation of existing heat wave adaptation policies of municipalities is completed. As mentioned in Section 1, heat waves cause negative impacts on human life, especially on the poor. Solving these problems by developing adaptation policies is a critical topic in the smart sustainable city. This research is meant to suggest a good example of a new modality for the smart sustainable city and environmentally-minded smart citizenship. Further research needs to examine a more detailed discussion on citizens' participation in smart climate change planning.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

GPS Tracking Data on Marginalised Citizens' Spatial Patterns: Towards Inclusive Urban Planning

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Abstract
Knowledge about how marginalised citizens use urban spaces is hard to access and apply in urban planning and policy. Based on current debates around "smart cities" and "smart governance," the City of Odense, in Denmark, has tested the integration of "smart engagement" by means of GPS-tracking techniques into the municipality's cross-sectoral strategy for an "inclusive city." In a period of austerity, cities have the incentive to optimise public services. Hence, GPS-tracking data was produced by 64 marginalised citizens, resulting in a data inventory covering three weeks of spatial behaviour. First, this article shows how these GPS-tracking data were processed into maps without revealing person-sensitive spatial patterns. Secondly, the article explores whether such maps and the GPS-tracking techniques that underpin them are considered valid, relevant, and applicable to urban planning from the perspectives of marginalised citizens, their representatives, and municipal planners and professionals respectively. The GPS project showed shortcomings as regards the quality of the data inventory and the representativity of the mapped behaviour, which made them inapplicable for optimising dedicated public service. However, the article also finds that the GPS-based maps succeeded in being non-person sensitive and in providing a valuable platform for citizen-centric dialogues with marginalised citizens with the potential for raising awareness and increasing knowledge about this citizen group's living conditions and urban lives. An important derived effect of the project is that it has ensured ongoing cross-sectoral collaboration among a range of professional stakeholders, imperative for ensuring creating greater equity in urban planning.

Keywords
GPS tracking; inclusive cities; marginalised citizens; Odense; public spaces; smart cities; smart engagement; smart governance

Issue
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1. Introduction

Around the world, cities are striving to become "smarter," more efficient, and more sustainable. The smart city discourse that began some 20 years ago started as a techno-centred approach (Goodman et al., 2020; Hollands, 2008). However, today it is widely acknowledged that a fundamental tool for a city to become "smart" is to involve its citizens. Hence, more citizen-centric approaches to smart cities have gained support, emphasised by concepts like "smart engagement" and "smart governance" (Lee & Lee, 2014; O'Grady & O'Hare, 2012). Nonetheless, a recent study has shown that the term "citizen-centric" has various meanings and is not always fully apt (Cardullo & Kitchin, 2019).

Homeless and marginalised citizens' everyday lives share the characteristic of being "unusual" in many respects, including their patterns of spatial and temporal behaviour, which challenges the shared use of public space. Their urban lives are often regulated by "defensive architecture" (Bauman, 2005), for instance, by removing benches or designing them so that the

homeless cannot lie on them, which makes planning for more just and inclusive cities a difficult task (Fainstein, 2005). Cities around the world are experiencing a period of austerity and a need to optimise public services to save money. Efficiency can be achieved in different ways, for instance, by identifying low-demand shelters or optimal locations of services. For this purpose, solid behavioural and spatial data are required.

Public participation involves many dilemmas regarding how to engage citizens in citizen-centric ways. New technologies for engagement have recently emerged. Global positioning systems (GPS) offer novel possibilities for collecting data on the spatial behaviour of elusive populations (Aasi & Lee, 2020; Gasson et al., 2010). The use of GPS-based techniques for mapping the use of and preferences for urban spaces by the homeless and marginalised citizen groups is considered a unique method of increasing the evidence base for urban planning, and it can help improve public services and protected spaces for these citizens (North et al., 2016; Šimon et al., 2019). GPS/GIS technology has also been suggested as adding spatiotemporal information to qualitative information, as revealed from walk-along interviews (Martini, 2020). However, there is still a need to evaluate the potentials and challenges of such methods to determine whether they are citizen-centric or not, as well as to assess how much they can underpin efforts at smart engagement and smart governance.

1.1. The GPS Project in the City of Odense

The Danish city of Odense (180,000 inhabitants) is a leader among European cities in respect of its inclusive and innovative urban governance (HABITACT, 2015). Its strategy—"The Inclusive City"—is anchored in the cross-sectoral collaboration between the public authorities and civic actors in the city's Council of Marginalised Citizens, a forum which represents the interests and needs of marginalised citizens by linking the issues of health, social security, urban planning, and housing, and targeting the social integration and spatial inclusion of marginalised citizen groups, both practical and strategic.

The city has worked systematically to provide inclusive public spaces for marginalised citizens in the city centre, not least because it was the pilot city in a national innovation project (Danish Ministry of Social Affairs, 2010). Meanwhile, radical urban transformations of public spaces have taken place in the city centre, where a huge construction work to bury a major street has boarded up a large part of the city centre for several years, disturbing marginalised citizens' use of existing daily paths and public spaces, as well as establishing new patterns of both.

On this basis, the city's planning authorities foresaw two overlapping challenges. First, they expected the new patterns of the use of public space by marginalised citizens to densely populate public spaces they previously only rarely used, which were predicted to cause complaints from other citizen groups about noisy and disturbing behaviour. Second, new barriers, both geographical and temporal, to marginalised citizens' access to social and health services were expected to follow the new patterns of spatial behaviour. Hence, the main task for the municipal planners was to find a way to approach these predicted challenges to marginalised citizens' new patterns of public life.

Until then, the city had focused its work on providing inclusive public spaces in the inner city, and in doing so had acquired a solid knowledge base on marginalised citizens' use of and preferences for central public space (Danish Ministry of Social Affairs, 2010). However, the city lacked knowledge about this citizen group's wider patterns of space use and movements that would have allowed it to establish a better background for the location and provisioning of an efficient health service, and of urban spaces aligned with marginalised citizens' need for both protection and shelter and proximity to a "normal'' urban life. The latter would enable planning to ensure conflict-neutral co-existence in public spaces for the various citizen groups by reducing the crowding of marginalised citizens into shared public spaces, for instance, by striving for a balanced spatial distribution of marginalised citizens' preferred spaces.

