Standardising the city:

A material-discursive genealogy of CPA-I_001, ISO 37120 and BSI PAS 181

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ABSTRACT

City standards are a rapidly growing and highly innovative new area of international standards development. They propose tools, techniques and guidelines for the governance of smart and sustainable cities. In this thesis, I survey the standards literature, develop a methodology for their study, and analyse three city standards, the institutions that support them and the material-discursive apparatuses that allow them to take shape. CPA-I_001 is a diagram for seeing, measuring and managing the city as a system of systems. ISO 37120 defines 100 performance indicators for assessing and benchmarking city services and quality of life. And BSI PAS 181 recommends practices for smart city leadership in the integration and management of government services. My decision to focus on the development, circulation and implementation of these standards prompted the use of semi-structured interviews and document analysis; methods capable of following their specific global movements. Drawing on data thus generated, I argue that city standards act as an effective political technology in three capacities: by propagating ideas, materials and techniques; by steering outcomes towards desirable goals; and by assuring city leaders and decision-makers. The case study analysis is augmented by an exploration of the broader intellectual traditions on which the three standards draw. This allows me to reveal their political assumptions and logics, and intervene upon their role in the production of future cities. My research contributes to: empirical work on standards in cities; research methodologies in human geography, and science and technology studies; and conceptual and theoretical debates within Foucault studies, the new materialism, non-representational theory and urban theory.

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ABBREVIATIONS

AFNOR - *Association Française de Normalisation*
ANSI - American National Standards Institute
ANSSC - ANSI Network on Smart and Sustainable Cities
ANT - actor–network theory
API - Application Programming Interface
BIS - Department for Business, Innovation and Skills
BSI - British Standards Institute
CA - City Anatomy
CEN - European Committee for Standardization
CENELEC - European Committee for Electrotechnical Standardization
CP - City Protocol
CPA-I - Informational City Protocol Agreement
CPS - City Protocol Society
CPTF - City Protocol Task Force
DIN - *Deutsches Institut für Normung*
DIS - Draft International Standard
DKE - *Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE*
ERM - Environmental Resources Management
ETSI - European Telecommunications Standards Institute
GCIF - Global City Indicators Facility
GCIP - Global City Indicators Programme
ICT - Information and Communications Technology
IEC - International Electrotechnical Commission
IETF - Internet Engineering Taskforce
ISO - International Organization for Standardization
ISOC - Internet Society
ITU - International Telecommunications Union
ITU-T - ITU's Telecommunication Standardization Sector
JISC - Japanese Industrial Standards Committee
JTC - Joint Technical Committee
JTC 1/SG 1 - ISO/IEC JTC 1 Study Group on Smart Cities
LEED - Leadership in Energy and Environmental Design
MBNCanada - Municipal Benchmarking Network Canada
NWIP - New Work Item Proposal

OASIS - Organization for the Advancement of Structured Information Standards

PAH - *Plataforma de Afectados por la Hipoteca*

PAS - Publicly Available Specification

RFC - Request for Comment

S_Cities SAG - ISO/TMB Strategic Advisory Group on Smart Cities

SAC - Standardization Administration of China

SCF - Smart City Framework

SCOT - social construction of technology

SDO - Standards Developing Organisation

STS - science and technology studies

TAFT ancha - Task and Finish Team for the Anatomy of City Habitat

TC - Technical Committee

TC 268 - ISO/TC 268 Sustainable Development in Communities

TC 268/SC 1 - ISO/TC 268 Subcommittee 1 Smart Community Infrastructures

TGF - Transformational Government Framework

TMB - Technical Management Board

TS/P - Technical Subject Proposal

TSB - Technology Strategy Board

UN-Habitat - United Nations Human Settlements Programme

UNE - *Asociación Española de Normalización*

WCCD - World Council on City Data

WG - Working Group

1. INTRODUCTION

Placing city standards

Cybercities, eco-cities, ubiquitous cities and low carbon cities; smart, sustainable and resilient cities—there are many visions of the future city and their meanings overlap. Their evocation in the media and in public policy is often imprecise, and they tend to be used interchangeably for political rather than substantive reasons (Hollands, 2008). Even in academia, it is not always clear how the terms are deployed; although there is some evidence that 'sustainable cities' and 'smart cities' are the most distinct and frequently used of them (de Jong et al., 2015). But neither are the ideas themselves particularly new. There exists an extensive and well-established literature that deals with future cities and the technologies associated with them (see for instance Batty, 1995; Mitchell, 1995; Boyer, 1996; Graham, 2004).

Although born out of eco-socialist efforts to rethink the relationship between economic development and ecological effects, the 'sustainable city' has slowly, over the past 40 years, lost much of its radical potential. Prior to the 2007/2008 economic crisis, it was generally used to signify the amelioration of ecological damages through gentler, greener and more self-aware processes of urban-centred modernisation. Since then, however, enthusiasm for the concept has dissipated into a number competing visions that displace its transformative potential with techno-fixes and an accommodation with global climate change (Hodson and Marvin, 2017); the 'smart city' is an example of the first type and the 'resilient city', an example of the second. I understand the 'smart city' to prioritise the application of information and communications technologies (ICTs) to problems of urban management, with the goal of optimising city systems and services—although there is another strand of literature that couples it with human intelligence and the knowledge economy. It often calls upon a particular spatial and temporal logic, in which urban control is (re)integrated or (re)centralised in order to respond to a greater volume, variety and velocity of data in a targeted and near-real-time manner (Kitchin, 2014b). The 'resilient city' foregrounds efforts to prepare for events which pose an existential threat to urban liberal life, by strengthening and securing the critical infrastructure upon which it depends. In a world of flux and uncertainty, it is continuous experimentation, learning and reinvigoration that become the norm (Evans, 2011).

Given their age and conceptual ambiguity, it is easy to become sceptical about the effects that future cities are having. It has been argued that the future they envisage is a proximate one, forever just around the corner—a promise that, in its very unrealisability, serves a purpose (Dourish and Bell, 2011; Greenfield, 2013). In this thesis, I investigate

voluntary consensus standards for smart, sustainable and resilient cities; technologies that exist in the here-and-now in order to bring these futures about. Many such standards have already been published, others are on the way, and their uptake, while not staggering, has certainly begun. The connection between them and the future city is not only mine, but is made by the developers and promoters of the standards themselves. The exact nature of that connection is one of the topics that I will address empirically at different moments within this thesis.

City standards are most closely affiliated with the smart city, with the sustainability city coming in a near second, and the resilient city a distant third. Given the connection between these visions and city standards, it is appropriate to position my work within a recent turn in the critical urban studies literature, from denouncements of what smart cities hope to achieve, towards empirically-driven research on the ways in which smart cities actually exist (Shelton et al., 2015). More than this, however, I want to take seriously the challenge of historicising my analysis. In fetishising the future, the smart city also denies its past. The city that could be, must be innovative and unprecedented. Much of the academic literature also forgets that these imaginaries, and the ideas on which they build, have a history (Kitchin, 2015).

Standards have long operated within cities, playing an important part in the urban sanitation and regularisation movements of the late 19th and early 20th centuries (Hall, 1988; Rowe, 1995), and since then, as building codes, land use regulations and municipal zones, they have helped shape and maintain public utilities and the built environment (Graham and Marvin, 1996; Ben-Joseph, 2005; Talen, 2012). But there is no denying that standards which act upon the city as a whole, or more accurately upon its governing bodies, are a recent phenomenon. The first such international standard was ISO 18091, a guide to applying ISO 9001 (a quality management standard) to local government (ISO, 2014a). ISO 37120, a set of 100 city indicators, was published three months later in May 2014. While the technical committee that deliberated over this standard, ISO/TC 268, met for the first time in mid-2012, it was not until 2016 that the official scope of this group was changed to recognise smart, sustainable and resilient cities. Prior to this, emphasis was placed on environmental management systems and (to a lesser extent) sustainable infrastructure. And yet it was in 2013 that the agenda for city standards emerged, when the International Organization of Standardization (ISO) and several other important standards organisations undertook strategic reviews of the role of standards in smart cities.

The newness of city standards draws into focus the questions that the present study will seek to address. What are city standards? Where do they originate? What do they hope to and actually achieve? And what do they mean for future cities and their study?

I have sought answers to these questions through a detailed study of three case studies, CPA-I_001, ISO 37120 and BSI PAS 181, all of which are presently under the

jurisdiction of TC 268. These standards are quite different. They originate from different regions of the world, were developed in different ways, attempt to standardise different things and reveal different aspects of future cities. By following them wherever they lead, I am able to show how they work, and identify the key individuals, organisations and institutions enrolled into their production. But to do this without losing track of the broader relations that restrict and constrain minor agencies is a problem of a different sort. To help me overcome this, I turn to feminist science studies scholar Karen Barad and her repurposing of Foucault's genealogical method. The distinct style of my thesis, in which lengthy descriptions of the case studies are situated within targeted histories of the apparatuses that condition them, is a direct result of my engagement with her philosophy. This approach helps me to explore both what city standards do and why.

On many occasions during my reading and research on standards, I have been struck by their intensely political nature. This is the case not only for city standards, but for technical standards as well. The following quote, taken from a historical study of US telecommunications standards, makes the point succinctly.

> Standardization is a social process by which humans come to take things for granted. Through standardization, inventions become commonplace, novelties become mundane, and the local becomes universal. It is a historical and therefore contested process whose success depends upon the obfuscation of its founding conflicts and contingencies. Successful standards, if they are noticed at all, simply appear as authoritative, objective, uncontroversial, and natural. (Russell, 2014: 16)

When a nominal standard becomes widespread and accepted, the politics of its production fall away. That which is standard, and by extension, that which is non-standard, are simply taken to be. In using a research methodology based on Foucault and feminist science studies, my ultimate aim is to unstandardise the standard, and make room for other, more marginalised approaches. It is in this way that I hope to address the core challenges of city standards research, as recently identified by Schindler and Marvin (2018): to reveal the social and material processes by which standards are implemented; to unpack and problematise the framework(s) on which they rely; and to expand the manner in which they are conceived and produced.

Having described what I am researching and why, I now state my philosophical and analytical commitments, summarise my interpretation of city standards and discuss my ethical and political approach. I conclude the introduction with an overview of the structure of the thesis.

Approach to the research

The philosophy observed in the thesis is a poststructural one. In the 1970s and 1980s, a group of (mostly French) thinkers, including Jacques Derrida and Michel Foucault, drew attention to the instability and interdependency of the conceptual systems upon which all thought and theory are based (Woodward et al., 2009). By establishing terms and making distinctions, the way in which the world can be known (i.e., epistemology) precedes what can be said about the world (i.e., ontology). This undermines the capacity of the structuralist—as well as the positivist and the phenomenologist—to represent reality with accuracy. While early poststructural methods (e.g., deconstruction and discourse analysis), held back from making truth claims about the world, a second generation of thinkers, including Gilles Deleuze and Bruno Latour, overcame this limitation by forwarding ontologies of constant movement and mutation. Rather than rely upon structures and forces exterior to the present, matter and difference are understood in terms of an imminent field of relations. The poststructuralist describes things in formation, interpreting the ways in which objects, bodies, perceptions, ideas and affects come together and unfold. For this reason, they prefer concepts such as 'agency', 'assemblage', 'apparatus' and 'atmosphere', to the more familiar 'nature', 'culture', 'society', and 'technology'.

The strand of poststructuralist thought that I am working with is associated with third-wave feminism, particularly in its theorisation of science and technology. Thinkers such as Judith Butler and Donna Haraway have drawn upon the work of Foucault to explore how power and knowledge help constitute and constrain bodies and subjects. This has allowed for a powerful critique of the gendered affordances of technology, which, it has been argued, were constructed wholly or in part by culture and society. Rather than reject technological change, Haraway (1990) famously invited socialist feminism to engage playfully and ironically with the transgressive figure of the cyborg. Her provocation has grown into a lively area of social and cultural theory, which explores natureculture as a composite of human and nonhuman agencies, both intimate and strange (see also Hayles, 1999; Braidotti, 2006; Wolfe, 2010). Barad's (2007) contribution to this literature, has been a metaphysics derived from a close reading of the physicist Niels Bohr[1]. Her agential realism, like the philosophies of Deleuze and Latour, is more-

[1] Barad argues that her philosophy is not only useful as a social theory, but is a legitimate interpretation of quantum mechanics. Seizing on Bohr's concept of 'complementarity', as distinct from Werner Heisenberg's 'uncertainty principle', she argues that meaning is co-constitutive of the materiality of quantum phenomena. While this is a crucial aspect of her work, I will, for reasons of brevity and simplicity, set it aside. For more on Barad's explanation of quantum mechanics, I direct the reader to Chapters 3 and 7 of *Meeting the Universe Halfway* (Barad, 2007).

than-representational, in that it foregrounds the entwined becoming of matter and meaning. Barad makes a strong claim about the role of concepts, ideas and discourse in the construction of material things and effects (and *vice versa*), well beyond the apparent limits of the human mind. For this reason, she refers to herself as both a realist and a constructivist (Barad, 1996).

As a poststructuralist, I regard standards as a technology for ordering lively agencies. At an ontological level, agential realism is a monistic philosophy. The differences between things are not set and stable. Matter and meaning are enfolded into one another, always moving and in the process of becoming. It is by way of a cut applied to these entangled agencies, that things are encountered in actions, perceptions and conceptions. Ordering effects emerge from iterative enactment within a topological manifold of relations. The power of well-established ideas, arrangements and practices (i.e., successful standards), is contingent upon the frequency, intensity and propinquity with which this occurs. Orders and their trajectories must be understood as an outcome of the continual performance of the rules and values that a standard represents. To study standards, then, one must begin at their site of enactment; the moment at which they are used to differentiate things from the unity of being. This does not mean that standards are investigated without history, for on every occasion of a performance, previous iterations are enfolded into the present. Thus, the role of the researcher is to identify and interpret the matters and meanings that are drawn into the site, as well as the ordering effects that they have.

In order to emphasise the materiality of CPA-I_001, ISO 37120 and PAS 181, my analysis proceeds from a problematisation of their implementation. Whenever these standards are enacted, a heterogeneous assortment of agencies are brought together. This includes people, with all their beliefs, habits and associations, but also urban forms, networks and infrastructures, and the analogue and digital media used to convey information about them. To recognise that this occurs is not to reduce events to the bumping of atoms, but to allow for a vitalistic world that pushes back against the ideas and ideologies impressed upon it. A description of the standard's implementation is thus used to call forth a wide-reaching interpretation of the materials and meanings therein assembled, without predetermining the effects that ensue.

While my focus is on the case studies, it is not my intention to separate them from their wider, supporting context. For this reason, I argue that they are descended and entangled with three traditions of postwar-thought: systems theory, neoliberal rationality and the governance turn. These arise respectively from the physical sciences, and the disciplines of economics and political science, and so can be regarded as distinct. Nevertheless, they are connected by concepts of 'complexity' and 'uncertainty', and at times build upon one another directly. They are identified and explored in order to help

understand why city standards do what they do, and to identify coherences and contradictions inherent to them.

On these theoretical, empirical and historical foundations, I argue that city standards act as an effective political technology in three capacities: by being highly mobile, by steering outcomes and by assuring subjects. The concept of 'political technology' is a posthuman generalisation of Foucault's (1977) 'political technology of the body', used to convey the imbrication of power-knowledge with material technologies and practices of governance.

The mobility of standards (i.e., their capacity to be freely circulated and implemented in a variety of contexts) is too easily assumed and unremarked upon. Yet mobility requires work. Standards need to be of a form such that they can be applied in multiple locations. CPA-I_001 achieves this through abstraction, ISO 37120 through a sophisticated mechanism of third-party verification and BSI PAS 181 by offering an array of options that can be adapted to local circumstances. But to be properly mobile, standards also need to find a setting favourable to their implementation. Again, the strategies for accomplishing this vary. The organisation responsible for CPA-I_001 sought to realise this by building up their own network of participating cities and then, later, by association with respected partners. Cities are actively courted by the principal ISO 37120 certifying body and, once they achieve certification, are encouraged to celebrate their compliance. PAS 181 was propagated by being made free and easily accessible on the website of the British Standards Institute (BSI). Recently, it has been developed into a Smart Leadership Programme that has been rolled out in India through the UK Foreign and Commonwealth Office.

As a steering technology, city standards act on the city and its systems and institutions in order to influence (rather than determine) certain behaviours and outcomes. CPA-I_001 presents a general diagram of the city's anatomy with the ambition of creating a common grammar for grasping and communicating the city as a system of systems. Its proponents hope to bolster new opportunities for dialogue and knowledge exchange. ISO 37120 attempts to achieve something similar, but through the medium of data rather than language. By establishing common and comparable metrics, city administrations will be able to benchmark themselves against one another and identify best practices. Rather than promote a more efficient system of communications, BSI PAS 181 describes management and governance practices to encourage the development of a competitive marketplace of services. It hopes to provide city leaders with levers to steer government towards a smarter city.

In theorising city standards as an assuring technology, I am attempting to identify an affective capacity of standardised management systems. This relies on two observations. The first is that the functions performed by ISO 37120 and PAS 181 (and

to a lesser extent CPA-I_001) are akin to the services provided by audit and assurance firms (such as Deloitte, KPMG and PricewaterhouseCoopers). Since the early 1990s, the focus of ISO has shifted from technical problems to issues public and private management. This has occurred most notably in areas of quality (ISO 9001) and environment (ISO 14001), but also in private security (ISO 18788), (corporate) social responsibility (ISO 26000), information security (ISO 27001), risk assessment (ISO 31010), anti-bribery (ISO 37001), occupational health and safety (ISO 45001), innovation (ISO 50501), asset management (ISO 55001), and in management system auditing (ISO 19011). City standards extend this trend into a new domain. The second observation is that city standards, through repetition, seem to be creating a kind of comforting order which helps to ease uncertainty. Neoliberal affects are usually theorised in terms of an anomie or anxiety resulting from economic precarity. In opening up a politics of assurance, however, my hope is to think through the calming and reassuring affects that city standards can have on the stresses of expert and elite subjects.

The market for city standards is still emerging and no standard has yet to achieve widespread success. What this research can be said to reveal, therefore, is the formative operations of the power of city standards. Each of the three capacities described above can be understood as a way of putting material and social relations into a productive alignment. They describe, respectively, technologies of propagation, utility and affect. But the power that is in formation here is also theorised in two explicit ways. First, I conceptualise the power at work in smart cities as integrative. CPA-I_001 forwards a holistic and functionally-oriented vision of the city, in which all material things and their relations are imagined to have a place. By measuring the connections between the nodes of this diagram, sites of feedback and control can be identified and managed. But the standard does more than this, moving from the ontological position of systematising the city, to the normative position of integrating its various components. This agenda, in which the city becomes a cohesive system to be quantified, analysed and optimised, leads me to conceive of the standard as an explicit programme for the integrative power of the smart city (much in the same way that Bentham's panopticon typifies disciplinary power for Foucault, 1977). Second, I argue that the *form* of power enacted by standards is iterative, in that it works through continual repetitions, rather than as a network of stabilised relations. This is not an argument about what power does, nor the effects that it has. Instead, it is the shape—or topology—of the operation of power that is of concern. Conceiving of the power of standards in this way allows for their flexible application to different settings, and for the possibility that ethical and political interventions might be made upon them.

There is a great opportunity to intercede upon city standards while their power is still in formation. I do not achieve this by roundly rejecting every standard under review.

Certainly, my case studies do not escape critique. However, it is only from a position produced in relation to them, that I identify their problems and limits. It would be inconsistent with my methodology to denounce city standards based wholly upon assumptions and principles that their proponents would fail to recognise. My political interventions, therefore, proceed by pressing upon existing conflicts and contingencies encountered in the research. By strategically reinforcing minority positions within the field of possibilities—that is, by forging alliances with my interlocutors—I hope to soften some of the harder edges of city standards to allow for more critical and progressive opinions. This form of ethical and political engagement, closely connected with my feminist poststructuralism, underscores the pluralism and indeterminacy of non-standard bodies and subject positions. Fundamentally, my hope is to multiply the number and variety of voices involved in the realisation of city standards and the future cities that they portend.

Structure of the thesis

While the thesis is empirically grounded, effort is made to specify a robust foundation for that empiricism. Chapter 2 reviews the standards literature, highlighting conceptual and analytical challenges that my research methodology needs to be able to address. Beginning with an association made in the *Oxford English Dictionary*, I work my way through different uses of the word 'standard' and what they reveal. A standard is understood as any set of rules or values by which things are put into order; standardisation is taken to refer to the process by which a standard becomes well-established. In defining my terms in this way, I echo Timmermans and Epstein's (2010) observation that standards lurk in the background of much sociological research. I then discuss three typologies, separating standards according to their ordering effects, their processes of development and the thing that they standardise, in order to construct a narrower schematic that can be applied to city standards. Accordingly, CPA-I_001, ISO 37120 and BSI PAS 181 are described as voluntary consensus standards, and, respectively, a terminological standard, a performance standard and a procedural standard.

From here, I consider the characteristics of standards in more detail. Following Star (1991), I draw out the political interdependence between that which is standard and that which is non-standard. I then turn to the effects of standards, showing that they overlap and interlink, are unevenly distributed, affect people in different ways, and embody ethics and values. Rejecting a static conception of space, I explore relational approaches to the spatiality of standards. While science and technology studies (STS) has long treated standards as networks of relations, I reject this in favour the more eventful theorisation of 'site' forwarded by Woodward, Jones and Marston (2010). For similar reasons, I prefer 'trajectories' (Bowker and Star, 1999) to signify the permanences of infrastructure, to

concepts that render technology a determining and stabilising historical force. In both cases, my aim is to resist slipping too far into either unbounded agency or an overly deterministic structure. Finally, I survey the literature on standards and cities, identifying four broad themes: the performativity of rhythms, repetitions and iterations in the city; standardised patterns in buildings and cities; the effects of norms, codes and regulations on buildings and cities; and critical engagement with urban indicators, ranking and benchmarking. Close attention is afforded to three papers responding to the emergence of city standards since 2013 (March and Ribera-Fumaz, 2016; Joss et al., 2017; Schindler and Marvin, 2018). While these make a useful start, I argue that research of considerably greater breadth and detail is required if urban studies is to get a handle on what is currently occurring.

Having established what city standards are, Chapter 3 takes up the task of elaborating a methodology suited to their investigation. I begin with an overview of standards research in STS, placing it in the historical context of the field, its main traditions and its intersections with other forms of sociological research. This allows me to expose the strengths and weaknesses of different approaches, and to establish a background against which to assess my own methodology. After explicating Foucault's genealogy and its limits, I draw on Barad's agential realism in order to realign it with the sited enactment of standards. The resulting research method, material-discursive genealogy, is able to explore the (immediate) materials and meanings that standards bring about, without losing track of the (contextual) apparatuses of bodily production that condition them. In addition to these methodological concerns, the chapter discusses the ethics and practicalities of doing research: how my case studies were selected and approached, how I generated and analysed data, and how my interviews were conducted.

