



Discovering smart: Early encounters and negotiations with smart street furniture in London and Glasgow

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ABSTRACT

In the late 2010s, publics in the UK encountered new kinds of street furniture: Strawberry Energy Smart benches in London and InLinkUK kiosks in Glasgow, with smart features such as phone charging, free Wi-Fi, free phone calls, information screens and environmental data. This article analyses how smart street furniture is socially constructed by relevant social groups, each with different interests, forms of power and meanings. Smartness became associated not only with advanced technologies, but with a neoliberal agenda of private-public partnerships promising urban transformations, such as free devices for councils and citizens in exchange for access to advertising or sponsorship space in public places. The research examined the design, use and governance of new types of smart street furniture using mixed methods, including document analysis of promotional and regulatory texts, site observations of these devices, and interviews. We found that the uses and meanings of these devices were discovered at different moments by technology companies, local councils, and the public. Few members of the public knew about the devices, and showed little interest in them, even if they were the assumed users. An exception was gig workers and people experiencing homelessness who found uses for the smart features and a community activist who campaigned against these as surveillant and intrusive. Businesses and councils embraced smart city visions but took multiple approaches to agreements for the implementation and governance of smart street furniture. Notably, these more powerful groups discovered and negotiated the meanings of smart street furniture well before these were publicly encountered. This article reveals how a social construction of technology (SCOT) approach is strongest when it accounts for the relative power of social groups in struggles over meanings and resources. It provides empirical information on everyday sociotechnical encounters that provide nuanced evidence for wider critiques of smart city agendas.

1. Introduction

As people move through everyday urban landscapes, they frequently encounter familiar devices designed to anticipate their perceived needs: benches for rest, street signs and maps for wayfinding, phone booths for communication, advertising to influence consumption, and so on. In some cities, people are recently discovering new ‘smart’ street furniture

with features such as internet access, information services, mapping, and mobile device charging. Our research follows two types of smart street furniture: (1) smart benches in the Borough of Southwark in South London by the Serbian company Strawberry Energy (Fig. 1); and (2) Information kiosks and advertising displays called InLinks in Glasgow (Fig. 2). In both cases, councils with smart city policies had negotiated with urban technology manufacturers to form private-public

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Fig. 1. Strawberry Energy smart bench in Southwark Borough Council area.



Fig. 2. InLink in Hope St in Glasgow City.

partnerships to install smart street furniture in cities in the UK.

This article aims first to understand the processes by which these devices came to be developed and installed, and second, to explore public perceptions, meanings, and experiences in encountering these devices. This research was undertaken as part of a larger project which sought to understand the design, use, and governance of smart street furniture and their relationships to prior urban forms.

The InLinks and Strawberry Energy smart benches support several contemporary meanings and uses. Both recognise the widespread use of smartphones in the urban media environment by offering free Wi-Fi and charging. Smart benches are familiar inasmuch as they provide the everyday public amenity of a place to sit. Strawberry Energy invoke an eco-friendly message by providing environmental data that visitors can access through a free downloadable app and also by prominently using solar panels mounted at the top of a large pillar. InLinks are more advanced devices that offer free phone calls, a touch screen information tablet, device charging and ultrafast Wi-Fi as well as 135.7 cm HD digital displays on both sides providing screen space for slide shows of advertising and community announcements. InLinks were originally created by InLinkUK, a joint venture between US company Intersection and UK advertising company Primesight in partnership with British Telecom (BT). However, the company did not achieve its goals, and InLinkUK went into administration in late 2019. BT took control of the devices, renamed them as 'Street Hubs', and continued their roll-out into selected sites in the UK (Willets, 2021).

The introduction of these smart street furniture devices was inextricably associated with aspirations in the technology sector and local governments to transform urban spaces into 'smart cities'. In the decade leading up to their introduction, businesses and governments participated in events and read promotional texts emphasising the role of information and communication technologies in future urbanism. Smart

technologies were purported to improve the functioning of government and the enhance the lives of the public. They were seen as advancing a general quest for 'efficiency' (Kummitha, 2018, p. 330) by reducing transaction costs, growing the economy, and addressing issues such as ageing infrastructures and environmental problems (Grossi & Pianezzi, 2017). However, there is no consensus on the meaning of 'smart city' (Angelidou, 2015; Cocchia, 2014; Joss, Sengers, Schraven, Caprotti, & Dayot, 2019). The term 'smart' has become a floating signifier (Lévi-Strauss, 1950) to be appropriated for use in a wide range of contexts: smart homes, smart appliances, smart cars, smart security, smart lighting and so on. The term 'smart city' has been deployed by governments, institutions, and corporate innovators to pave the way not only for new technological developments, but also new arrangements such as private-public partnerships that shape the city and people's experiences of urban space (Sadowski & Bendor, 2019). Smart street furniture is also sometimes implemented as part of more regular city maintenance strategies and in this sense, often represents a 'piecemeal' approach to smart cities (Coletta, Heaphy, & Kitchin, 2019; Dowling, McQuirk, & Gillon, 2019). In their analysis of smart urbanism initiatives in Sydney and Melbourne (Australia), Dowling, McQuirk & Gillon (2019, p. 439) show how the opportunity for making the city 'smart' is translated by local authorities as extensions to their existing civic management responsibilities such as 'rubbish, rates and roads'.

Many 21st century smart city developments have been characterised by reconfiguring relationships between government, corporate partners, and citizens. Traditionally, councils have serviced the needs and desires of their constituencies, evaluating candidate technologies, and installing them with ratepayers' funds (Wilson & Game, 1998). This has always been quite different from the relationship between retailers and consumers — the former acting as intermediaries who decide to stock and promote candidate technologies and offer them as commodities for

private sale. This article shows that a smart city agenda, fostered by technology companies and embraced by some local governments, led to a distinctively new model of financing public services using private companies as infrastructure partners. For both the InLinks and the smart benches, the companies agreed to provide and maintain these devices at no financial charge to the local council, while expecting advertising or brand sponsorship rights in return. Local councils were able to leverage their power as regulators of public space in return for smart services for ratepayers and visitors. Local councils became intermediaries between creators of innovations and ‘end-users’, negotiating the terms under which they would be installed and maintained. Through these public-private partnerships, local councils entered more fully into consumer and market relations in their place-making activities.