In order to meet these requirements, the city decided to test GPS tracking as a method of collecting evidence on spatial behaviour with the additional expectation that the representation of marginalised citizens by means of their direct involvement would be improved. The city's main motivation for the application of new digital techniques was to test how such data could support the city's strategy of achieving an inclusive and smart city (City of Odense, 2015a, 2015b). Two technical reports were produced (Carstensen et al., 2017; Skov-Petersen et al., 2017). The rationale for the city's choice of GPS technology relied on an expectation that this could produce knowledge about spatial behaviour that was considered hard to access by other means. It was expected that making the marginalised citizen's spatial behaviour and needs visible on maps would improve their representation in stakeholder discussions. Specifically, it was expected that the data would reveal the spatiotemporal dynamics of the group so that they could be related to the effects of the closure of public spaces that were popular with this group due to urban renewal and be useful in locating services relevant to the group.

The GPS project started in 2014. At the time GPS-based tracking was still in its infancy where the involvement of marginalised citizens was concerned. Thus, there was a need to develop and adjust the methodology to test and evaluate its potential as regards the technical, governmental, and ethical aspects. To meet these needs, the city authorities approached the University of Copenhagen for assistance, and a research project was defined based on the existing data inventory and collected through the City of Odense's GPS project.

This article explores the potential and challenges of using GPS-based data in planning an inclusive city, as is underway in the City of Odense. It evaluates processes of analysing and displaying GPS-based tracking data and explores how such data are perceived to be relevant and applicable to urban planning and policy from the perspectives of three core stakeholder groups: marginalised citizens, their representatives, and municipal planners and professionals. The article starts by outlining the form the smart city discourse takes in the City of Odense and especially how it resonates with "smart engagement" and "smart governance." Then the study's methodological approach is presented. In the analytical sections, we first describe our efforts to produce non-person sensitive maps of the urban life patterns of marginalised citizens by means of GPS-based tracking and revealing the resulting maps. Second, the article analyses the validity, relevance, and potential applicability of such data from the perspectives of the three stakeholder groups respectively. Then follows a discussion of the different technical, ethical, and governance potentials and challenges related to collecting and applying GPS-based data in planning assessed from the distinct stakeholder groups' perspectives. The article concludes by outlining how these findings relate to current debates around smart cities and smart governance.

2. Background

2.1. The Smart City

The concept of the smart city has grown rapidly until it has reached the point where it has become "a favoured response to the 21st-century urbanisation challenges" (Praharaj & Han, 2019, p. 1). To reduce the somewhat confusing application of the term, many attempts have been made to formalise the concept and to assess its conceptual and discursive evolution (Kummitha & Crutzen, 2017; Toli & Murtagh, 2020). Cohen (2015) divides the evolution of the smart city concept into three distinct phases or periods. It is acknowledged that the idea for smart cities initially grew out of digital technologies, including sensor systems, networks based on the Internet of Things, and centralised dashboards targeting a city's sector-specific efficiency in terms of, for example, its use of energy, resources, and transport systems. From this internal management perspective, applications to support the provision of public and private services to citizens, institutions, and private companies were added. Thus, the first phases of smart cities focused on the use of technical infrastructure to make cities more responsive, efficient, sustainable, and intelligent. More recently, collaborative democratic approaches that permit participatory citizen-centric urban innovation have become prominent features of the smart city concept (Fernandez-Anez et al., 2018; Lee & Lee, 2014; O'Grady & O'Hare, 2012).

2.2. Smart Engagement

Cities labelled as smart have been criticised for being overly technocratic and instrumental and as high-tech variations on the notion of the "entrepreneurial city" (Hollands, 2008). As a reaction, some cities have reframed their initiatives as "citizen-centric." However, as Cardullo and Kitchin (2019) have pointed out, what "citizen-centric" means in practice is rarely specified. Smart cities tend to frame citizens as smart, and they measure their inclusion, participation, and empowerment in diverse ways. Analyses have shown that "citizen-centric" smart-city initiatives are often rooted in a neoliberal conception of citizenship that prioritises market-led solutions to urban issues, rather than being grounded in civil, social, and political rights and the common good. Thus, research is required if smart cities are to be refashioned to become truly "citizen-centric."

In this respect, theory and practice are both dominated by ambivalence about the very idea of participation and direct involvement. The conflicts between individual and collective interests, or between the ideal of democracy and the reality that many voices are never heard, produce dilemmas that are hard to solve. An emerging set of practices of collaborative public engagement from around the world demonstrates how alternative methods can better meet the goals of public participation (Innes & Booher, 2004).

A new repertoire of techniques that provide alternatives to traditional methods of involvement has been developed, for example, urban laboratories, art interventions, foresighting, web-based participation, charrettes, and a variety of location-based digital media. These techniques of involvement are considered fruitful for engaging specific citizen groups, for instance, young people (Townley et al., 2016). Not least, smart-city initiatives have shed new light on novel means of enabling citizen engagement and participation in urban planning. To increase citizens' social integration, spatial inclusion, and democratic engagement, new methods, practices, and tools that enable smart engagement have a lot of potential for urban governance and planning (Aasi & Lee, 2020). For instance, they could contribute to reframing smart cities as sites where citizens are actively engaged in the design and planning of urban space. Moreover, they might be very useful for handling different but related public interventions that aim to be coordinated and integrated.

2.3. GPS Tracking for Understanding the Spatial Behaviour of Marginalised Citizens

So far, studies of marginalised citizens using GPS techniques have been applied in a limited number of cases (North et al., 2016; Šimon et al., 2019). In general, it is recognised that individuals within marginalised groups can be hard to reach out to and maintain contact with (Snow & Mulcahy, 2001). Accordingly, information about

the spatial behaviour of such individuals is hard to obtain and verify. In the present study, the intention was to assess behaviour on the city scale over an extended period (a week) as comprehensively as possible. GPS tracking provides the required spatial and temporal coverage and degree of detail feasible for the purpose. Assessments based on direct personal contact, including interviews and in-person questionnaires, would in many cases suffer from having a lower temporal coverage since respondents rarely can recall every trip they made a week back in time (Snow & Mulcahy, 2001). Sketch mapping, as part of interviews, is often challenged by a lack of accuracy—in space and time—during the depiction of routes and locations. Although GPS registration is regarded as being a feasible option, the need for direct contact with the respondents when collecting qualitative data by means of interpretative approaches is regarded as imperative, both as a means of verification and to add further semantic information to the data (Gasson et al., 2010).

