

Designing Physical and Virtual Walkshop Methods for Speculative Internet of Things Research

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Abstract. This paper describes a novel method combining speculative design with walking workshops to reveal the ethical and social challenges of connected technology in public spaces for policymaking. In the digitally hyper-connected society, digital technologies such as sensors, the Internet of Things (IoT), and Artificial intelligence (AI) enable people, and ordinary objects, to be connected in almost every place. This project tested different methods such as a walking method called walkshop and digital recreation of the physical environment to allow policymakers to explore a future connected place. We introduce a comparative analysis to show the opportunities and challenges of both physical and digital methods. The findings show the value of physical and virtual walkshops to engage communities and place managers on building a connected place in a participatory manner.

Keywords: Speculative design, walkshops, connected places

1 Introduction

Since the breakthroughs in digital technology in the 1950s (WEF, 2016), we now live in a digitally hyper-connected society, where the technology enables people and even ordinary objects to be connected in almost every place. It includes smartphones, sensors, Internet of Things (IoT), edge computing, and Artificial intelligence (AI). As a result, the world is said to have become more digital and 'smart', which has been termed the Fourth Industrial Revolution (Schwab, 2017). The widely known concept of the connected place (also known as a smart city) is that deployed sensors around a physical place gather and transmit the data in real-time and analyse and use it for decision making (NCSC, 2021). Meanwhile, policy is a vital part of this socio-technical transition because it is influencing the diffusion process of technology (Stoneman & Diederer, 1994). However, while research has explored and continues to explore how the life of a city and the activity of those who inhabit them will be changed, less research explores the methods that might be used to examine these changes and support policymaking.

This paper describes the ways in which design research can contribute to investigating the transition of society, culture, and environment driven by technology before these changes are established and designing research more effectively considering physical and digital contexts. The main contribution of this research is to explore speculative design in the future of connected public space and examine the opportunities and challenges of combined methods for the future use of physical and digital placemaking.

The motivation presented in this paper is to explore potential areas in policymaking through speculative design and design fiction to reveal the ethical and social challenges of the information society and connected technology in public spaces. Ordinary yet fictional objects situated in place can turn into provocations for people to respond to a series of questions, such as what technology is, how it works, and who will be responsible for deploying devices and managing the devices and data. The process of questioning the issues will add to knowledge about the existence and use of such digitally connected systems. The methodological perspective of this project uses mixed methods based on design fiction and speculative design. First, we tested walking methods combined with speculative design to give participants a place-based experience of a future connected place. Later, we built an approximate virtual city centre in a digital platform, Gather Town, to carry out a virtual walk with participants in the distance. The aim of building the virtual city was to recreate the experience of the physical space, engaging a broader audience to overcome Covid-19 related travel restrictions.

The literature review explores IoT sensors and connected places, speculative design methods and current practices in digital placemaking. It then addresses explicitly our approach and methods towards walking workshops (or walkshop, a combined method between a workshop and physical walking) in physical and virtual worlds and discusses future use. Next, we offer an overview of the methodological perspectives of two walkshops, the process of designing them and the materials to support them. The findings from the walkshops are then described by reflecting on discussions of the participants. Finally, we conclude with insights from the findings, limitations of the research, and recommendations for further research.

2 Background

The meaning of a ‘place’ has broadened its scope from physical and geographic to digital and hybrid space (Kluitenberg, 2006). A digital transformation, which is largely invisible, has permeated pre-existing physical and built environments, creating a ‘connected place’ (Greenfield, 2017). As people get more digitally connected, the boundary between the digital and physical world becomes blurred (Schwab, 2017). The general assumption of the connected place is to help place managers to distribute the civic resources and increase operational efficiency, based on rich data collected from sensing infrastructures around the place (Mohanty et al., 2016). Various data types can be collected, such as traffic flows, weather conditions, parking space occupancy, and human activities in public spaces (Hviid Trier & Jenkins, 2020). Furthermore, the cyber-physical system is widely adopted in industrial and public sectors, such as digital shadow and digital twins. These systems can simulate different scenarios almost in real-time in

the digital world before any modifications are applied in the real world based on the data collected from the physical world (BEIS, 2022).