Many critics of smart city discourses and practices in the academic literature argue that smart cities forward neoliberal agendas such as privatising public spaces and services (Gibbs, Krueger, & MacLeod, 2013; Grossi & Pianezzi, 2017; Sadowski & Bendor, 2019; Sadowski & Frank, 2015). They have labelled the smart city as utopian ‘corporate storytelling’, creating ‘moral imperatives in urban management’ (Söderström, Paasche, & Klauser, 2014, p. 307). Others have pointed out that designers often develop smart city technologies with problematic beliefs about the assumed users in the sites of their installation (Harri-son, 2017). In practice, community groups, activists and members of the public have resisted these developments through information campaigns and submissions to planning processes objecting to what they saw as surveillance, obstruction, commercialisation of public space, and visual pollution. For example, CityBridge, the former supplier of the LinkNYC kiosks in New York City, met with substantial public and media scrutiny after the initial 2016 network deployment with many groups citing privacy and surveillance concerns. In 2017, the City of New York amended the LinkNYC privacy policies in response to strong campaigning by the New York Civil Liberties Union. Although there is a common idea that smart cities should be managed by real time decision-making driven by embedded sensors and data extractive technologies, the meaning of ‘smart’ cannot be considered as a given, and nor can the future of smart street furniture, as shown by the collapse of InLinkUK. In fact, these devices and networks are physically, politically, and economically precarious, even when they are introduced on a large scale. This was illustrated again in the abrupt withdrawal and discontinuation of the Toronto (Canada) dockside project (Warburton, 2020) with Sidewalk Labs, the Alphabet subsidiary, citing the ‘sustained unpredictabilities stemming from the coronavirus pandemic’ (Cecco, 2020).

As smart city projects rolled out, scholars extended their work from interrogating smart cities institutions and discourses and began conducting more situated accounts of ‘actually existing’ smart cities (Coletta et al., 2019; Hollands, 2008; Karvonen, Cugurullo, & Caprotti, 2018; Shelton, Zook, & Wiig, 2015). Here, research has addressed the need for empirical case studies and more user-centred and place-sensitive accounts (Kitchin, 2015). Therefore, our study follows this tradition in accounting empirically and theoretically for the connections between corporate-led smart city visions (van den Buuse & Kolk, 2019), the adoption of ‘smart city’ strategies by many local governments since the mid-2010s (Urban Foresight, 2016), and their later implementation as everyday technologies in actual urban places (Kummitha, 2020).

There is little scholarly research into the situated knowledges and attitudes towards smart street furniture. In this article, we address this gap by examining the development of smart street furniture by Strawberry Energy and InLinkUK/BT; the decision-making contexts for Glasgow City Council and Southwark Council in installing these devices, and the impressions of the devices from locals and visitors. Through an applied thematic analysis of industry and policy documents, semi-structured interviews, site observations, and vox pops (also known as ‘person-on-the-street interviews’ (Beckers, 2019) we found a range of meanings associated with smart street devices as these were encountered and negotiated by different social groups. We found ‘discovery’ to

be a significant concept that emerged in the thematic analysis for identifying and revealing the process by which these devices were socially constructed at different moments and locations in development, implementation and adoption. We found that local councils played a key role as intermediaries in a discovery process negotiating government-corporate partnerships and determining the sites at which they are installed. This, we note, occurred months or years before the devices were discovered by publics in situ. We found that many members of the public we talked with had not yet discovered the smart features of these devices, with a majority of passers-by knowing little about their functions or uses. When asked, most approved of their modern appearance, and saw their benefits for other people, particularly for precariously connected members of the public such as the homeless, but few expressed an inclination to use them themselves.

Our research is informed by the SCOT approach which offers conceptual resources for understanding the social processes by which smart street furniture devices are given meaning and taken up by different social groups with different agendas. The article highlights a disparity between industry and policy imaginaries of what smart street furniture might be and how it might or ought to be used versus their actual imaginaries and engagement by various publics in everyday urban life. Our results support the development of more inclusive and participatory forms of smart city planning and governance at a local level, whilst stressing the value of innovative qualitative and mixed methods research for making sense of the social construction process for smart city technologies.

1.1. Theorising the social construction of smart street furniture

We evaluate peoples’ encounters with smart street furniture by drawing on the ‘social construction of technology’ (SCOT) framework proposed by Bijker and Pinch (1984). Their work brought approaches from social studies of science into technology studies, stressing the agency of social groups in defining the meanings and uses of technologies. In drawing on SCOT to draw out claims from empirical data we remain sceptical about the exorbitant claims of some smart city advocates, and conscious of the influence of neoliberalism in advancing corporate agendas. However, a SCOT approach also allows us to remain open to discovering the social processes that constitute the situated uses of smart furniture by relevant groups in everyday urban life.

Proponents of a SCOT approach argue that different social groups can have very different interpretations of technologies (Bijker & Pinch, 1984). That is, they consider that an object or device can be interpreted by different groups of people as a different thing with different purposes and underlying politics. They argue that an innovation does not exist socially until it is actively constructed by ‘relevant social groups’ which develop shared or contested meanings for it (Clayton, 2002). As such, relevant social groups come to cohere around shared interpretations. It is the actions of different social groups that ascribe meaning to devices, so technologies such as smart street furniture are emergent — made meaningful through development by companies, installation by councils, and resistance and use by publics. Thus, the social construction of technology is ‘a process in which multiple groups, each embodying a specific interpretation of an artifact, negotiate... with different social groups seeing and constructing quite different objects’ (Klein & Kleinman, 2002, p.29–30). These processes form collective sets of interpretations that constitute technologies as socially constructed.

However, the original SCOT approach underplays the significance of power relations and institutional locations of the relevant social groups that constitute such meanings (Winner, 1993). Companies, advertisers, councils, activists, and people in the street have different forms of power, and their meaning-making reflects this. For example, the smart city companies explicitly fashion different sets of meanings for their products for different groups: councils, advertisers/sponsors, and publics. In addition, the meanings of these devices rely upon a wider circulation of ideological meanings of the smart city detailed above. We

found that these meanings remained contested and unstable. Socio-technical developments such as these are multidirectional, multi-temporal, emergent, open to negotiation and constantly undergoing change. They never achieve a singular or fully stable identity or state. Thus, people who have problems with an innovation, and have different interpretations of what it may be used for, are potentially generative actors partly responsible for socially constructing a technology.

It is not unusual for a technology to have a plurality of meanings. [Bijker and Pinch \(1984\)](#) emphasise the ‘interpretive flexibility’ of innovations — the ‘capacity of a specific technology (or other knowledge system) to sustain the divergent interpretations of multiple groups’ ([Sahay & Robey, 1996](#): 260). Different relevant social groups can comprehend, interpret, and use a device in different ways. [Bijker and Pinch \(1984\)](#) noted that the early stages of a technology are when it is open to more flexible interpretations by different groups. Over time, groups’ interpretations coalesce into regularised sets of assumptions, expectations, and knowledges that conceptualise the shape and purpose of a device — a technological frame, or ‘overarching framework of shared practices values, and meanings built around a particular technic and set of techniques that goes beyond any individual social group’ ([Pinch, 2009](#): 49). [Bijker and Pinch \(1984\)](#) observe that closure and stabilisation are not simply achieved through technical innovation, but through the emergence of a loose social consensus as relevant groups cease to be effective in identifying problems with the technology, and a dominant set of uses and meanings for each group is accepted over time in the form of technological frames. The devices achieve a defined identity and purposes which structure future uses — always with the possibility that these meanings can be destabilised and changed.