To assess the optimal location of shelters in Texas (US), North et al. (2016) studied the spatial behaviour of 18 marginalised citizens by means of GPS. The main strategy of the study was to involve respondents in assessing the variation between self-reported and recorded travelling distances and durations. The study reported by Šimon et al. (2019) combines week-long GPS tracking of marginalised citizens in the Czech Republic, combined with post-deployment interviews. The main motivation was to assess the size of respondents' activity spaces and how they were influenced by city size, age, gender, housing situation, and education. In a study not aimed specifically at marginalised citizens, Martini (2020) applies a "spatial transcript technique" to GPS tracking to add spatial and temporal semantics to walk-along interviews. In all three studies, interviews with the respondents were conducted to complement the recorded data. However, such studies do not include the involvement of marginalised citizens in data collection/interpretation or urban planning/design.

Townley et al. (2016) investigated the activity spaces of homeless youth by means of participatory mapping and GIS to involve the respondents in the research process and thereby "grant a voice" to them during knowledge generation. In this case, the involvement and the openness of the resulting dialogue are regarded as just as important as the resulting maps per se.

3. Methods and Data

3.1. Collection of GPS Data

The collection of the GPS data was initiated and conducted by the City of Odense in collaboration with the Danish charity DanChurchSocial, which runs a local shelter for marginalised citizens in Odense.

The service and support places for marginalised citizens in Odense are mapped in Figure 1. The health service is run by the municipality and includes health clinics and drug dispensaries. The care service is mostly run by private organisations and consists of day or night shelters, one of which is for women only. Some have a religious dimension (Christian), while others are non-religious. The shelter run by DanChurchSocial is the biggest of its kind in Odense.

The shelter staff recruited all the participants (partly by means of a flyer entitled "Where to Situate New Refuges in Odense?") and handled the GPS equipment. The respondents received three meal tickets for participating in the experiment. The GPS units, which consisted of a GPS tracker/logger and access to the mobile GSM network, enabled reminders to be sent to recharge the unit, for example. The shelter staff kept track of the relationship between the respondent and the units. The authors (the research team) conducted the data analysis and the subsequent workshops, assisted by a facilitator. As also noted by Townley et al. (2016), recruitment of respondents at the shelter might introduce a selection bias for those who socially can afford such interaction.

An initial set of GPS-tracking campaigns was conducted between December 2014 and October 2016. A total of 70,176 points were collected. No scientific documentation exists, but the ideas and early endeavours were presented in a Ted Talk by the project leader (Rønning, 2014). The time lap between the points was more than 20 minutes on average. Accordingly, since the analysis of respondents' routes and resting points were focal issues, the data sets from the initial campaigns were considered inadequate and were set aside. To compensate for this, three additional campaigns with a higher temporal resolution were conducted during weeks eight, nine, and 17 of 2017, resulting in a total of 596,715 recorded points.

The 64 respondents each carried the GPS unit for an entire week. The respondents comprised 14 women, 49 men, and one individual whose gender was not recorded. The gender imbalance of the sample—approximately a quarter female and three-quarters male—corresponds with the national average for shelter and care-home users in Denmark (Statistics Denmark, 2023). All respondents were more than 30 years of age. The national statistics for shelter and care-home users reveal that 25% are younger than 30 years. A main reason for the lack of young users in our sample is expected to be due to the inclusion of "care homes" in the statistics, which can be expected to cover a younger user type than targeted by the present sampling site. Accordingly, the number of respondents above 50 years of age is high compared to the national statistics.

Nine (14%) out of the 64 respondents reported not having a permanent dwelling, without any further specification of whether their situations were "roofless," "houseless," "insecure," or "inadequate" (cf. the ETHOS typology; Amore et al., 2011). Further information was unavailable due to the researchers' lack of options for direct access to the respondents.

With respect to data handling and privacy, a protocol for a code of conduct was drawn up:

- Data collection: Only the employees of the shelter know the respondents' identities. Anonymised age, gender, and access to a dwelling of the respondents are to be known to the researchers and the city authorities.
- Analysis and visualisation: Only the research team have access to the raw data. No data transfer, by whatever means, is to be permitted to anyone outside the team.
- Handling and management: In cartographic communications between the research team and the city authorities, the addresses of individual respondents must not be identifiable.
- Dissemination and publishing: All locations of stopping points or movements must be aggregated and obscured before being published. Stopping points used by only a single person are to be deleted.

3.2. Analyses of GPS Data

The raw data generated an anonymised identification of the respondent, locations, and times of recording. Of the originally recorded 596,715 data points, 404,603 data points (68%) of poor or irrelevant positioning were set aside due to (a) horizontal dilution of precision above 10, (b) positions at latitude/longitude equal to 0.0 (i.e., location lacking), (c) locations left over in data-loggers from previous registrations, or (d) locations appearing to be "spikes" (technical faults resulting in sudden, unmotivated shifts in coordinates). The main reason for the inferior quality of locations was the occasional indoor recordings.

After filtering, the points were divided into *stops* and *movements*. Sequences of points constituting a stop were defined and identified as being within a maximum radius of 250 m (about 820.21 ft) for periods of over 30 minutes. The method was adapted from the software V-Analytics (Andrienko & Andrienko, 2013, 2017). The location of a stop point was revealed as the average of the *x* and *y* coordinates of the points involved. Similarly, the start, stop, and duration of each stop were calculated based on the constituent points. Stops consisting of fewer than five recorded points were omitted from further assessment. To further distinguish stops during daily activities (which were the main interest of the study) from stops at home (which were removed from further assessment or communication), a "home stop" was defined as lasting longer than eight hours and/or starting or ending between 8:00 p.m. and 7:00 a.m. Points between stop sequences, defined as "movements," were collected into polylines and further classified according to average speed: walking < 6 km/h (3.72 mi/h), cycling/running 6–18 km/h (3.73–11.18 mi/h), driving or riding on public transport > 18 km/h (11.18 mi/h). To generate maps where an individual's behaviour could not be identified, both stops and movements were "blurred" as "kernel distributions." A similar technique has previously been applied to the analysis and visualisation of cluster patterns of disease transmission, injuries, and drug use among homeless citizens (Ahasan et al., 2022).

