Part I

Smart thinking

Chapter 1

Scaling the smart city

1.1 Introduction: The smart city as a scale-making process

The smart city is a big idea. By digitally upgrading the traditional city, so the rhetoric goes, the smart city promises to deliver urban management efficiencies that will in turn create sustainable, equitable, and livable cities. The smart city is an aspirational concept, shot through with technological determinism, that has become the dominant urban planning, development, and management paradigm of the early 21st century. While the definition of a smart city has countless variations, at a fundamental level it is a model that prescribes a particular way of understanding the integration of digital information technology and urban space. In cities and regions across the globe the smart city model has typically manifested as the discreet merger of small-scale, but expansively distributed sensor-based technologies within urban space to extract vast volumes of data to fuel the automated optimization of urban infrastructure systems and services.

Over the last two decades the smart city's stratospheric rise in popularity has been propelled by big technology corporations seeking out new markets for their products and services. Following the 2008 global financial crisis, the smart city concept found wide appeal among governments and municipalities who were grappling with new fiscal constraints. Its seductive proposition hinged on the use of networked digital information technologies to solve urban problems with (allegedly) fewer human and economic resources, while also making nations, governments, and municipalities appear progressive and innovative. Now a mature concept, the smart city has evolved beyond the speculative realms of science fiction and corporate storytelling to occupy a central place in national and municipal policies and urban operations in cities and regions globally.

Across the globe, municipal–corporate partnerships and research collaborations have created innumerable smart-city strategies, pilot projects, urban laboratories, urban living labs, and urban testbeds. Yet, in terms of physical and visible changes to urban space the smart city has seemingly amounted to a collection of smart accoutrements. In other words, on-the ground and at a 'local' scale the smart city is made material in the form of individually oriented smartphone app engagement and the unremarkable addition of countless closed-circuit television cameras (CCTV), sensor-based technologies, and pro-

Scaling the Smart City. https://doi.org/10.1016/B978-0-443-18452-9.00001-X

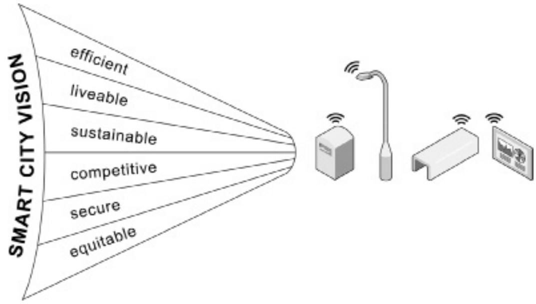

FIG. 1.1 From smart city vision to smart accoutrements. *(Credit: By author.)*

prietary smart bins, smart benches, and smart street lights (Fig. 1.1). The plunge from grand smart city vision to (mostly) inconspicuous, mundane, and inert small smart objects is a jarring scale-jump down that alludes to a missing middle. Put another way, while it is imagined and operationalized at a large-scale and assumes physical-material form as sensors and objects at a small-scale, the smart city lacks articulation at a socio-spatial scale.

While the socio-spatial dynamics of local-scale contexts do not escape the gaze of autonomous smart city systems, the aggregation of data from multiple source points to create large datasets, or big data can, when computationally analyzed, subsume local specificity. And as big data analytics have become the bedrock of many smart city strategies and systems, patterns and probability have assumed credence over uniqueness. Further perpetuating universalizing perspectives of urban life are the smart city's favored mode of dashboard data visualizations that communicate curated, scaled, and compartmentalized views of the city against a backdrop of operational performance objectives. As Usman Haque reflects, "[u]rban data isn't simply discovered, it is invented, manipulated and crafted" (Haque, 2013).

Shannon Mattern argues that smart city dashboards are *designed* "to keep out the mud" (Mattern, 2021, p. 48). Mattern (2021) further considers whether there might also be certain kinds of local-scale phenomena, or forms of "urban intelligence", that simply "do not compute" (p. 22). For example, individual and social interactions, activities, meanings, and values that transform locations into 'places' may be less amenable to the (current) methods of extraction and abstraction typically performed by smart, sensor-based technologies, and computational systems. However, this does not mean that smart city systems and initiatives lack the technical wherewithal to grapple with and be responsive to socio-spatial phenomena in local contexts, but rather that in most cases they are simply not designed to do so.

In a 2021 review of smart city literature smart urban places were observed to, "… somehow disappear in the gap between the literature on architecture and urban planning" (Keshavarzi, Yildirim, & Arefi, 2021, p. 2). According to this view, while urban planning discourses conceptualize the smart city in terms of city, region, and global scalar categories, and architects interpret the smart city at the scale of smart buildings and facades, the "smart street and smart neighbourhood … are underexplored compared to other smart city scales" (Keshavarzi et al., 2021, p. 9). Importantly, this suggests, not that the smart city does not exist or materially unfold across a range of scales, but rather, that certain scales appear to matter more than others. In other words, the smart city uses scalar concepts and representations in ways that shape who participates in its creation and management, which problems it addresses, and ultimately, who benefits.

The smart city is imagined and materially unfolds at various scales, but it is also a scale-making project. This perspective draws on the argument that scale is a social construct; an idea that challenges conventionally held notions of scale as a natural, pre-existing, and fixed hierarchy and order over space. Debates about the status of scale have been a significant focus of critical inquiry and research in human geography and political economics since the early 1980s. Numerous scholars have explored to what extent scale can be said to exist independently of the things we observe and measure, and to what extent it is a human-made or social construct (Jones, 1998; Kaiser & Nikiforova, 2008; Manson, 2008; Marston, Jones, & Woodward, 2005; Smith, 2008). Some have gone as far as to suggest that the concept of scale is so problematic that it should be expunged altogether (Marston et al., 2005). Others reason that, rather than excising scale, it is critical to examine, interrogate, and reveal its various constructions and uses (Kaiser & Nikiforova, 2008; Mackinnon, 2011).