As an analytical lens, SCOT provides a useful entry point into the sense-making work around the perceptions and practical experiences associated with smart street furniture devices. We might add that the devices themselves become ‘boundary objects’ that connect a multiplicity of technological frames ([Bowker & Star, 1999](#)). By comparing meanings and uses ascribed to the devices by companies, governments, and people on the street, we can understand where they have reached points of relative closure and stability. This differs from other approaches to technological uptake, such as [Everett Rogers’ \(2003\)](#) theory of ‘diffusion of innovations’ in so far as we are not assessing the rate of the devices being taken up at different points across time, but rather how they have been interpreted by relevant social groups. It also differs from design-focussed theories such as [Norman \(2013\)](#) notions of ‘affordances’ and ‘discoverability’ which address the physical and psychological relations between the technology and its potential and actual users. Whilst we address the affordances offered by the two devices, and processes by which they are made meaningful, our focus is on the contestations of meanings for these devices among social groups within the companies, governments, and publics, particularly around their supposed ‘smartness’.

We are conscious that SCOT has appropriately been subject to criticism, with charges that the approach ‘underplays the importance of structural influences, in particular, the larger structural forces in society such as class, institutions, economic and political systems’ ([Prell, 2002](#)). In this article, our empirical data on representatives of the relevant social groups suggest that each group we identified has different forms of economic, political, and social power. Beyond the SCOT approach again, we must also address the historical role of neoliberalism in the discourses, production, planning, governance, and consumption of smart devices in the 2010s. Beyond the devices, we must also consider urban space itself as historically produced and contested by everyday people, planners and others ([Lefebvre, 1991](#)). Our SCOT approach allows us to situate the studied devices historically in relation to their precursors in the form of telephone boxes and traditional benches, and to the more recent technological frame of the smart phone. To clarify, taking SCOT as analytical approach provides an entry point into understanding the encounters that companies, governments, and members of the public have with new ideas and objects within urban infrastructures. With the

introduction of these new designs of street furniture, communication services, data connectivity, public information, and advertising, the meanings and uses of these devices. Our analyses draw on the SCOT approach to examine how each of the smart street furniture devices are first discovered (apprehended) by different stakeholders, how that relates to the design and affordances offered by each of the devices, and the public experience of using them. In doing so, we look at the agency of different relevant social groups in making their own uses and meanings of the technology, their critiques of it, and possibly their lack of engagement, suggesting some paths for future research and theorisation of smart street furniture. The relevant social groups we focus on include: *end-users*, ranging from activists to proponents and people who are largely indifferent to the technologies, through to vulnerable groups such as those experiencing homelessness; *technologists*, as providers and owners of the devices; and *local government authorities*, such as councillors, and planning and policy official — members of the public were seen using the street furniture, passers-by and people in the immediate vicinity.

2. Methodology

The analyses that underpin this article follow the mixed methods approach of a broader research project which sought to examine smart street furniture and urban street life. The project gained ethical approval from the University of Glasgow College of Social Science Research Ethics Committee (Ref: 400180241) in June 2019 based on this approach. Each of the research methods we chose (industry and policy document analyses, semi-structured interviews, site observations, and vox pops) served to generate a standalone analysis of a different ‘facet’, allowing the object of enquiry to emerge in such a way that no single method took precedence ([Mason, 2011](#)). Our mix of methods for different relevant social groups necessarily produced different forms of knowledge that we draw together in the results.

In the first phase of the research, we analysed 21 texts, including industry and policy documents, publicity materials, and technical documentation about the InLinks and smart benches. We considered the promotional, policy, and planning documents as in their own way performative within the social contexts of corporate workplaces and local government ([Lehtonen, 2000](#)). These texts often positioned the devices as desirable both for government decision-makers and imagined end users.

We developed our analysis of these texts alongside 20–30 min semi-structured interviews with four stakeholders. We interviewed the CEO of the smart benches company on the site of a smart bench close to London Bridge Station. We interviewed a planning officer and a councillor in the offices of Southwark Council, London. In Glasgow, we talked with an activist campaigning against smart street furniture. Each offered a perspective and conceptualisation of the devices representative of specific relevant social groups.

Next, in our field research, we wanted to investigate how members of the public discovered these new kinds of smart street furniture, made sense of them, formed a desire to use them (or not), and (sometimes) made use of them. To do this we selected sites for the two different types of street furniture, we carried out site observations, and alongside these conducted short vox pops or ‘street interviews’. To examine how smart street furniture features within the cityscape, we chose three sites of InLinks in Glasgow city centre and three sites of smart benches in the Borough of Southwark in south London (see [Table 1](#)). Glasgow is the country’s third largest city with a population of approx. 635,640 people and a highly urbanised city centre renowned as the biggest shopping destination in the UK outside London. We decided to perform our interviews and observations at peak times during the day. As the city centre boasts a strong service sector economy, InLinks see peaks in footfall during the opening and closing times of businesses, and during lunch breaks. By contrast, amidst London’s population of nine million people ([Greater London Authority, 2022](#)), the borough of Southwark

Table 1
Locations of vox pops and stakeholder interviews.

Location	Description	Method	Dates
Buchanan St, Glasgow	A busy street with high pedestrian footfall at peak times, with high-end shops and eateries, and a nearby shopping centre. The site is also located close to the city's main train station and a busy subway station, seeing commuters pass by at peak times too.	10 vox pops	27 June 2019
Hope St, Glasgow	A street with one-way traffic close to major travel hubs for bus, train, and car/taxi connections. Buildings on the street consisted mainly of offices interspersed with eateries and small shops.	11 vox pops	2 July 2019
Sauchiehall St, Glasgow	The pedestrianised street holds a broad range of high street retailers, commercial outlets, and restaurant/bars, alongside hotels and a tourism information centre.	9 vox pops	4 July 2019
Borough Rd, London	At the intersection of two main roads, on a tree-lined street, and close to the rear entrance of a University building and across the road from an underground station. The bench is within 100 m of an InLink.	15 vox pops	3–4 July 2019
Elephant Rd, London	Set back from the centre of a busy commuter travel hub for buses, over/underground trains, bikes, cars, and pedestrians. It is at the intersection of a main road and tributary road with small cafes and eateries, many linked to a local South American community. It is located close to a nursery, and beneath railway arches with a small tree overhanging the bench.	16 vox pops	3–4 July 2019
Southwark Bridge Rd, London	Outside a national chain supermarket, set back in a precinct that formerly housed a postal sorting office, at the intersection of three main roads. There is a nearby underground station, and the local area includes both residential apartments, small shops and bars/cafes and business buildings.	14 vox pops	3–4 July 2019
London Bridge station	Busy street next to a Strawberry Smart Bench near London Bridge Station in Southwark	Interview: CEO of Strawberry Energy	27 Sept 2019
Southwark Council	Local government office, South-east London	Interview: Councillor	27 Sept 2019
Southwark Council	Local government office, South-east London	Interview: Planning official	11 Oct 2019

stretches from the city's centre to its southern inner edge. It comprises a diverse population of 314,000 people (Southwark Council, 2021), encompassing business areas, travel hubs, and residential housing. We focussed again on times around business hours, conducted observations at various times between 9 am and 6 pm.