The next chapter presents a historically-sensitive interpretation of the material-discursive apparatuses that help produce city standards. This is used to help identify resonances and dissonances between them, and map out their broader field of possibilities. I begin by looking at systems theory, a collection of scientific, engineering and management practices loosely arranged around the concept of 'system'. Of particular significance is the growth of information theory and cybernetics in the US immediately following the Second World War. Using the work Warren Weaver, Jane Jacobs and Jay Forrester, and the histories of Light (2003) and Flood (2010), these ideas are linked to urban studies, local government policy and the city standards discourse. Systems theory is not without its own internal disagreements, however. While it is often used to reduce the city to a closed system of linear dynamics, there are those who think in terms of open systems, positive feedback, non-linear dynamics, complexity and emergent behaviour. An awareness of these differences counteracts simple designations of city standards (or smart cities) to one or another tradition.

Systems theory has not remained the sole preserve of the natural sciences, but has also been taken up by thinkers in the social sciences and humanities. One of the more interesting and enduring of these was the Austrian economist Friedrich Hayek (1945). In representing the economy as a complex system of many, interacting components, he repositioned planning as a problem of communication. Price came to be associated with information for Hayek, capable of transmitting local, tacit knowledge form one location to another. Far from being a source of anxiety, uncertainty about the future becomes the very thing that allows the price mechanism to function. I go on to explore various facets of 'neoliberal rationality', a term borrowed from Dardot and Laval (2013) to refer to the analysis and evaluation of social and political life according to assumptions and logics developed for the theorisation of perfectly competitive markets. This definition allows me to include post-1970 trends of deregulation, liberalisation and monetarist policy in my discussion, as well as specific interpretations of corporate law, market regulation and urban economics. My take on neoliberalism is narrower than what is typical in critical urban studies. I do this for strategic political reasons, and to ensure that neoliberalism does not overwhelm my discussion of other material-discursive relations that affect city standards.

The third of the material-discursive apparatuses, the governance turn, refers to a shift in the early 1990s, both in public policy and in the political science literature, away from centralised government and towards distributed management by diverse state, industry and civil society actors. I open my discussion by reflecting on the work of two political scientists, both of whom draw on systems theory to acknowledge and respond to the market interpretation of Hayek. Problems facing the contemporary world, such as mass urbanisation and climate change, are seen to be too complex for the state and the market to manage on their own. What is needed, it is argued, is an approach to governing that is of a commensurate nature. Rather than vertically integrated systems, or competitive markets, the governance turn advances networks of public and private organisations and individuals, working together for the good of all. After tracing an intellectual history of this material-discursive apparatus, including a contribution from the director and CEO of WCCD, I locate it within the e-government policies of the Clinton and Blair administrations.

Chapter 5 presents an overview of the city standards market and the engagement of the International Organization for Standardization with smart cities. Using a document prepared by the American national standards body, I list the national and international standards developing organisations within this space, reflecting briefly on their technical work and governance. This serves to demonstrate the considerable size and variety of the market, and to introduce ISO's place within it. My focus then turns to ISO/TC 268, the most important site for the development of international city standards. I touch on its

origins between three groups—the *Association Française de Normalisation*, the Japanese Industrial Standards Committee, and the Global City Indicators Facility—before teasing out how the case study standards were brought to the international stage. After revealing the committee's uneven approach to smart cities, I explore higher level harmonisation efforts conducted on behalf of the ISO Technical Management Board, and the Joint Technical Committee between ISO and the International Electrotechnical Committee. Through this exploration of the institutional setting of city standards, I am able to show the contingency and contestation with which they are developed and put into circulation. Far from representing dry and pragmatic common-sense, city standards are revealed as a domain in which powerful interests and organisations are struggling to establish the form and character of the future city.

Having set the scene, theoretically, historically and institutionally, Chapter 6 delves into the first of my case studies. CPA-I_001 played a central part role in the smart city programme of the City of Barcelona under mayor Xavier Trias, informing its agenda and departmental restructure. When Trias was succeeded by Ada Colau in 2015, the standard was sidelined and funding for City Protocol, the organisation that developed it, was halted. I ask why it was that the standard, despite claims to the contrary, proved unable to transcend the politics of these administrations. To answer this question, I begin by exploring the origins CPA-I_001 and City Protocol, granting particular attention to the Chief Architect under Trias, Vicente Guallart. I then explore how the standard was affected by public deliberation and debate, showing that while the diagram of the city anatomy remained relatively stable, its accompanying text underwent considerable changes. This allows me to draw out the great flexibility of systems theory as well as its inevitable limits. For while there are things to like about the standard, it is unable to properly account for the productivity of meaning and culture, and so is blind to political contestation and social solidarity that respond to dysfunction. This, I argue, renders it fundamentally incompatible with the political activism advocated by Colau.

I open the second case study chapter with a disagreement over the release of ISO 37120 metadata. For the City of Melbourne, implementation of the standardised indicators is part of a general trend towards open government, whereas for the certifier, the World Council for City Data (WCCD), the process and its outcomes are positioned as its intellectual property. The question posed is: what could a non-profit intermediary possibly hope to gain by limiting the transparency of a local government?

The chapter wends its way towards an answer by exploring where the standard comes from and how it operates. I begin by surveying the origins of the standard in the World Bank and its transfer to a specially established research department at the University of Toronto. Drawing on a range of documents, I identify two tensions that have pursued the standard throughout its development and implementation. The first is

between the mismatched geographies of an urban agglomeration and its political jurisdictions. The second is between the different economic needs of cities in developed and developing countries. Having established how the standard was put together, I then turn to the practices of verification and certification used to ensure its proper implementation. These reveal a subtle and nuanced mechanism that slowly draws indicator data towards a common ideal. But there remain significant limits to the comparability of resulting data. I tease these out by positioning Melbourne's data alongside those of the City of Toronto. Particularities in the cities' political geographies, by-laws and histories of data collection all undermine commensurability. This reveals the fundamental importance of ISO 37120 metadata to any decision of when and how a comparison should be made.

It is not until exploring the reasons for implementation, that an answer to the question posed in the chapter's introduction begins to take shape. Cities are interested in using the data to benchmark themselves against their peers in order to discover where and how to improve. In addition to this, WCCD have proposed using the data to inform the calculation of state-led infrastructure investments, municipal bond rating agencies, and insurance and reinsurance premiums. While local governments perceive the standard as a way of steering and improving their own performance, it could also enrol them into circuits of global capital that deepen the financialisation of the city. It is in anticipation of selling detailed data and metadata to financial institutions, that I argue that WCCD have intervened on the open data practices of the City of Melbourne. This allows me to expose the workings of a neoliberal rationality. Rather than suppose that a city's democratically elected institutions are capable of securing the future prosperity of liberal life, WCCD would further the capacity of profit-maximising economic agents to manage risk through financial calculation.

Chapter 8 focuses on BSI PAS 181. Despite receiving a lukewarm reception in British cities, this standard is, nevertheless, being used to expand UK governance expertise into Asia and the Middle East. I ask how this is being rationalised. My discussion of the PAS 181's origins begins in Tony Blair's Cabinet Office, follows the establishment of a spin-off consultancy, and the movement of its ideas into international circuits of standardisation. By comparing three versions of the standard, I show how it has been put together and where its recommendations originate. Particular attention is paid to the structure and style of the documents, which play an important role in their strategy of circulation. From here, I turn to the content of PAS 181, analysing its recommendations in the context of the Third Way politics of New Labour. I argue that its model of citizenship is an inherently passive one, devoid of conflict. A holistic approach to citizen needs lies at the centre of the standard, and yet actual citizens are denied the possibility

to challenge its political prescriptions. What emerges is a recipe for Blairite policies to be applied universally, with or without a democratic mandate.

The conclusion addresses the central questions of the thesis. I discuss what city standards are and attempt to achieve, develop my political position in relation to them, and flesh out what they mean for future cities and their study. The chapter begins by re-stating the empirical findings of the research. While my genealogy emphasises the particularity of the case studies, I nevertheless identify four ambitions found across them. These are to: facilitate inter-city communication and knowledge exchange; integrate urban systems and data generated about them; make city data internationally comparable; and spread tools and techniques for managing cities in a leaner and more responsive way.

Drawing on the sophisticated map of agreement and contention between the material-discursive apparatuses discussed in Chapter 4, I then make three tactical interventions in the field of possibilities. I challenge the use of reductive models of systems by arguing that cities are complex; undermine the logic of departmental silo busting by questioning its empirical evidence and asserting that existing governmental structures serve a role in internalising transaction costs; and stress the importance of locally-specific indicators rather than one-size-fits-all, global benchmarking. By adding my voice to those of my interlocutors, I hope to create space for the non-standard within future cities.

Given the empirical focus of the thesis, several of the concepts discussed in this introduction and then developed alongside my data, remain to be situated within the academic literature. After placing my methodology in relation to STS and human geography, I consider three substantive theoretical contributions: conceptualising iteration as a form of power; exploring the affective capacities of assurance; and stressing the importance of critical research on city standards to urban studies. These begin to eke out a place for the thesis in debates on Foucault studies, the new materialism, non-representational theory and urban theory.

There are many, contested visions of the future city. In producing standards for them, the risk is that certain futures are filtered out, leaving only those which conform to a narrow set of assumptions, logics and desires. For every standard, a non-standard is produced. Rather than place limits on the future city, I would like to see standards that acknowledge this multiplicity and are comfortable with the range of human and non-human agencies of which cities are composed. At the very least, it is my hope that this work encourages city stakeholders and local governments in Ireland and abroad to become involved in national technical committees for city standards. While standards-making is often a difficult and drawn-out process, it is crucial that cities have their voices heard, as the stakes may prove to be significant.

2. THINKING ABOUT STANDARDS

Introduction

In the introduction to the edited collection *Standards and their Stories*, Star and Lampland (2009) suggest that one reason why standards have been neglected as a topic of study is that they are generally perceived to be boring. Formal standards, classification schemes and practices of quantification do indeed seem to fade from view to become part of the invisibility of infrastructure (Larkin, 2013; Amin, 2014). If they are seen at all, it is as technical, detail-oriented and pragmatic—the very characteristics that confer on them a sense of trust. Like Star and Lampland, I believe that these boring things are an often overlooked but crucial component of everyday social, technical, economic and political life, and are therefore worthy of examination.

Broadly defined, standards are everywhere. They are used to measure and compare, to asses and judge, to establish connections, communicate and put things into order. Standards explicitly *for* cities might be new, but standards have always helped constitute the materials and meanings that gather into the densities and intensities of urban life. There is, as such, a wealth of literature that can be brought to bear on standards and their effects on cities. In this chapter, I discuss useful aspects of this work in order to address two questions. What are standards? And, what might they do in the context of cities? My ultimate aim is to lay the foundations for the methodology with which I will explore the social and political ramifications of my research topic. Any study of city standards that fails to consider these two questions, risks neglecting an important aspect of their character and consequences.

In what follows, I define standards and standardisation, describe their common features, and review relevant literature from urban studies. I begin with a broad definition of a standard as any set of rules or values that produces ordering effects. Drawing on Busch (2011), four types of orders are discussed. I then consider the difference between *de jure*, *de facto*, and voluntary consensus standards, setting this alongside a distinction between representation and performativity. A typology of voluntary consensus standards proposed by Timmermans and Berg (2003) is described as a way of introducing the work of the standards developing organisations (SDOs). In the second section, I discuss characteristics of standardised effects, as identified by Star and Lampland (2009). Important here is the ethical and political reflection that standards necessarily produce a non-standard other. Next, I theorise the spatiality and temporality of standards. Rather than consider standards as stabilised forms or relations, I regard them as something that is continually done. My purpose is to allow for slippage, failure and resistance. As a result,

standards are taken not to exist in space and time but to produce spatial and temporal effects. Having defined standards and described their features, I present an overview of the literature on standards and cities. I identify four themes: urban iteration, repetition and rhythm in a theoretical vein; the classification of standard urban forms; the effects of standards on cities; and urban indicators, ranking and benchmarking. The third of these is covered in the greatest detail. While work on voluntary consensus standards is still thin, the breadth of this related literature nevertheless supports the claim of their invisible ubiquity.

Defining standards and their types

The *Oxford English Dictionary* (2018b) identifies a compelling link between two early uses of the word 'standard'. The first use is as a symbol-bearing pennant, flag or banner. On the battlefield, the king's standard is immediately and widely recognisable. It marks the central point of organisation and command. The second use of the word is as an accepted comparator. Also at times referred to as the king's standard, this is an object from which the properties of other objects are obtained. Take for example, the universal metre. The length of a metre was initially defined as one ten-millionth part of a quarter of the Earth's meridian. This was calculated in the late eighteenth century, after the efforts of two French astronomers to precisely determine the distance between Dunkirk and Barcelona (Alder, 2002). To establish its inviolability, the length was cast as a bar of platinum and stewarded by the International Bureau of Weights and Measures. In both cases, in battle and in measurement, authority was embodied in a physical form.

But not all standards are embodied. Use of the word in the singular plural (as in 'high standards', or 'double standards') refers to norms of virtue and worth (Williams, 1983: 298). This is what is meant in the phrases 'a good living standard' and 'a minimum standard of housing'. In this case, there is no physical object to convey authority. Instead, a thing is measured and assessed against general expectations. While such standards are usually implied, there have been attempts to specify minimum living standards and standards of professional practice. In 1896, The Paris Commission on Work published a model budget for a labourer's minimum level of subsistence (Simmons, 2015). The text reflects the politics of its time. On the one hand, it allows 20 centimes for wine and bread to help pass the daily walk to work. On the other, it offers only the barest outline of the cost of maintaining the home: 250 francs a year for clothes, shoes, heating and pressing. Nevertheless, this effort (and others like it) were important in the establishment of a legal minimum wage. An obvious example of the standardisation of professional practice is the swearing of the Hippocratic Oath (Miles, 2004). Here, the text not only represents but also, through its utterance, reinforces. In speaking the oath, a physician commits to abide

by a standard of appropriate behaviour. Indeed, professionalisation has often been entwined with the performance of a code of conduct. Electrical engineering, for example, emerged with the formal description and adoption of a standard of practice in nineteenth century Britain (Arapostathis, 2008).

From exemplars of measures to professional codes of conduct, standards are varied in form and function. They can be, but are not always, embodied. Some are explicitly and precisely stated, while others are only ever inferred from context. In a broad sense then, a standard is any set of rules or values by which things are put into order. Standardisation is the process by which such a standard is established.

Two observations follow on from this. The first is that there is no clear distinction between standards, customs, norms, regulations and laws. As the above examples illustrate, standards affect both human and non-human relations. Although the Hippocratic Oath and the universal metre pertain to different matters, both are said to be standards. The word can be applied to both the social and the technical. Moreover, standards can be informal as well as formal. What exactly 'a good living standard' entails is quite flexible and context-dependent. A minimum wage, however, is a precise and knowable quantity enforced by political and legal institutions. While the first might, with confidence, be referred to as a norm and the second a law, both can be called standards.

This is not only a semantic issue. As Busch (2011: 4) observes, the assumed separation of customs, norms, regulations and laws is mirrored by the subject topics of academic disciplines. Anthropologists study customs, sociologists focus on norms, political scientists are interested in regulation, and legal scholars study the law. At a higher level of abstraction, science and engineering confine themselves to natural and technical standards, whereas the social sciences emphasise those of a social nature. While efforts have been made to disentangle these terms (see for example Bicchieri, 2017), for Busch (2011: 26–27), formal ontological distinctions between technical standards and social norms, and between private standards and public regulations, do not hold up to scrutiny. Rather than assume or attempt to define them as different, he argues that it is necessary to confirm their differences through close empirical examination. Just as actor–network theory (ANT) proposes an analytical symmetry between human and non-human agents (Callon, 1986), so there is no reason to maintain an *a priori* distinction between human and non-human standards.

Busch's theoretical assertion leads to a broad and inclusive conceptualisation of standards combined with careful attention to the work they perform. He proposes a typology of their ordering effects, consisting of olympics, filters, ranks and divisions (Busch, 2011: 43–48). Drawing on the metaphor of the Olympic games, *olympic* standards specify the winner within a particular domain. This includes awards for sporting and artistic achievement, as well as for consumer products and services. Any kind of prize in

which the winner takes all is of this type—for example, the standard for outstanding literary work in a given year, is the recipient of the Nobel Prize. *Filters* are standards which sort things according to a minimum or threshold value. Conditions are specified and an assessment is made as to whether those conditions have been met. Where olympic standards elevate a single winner, the purpose of filters is to prevent the occurrence of anything deemed unacceptable. Examples of this type of standard include occupational certification, acceptance into a university program, setback distances for building fronts, and the tolerable mercury limit for drinking water. *Ranks* organise items of a similar class of things according to a measurable quality. They differ from olympic standards in that every item, and not only the winner, receives a rank. They differ from filters in that they propose a hierarchy of values, rather than assess inclusion on specific terms. Military ranks within an armed force are an example of this type of standard, as are grades of grain and the Richter magnitude scale for earthquakes. *Divisions*, finally, are unranked categories. They do not assume an order of preference; although individuals may impress one upon them. Here we might include everything from academic disciplines to varieties of apple (such as Granny Smith, Fuji and Pink Lady), and from family genealogies to political identities (such as class, gender, race, sexuality). Figure 2.1 illustrates the relationships between the four types of standards. It shows that an olympic standard is a special type of filter, both of which imply some sort of normative or distributive ranking. Divisions differ in their refusal to organise according to measurable and sequential properties.

The second observation is that while standards represent things, they also come to affect them. Standards are developed from data about the world. They may describe extant orders, patterns and rhythms, but they just as often approach data in a more narrow and normative manner. The Parisian worker's budget is clear example of how standards represent and respond to worldly conditions. But standards are also enacted. Once something is recognised as a standard, it reflexively affects the very thing that it represents. The Hippocratic Oath, upon being stated, reinforces its principles of ethical medical practice. Put differently, standards are both representational and performative.

This observation informs the way in which standards are classified. Russell (2014: 18–19) divides standards into three types according to the manner of their genesis: *de facto*, *de jure* and voluntary consensus. Unlike Busch's typology, which is based upon ordering effects, this typology concerns the continuous process of becoming standard (i.e., standardisation).

De facto standards are products and practices which have become dominant through market ascendancy or general acceptance. They are usually developed by individuals and companies to be competitive rather than normative. Examples include the QWERTY keyboard and the use of alternating current on electrical grids (David, 1985; David and Bunn, 1988). Here, 'standard' is used as an adjective to describe something that is already

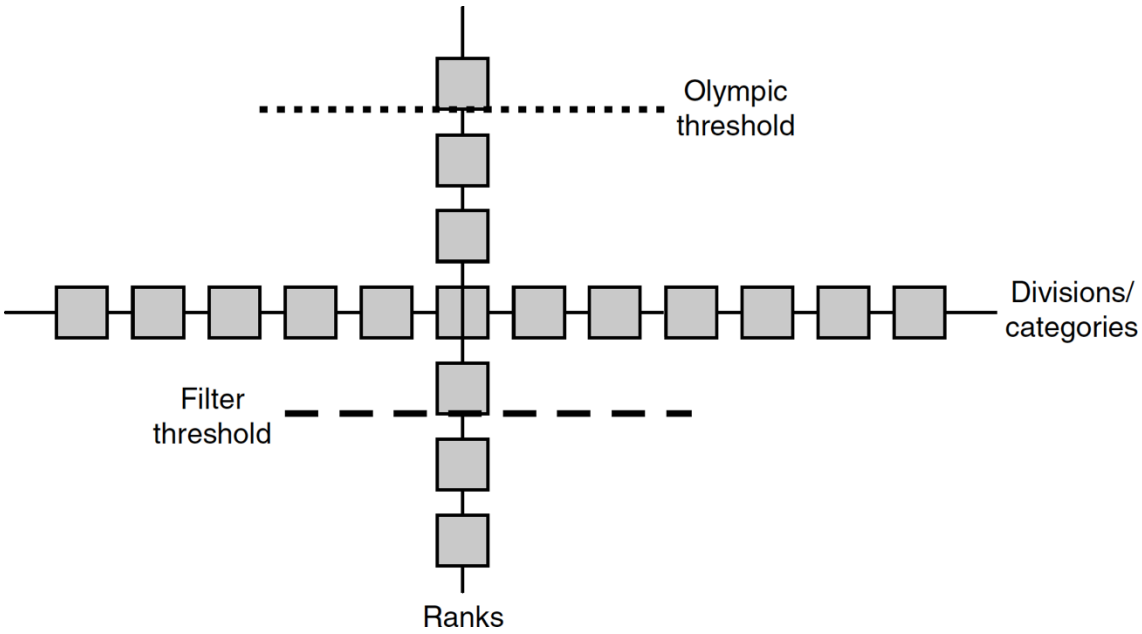

Figure 2.1. The relationships among olympics, filters, ranks and divisions. Reproduced from Busch (2011, 48).

pervasive and well-established. This sense of the word does not refer to an embodied archetype, nor to norms of virtue and worth. It does not necessarily imply comparison or prefiguration. The act of calling something a *de facto* standard then, is largely representational in that it occurs after a process of standardisation has already begun. A thing is standard, in fact.

De jure standards are laws and regulations mandated by local, regional and national governments. They are more performative in nature than *de facto* standards. Conformance to *de jure* standards is usually assessed through audits and tests, and non-compliance dissuaded by the threat of punitive action. Most food and product safety standards are of this type. Unlike *de facto* standards, *de jure* standards may or may not be well-established. This is not to say that they do not have some representational character. Laws and regulations are not discovered fully formed; development does not occur in a vacuum. Rather, *de jure* standards rely upon and respond to things in the world. But in order to be effective, these standards must be observed and their normative intentions implemented. Put differently, they are standards prior to and irregardless of standardisation.

The label *'voluntary consensus standard'* is narrower in scope than the uses of the word 'standard' so far discussed. It refers to designs, processes and practices published for the purpose of general adoption. Voluntary consensus standards are developed by industry associations, unions, consortia and other SDOs, such as ISO, the International Electrotechnical Commission (IEC) and the International Telecommunications Union (ITU) (Murphy and Yates, 2009; Schmidt and Werle, 1998). Their development is open to a range of interested parties, so long as they abide by a (more or less formal) deliberative and consensus-based process of development. Like *de jure* standards, voluntary consensus

standards are normative and performative. They are made with the intention of intervening on something in the world and must be implemented in order to do so. Unlike *de jure* standards, they are seldom enforced by a sovereign state but are adopted voluntarily by individuals, firms and industries. If they are to become pervasive and well-established, voluntary consensus standards must be actively circulated. As such, they are usually made available as published documents, and are promoted by developers and key stakeholders at industry events and in specialist journals. Examples of this type of standard include: ISO 1161, which describes the design of corner castings for shipping containers (Levinson, 2006); ISO/IEC 7810, a standard specifying the width of credit cards (Easterling, 2014); and ISO 9001, the dominant quality management standard (Furusten, 2000; Gibbon and Henriksen, 2011).