In its most abstract sense, from a 'realist' perspective, and in terms of common use, scale is conventionally understood as a measure of relative size, extent, level, resolution, or degree. Scales are used to measure weight, length, and other properties, and in this way are schemas that organize and explain phenomena in the world. A core question that philosophers as well as human and political geographers have long reckoned with is how and why certain hierarchies or levels of scale come to be. While realists contend that "there are natural scales independent of observers", constructionists argue that "social forces actively manipulate scale" to produce material effects (Mason, 2006, p. 776). These debates focus on the ontological status of scale, and in so doing, they challenge normative and naturalized understandings of geographic or spatial scales.

Human geographer Neil Smith is widely held to have ignited geographical scale debates in the early 1980s in his Marxian critique of late 20th century capitalist development. Smith (2008) observed that, "[w]e tend to take for granted the division of the world into some combination of urban, regional, national, and international scales, but rarely if ever explain how they came about" (p. 180). Through a political economy lens Smith reasoned that scales are a relational product of wider competing social, political, and economic forces. He argued that power relations play out in scale-making processes and in turn create material effects. Smith, and others, use the term 'politics of scale' to refer to the task of understanding how scalar characteristics influence socio-political struggles as well as how scale, and scalar categories are constructed, contested, and redefined through socio-political struggles.

Smith (1996) described the public art project *Poliscar* by Krzysztof Wodiczko as a powerful demonstration of the politics of scale in action. Staged in New York City in the 1990s, and before the advent and accessibility of mobile phones, *Poliscar* was a vehicle designed for use by homeless persons to sleep in, to travel in, and to communicate through. Kitted out with the communications technology of the time, *Poliscar* aimed to expand the scale of everyday life for its users by making places and social connections more accessible. Reflecting on *Poliscar,* Smith wrote,

> *It is simultaneously absurd yet utterly functional; a satire on military industrial technology and a forceful assertion that the city is itself a warzone; a means of reversing the habitual surveillance of homeless people in the street and a vehicle of political empowerment and organization; mobile communications and living unit and a rhetorical outage against the ordered privatization of public space (Smith, 1996, p. 64).*

Smith described *Poliscar* as a rescaling project, but also a key example of "the complex social connections between technology, space and politics" (p. 64). *Poliscar* highlights how new technologies can be deployed "… to restructure the scale of living and simultaneously restructure power relations" (Smith, 1996, p. 72). Smith saw *Poliscar's* physical and informational affordances as a political strategy to help the disenfranchised to "jump scale" and enable them to participate in wider scales of social and political life (Smith, 1996, p. 72).

Poststructuralist thinkers criticized the political economy approach to rethinking scale for its potential to reify scale(s). For example, the idea of jumping scale can presuppose the existence of scales to jump between. Yet, 'existing' scales can also be understood as those that have been previously socially constructed, and in this way the constructionist argument is not undermined. Further, scholars have observed that the political economy perspective on scalar construction is narrowly focused on large forces and interprets scale-making processes chiefly in terms of more universal socio-political struggles. However, Smith's reflection on *Poliscar* does connect with some aspects of poststructuralist thinking on scale, namely, that scale-making processes can include everyday practice (moving bodies) and performance.

An objective of poststructuralist perspectives on scale has been to extend thinking on scale-making processes to take account of a wider range of social actors as well as everyday social practices (Kaiser & Nikiforova, 2008). As such, scholars have explored scale as an epistemological construct and as a "representational device or discursive frame deployed by different actors and groups as they seek to gain particular forms of recognition and advantage" (Mackinnon, 2010, p. 26). Because, as Katherine T. Jones (1998) reasons, "[o]nce we accept that participants in political disputes deploy arguments about scale discursively, alternately representing their position as global or local to enhance their standing, we must also accept that scale itself is a representational trope, a way of framing political-spatiality that in turn has material effects" (p. 27).

Drawing on Ola Söderström's work (Söderström, 1996), Jones cites urban planning practices such as "geometrical plan, zoning, and social cartography" and "aggregate maps" as key examples of scale-making mechanisms that construct scaled ways of knowing the city to in turn influence and limit "… the questions which can be asked about the city" (p. 27). More recently, Benjamin Linder has argued that events associated to the coronavirus pandemic (COVID-19) demonstrate how the scale of everyday life can be remade. For Linder the spatial response to COVID-19 illustrated how "scale is not only a material or discursive structure but also an experiential category" (p. 69). Following the declaration of COVID-19 as a pandemic, "… state officials imposed diverse, and diversely scaled, measures to curb the disease" (2022, p. 68). National and international border closures, stay-at-home orders, and social-physical distancing dictates that expanded personal proxemics, such as in Australia where rules prescribed a minimum 1.5 m distance between people, were measures that also remade the uses, understandings, and experiences of urban spaces.

Linder (2022) argues that the biological and political-economic forces associated to COVID-19 radically restructured everyday life and social interaction, and in so doing transformed—albeit temporarily—conventionally accepted notions of the domestic, global, and urban scales. During COVID-19, people's restricted movements and the relational position of their bodies—their spatiality—visibly and tangibly enacted, performed, and (re)produced new scales of living. For Linder, the significance of this lay in the way that such scalar reconfigurations were "actualized in everyday, embodied experiences" (p. 81). Based on this Linder proposes a humanistic sense of scale that further extends understandings of scale-making processes beyond political economic processes and discourse, to also include everyday embodied interactions with specific sites (p. 81).

1.2 The global, grand, and urban scales of the smart city

The smart city can also be examined as a scale-making process in a political economy sense, as an epistemological construct, as a technological construct, and from an everyday and embodied perspective. For example, scalar categories and scale-talk are integral to the smart city imaginary and to narratives constructed by various actors to shape ideas about what the smart city means, who is permitted to participate in its making, which problems it addresses, how it is materially assembled and operates, and who benefits.