Our selection of InLinks and smart benches sought to capture a range of urban contexts, such as devices on busy walkways that commuters use when going to and from work as well as devices tucked away into side streets. We worked in teams of 3 to 4 researchers, with each researcher independently taking observational notes at each site whilst one of the researchers conducted vox pops. This enabled us to assess people's

interactions with each of the devices in situ, focusing on the temporal and spatial aspects alongside other influencing factors in the local environment. To see how people interacted with these devices, and whether (and how) each device emerged as a smart city technology, we conducted 30 to 60-min-long observations at each of the sites at three points in time around the working day (morning, lunchtime, and late afternoon), doing so over three days in total.

Alongside the site observations, we carried out a total of 75 vox pops with randomly sampled passers-by and users at each of the six sites. We displayed a poster with a participant information statement in areas immediately surrounding each of the observed kiosks and benches which served to capture a range of types of passers-by. We approached any people who showed an interest in the device. This method entailed conducting 5–10-min audio-recorded interactions (with informed consent) during which we gathered insights on people's impressions of the devices, and their past experiences of either using them or passing by them. Doing so most often garnered immediate responses rather than in-depth reflections (Mason & Davies, 2011). The vox pops used the same questions each time, covering the person's previous awareness of the device, their perceptions about what it might be used for, and their practical experiences of using it. Many participants offered opinions on the usefulness/value of the device, and on its design too. While conducting the vox pops, the interviewers drew attention to the devices and their signage, so that if the participant was not already familiar with them, participants could discover the object through observation, talk, and action. To mitigate any influence by the researchers, we began each vox pop with the same question about whether people had noticed the device before, and whether they had interacted with it (if at all). This allowed us to contextualise our analyses of the vox pop interviews according to previous knowledge and use. Together, the site observations and vox pops provided insights into how people had first encountered and personally made meaningful contact with each of the devices.

We transcribed all the vox pop and interview audio recordings into text, compiled, coded, and analysed them using the qualitative data analysis software NVivo (version 11). In this platform we could combine insights from the vox pops, the stakeholder interviews, and the policy and industry documents. Through this process, we developed an applied thematic analysis (ATA) to draw out a set of emergent themes through a three-stage inductive interpretative approach (Guest, MacQueen, & Namey, 2014, p. 4). It involved the research team working collaboratively (through a shared codebook) to first segment interview transcript text, field notes, and documents by manually coding them, before then whittling those initial codes into a more refined set in a second stage of analysis, before finally refining them into conceptually grounded themes. While ATA offered a way of analysing variable data consistently yet quickly, it offered less scope for delving into topics beyond the scope of the data — unlike grounded theory (Guest et al., 2014, p. 17). Here, for example, the concept of *discovery* the focus of this article, emerged as a major theme that intersected with smart city imaginaries, public perceptions, practices, and data governance. Thus, using SCOT literature to make sense of the ATA findings provided a way to understand how the meanings for each device were stabilised and what forms of agency relevant social groups had performed in its construction.

In what follows, we show how smart city companies and local councils went through preliminary phases of constructing devices, meanings, and locations. Their negotiations reflected a neoliberal agenda that combined private sector speculation and production with government aspirations for innovation tempered by austerity. These tensions and synergies reflected the power relations involved in the construction of meanings for the two devices even before they reached the public. We then examine how social groups in the public constructed the functions and meanings for the devices, each with some interpretation of 'smartness'. We found that moments of discovery can be simultaneously considered as both an encounter between an individual and a designed object and an insight into the social construction of a technology. In doing so, our argument is firmly tied to our empirical

findings, with a refined SCOT approach as an analytical lens to render these data meaningful.

3. Findings

3.1. Negotiations between smart city companies and local governments

The social construction of smart street furniture began long before the council or public encountered it, as it was presaged by the circulation of smart city discourses in the years previous. For example, CISCO and IBM announced smart city initiatives in the mid-2000s that set an agenda for an ambitious but ill-defined project for urban transformation through technology (Shelton et al., 2015). The councils we studied developed policies in the mid-2010s that foregrounded ‘smart city’ initiatives. Southwark Council (2016) developed a ‘Digital Strategy’ that emphasised digital inclusion, access to infrastructure, and reduced costs. Their ‘Digital infrastructure strategy 2017–2020’ report (Southwark Council, 2017) argues that ‘connectivity to ultrafast broadband, fast wireless and mobile connectivity (including, after 2020, 5G), are essential foundations for economic growth and prosperity’ (Southwark Council, 2017). Similarly, Glasgow City Council was one of the main Scottish cities that commissioned the ‘Smart cities Scotland blueprint’ (Urban Foresight, 2016). Its objectives included ‘improving lives’, ‘collaboration and engagement’, ‘open data and transparency’, ‘technology and innovation’ and ‘environmental sustainability’. In, 2018, Glasgow City Council announced the Digital Glasgow Strategy, which heralded the introduction of the InLinks. It placed ‘the digital’ at the centre of public policy, celebrating existing strengths in IT, aiming to address ‘barriers to digital inclusion’, and aspiring to improve ‘smart public services’ (Glasgow City Council, 2018, p. 34).

Meanwhile, companies influenced by smart city discourses looked to develop specific technologies that addressed such aspirations. For instance, Strawberry Energy, a young company founded in Serbia in 2011 designed a range of smart benches and sought out cities in which to install them (Strawberry Energy, 2021). In an interview with the company’s Chief Executive Officer about what inspired the development of the bench, he said that the design concept for the bench responded to recent changes in technology and in culture with reference to the influence of the smartphone: ‘So the iPhones and smartphone as a thing started becoming more and more central in our way of life’ (CEO Strawberry Energy: Sept 27, 2019). He explained how the choice of using solar power for the benches had both practical and symbolic value. As well as making the bench function without external power, it projected positive connotations of environmental sensitivity, public amenity, and futuristic innovation which served to make the smart bench offer more attractive to local councils:

And then basically we just connected the dots, we just said okay, actually what you can do with this technology is you, maybe you cannot power the whole planet... but you can power people’s devices in the public spaces where they need them.