Timmermans and Berg (2003: 24–26) identify four types of voluntary consensus standard: design, terminological, performance and procedural. *Design* standards prescribe morphological parameters for objects. Here, exact measures of things are stipulated, rather than minimums, maximums and ranges. Design standards exist for many everyday objects, including envelope sizes, screw thread widths and the hot shoe used to mount a flash to a camera. *Terminological* standards set the terms by which a general problem area is to be addressed. These standards vary in scope, detail and formality. Upon establishing a new topic area, ISO often begins by defining the language that will be used to discuss that topic in subsequent standard-making efforts. ISO 37100, for example, sets out a vocabulary for sustainable development in cities and communities. It is unlikely that ISO participants anticipate the formal adoption of this language outside the organisation. *Performance* standards describe outcomes and behaviours. Unlike design standards, they do not prefigure a thing's dimensions but place limits on its qualities and quantities. Their purpose is to screen out anything deemed undesirable. In the workplace, performance standards influence the result of an action rather than the method used to obtain that result. In communication protocols, they define acceptable behaviour at the interface between the transmitter and the receiver. Finally, *procedural* standards address processes and practices. Where performance standards affect results, procedural standards are interested only in how that result is obtained. The work of health care providers, for example, is regularised through the use of clinical practice guidelines. This type of standard is also used to ensure the consistency of conformance testing other types of standards.

The word 'standard' is used in various ways to refer to the material and discursive rules by which things are ordered. In this section, I have made two general observations about them—that they blur the boundaries between customs, norms, regulations and laws; and that they both represent and affect the world—and introduced three typologies

by which they can be understood. Having explored various meanings of the word 'standard', I now turn to the work of one scholar in consideration of their characteristics.

Common characteristics of standards

In a well-cited paper, Susan Leigh Star (1990) admits to an allergy to onions. While not a profound disability, she describes it as something that affects her in unanticipated ways. Large franchise restaurants have highly standardised menus that cannot always accommodate atypical dietary requirements. A burger without onions can take half-an-hour longer to prepare than a burger with onions. Finding fast food while travelling can sometimes prove a challenge. The argument Star pursues in the paper is an important one. Standards create difficulties for people who do not fit within their assumed categories, and these categories can be difficult to challenge and overturn. Norms necessarily produce abnormalities. Disability and deviance can be understood as a side-effect of well-established standards of expected behaviour (see also Barnes and Mercer, 1997). An allergy to onions is an everyday example of how this occurs.

Star's observation can be applied to far more than burgers and franchise restaurants. It also offers insight on inherited structures of knowledge production. Standards not only impact the nature of things, but the nature of how things come to be known and expressed. Epistemic problems relating to the authority and legitimacy of truth claims can be framed within the language of standards[2]. In order for an assertion to be taken seriously, it must meet common assumptions, forms of argumentation and burdens of proof. These are not universal requirements, but have emerged within a particular social and historical milieu. Like all standards, they are contingent, contextual, relational, and neither universal nor truly stable. Once this is appreciated, other ways of perceiving and understanding can be properly encountered and brought to the fore. Standards, whether material or discursive, ontological or epistemological, are inherently political, just as their production is always a political act. As Haraway (1997: 269) observes:

> Attention to the agencies and knowledges crafted from the vantage point of nonstandard positions (positions that don't fit but within which one must live), including the heterogeneous locations of women, and questions about for whom and for what the semiotic-material apparatuses of scientific knowledge production get built and sustained are at the heart of feminist science studies.

[2] For a detailed discussion of these issues, see the literature on standards for evaluation (Shapin and Schaffer, 1985; Porter, 1995; Daston and Galison, 2007) and justification (Boltanski and Thévenot, 2006).

This ethical and political commitment to the non-standard also lies at the heart of my own research.

Star's onion-allergy paper opened a rich seam of research on the sociology of infrastructure that she worked productively over the next twenty years. In 2009, she co-edited a book that opens with a wide-ranging discussion of standards and the challenges faced in their research. Star and Lampland (2009) do not define standards with the breadth of Busch (2011) nor the specificity of Russell (2014). Nevertheless, they offer a useful account of their analytical commonalities that I wish to summarise here. Standards are presented as: nested; interlinked and integrated; distributed unevenly through the sociocultural landscape; relative to communities of practice; and an embodiment of ethics and values.

The *nesting* of standards refers to their manner of overlapping, interacting with and existing inside of one another. ISO 1161, which specifies the design of corner castings for shipping containers, presents a clear example of how this occurs (Busch, 2011: 166–177). This standard was crucial to the post-war expansion of commercial shipping. However, without standards for container dimensions, for the machinery used to load and unload containers on ships, and for the mechanism by which containers are fastened to truck trailers, it would not have become as widespread as it has. The example can be stretched further. Without accepted commercial shipping lanes or radio communication protocols, the increased number of ships may still have overburdened port infrastructure. Without better standards for road construction or rules for mixed vehicular use, trucking may have been unable to meet the growth in demand.

More than simply nesting, standards also function in tandem. They are *interlinked and integrated*. Corner castings allow shipping containers to be fastened together. This is achieved by another standard, a twistlock mechanism, which consists of two conical sections that are inserted into corner castings as containers are stacked (Levinson, 2006: 56). When rotated with a handle, the twistlock changes shape, locking the containers together and preventing them from sliding over one another during transportation. Another example is the standardisation of container lengths. While early containers were of many lengths, they were eventually standardised at 10, 20 and 40 feet. This had a run-on effect on the dimensions of mobile gantry cranes, and on the design requirements of trains, trucks, ships and ports.

Standards are *uneven* in their social and spatial distribution. Not everyone, for example, has access to the same standards of education (Star and Lampland, 2009: 6). Urban populations tend to be better educated than rural populations, just as wealthier nations tend (with some obvious counter-examples) to support their public education systems more generously than do poorer nations. Related to this, standards are also *relative* to the individuals and groups that they affect. Students respond differently to standardised

tests, depending on their perceived importance and on the time that can be afforded their preparation. For those who perform well—bearing in mind that different career paths demand different results—standardised tests can lead to further eduction opportunities or a desirable job. But for those who perform poorly, fail their tests or are unable to sit them, they may become a barrier that prevents individuals from doing what they wish in life. Standards are unevenly circulated, but they are also implemented within a range of different contexts.

Finally, standards *embody ethics and values*. Whenever a standard is implemented, some kind of order is impressed upon the world. Busch's (2011) four types can be used to give an indication of the ways in which this occurs. Ranks assert that some things are more valuable than others. Olympics and filters take this a step further by preventing unlimited diversity. Even divisions, in deciding where the barriers between groups are to be placed, are normative. In the case of the standard hamburger, a choice has been made about what a hamburger should contain and consequently about what customers should be able to eat. A more important example discussed by Bowker and Star (1999) is the racial classification system used in Apartheid South Africa. Under the Population Registration Act of 1950, people were required to register under one of four groups: Europeans, Asiatics, coloureds (or persons of mixed race), and Bantu (which was in turn divided into eight main subgroups). Racial classification dictated where a person could live and work, as well as the rights available to them under Apartheid law. While it was possible to apply for reclassification, it was rarely approved. Busch (2000) argues that grades and standards constitute a moral economy that regulates and secures the political economy.

Over the course of her academic career, Star revealed many of the important features of standards. She understood that they are political, both in development and implementation. She showed that a thing is never non-standard by nature, but is constituted as such through its encounters with assumed ideas and categorisations. Star understood that standards have their own patterns of organisation and exchange. They nest within one another, and become interlinked and integrated into a complex knot of rules and expected behaviours. She explored the geographies of standards, appreciating that they are unequal in their distribution and impact. Finally, Star understood that standards translate orders of meaning into material effects.

The spatiality of standards

While Star and Lampland pick up on the uneven geographies of standards, they do not fully explore their spatial effects. They are not alone in this. Much of the empirical work on standards and standardisation operates within an implied scaffolding of absolute space. Space is regarded as a framework of co-ordinates against which global, decontextualised

standards touch down in local settings. This is referred to indirectly through concepts such as location and distance, and through the use of metric or imperial units. While this approach is usually adopted pragmatically, its underlying assumptions have long been challenged by the critical and interpretive social sciences. Since the 1970s, the production of space has been explored in numerous ways, first through the dialects of capitalist production (see for example Lefebvre, 1991; Harvey, 2006), and then by way of postmodernist and poststructuralist experimentation with relational ontologies (see for example Soja, 1989; Crang and Thrift, 2000). While different, these accounts share: an appreciation of space as an ongoing, relational process; and a sensitivity to the involvement of space with social and political difference. In order to tease out the spatial effects of standards it is necessary to apprehend space in this way.

For actor–network theorists Latour (1990), O'Connell (1993) and Callon (1991), standards are not understood as a global, decontextualised technology. Rather, they are approached in terms of the geometries of their associations. An arrangement of interacting actors (or actants) is perceived as a relational network, which at a different scale of analysis might in turn be perceived as an actor. By following and describing actor–networks, these thinkers hope to obtain appreciation for the complexities of the material world. In each case, different concepts are forwarded: for Latour, immutable mobiles; for O'Connell, metrology; and for Callon, irreversibility and stabilisation. By presenting them in this order, I reveal a shift in emphasis from the standardised object to the standardising apparatus.

The immutable mobile is Latour's materialist answer to an epistemological question: how is it that observations cohere and harden into fact? The example with which he introduces the concept is instructive (Latour, 1990: 24). A map of the coastline, when traced in the sand, is able to convey the information necessary for safe sailing. It selectively draws together relevant relationships in a manner legible to individuals of different cultural backgrounds. But with the rising tide, the map is washed away. For a map to convey its information through space and time, it needs to be written on paper or parchment, thus becoming both immutable and mobile. Rather than explain the establishment of facts using method, evidence, argument or social standing, Latour is interested in the materials and representations deployed to assemble allies to an idea. His ultimate purpose is to disclose the mundane mechanisms of scientific practice that are too often taken for granted. In an exploration of the concept's topology, Law and Mol (2001) insist that immutable mobiles are situated between two spatialities: regional space (which prioritises location and relational co-ordinates) and network space (which is concerned with connection rather than position). For them, it is immutability in network space that confers the potential for mobility in regional space.

In an eclectic paper, O'Connell (1993) uses the concept to help explain how systems of measurement and comparison are established. Unlike Latour, he is not interested in the persuasiveness of immutable mobiles so much as the communities of conference and exchange that are put into operation around them. O'Connell argues that metrological practices are stabilised "by establishing the authority of a particular representative, circulating it, and assuring that comparisons are made to it" (O'Connell, 1993: 165). His point is that a standard is both particular and (in aspiration) universal, embodied within an indivisible object but constructed as an authority through the ubiquity of its relations. The appearance of universality is achieved through circulation and implementation.

Even more interested in the stabilisation of practice is Callon (1991), whose theorisation of techno-economic networks encompasses standards and standardisation. Considered as a set of heterogeneous actors bound by the intentionality of their productive methods, Callon's concept is used to explain how science and technology result from interactions between a large number of diverse components. While the paper introduces many interrelated terms, of particular relevance to the spatiality of standards are 'irreversibility' and 'stabilisation'. As networks become larger and enrol ever more numerous and diverse components, they resist mutation and change. If this proceeds far enough, a 'codified metrology' can emerge.

> Normalisation makes a series of links predictable, limits fluctuations, aligns actors and intermediaries, and cuts down the number of translations and the amount of information put into circulation. It operates by standardising interfaces—that is, by standardising and constraining actors and intermediaries. (Callon, 1991: 151)

In such a network, the variety of action performed by any one actor is limited. It becomes docile and predictable, constrained by the norms of the network. The irreversibility of individual practice implies stabilisation of the whole. This has implications for how standards are conceived. Emphasis is placed less on the circulation of a particular fixed actor (the standard), than on the relational fixity of a set of interactions.

These three approaches to standards and standardisation share philosophical ground. All are materialist, empiricist and observe a relational ontology in which the boundaries between objects blur. Accordingly, the language of absolute space gives way to a description of the geometries of association. 'Global' and 'local' are superseded by 'network', and connection is explored in terms of character and intensity, rather than location and distance. In this way, standardisation comes to be understood as a stabilisation of object-relations. This is evident in the immutability of Latour's immutable mobiles and in the irreversibility of Callon's techno-economic networks. Actor network theory describes the spatial effects of standards as a configuration of relations.

Other approaches to the spatiality of standards prefer different terms. Barry (2001; 2006), for example, has developed the concept of the 'technological zone' to refer to

spaces which emerge from an alignment of practices. Through the adoption of common standards, things are made commensurate and compatible, lowering the barrier to interaction and exchange. The spatial relations which emerge are fluid and harmonious. And yet the term itself is awkward and unfamiliar. Indeed for Barry (2001), its purpose is to denature the opposition between static national territories and deterritorialised flows of capital. A zone is not a region or a territory, but neither is it really a network or geometry of association. It can instead be thought of as a topological manifold. Technological zones overlap and enfold one another. They are distinct from state and corporate spaces, but are imbricated with them, such that technical uniformity is mingled with social and political differentiation. Technological zones are not fixed, but are always in process. They are disjointed and fragmented, demanding constant maintenance and reconfiguration. All told, the 'technological zone' is a useful way to conceptualise the spatial effects of standards.

Elsewhere, I have argued that the spaces of standards and standardisation can be rethought through the concept of 'site' (White, 2017). My use of 'site' here is perhaps a little counter-intuitive. I do not mean it to refer to a location in absolute space, nor even to a more diffuse and phenomenological place. Rather, it is intended, following Schatzki (2002), and Woodward *et al.* (2010), as a way to perceive, interpret and describe bodies in action and connection. Site is less where something occurs than how it occurs. Site ontologies reject the possibility of encounters between discrete, ready-formed objects. Space does not precede the site, but is an expression of its internal logics. Its mediating qualities, whether conceived as a static scaffold, a network configuration or a zone of operation, are downplayed. Site ontologies thus differ from ANT. But they also differ from hermeneutical and dialectical approaches to space. How a thing occurs is not accounted for by deeply-hidden forces, but by material practices and orders of meaning imminent to unfolding events. Social and spatial interpretation are conducted with a light touch, leaving open the possibility for unexpected political impulses and effects. Where early ANT follows structuralist theories in emphasising stabilisation, site ontologies take seriously the challenge of propinquity, slippage and happenstance. Rethought in this way, standards do not exert a power that extends beyond the act of their performance. In the next chapter, I flesh out a site ontology of standards with the help of the philosophers Michel Foucault and Karen Barad.

The permanence of standardised infrastructure

Standards have temporal as well as spatial effects, the theorisation of which leads to an engagement with agency and causality. Before discussing these, it is necessary to very briefly establish the connection between standards and infrastructure. Carse (2017) notes

that the word 'infrastructure' was first used to denote engineering work that was literally beneath or prior to the assembly of a physical structure. Planning, surveying, track bed preparation, and bridge and tunnel construction were all infrastructure for the laying of railway tracks. Today, the word is used more generally to refer to any foundation for society and the economy. Thus, the education and healthcare systems can as easily be described as infrastructure as can the road, energy and water networks. Some social theorists have even extended the concept to include people (Simone, 2004) and their emotional interconnections (Berlant, 2016). But unlike 'system' and 'network', 'infrastructure' maintains a sense of hierarchy or depth. In lying beneath daily life, standardised infrastructure is relied upon as something more permanent than the structures built atop it.

The permanence of infrastructure has been discussed under a number of terms within and beyond science and technology studies. Indeed, Callon's (1991) notion of technological irreversibility refers to the accumulative effect of a network of relations over time. Normalisation, or standardisation, is here used to describe the process by which a range of possible behaviours and associations is winnowed away. The weight of a network's history bears down on its participants, limiting what they can and cannot do. But it need not be so. Three alternative conceptualisations are of note: path-dependency (Busch, 2011), technological momentum (Hughes, 1994), and trajectory and torque (Bowker and Star, 1999). While all acknowledge the permanence of infrastructure, each affords a different degree of agency to the parts.

'Path-dependency' is an economic concept describing a sequence of changes that are strongly influenced by prior events, especially ones characterised by chance. Neoclassical economic theory anticipates that under ideal conditions, *laissez-faire* capitalism guarantees the survival of superior technologies (Liebowitz and Margolis, 1995). Whenever similar products compete for the same market share, the one that is able to provide the most value for the least price will be expected win out. Random events are unable to disrupt the equilibrium point of supply and demand. This expectation is not borne out by evidence, however, as economic historian David (1985) has shown using the example of the QWERTY keyboard. In the early 1870s, Christopher Latham Sholes, the fifty-second person to invent the typewriter, arrived at the QWERTY layout largely through trial-and-error. His aim was not to promote efficient typing, but to minimise the frequency of typebar clashes. Nevertheless, the Sholes and Glidden typewriter was a success, thanks largely to its inclusion of both lower and upper case letters. With the advent of touch typing in the 1880s, the QWERTY keyboard became a *de facto* standard, even though more efficient layouts existed on the market. Sometimes minor, accidental decisions become dominant thanks to their path-dependency. Arthur (1989) frames the problem differently, arguing that path-dependency only ever occurs when complex

technologies demonstrate increasing returns to popular adoption—what Katz and Shapiro (1994) later characterised as network effects. For technologies that do not gain in value as their total usage increases, overall success will not be swayed by chance events.

Busch (2011: 60) pulls 'path-dependency' into his own constellation of terms, describing it as an outcome of the layering, coupling and commensurability (i.e., the nesting, interlinking and integration) of standards. The concept is particularly useful, he suggests, for understanding why it is difficult to introduce new standards or radically alter existing, well-established standards. In order to become successful, standards require a considerable investment in time, money and resources (see also Thévenot, 1984). Complex relations and practices are put into place around them, making fundamental change expensive. The future becomes contingent upon actions taken in the past. But not all standards become path-dependent. Busch discusses criteria for the path-dependency of standards, identifying variations amongst their type, degrees of reversibility, superfluity and coupling, and the distribution of their production.

Although Busch uses the concept pragmatically, 'path dependency' leads to an idiosyncratic position in the structure-agency debate. On the one hand, it counteracts economic determinism, opening the way for individual actors to affect the overall direction of society. On the other, its assumptions limit the way in which this can occur. When free markets operate as expected, history is determined by economic forces. It is only with the emergence of a new technology that human agents are afforded the opportunity to affect unfolding events. But this opportunity is fleeting. Once the technology has become established, it proceeds in a path-dependent manner, distinct from both human agency and economic forces. Human agency is squeezed between economic determinism on one side and technological determinism on the other.

The concept of 'technological momentum' is more promising. Hughes (1994) introduces it as a way of mediating between technological determinism and social constructivism. Technological determinism is defined as the belief that technology shapes society, while social constructivism is defined as its opposite, the belief that culture and society shape technology. For Hughes, causality can run in either direction—to characterise the relationship solely one way or the other is a mistake. Early on in the development of large sociotechnical systems, the performance and design of technology is highly susceptible to social interference. As systems mature, however, the reverse tends to be the case; at some point, the causal direction flips and technology comes to determine social relations. Conceived as such, 'technological momentum' reveals the evolving nature of sociotechnical systems without slipping into an absolutist position. But the concept is not without its problems. Unlike others who have challenged the inflexibility of technological determinism and social constructionism (such as Latour, 1993; and

Pickering, 1995), Hughes accepts an easy distinction beween 'technology' and 'society'. His focus is on the macro scale, at the detriment of the ontological status of minor agents.

If Hughes leaves the human untheorised, Bowker and Star (1999) offer a way to draw out the relationship between infrastructural permanence and human agency. 'Trajectory', a concept borrowed from medical sociology (Strauss et al., 1985), is used to discern the entwined movements through time of bodies, biographies, pathologies and medical institutions (Bowker and Star, 1999: 163). Like 'path-dependency' and 'technological momentum', it allows for the role of the non-human in the constitution of social and cultural life. Technology can shape history. But 'trajectory' departs from these concepts in two significant ways. The first is that it does not make causal pronouncements. Bowker and Star are less interested in whether one thing lead on to another, than they are in the ongoing relationship between those things. Their view of history is far more consistent with an ontology of presence. This leads on to the second point of departure: 'trajectory' is nonscalar. The concept can as easily be applied to the life course of minor agents as it can established standards and large-scale infrastructure. For example, Bowker and Star use it to visualise the resonances and dissonances between individuals carrying a disease and the typologies used to classify and help treat them. As a pathology pulls away from standardised classifications, individuals experience stresses and strains. This process they refer to as 'torque'. The non-standard is not an unchanging externality. It is instead produced through encounters between bodies, subjects and infrastructure. Taken together, 'trajectory' and 'torque' are flexible conceptual tools, well suited to descriptions of the temporal effects of standards regardless of scale.

The site ontology I advanced with respect to the spatiality of standards emphasises presence over permanence. Just as it troubles the co-ordinates of absolute space by granting ontological priority to unfolding events, so does it trouble the linearity of time. Time is considered to be less a medium through which things move and interact, than an outcome of relations expressed within the site. While this does not mean that site ontology is ahistorical, it does signal its incompatibility with transcendent historical forces. History must be conceived not as an tireless march through the ages, but as something that works on and is worked on by the present. Given this, I regard the historicity of infrastructure principally in terms of imminent material and discursive relations. Permanence is an effect of the reiteration of expected behaviour and nothing more. Infrastructure can have neither an essence nor a telos. Of the concepts explored, only Bowker and Star's (1999) 'trajectory' can account for the permanence of infrastructure without overwhelming the relations between its constitutive parts.

While my focus in this section has been on permanence, it is important to recognise that this is not the only way in which the temporality of infrastructure is discussed. Given the role of infrastructure in modernist planning, development has often entailed a looking

forward to a brighter and better future. Kaika and Swyngedouw (2000) frame this as a fetishisation of the urban, arguing that the visibility of the materials of railways, towers, pipes and wires, was an expression of the presence of the state in everyday life. As politics has changed, and with it the perception of the appropriate role of the state, infrastructure has sunk beneath the surface of the city, out of sight and mind. Larkin (2013) refers to this as the poetics of infrastructure in an effort to reveal the interplay between the visibilities and invisibilities of public utilities and networks (see also Amin, 2014). In a recently published collection, the promise of infrastructure is explored as a material substrate forgotten by liberal capitalism and as a concept which transgresses disciplinary boundaries (Anand et al., 2018).

Standards and cities

Standards, as I have defined them, are everywhere in cities. They regulate the physical form of roads, buildings and plots of land. They permeate infrastructure, overseeing distribution and the reliability of interfaces. They regularise human and non-human behaviour, easing interaction, communication and exchange. They infect imagination and populate discourse, tempering what is deemed appropriate, possible and desirable. Standards are everywhere in cities and yet use of the concept of 'standard' in urban studies is rare. The reasons for this are complicated. Standards are sometimes equated with product standards (or commodity fetishes) and identified with the modernist period of urban development. Some urban thinkers are interested only in powerful economic forces, and so tend to overlook how markets are performed in the here-and-now. For others, cities are unique, exceptional and irreducible; the very opposite of standard. Nevertheless, there is a lot of work at the intersection of standards and cities, even if it is not discussed in these terms.