3.3. Workshops

Three workshops to assess the GPS data's precision, relevance, and applicability were carried out from 30 May to 14 June 2017, and each had a duration of two hours. In order to enable comparison and cross-assessment of the GPS-tracking technique, the same maps were applied to all three workshops. If the workshops had been conducted separately, the methodological approach could have been adjusted to suit one of the three stakeholder groups more specifically. However, the participants at the first two workshops dismissed the map's ability to provide insights into spatial dynamics. Hence, it was the wider outcomes of the GPS project that came into focus at the last workshop with the municipal planners and professionals.

3.3.1. Workshop 1: Marginalised Citizens

The first workshop was attended by marginalised citizens who enrolled as respondents and "GPS carriers." The shelter staff announced the workshop and its aims to the potential attendees. The aim was to validate the GPS-based spatial patterns displayed on A1 wall maps and to explore the participants' experiences as GPS carriers. The workshop consisted of individual interviews (N = 12) and map-based group dialogues (N = 8). Potential participants were contacted on-site by the shelter staff ahead of the workshops. The individual interviews focused on the data collection experience. These were conducted around tables in the shelter's courtyard using an interview guide and took 10 minutes each on average. The map-based group dialogues took place inside the shelter in front of the wall maps (see Figures 1–3) and focused on validating the precision, relevance, and collection of further semantics and storytelling.

3.3.2. Workshop 2: Representatives of the Marginalised Citizens

The second workshop was held with members of Odense's Council of Marginalised Citizens, considered as marginalised citizens' representatives, and included private and public care providers (N = 6), who possess a high level of knowledge about the group's daily living conditions and could accordingly provide supplementary information. The aim was to validate the mapped GPS-based patterns and to assess the applicability of such data. The participants were asked to sketch their anticipation of the spatial behaviour of the marginalised citizens

(places and routes) on "blank" city maps. Afterwards, the maps were assessed in two subgroups and the potentials, pitfalls, and barriers of the GPS tracking technique were discussed.

3.3.3. Workshop 3: Municipal Professionals and Planners

The third workshop was carried out with the city's professionals and planners from two departments: Labour and Social and City and Culture (N = 12). The aim was to facilitate a broader discussion of the derived effects of the GPS test and of the potentials of and barriers to using similar evidence-based information in intersectoral (strategic) collaboration. Data collection consisted of joint meetings and sub-group discussions around the themes of "evidence-based knowledge for strengthening professional collaboration around the vision of the inclusive city" and "the potential use and applicability of GPS." Data consisted of written inputs and outcomes that were analysed.

4. Results

4.1. GPS Data

Tables 1 and 2 and Figures 1, 2, and 3 show the number and distributions of stops "in town" and moves. For further details of the methods used, see the previous sections.

A series of four A1 (594 × 841 mm, 23.4 × 33.1 in) posters were produced to support the dialogues in the workshops. Two maps are included as Figures 1 and 3. All maps are available in full resolution online (legends in Danish):

1. Stops "in town" for the entire City of Odense (Figure 1): http://joom.ag/af0L

Table 1. Respondents' stops during weeks 8, 9, and 17 of 2017.

Number of stops			
Total	More than five points	"At home"	"In town"
919	707	393	314