The vision of the connected place and the cyber-physical system is to improve the quality of life for people in the place via connected technology (NCSC, 2021). However, this vision has been criticized for technology-led and top-down approaches, and it is still unclear how the data can benefit local people (Tomitsch, 2016). Thus, it is vital to find ways to create an approach that redistributes power between governments and citizens. In particular, the deployment of IoT sensors in public spaces is controversial, provoking challenges across diverse issues, such as lack of public awareness, lack of understanding or consent, suspicion, mistrust, vandalism, malfunctioning and poor user experience (Mikusz et al., 2018). The possible scenarios of the technology implementations should be examined in association with those they impact, including experts and policymakers before they are deployed on a large scale and become too embedded to be significantly changed.

2.1 Speculative design and design fictions

In the late 1950s, the emergence of speculative design began with critical designers questioning and criticizing the mainstream design, industrial design, and the dark side of technology (Malpass, 2017). Speculative design is an explorative and experimental approach that does not support conventional commercial design work (Sanders & Stappers, 2014). Design fiction is a specific type of speculative design method used to create tangible objects representing speculation. It is also seen as an emerging tool to involve people and provoke questions about the future of technologies and implementation (Coulton et al., 2017; Galloway & Caudwell, 2018). Sterling (2005) essentially considers design fiction a kind of science fiction that contains science backgrounds and objects merging with design principles and practices. For Dunne and Raby (2013), design fiction attempts to tackle technology's cultural, social, and ethical impact but with fewer intentions to provoke debates and promote changes in situations (Galloway & Caudwell, 2018). Bleecker (2009) describes design fiction's distinctive characteristic as making more sense than science fiction by thinking of 'near' futures. Blythe (2014) describes design fiction as the assemblage of activities to engage with the imagination of possible futures. It integrates with storytelling, technology, and design, allowing people to imagine how the world will be in the future and consider how making and forming things enables people to think about what is possible and what should be possible. Design fiction is a collage of fact and fiction, science fact and science fiction where 'ambiguity' and 'imaginary abstracts' have played a significant role in enabling fictional objects to look like everyday designed objects (Lindley & Coulton, 2016). The current applications of design fiction have become more comprehensive, from provoking discussions around technologies to involving the public in imagining the futures of policy implications (Blythe, 2014; Tsekleves et al., 2017). The broad uses of design fiction indicate the potential for studying future connected places and related policies.

2.2 Physical and digital sensemaking of place

In this work, we consider speculative objects situated in places to capture in-depth insights from people about those places. A place includes tangible attributes, such as the physical location and setting, and intangible attributes, such as human activities and concepts (Canter, 1977). In addition, place concepts indicate cognitive elements that enable people to build a long-term relationship with a place, such as meaning and identity (Ahmed & Zeile, 2020). To understand and reinforce intangible aspects, walking has emerged as a practice that engages and interrogates a range of technological assemblages within a place. Workshops on the move ('walkshops' as named in this research) are understood as a "learning experience that's equal parts urban walking tour, group discussion, and spontaneous exploration" (Greenfield & Kim, 2011). The walkshops are an experiential mode of interrogating various issues relating to technologies and their impacts on people and places.