I want to begin my survey of this literature with attempts to think through the performativity of rhythm, repetition and iteration in the city (Giedion, 1958; Jacobs, 1961; Sennett, 1970; Lefebvre, 2004; Tavernor, 2007; Carpo, 2011; Easterling, 2014; Wolfe, 2014). This work varies tremendously in its theoretical and empirical approach to standards. Tavernor (2007), for example, undertakes a sustained humanist attack on scientific quantification and precision. He argues that prior to the Enlightenment, architecture and the body were in perfect alignment thanks to the use of human proportions in measurement and design. The modern era's disposition to measurement by contrast, has been one of standardisation and bodily detachment. The built environment has become less a reflection of human utility than a symbol of its cold, mechanical aspirations. Writing in the 1960s, Jacobs (1961) used standardisation as a catch-all for the failures of American planning theory: decentralisation, self-contained

housing and single-purpose land use. Against this, she advocated policies to encourage diversity of population, urban use, and building age and design. Sennett (1970) is similarly polemical, railing against the stymieing effects of order on urban life and the human condition. While he and Jacobs share an admiration for diversity, Sennett is more interested in disorderly creativity than he is a bottom-up practice of urban place making. More sanguine but highly abstract is Lefebvre (2004), who advances an approach to the study of embodied rhythms. While this does not involve intentional standards, it could easily be made to do so. The patterns of everyday life are to be found, like infrastructure, beneath the surface of urban appearances. Easterling's (2014) work is guided by a similar sentiment. She argues that repeatable codes and formulas are intrinsic to the places we live and work. Standards are for cities what software is for a computer operating system: an unseen force shaping the form and function of things. They enable what she calls extrastatecraft: political power which moves within and between national territories.

Other work is more concrete, seeking to identify and interpret standard patterns in buildings and cities to understand the historicity of place and inform the practice of architecture, planning and urban design (Conzen, 1960; Lynch, 1960; 1981; Cullen, 1961; Rossi, 1982; Whitehand, 1987; Kostof, 1991; 1992; Panerai et al., 2004; Scheer, 2010). Within urban geography, Conzen (1960) and Whitehand (1987) examine ways in which specific buildings and land plots have changed over time. By following extensions, reductions and shifts in form, they explore place in terms of historical events and contemporaneous social and cultural attitudes. Architectural historian Kostof (1991; 1992) is motivated by a similar desire but employs a different focus. Where Conzen and Whitehand are thoroughly detailed, Kostof is expansive and inclusive, encompassing the city patterns of diverse cultures over hundreds of years. In a chapter on the grid, for example, he describes the redevelopment of Suzhou in Sung Dynasty China, reflecting on the great flexibility that a simple orthogonal street plan allows. Other architects, such as Scheer (2010), are less concerned with heritage and history than they are with professional practice. Their classification schemes are still representative, in the sense that they abstract from observations about cities in order to gain a better appreciation of their common features. But they take this one step further, advocating for their use to affect the production and maintenance of cities. They not only examine and define *de facto* standards, but seek to reinforce and improve upon them. Finally, Lynch (1960; 1981) and Cullen (1961) can also be included within this group, although the patterns they describe are more phenomenological than morphological. Beginning from the assumption that encounters are prefigured by perception, these writers attempt to identify features of harmonious urban environments. Like Scheer they are practice-oriented, but their work is more applicable to urban design than it is to architecture and planning.

There is also considerable historical and empirical literature that attempts to understand how buildings and cities have been shaped by norms, codes and regulations (Hall, 1988; Rabinow, 1989; Rowe, 1995; Nivola, 1999; Joyce, 2003; Southworth and Ben-Joseph, 2003; Ben-Joseph, 2005; Ben-Joseph and Szold, 2005; Imrie and Street, 2011; Talen, 2012) Ben-Joseph (2005) takes a broad, historical perspective, following the use of standards in the earliest human settlements right through to the cities of today. To take one example, in the mid-eighteenth century, Gunter's chain, a surveyor's tool comprised of one hundred 7.92 inch long links, was used to divide and portion out large swathes of the American territories—which accounts for the enormous rectangles of land that are observable while travelling across the country by plane. Such rigid and orderly partitions were common to the planning and construction techniques used in European colonies. Ben-Joseph's work concludes with broad policy lessons aimed at preventing the over-regulation and suffocation of place. Rowe (1995) is narrower in focus, paying particular attention to normative interventions in housing during the late nineteenth and early twentieth century. Overcrowding and poor living conditions were connected with poor health and crime in large American and European cities. Rowe describes three ways in which standardisation helped address this: through the use of minimum standards to improve comfort, light, air and access to green spaces; through the falling costs of automobiles and standardised products for the home; and through the use of state programs to classify and intervene upon troubled areas. Talen (2012) addresses the effects of standards on the urban environment in US cities in the twentieth century. She describes: how building codes have been used place limits on the heights, breadths, strengths and colours available to architects; how planning regulations are used to determine street widths, curb radii, the setbacks on plots of land and so on; and how zoning is used to create specific densities and uses of space. While she sympathises with their intentions, she argues that standards have led to undesirable urban forms and an over-reliance on automobiles. Some critics of architectural regulation take this critique a step further, bemoaning the overburdening effects of building codes on creativity and design (see the edited collection Ben-Joseph and Szold, 2005). Imrie and Street (2011) question the empirical basis for this argument, however, drawing on a broad set of interviews with practicing architects in the UK. They show that building standards and codes are not only perceived as flexible in how they ensure safe construction and use, but are sometimes considered a boon to creativity. In addition to these studies on codes, laws and regulations, Rabinow (1989) and Joyce (2003) have explored the role of norms and values in architecture and urban planning. Where Rabinow focuses on France and its colonies from the 1830s to 1930s, Joyce is more interested in how liberalism was expressed in cities and infrastructure in London and Manchester.

Empirical research on voluntary consensus standards for cities is thin for the simple reason that they are a relatively new phenomenon. An exception to this is the green building standard, Leadership in Energy and Environmental Design (LEED). LEED was developed in the 1990s by the US Green Building Council, a private non-profit, using a consensus-based model. Unlike building codes and regulations, it does not depend on a government body to enforce compliance and is instead adopted voluntarily (Cidell, 2009). Buildings are assessed in specific domains, such as energy efficiency, storm water drainage and waste management, and are granted points for the performance criteria they meet. Normal certification requires 40 to 49 points; silver, 50 to 59; gold, 60 to 79; and platinum, 80 and above. Achieving LEED certification is not cheap. Individuals and developers implement the standard to reduce their environmental impact and help differentiate their building amongst discerning, ecologically-conscious consumers. But there is another reason that help account for the standard's success: in some states in the US, certification allows developers to claim tax credits. While widespread, the extent to which LEED has actually improved the energy efficiency of building construction and use is debated (Scofield, 2009).

A small amount of research has been published on standards for smart, sustainable and resilient cities (March and Ribera-Fumaz, 2016; Joss et al., 2017; Schindler and Marvin, 2018). March and Ribera-Fumaz (2016) survey the smart city programme of the City of Barcelona under mayor Xavier Trias. While they touch on the work of Vicente Guallart (2012) and City Protocol, topics which I explore in depth in Chapter 6, their focus is not on standards, but Barcelona's urban planning and governance policies. They argue that excitement around the smart city is a gloss for public-private partnerships with large utility companies that further open the city to capital accumulation and circulation. Joss, Cook and Dayot (2017) attend more closely to city standards, analysing a body of documents published by the British Standards Institution (BSI) prior to 2014—including BSI PAS 181. Asserting that these standards represent sector-wide opinion, they argue that the smart city citizenship model is split between passive recipients of change and entrepreneurial drivers of change. By assuming that a public consensus already exists, citizens are denied the opportunity to engage in political debate. Given that Britain's city standards were written not through consensus, but by a technical author with a small oversight committee (BSI, 2012), their conclusions, while useful, cannot be applied as generally as they would like. Schindler and Marvin (2018) explore output of the ISO technical committee for smart and sustainable cities and communities. They describe three standards, ISO 37120, ISO 37101 and ISO 30182, arguing that they attempt to simplify the complexities of the city through one-size-fits-all metrics and management systems. However, without a recognition of the formation and operation of the technical committee, they overlook the messy production of these standards and the variety of

opinions that they attempt to resolve. To take one example, many standards developers are not interested in reducing urban complexity, so much as coping with it. At the root of this distinction lies contestation over the nature of urban systems and the way that they should be governed. Together, these authors have only begun to scratch the surface of what city standards involve.

Finally, there is a set of critical literature within urban studies on city indicators, ranking and benchmarking (Taylor, 2004; Larner and Walters, 2004; Kitchin et al., 2015). Here, the standard does not operate within the city, but *upon* the city, as a symbol or brand. Two strands of work can be identified. A touchstone for the first is Harvey's (1989) paper on the shift in urban government from managerialism to entrepreneurialism. In a world of free-wheeling capital and highly-mobile (and highly-skilled) workers, cities are pitted against one another in an effort to secure investment and labour. Here, the city is not governed as a discrete and isolated entity, but seeks to use attractive conditions to promote itself on the international stage. In this environment, international ranking schemes become a way for individuals and firms to identify the cities in which to invest their time and money. A notable example is the Economist Intelligence Unit's 'Global Liveability Ranking', which assesses 140 cities in areas of environment, lifestyle, healthcare, education, infrastructure and security (Ruth and Franklin, 2014). The second strand of work is concerned less with urban competitiveness, than with the techniques and technologies of governance. Government is here understood as a confluence of divergent and conflicting tendencies, many of which are seeking to improve the city for the benefit of inhabitants. This multiplies and complicates justifications for measuring, comparing and learning, even if these are typically underscored by a pragmatist and realist epistemology. Kitchin, Lauriault and McArdle (2015) offer the Federation of Canadian Municipalities' quality of life indicators as an example of collaborative benchmarking, in which cities work together to define indicators and share knowledge.

The literature on standards and cities covers a lot of ground. It approaches standards in a highly theoretical manner as rhythms or repetitions in the urban environment. It examines the *de facto* standard forms and functions that populate the city, and the *de jure* standards, laws and regulations that help give it shape. It can be historical in focus, or more concerned with analysis and intervention in the present. Although voluntary consensus standards for cities are new, empirical work has been published on the green building standard LEED and on city standards published by ISO and BSI. In addition to these areas, there are sizeable literatures on technical standards (Egyedi, 1996; Schmidt and Werle, 1998; Jakobs, 2000a; DeNardis, 2011; Inkster, 2008; Russell, 2014), standards and economics (Arthur, 1989; David and Greenstein, 1990; Hawkins et al., 1995; Matutes and Regibeau, 1996; Blind, 2004; Busch, 2011), and standards and politics (Scott, 1998; Brunsson and Jacobsson, 2000; Barry, 2001; Higgins and Larner, 2010;

Ponte et al., 2011; Thévenot, 2009), which bear on the city as a site of living, working and playing together. Urban studies, despite its neglect of the concept of 'standard', has a lot of material to draw upon if it is to come to terms with what standards mean for cities.

Conclusion

Research on standards demands a shift in perspective. As a boring part of everyday life, standards often go unseen. Their involvement with infrastructure eases them into the routines of everyday life. They become invisible, just as trust in them and reliance upon them increases. Standards must, therefore, be seen before they can be properly grasped. My first move towards achieving this, has been the adoption of an inclusive definition. Any set of rules or values that produces ordering effects is understood to be a standard—their ubiquity underlines their social, cultural, technological, economic and political significance. The breadth of this definition reveals the range of work that standards are capable of performing. It renders my research more sensitive to the invisibilities of infrastructure and makes standards far less boring.

Standards overlap with customs, norms, regulations and laws. I have used the demarcation between *de facto* and *de jure* standards to tease out differences between these concepts, and to recognise the traffic between them. Customs can be written into laws, just as lapsed regulations can continue on as social norms. My use of 'representation' and 'peformativity'—with *de facto* standards tending towards the former and *de jure* standards towards the latter—adds some colour to this, and foreshadows the next chapter's epistemological and methodological discussion. In addition to my movement across these concepts, I have attempted to disregard the boundaries between the disciplines that respond to them. I have drawn on thinkers from anthropology, human geography and sociology, as well as from the interdisciplinary fields of science and technology studies, and urban studies. While my thesis lies within the interpretive social sciences, I will also draw upon and describe the work of thinkers from the humanities and natural sciences. It is only by adhering to an inter-disciplinary ethic that I will be able to properly follow city standards.

Related to their semantic and disciplinary transgressions, standards are also ontologically elusive. They are often embodied in a physical form and they certainly bring about material effects, but it would be a mistake to engage them in a purely materialist way. Without analysing the values and meanings that put standards into action, it is impossible to appreciate the normative agenda that they enact. Standards must be apprehended both materially and discursively. More than this, standards also challenge the ontological separation of society and technology. This is not simply an observation of the existence of standards for social and technical systems. It is, instead, a far more

fundamental statement about the mix of objects, agencies and ideas of which standards are composed but also work upon. Adhering to a relational ontology is the best way to ensure that these entanglements are not overwhelmed by assumptions of stability.

In addition to the definition and character of standards, I have also discussed some of the language used to think through their spatial and temporal effects. Rather than perceive standards within a container of space and along an arrow of time, I have argued that space and time be understood as an outcome of unfolding processes. Here the site of the standard is brought to the fore and its apparent permanence conceptualised as nonscalar trajectories. In the next chapter, I take this relational and processual approach one step further by forwarding a realist and constructivist account of the sociotechnical and spatiotemporal performativity of standards.

Finally, I have sketched the outlines of the ethical and political commitments of the thesis. By disclosing the materials and discourses of city standards, I want to draw attention to their importance and encourage a variety of histories, lives and voices in their enactment. It is not my intention to speak for the non-standard, nor even to speculate about what the non-standard might, in this case, involve. Rather, by taking care with my materials, I rely upon the co-consitution of the researcher and their subject to help identify and build alliances. This allows me to push upon the contingencies and contentions that are inherent to city standards, and thus undermine their singular authority.

3. RESEARCHING STANDARDS

Introduction

There are many ways of researching voluntary consensus standards. While some are more effective and thought through than others, it would be a mistake to argue for a definitive methodology. Instead, it is the task of the researcher to show that their approach is both theoretically coherent and consistent with the subject area under examination. As city standards are a relatively recent phenomenon, there is no established way to tackle them. Urban studies, on the whole, has paid little attention to voluntary consensus standards, focusing instead on the *de jure* standards of building codes and planning regulations. While there remain many things to be learnt from this research, my focus in this chapter will be on a different field, science and technology studies (STS). Since the 1980s, STS scholars have developed theoretical and conceptual tools especially tuned to the kinds of problems that city standards pose.

In the previous chapter, I argued that standards can be material and meaningful, social and technological, and representative and performative; that they embody ethics and values, and so are inherently political, both in content and effect; and that consideration of their spatial and temporal effects should not overwhelm the potential for human agency and political change. Drawing on the writings of Michel Foucault and Karen Barad, I will now forward a methodology for researching standards that is in keeping with the observations that I have made about them. What I propose is certainly not the only way of researching standards effectively. It is, however, well suited to revealing the materials and meanings that city standards and standardisation bring about. By placing my methodology in the context of STS, I hope to make this strength clear.

Throughout the chapter, a distinction is made between three types of social scientific research. *Positivist* methodologies endeavour to use empirical material in a thorough and sustained manner in order to say something that is true about the world. Findings are intended to be reproducible and conclusions authoritative. Postpositivists recognise the pragmatist, postmodernist and poststructuralist critique of objectivity, but remain committed to the search for knowledge and certainty. *Critical* research is explicitly political in tone. Practitioners analyse their own and other people's data in order to challenge well-established ideas, theories and beliefs. This work can also be (post)positivist, but proceeds from the assumption that truth claims are contested. *Interpretivism* suspends the desire for objectivity in favour of detailed inter-textual analysis in the context of broader assertions about knowledge and its production. Empirical data, if it is generated, is usually regarded as messy, incomplete and biased. These three types of social scientific

research are understood to be roughly equivalent to Habermas' (1987) varieties of science: empirical-analytical, critical and historical-hermeneutic (see also Kitchin and Tate, 2000).

I open with an overview of standards research in the history of science and STS. While an understanding of actor–network theory (ANT) and the social construction of technology (SCOT) is central to this endeavour, I also show how these approaches have intersected with other methodological traditions. In the next section, I offer an account of the genealogical method developed by Foucault. This involves a discussion of his interpretation of Nietzsche's thought on origins; his conceptualisation of power, bodies, and the apparatus; and the shift in his research disposition from a double reduction to interpretive analytics. Following this, I echo non-representational and new materialist critiques of Foucault, using them to expose the ways in which his genealogy might be unsuitable for standards research. Responses to these critiques are introduced, with a focus on Barad's extension of Foucault's method by way of posthuman performativity. Next, I summarise the theoretical steps taken to turn the genealogical method towards the study of standards and standardisation. This is followed by a grounded discussion of my use of case studies, data generation and manipulation, and ethical approach. To conclude, I discuss my methodology in the terms with which I began the chapter, reflecting on its strengths and weaknesses.

An overview of empirical research on standards

As was shown in the previous chapter, examples of standards research can be found in architecture and planning (Ben-Joseph, 2005; Imrie and Street, 2011), computer science (Jakobs, 2000b), economics (Hawkins et al., 1995; Blind, 2004), human geography (Freidberg, 2004; DeSombre, 2006), media studies (Galloway, 2004), political science (Greenstein and Stango, 2006; Higgins and Larner, 2010) and sociology (Brunsson and Jacobsson, 2000; Ponte et al., 2011). While these disciplines are in dialogue, they vary in their epistemological and methodological commitments. Orthodox economics, for instance, operates through the development of formal models based on empirical research and quantitative data. Media studies tends to be more adventurous, combining social and cultural interpretation with an eclectic use of critical theory. In an effort to keep this overview of empirical standards research manageable, I will remain close to the history of science and STS. As a multi-disciplinary field of study, STS is methodologically liberal, allowing for a range of well-reasoned and justified approaches. By focusing on this area, I am able to attend to important differences in standards research without sacrificing details.

Historians of science have granted significant attention to measurement, precision and standardisation (see for example Kula, 1989; Schaffer, 1992; 1997; Wise, 1995; Alder,

2002; Bartky, 2007; Inkster, 2008; Russell, 2014). Epistemologically, they draw on general trends in historiography and the philosophy of science. The professionalisation of history is usually connected with ideas expressed in the late nineteenth century by Ranke (see Iggers, 2005). His thought was characterised by an effort to uncover history as it actually occurred through the objective analysis of primary materials. It was not until the first decades of the twentieth century that the history of science emerged as a distinct field. Sarton (1927), founding editor of the journals *Isis* and *Osiris*, offers an illustrative example of the field's initial commitments. He believed in the successive improvement of science and in its capacity to contribute to the advancement of human society. This teleological approach was firmly rejected by Kuhn (1962), for whom science was not to be understood as the incremental discovery of natural truths, but as a series of paradigm shifts in knowledge and practice. Kuhn understood that science is irrevocably bound up with economics and politics, and that the history of science cannot assume their separation. Histories of measurement, precision and standardisation differ in their epistemology and perception of scientific practice, but are unified in their methodological commitment to textual analysis and interpretation.

STS underwent two shifts in response to Kuhn's influential theory; one methodological, the other analytical. In the late 1970s, a concerted effort was made to demystify scientific practice by opening up the laboratory as a site of research (Knorr, 1977; Latour and Woolgar, 1979). This involved the use of ethnographic methods to follow, observe and learn from scientists and laboratory technicians. Several years later, there followed a shift in analytical focus from (pure) science to technology (or technoscience) (MacKenzie and Wajcman, 1985; Harding, 1986; Bijker et al., 1989). This entailed a trenchant critique of technological determinism and a lively discussion of the extent to which society and culture shape science and technology. As STS underwent these changes, it began to engage more and more with the problems of standards and standardisation. This is evident in the development of concepts such as closure and stabilisation (Pinch and Bijker, 1984), immutable mobiles and action at a distance (Latour, 1987; 1990), and irreversibility and metrology (Callon, 1991), many of which were discussed in the previous chapter. By the 1990s, STS scholars had begun publishing research findings on formal standards and processes of standardisation. Examples can be identified in the field's two main traditions: SCOT (Egyedi, 1996) and ANT (O'Connell, 1993). While historically related, these approaches hold different positions on the relationship between technology and society (Bijker and Pinch, 2011). For the former, technological change cannot be understood without a consideration of the role played by social and cultural forces. The latter goes further, arguing that the ontological inseparability of technology and society must be reflected in the study of their relational interconnections. This leads to quite different methodologies.

SCOT is more flexible than ANT, and can more easily be combined with structuralist and functionalist methodologies. Egyedi (1996) sets out to develop a comprehensive view on standards and standardisation that takes full stock of the social factors involved in their generation. She uses three perspectives to reflect upon different aspects of the social construction of telematic services: an institutionalist approach is used to explore the role played by standards developing organisations; a political approach reveals the agency of individual actors; and a socio-cognitive approach exposes the importance of broader epistemic paradigms. Although her analytic lens changes, the use of interviews, observations and document analysis remains constant. Egyedi offers many insights on telematic standards, and is unabashed in her syncretic and positivist ambition.

Actor-network theory observes a principle of generalised symmetry, meaning that equal attention is afforded to human and non-human agencies (Callon, 1986). Analysis proceeds through free association and, like ethnomethodology, by following actors without prior assumptions about their behaviour. More than SCOT, ANT involves detailed descriptions of specific associations. While at times highly conceptual, it is nevertheless empirically-driven and open to a range of qualitative (and to a lesser extent quantitative) research methods. O'Connell (1993) illustrates his discussion of metrology with three case studies: the international standardisation of electrical units; the development of medical devices to measure the composition of body tissue; and the role of the US Department of Defence in regulating measurement and calibration. The first of these relies on an assortment of primary and secondary historical materials, while the other two draw on interviews, document analysis and relevant research papers. These texts are woven into a story that supports O'Connell's argument. The approach is interpretive, rather than (post)positivist or critical.

As a porous and multi-disciplinary field of study, STS has also been adapted, extended and distorted by other sociological approaches. This is certainly the case for standards research, where STS has been mixed with feminism and symbolic interactionism (Star, 1991), institutionalism and rational choice theory (Schmidt and Werle, 1998), social complexity and conflict theory (Barry, 2001) and phenomenology (Busch, 2011). Star's (1991) feminism encourages analysis of the othering effects of standards, and her symbolic interactionism is expressed through a methodological emphasis on local meanings and materialisations. A variety of qualitative methods are available to her, including auto-ethnography, ethnomethodology, participant observation and interpretive document analysis. Schmidt and Werle (1998) are more positivist in approach. While they assert that standards are, at the macro level, a clear example of SCOT, they call upon actor-centred institutionalism to encounter them at the meso and micro levels. This involves combining the empirical focus of institutionalism with the assumptions of rational choice theory, so as to afford attention to both firms and

individuals in the construction of technology. Schmidt and Werle use participant observation, semi-structured interviews and document analysis to explore three telecommunications standards developed at ITU's *Comité Consultatif International Télégraphique et Téléphonique* (which was renamed the Telecommunication Standardization Sector, or ITU-T, in 1993). Where Star's approach is interpretive and Schmidt and Werle's postpositivist, Barry's (2001) is critical. Beginning from the assertion that society is a complex system of conflicting and competing agencies, he argues that standards are intrinsic to the contemporary operation of political power. Standards not only create harmonies within and beyond territories, but also open up new sites of fracture and dislocation. Barry uses illustrative examples, as diverse as the regulation of bathing water and the protection of intellectual property, to strengthen his larger argument. These are exposed through interviews and interpretive document analysis. Methodologically, Busch (2011) is nearer to Star than he is to Schmidt and Werle, and Barry. He adopts a phenomenological approach that is sensitive to the multiplicity of forms, uses and meanings of standards. Rather than critique a dominant position or develop an argument from a handful of cases, he makes observations about standards in order to build a theory that accounts for them. His principal methods are observation and document analysis. While Busch's approach is interpretive, he operates at a higher level of abstraction than Star, seeking general statements rather than particular descriptions.