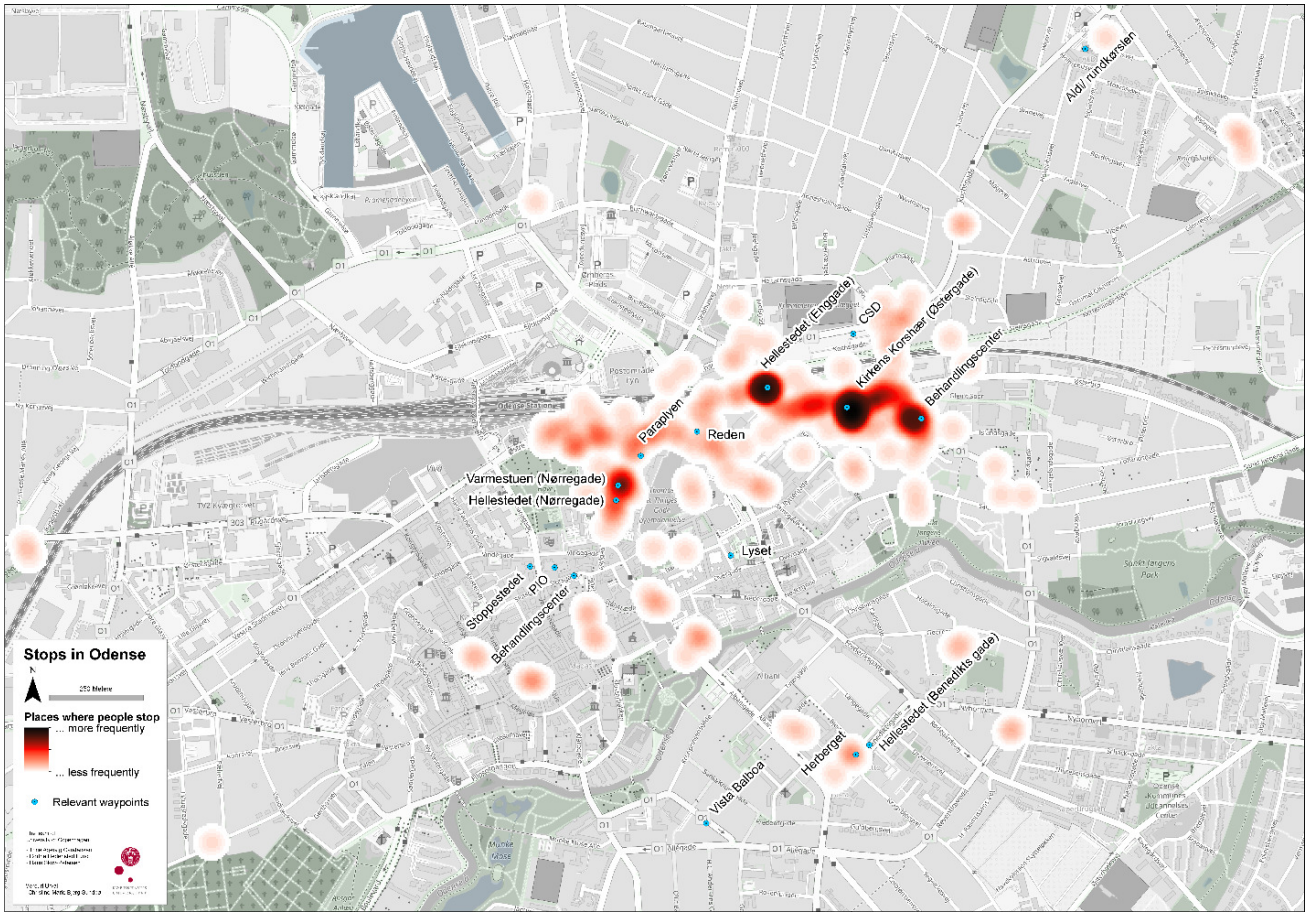

Figure 1. Stops "in town" (not "at home") in downtown Odense.

2. Stops "in town" in downtown Odense: http://joom.ag/ef0L
3. Walking through the whole of Odense (Figure 3): http://joom.ag/df0L
4. Walking to downtown Odense: http://joom.ag/zf0L

The maps were deliberately designed in a large size (A1) to foster dialogue between the participants of the workshops. Furthermore, several relevant and generally well-known locations (waypoints) have been added to the maps.

4.2. Workshop 1: Marginalised Citizens

The respondents explained that they were motivated to participate by shelter staff and by the meal vouchers they received from participating. They wanted to assist the DanChurch Shelter and the municipality in improving their understanding of the group's behaviour and needs. They thought it was an exciting project that could contribute to urban planning focused on marginalised citizens. They expected that the outcome of the GPS project would be to identify locations for new refuge(s).

The participants felt safe about the project, and they did not feel they were being surveyed. One respondent stated that, in the beginning, it felt a bit weird knowing that the municipality could follow one's behaviour. Another respondent talked about the relationship between surveillance cameras and safety. When a favoured spot in a square with an overhead surveillance camera was moved elsewhere due to urban redesign, the camera remained in place. Thus, the spot-users soon asked the authorities to move the camera too, as it provided them with a feeling of security and comfort, presumably in relation to local criminal gangs and mobs. Conversely, surveillance was an issue for those shelter users who did not want to become part of the data collection.

The shelter users who participated in the group dialogues found that the map revealed a precise and relevant picture. However, they also pointed out that a handful of important places were missing. One respondent explained that a group of GPS carriers had deliberately enrolled with the intention of going frequently to a preferred location to actively enhance its activity level, and thus raise the site's candidacy as the location for a new refuge. This shows that the participants were aware of the technology as a potentially new or added option in "being heard" in a public planning process by being recorded, thus choosing to "vote with your feet."

In examining the mapped spatial patterns, the respondents immediately started to explain how these were reasoned, for example, how a lack of safety led to the dominant choices of the route being along the major roads, where they felt less threatened by local criminal gangs and mobs, and avoiding minor ill-lit roads.

The workshop participants also provided additional information on preferred urban spaces and spatial qualities. Dedicated spaces, such as the refuge near the shelter, were important. They also stressed a preference for public spaces that were not too isolated and that provided them with a feeling of belonging to the city and of being part of the urban spectacle. However, some segregation was also valued, as it created a feeling of not disturbing the public order. They reflected on how the group's behaviour with crowding and creating noise and

Table 2. Respondents' movements during weeks 8, 9, and 17 of 2017.

			Average		
Means of mobility	Number	%	Distance (km)	Duration (minutes)	Average speed (km/h)
Walking	200	48%	1.4	42.8	3.0
Cycling	208	49%	3.3	44.5	10.1
Car/bus	13	3%	7.4	42.1	21.8
Total	421	100%			

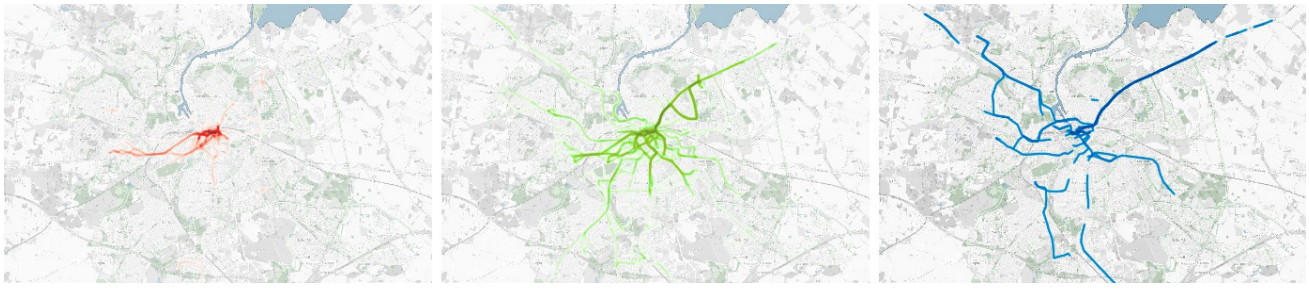

Figure 2. Maps of density/kernel distribution of points on the move. Notes: From left to right, we have, in red, walking (see details in Figure 3); in green, cycling/running; and, in blue, car/public transport.