The CEO claimed that their benches offered a compelling proposition for three key groups, which we may provisionally consider as ‘relevant social groups’ in SCOT terms:

With three major stakeholders: local government, people, and local brands. And for local government it’s completely free infrastructure that otherwise they... would usually have to buy and finance themselves... So, they can get completely free of charge. Then for the people it’s just a bunch of useful services, completely free of charge, designed around their needs...

The CEO positioned Strawberry Energy as a central actor in a larger governance ecosystem: ‘we provide the infrastructure, the brand partner provides the funding for that, and the government provides the locations’. Around the time of our observations these brand sponsorships included Cancer Research UK, Duolingo and Ford. This three-way

partnership is one that is replicated in other smart street furniture ventures such as in the case of the InLinks. InLinkUK was a joint venture between U.S. company Intersection, the British advertising company Primesight (now Global) and BT established to install the InLinks throughout the United Kingdom, and thus align with notions of a neoliberal turn towards smart cities being underpinned by a changing relationship between private and public services.

Before the smart street furniture was installed, there were complex negotiations between companies and local governments with planning and licensing power. The most sensitive issue related to finding locations that would suit both government and corporate agendas. Considerations for companies and councils included the relation of the devices to ‘footfall’, public safety, traffic interaction, visual impact, and local heritage (InLinkUK, 2018). InLinks required full planning approval according to UK planning laws because they were fixed and permanent infrastructures. On the other hand, Southwark council approved Strawberry Energy benches as temporary fixtures, based upon a five-year renewable street furniture licence with Transport and Roads, rather than being negotiated with the council’s planning department apart from those on privately-owned land, which required full planning approval.

An official dealing with licensing and enforcement at Southwark council echoed some of the CEO’s ideas about the purpose of the smart benches. Their remarks suggested they were persuaded about the value in the infrastructure and information features of the smart benches:

...as time goes on, more and more Wi-Fi is available all over the place, but with the bench, the charging capability was interesting. It’s something we don’t have around the borough... the environmental monitoring was important as well, because as time goes on, we want more information about air pollution, and the more we have the better...

The process of choosing locations began as Strawberry Energy’s initiative but was ultimately decided upon by the local council, as the same official explained:

Strawberry sent us an enormous list of locations they liked and that they would like us to consider. So we went through a lot of those and the issues we had to think about: is it near housing, next to flats for example, in regard to making noise, also conservation areas, we couldn’t put them in conservation areas... And my idea was that it needs to be somewhere that’s busy and overlooked all the time, because otherwise there may be anti-social behaviour.

The Southwark councillor we interviewed was more ambivalent about the smart benches. They complained that local stakeholders had not been consulted about their installation and said that the benches were unpopular with locals, but appealed to various ‘people in need’, such as travellers, tourists, homeless people, and people without internet access — highlighting potential for different interpretations by different relevant social groups:

Participant LO2: Very few people like them.

Interviewer 2 (MH): So the, but are there any positives or...?

Participant LO2: A majority hate them. Tourists love them.

In this way, different actors within local councils developed certain understandings about the kind of users of these devices, and their public reception among different groups. One Strawberry Energy bench was identified as being particularly problematic. According to the councillor, a local resident complained because one of these benches was situated directly beneath the window of her apartment, and groups of people were often gathering there making noise. The councillor recalled the resident’s complaint that people using the bench ‘were having picnics, they were having parties, they were making phone calls, they were charging the telephone... But then it continued and developed into actual drug dealing’. In response, the councillor consulted with the licensing officer and Strawberry Energy and organised moving the bench

to another location in the borough. The technological frame constructed around the device by residents, the technology provider, the councillor, and various council services was that the smart bench was temporary and moveable. However, the councillor indicated some frustration over the temporary licensing arrangements, which, while legitimate, bypassed a more formal planning process.

InLinks required more intensive planning and approval processes by the local councils in which they were to be installed. They are permanent installations featuring prominent street advertising and multiple cameras. They required connection to power and data infrastructures and offered a more diverse range of services. During the planning process, social groups and councils raised concerns such as privacy from the cameras, street clutter, heritage issues, visual pollution and uses of telephones that were deemed problematic, such as reports of drug dealing (Clements, 2019). Our interview with the self-identifying activist provided examples of the interpretive flexibility around the devices by changing the technological frame to draw attention to the devices' impacts on the city and its inhabitants. The activist participated in social groups that campaigned to challenge the introduction of InLinks. They negotiated with councils and put submissions into planning processes across the UK, raising issues such as the privacy risks of the inbuilt cameras, microphones, and Wi-Fi tracking. The activist said that one council responded, 'privacy is not a planning issue'. The activist responded, 'well if it isn't, maybe it should be'. Where InLinkUK claimed that the InLinks would contribute to decluttering the street, the activist rejected this, arguing that 'it impedes people's movements and it's un-aesthetic... So a lot of councils are appraised of this kind of idea now.' The influence of these contestations is apparent, for example, in the rejection of a InLink in Sheffield in 2022 on the basis that the InLink outside Sheffield United's ground would 'adversely affect the safety of (the) public' (Ashton, 2022).

The activist we interviewed also questioned the speed of the roll-out: 'companies like InLink and Strawberry Energy and so on, what they're doing is a literal land grab, where they're trying to get as much kit on the street as they can, as quickly as possible.' Another argument related to the privatisation of public space. They argued that InLinks presented publics with unavoidable exposure to advertising images, which was unlike the somewhat voluntary exposure to ads on social media.

You can block Facebook wholesale if you really, really don't like it... there is an element of personal control and personal veto over that... Whereas, as I say, you can't opt out of public space.

This activism seemed to have some efficacy. When InLinkUK went into receivership in November 2019 they blamed the complication and expense of getting approval from local councils across the UK (Cook, 2019). A journalist's freedom of information request discovered an internal document:

employees complained that each kiosk faced a planning process which often took more than five months. The document claimed some planning authorities had a "lack of objectivity in reaching conclusions" about approving the kiosks. "Some authorities appear to use conservation areas as an excuse for refusing to provide any form of modern service capabilities" (Cook, 2019).