In a study of the historical trend toward open standards in the information and telecommunications sector, Russell (2014) has sought to complement his methodology with theory from STS. He explicitly rejects mono-causal interpretations of technological development in favour of a rich account of the complex interactions between technology, and cultural, economic and political forces. While history should attend to innovators and entrepreneurs, this should not supersede analysis of the conditions and institutions which allow and constrain individual activity. To help achieve this, Russell forwards two interlocking concepts: 'ideology' and 'critique'. 'Ideology' refers to an overarching set of social and political ideas, and a reflexive appreciation of their historical and contemporary significance. He uses the term in a less loaded and less specific manner than many Marxists, referring to the general world views of individuals and groups. 'Critique' signifies the act of putting ideology into action. It is not simply the criticism of some other, predominant way of doing things, but also must be understood as an act of creativity and construction. For Russell, standards advance a normative position by critiquing the way things are currently achieved and actively constructing a different world according to their ideology. In studying standards, one must be sensitive to both the meanings they represent and the way in which those meanings are conveyed. While Russell overcomes much of the intellectual baggage of Rankean history, he conforms to its methods and burden of

proof. Rigorous archival research and document analysis allow him to present his case studies in support of a central argument.

Social scientific research on standards operates under a broad range of theoretical and methodological commitments. This is not to deny that some approaches are more consistent than others. If one's goal is to critique the dominant understanding of sovereign power, then the framework adopted by Barry is a great fit. If one wished to extend a theory of how standards are developed, one could assemble more consequential theories than those marshalled by Schmidt and Werle. For the purpose of tracking the orders of meaning that are inculcated and solidified by particular standards in the present, both approaches are unsuitable. Indeed, none of the methodologies discussed in this section (with the possible exception of Russell's) are particularly well-tuned to this task. The great variety of ways to study standards and standardisation reflect the more general epistemic plurality of the social sciences. In this context, the job of the researcher is to not assert the superiority of their methodology, but to establish its internal consistency and suitability to the particular topic under investigation. It is to this task that I now turn.

Foucault's genealogical method

Michel Foucault (1972) describes the approach adopted in his early work as archaeology. Rather than conduct history by focusing on notable individuals and events, an archaeology takes as its object of study the rules that govern what can and cannot be meaningfully said. This challenges Rankean history on three fronts. First, it undermines the significance of individuals and individual agency. In this sense, Foucault is an antihumanist. He is not interested in people so much as statements, discourse and meaning (Mills, 2003). Second, archaeology is distrustful of teleology and historical essences. Foucault is a nominalist and a postmodernist in that the plurality and contingency of history take precedence over its grand narrative (Flynn, 2005). Third, archaeology shifts emphasis from the temporal to the spatial. Having denied history a sense of progress, Foucault emphasises the ways in which historical events, processes and structures are spatially dispersed and fragmented (Philo, 2000). What occupies archaeology are strata of discursive and (to a lesser extent) non-discursive practices, fixed in time but unevenly spread across a hypothetical field (or table) of relations.

This is connected to Foucault's notion of the 'episteme'. An episteme is not an overarching world view, nor a set of coherent, fundamental principles. Rather, it refers to the rules which govern the dispersal of discursive and non-discursive practices across the field of knowledge (Foucault, 1991: 55). While this relational space is dynamic, Foucault's analysis of it is discontinuous. He does not follow the shifts within and between epistemes but examines them as discrete moments in time. How breaks and changes occur between

historical periods is not an archaeological concern. Foucault's analysis instead addresses the spatial order of an episteme. This is discovered in the arrangement of the things, events and practices under study; "the distances between them (whether they stand together, nearby, or far apart) being indicative of the extent to which they differ from one another" (Philo, 2000: 220).

The task of the archaeologist is thus to map the rules, relations and practices which allow statements to be considered meaningful. This is done by describing what was actually said during a period and then relating that to the period's broader episteme. Dreyfus and Rabinow (1983) describe the archaeologist as engaged in a double reduction. First, the truth claims of what was said must be bracketed. The archaeologist is not interested in the accuracy of a statement nor whether it was spoken with honesty. Second, the coherence of meaning claims must also be set aside. Whether what was said makes sense, whether it is intelligible or logical, is irrelevant to the archaeologist. Statements are not judged according to a set of axioms or assumptions external to the episteme under investigation. The archaeologist attempts to suspend their own ontological and ethical commitments and engage with discourse on its own terms. The purpose of the double reduction is to open up "the possibility of a pure description" (Dreyfus and Rabinow, 1983: 50) of the formation and transformation of discursive and non-discursive practices.

Discipline and Punish (Foucault, 1977) marks a departure from archaeological investigation by taking on the problem of descent and emergence. Where archaeology is disinterested in the manner in which epistemes adapt, strain and break, genealogy presents a set of conceptual tools—power, power-knowledge, the body and the apparatus—that attend to epistemic change. Before turning to these tools, it is worth considering Foucault's use of the words 'descent' and 'emergence'.

In his essay *Nietzsche, Genealogy, History*, Foucault (1984) engages critically with Nietzsche's work on origins. Foucault argues that the German word *'ursprung'* is used to refer to the definitive origins of a historical idea or event. In pursuing such origins, the historian assumes that things exist in a pure form or essence which precedes their manifestation in the world. The hope is that such origins reveal a timeless truth. By contrast, genealogy asserts that the essence behind things is a fabrication. Truth is not to be pursued by the genealogist, but placed upon the table for dissection and examination. The origins gathered together in a genealogy are referred to as *herkunft* and *entstehung*, translated as descent and emergence. Descent signifies the accidents and errors that underlie the objects of historical attention. By disclosing ways in which ideas and events descend from contingent and fragmented sources, genealogy subverts the pursuit of pure forms and essences. At a tangent to this, emergence is concerned with the origins discovered in confrontation and struggle between unequal actors. It aims, put differently, to reveal the formative operations of power. By bringing subjugated knowledge to the

fore, genealogy counters Rankean history by advancing a perspectival rather than absolute notion of truth.

In deploying the concept of power, Foucault risks his genealogy being perceived as an engagement with structural processes. This is not his intention. As such, it is necessary for him to deconstruct (sovereign) power and redefine it as a 'micro-physics' (Foucault, 1977). Foucault understands power as a verb—that is, as an action or a doing. It is not an external force which intervenes on the world. It cannot be gathered up and stored. Rather, power is an alignment of the relations between people (Wartenberg, 1990).

> It seems to me that power must be understood in the first instance as the multiplicity of force relations immanent in the sphere in which they operate and which constitute their own organization; as the process which, through ceaseless struggles and confrontations, transforms, strengthens, or reverses them; as the support which these force relations find in one another, thus forming a chain or a system, or on the contrary, the disjunctions and contradictions which isolate them from one another; and lastly, as the strategies in which they take effect, whose general design or institutional crystallization is embodied in the state apparatus, in the formulation of the law, in the various social hegemonies. (Foucault, 1978: 92–93)

Three assertions follow on from this definition. First, if power cannot be held exclusively by an individual or institution, then it can be deployed by the oppressed as well as the oppressors. This is in keeping with the genealogical impulse to unveil the counter-narratives of emergence. Second, the operation of power can be understood as productive. Where power is sometimes theorised exclusively in terms of what it suppresses or determines, Foucault is interested in the ways in which it ushers in new practices and subjectivities. Third, in acting upon something, the very doing of power necessitates its obverse. Whenever and wherever power is exerted, new subjectivities and resistances are produced. This has ramifications for Foucault's thinking on knowledge and the body.

When applied to epistemic problems, Foucault's conceptualisation of power is rearranged into the famous dyad of power-knowledge. This asserts that power cannot be exercised without knowledge, just as knowledge cannot exist without the operation of power (Foucault, 1980a: 52). The significance of this pairing is in its foregrounding of the *emergence* of truth claims. No form of knowledge, whether the object of an analysis or its outcome, can be separated from the power that sustains it. The historian's search for truth is not so much undermined as placed in its broader social and political milieu.

By associating his problematisation of meaningful statements with the operation of power, Foucault is able to redress some of the shortcomings of archaeological investigation. The problem of how statements are governed finds a satisfying answer (Dreyfus and Rabinow, 1983). The researcher no longer simply maps out the rules which give statements their meaning, but now also traces powerful alignments and their effects

upon the field of relations. Time is opened up by genealogical analysis in a way in which the archaeologist is unable to recognise.

But genealogy is not only interested in knowledge. Through a focus on bodies and their engagements, materiality is also granted attention. The body is approached as a site or surface upon which the micro-physics of power play out. Thus, in *Discipline and Punish*, in which Foucault (1977) tracks the displacement of public torture by an apparatus of discipline and incarceration in eighteenth century France, the confinement, arrangement and disassembly of bodies is described in stark and memorable detail. Foucault opens the book by recounting the horrific manipulation and abuse exercised upon the body of the regicide Damiens in 1757. This is analysed not as a singular act, but in terms of its intersection with a wider relational field; specifically, as a staging of the performance of sovereign power. Later, in discussing the origins of the prison system, Foucault theorises disciplinary power through the production of docile bodies. Norms of position and behaviour are written and rewritten onto the body through the cellularisation of space and the routinisation of time. By attending to the site of the body, power is shown to affect not only the discursive but the material as well.

Attention to non-discursive practices expands the limits of Foucaultian analysis. Rather than an episteme, the field of genealogical investigation is conceived as a *dispositif*, or apparatus (cf. Agamben, 2009). This signifies not the specific sites on which power acts, but the discursive and non-discursive practices that grant objects and events their meaning. When asked in an interview to clarify his use of the term, Foucault defined an apparatus along three lines, as:

> [1.] a thoroughly heterogeneous ensemble consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral and philanthropic propositions—in short, the said as much as the unsaid… [2.] the nature of the connection that can exist between these heterogeneous elements… [3.] a sort of… formation which has as its major function at a given historical moment that of responding to an *urgent need*. (Foucault, 1980b: 194–195, italics in original)

Put differently, the apparatus is the context that conditions the possibility for things to take place. Again, this does not operate as an essence or transcendental force but rather as a dynamic field coterminous with unfolding events (Braun, 2014). The apparatus does not exist except in response to a particular and pressing problem. Methodologically, genealogists do not attempt to mine the dark, hidden depths of meaning. Rather, analysis proceeds historically (by teasing out descent and emergence) and at the surface of things (in connection and dislocation).

Where the archaeologist engages in a double reduction, the genealogist conducts interpretive analytics. Dreyfus and Rabinow (1983: 122) intend this term to stress that

while Foucault inherits the task of analysing conceptual origins from Kant and Heidegger, he uses Nietzsche to deny it of universal ambitions. Thus, within the constraints of present practice, the possibility of a free play of interpretations is opened up. Importantly, interpretive analytics does not wholly supersede the double reduction. Rather, the suspension of the judgement of truth claims is understood through the concept of power-knowledge. Epistemology is politicised in terms of its relations of power. But where does this leave the researcher? For Dreyfus and Rabinow, the position obtained by the genealogist is not outside the field of relations but rather produced through its analysis. In selecting what to include and exclude from interpretation, the researcher is engaged in genealogy as a form of critique (see also Koopman, 2013).

Foucault (1977: 31) provocatively refers to his genealogy a 'history of the present'. This does not betray a presentism, in which one would use the concerns of the present to reimagine the past. Rather, it underscores his use of historical material to come to grips with something presently assumed but also problematic. It supposes the historicity of present phenomena and undertakes not a search for their definitive origins but a disquieting of their taken-for-grantedness. Thus, a history of the present opens with a description of the apparatus which regulates the problem, followed by a diagnosis of the problem and the ways in which it might be attended to by historical analysis (Garland, 2014; see also Flynn, 2005). The problematisation of the present is used to call forth a geneological approach.

In this section I have outlined the conceptual and methodological tools of Foucault's genealogy. Briefly stated, a genealogy involves: the problematisation of a phenomenon in the present; the tracking of that problem's contingent and contested origins; a description of its discursive and non-discursive practices; and an interpretation of associations and alignments within its broader field of relations. In the next section, I draw on the philosophy of Barad to propose a modified conceptualisation of genealogy, retuned to the study of voluntary consensus standards.

Material-discursive genealogy

Genealogy has been used to track the descent and emergence of morals, epistemological structures, academic traditions, modes of justification and theoretical concepts. It has not, to my knowledge, been used to examine voluntary consensus standards. At a theoretical level, the method is often perceived to be unsuitable for ontological investigations. Standards are clearly material, whether in the sense of a physical exemplar or in their technological and infrastructural manifestations. Any approach which focuses principally on meaning and discourse would be unable to fully account for this. Foucault's genealogy is sometimes presented in such a way.

Thrift (2000; 2007) offers a nuanced illustration of this position. His critique of Foucault operates at two registers. First, he asserts that Foucault is a gloomy thinker (Thrift, 2000). While Thrift allows for the productivity of power—the notion that power can be exercised as an affirmation of repressed subjectivities—he nevertheless interprets Foucault's world view as one in which life and the body are forever being shaped and confined by social norms and institutions. This places ethical and political limits on his work. Second, Thrift (2007) identifies four analytical blind spots which contribute to this feeling: phenomenology, affect, space and things. He argues that Foucault's antihumanist attention to processes and practices without subjects causes him to overlook perception and the ontology of bodies. A similar observation is made by Dreyfus and Rabinow (1983: 112), who point out Foucault's inattention to the structural and topological affordances of the human body (i.e., that it tends to move forwards rather than backwards, and have a head, two arms and two legs). Affect is similarly absent from Foucault's work. Thrift speculates that this could be due to an underlying Stoicism, an ontological emphasis on power (rather than desire), or an inclination to favour discursive analysis. Whatever the reason, Foucault seems unable to think through the feelings which put bodies into action. Thrift acknowledges Foucault's sensitivity to the spatiality of discursive relations and to the spatial politics of architecture. Nevertheless, he asserts that too little was done with this. Foucault perceives space through its ordering effects and so dampens and constrains its social and political potentialities. Finally, Thrift asserts that things and thingness are curiously absent from Foucault's work. Whether part of a disregard for the economy, or an outcome of an overemphasis on texts, things are left immobile and inanimate. For Thrift, these four areas help constitute a field of research, the non-representational, composed of pre-individual perceptions and practices. Foucault's blindness to this field renders his work bereft of life's capacity to bubble up and exceed restrictions.

Without opposing the ambitions of Thrift's non-representational approach, Philo (2012), Lemke (2015) and Barad (2007) have sought to recover a Foucauldian methodology that is sensitive to materiality and vitality. Philo (2012) interprets Thrift's critique as being rooted in a binary between words and life. Foucault is (apparently) too interested in statements, discourse and meaning, and not interested enough in bodies, perceptions and materiality. Taken literally, this binary renders Foucault a social constructivist, unable to say anything about the ontology of the physical world. Philo attacks this in two ways. First, he shows that the words/life binary fails to account for the creativity and liveliness of texts, or for the slippage that occurs in their enactment. Better by far is to situate Foucault's work at the intersection of Apollonian order, stability, conformity and determination, and Dionysian disorder, chaos, uncertainty and desire (see Nietzsche, 1999). Powerful norms and institutions seek to suppress the Dionysian, but they both rely upon its existence and produce opportunities for its escape. Second, through an

engagement with Foucault's *Collège de France* lectures (see for example Foucault, 2007; 2008), Philo argues that a concept of 'population' was being nurtured which, in addition to 'the body', draws out the liveliness that power seeks to suppress. Philo resists Thrift's claim that Foucault was blind to affect, space and things; gloominess is an outcome of selective reading and interpretation.

Lemke (2015) excavates a different concept from Foucault's lectures: the 'government of things'. This is developed in opposition to sovereign power. Where the sovereign acts upon a territory and its inhabiting subjects, government concerns the definition and arrangement of things. According to Lemke, Foucault does not assume a distinction between the human and the non-human here, but emphasises their relationship as an origin of political power. In acting through and upon things, government helps produce subjects and objects, and the boundaries that individuate and stabilise their properties. The constitution of things is thus bound up with politics and the operation of power. Where Thrift interprets Foucault's inattention to thingness as a blindness to life, Lemke argues that life is itself not to be taken for granted. For Foucault, life can not be reduced to science or politics, but must be conceived as a historical transaction between matter and meaning. Lemke prefers the 'government of things' to Foucault's use of 'biopower' for this very reason. With this concept, Lemke finds a way to reposition Foucault's theory of power at the cusp of the human and the non-human.

Karen Barad is attuned to the limits of Foucault, but seeks to amend rather than defend his powerful methodology. Before I can discuss this, some preliminary remarks on her agential realism are necessary. In *Meeting the Universe Halfway*, Barad (2007) elaborates a realist and naturalist metaphysics of entangled agencies. The primary ontological unit in her philosophy are phenomena, understood as "relations without preexisting relata" (Barad, 2007: 139). Within a phenomenal enactment, the intra-action (i.e., interaction within a manifold) of enmeshed posthuman agencies resolve into objects, agents, materials and meanings. For Barad, performative action precedes individuation, subjectification and their attendant physical, social, spatial and temporal apprehensions. Agency is pre-individual (Dolphijn and van der Tuin, 2012a). Surfaces, properties and identities are not inherent to objects but the result of an agential cut applied to an entanglement of relations. Thus, Barad positions the constitution of phenomena prior to the familiar structuring binaries of western thought: nature-culture, subject-object and ontology-epistemology.

Because of the primacy it affords the performative event, Barad's agential realism can be understood as a site ontology (see also Barad, 2012). Barad does not use the term 'site', preferring the concept of the 'spacetimematter manifold', a non-Euclidean, multi-dimensional space of relations. Within the manifold, matter and meaning are assembled, their complex connections and disjunctions expressed as an imbroglio of twists, knots and breaks. As an event takes place, this confluence of agencies is cut, producing the subjects,

objects, spacings and timings familiar to everyday experience. Material, social, spatial and temporal relations are all an outcome of a manifold's intra-action.

Like Thrift, Barad argues that Foucault's genealogy is weakened by its emphasis on epistemology. By foregrounding ways in which things in the world are known, at the expense of the things themselves, human and non-human agencies are collapsed into a concern with representation. Materiality is rendered flat and unresponsive. Thus, when Foucault discloses a productive apparatus it is too steeped in the realm of meaning (Barad, 2007: 65). The body does not push back against the iterations of power inscribed upon it. While Butler (1990; 1993) opens up a discussion of the agency of bodies, her genealogies are too anthropocentric (Barad, 2007: 145). The attention given to the production of human bodies pushes the non-human out of the performative event.

Barad's (2003) 'posthumanist performativity' acknowledges the agency of meaning and materiality, and humans and the non-human. Two strands of feminist thought are being brought together here. The origins of the concept of *'performativity'* can be traced to J. L. Austen's theory of speech acts, wherein an utterance consummates an action (Sedgwick, 1993)—"I now pronounce you husband and wife". Words are understood to be bound up with the constitution of social and cultural practices, and not merely a representation of them. But Barad uses the concept in a more corporeal way, citing Butler's work on the association between the performance of gender and the production of sexed bodies (Barad, 2007: 413, n. 39). Over the past twenty years, 'performativity' has gained widespread use in social theory, where it signifies the *effects* of ideas, logics or discursive practices (Butler, 2010). Performativity moves analysis beyond representation into a description of the world in its construction (all the while preserving a nominalist position on origins). Where performativity puts meaning into action, *posthumanism* takes up the problem of an action's cause and constitution. Theoretically, it draws on the antihumanism of Foucault and the cyborg imaginary of Haraway (1991); it refers not only to a deconstruction of liberal notions of the human subject but to a positive statement on the kinds of things that are able to do work. Posthumanism extends agency to matter of all forms, including pets, plant life, computer code and waste materials. Even a substance as apparently implacable as stone is afforded the opportunity to act. All materials are granted agency, not only human (or ecological) life[3] (see also Bennett, 2010; Braidotti, 2013). To adopt a posthuman perspective on performativity then, is to perceive material

[3] Pickering (1995) makes a distinction between agency and intentionality, arguing that while non-humans can have agency, only humans can act with intentionality. For Barad, the differentiation between causes and effects is made after the agential cut has been applied. Agency is exercised before intentionality. In this way, Barad is able to sidestep the ontological problem of different grades of action.

phenomena and meaningful effects as the outcome of action within a complex and heterogeneous manifold of agentive relations.

This is evident in agential realism's conceptualisation of meaning. For Barad (2007: 63), Foucault fails to account for the relationship between discursive and non-discursive practices. His description of the apparatus comes close, but the nature of 'the said' and 'the unsaid' is left open. Barad (2007: 147) understands discursive practices not as statements or speech acts, but as the local social and material conditions which allow and constrain expressions of knowledge. Meaning here is not a property of particular words or phrases, but a result of the repetition of the practices which contextualise those words. Put differently, it is discursive practices which make semantic and ontic distinctions seem so familiar. But Barad (2007: 148) also challenges the assumption that meaning is distinctly human. If the boundary between human and non-human entities is produced by discursive practices—as is consistent with an antihumanist conception of history—then it makes no sense to assume a prior conception of the human. Meaning must also pertain to the non-human. '*Non*-discursive practices' are unintelligible: "it makes no sense to speak of the 'nondiscursive', per se, given my posthumanist conception of discursive practices as boundary reconfigurings that are inherently material and need no material support" (Barad, 2007: 430, n. 25). For Barad, discursive practices are the continuous intra-actions which bring things about. They operate within the manifold, prior to the individuation of bodies and the separation of the human from the non-human. Meaning is positioned as the becoming intelligible of objects to subjects, an ongoing dance of discursive practices and material phenomena.

Barad reconfigures Foucault's apparatus as a 'material-discursive apparatus of bodily production'. This needs unpacking. First, the hyphenation of the 'material' and the 'discursive' acts to recognise their ontogenetic entailment and mutual irreducibility: "Neither discursive practices nor material phenomena are ontologically or epistemologically prior. Neither can be explained in terms of the other. Neither is reducible to the other" (2007: 152). For Barad, it is important to appreciate the agency of matter in producing effects in the world. Second, where Foucault introduced the apparatus as a way to map the discursive and non-discursive practices which grant statements power, Barad uses the term to encompass the Foucaultian apparatus *and* the apparatus of the scientific experiment. Where Foucault's apparatus is marshalled only in response to an 'urgent need', Barad generalises the term. She asserts that experimentation enlists intangible and often unanticipated cultural relations, and that broader social norms and practices are historically interwoven with the vitality and dynamism of matter. Again, the purpose is to acknowledge the mix of agencies swept into the manifold. Third, the use of bodies is more general than Foucault. It refers, in the first instance, to human bodies and other individuated physical bodies (including those of non-human lifeforms, technical

instruments, land masses, *etc*.), but also might be extended to cover cultural and social bodies (e.g., bodies of text or the body politic). It is intended, following Foucault, to foreground the sites on which power works, but following Haraway (1988), to emphasise the ontological and objectivist ambition of the concept. For Barad, the 'material-discursive apparatus of bodily production' is the imminent structure that iteratively configures the agential cut made to the manifold. It includes discursive practices but is broader than them, also encompassing the productivity of non-human agency and the manifold on which these things go to work.

The kind of social analysis conducted in adherence to Barad's metaphysics is conceived of as a 'genealogy of the material-discursive apparatuses of bodily production' (Barad, 2007: 451, n. 25). I understand this to entail a detailed description of the materials and meanings of the performative site, combined with interpretative analysis of the context which allows this to be brought about.