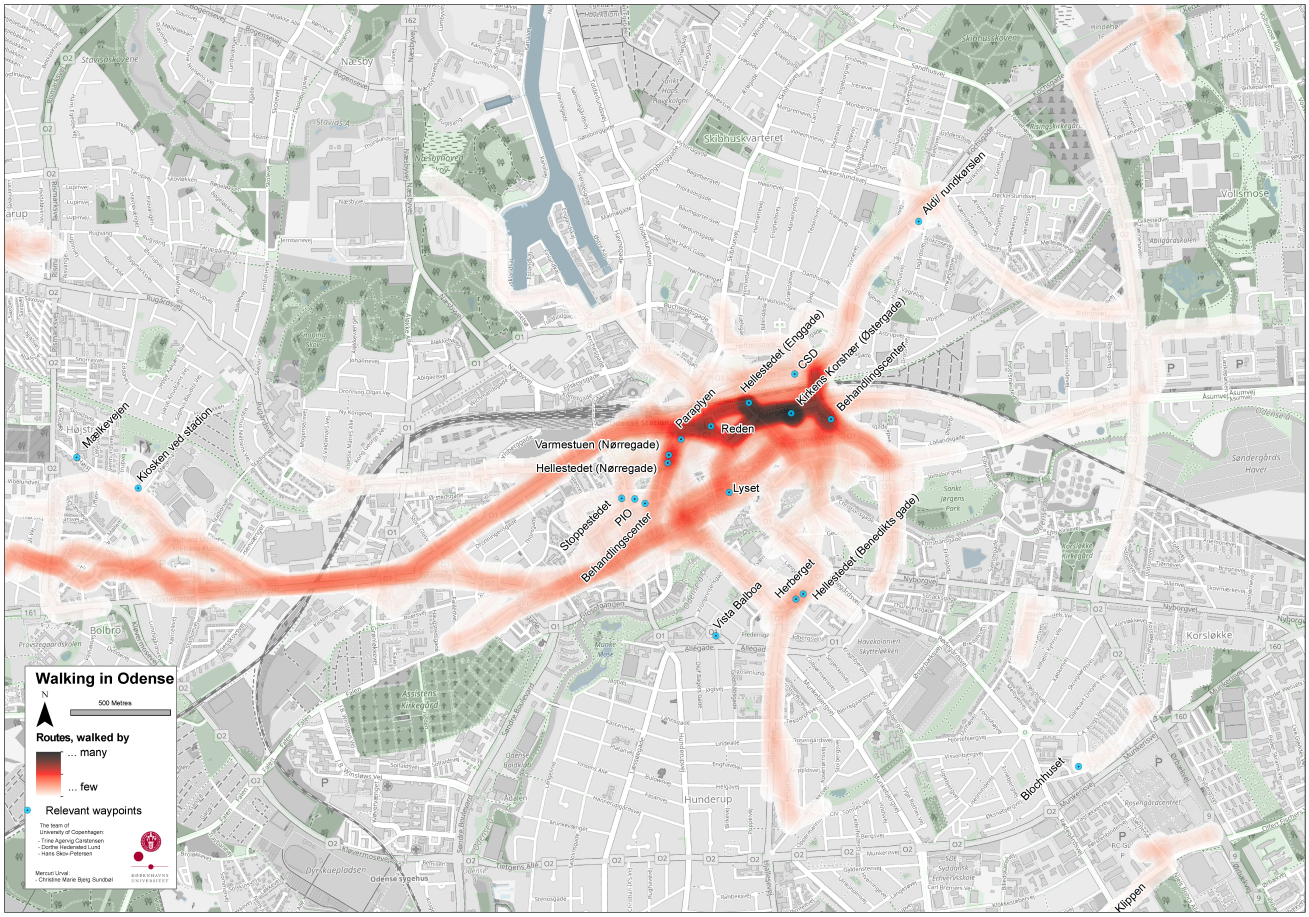

Figure 3. Stops "in town" (not "at home") in Odense: Entire area of recording.

litter negatively impacts their harmonious cohabitation with other citizen groups.

One of the lessons of this workshop was that GPS tracking has the potential to make the social visible by revealing spatial patterns, as well as empowering the "muted" citizen groups, but also that it cannot stand alone. The GPS-based tracking and the resulting maps were experienced as a valuable communicative platform for and contribution to the dialogue with the marginalised citizens and thereby improved insights into the patterns and spatial needs and preferences of this group.

4.3. Workshop 2: Marginalised Citizens' Representatives

The workshop started with the representatives drawing their own maps of how they saw the marginalised citizens' spatial behaviour. These mappings were almost identical to the GPS-based maps, which showed that the representatives already possessed much of the knowledge on spatial behaviour that the GPS project was striving to uncover.

In addition, the representatives found that a lot of behaviour was missing from the map and that it only represented a narrow section of the marginalised citizens, namely citizens over 30 years of age and mostly men with alcohol problems. This was the result of the sampling strategy, as a lot of Odense's marginalised citizens do not use the DanChurch Shelter. When discussing how to collect data that would represent the entire group of marginalised citizens, they saw more challenges than solutions.

These workshop participants did not find that the GPS method revealed relevant information. For them, what was important was to grant a voice to marginalised citizens. They found that the method had many limitations, as the maps only revealed spatial patterns. They also discovered that the maps had the potential to show how the locations of existing health services and public spaces determine marginalised citizens' daily life patterns and living conditions. They were also critical of how the data would be applied in the future. They asked whether the revealed routes to a suburban neighbourhood, where 30% of the marginalised citizens live, should be interpreted as a wish to have a refuge (a dedicated public space) located in this part of the city. It was concluded that GPS tracking is not enough to include socially marginalised citizens in the planning for an inclusive city. Other sources of explanation are important too.

The representatives were sceptical about whether the GPS tracking provided any necessary knowledge at all. First, this was because they already possessed that

knowledge themselves. Second, as gatekeepers and protectors of the group, they felt that the project's outcomes did not legitimise the GPS method. In their opinion, the direct engagement of marginalised citizens as GPS carriers had intervened unnecessarily in their lives, both when deciding to enrol and when waiting for the results. The GPS project had been running for almost three years before its results were presented, by which time the marginalised citizens' patience was exhausted.

4.4. Workshop 3: Municipal Professionals' and Planners

In the workshop with the municipal professionals and planners, the mapped behaviour was discussed indirectly. The workshop focused on a broader discussion of the derived effects of the GPS project and of the potentials of and barriers to applying such evidence-based data in intersectoral strategic collaboration within the municipality.

The GPS project had been running for three years, during which time many meetings across the different municipal sectors and professions were held, which facilitated discussions and decisions around the implementation of the inclusive city. Thus, GPS tracking had been contributing to the establishment of an internal common narrative and anchoring of the vision of the inclusive city.

The workshop participants found that the knowledge base prior to the GPS test was influenced to a high degree by the gut feelings and assumptions of the various actors and that the main motivation for the evidence-based approach would be to add to such individually based interpretations. Hence, the provision of a better, more factual, and representative foundation for decision-making was assessed, being needed in a setting where actors with diverse agendas must plan for communal and public intervention and service.