Scale talk is central to the smart city vision. Most obviously, the very concept of the "smart city" includes a scalar category. The term "city" is widely understood to refer to a large-scale human settlement within an administratively defined boundary that is characterized by its population density. A city is a scalar category that is defined as a relative measure of geographical and jurisdictional space and in the context of other scalar terms such as local, regional, national, and global. Yet, methods of defining cities are also not universal. Measures of population density in relation to a contiguous geographical area have historically varied across national borders, making it challenging to compare cities and their differences. For this reason, in 2020 a coalition of six international organizations developed a new global definition of cities, towns, semi-dense areas, and rural areas to enable more accurate ways to compare a city's performance in relation to, for example, the United Nations (UN) Sustainable Development Goals (SDGs).[a] In other words, the scale of a city is neither pre-given, nor fixed; it is also constructed.

Scale talk is equally reflected in smart city rhetoric and in the many smart city narratives that describe cities struggling against the tide of surging urban populations, rapid urbanization, and the ageing population. Neil Brenner and Christian Schmid (2014) describe the reporting on urban population trends as having long reflected an "apocalyptic tone" (p. 732). They add that since the late 1990s the urban age thesis has been frequently exploited "by influential thinkers and practioners, as a convenient metanarrative for framing a wide variety of investigations within or about cities" (p. 733). Projections on the percentage of the total human population that will live in urban areas by 2050,[b] and the predicted increase of mega cities, is a common feature of municipal smart city vision and strategy documents. For example, the introductory line in the Smart London Plan opens with, "From 2011 to 2021 London's population will grow by a million—the fastest rate of acceleration ever" (Mayor_of_London, 2011).

Similarly, the marketing media for tech corporations and innumerable academic research articles related to the smart city overwhelmingly feature opening statements about the phenomenon of accelerated urbanization. In an examination of smart city promotional videos made by tech corporations, Gillian Rose (2017) observes that urban population growth was mentioned by most within the opening few seconds (p. 100). For example, in a 2018 marketing video by McKinsey & Company titled *Smart Cities: How Technology Can Deliver a Better Quality of Life*, the voiceover begins by stating that "cities everywhere are under stress … in many of them growth has led to growing pains including traffic, pollution, and crime to name just a few."[c] This reflects, as Tan Yigitcanlar et al. (2018) remark how, "At the dawn of the catastrophic global climate change era, 'smart cities', came to the scene as a potential panacea, to somehow, reverse or ease the impacts of ill urbanization, industrialization and consumerism" (p. 145).

a. https://blogs.worldbank.org/sustainablecities/how-do-we-define-cities-towns-and-rural-areas.

b. The United Nations (UN) Department of Economic and Social Affairs estimates that 68% of the world's population will live in urban areas by 2050 (United Nations, D. O. E. a. S. A., Population Division, 2019).

c. https://www.youtube.com/watch?v=inRDNLNPonA.

To stake a claim on the creation and control of future cities, the smart city is positioned as the answer to the global and grand challenges of sustainability, livability, and equity. In one sense, as Alberto Vanolo (2014) observes, this "… produces a new responsibilisation of the city as concerns environmental protection, technological upgrading and quality of life" (p. 893). But aligning the smart city to global and grand challenges is also scale-making strategy to delimit the kinds of problems that its initiatives are directed at, as well as the kinds of technological solutions it favors. The very concept of a grand challenge is also a scale-using and scale-making mechanism. Katherine Dittrich (2022) observes how the discourse on grand challenges typically deploys scalar terms such as "global," "largescale" and "system-wide" problems not simply to describe problems but to construct them (Dittrich, 2022, p. 188). Dittrich (2022) argues that scalar terms such as the global and local are deployed in grand challenge discourse as they are conventionally conflated with ideas about the locus of power. While the global scale is typically associated to strength, domination and action, the local scale is seen as compliant and passive (Gibson-Graham, 2002). Referring to "global" problems and "grand challenges" becomes a way to reinforce expectations that the "power and authority [to direct and affect change] are located at the top and from there flow down to impact the bottom, that is, local actions" (Dittrich, 2022, p. 188).

The smart city's grand agenda however can also be attributed to its status as an amalgam of earlier urban and technological imaginaries (Cugurullo, 2019; Sadowski & Bendor, 2018). For this reason, Martjin de Waal refers to the smart city as a 21st century "techno-urban imaginary" wherein ideological beliefs about the inevitability of technological solutionism and progress have been brought together with urban ideals (2011, pp. 5–7). Smart city thinking envelops and assimilates attributes of many other future city visions such as the global city, the creative city, the sustainable city, the resilient city, the information city, and the eco-city (Vanolo, 2016). The smart city also extends from concepts such as cyber cities (Benedikt, 1991; Boyer, 1992; Graham & Marvin, 2001, 1996), intelligent cities (Komninos, 2002; Mitchell, 2003), wired cities (Townsend, 2003), digital cities (Willis & Aurigi, 2018) and sentient cities (Crang & Graham, 2007; Shepard, 2011). And of course the smart city has numerous antecedents including earlier digital technology and urban space integration models such as India's electronic cities in the 1970s (E-city), Japan's Technopolis in the 1980s (Castells, 1994; Tatsuno, 1986), Japan-Australia's Multifunction Polis (MFP) in the 1990s (Anderson, 1989; Fast Train Polis Action, 1989; Glasmeier, 1988; Inkster, 1991; Tokmakoff & Billington, 1999), and the Republic of Korea's (ROK) ubiquitous city in the early 2000s (u-city) (Halpern, Lecavalier, Calvillo, & Pietsch, 2013; Lee, Han, Leem, & Yigitcanlar, 2008; Shwayri, 2013).