Digital tools and platforms in place contexts form the concept of digital placemaking, increasing a sense of place through digital media. The growth of advanced computational interfaces and material technologies have merged the area between physical and virtual interfaces. Form-making activities with digital technologies have become more interactive and functional (Jung & Stolterman, 2012). Based on human-computer interaction (HCI), digital placemaking is a new, playful way of interaction, enabling people to learn about the history and understand the future of a place (Pang et al., 2020). Furthermore, through experiencing the COVID-19 pandemic, people are re-thinking the meaning of public and domestic 'places' with the dramatic change in physical mobility with lockdown and quarantine measures. The restrictions on movement or social gatherings have also led to the shift online and increasing use of digital videotelephony platforms such as Zoom and Microsoft Teams (Hardley & Richardson, 2020). However, digital interventions are still challenging in place contexts as digital platforms and stories provide limited spatial experiences. People are not generally familiar with digital platforms in the place context. Therefore, there is a danger that these interventions might misrepresent the dynamic of the public space. Digital divides are a challenge for digital placemaking due to generation gaps and cultural divides (Stokes et al., 2021). The endless combination of digital and physical environments has raised about questions what 'place' is and how people can experience the physical place with digital platforms (Halegoua & Polson, 2021).

3 Methodological perspectives: Walkshop and online walkshop

Previous research (Jacobs et al., 2022) used design fiction methods to create speculative near-future public space IoT deployments explicitly tailored to a local area. These were used in participatory work where residents and service providers can discuss practical considerations relevant to the individuals' experiences. For example, one set of design fiction objects included a series of mock-ups of local newspaper coverage of a smart bin installation, which had positive and negative reactions commenting on improved efficiencies and potential privacy violations. To develop these fictions, the devices and associated systems portrayed went through an entire design process based on current

and proposed technologies and similar deployments in other locales to create a setting to link fiction to everyday life.

In work reported here, we investigate how such methods, such as design fiction and walkshop, can be used to speculate future connected places specifically to engage policymakers and how digital artefacts and interactions can assist people in thinking about physical spaces. The essential contribution is combining the speculative design approach with the walkshop methods and the innovative use of a virtual walkshop. The two walkshops addressed IoT infrastructure's ethical and cyber security challenges in public realms. The workshops aimed to gather different stakeholders' experiential knowledge and expertise by using a mixture of location-based materials, such as a field guide, with speculative design fiction objects. Below we describe the process of developing and running these two events, the first of which was held as an in-person, physical event.

3.1 Speculative design and design fictions

The first walkshop was conducted in person with city council officers. The starting point of the design process was to define what IoT, and sensors already exist in Lancaster and where they are located. Existing sensors were identified through prior discussions with council officers. However, this proved challenging since there is no comprehensive list of deployments.

These existing deployments and cases were supplemented with several fictional scenarios represented by design fictions to create eight instances of IoT in the city, as listed in Table 1. The process of selecting public places in Lancaster began with observing mundane objects and routines around the public places and matching them with the fictions. For instance, lamp posts and bins in a square turned into smart lighting and smart bins. We also considered additional speculative aspects to allow us to explore challenging but interesting questions, such as an AI monitoring system in a bus station. Sites were selected in the city centre regarding their proximity for carrying out the walk within a two-hour session. For example, river sensors that check water levels were initially considered but were excluded as they were distanced from the city centre. As a result, eight stops were chosen, including four public spaces in the city centre.

Table 1. List of walk stops and types of devices

Stop	Type of device	Fiction or real
1	Smart Bin	Fictional (signage)
2	Air quality monitor	Real (no signage)
3	Parking Meter	Fictional (signage)
4	Bollard	Fictional (no signage)
5	Bus Station	Fictional (signage)
6	Coffee shop	Real (signage)
7	AI Monitoring	Fictional (signage)
8	Smart Light	Fictional (no signage)

These IoT deployments have varying levels of transparency. Some of the objects (both real and fictional) display signage that conveys some information about them to passers-by. In some of these signs, the design fiction was supplemented by using different visual typography and graphics, representing various signages around the city designed and placed by diverse stakeholders, such as traffic signs, public advertisements, warnings, and etc., as well as speculative iconography developed by Lindley *et al.* (Lindley *et al.*, 2020) (Figure 1). The iconography was developed to speculate on the legibility of AI systems, covering the concepts of AI processing location, learning scope, data provenance, training data type, and intrinsic work for AI operators (Lindley *et al.*, 2020).