The participants saw huge potential in GPS tracking producing evidence for pre- and post-assessments of public investments. The data could ensure a common point of departure for cross-sectoral collaborating actors, promote health and prevent marginalisation, ensure continual contact with target citizens' groups, ensure a focus on establishing urban spaces and services for marginalised citizens who do not benefit from existing services, increase the security of all citizens, and establish specific spatial improvements, such as squares, shelters, and parks. They found that data could also improve marginalised citizens' everyday lives by enhancing the coherence of daily life, reducing mobility needs, and providing accessible health services and protected public spaces.

5. Discussion

The GPS project's validity, relevance, and applicability were assessed differently at the workshops with the three stakeholder groups. The maps were seen as the main outcome of the project in the first two workshops. However, it was soon realised that these maps only gave a time-limited snapshot and did not meet the expectation of providing insights into spatial behaviour dynamics within the citizen group applicable to identifying new dedicated public spaces in alignment with marginalised citizens' changed spatial patterns as a result of urban renewal.

At the first workshop with the marginalised citizens, assessments were made on whether the maps succeeded in revealing valid spatial patterns of the group. The workshop participants saw potential in the displayed patterns, which they validated as non-person sensitive. They also saw challenges regarding the partiality of the mapped behaviour and added more information to increase the maps' representativity of the group, as perceived by the participants. The practice of adding was already brought into play when the data was produced. Here, some of the GPS carriers had sought to align the data's applicability with their own preferences for urban spaces by staying in such spaces deliberately. This practice clearly indicates that some of the marginalised citizens had already foreseen the vulnerability due to the data quality and saw an opportunity to influence the results. Apparently, they had low expectations that the project would be able to identify potential locations for a new dedicated public space. Despite the shortcomings of the data inventory and the maps, the participants found that the GPS project had the potential for increasing the citizen group's empowerment, involvement, and representation in planning and policy. Allowing for the digital participation of marginalised citizens was considered meaningful by some of the participants. They stressed the productive aspects of surveillance as a means of creating safety and felt empowered when they were made "visible." The aspects of visibility were assessed differently within the group. Whereas those who had participated in the GPS project as GPS carriers found that increased visibility ensured safety, another group of shelter users did not want to carry the GPS. This group had no trust in the project and feared the consequences of having their spatial behaviour made too visible in relation to previous experiences with policy authorities and other urban space users.

The second workshop with the marginalised citizens' representatives also centred around the maps as a core outcome of the GPS project, which they approved as being non-person-sensitive. As they already possessed much knowledge about the spatial behaviour of the marginalised citizens, they stressed that the maps mostly displayed the spatial behaviour of what they characterised as "middle-aged to older alcohol-drinking men," with very little representation of other gender and age groups. These shortcomings would have been evened out if the GPS tracking had included a greater variety of the city's health and service landscape. The GPS tracking was considered a unique method of increasing the evidence base for urban planning, but they raised the question of whether the project was adding new knowledge

applicable to urban planning and policy. Still, this workshop's participants were concerned about whether the GPS project's limited mappings would be taken as representing marginalised citizens' use of urban spaces in the future.

The maps' lacking ability to provide insights into spatial dynamics had already been established in the discussions at the two previous workshops. Hence, they played a marginal role in the last workshop with the municipal planners and professionals. At this workshop, the validity, relevance, and applicability of the data inventory behind the maps were framed as a purely technical challenge that could be improved in the future. Instead, they focused on the derived outcomes of the GPS project. They found that the GPS project had the potential to provide a platform for interdisciplinary and cross-sectoral collaboration around the vision of "the inclusive city." They stressed the amount of knowledge of the citizen group they had shared and generated together in the group and how that is being integrated into the work of the individual municipal sectors supporting the engagement in how to enhance the living conditions and welfare of the city's marginalised citizens. Furthermore, they underlined how the GPS project has had derived effects on the city's external branding as an inclusive and innovative city by attracting attention from the outside world, for example, due to a Ted Talk and EU-based city-level collaborations.

6. Conclusion

This article has explored and evaluated the potential and challenges of applying GPS-based data in planning an inclusive city in Odense, Denmark. It has focused on the city's GPS project and the extent to which its maps of spatial patterns were perceived as valid, relevant, and applicable to urban planning and policy from the perspectives of marginalised citizens, their representatives, and municipal planners and professionals. From these three perspectives, various technical, ethical, and governmental challenges and potentials of the GPS project are stressed.

At the time the GPS-based tracking method was applied in the Odense, the method was still new in relation to marginalised citizens. Thus, the GPS project was largely an innovation project and not, as such, clearly defined. The collected GPS data inventory was widely expected to be applicable for understanding how urban transformation impacts spatial behaviour and for optimising the location of public spaces and healthcare services for marginalised citizens. Hence, the aim of the project was both broad and ambitious.

First, the article has developed an analytical framework for revealing group-based and non-person-sensitive maps of spatial patterns based on individual GPS-based data. From the perspectives of the marginalised citizens and their representatives, the procedures for processing the GPS data into maps, outlined here, succeeded in revealing non-person-sensitive spatial patterns. However, due to the data collection period being restricted to one week per person, it was not possible to create a comprehensive picture of the groups' spatial behaviour over all the seasons of the year. Moreover, the data inventory's representativity of the city's marginalised citizens is poor, with the maps only giving a partial snapshot of a limited sample of this group. This representational gap was pointed out by both the marginalised citizens and their representatives in the map-based workshops.

Regardless of the shortcomings of the data inventory and the maps, the municipality decided to locate a new dedicated public space in a suburban neighbourhood undergoing urban renewal. This could be interpreted as a pragmatic solution to meet the expectations of the GPS project, as well as being a way to give the marginalised citizens something in return for spending their time and effort on the project. On the other hand, the marginalised citizens' representatives interpreted the decision as a misuse of data that might harm the marginalised citizens' confidence in the local authorities. They were especially critical of the suburban location, as they saw a need to be in the city centre, where the existing facilities were under high pressure, not at least due to the urban renewal process, that had closed off some of the group's most preferred public spaces.