Unlike earlier ideas and models of digital technology and urban space integration, since the late 2000s industry, governments, and academia alike have coalesced around the idea of a smart city. A confluence of global events and technological developments created ideal conditions that fostered the smart city's wide appeal. The global economic crises of 2008, and the much-hyped tipping point in human history when, as mentioned earlier, more than 50% of the world's human population were said to be residing in urban areas, took place in parallel with rapid growth in digitally networked things and people. Amid this, technology corporation IBM crafted its Smarter Planet vision[d] in 2008 and its Smart Cities campaign in 2009 (Söderström, Paasche, & Klauser, 2014). Significantly, IBM recognized that all manner of everyday things, including mobile phones, cars, roads, buildings, electricity supply, water supply, and freight logistics, could be data sources and thus represented significant data harvesting potential.

IBM's Smart Cities campaign described notions of instrumentation, interconnectedness, and intelligence through the power of computation. By developing products and systems to capture and interconnect existing and new data sources, IBM envisaged a powerful new era of real-time and predictive analytics, as well as new avenues to accumulate and monetize data. IBM's campaigns intended to propel a new and lucrative municipal IT services market pitched at optimizing business processes and operational efficiencies across a range of organizational scales, including companies, industries, communities, and cities. However, technologically solutionist narratives were adopted to position the proposed technology systems as those best suited to addressing economic instability and sustainable ways of living in cities (Sadowski & Bendor, 2018).

1.3 The technological scales of the smart city

Söderström et al. (2014) describe IBM's campaign as a "specific form of storytelling … that mobilizes and recycles two long-standing tropes: the city conceived as a system of systems, and a utopian discourse exposing urban pathologies and their cure" (p. 308). Söderström, Paasche and Klauser describe IBM's goal to market its products and services to management levels of city governments and logistics companies by recreating the city "from the point of view of a municipality" (Söderström et al., 2014, p. 312). In so doing, both discursively and operationally IBM set out to rescale the city. Yet, in addition to redefining urban conditions and problems as code, to realize the smart city in a technical sense also demanded new scales of computing. As such, IBM's smart city campaign not only breathed new life into old urban science ideas, and monetized systems thinking, it also propelled and normalized the computer science vision of 'ubiquitous computing' (ubicomp) (Söderström et al., 2014, p. 318).

Ubicomp is vision of the future of computing set out by computer scientists including Mark Weiser and his team at the Xerox Palo Alto Research Center (PARC) in the late 1980s. Weiser believed that computers should be drawn "out of their electronic shells" and form "… an integral, [but] invisible part of the

d. https://www.ibm.com/smarterplanet/us/en/.

way people live their lives" (Weiser, 1991, p. 94). He described the goal to create computers that could "… fit the human environment instead of forcing humans to enter theirs, [and to] make using a computer as refreshing as taking a walk in the woods" (Weiser, 1991, p. 104). Weiser reasoned that desktop personal computers too often get in the way of work and life and unduly occupy people's attention. This underscored his position that "[t]he most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" (Weiser, 1991, p. 94).

Ubicomp envisaged expanded contexts for computing but in ways that would not "distract" citizens. For this reason, ubicomp, is also referred to as pervasive, ambient or "calm" computing. It is a vision of computing where vast quantities of micro-computers are integrated within urban space and operate silently to calibrate citizens' everyday lives (Fig. 1.2). The vast and mostly invisible integration of microcomputers into all corners of the urban environment has been legitimized by the smart city vision, but it has also relied on several other kinds of scaling including a significant scaling-down in the size (and cost) of computing components and a corresponding scaling-out of component production.

While the original ubicomp vision of vastly distributed but invisible computing connected to social ideals, and imagined new kinds of relationships between citizens and computers, computer scientist John Stankovic (2014) argues that the contemporary smart city is simply an enormous scaling-up of the Internet of things (IoT) technology. Stankovic's technical definition of the smart city reflects how the idea and uses of IoT has also evolved since the early 2000s. While initially conceptualized as an extension of the Internet into the real world of physical things to enable communication and interaction between humans and things, definitions of IoT now emphasize "… the role of things as *data producers* and the network as an enabler of new services" (Ibarra-Esquer, González-Navarro, Flores-Rios, Burtseva, & Astorga-Vargas, 2017, p. 10, my emphasis). In this way, the smart city's scaling-out of IoT technologies also participates in the rescaling of economic production.

The integration of IoT technologies in cities is also described as a cyber-physical system (CPS) (Cassandras, 2016; Ma & Stankovic, 2021; Puliafito, Tricomi, Zafeiropoulos, & Papavassiliou, 2021; Stankovic, Sturges, & Eisenberg, 2017). A CPS refers to an entanglement of computers with physical systems to facilitate autonomous ways of monitoring and controlling physical processes. A CPS is characterized by concepts such as feedback loops that allow physical processes and computations to influence each other. Edward A. Lee (2015) argues that while concepts such IoT refer to "… a vision of a technology that deeply connects our physical world with our information world … the term 'CPS' is more foundational and durable as it does not directly reference an implementation approach (e.g., the "Internet" in IoT)" (p. 4838). A CPS refers to any physical system that is linked to a computer as distinct from a "Digital Twin" that generally refers to a virtual replica of physical objects and systems.