On the surface, this is not wholly unlike actor–network theory. Both approaches trace material relations in an attempt to dissolve the distinction between 'the social' and 'the technological', and so overcome the impasse between social constructionism and technological determinism. But the theories have important differences. ANT tends to hold the script in greater deference than it does its performance. For Barad, phenomena come first; enactment is used as a way of opening up intentionality and never the other way around. More than this, in examining the apparatuses that condition the possibility for these relations, material-discursive genealogy extends beyond ANT into a consideration of power, institutions, and structures of habit and meaning. Barad refers to this context as a field of possibilities.

> Discourse is not what is said; it is that which constrains and enables what can be said. Discursive practices define what counts as meaningful statements. Statements are not the mere utterances of the originating consciousness of a unified subject; rather, statements and subjects emerge from a field of possibilities. This field of possibilities is not static or singular but rather is a dynamic and contingent multiplicity. (Barad, 2007: 146–147)

Importantly, the field of possibilities is not stable but is uneven and in constant flux, continually worked and reworked by things and their productive relations. Thus, while it comprises everything that can be said and done, it also opens up the way for change. Every agential cut acts back upon its apparatus of bodily production and the broader terrain of its field of possibilities. Through iterative action, structuring rules are reinterpreted and redefined, altering what can come to matter. Where ANT is often purely descriptive, material-discursive genealogy reveals opportunities for strategic ethical and political intervention.

While Foucault's method has been criticised for its inability to attend to materiality, making it a poor fit for standards research, recent work has pushed back against this claim. In reconsidering and retheorising Foucault's work, Philo, Lemke and Barad extend the limits of what his genealogy can be expected to do. In the next section, I consider standards research as a problem to be engaged with using Foucault and Barad.

Doing standards research with Foucault and Barad

The suitability of material-discursive genealogy to the study of standards rests on three theoretical moves. The first is the foregrounding of the site of enactment. Rather than depend upon spatial metaphors external to the event of a standard's implementation, space is conceived as a process. This rejects the static co-ordinates assumed by the majority of standards research and exposes a rich mix of productive agencies. There is a risk that by fixing analysis upon the moment at which a standard is implemented its development will be ignored. Stabilisation could become of greater significance than circulation. But this risk is diminished by the second move: acknowledging the importance of iterative citationality to the performativity of standards. By recognising that standardised practices cite previous articulations and instantiations, this trap is avoided and the historicity of a standard fully exposed. But iteration involves the same as well as the different (Cuddon, 2013: 373), just as standardisation does entail repetition. Hence, with the third move, the trajectories of standardised infrastructure are approached using Foucault's conceptualisation of power. Standards are not inherently powerful but can become as much through successful circulation and implementation. A widely adopted standard can thus be thought of as an alignment of discursive practices or a sedimentation of the cuts made by an apparatus of bodily production.

The site of a standard is understood to be the event of its enactment, whereas the material-discursive apparatus encompasses both the site and the discursive practices that give it meaning and form. At a higher level of abstraction, the field of possibilities refers to the various and at times contradictory assumptions, logics, institutions and social alignments that sanction and allow discursive practices. I resist referring to these as micro, meso and macro analytical scales because of the hierarchy and structural permanence that these terms entail.

My material-discursive genealogy of city standards operates within an overarching case study framework. The case study approach to empirical research can be flexibly adapted to a variety of methodologies (Ragin, 1992; Flyvbjerg, 2006). In keeping with the positivist tradition, Yin (2009) advocates the use of case studies in the generation of rigorous scientific data. Pushing back against the supposition that case studies can only be used in the exploratory phase of a research project—that only experiments are suitable

for producing explanatory knowledge—Yin delineates procedures for selecting appropriate cases, generating data about them and analysing those data in pursuit of systematic results. At the other extreme, Foucault (1977) carefully selects his case studies as paradigmatic examples of the more general themes under investigation. Thus, Benthem's panopticon is presented as an 'explicit program' of disciplinary power (Dreyfus and Rabinow, 1983: 132). This is not an ideal type in that it does not seek to capture the essence of a thing. The panopticon was an actual (if unrealised) schematic for real action and reform. As such, it grounds Foucault's discussion of the disciplinary apparatus in an evocative and illustrative example.

My use of case studies is nearer to Foucault than it is to Yin. Like Foucault, I am interested in connecting explicit examples of a phenomenon (city standards) to broader social trends (practices of urban management and governance). This is an interpretive rather than (post)positivist or critical undertaking. Unlike Foucault, I did not select my case studies as paradigmatic examples of those trends. I began by conducting a survey of the city standards currently under development. Three were selected for further research: a terminological standard, a performance standard and a procedural standard. The decision to pursue the cases was made on the basis of their empirical richness, their variance and the interest that they were generating in the standards community. My attention has, first and foremost, been on the materials and discourses of these three case studies. Only as my research progressed have I applied interpretive analytics to the structures of meaning and forms of power at work in the governing of cities. In this sense, I have worked in the opposite direction to Foucault. I understand Barad's ontological commitment to unfolding events as an imperative to work out from the case studies and take care with the particular details of their data. My material-discursive genealogies are thus personal, partial and incomplete. Where Foucaultian genealogy can feel overbearing, Baradian genealogy aims to be full of life and possibility.

Traditional site-based methods, in which the researcher is immersed within a particular location, struggle to account for the complexity and heterogenity of contemporary social and economic relations. Social scientists from across the disciplines have grappled with this problem over the last 20 years. Many techniques have emerged to foreground the object or event of study and engage with it on its own terms. These include multi-sited and global ethnography (for example Burawoy et al., 2000; Ong and Collier, 2005), ANT (Whatmore, 2002; Latour, 2005), mobile methods (Fincham et al., 2010; Büscher et al., 2011), policy mobilities (McCann and Ward, 2011; Peck and Theodore, 2015) and interpretive policy analysis (Yanow, 2000; Finlayson et al., 2004). While these approaches are different, each unsettles the site of study in an attempt to properly account for the global interconnections of people, objects and texts. Research is untethered from a particular location and allowed to follow on from the action of the

particular thing under scrutiny. In keeping with Barad's metaphysics, I adopt a slightly different perspective. For me, the thing, its behaviour and its spatial (and temporal) relations are all understood as performative effects of agential intra-action. Sites are not mapped out over a static world. Instead, the world is considered as an outcome of sited enactments[4]. Nevertheless, every one of these approaches has influenced my use of qualitative methods. In producing data on city standards, I have engaged with relevant texts, attended workshops and conferences, and spoken with people (both informally and in semi-structured interviews) involved in their development and implementation. I have not focused on a particular city or institution, but on the performativity of each of my standards.

My research materials were gathered in a continual and recursive process, with one source leading on to others. Some were downloaded or scraped (using wget and httrack) from official websites, others turned up through Google 'filetype:pdf' searches, while still others were emailed or handed to me by interlocutors. A few of the developers of the standards have published academic articles, which were included amongst my research materials. In other instances, my reading of secondary texts turned up papers which have helped me to understand a standard's broader context. I did not limit my document search to the three standards either, and have accumulated a large amount of content on city standard co-ordination and harmonisation efforts at ISO, IEC and ITU. I have collected standard documents, working papers, reports, articles, planning materials, meeting minutes, public email archives, YouTube transcripts, slide decks, images and diagrams, and marketing materials. Everything of relevance to my three case studies and the co-ordination of ISO's city standard efforts was entered into a MaxQDA project file.

The workshops and conferences I have attended include the 2014 Web Summit in Dublin, Smart City Expo 2014 in Barcelona, the 2016 Smart City Event in Amsterdam and a handful of webinars organised by the American National Standards Institute's Network on Smart and Sustainable Cities. While I have drawn on my field notes from these events, for the most part they inform the analysis in an indirect way. It was at these events that I learned about the city standards market, gathered research materials, conducted one short interview and established contacts for later, lengthier interviews.

The most important form of data generation has been the 51 semi-structured expert interviews conducted between June 2015 and August 2017 (listed in Appendix 1). I spoke with a total of 49 people, including standards professionals, academics, civil servants,

[4] My approach is nearest to Whatmore's (2002). Both of us apprehend the site of study as an assemblage of disparate and far flung materials and meanings. But where she is interested principally in the fact of their assembly (and what that means for 'nature'), I am more concerned with their potential and actual ordering effects.

representatives from non-governmental organisations and small and medium-sized enterprises, and private individuals. Those not directly engaged in city standards development, promotion or implementation (14 people in total) were involved in a related activity that helps contextualise the case studies. I once interviewed two people and on three occasions conducted follow-up interviews. Most of the interviewees were identified through organisational affiliations or published materials pertaining to city standards. Usually they were contacted via unsolicited email, but on a couple of occasions I established prior contact at an industry event. At other times, particularly in Australia and during my field trip to North America, interviewees introduced me to relevant colleagues and collaborators. Interviews were held in Dublin (where I lived for the duration of the PhD), Melbourne (in July 2015 and August 2016), London (in November 2015 and June 2016), Toronto (in January and February 2016), Boston (in February 2016), and Barcelona and Tarragona (in August 2016). Skype (audio only) was used for 21 of the interviews, when I did not have the opportunity to meet the individual in person. Most of the face-to-face interviews were held in the work place of the interviewee(s). A few of my early interviews were conducted in cafeterias and pubs.

After introducing my research and ethics protocol[5], I allowed the interviewee(s) the opportunity to ask any questions they might have. The audio recorder was then switched on and the interview begun in earnest. Although I usually had a few guiding questions, I attempted to respond to the unfolding discussion, asking follow-up questions or prompting the interviewee(s) to elaborate on areas of particular interest (Longhurst, 2010). My most interesting and informative interviews occurred when I was well-prepared. Nevertheless, I also had some good experiences where my lack of preparation (due to timing), forced me to be more attentive and engaged. Although unequal power relations are sometimes felt to be an issue in expert interviews (Smith, 2006), once underway, I seldom felt anxious while speaking with those in high academic, government or corporate positions—thanks in no small part to my relative privilege as a well-educated, white, middle-class male. In terms of moments of failure (Rose, 1997), my worst interviews probably occurred over Skype, when, for whatever reason, the connection puttered and stuttered and the natural flow of the discussion was lost (see also Salmons, 2015). One interview involved me stalking through my home, laptop in hand, in a desperate attempt to find a strong WiFi signal. Beyond issues of technical failure (Sullivan, 2012), these experiences point to the presence of the non-human in the performance of interviews.

[5] My research has been subject to Maynooth University's normal process of ethical oversight and approval. This involved the submission and approval of an ethical review form and the collection of written consent from each of the interviewees.

The interviews were transcribed and the transcriptions added to the MaxQDA project file. I have found the process of coding to be difficult, messy and sporadic (Cope, 2010). While my reading, interviews and research notes helped establish the keywords, themes and issues that I was interested in, the breadth of the material quickly overwhelmed my original scaffolding. In an effort to amend this, I have worked and reworked the codes through a steady engagement with the transcripts and other texts. While I have some reservations about coding, perceiving it to be at odds with poststructuralist theory and interpretive analytics (MacLure, 2013), I have nevertheless found the process rewarding. It has granted me a heightened familiarity with the research materials that I believe is in keeping with the ethics of my methodology.

Material-discursive genealogy encourages research to be conducted in an ethically situated manner. As human agency is always already caught up within the manifold, it is impossible to stand outside. The researcher is entwined with their object of study; indeed, they and the research site are produced through mutual intra-action. To see, listen and reveal are all deeply ethical activities. Politically, Barad (2003) is careful to assert that the manifold is open-ended in the sense that there remains the possibility for social change. Human agency is only part of any mattering, but it is a part. In every research engagement there is an opportunity to change when, where and how the agential cut is made. In becoming political subjects, we affect the objects and relations with which we are co-constituted, an act which affects the field of possibilities and, in turn, subsequent iterations.

While my approach to standards research is different from those discussed in the first section of this chapter, it intersects with them in a number of ways. Historiographically, Foucault's critique of origins is of a kind with Kuhn's rejection of teleology. In drawing on their legacy, my methodology fits within a broad academic tradition that uses history to understand the present, without supposing that the past lead indelibly to this moment. As such, my consideration of apparatuses is not unlike Russell's (2014) conceptualisation of ideology and critique. Foucault can also be credited as an influence on my interpretive approach to analysis. In this respect, Star is not only a political ally, but an analytical one as well. The same is true of Busch (2011), although his hermeneutics is suggestive of social structures and historical forces with which I am uncomfortable. Conceptually, my understanding of the spaces of standards shares a lot with Barry's (2006). We are, however, quite unalike in our approach to empirical material. In this respect, there are similarities between my approach and that of Schmidt and Werle (1998). Both of us use a small number of examples to build up an understanding of general trends. But in our treatment of scale, we part ways. Schmidt and Werle deploy different methodologies at the micro, meso and macro levels, while I attempt to stay true to a single methodology. Here, I am nearer to O'Connell (1993). Both of us attend to a small number of cases without prior assumptions regarding their composition and scale of relations. But

where he sets out to describe networks, I am interested in sites. In terms of my use of qualitative methods, there are many antecedents; interviews and document analysis are very common in the social scientific study of standards. The particular strength of my approach is in the use of these methods to help interpret the expression of broader orders of meaning in the present.

Conclusion

The methodology I have elaborated in this chapter inherits its strengths and weaknesses from the thinkers on which it draws. Just as Foucault's history of the present problematises commonly held ideas, assumptions and logics, so am I able to worry away at taken-for-granted beliefs about the relationship between cities and technology. Statements made without recognition of their past are untethered from the individuals who uttered them and subjected to an interpretive analytic that brings to the fore their contingent and contested origins. Even as standards purport to be a consensual expression of a technical optimum or best practice, my methodology helps reveal the politics of the ideas that usher them into being. Following Barad, discursive practices are understood to be not purely discursive, but in their ontogenesis, also material. I have tried throughout my genealogical enquiries to remain faithful to the ontological precepts of Barad's posthumanism. This has not always been straightforward. The social sciences and humanities have furnished a wealth of material on human societies in cities. When it comes to the non-human, however, there is less to draw upon. A sure weakness of the approach then, is that its generalised symmetry is difficult to adhere to in practice.

The concept of 'performativity' highlights the production of bodies and subject positions. Successful standards are never purely representational. Rather, they are enacted by a confluence of agencies, and in turn bring about intended and unintended effects. Attending to the site of the standard allows these performative effects to be properly foregrounded in the analysis. But it also helps loosen the grip that the history of ideas can sometimes hold over the present. Unanticipated material-discursive agencies always intervene on discourse. Citation is never perfect. In Barad's metaphysics, there is always a sense that ethical and political change is possible; something that can not be said of Foucault's work. But standards do establish ordering effects that are consistent with ideas expressed by their developers. Showing that this occurs is the great strength of the methodology. Standards rely upon and reinforce conceptualisations of materials, forces and effects. By connecting the production of normal bodies and behaviours to broader material-discursive apparatuses, it is possible to disclose the very relations that allow the micro-physics of power to be exercised. But the mechanism by which this occurs is as significant as the fact of its occurrence. Standards are used by a variety of state and non-

state actors to order and organise the world. Iteration as a form of power then, is revealed as a crucial way in which social and material conduct is shaped and curtailed.

Due to a lack of uptake, I was not always able to find fully-realised implementations of the case study standards. The analysis thus focuses at times on intentions expressed by the standards rather than the success or failure of their performance. Insights can be generated in this way, but these speak to city standards more than they do to any particular city. Without a definitive site of implementation, I am forced to lean more heavily on Foucaultian discourse analysis. This invariably leaves me susceptible to the criticisms levelled at Foucault's work—namely, an inattention to human bodies, affects and things.

Nevertheless, I remain excited and inspired by the promise of Baradian social scientific research. In historicising posthuman performativity, Barad's metaphysics allows the description of material and embodied effects to be combined with an analysis of the background through which those effects take place. Importantly, this is achieved without recourse to discrete scales of analysis. The micro, meso and macro are woven together into the site of enactment. Agency is afforded expression, but not at the expense of the broader shaping and constraining structures. Standards have power through their (re)iteration. This open up a discussion of trajectories of order, stabilisation and rationalisation, without suffocating the potential for change.

4. THE CONTEXT OF CITY STANDARDS

Introduction

According to the antihumanism I inherit from Foucault, the relationship between city standards and the individuals that produce them is mediated by things, apprehensions, affects, discourses, institutions and power relations. These condition a field of possibilities, a set of discursive practices that sanction the meanings and forms that city standards take. In this chapter, I discuss three of the material-discursive apparatuses that constitute this field of possibilities: systems theory, neoliberal rationality and the governance turn. While there is a flow of ideas and concepts between them, they can be distinguished on the basis of their disciplinary affiliation and moment of emergence. Systems theory grew out of the physical and natural sciences at the end of the Second World War, neoliberal rationality is closely connected to economists based at The University of Chicago during 1950s and 1960s, and the governance turn owes a debt to political scientists writing in the 1990s.

These three apparatuses are not the only way in which city standards are known and produced. Those involved in ISO/TC 268 come from a variety of backgrounds and draw upon many different theoretical frameworks. My decision to stress these particular strands of thought is founded on an engagement with my research materials. During my reading, interviews and fieldwork, I continually encountered keywords, concepts and phrases related to systems, silos, complexity, information, uncertainty, competitive markets and global networks. I pursued a range of primary and secondary literature in an effort to better understand and contextualise these data. While each of the apparatuses bears upon all three case studies, it would be a mistake to attempt to quantify their importance. Having said this, my sense is that systems theory is the most significant, followed by the governance turn, with neoliberal rationality being a quieter, although still significant, influence.

In referring to these three apparatuses as the context of city standards, I want to evoke them as a social and historical background of force relations. Whenever a standard is enacted, this context is cited in order to justify particular ordering effects. The materials, meanings, spacings and timings of a standard are all contingent upon this imminent set of relations.

The chapter uses Barad's concepts of the 'apparatus' and the 'field of possibilities' to interpret the context of city standards. Its three sections respectively describe systems theory, neoliberal rationality and the governance turn. I do not want to incorporate these orders of meaning into my own ontological framework, but nevertheless attempt to suspend judgement of their truth and coherence in an effort to regard them on their own

terms. In each instance, I offer a paradigmatic expression from my data, describe core assumptions, concepts and logics, and consider their influence on urban studies and government policy. While I give examples of how each pertains to my empirical material, I am most eager to follow the development of notions of complexity and uncertainty. These reveal similarities between the apparatuses, but also their normative differences—namely, their preference for ideal organisational forms of either systems, markets or networks. In the conclusion, I reflect on their ethical and political limits.

Systems theory

> The physical and social resource systems can be thought of as delivery channels, enabled by supporting information flows… At present service delivery through the vertical channels tend to operate in isolation from each other—they are 'silos' of information, activity, and governance. However, there are many areas where information gathered through the city's infrastructure for one service is relevant to another service. Digital infrastructure provides a medium for delivery of digital services and taking information from citizens, offering the potential of increased service integration within and between delivery channels, enabling 'smarter' cities—delivering improved services to citizens and businesses, and making much more efficient use of physical and social resources. (BSI, 2014b: 5)

As it was developing its city standards, BSI (2013; 2014b) published a strategic analysis of the smart city market, describing its animating forces and conceptual foundations. The document positions the future of the city as a problem space to be addressed by digital services and communications infrastructure. Projected changes in global urban population by 2050 are used to assert that cities (in general) must prepare for this inescapable threat. Heightened demand will place a strain on resources and their traditional delivery mechanisms. Not only will water, waste and energy utilities struggle to cope with a surging number of residents, but so too will public services such as health care, education and transportation. Given that the city's economy depends upon these physical and social infrastructures, their failure will undermine the potential for sustainable growth. Anticipation of these challenges rests on an assessment of present vulnerabilities. Traditional state-run services are perceived to be inefficient and unresponsive due to their functional specificity. City departments are too narrowly-focused; their data, knowledge and expertise too tightly-guarded. The smart city is framed in opposition to this (for a detailed examination of how this occurs see White, 2016a). It promises to monitor and control city resources in a holistic and integrated manner. By generating and aggregating data, and by analysing those data in cohesive manner, a smart city will be better able to match supply and demand. By fixing sensors to buildings, roads

and other aspects of the urban fabric, new sources of information will yield more specific spatial and temporal responses.

This anticipatory logic is bolstered by a functional conception of 'the city' as a set of overlapping and interacting systems, the complexity of which existing management practices fail to recognise. BSI refers to these city systems not as departmental bureaus but as delivery channels, and calls for their interconnection.

> A defining feature of smart cities is the ability of the component systems to interoperate. The optimal use of resources across a complex urban environment depends on the interaction between different city services and systems. To identify the most effective use of resources therefore requires communication between the different component systems. (BSI, 2014b: 14)

BSI's vision of a smart city challenges the impermeability of city silos by integrating discrete city systems into a total 'system of systems', opening up new communications pathways and wherever possible sharing information. All closed data must be opened; not according an external set of norms or values, but in order to allow the system to obtain its essential function and reach its optimal state. Only once this occurs, will a city's leaders have any hope of preparing for the problem space of the twenty-first century.

The material-discursive apparatus that gives meaning to these statements came together under the auspices of US post-war research funding (Mirowski, 1999; Heyck, 2015). While many individuals and institutions were involved in this shift, few were more important than Warren Weaver. From his senior position at the Rockefeller Foundation, Weaver oversaw an influential and far-reaching funding programme. He was a benefactor to both Norbert Wiener and Claude Shannon, awarding grants which helped them to pursue their interests in servomechanisms, neurophysiology and information theory (Kline, 2015). Mirowski (1997: 22) even goes so far as to refer to Weaver as "the Svengali of the cyborg sciences", arguing that he was amongst a small cadre of research managers and funders who helped secure the spread of physics into the biological and sociological disciplines. But in addition to this strategic work, he also a published a modest number of papers that helped reinterpret the emerging science of systems theory for a popular audience.

In his introduction to Shannon's foundational paper on information theory, Weaver (1949) argues that there are three distinct levels to the study of communication. The first level, concerning the accurate transmission of a signal between two parties, is technical in nature. This is separate from the signal's meaning and understanding, which Weaver considers to be problems of the semantic level. Lastly is the level of effectiveness, which encompasses human relations of persuasion, influence and power. Shannon (1948) theorises information as a measure of the entropy (or uncertainty) in a sequence of symbols. This separates the technical problem of communication from those of semantics

and effectiveness. While Weaver agrees with Shannon that the meaning of a signal is irrelevant to its transmission, he argues that the inverse does not necessarily follow (Weaver, 1949: 8). As the social levels of communication overlap with and are dependent upon the material structure of the communicative act, so the relevance of information theory to social systems must be acknowledged.

This has important managerial and organisational ramifications. In a paper published in *American Scientist*, Weaver (1948) ruminates on the success and progress of science. He defines the scientific method as a way of solving problems, arguing that it demands of its practitioners inquisitiveness and honesty in the pursuit of truth. And yet the essence of science is not one of appearances—its values are not sufficient to make it as unique. Instead, it is the organisational form of science which contributes to its 'inner spirit'.