The workshops also revealed a range of perceived and derived potentials of the GPS project. The maps themselves proved to have the potential to empower the marginalised citizens. First, they made the groups' spatial patterns visible and thus established their citizenship as genuine. Second, they provided them with an opportunity to talk about their living conditions and preferences for urban life. Cartography is a form of knowledge which creates a common platform for reflections and interpretations. Such dialogues are important in re-contextualising behaviour and reminding us that the people behind the data points are flesh and blood with rich experience and expertise. The value of having dialogues about tailor-made maps with spatial data about the group behaviour of citizens has shown much potential compared to what a standard city map could facilitate.

In conclusion, the GPS project in Odense has provided important insights into the potential and challenges of applying GPS-based data to urban governance and planning. The article has revealed how complex it is to provide evidence for spatial patterns of a marginalised citizens group useful to localise services. Despite immature methodologies and technical challenges, the GPS project has produced important side benefits ranging from marginalised citizens' sense of empowerment to fruitful collaborations about the project among municipal planners and the marginalised citizens' representatives. Hence, building on the lessons learnt in the crucible of Odense, we find the approach relevant for further exploration and testing in other cities and future studies.

It would be crucial to apply a more systematic approach to sampling strategies and order to ensure a better representation of the group's spatial behaviour. Although distrust would be hard to overcome when making the social visible, the project has shown that non-person-sensitive spatial patterns can be made visible and have productive effects on the urban governance of more inclusive cities.

As Goodman et al. (2020) have argued, many municipal governments see public participation as a top-down tool, despite sincere attempts to become citizen-centric. To some extent, this was also the case in the Odense project, and it relates to the GPS project's objectives, which did not include the marginalised citizens' needs and preferences at its point of departure. Some important methodological insights have been gained, potentially making future projects more citizen-centric. This study has taken its point of departure in GPS-based maps, which allow the social to be made "visible." Such maps provide important platforms for communication and inclusion. They can increase civic, professional, and political awareness about marginalised citizens' living conditions and well-being, and they can work as consultancy tools enabling marginalised citizens to increase the knowledge base for their urban space preferences and use, thereby making urban planning more citizen-centric.

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Conflict of Interests

The authors declare no conflict of interests.

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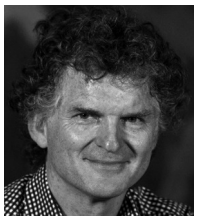

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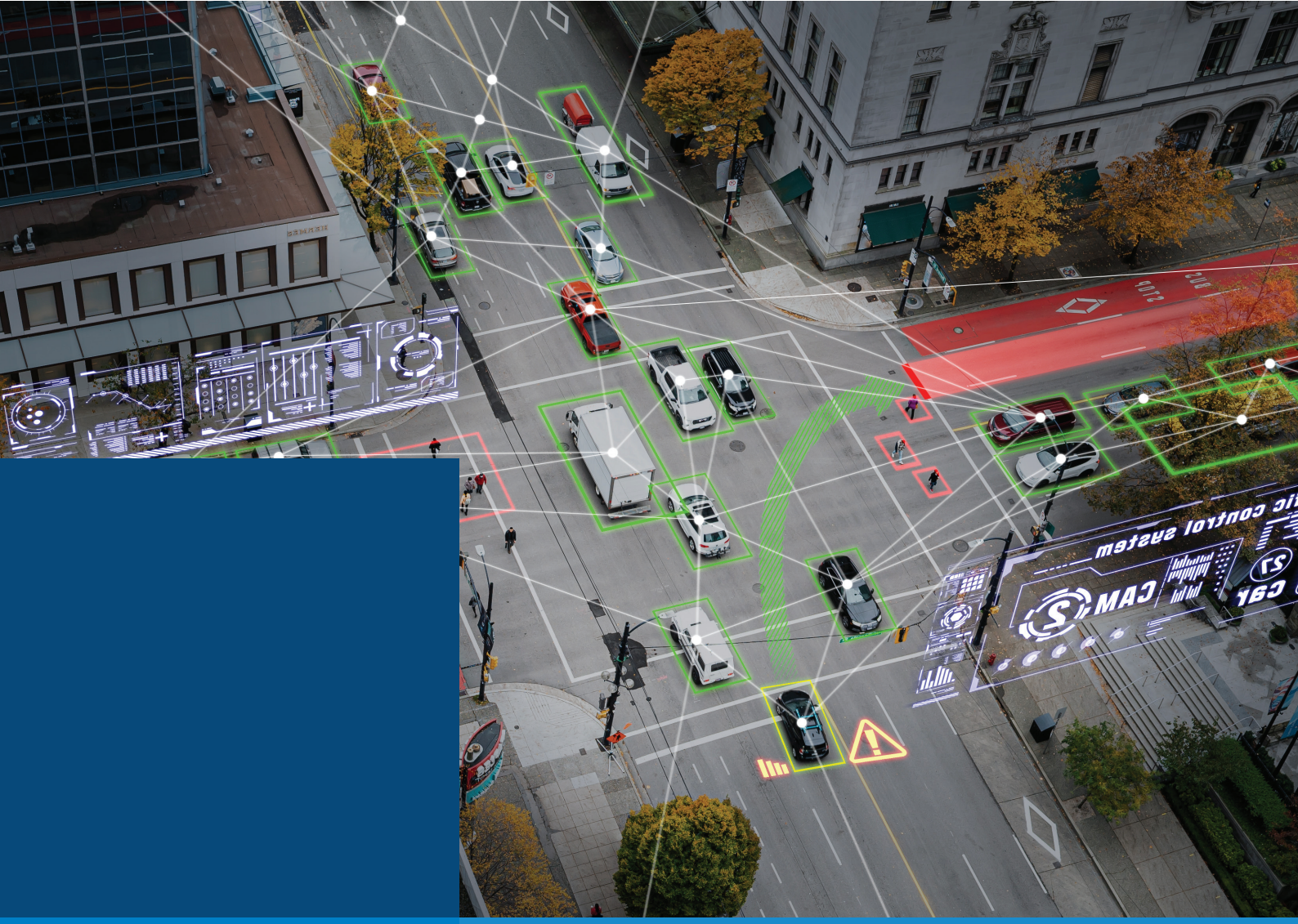

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