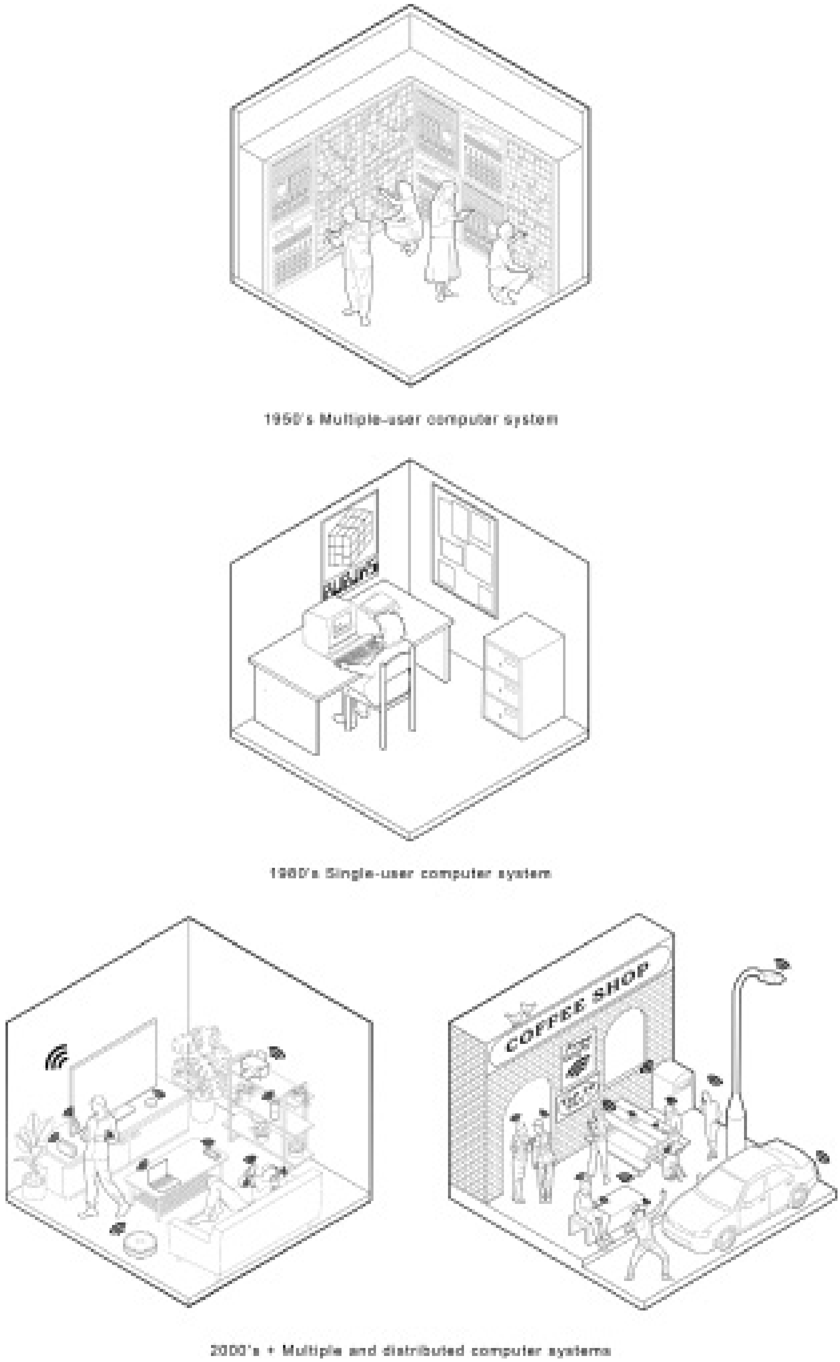

FIG. 1.2 The scaling of computing from the 1950s to the 2020s. *(Credit: By author.)*

Framing the smart city as a CPS situates it in the domains of information systems engineering and computing. Expertise in CPS design is argued to involve a range of computing concepts, including embedded hardware, data structures, algorithms, models of computation, software engineering and model-based design, real-time operating systems and network programming (Stankovic et al., 2017). In a technical sense, the idea of scale is equated with the extent and coverage of a smart system (i.e., sensor quantity, data quantity, and computational capacity) but also its duplicability or scalability potential. Scalability is defined as the potential of a project, innovation, or change to be expanded or replicated without distorting the model (Tsing, 2012). More generally, scalability is seen as critical to the success of most digital technology solutions and businesses in both an economic sense and because network effects are fundamental to the value proposition and utility of most digital products and services. To this end, Pfotenhauer et al. (2022) observe how the notion of "vast scale" has become quasi-synonymous with the success of platform technology companies such as Meta (née Facebook), X (née Twitter), Uber, and Airbnb. They observe that "… in the era of big tech, the aim is frequently to scale up first and profit later" (Pfotenhauer et al., 2022, p. 5).

Scalability is central to the innovation logic and entrepreneurialism that drives the big tech sector and in turn those who design, supply, and promote smart-city technologies and systems. Similarly, scalability matters to the stakeholders of smart city systems as network effects are also fundamental to its value proposition. Scalability is regarded as a fundamental logistics problem and core technical challenge for smart city technologies and systems (Kuguoglu, Voort, & Janssen, 2021; Van Winden & Van Den Buuse, 2017). Critically, the logic of scalability can limit design approaches to digital technology and urban space integration. For example, smaller-scale and locally developed smart city pilot projects are often criticized because they 'fail to scale' (Ciuffoletti, 2018; Sista & Pietro De, 2021). Brynskov, Heijnen, Balestrini, and Raetzsch (2018) reflect that while individual experiments with IoT technologies and open data can be "… insightful and innovative on a local scale" (p. 151), they are often not progressed because they are not deemed scalable to other cities and communities. And prioritizing scalability in the design of smart city initiatives and models of digital technology and urban space integration, is problematic because it also carries with it "… a series of normative assumptions on how society and social change function [and] what kind of solutions are feasible and desirable" (Pfotenhauer et al., 2022, p. 7). Put another way, adhering to a scalability logic can create a context where problems are selected to legitimize scalable technology solutions rather than problems shaping the nature of proposed solutions.