> [S]cience is an almost overwhelming illustration of the effectiveness of a well-defined and accepted language, a common set of ideas, a common tradition. The way in which this universality has succeeded in cutting across barriers of time and space, across political and cultural boundaries, is highly significant. Perhaps better than in any other intellectual enterprise of man, science has solved the problem of communicating ideas, and has demonstrated the world-wide cooperation and community of interest which then inevitably results. (Weaver, 1948: 543)

Just as information theory unbundles the signal from its content, so is the fact of communication given greater precedence than the meanings which it conveys. The success of science is not accorded to its innovations and applications, but to the medium of agreed upon terms and modes of engagement that has allowed it to flourish. In this, one can see the normative stirrings of an ideal form of communication which is echoed, albeit in a different context, in the smart city strategy documents of the BSI (2013; 2014b).

Systems theory is a catch-all term for a variety of complex, ongoing and often conflicting domains of engineering and scientific knowledge production. It is comprised of three principal research trajectories: the ecological mindset of general systems theory (Hammond, 2002; 2003); the information and communication theories of first-order and second-order cybernetics (Richardson, 1991; Heims, 1993) and the management practices of systems engineering, operations research and systems analysis (Fortun and Schweber, 1993; Hughes, 1998; Hughes and Hughes, 2000). While historically and theoretically specific, these areas share assumptions, concepts and methods. All take as their principal ontological unit an open or closed system whose function emerges from the interaction of its parts. These parts can be both human and non-human; a system can be organic, machinic, or a combination thereof (Galison, 1994; Rasch and Wolfe, 1995). Early cyberneticians observed that systems were able to maintain a steady-state by detecting and responding to changes in their environment (Hayles, 1999). From specifying

the feedback mechanisms that ensure homeostasis, it follows that systemic performance can be adjusted or improved. The concept of 'control' was developed to describe the achievement and manipulation of a system's steady-state operation. Analytically then, systems theory prioritises function over form; its mode of analysis endeavours to be explanatory rather than descriptive. 'System' is a general and elastic term, that tends to encourage a teleological and at times even deterministic world view.

But how did this apparatus come to be applied to cities and city government? Throughout the 1950s, systems theory was widely promoted in the US as a universal and trans-disciplinary science (Bowker, 1993; Kline, 2015). The promised ability, especially of operations research, to abstract general processes, identify measurable indicators and improve productive efficiencies, resonated with that period's pragmatic, interventionist approach to economic growth. Inroads were made into a number of the natural and social sciences, including urban studies. Here, systems theory can be identified as an influence on the formative texts of urban design (Jacobs, 1961; Alexander, 1964; 1966; see also Steenson, 2017); as an aspect of geography's quantitative revolution (Berry, 1964; see also Barnes and Farish, 2006); as an intellectual precursor to Forrester's (1961; 1969) system dynamics (Townsend, 2013); and in urban planning (Wilson, 1968), where it dovetailed with the sociological tradition of structural functionalism (Scott and Roweis, 1977; Gregory, 1980).

Jane Jacobs' (1961) seminal work, *The Death and Life of Great American Cities*, closes with an ontological assessment of the problem posed by cities (Laurence, 2006). Citing Weaver's (1948) paper in *American Scientist*, Jacobs rereads the history of science through its ability to tackle problems of simplicity, disorganised complexity and organised complexity. She argues that the city, as a problem of organised complexity, is insoluble to scientific techniques developed to tackle earlier problems; respectively, mechanics and statistics. Simple, mechanistic relationships can not accurately represent the city. But neither can statistics—the multitude of variables affecting cities are neither fully random nor independent. A different approach, one based not on physics or mathematics but biology, is required in order to comprehend the city as a complex system. In place of the vision of the singular, heroic planner, urban studies must be sensitive to the cumulative and unanticipated effects of many, self-organising actors.

Jay Forrester (1969) set out to model the city as a dynamical system (Batty, 1976; Townsend, 2013). Where contemporaneous efforts to quantitate cities were usually fixed in time, Forrester adapted his own, unrelated, business management methods into a theory of urban change. His model breaks the city into three aspects, the labour force, housing and industry, each of which is were further divided into three types. Managerial, labouring and underemployed groups, are placed respectively in premium, worker and underemployed housing. Industry is comprised of new enterprises, mature businesses and

declining industries. Using metaphors of stocks and flows, Forrester modelled how changes in the amount of one category affect amounts in the other categories. His work is general rather than specific, and applies to cities in the abstract. According to Edwards (2010: 367), Forrester firmly believed that "system structure and dynamics mattered far more than precise inputs". The resulting differential equations, while too numerous to be solved by hand, could be fed into the time-share computers at the Massachusetts Institute of Technology. Forrester's model produced alarming results: with time, a city will tend towards an equilibrium of declining industry, high unemployment and poor housing.

Beyond the academy, the influence of systems theory on city government and urban policy has long been recognised (Hoos, 1972; Lilienfeld, 1978) and given appropriate historical treatment (Light, 2003; 2008; Flood, 2010). In a detailed historical analysis of the influence of military professionals on postwar government in the US, Light (2003) tracks the application of systems theory to urban management in Pittsburgh, New York City and Los Angeles. In New York in the late 1960s, sweeping changes inspired by operations research and systems analysis were introduced. Information systems were developed and government records digitised in the name of sharing data and knowledge across the city bureaucracy. In an effort to encourage communication and the co-ordinated use of resources, thirty of the city's departments were consolidated into just ten 'super agencies'. These policies of centralised command and control can be associated with early conceptualisations of the city as a communications system. In 1969, at the behest of Mayor Lindsay, the military research corporation RAND opened a New York branch. While it was short-lived and had negligible direct impact on the city, the RAND Institute helped ingrain techniques of data processing and program analysis into public policy. Flood (2010) examines the effects that these organisational changes had on the NYC Fire Department. Following the construction of a computer model, many of the city's fire stations were shut down, even as the total number of fires was increasing. This had devastating effects, particularly on poor and ethnic minority communities. Flood identifies a confluence of reasons for this catastrophic government failure, not the least of which was the overconfident application of a reductive model. Light's assessment reinforces this, pointing to the poor understanding of these tools by government employees and their application to problems resistant to quantification. Nevertheless, strong relationships were forged between former military personnel and city officials, and many of the principles of systems theory became entrenched in the operations of government.

Systems theory is clearly an influence on the developers of CPA-I_001. Ramon Margalef and Nicholas Negroponte, two of the inspirations for the diagram of the City Anatomy, can be located within this literature. The former sought to interpret ecology through information theory (Margalef, 1958; 1963), while the latter is famous for

architectural interventions that utilise cybernetics (Steenson, 2017). Core members of City Protocol Society, Francesc Giralt and Robert Rallo, have published academic work on complex, turbulent systems (see for instance Giralt et al., 2000). Time and again, the anatomy is described as a 'system of systems'. The linguistic style of BSI PAS 181, known as pattern language, was developed by Christopher Alexander, who in turn drew upon the work of cyberneticians Norbert Wiener and Ross Ashby (Pickering, 2010; Steenson, 2017). ISO 37120 relies on systems theory when its proponents assert that inter-city communication is fundamental to achieving optimal functionality. Even at the institutional level explored in the next chapter, gestures towards systems theory are easily identified: both the ISO/TC 268 business plan and amended scope refer to the importance of 'holistic and integrated approaches' (ISO, 2013a; 2016b: resolution 65).

For Krivý (2016), excitement around smart cities can be understood as an expression of second-order cybernetics, a counter-trend within systems theory. In this line of thought, focus shifts from closed systems, negative feedback and homeostasis, to open systems, positive feedback and reflexivity. Where in a closed system, environmental inputs are used to maintain a steady state, in an open system, those inputs become outputs that are fed back into the system as inputs, in a continuous iterative loop. Such positive feedback mechanisms lead to emergent properties and unpredictable effects. Systems take on a more lifelike and autopoetic character (Varela et al., 1974; see also Wolfe, 1995)—the dynamic complexity of non-linear systems appears to hold the second law of thermodynamics at bay (Prigogine and Stengers, 1984). Where closed systems are distinct from their external and (potentially) objective observers, second-order cybernetics reconceives systems and their observers in a process of mutual construction and exchange. This has consequences that many system theorists, trained in the epistemology of scientific realism, find uncomfortable (Kline, 2015: 198). Certainly, aspects of urban informatics and 'the new science of cities' descend from this line of thought (see Batty, 2013; West, 2017). Nevertheless, it is a mistake to conclude that the smart city is simply an expression of second-order cybernetics. Many of the suppositions and commitments of first-order cybernetics, operations research and systems engineering persist in existing smart city technologies (Halpern, 2014)—a concrete example of which is the use of Forrester's system dynamics by IBM in Portland, Oregan (Townsend, 2013). And systems theory is certainly not the only material-discursive apparatus that produces the smart city and city standards. In the next two sections, I continue my exploration of the city standards' field of possibilities, by tracking the deployment of these ideas in economics and political science.

Neoliberal rationality

> Just imagine what a mobile phone would look like today if it was designed 20 years ago by a government committee. I dread to think. The last thing we want are smart cities in the future shoehorned or straitjacketed into what we think today a smart city of 2050 should look like. So, common standards do not mean a common […] picture of what the endpoint looks like. It is an enabling process to allow people to understand a common view of where we're trying to get to and what we're trying to achieve, but not necessarily exactly how we're going to achieve that. (Byles, 2014)

In late 2014, Dan Byles, then Conservative MP for North Warwickshire and vice-chair of the UK government's All-Party Parliamentary Group on smart cities, spoke about the need for smart city standards before a small audience at the Smart City Expo in Barcelona. While he anticipated the benefits of the smart city, he nevertheless conceded an uncertainty as to what that would involve. No one really knows what the smart city will be, he said, "the smart city journey is a journey without an end […] there is no finish line" (Byles, 2014). This uncertainty was not only inevitable but was, in itself, something good. Byles argued that it would be a mistake for standards to attempt to second-guess the future. As such, city standards should be used to construct a framework in which innovation can unfold in a natural and responsive way: "the key is putting in place the underlying enabling infrastructure to future-proof the city, to […] allow future flexibility for a future that we don't even know quite what it's going to look like" (Byles, 2014). For Byles, standards are not a way of realising the future in the present. Rather, they are a way of preparing for uncertainty by constructing a scaffolding through which a range of responses to perceived challenges can emerge and vie for precedence. Put differently, his hope is that city standards will be used to nurture a market for smart city applications and services. Within such a vision, high quality data and information act as signals to citizens and states, allowing them to bring their behaviour in line with a rational ideal. The social benefits of smart cities are the same social benefits which accrue to a well-functioning market.

An implicit warning underlies Byles' speech. If standards are too prescriptive they will stymie innovation and stunt the smart city's potential. And yet Byles is not rejecting all planning. Rather, he positions standards as a way of recuperating planning by dispersing responsibility for it through a global network of experts. It is a fine line he walks. The challenge is not standardisation itself, but standardising the right things in the right amount. From where does this curious relation to smart cities and standards arise?

Friedrich Hayek (1945), in his most highly cited paper, 'The Use of Knowledge in Society', offers an account of the mechanism by which natural economic order is established and maintained. He describes two basic types of knowledge. Scientific knowledge is the formal theory of "a body of suitably chosen experts" (Hayek, 1945: 521).

This tends to be technical in nature, but also general and slow to put into practice. At odds to this is a more tacit and pragmatic type of knowledge, formed from local circumstances. Given that the economy demands immediate and geographically-specific responses to changing conditions, Hayek argues that practical knowledge is better suited to the distribution of goods and services than scientific knowledge. Taken as a whole, the economy is a complex phenomenon that resists being grasped by predictive methodologies (Hayek, 2014; for a rich discussion of the role of Wiener's concept of 'complexity' in Hayek's thought, see Caldwell, 2004).

But this fails to fully address the problem. As Hayek (1945: 525) puts it, there remains the issue of *communicating* the necessary information such that local decisions can fit into a pattern of broader economic changes. Inspired by systems theory, he theorises the price system as a medium through which information about the economy as a whole is communicated.

> In abbreviated form, by a kind of symbol, only the most essential information is passed on, and passed on only to those concerned. It is more than a metaphor to describe the price system as a kind of machinery for registering change, or a system of telecommunications which enables individual producers to watch merely the movement of a few pointers, as an engineer might watch the hands of a few dials, in order to adjust their activities to changes of which they may never know more than is reflected in the price movement. (Hayek, 1945: 527)

To summarise, price communicates information about changes that occur elsewhere in the economy. Individual actors draw on practical knowledge to respond to this information in a locally appropriate manner. Knowledge as to why, where and how those changes occurred in the first place is irrelevant. The price system distributes particular perturbations and irregularities throughout the economy, maintaining a rational order.

From this emerges an idiosyncratic and counter-intuitive disposition to the future. On the one hand, Hayek's denunciation of scientific knowledge introduces an element of uncertainty into economic theory. If government refuses to intervene in matters of production and consumption, then its capacity to anticipate and directly respond to perceived threats is diminished. On the other hand, by staying out of the way of individuals, government allows local, practical knowledge—which can be ignorant of the content of things occurring elsewhere—to imbue the economy with a greater responsiveness to change. It is here that another economist—and one-time colleague of Hayek's at The University of Chicago—Frank Knight (1921: 311), identified the origins of innovation: "Profit arises out of the inherent, absolute unpredictability of things, out of the sheer, brute fact that the results of human activity cannot be anticipated and then only in so far as even a probability calculation in regard to them is impossible and meaningless". Conceived as such, the perceived threat of uncertainty is diminished.

Uncertainty is not something to be afraid of, but something to be revered and encouraged. Just as Byles argued, the role of government is to plan for competition by creating the conditions under which uncertainty can flourish and information can move quickly throughout the economy.

The word 'neoliberalism' is often used as a pejorative for free market capitalism. Following a recent body of scholarship (usefully summarised by Davies, 2014), I reject this use in favour of an engagement with intellectual origins, assumptions, logics and ethics. Neoliberal thought has been reinterpreted in the context of its continuity and dislocation with classical liberalism, its internal contingencies and inconsistencies (i.e., its differential expression by Austrian, Freiburg, Chicago and Virginia schools), and the think tanks responsible for devising and popularising its policies (Foucault, 2008; Mirowski and Plehwe, 2009; Peck, 2010; Burgin, 2012; Jones, 2012; Gane, 2013; Davies, 2017).

Two broad phases can be identified. In *The Road to Serfdom*, early neoliberal thinker Hayek (1944: 43) drew a distinction between planning *for* competition and planning *against* competition. In the case of the former, government establishes and enforces the legal and regulatory apparatus within which competition can properly occur. In the case of latter, government attempts to replace the market by directing the distribution of goods and services. Hayek was an advocate of planning for competition, arguing that the economy is composed of so many interconnected variables that it lies beyond the ability of any individual planner or centralised authority to comprehend. Rather than act to distribute goods and services, the state should steward the market economy, ensuring its proper structure and correcting against market failure (such as monopoly formation and negative externalities). As was discussed above, by seeking to curb state intervention in this way Hayek rendered the future more uncertain. To address this, he incorporated a modified form of economic planning into his theory. Competition is redefined as "decentralized planning by many separate persons" (Hayek, 1945: 521). Planning is an outcome of the rational self-interest of dispersed actors; it is many small, individualised anticipations that together imbue the economy with a responsiveness to change. Put differently, co-ordination is an unintended consequence of competition. Whenever centralised economic planning occurs, the will of the few is imposed onto the will of the many, preventing the emergence of natural order.

Later neoliberal thinkers Ronald Coase (1960) and George Stigler (1971), critiqued the ability of the state to make judicial and regulatory decisions in the interest of preserving competition. They argued that microeconomic assumptions and calculations, rather than classical liberal values, ought to be used to assess the necessity of intervention.

Coase (1960) set out to rationalise the adjudication of negative externalities (Davies, 2017). Most economists, he wrote, use Pigou's (1932) formulation of the tension between private products and social effects to argue that firms should be held accountable for any

damaging results of their activities. Thus, the factory which emits a harmful smoke, would be expected to pay a pecuniary recompense to those living nearby. For Coase (1960: 15), however, this logic is guided by values which are irrelevant to functioning markets. He proposed that the damage done by the firm be weighed against the damage that would be inflicted upon them were the court to take action. Intervention should only be made if it is the choice of least cost.

> All solutions have costs and there is no reason to suppose that government regulation is called for simply because the problem is not well handled by the market or the firm. Satisfactory views on policy can only come from a patient study of how, in practice, the market, firms and governments handle the problem of harmful effects. (Coase, 1960: 18)

Coase rejected the liberal ideal in which the free market is subservient to an ethic of fairness and equality. Instead, he argued that a firm's activities be measured and assessed without recourse to an overarching metaphysical framework. Decision-making should be governed by utility maximisation, not justice. Coase paved the way for an influential critique of antitrust law (Posner, 1976; Bork, 1978) and for judicial acceptance of large, highly integrated firms.

Stigler (1971) translated this style of thinking into an analysis of market regulation. Prior to Stigler, regulation was usually understood by orthodox economists to have been implemented in the interest of the general public (Levine and Forrence, 1990). In order to minimise the inefficiencies that result from monopolies, negative externalities and other instances of market failure, limits were imposed on market actors by politicians and the state bureaucracy. As with antitrust law before Coase, action over the economy was sanctioned by classical liberal values. Stigler's innovation was to subject the relationship between regulators and the regulated to the logic of microeconomic analysis. Rejecting the concept of the 'public good', he assumed that politicians, political parties, corporations and the wider public would be better apprehended as narrowly self-interested economic agents. Given that the state alone has the power to coerce its subjects, it follows that private actors will attempt to bend the state towards their own ends. Given that politicians and political parties require private funding to maintain their power, it follows that they (and public officials) will avoid policies which undermine wealthy supporters. Stigler thus asserts that over time regulation will come to serve those with the most political power. Rather than minimise market inefficiencies in the interest of the public, regulation will tend to work against the operation of the free market to the benefit of a small group of individuals. While Stigler provided some empirical support for his theory, his paper is mostly notable for its Coasian inversion of the logic of regulation.

Putting this together, I understand neoliberalism to involve the withdrawal of the state from the (re)distribution of goods and services, a curbing of its role in the correction

of market failure, and an increase in the use of microeconomic assumptions, logics and models in the organisation of social and political institutions. Liberalisation and marketisation are an important aspect of neoliberal reform, but they do not capture what makes it distinct from neoclassical economics (Jones, 2012). That lies in the reconfiguration of social and political life as a domain of economic analysis (Foucault, 2008; Dardot and Laval, 2013; Brown, 2015). Examples of neoliberal rationality at work include the explicit use of incentive structures within government organisations to steer behaviour towards the rational ideal of *homo economicus* (Ferlie et al., 1996), as well as the nudging, prompting and prodding that increasingly occurs when behaviour deviates from that ideal (Davies, 2015).

Whenever city standards are framed as a way of facilitating competitive markets, they do so within the context of neoliberal rationality. This occurs in the documents that stimulated the formation of ISO/TC 268 (ISO, 2011), in the final report of the ISO/TMB S_Cities SAG (ISO, 2015b) and in some of the ambitions for CPA-I_001 expressed in my interviews. One of my interlocutors even went so far as to describe city standards as 'marchitecture', that is, as "an architecture for a market" (interview 42, Paul Wilson, TM Forum, January 20, 2017). The argument that a free and competitive market for smart city goods and services would be the best way to distribute technology and expertise to local governments is in keeping with neoclassical economics. To also argue that it is the role of the state to assure this by voluntarily implementing standards developed by the private sector, is to ease into a neoliberal logic. BSI PAS 181 takes this one step further, advocating for a service commissioner model of public provision, where government creates the conditions under which public and private providers compete for customers and service contracts. Here, the market being created is not simply for smart cities, but for all state services and utilities. This is given a different twist entirely by the World Council on City Data, who imagine using ISO 37120 indicator data to feed the financialisation of state assets, infrastructures and futures. Any ambition to present a fair and transparent face of government to an active citizenry, gives way before the conviction that profit-maximisation will ensure the best use of a database of urban indicators.

The epitome of the permeation of neoliberal rationality into city scholarship more generally, is the well-known urban economist Edward Glaeser (2011b). Beginning from the assumption that people move to a new city to maximise their human capital (i.e., the sum of their capacity for productive labour), Glaeser analyses agglomerated, quantitative data to identify specific reasons for locational choices. His findings are varied, but include things such as sunshine, safety, good schools, (other) skilled workers, housing deregulation and tax incentives. Glaeser advances policy positions for cities to attract desirable workers and promote the kinds of innovative small businesses that follow in their wake. These involve the promotion of consumer choice, the defence of property rights and supply-side

market reforms. Politically, Glaeser (2011a) positions himself as a 'radical centrist'. Following Friedman's (1953) distinction between 'positive' and 'normative' economics, he argues that while it might make sense to allow the poor and homeless to fend for themselves, ethically, he is in support of minimal state assistance. This places him somewhere between the two phases of neoliberal thought. Economically, he adopts the (radical) assumptions, concepts and methodology of Coase and Stigler, applying them to an understanding of intra-urban and inter-urban migrations; the city is recast as a sphere of self-interested economic agents prime for microeconomic analysis (Peck, 2016). Politically, however, he is nearer to Hayek, believing in liberalisation and deregulation, but also in (centrist) intervention to correct market failure and preserve competition.

An impressive amount of empirical research has been undertaken into the 'actually existing' (Brenner and Theodore, 2002) and 'variegated' forms (Brenner et al., 2010) of neoliberalism in cities and city governments (see for example Brenner and Theodore, 2003; Hubbard, 2004; Boyle et al., 2008; Candan and Kolluoğlu, 2008; He and Wu, 2009). For example, Boyle, McWilliams and Rice (2008) begin from a recognition of the many and often conflicting ways in which neoliberal doctrine become grounded in particular policies and political reforms. They identify the need for an analysis of its local instantiations, and entanglements with existing ideologies and agendas. Examining social, political and economic changes in Glasgow between 1977 and the early 2000s, they point to the emergence of a "complex series of hybrids which at times do not look particularly neoliberal at all" (Boyle et al., 2008: 323). Nevertheless, they persist in using 'neoliberalism' to signify broad changes that have actually occurred: supply-side tinkering rather than demand management; flexible planning in line with market trends rather than regulatory planning and development; and customer-led service provision rather than a general programme of wealth redistribution. Their final remarks on the term are stark. Only if 'neoliberalism' is reconceived as a force manifesting in different and various forms will it continue to be of use in the academic vocabulary.

While this work is informative and politically useful, it sometimes interprets neoliberalism as little more than the latest phase of accumulation by dispossession (following Harvey, 2005). This allows for powerful and satisfying political economic explanations that reinforce theorisations of the city as a spatio-temporal fix for surplus capital. But it also presents neoliberalism as an intractable and ineluctable force. I have defined the phenomenon in a slightly different way, not simply as the rolling back of state services by free market ideologues since the late 1970s, but as the displacement of liberal ethical and political reason by the logics of utility and profit maximisation.