After the collapse of InLinkUK, when ownership of the devices passed exclusively to BT, contestations over the meanings for these devices continued. BT re-launched the devices, adopting the name 'Street Hub 2.0', and introducing new features such as environmental monitoring and mobile data upgrades. They even offered £7.5 million in free advertising for small businesses (McCaskill, 2021). In a webpage addressed to councils they attempted to reset the technological frame by asking the rhetorical question 'How can Street Hubs help?' They answer by claiming that the hubs' 'Future-ready infrastructure and modern design removes street clutter and allows real-time information sharing at no cost' (BT Group, 2022a). Another BT webpage is addressed to businesses, with the headline Street Hubs are the new kit on the block

bringing HD advertising to your business (BT Group, 2022b).

However, we needed to adapt the early SCOT approach because these conflicts between relevant social groups represented a performative struggle between groups with different forms of power: the corporate agendas of the company, the planning powers of councils, the capital of advertisers, and the activism of public interest groups. Overall, rather than smart street furniture gaining initial public uptake fuelled by a set of early adopters, as Rogers (2003) would argue, there were points in social construction under public-private partnerships which evaluated the technology and identified sites for installation. While the benches in London had a minimal approval process, the InLinks' more intensive examination of planning gave more scope for negotiating meanings. In most cases, the general public were exposed to the devices months or years after the council. Publics engaged with the device as potential end-users, not as designers or policy makers. In this case, publics may have been informed about the devices through information directly from the local council, through the media (mass or social), but most likely simply from observing smart street furniture in their neighbourhood after it was installed.

3.2. Observations and Vox Pops of Strawberry Energy benches and InLinks

3.2.1. Strawberry energy benches

In the second phase of our research, we focused on the social construction of these devices by the public. Observing the Strawberry Energy smart benches in London, we saw that many people evidently interpreted and used them as traditional benches — sitting on them, using them as a meeting point and/or as a site for gathering. However, it was interesting how many people on the benches were using their smartphones to access the internet or make phone calls. Fewer than half the people we spoke to were aware of the smart affordances of the benches. 35 of the 45 people we stopped and spoke with in the London vox pops had noticed the devices before, but only 19 had themselves used the smart features they offer, such as the USB ports for charging, the free Wi-Fi, or the downloadable mobile app for checking environmental data. Some discovered the benches' smart functionalities during the vox pop itself, with our prompting, providing an opportunity for them to explore the devices in more detail. This is captured in the following exchange, in which one interviewee reflected on not having noticed these particular benches before, whilst making comparison to other similar devices:

Interviewer: Have you noticed this bench before, or are you passing by for the first time?

Respondent: Not really. I've passed a few times but didn't notice it... It's more interesting than a regular bench, for sure. But it's quite small and looks similar, I think I've seen similar benches trying to do a similar sort of thing... you can charge your phone and it serves Wi-Fi, it looks like.

(Vox pop, Elephant Road, London)

Many of the people passing by the benches we interviewed remarked favourably on their appearance, noting that the diagonal pillar set them apart from other benches. For example, commenting on the bench design at Borough Road, one person said:

Well, if you didn't have the, like, that angular thing, you wouldn't know it was any different so. I thought, that's a cool design... I like the design, yeah, the shape.

However, the function of the pillar — to hold up the solar collector — was often not appreciated, as another Borough Road vox pop interviewee noted:

Interviewer: All right. So, sort of design-wise, what do you think this pillar is all about?

Respondent 1: Modern art?

Meanwhile, another person at the same site appreciated the design and build of the bench, saying that it was suitable for its context:

I mean, it's appropriate for the public square, you know, strong and lasting.

(Vox Pop, Southwark Bridge Road, London)

Others speculated on the possible smart functionality of the benches:

Um maybe it has, you can say where you're wanting to go, and it'll give you a map? I don't suppose it monitors your heartbeat does it? ...or see if you're going to have a heart attack! [laughs].

(Vox Pop, Borough Road, London)

While most people saw the bench design in a positive light, there were more mixed reactions to their placement. Some thought that these would be better located in open spaces, noting that the placement of benches on busy roads worked against the affordances of being able to recharge your phone in comfort:

I feel probably in parks and stuff like that it would probably be a better idea. Um but on this other street's good as well, for people who are just passing by and need to charge up, but like parks and stuff like that, they might fit into the environment a bit more because, maybe, this is a really busy road, it's not the nicest of places to sit, to be honest, and wait for your phone to charge. (Vox pop, Borough Road, London).

As such, the interpretive flexibility included notions of other potential uses curtailed by the placement of the benches, suggesting an imaginary for what the devices and thus the smart city could be (Gangneux et al., 2022). Those who had used the smart benches' charging and Wi-Fi facilities clearly drew upon their prior knowledge of the more stabilised meanings of mobile phones. In other cases, people reported that they had discovered the charging features when they saw other people using them, and thus they shared practices with others in the same relevant social groups. However, there were several practical issues that prevented people using these services, such as lost or broken cables, poor maintenance, operability, and other people using them. The debris we saw around the benches signalled these issues, and were also pointed out by people we spoke to:

I don't have the cables, because some of them are missing... to charge your phone and it's impossible to charge it! [laughs] I think somebody is coming out taking the cables to be useless. Why are you taking it? (Vox pop, Southwark Bridge Road, London).

None of the people we interviewed knew about the environmental data available through the Strawberry bench mobile app, or had engaged with it in any way. However, as a research team, we found there were problems with the usability and reliability of the data. The air temperature readings varied considerably from the Meteorological Office reading for the same location, and pollution measures seemed not to change over time. Similar operability issues applied to the Wi-Fi service which we couldn't connect to at all the smart bench sites at the time of the study. It was also difficult for us, as researchers, to detect use of any of the smart benches' data services such as the environmental data and Wi-Fi during observation since these connections are not materially visible, pointing to broader questions about the gaps or silences in the data relations of street furniture and the need for relevant methods to investigate the discovery process of data services in-situ.

Finally, issues came up about sharing smart benches in public space. One vox pop seemed to question the desirability of homeless people charging their phone on the bench, but conceded that they did have a particular need:

I've seen a lot of er, I don't know whether it's the right crowd, but homeless using them to charge their speakers, their phones, stuff like that because they don't really have access to charging amenities. (Vox Pop 02, Borough Rd, London).

Other vox pops reported feeling uncomfortable using these because of their heavy use by particular social groups:

If for example I was working and I want a break, to sit on, but you can't sit on them because the homeless people are using it most of the time, so you won't be able to make use of the chair, that they lie on it or they don't want anybody to sit, they occupy the whole space (Vox pop, Borough Road, London).