Having been largely championed by technology sector corporations, first generation smart city initiatives were formulated more as scalable technology solutions than as urban design projects. Equally, this has meant that the predominant approach to integrating digital technology and urban space has been driven by computing specialists, tech sector professionals, and government and municipal stakeholders. In other words, those traditionally skilled in city making and urban design, such as architects, landscape architects, and urban designers have not typically been at the forefront of smart city design and decision-making. More often, architects and designers have been called upon to visualize and give-form to "smart-from-the-start" or greenfield smart city strategies to aid in marketing. This includes notable examples such as New Songdo in South Korea by Kohn Pedersen Fox, Heatherwick Studio's contribution to Google Sidewalk Labs' unrealized Quayside development in Toronto, Canada, and Morphosis' involvement in the vision of The Line for the NEOM megacity in Saudi Arabia.[e] In turn, this also means that significant decisions about the coming together of digital technologies and urban space have been made by those from historically gendered and non-diverse disciplines and industries, namely, computer science, software development and computational science (Craig, 2015; D'ignazio, 2020; Hayes, 2010; Lagesen, 2008).

The lack of diversity in smart city-related design and decision-making is echoed by Germaine Halegoua (2020), who reports that "[m]any discussions and policy decisions about smart cities occur within boardrooms or conferences geared toward technology industry representatives, government officials and urban developers" (p. xii). Rose (2015) observes that "smart cities seem to be being planned and created almost entirely by men", and Mattern (2021) reflects that the cultures of smart city development *and* critique are "overwhelmingly male" (p. 20). This matters, as urban science and planning scholars Catherine D'Ignazio and Lauren F. Klein (2020) write because when "… teams are primarily composed of people from dominant groups, those perspectives come to exert outsized influence on the decisions being made—to the exclusion of other identities and perspectives" (p. 28).

1.4 The operational scales of the smart city

Wider participation in the creation of the smart city is also curtailed in an operational sense. In existing and prominent smart cities such as Vienna, Barcelona, London, and Singapore, the sensor-based technologies and systems that are critical to smart city operations are not typically interactive opportunities. Rather, smart city systems take ubicomp's invisible ideal literally and operate discreetly; sensing, computing and transmitting data about city life to city management systems, civic and commercial apps, and potentially numerous other third parties. Smart city advocates often justify urban data harvesting practices by reasoning that it enables more convenient and efficient services and provides citizens with new avenues for participatory democracy. Yet, "participation" in the smart city is also tightly coupled to political-economic processes and objectives and represents additional way to collect yet more data. Others argue that citizens can also freely access open data repositories and/or real time

e. https://news.yahoo.com/eye-popping-saudi-prince-unveils-025852445.html.

data-driven apps and dashboards to help them make better decisions as they go about their lives. This argument rests on the problematic assumption that the automated provision of yet more digital information is an incontestable good.

Additionally, while smart city dashboards and open data repositories are promoted as accessible to everyday citizens, they are not necessarily their target audience. Dashboards and data repositories are more often built for authorized decision-makers and platform economy entrepreneurs and can be of limited real-world use to citizens on the ground (Mattern, 2021; Tkacz, 2022). Even where data repositories are open and allow citizens to download data in a range of file formats, such as from Barcelona city's Open Data Portal (Open Data BCN)[f] and Dublinked: Open Data for the Dublin Region,[g] using these productively can require a degree of expert knowledge.

Moreover, equating the convenience and efficiency of data widgets and real-time app updates on the dynamics of cities (e.g., weather and traffic conditions) with livability is a narrow view. Smart city initiatives can create measurable operational and service delivery efficiencies, but to seriously address urban livability and social and environmental goals "scaling up must be complemented by attending to the local" (Leitner & Miller, 2007, p. 122). Urban livability entails more than the optimized management of essential city services and infrastructure. As, while urban environmental quality is a concept associated to objective measures, urban livability is a "… relative rather than an absolute term" whose meanings are also spatially and temporally contingent (Pacione, 1990, p. 1). That is, urban livability concerns the capacity for urban spaces to meet citizens' quality of life expectations, also from the perspective of social, cultural, and aesthetic dimensions. For example, social inclusion, social interaction, and creating opportunities for cultural and artistic expression at a local or experiential scale are also significant to the project of urban livability (Badland et al., 2014; Pacione, 1990). Moreover, it's worth remembering that the notion of a livable city—that gained traction in response to the documented failures of modernist urban planning efforts—is also a critical concept that was devised to draw focus *back* to the social and collective scale of the city and to the quality of citizens' interactions within and in relation to their everyday urban environments.

1.5 The actually existing scales of the smart city

Scalability logic is reflected in the smart city's prevailing approach to the integration of smart digital technologies and urban space; however, the smart city concept is also more generally a scalability project. Scalability is defined as the potential of a project, innovation, or change to be expanded, or replicated without distorting the model (Tsing, 2012). The objective of scalability, as

f. https://opendata-ajuntament.barcelona.cat/en/ Last accessed 01 September 2022.
g. https://data.smartdublin.ie/dataset Last accessed 01 September 2022.

Anna Lowenhaupt Tsing (2012) explains, is that "… project elements [must] not form transformative relationships that might change the project as elements are added" (Tsing, 2012, p. 507). This matters, as Tsing observes, because scalability projects aim to "banish meaningful diversity" (p. 507). In one sense, the smart city model has demonstrated remarkable scalability, as hundreds of cities around the world have taken it up, published official smart city strategies, and implemented smart city initiatives. However, research has shown that local or contextual conditions do bear on the ways smart city strategies "take[] root in particular places around the world" (Shelton et al., 2014, p. 14).