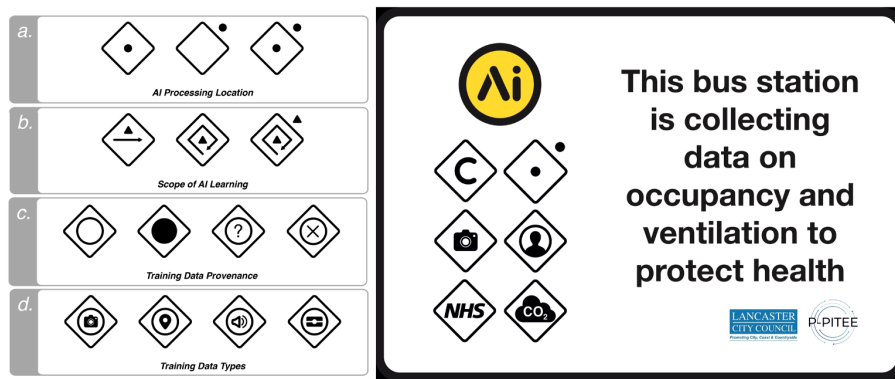


Fig. 1. Icons for AI legibility (left) and an example of design fiction signages (right) adapted from Lindley *et al.* (Lindley *et al.*, 2020)

The final stop on the walk was not an individual design fiction object but a highlighted area that offered the participants the opportunity to speculate on what other uses of IoT may be likely in this space.

Design of the workshop materials: Signs, field guide and a map

The materials were designed to encourage interaction and engagement with and between the participants (Figure 2). We drew upon a range of inspiration regarding the physical capture of research data during the workshop. The physical data capture tool was designed in the form of a field guide. The field guide lists each site alongside six prompt questions: What is it, and how does it work? What data does it collect and why? What are the potential benefits? What are the potential risks? Are there any security challenges? And are there any ethical challenges?



Fig. 2. Workshop materials: a field guide, stickers and a map

Stickers were printed with descriptions of the objects. After answering the initial questions about the object's purpose, the participants were provided with the correct sticker at each location. The purposes of the stickers include revealing whether an object is real or fictional and providing more information about design fictions to the participants, what and how they worked. Furthermore, they allow the participants to speculate what the object is and how it works, what data it collects, and why and provide more informed consideration with the supplemental information not revealed by the in-situ object. In addition, to guide the participants safely, a tourist map of Lancaster centre was revised and provided, mapping the nine locations and providing a route.

3.2 Virtual workshop: Recreation of physical experience in Online space

The virtual workshop was planned to reach experts on IoT and adapt to travel restrictions during the Covid-19 pandemic. It was an opportunity as well as a challenge in designing research to recruit participants in the distance and conduct a 'walking' workshop. We built virtual 2D spaces on the Gather platform based on the tourist map of Lancaster city centre (Figure 3). Gather is an online conferencing platform that allows users to select an avatar and video chat by proximity between these avatars. In addition, the users can virtually walk around the space to join and leave the conversation with others using direction keys (Jacobs & Lindley, 2021). The challenge of this experimental workshop was to recreate the experience of being in physical spaces on a digital platform. This function of Gather enabled us to partially replicate the experience of the workshop.

In the Gather space, photographs of some public spaces were uploaded to form part of the Gather environment and representations of other parts of the route. Since it was

impossible to re-create the whole city photo-realistically, the representation of the sites in Gather did not accurately portray all real sites in the city on the route. This limitation leads to abstraction on the 2D map and provides selective experiences of the places. To supplement the absence of spatial experience, the nine stops were video recorded in 360 degrees showing the actual or design fiction objects and any associated signage. They were embedded in the Gather space. A further measure to enhance the physical interactions was the provision of physical materials via post to the participants, who were sent a printed field guide, map, and stickers. Participants were asked to send the field guides back post after the workshop. An online version of the field guide was additionally sent as a backup in case delivery of the materials did not arrive on time for the virtual walking workshop.