Tensions expressed around the public sharing of smart street furniture reflect longstanding considerations and moral judgements about the 'proper' uses and users of public utilities (Kawash, 1998). Interestingly, Strawberry Energy addressed this form of contestation over access to benches at the design level in later versions of the benches. The original model featured a full-length bench space that afforded lying down, but the newer designs featured rails that made lying down impossible. This form of social construction of technology, which makes certain uses impossible has been described as 'hostile architecture' (Petty, 2016), raising ethical and political questions about the roles of governments and service providers to cater for all the publics they service. In line with SCOT, there was a strong social dimension to the processes by which Strawberry Energy benches in London were socially constructed, but these processes raised additional questions about power and the spatial politics of public spaces.

InLinks.

In our vox pops near the InLinks in Glasgow (see Table 1), we found that while 22 of the 30 members of the public we spoke with had noticed the devices before, only five had used them. Here, 25 of the 30 people we spoke to discovered key features of the InLink only when they were prompted by us and were given an opportunity to explore the devices and their signage. One of the main uses that we observed was for making phone calls through the keypad and built-in touchscreen tablet and charging mobile phone handsets using the USB charger, especially by people who appeared to be living rough, young people and gig workers. Once again it was not possible to determine who of those passing by were connected to the InLink's Wi-Fi network since these were invisible connections that devices made automatically once users had registered and signed up to use the service.

We found that the free phone on the InLink had problems in comparison with the traditional telephone booths that they were replacing, despite these being well utilised services. The kiosk structure offered no shelter from the weather, surrounding noise, or the attention of passers-by. As the activist said about the placement of InLinks to favour the visibility of the advertising: 'it's not a great place to make a phone call. Whereas with InLinks it's kind of like, frankly they don't really care about people making phone calls, that's just kind of like a tick box kind of thing, that's not really the main concern, it's like get the advertising screen, put it right up at the kerb.' These problems were compounded because the sound from the calls was amplified through a loudspeaker, so making private calls was very public, unless the caller brought their own earphones. The USB charging facility was also limited because they required users to have their own cable. Even then, people needed to stand next to the device for many minutes while it charged, as there was no container that would allow the user to leave it there. This also relied on a certain amount of comfort or confidence standing in a public space with many people walking by. Another problem was that the touchscreen was often grimy with other peoples' fingerprints. Even then, the content on the screen in Glasgow was quite limited, predominantly focusing on local government services.

Like the smart benches, users were often not those envisaged or framed in the publicity material about kiosks. These often depicted young, urban figures: a user group already well connected. Instead, end users were predominantly those with insecure access to internet and telecommunications, such as people who were homeless, younger people, travellers, and gig economy workers. These groups held a different relation with public space: gig workers, for whom the streets are a workplace, and homeless people for whom the streets are a surrogate

home. For these groups, the city was appropriated quite differently for the ways it could support access to resources they might otherwise lack. While these relevant social groups displayed a higher level of familiarity with the devices and early adoption of them, it was not so much a reflection of their enthusiasm for technology in general, or their status as opinion leaders. It was, instead, suggestive of the self-reliance required — but not necessarily attainable — within largely privatised neoliberal city contexts that these devices catered for. We observed one man, a rough sleeper apparently experiencing homelessness, had found and flattened a cardboard box to place next to an InLink so that he could sit down while he used the charger. Several other people we interviewed said they had observed homeless people charging their devices, acknowledging the perceived public value of such infrastructure. Besides observing several people who appeared to be living rough approach the InLinks, we interviewed two people who identified as homeless in Glasgow. One of these claimed they often used InLinks to call friends and their brother (Vox Pop 02, Buchanan St, Glasgow). They said that they were surprised when first seeing these devices, remarking ‘What the hell is that?’ but quickly found the touch screen and the phone was easy to use, and said they came to use them regularly. In fact, it had ‘saved my bacon a few times’, such as when they had a health crisis after taking ‘street Valium’. When InLink was developing the InLinks, the company was conscious of the potential that some users may be in crisis, specifying in a media release that the hubs included ‘free one touch lifelines to four national charities’ (InLinkUK, 2018). Elsewhere, we observed a Deliveroo bicycle rider spend several minutes charging and talking on his mobile phone at the InLink, and using the free Wi-Fi service. We asked him when and why he found it useful to use public Wi-Fi via the kiosk:

Sometimes my phone asks me to update things so I can't use my data, so I can come and use these things. I think public data is better because it is faster, as well, than the mobile data and sometimes mobile data you don't have a connection and it's very hard to access, public wi-fi is much, much better. (Vox pop, Sauchiehall Street, Glasgow).

The InLink also served as a meeting place — the person we interviewed above using the kiosk as an object to lean against was joined by another delivery rider. The kiosk was interpreted both as a social site and as a resource for workers in the gig economy. At another time, we observed children playing hide and seek behind the kiosk, interpreting them as tools for play.

In our vox pops we found that while a majority of participants had noticed the new InLinks that had been installed in various sites of central Glasgow, most had not paid much attention to them and held little to no prior knowledge of their features or affordances. Only 5 of the 31 had used them. Most had overlooked their smart affordances and saw them as just another platform for advertising. When prompted, many interviewees said they saw the other features of the devices as desirable in the abstract, observing they could be useful travellers, tourists, or people experiencing homelessness. However, this awareness was often complicated by a lack of clarity on what constituted use. One interviewee, for example, discovered during the vox pop that they had been using the Wi-Fi from the InLinks without realising it. Furthermore, 25 of the 30 people interviewed in the Glasgow Vox pops did not fully understand the features of the InLinks. Here, the process of interpretive flexibility was brought to the fore. In one Hope Street vox pop (see Table 1), for instance, the participant had noticed the InLinks, and even been impressed with their contemporary appearance, but could not yet make sense of their purpose:

Interviewer: Yeah? What was your first impression when you were seeing them?

Respondent: They're quite up to date, new things, yeah! [laughs].

Interviewer: Yeah? Are you aware of what they do and the services that they provide?

Respondent: Er I'm not too sure, no, not really.

(Vox pop, Hope St, Glasgow)

Several vox pop interviewees seemed to formulate their opinions about the value of these innovations only at the time of discussing them with us. Adapting to this, we showed some people the kiosks' phone facility on the touchscreen tablet, Wi-Fi, charging and other information services such as maps and the local services directory. Most seemed reasonably comfortable with the notion of using these functions and acknowledged their value. Participants demonstrated prior familiarity with similar kinds of services — drawing on the technological frames of smartphones and other digital devices or even traditional telephone boxes for their interpretations. However, a range of factors, including the limitations of signage or directions on the kiosks meant that these knowledges had not been applied to the devices when encountering them before being prompted. Instead, the kiosks were dismissed as just another advertising platform.

Some of the smart features proved problematic in practice. At one kiosk near the Glasgow's central train terminal (Buchanan Street), we helped a group of passing travellers to use the Maps functionality on the InLink, but they struggled to orient themselves. The map interface was difficult to use, lacking any visual signifier of the current location of the user (such as a marker indicating ‘you are here’) making it difficult to gain spatial orientation of the map relative to the InLink being used.