For this reason, Shelton et al. (2014) distinguish between "the idealised but unrealized vision" of the smart city and the "actually existing smart city" (Shelton et al., 2014 p. 14). A number of empirical case studies that have examined actually existing smart cities further demonstrate how their character, scope, and technological foci are differentially shaped by local phenomena, from economic conditions, funding opportunities, governance structures, and politics to local actors and material conditions (Dowling, Mcguirk, Maalsen, & Sadowski, 2021; Maalsen, Burgoyne, & Tomitsch, 2018; Kitchin, Coletta, & Heaphy, 2019b; Karvonen, Cugurullo, Caprotti, 2019, Bunders, & Varró, 2019; Caprotti & Cowley, 2018; Rose, 2020; Sadowski & Maalsen, 2020; Shelton & Lodato, 2019; Mora & Bolici, 2017). In this way, the global smart city project is always remade and rescaled as it is filtered through the political economies of nations and local governance processes (Dowling et al., 2021).

For example, while the impacts of the global financial crisis shaped the austerity logic of smart cities in Europe and North America, Australian smart city strategies have evolved in relation to a wider mission to digitally transform sectors, industries, and organizations (Maalsen et al., 2018; Sadowski & Maalsen, 2020). Different models of government also influence the aims and scope of smart city strategies and initiatives. As Dowling et al. (2021) argue, Australia's three level government system places limits on the kinds of partnerships that municipalities can strike up with large-scale technology corporations (p. 6). By contrast, Singapore's ambitious Smart Nation strategy is matched by its centralized government that has both the political resolve and authority to drive its implementation. The trade-off of this, however, is the possibility that smart city initiatives are implemented in ways that evade deeper scrutiny. As Dean Curran and Alan Smart (2020) reflect, China's model of government has allowed the swift implementation of smart, data-driven governance "… in ways that are producing the world's biggest data pools, allowing the training of what will likely become the most powerful forms of deep machine learning" (p. 492).

National priorities as well as local economic, social, spatial, and material conditions can also influence how governments and municipalities prioritize and implement certain smart city initiatives over others (Anthopoulos, 2017). For example, the pursuit of economic growth in Ireland has influenced Dublin's smart city initiatives and their focus on open data, that has included the creation of the Dublin Dashboard (Kitchin et al., 2019b; Mcardle & Kitchin, 2016). By contrast, local crime conditions were a priority for authorities in Santa Cruz, California, that saw them develop and deploy sensor-based technologies and the now banned data-driven predictive policing (PredPol) initiative.[h]

Numerous smart city case studies have examined how municipalities make decisions about smart city priorities and their processes of implementation. Consequently, the story of actually existing smart cities so far has largely been told from the perspective of local government or municipal representatives (i.e., by interviewing mayors, councilors, chief technology officers and project officers) and through a political-economy lens (Bulkeley, Mcguirk, & Dowling, 2016; Dowling, Mcguirk, & Gillon, 2019; Dowling et al., 2021; Maalsen et al., 2018; Sadowski & Maalsen, 2020; Yigitcanlar, Kankanamge, Butler, Vella, & Desouza, 2020). Documenting how smart city strategies and initiatives have taken shape has also valuably demonstrated how a fairly narrow composition of "creators" at the local level contributes to shaping, translating, and rescaling smart city strategies and initiatives. Equally, research on actually existing cities evidences how "the focus, objectives and solutions" of smart city strategies often *precede* citizen engagement and participation (Kitchin, Cardullo, & Di Felicaiantonio, 2019a).

Kitchin et al. (2019a) point out that larger forces such as supranational and national smart city funding programs can also "structurally preclude any serious intent to include citizens in the formulation of projects" (p. 10). As a result, official efforts to engage citizens in processes of creating smart cities can be tokenistic and inauthentic. The smart city has been widely criticized in scholarly and popular media contexts for both, failing to account for citizens and their needs and rights, and failing to authentically involve citizens in the processes of making smart city strategies and initiatives (Calzada, 2021; Cardullo, Di Felicaiantonio, Kitchin, & 2019; Foth et al., 2011; Gardner & Hespanhol, 2018; Komninos, Tsarchopoulos, & Kakderi, 2014; Lara, Moreira Da Costa, Furlani, & Yigitcanlar, 2016; Rose, 2017, 2015; Shelton & Lodato, 2019; Thomas, Wang, Mullagh, & Dunn, 2016). Examinations of the smart city as a neoliberal project have widely explored how citizenship is reconfigured in the smart city and called into question citizen's "right to the smart city" (Allwinkle & Cruickshank, 2011; Gabrys, 2014; Greenfield, 2013; Hollands, 2008; Iveson, 2011; Kitchin, 2014; Malek, Lim, & Yigitcanlar, 2021; Shelton & Lodato, 2019; Söderström et al., 2014; Vanolo, 2014; Wiig, 2016).

Efforts to (re)centralize citizens in the smart city have also been taken up by scholars and design professionals whose interests lie at the intersection of information technology and creative design. Numerous strategies and projects have proposed "bottom-up", "citizen-centric", "human-centered", "participatory", and people-powered reimaginings of the smart city (Brynskov, Foth, & Ojala, 2015; De Waal & De Lange, 2019; Foth, 2018; Foth et al., 2011; Greenfield,

h. https://www.latimes.com/california/story/2020-06-26/santa-cruz-becomes-first-u-s-city-to-ban-predictive-policing.

2013; Hollands, 2015; Lara et al., 2016; Morozov & Bria, 2018; Paskaleva, Evans, & Watson, 2021; Tomitsch, 2018; Townsend, 2014). Many of these approaches echo the ethos of *Poliscar* as they variously propose to leverage, reconfigure, and repurpose smart urban technology to expand the agency and participatory affordances of citizens in the smart city.

In 2014 Söderstrom, Paasche and Klauser (Söderström et al., 2014) argued that it was imperative to move beyond the critique of the smart city and to craft an "alternate storytelling about smart cities" (p. 318). Yet, the shift from top-down, corporate smart city, to bottom-up citizen- and human-centred smart city represents a pendulum swing from one extreme to other. Problematically, the citizen- and human-centred smart city risks amplifying individualism over collective intelligence, collective action, shared values, and social cohesion (Helbing et al., 2021). Yet, if the smart city can be rescaled from city to citizen, it is reasoned here that it can also be rescaled by design to the urban precinct or local scale and in ways that can address the collective, social, cultural, and environmental needs of cities.