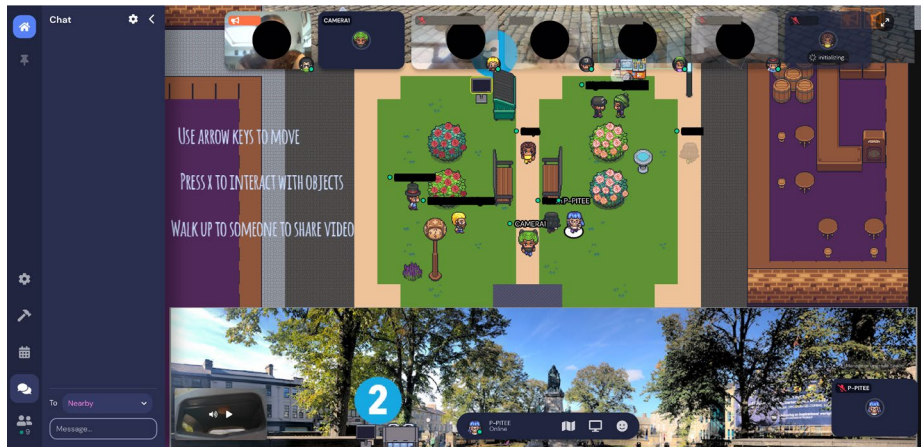


Fig. 3. Screenshot of Gather Town

4 Comparative analysis of walkshop facilitations

The two different platforms used (physical and virtual) required two different approaches to facilitation (Table 2). During the in-person walkshop, a facilitator first asked the participants to walk to a site and observe a design fiction object in a public space. The first walkshop was conducted with city council officers who are experts in integrated approaches to policy and public inquiries. The participants were asked to respond to the prompt questions in the field guide. The facilitator also opened a discussion space to share what they think regarding their own speculations and information they have already known. After the discussion, a research team member handed a sticker out, and the participants were asked to stick it on their field guides. With the information on the stickers, they were encouraged to discuss the benefits, risks and security and ethical challenges.

We found that the online workshop added more complexity to the facilitation. For example, while the facilitator guided the participants through each stop on Gather, the facilitator pointed out the right moment to watch the videos and reveal the stickers.

With the facilitator's instruction, the participants had to move their avatar close to a video point and watch it by themselves by pressing a play button. We also found more modes of interaction in the online walk, such as chats, verbal discussions, and keeping notes on the field guide.

Table 2. Comparison between in-person and online workshops

Format	In person	Online
Participants	<ul style="list-style-type: none"> • Council officers 	<ul style="list-style-type: none"> • Cyber security experts
Materials	<ul style="list-style-type: none"> • Printed map • Printed stickers • Field guide • Signs designed with different visual languages, and icons 	<ul style="list-style-type: none"> • Printed map (sent via post) • Printed stickers (sent via post) • Printed field guide and digital field guide (sent via post) • Embedded 360-degree videos and pictures of the places
Locations	<ul style="list-style-type: none"> • City centre 	<ul style="list-style-type: none"> • Gather Town based on the map of Lancaster city centre
Interaction & facilitation points	<ul style="list-style-type: none"> • Walking with the facilitator • Sharing the thoughts by speaking • Filling up the guides 	<ul style="list-style-type: none"> • Virtually walking with the facilitator • Sharing thoughts by speaking • Texting in the chat • Filling up the guides
Participants	<ul style="list-style-type: none"> • Council officers 	<ul style="list-style-type: none"> • Cyber security experts

The initial settings of both workshops seem similar in that they use the walking method (even though online 'walking'), the same design fictions, presenting the same stops and facilitation processes. For the online workshop, there were additional considerations to the recreation of the digital space and delivery of tangible materials, such as a printed map, field guide and stickers, via post. However, facilitation between in-person and online was still different due to methods of communication and the nature of the environment. In the in-person workshop, the facilitator had to take into consideration external factors in the public spaces, such as speaking loudly and walking through a crowd. On the other hand, even though there were no noise and crowds in the online space, online participants had to deal with a larger number of communication channels such as using a chat window and turning on the video and microphone.