In several vox pops, interviewees said that they first noticed the kiosks when they saw other people using them:

Interviewer: Have you noticed these before, have you noticed them around the city?

Respondent: I watched a guy charging his phone and that's why I got interested in it.

Interviewer: Yeah?

Respondent: That was it. Even I did, I thought it was guides and information for tourists.

(Vox pop, Buchanan Street, Glasgow)

We encountered some resistance to the implementation of both devices. For instance, one Glasgow (Buchanan Street) vox pop participant preferred to use his own personal smartphone, noting that unlike the kiosk the screen, it ‘doesn't have greasy handprints all over it’. He also pointed to the lack of privacy in using the device in public where ‘people can look over your shoulder’. Meanwhile another Glasgow (Hope Street) vox pop participant raised a question about the health risks of Wi-Fi signals: ‘I come from a public health background, so these are questions, you know. There's no random control trial that's taken ten years before wi-fi was introduced; it was just introduced because it was expedient.’

These comments, and many more like them, reveal how people internalise norms of privatism which are then projected onto conceptions of what smart city space and devices implemented with it ought to be like, and what values they should embody. In doing so, the interpretive flexibility of the smart benches and kiosk are foregrounded, framing them as technologies that are used in different ways by different relevant social groups, and not yet stabilised.

4. Discussion and conclusion

Our study revealed how smart city discourses, which came to prominence in the 2010s, informed both companies and local governments in actualising these as smart street furniture. These meanings participated in the social construction of these devices for companies and councils, but evidently less for the publics who remained, for the most part, imagined users. Bundled with the devices were ideological models for funding public infrastructures by trading councils' planning powers over urban space for access to public attention through

advertising and sponsorship. As Gibbs et al. (2013) noted, the pitch for these devices was based on claims for economic prosperity, ecological integrity and social equity. In this way, our article reveals in close empirical detail the power dynamics identified by the broader critical literature on smart cities and how these play out through processes of social construction as these technologies emerge in place (Grossi & Pianezzi, 2017; Sadowski & Bendor, 2019; Sadowski & Frank, 2015).

Our findings in Glasgow and London echo the work of Dowling et al. (2019) in Sydney and Melbourne, and Coletta et al. (2019) in Dublin, which found while there were broad strategic smart city visions, actual implementations tended to involve social construction processes that were more accidental and piecemeal. While both local councils we studied had positioned digital technologies at the centre of their public policy, the actual smart street furniture installed aligned only roughly with those agendas. Whether through a full planning process or a licensing arrangement, councils participated in a range of conversations and made decisions about smart street furniture, choosing the types of furniture installed, selecting their location, negotiating the advertising and public information content they provided and so on. Thus, the interpretation of smart street furniture devices in policy represented one specific technological frame approaching closure even before the devices were installed and encountered by the public.

It is apparent that processes of discovery of smart features across a population are complex and nonlinear. That is, discovery does not necessarily equate with adoption of a technology, nor with a more active and/or purposeful form of social construction. Likewise, affordances are complicated by dynamics of material visibility, prior knowledge and immediacy of need and are not just a matter of 'good' design. The smart benches in London fulfilled their usual roles as traditional benches, and were used in variable ways by different relevant social groups, but their smart functionality was similarly not well known by many people. The public was left to make sense, and possibly make use of these devices with minimal instruction.

Our research suggests that smart features of new urban devices remain largely invisible to many passers-by, for whom their affordances are not understood to be part of their everyday needs. However, there are relevant social groups for whom discovering these services is essential: those without easy access to phones, data services or device charging. We found that most people discovered these through an intermediary, such as other members of the public or the researchers themselves (us). Here, discovery, in a normative sense of finding and making use of something was lacking in the case of the smart functionalities for both smart benches and InLinks, but this was often made up for by the 'street smarts' that some users had from prior use, or from having to be more familiar with free public services by necessity. Here, the technological frames constructed around each device in use differed from those constructed by technology providers and/or policymakers upfront.

Even after the devices had been 'discovered', the features they offered seemed to bring incremental change rather than being as socially transformative as 'restrictive' and 'reflective' smart city discourses might suggest (Kummittha, R & Crutzen, 2017). Even for those relevant social groups that use these new hybrid technologies for connectivity, there may be other or better ways for their access needs to be met. We found that the smart street furniture features that might have the most impact — new data services and real-time information — were the least discernible — a follow-on perhaps from the mismatch between assumed and actual users (Harrison, 2017); or perhaps because our methods were insensitive to them, given that as a key limitation we had no access to device usage data. Thus, more research is needed to understand these data aspects, which are largely invisible to traditional research methods, especially among the specific relevant special groups identified in this paper (i.e. gig economy workers, people experiencing homelessness, and young people with precarious access to the internet and/or phone calls). This is not only important for revealing how data services are being used by various end-users, and their needs of such services, but also their use

and value for local councils and private partners. At present, we have found that smart street furniture is being implemented in often experimental ways, and their purposes and uptake are still very much in the early stages, with different technological frames yet to meet the point of closure. We also found that the private-public partnerships behind the implementation of both devices had distinctive characteristics in the way that local councils and companies negotiated over many aspects of the technologies prior to their public discovery. Here we argue that there are opportunities to bring a wider range of publics into this process at an earlier stage, which would serve to better support the discovery of smart street furniture through improved signage, and better engagement with early adopters and other intermediaries. Here, we suggest that specific relevant social groups such as gig economy workers, people experiencing homelessness, and young people could all usefully input to the future design of smart city services. Discovery, rendered through a SCOT lens, then, proves to be a critical process to study for understanding how smart cities materialise to combine services and technologies. Our application of this theory provides the basis for nuanced understandings of the activities of differing social groups, existing affordances, and forms of urban knowledge central to the way people discover these innovations. Discovery is a process shaped not only by the capacities of technologies and alignment of design with use, but also by smart city discourses, local council policies and practices, and the designs of technology providers — who each act as intermediaries prior to publics encountering and negotiating smart street furniture in everyday life.

Therefore, our attention to social construction processes extends the classic SCOT approach by recognising the influence of an ideological climate fostered by more powerful social groups and corporations than those intended to be involved in socially constructing the artefacts. Our findings also suggest that social groups are constituted not only by the meanings that they make, but also by the forms of power that they are able to mobilise and the different technological frames they hold. The social construction process for the smart street furniture reflected institutional relations with devices as boundary objects that manufacturers, advertisers and councils could mobilise in their own interest. For the most part, 'end-users' had little agency or even interest in the processes that located their devices in public space.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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