1.6 (re)scaling the smart city

This chapter has explored the smart city through the conceptual lens of scale, as a scale-making project and as a project that is subject to scaling processes. It has discussed how scalar notions figure in smart city thinking and narratives and how they are mobilized to legitimize new models of urban governance. While the global smart city vision is filtered through national and municipal policies and is reshaped and rescaled as it touches down in different locations, it remains indifferent to local social conditions and historically given and situated notions of placeness. This book challenges the assumption that smart city projects must be scalable. It argues that smart city initiatives do not always have to be large-scale, costly, and invisible, and not every urban technology project must scale-up or scale-out. This does not mean smart city projects should not be scalable. Rather, it is reasoned that deprioritizing scalability can make way for design explorations of alternate models of digital technology and urban space integration that can also address the social, cultural, and aesthetic dimensions of urban livability. Moreover, and as elaborated in Chapter 2, (re)scaling the smart city through a design-led approach that centralizes local context and pays close attention to life-technology relations, can also offer a productive way to re-orient thinking on the ethical significance of the smart city.

Scaling the Smart City is structured in two parts. Part 1 of this book introduces its conceptual foundations including scale theory (Chapter 1), philosophical thinking on technology (Chapter 2), and integrated and interdisciplinary design methods (Chapter 3). The following paragraphs provide a brief overview of the book's overall structure and the content of each chapter. Part 2 of this book focuses on illustrative examples of real-world urban technology projects and speculative urban technology projects. These projects are organized according to four main themes: urban activation and placemaking, social engagement, sustainability, and cultural heritage. Each chapter begins by outlining foundational concepts related to the chapter theme and discusses the illustrative examples in relation to their technical systems and ethical significance.

Chapter 2: Ethics and the smart city construes the smart city's rhetorical swing from tech-centric to human-centric and from smart city to smart citizen as an effort to create the image of a more ethical smart city. It discusses how the topic of ethics has intersected with the smart city in particular ways, and predominantly through the lens of data governance and the protection of privacy rights. It argues for an expanded approach to smart city ethics and brings philosophical thinking on technology to bear on urban technology design to bridge the gap between a micro-ethical focus on data ethics and macro-level political-ethical critique.

Chapter 3: Designing and prototyping smarter urban spaces outlines how the concept of the smart city is explored and challenged in an undergraduate design course that adopts a cross-scale framework to design and prototype urban technology projects. It explains a pedagogic logic that is grounded in sociotechnical systems thinking and brings spatial design together with physical computing and expands the materials of the design system. It describes how urban technology prototyping creates opportunities for experiential learning, digital literacy skills development, as well as the practice of moral imagination. It frames urban technology design projects as thought experiments and as situated approaches to surfacing and examining the ethical dimensions of the smart city.

Part 2: Smart design—Chapter 4: Smart design for urban activation and placemaking charts out the distinction between digital placemaking and smart placemaking. It examines existing urban technology projects and speculative urban technology design projects that combine spatial design and physical computing to address traditional placemaking goals such as urban activation, amenitization, and safety and security. Different from conventional smart city initiatives that silently surveil urban dynamics *en masse*, the projects in this chapter engage sensor-based technologies and interaction concepts to create localized and tangible actuation and to address the social, cultural, and aesthetic dimensions of urban livability.

Chapter 5: Smart design for socially engaging environments explores opportunities for urban technology projects to catalyze interaction among citizens. Drawing on a range of concepts such as social cohesion, social capital, and object-centered sociality, this chapter features urban technology projects that combine spatial design and physical computing in various ways to scaffold and amplify opportunities for social engagement. These illustrative examples mobilize tactics of proximity, curiosity, and play to create new and different ways for people to connect with each other in public realm spaces.

Chapter 6: Smart design for sustainable behaviors draws on transition concepts and behavior change theory to explore how small-scale, localized and situated urban technology projects that combine spatial design and physical computing can be engaged as complementary methods to anchor sustainability culture within the urban lives of everyday citizens. It discusses the ethical dilemmas that arise in engaging interactive urban technology systems to nudge behavior changes such as increased sustainability awareness.

Chapter 7: Smart design for revitalizing cultural heritage explores the evolving relationship between cultural heritage and the smart city. It draws on a growing body of smart heritage discourse and draws on the illustrative examples to expand the definition of smart heritage. These examples demonstrate how a combined approach of spatial design and physical computing can help to simultaneously monitor and manage cultural heritage sites as well as shape interactive approaches to cultural heritage interpretation and experience.

Chapter 8: Smart futures: Responsive and responsible design connects across the themes of ethics, technology, and design to outline the key takeaways of the book. It reflects on the emerging trends and challenges associated to the evolution of artificial intelligence technologies and advocates for the normalization and scaffolding of ethical reasoning skills alongside digital literacy development in design education to enable a doing of ethics by design.

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Non-Print Items

Abstract:
This chapter explores the smart city through the conceptual lens of scale, as a scale-making project and as a project that is subject to scaling processes. It explores how scalar notions figure in smart city discourses, and how the drive to scale shapes the prevailing approach to digital technology and urban space integration. It argues that deprioritizing the smart city's scalability logic can bring into view different ways of designing the integration of digital technologies and urban space that can better connect with the contextual and material specificities of local contexts and less attended-to dimensions of urban livability. Rescaling the smart city to the local urban precinct scale and paying close attention to life-technology relations is further reasoned as a way to productively re-orient and extend thinking on the ethical significance of the smart city.

Keywords: Cyber-physical system; Design; Interaction; IoT; Scalar; Scale; Scaling; Smart city; Techno-urban imaginary; Urban design; Urban technology