5 Discussion

5.1 Combining the speculative design method with the walking method

The combination of speculative design objects and physical walks is a novel approach in both technology and place contexts. While speculative design methods and practices can add a critical perspective of technology to address social and political issues (Lukens & DiSalvo, 2011), the walking method can offer a place-based experience of the future connected place and relevant digital technologies. This approach can open the space for discussion about the benefits, risks, and challenges of connected public places even with participants who might not have a deep understanding of IoT (Mullagh et al., 2022). In addition, by combining the fictional objects in actual places to trigger participants' imagination with actual objects we could provide an immersive environment to think about objects that have yet to exist.

The process of the place-based experience can be categorized into three stages: observation, speculation, and discussion. First, observation allows people to look at an object in the actual place and walk around the place itself. This stage bridges a gap between fiction and the near future. The participants often asked us if the objects were real or already deployed due to the mix of fictions and everyday contexts. Throughout this process, we found it useful to consider current issues being faced by the public sector. For instance, in the workshops with the council officers, it was challenging to identify what deployments were being used in public spaces because there is no centralised system to keep the records or control them. One of the participants also revealed that even though sensor bins that can check the fill level of the trash are already used in the public domain, few people knew about existing sensors. In the second stage, speculation, walkers considered how these deployments work associated with their understanding of the technology. The stickers given, as an intervention, offered additional information and new insights to speculate on, such as external partners, systems, and relevant activities. Lastly, during the discussion, the participants were able to articulate their thoughts about potential benefits, risks, and challenges. This last stage provides a mutual learning space to develop a more in-depth understanding of the technology and issues. Throughout discussions, the walkers mentioned that they could understand possible scenarios related to IoT sensors and services and see the landscapes of digital infrastructures and systems in public spaces.

A physical workshop has clear benefits of exposing people to contexts of place and various sensorial activities, which may facilitate social connections and potentially affect place attachment (Lewicka, 2011). However, it also poses challenges in terms of facilitation. It was observed that some participants were physically tired after two hours of walking and standing so they had less discussion than at the beginning of the workshop (the workshop took place during the summer on a hot day). While the walk was on flat ground and thus wheelchair accessible, this method may not be suitable for those with physical disabilities which impair general mobility. The ambient noise, crowd dynamics, and traffic also made it challenging for the participants to maintain their concentration and may have prevented them from being fully engaged in the dis-

cussions of the workshop. Lastly, we found that the interaction with tools could be re-designed and supplemented further in terms of the practical aspect of combined methods. For instance, even though the field guide presents prompt questions comprehensively, there were few written responses on the field guide. We observed that some participants struggled to write while walking or standing in the public spaces.

5.2 Using digital space to explore physical space

Although the use of digital platforms to explore physical places is still experimental, digital spaces have been recognized as collaborative creation spaces in placemaking (Foth, 2017). Recreation of spatial places provided a remote 'walking' experience around the virtual city centre. This experience enabled the participants to interact and feel the city indirectly without the distractions of the physical environment. The digital space also provides controlled but limited experiences of places by an abstract representation of the place.

To some extent, it was possible to replicate the physical and unique elements of place in the virtual space, but the digital city centre is not accurate. Because of the limitations in building a digital space on a 2D surface, the digital space looks more like a game space than panorama views of the real world, as found on platforms such as Google Street view. Most of the participants from the online workshop had never visited the city. Interestingly, the participants of the second workshop appeared more focused on the place when connecting speculative ideas. For instance, some participants pointed out that one of the currently deployed sensors does not harmonise with the public space's appearance, a city's historic site. By watching the short videos providing limited but less distracting contexts, the participants paid close attention to what was happening in the places. A further example of this is the video of the smart light design fiction, which shows a bank near the lamppost. Some participants speculated on possible cyberattack scenarios in the bank through the smart lighting system. This observation highlights how spatial experience can be delivered and expressed on an online platform.

Abstract representation in the digital space can maintain the 'ambiguity' of design fiction. This ambiguity in digital space becomes an opportunity to imagine the city without the constraints given by the meanings attached to the current physical environment. The abstract digital place can push the boundary of thinking about what the place currently looks like and what the place can be. The platform also offers 'playful' experiences for people with game features such as selecting an avatar and moving with direction keys. This approach can be advantageous as a research method because data can be collected through chats, conversations and activities without the crowds and noise in the public spaces.

Despite these benefits, we also found some challenges with the virtual workshop. First, it seemed more demanding for participants in terms of communication. Several channels were open to communicate via audio, chat, and even handwriting in the field guide. The openness of these channels can misdirect participants or distract them from the conversation. Second, participants of the digital workshop most likely did not experience the same place attachment as the participants of the physical workshop. Thus, participants of the digital workshop do not have the opportunity to experience the actual

city centre or know what is happening there in real time. Third, there are infrastructural limitations such as access to the internet and digital literacy that segment the participation of certain groups. For instance, this method would exclude people with no access to the internet or sufficient digital literacy and may be challenging for those with visual impairments.

Table 3. Opportunities and challenges of in-person and online workshops

	In-person Walkshop	Online walkshop
Opportunities	<ul style="list-style-type: none"> • Building understanding of place • Sensorial activities of the place 	<ul style="list-style-type: none"> • Controlled environment with less distraction • Easy to draw attention • Easy to collect data • Abstract representation of physical place provides space for imagination • Creative and playful activities
Challenges	<ul style="list-style-type: none"> • Physical tiredness of participants • Difficulty in facilitation in the public spaces • Interaction with physical tools 	<ul style="list-style-type: none"> • Limited experiences of place • Confusing interactions including chats, verbal communications, and writing on a physical field guide • Involving people with constrained internet connectivity

6 Conclusion

This paper describes research that applied experimental approaches and design methods to unveil the benefits, risks and challenges of sensors, Internet of Things (IoT), edge computing, and Artificial intelligence (AI) deployed in public spaces. This study combined a walking method with speculative design and then recreated a place-based experience in the digital space for wider audiences.

One of the limitations of this study, as a short research project, was the number of participants. Two groups of stakeholders, council officers and data security experts, were involved. It was limited by being a short pilot study, and future work is planned to involve a wider range of participants and stakeholders including the public. Despite this limitation, the workshops and design fiction results seem promising for imagining future public spaces and bringing insights and considerations around connected places. It indicates there are still diverse stakeholders who can bring other understanding and perspectives for future policymaking.

The combined approach reflects the potential use of the walking method and speculative design in future place research. We observed that the in-person walkshop can add tangible experiences of a future connected place presenting ordinary yet fictional objects. These situated objects enabled the participants to become immersed in design fiction, which helps them to imagine and observe the objects, the built environment, the

people, and the content of the place. However, the short pilot study was time-limited, so further research is needed to investigate how to provide better interactive tools to collect the insights of people and engage with a comprehensive range of stakeholders, including the public.

The opportunities and challenges of both workshops imply insights into the future use of digital platforms in building a connected place. To build a better future place, balancing the benefits of physical and digital methods will be beneficial to support community and place managers. Further research is needed to explore possible hybrid approaches that combine digital platforms with physical contexts and activities, as the approaches might bring different but diverse results. It should also be examined how abstraction in digital places can influence people to think about the actual place and speculate about the future and where the methods can be used to explore potential policy areas and engage different groups of people to co-create better places.

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