The governance turn

> We live in a world of cities. The acceleration of urban growth is causing new challenges that must be addressed. We need new collaborative solutions to create more efficient and responsible development. From this mission arises City Protocol, a global platform where cities work together with cross-sector partners to generate multi-city, multicultural, multi-partner and scale-free solutions. […] With the help of the City Protocol community of experts, we seek to establish a common language beginning with the City Anatomy, which identifies and articulates the essential elements that make up a city. This allows us to set up a framework as the basis for an effective evaluation and transformation of cities, and […] interconnect cities to develop common projects to learn from each other. All in order to create a global network of cities: the Internet of cities. (City Protocol, 2015)

In April 2015, City Protocol uploaded a short promotional video to YouTube that outlined the scope and ambition for its newly founded platform. The narrator begins with a familiar evocation of urban uncertainty, optimistically accompanied by jaunty music and a SimCity-like cartoon. Rather than cherish that uncertainty, or seek to ameliorate it through urban integration and efficiency gains, a different strategy is proposed. By working together, across sectors and cities, collaborative and scale-free solutions will be found. Cities are presented as unique, but also as having a lot in common. By establishing a common language which recognises the essential character of cities, they will become comparable, partnerships will flourish and best practices will be shared. While this language is based on a systems account of cities, it breaks with the logic of the self-contained, closed system (as in City Protocol, 2013a) to embrace inter-connection and collaboration. Advocacy for a global network does not necessarily follow on from the principles of systems theory. But neither is this a complete rejection of government's ability to plan for the general good: "As a city, company, institution or individual you can help to guide your city and others towards a more sustainable, self-sufficient and responsible future" (City Protocol, 2015). Through participation in a collaborative network, anyone from any background can help steer their city to anticipate the challenges of the twenty-first century. Classical liberal values have seemingly been reconciled with complexity and uncertainty. But how has this been achieved?

For governance scholars, it is not at all evident that markets are, on their own, sufficient to solve the problems produced by complex societies. In fleshing out the connection between order, intentionality and governance, US political scientist James Rosenau (1992) differentiates between two types of self-conscious social arrangements: fundamental and routinised. The first can be thought of as the formal structures of government, the distribution of power amongst its key roles and the rules by which its agents interact. The second is more infrastructural, referring to the backgrounded

procedures, such as taxation, trade and passport control, which allow government to persist. In addition to these self-conscious arrangements, Rosenau acknowledges the significance of more undirected and emergent forms of order.

> Some of the arrangements derive, rather, from the aggregation of individual decisions that are designed to serve immediate subsystem concerns but that cumulate to system-wide orderly arrangements. The setting of prices in a market place exemplifies a self-regulating aggregation that facilitates order: sellers are concerned with receiving the highest possible amount for their goods and buyers seek to pay the lowest possible amount, but the result of their individual bargains is normally a stable and orderly system-wide market for the commodity. (Rosenau, 1992: 5)

This conception of markets is very close to the one advanced by Hayek (1945). While individuals within the system act in their own rational self-interest, their activities add up to an order that is of overall benefit. And yet Rosenau also pushes back against this conceptualisation, highlighting the rules and regulators that have been put in place to curb the effects of market failure. Markets are governed not only by governments, but also by industry-appointed officials and non-profit watchdogs. For Rosenau, competition must be understood under the umbrella of the intentional organising patterns of governance. These are to be conceived, on the one hand, as a proliferation of the centres of authority, and on the other, as a multiplicity of interdependent forms of governing (Rosenau, 2009).

Writing from a European perspective, Jan Kooiman (1993b: 10) argues for "structural components [to] follow as part of the outcome of interactions". Rather than putting the strategy first and restructuring the organisation accordingly, government should respond to the problems they face in a way that is consistent with their complex, dynamic and diverse character.

> In a more theoretical perspective one could speculate that in these new forms of governing and governance… more fundamental characteristics of modern societies are (finally?) being taken somewhat more serious[ly]. By this I mean that the growing realization of the enormous complexity, dynamics and diversity of social-political subsystems (such as health care, education, transportation, environmental protection and social welfare) should not be left alone but somehow and in some respects have to be 'governed'. Even a profound neo-liberal like Hayeck [sic] was of this opinion. (Kooiman, 1993a: 35)

For the neoliberals, markets are better able to co-ordinate the distribution of services than are centralised institutions ('governed', like 'planned', might perhaps be understood as an emergent effect); government should only intervene to establish functioning markets or to improve competition in instances of market failure. Kooiman means something different than this, arguing for "a third way… a shift from unilateral (government or society

separately) to an interactionist focus (government with society)" (Kooiman, 1993a: 35; see also Giddens, 1998). Put differently, the traditional divide between the public and private sectors is taken to be no longer pertinent. In recognition of the complexities of contemporary life, the public and private sectors ought to work together in the management and co-ordination of society. This is very close to the founding purpose of City Protocol (see also Barber, 2013).

The *Oxford English Dictionary* (2018a) defines 'governance' as the action or office of governing (i.e., governance is both government and what government does). Since the early 1990s, however, 'governance' has been used more specifically to refer to decentered and distributed styles of governing. The management and co-ordination of society is no longer understood to be the sole responsibility of a cohesive political core, but an outcome of action amongst a dispersed collection of government, business, non-profit and individual actors. Whether born of the Westminster model (Rhodes, 1996), or "the conceptual trinity of market-state-civil society" (Jessop, 1995: 310), the notion that government is distinct from the population which it governs has fallen out of favour. Partly, this can be attributed to the erosion of public life by private firms since the 1970s. But it also must be seen as a response to the perceived complexities of the contemporary world (Walters, 2004) and the inability of neoliberal reforms to fully deal with those complexities (Bevir, 2010). Rather than markets of self-interested agents, attention has turned to networks of concerned stakeholders (Kickert et al., 1997; Rhodes, 1997) In this way, the *form* by which planning, management and co-ordination are exercised is made consistent with the multi-faceted and multi-causal nature of the problems society must face. The public sector has been rearranged to involve "'less government' (or less rowing) but 'more governance' (or more steering)" (Rhodes, 1996: 655). Its role is has become one of metagovernance: "coordinating different forms of governance and ensuring a minimal coherence among them" (Jessop, 1997: 574).

'Governance' is derived from medieval Latin, where *'gubernantia'* denotes piloting, steering or guiding (Jessop, 1995: 327, n. 4). Similarly, 'cybernetics' was named after the Greek word *'cybernḗtēs'*, also meaning steersman, governor or pilot (Kline, 2015: 71). This is no mere coincidence. Both systems theory and governance concern the operation and management of diverse, interacting components. Some governance scholars even build on systems theory directly (see for instance Kooiman, 2003; Rosenau, 2003). Nevertheless, it would be a mistake to consider one a direct outgrowth of the other.

Bevir (2010) identifies four origins of the governance turn in political science: rational choice theory, the new institutionalism, systems theory and regulation theory. *Rational choice theory*—an important aspect of what I have defined as neoliberal rationality—attempts to account for social and political behaviour by modelling individuals in pursuit their own interests. Governance networks that encourage joint

responsibility for shared resources are here held to have the potential to allay the free-rider problem (Dowding et al., 2000). The focus of the *new institutionalism* is less on micro-level interactions, than meso-level social norms, practices and organisations. Its analysis is more historical and sociological. As such, governance is theorised as a way of introducing policy ideas into an institutional environment that has often been resistant to change. *Systems theory* considers the problematic in terms of the capacity for government to steer social and economic systems. For Kooiman (2000), governance is an outcome of interactions within a social system: between the state and industry; between politicians and citizens; and between government departments and the material and social forces they regulate. Any one of these associations presents an opportunity for government to steer the performance of the whole. Finally, *regulation theory* addresses the ways in which the political economy is regularised by embedded social institutions and conventions (see also Jessop, 1995). While in the past, government has acted to stabilise the fractious relationship between labour and capital, within a post-Fordist regime of capitalist accumulation—in which the welfare state has been rolled-back and labour-intensive industry outsourced to the Global South—its role has changed. Governance networks are thus understood as a response to political economic changes, particularly the privatisation of public services and the rise in supply-side policy intervention.

The flexibility of the concept of 'governance' allows it to be used by academic disciplines and policy areas in a variety of ways. As examples of its differential expression, Walters (2004) points to the use of 'global governance' in international relations, 'good governance' in development policy, 'multilevel governance' in European Union studies, and 'corporate governance' in finance and management. In addition to this, many human geographers have engaged with 'urban governance' in a critical vein (Harvey, 1989; Brenner, 1999; Jessop, 2002). While these uses of the term are not without their particular perspectives and concerns, they share certain assumptions and logics—namely, a recognition of the complexity and rapidity of change brought on by global finance and ICT; an understanding that contemporary power is diffuse (rather than sovereign or centralised); and a preference for self-organising networks (as opposed to the state or market) as a model for social organisation.

There is a well-established literature that connects the rise in voluntary management standards to the governance turn (Tollefson et al., 2008; DeNardis, 2009; Murphy and Yates, 2009; Higgins and Larner, 2010; Ponte et al., 2011). This should come as little surprise. At one level, standards help regularise the co-ordination of operations within large organisations and throughout their supply chains. As capitalism has become increasingly globalised, corporations have seized upon mechanisms of management and control capable of transgressing political boundaries. International standards have played a key role in helping this to occur. What is more, the practice of

standards-making itself distributes the production of soft laws and best practices amongst a network of global experts. Both in their content and in their mode of generation, standards can be understood as a technology of governance. This is supported by the founding documents of ISO/TC 268, which propose standards for "*steering* and assessing the performance of communities" (ISO, 2013a: 4, italics added).

While CPA-I_001 is based upon systems theory, it has also flirted with the perspectives and prescriptions of governance. This was present from the very start of CP, with Manuel Sanromà's (2012) two definitions of the word 'protocol' evoking communications systems with one breath, and deliberative methodologies with another. It is further evidenced in the tension between Vicente Guallart's (2014) original vision of an anatomy of the city based upon interconnected computers, and the quote with which I opened this section. While it is not necessarily the case that these contradict one another, their co-presence undermines the integrity of the narrative with which the standard is promoted.

The connections between the governance turn and my two other case studies are even more clear-cut. The director and CEO of the World Council on City Data, Patricia McCarney, has used the concept of 'governance' in her academic work. In a paper published in *Urban Forum*, she describes two discourses of governance within the field of international development (McCarney, 2000). Operating at a global level, the World Bank has come to frame governance as a strong state in support of economic development and free market reform. McCarney charts the introduction of the term in Bank literature in the late 1980s as a response to narrow quantitative economic analyses, through to its expression as productive state-market relations and subsequent coupling with an anti-corruption agenda. At a more local level, governance has been used to decentre research on power, authority and democracy from the state to civil society in general. This has helped reveal the delivery of basic services in cities in the Global South by community groups and social movements in myriad ways often considered informal or illegal. While leaning towards the second conceptualisation, McCarney nevertheless proposes a synthesis in the interest of the cohesive analysis of state-society-market relations. She hopes that a revised concept of 'governance' will prompt development studies to explore the capacity of local government to respond to imminent urban growth, encourage new relationships between government and civil society, and address issues of fragmentation and legitimacy in the provision of services. For McCarney, this is a normative project. Considerations of governance can also help bring civil society—an "active, organised and potent urban force" (McCarney, 2000: 12)—into the work of the World Bank and other development agencies, tempering their neoclassical economic and neoliberal tendencies.

The national governments of Ronald Reagan and Margaret Thatcher are often considered neoliberal, while the governments of Bill Clinton and Tony Blair are

associated with the governance turn. Clinton and Blair both proposed to balance state intervention with the benefits of free trade—with the latter even deploying the same 'third way' term used by Kooiman. It was also under their administration that the dot-com boom and bust occurred, and that governments began integrating their online presence. Chris Parker, the technical author of BSI PAS 181, worked as Deputy e-Envoy in Blair's Cabinet Office, before co-founding a private consultancy based on the UK's experiences of e-government.

The multinational analysis of e-government strategy conducted by Dunleavy et al. (2006b) places the phenomenon within a broad political and economic context. Two phases of government strategy are recognised. The first, New Public Management, is largely neoliberal in character and draws on ideas from business management and public choice theory. It involves: the disaggregation of public sector hierarchies into smaller and more specialised departments that are overseen by information and management practices adopted from the private sector; the formation of a competitive marketplace of service providers in the hope of facilitating consumer choice; and incentive structures that encourage the performance improvement of individuals within government. While these ideas are not wholly replaced by the second phase of government strategy, the authors nevertheless chart their decline in many countries, including the US and UK. They argue that a new policy logic, Digital Era Governance, is on the rise. This includes: using ICT to reintegrate the services fragmented by New Public Management policies; a needs-based holism, in which simplified citizen-service relationships are managed by an agile government; and an emphasis on the transformational productivity gains that will be wrought through the use of new technologies. In a follow-up paper, Margetts and Dunleavy (2013) discussed Digital Era Governance in the context of post-crisis austerity politics, arguing that it continues to unfurl with particular importance placed on opening government datasets to the public. The connections between this mode of governance, open data and smart cities will be discussed at greater length in the chapter on PAS 181.

Governance is so closely associated with neoliberalism that many refer to a pervasive mode of 'neoliberal governance' (Fougner, 2008; Peck et al., 2010; Brown, 2015; Sadowski, 2016). Without denying their intersection, I have defined them separately. Neoliberal rationality refers to the use of microeconomics to model, interpret and modify social and political behaviour without recourse to broader metaphysical values. By contrast, the governance turn refers to an intellectual and historical shift from centralised to decentralised mechanisms of regulation and control. Both apparatuses use systems theory to think about complex social relations, but both are more ambitious in their normative agenda. Put simply, systems theory calls for optimised systems, neoliberalism for free markets and governance studies for dispersed networks.

Conclusion

Systems theory, neoliberal rationality and the governance turn are not incompatible, although each has its own normative preferences and inherent weaknesses. The first is concerned principally with the integration and efficient operation of systems. Instead of managing the city through highly-specialised and siloed departments, systems theorists conceive of the city as an integrated and dynamical system of systems. City structures and practices must be rearranged in keeping with an understanding of their emergent and interacting functions. For BSI (2014b), this is articulated in terms of holistic service integration across government delivery channels. This idea is not new, but can be traced to the application of operations research to civic management in post-war America, where, time and again, overconfidence lead to overly simplistic solutions (Light, 2003; Flood, 2010). While the systems approach to cities is often presented as common sense, there is little empirical support for the efficiency gains it promises. Moreover, its blindness to culture and meaning leave it open to shifts in political sentiment, not to mention direct critique.

Neoliberal rationality is a form of social analysis in which individuals are expected to act in their own narrow self-interest. Here, the ontological primacy of the market is stressed. Instead of delivering services directly, neoliberals argue that government should encourage competition and innovation. As Byles (2014) would have it, the role of the state is not to decide what the future smart city will involve, but to establish conditions in the present that will ensure that the best outcome is reached. Through the privatisation of public assets and the construction of a marketplace of providers, capital is freed up and operating expenses are reduced. Public choice is placed ahead of public control and the proper function of government is to commission services from others.

Two irregularities of neoliberal rationality need to be stressed. First, not every free marketeer is a neoliberal and not every economist is for unfettered competition. The academic discipline of economics is rich and diverse (Chang, 2014). It may be possible to pluralise the voices at work in city standards (and, by extension, the smart city) by engaging with macroeconomic and heterodox theories that upset the neoclassical norm. Second, what marks neoliberal rationality as distinct from neoclassical economics is the application of the latter's central assumptions and logics to the study of social and political life. Public choice theory and the economic analysis of law are the two most visible applications of this (Amadae, 2003; Davies, 2017), but the tendency is quite diffuse and also intersects with popular economics (for example Levitt and Dubner, 2006), behavioural economics (Davies, 2015) and many conservative think tanks (Jones, 2012). While neoliberal thought can be used to advance a progressive social and political agenda (for instance Ostrom, 1991), it is dangerous to use it in this way—there is a large body of

critical literature detailing its atomising, alienating and undemocratic consequences (see for example Klein, 2007; Mirowski and Plehwe, 2009; Brown, 2015; Davies, 2017). Neoliberalism should be resisted, but preferably in a manner that is pointed rather than indiscriminate.

The governance turn champions not systems or markets, but networks of interconnected and engaged stakeholders. Given the great complexity of problems faced by the city, and given that these problems are global in nature, adherents of networked governance assert that cities cannot direct their attention inwards. City Protocol was established as an international platform with the goal of facilitating "multi-city, multicultural, multi-partner and scale-free solutions" (City Protocol, 2015). The onus is on cities to join the global community, compare and benchmark themselves with their peers, and always be on the look out for the latest policy innovation. But in being forever global and interconnected, the specificity of problems can be overlooked. Cities are different (perhaps irreducibly so) and questions need to be asked about the extent to which technological and managerial solutions can be moved between them. This is not to say that cities cannot learn from one another, only that this is not the panacea it is often said to be. Furthermore, there is a political risk in dissolving the market–state–civil society triumverate into a network of stakeholders. In favouring weak connections over communities and institutions, public responsibility and accountability become more distributed (Bevir, 2010). Knowing who to blame and how to roll-back changes becomes increasingly difficult. Governance networks may end up exacerbating the complexity that they hope to salve.

5. ISO/TC 268 AND THE SETTING OF CITY STANDARDS

Introduction

There are several explanations as to why standards have begun to address cities and their governments. Standards and related documents often open with a description of the complex problems that cities must face in the twenty-first century (see for example ISO, 2013a; 2015b; BSI, 2014b). Given projections of rapid urbanisation in the Global South (driven by migration into cities) and an ageing population in the Global North, these documents anticipate that rising demand will place an overwhelming stress on urban services. Here, city standards offer tools to allow governments to future-proof liberal life against these threats (White, 2016a). Another explanation is that city inhabitants are often believed to be drivers of wealth creation (Florida, 2005; Glaeser, 2011b). The internet and other ICTs are changing work practices and the structure of national economies. Nevertheless, face-to-face contact remains crucial for exchanging ideas and building trust in business. Cities are thus held to be important both in their capacity to concentrate economic relations and as a site for the deployment of these technologies—both of which are expected to lead to innovation and productivity gains. A third explanation, seldom stated by city standards but raised by one of my interviewees (interview 46, Remco Perotti, Netherlands Standardization Institute, February 6, 2017), is that municipal governments are believed to have the capacity to act over and beyond regional and national governments. These are scales of government seen to lack political capital; they are drawn in too many directions, and have become overburdened by debt and partisan politics. When pushed too far, this argument slips into hagiographies of city mayors and an unreflective praise of pragmatism (Barber, 2013; Katz and Bradley, 2013; Goldsmith and Crawford, 2014).

This chapter explores the setting of city standards. 'Setting' is used in two interlocking senses. I am interested in exposing the process by which voluntary consensus standards are set. This includes formal deliberation and debate, but also takes in the setting in which this occurs. Thus, my focus in this chapter is on the organisations and institutions that bring people together to develop city standards. I attend to the ways in which these are established, managed and operate, as well as the high-level efforts to reduce the duplication of work between them.

It is not easy to measure the exact size of the city standards market. Many organisations are involved, and projects are continually being started, finished, amended

and abandoned. There are also variations in the definition of 'smartness' and 'sustainability', with the additional difficulty that their promoters perceive city systems and services holistically. Should city standards include only standards intended for city employees? What role do standards developed exclusively by and for the private sector play? Should city standards encompass relevant technologies, such as big and open data, autonomous vehicles, embedded sensors and microprocessors, and the internet of things? What about smart grids, smart health, smart mobility, smart money, smart phones, and so on? Smart, sustainable and resilient cities are composed of a variety of sectors, technologies, and governance practices. Where the borders of the market lie are open to debate. In mapping out the smart cities market, I have elected to stay close to the functional definitions adopted by national and international SDOs. As such, my focus is on standards attending to the co-ordination of a government's smart city efforts, rather than the technical standards that will be used to help execute this.

The chapter draws on primary data to offer an overview of the city standards market and a detailed examination of the role of ISO within that market. It is structured in three sections. I begin by using a directory developed by the American National Standards Institute (ANSI), to map the landscape of city standards. The purpose of this exercise is not to present a comprehensive list of relevant standards initiatives, but to give an indication of the market's tremendous size and scope. In the second section, I zoom in to focus on ISO, a large, complex organisation in its own right, which struggles to maintain cohesion, co-ordinate its areas of work and eliminate political bias. I begin by outlining its structure, key governance directives and method of standards development. Next, I introduce ISO/TC 268, the principle site of city standards development, paying particular attention to the diversity of ideas and opinions it contains. In the third section, I analyse efforts to co-ordinate ISO's overall smart city strategy and co-ordination with the International Electrotechnical Committee (IEC). While every effort is made to ensure that voluntary standards represent best technical solutions, my research reveals the difficulty of obtaining this ideal. City standards are being developed not through collaboration and consensus, but in a context of contingency, contestation and compromise. I conclude by reflecting on why it is politically important to disclose this.

Mapping standards for smart, sustainable and resilient cities

The ANSI Network on Smart and Sustainable Cities (ANSSC) was launched in 2014 as a hub for information on city standards. It had two main outputs. The first was a webinar series, during which representatives of standards organisations were given the opportunity to summarise and promote their work. Included amongst its topics were the ISO 37120

city indicators (McCarney and Ng, 2014), ANSI's engagement with ISO/TC 268 (Housewright, 2016), and the findings of the ISO/TMB S_Cities SAG (Welsh, 2015). The second was the collation of projects and organisations into a 'Directory of Smart and Sustainable Cities Standardization Initiatives and Related Activities' (ANSI, 2016). The final version of the directory splits activities into fourteen categories. These include standardisation initiatives, assessment and rating systems, and corporate-led initiatives, as well as more peripheral think tanks, non-governmental philanthropic initiatives, and news and information exchanges. In total, 169 initiatives are included (a reproduction of the list can be found in Appendix 2, Table A2.1). There is a small amount of redundancy between them (for example the 'Global Cities Indicator Facility', the 'Global Cities Institute', and the 'World Council on City Data' are essentially the same organisation), and many have only a tangential link to smart, sustainable or resilient cities, let alone city standards (the 'International Society of City and Regional Planners', the 'Local Government Commission', and the 'US Agency for International Development' being three obvious examples). There is, moreover, a strong North American flavour to the initiatives, with the directory being particularly weak on efforts in Asia and Oceania. Nevertheless, the document offers a comprehensive summary of the city standards market, and can be used as a launching point for a summary of its size and variety of activities.

Fifteen standardisation initiatives are described. These can be grouped into those overseen by international and regional-level SDOs, national-level SDOs, and other standards networks. Each of the three principle, consensus-based international standards organisations, ITU, IEC and ISO, established groups to help co-ordinate their city standards efforts. The 'ITU-T Focus Group on Smart Sustainable Cities' met between 2013 and 2015, before publishing 21 technical reports and specifications, with titles such as 'Master plan for smart sustainable cities' and 'Overview of key performance indicators in smart sustainable cities' (ITU-T, 2015). These continue to inform standards development within ITU-T Study Group 'SG20: Internet of things and smart cities and communities', particularly the 93 recommendations comprising the Y.4000-series (ITU-T, n.d.). Also between 2013 and 2015, the 'IEC Systems Evaluation Group on Smart Cities' put together their own city standards strategy. In its wake, the 'IEC Systems Committee on Smart Cities' was established to oversee the development of IEC standards, which include a vocabulary standard for the online terminology database Electropedia and a 'Smart Cities Reference Architecture' (IEC, 2018). IEC has also published two related white papers on the internet of things (IEC, 2014a; IEC, 2016a) and another explicitly addressing smart cities (IEC, 2014b). The role of co-ordinating and developing standards at the intersection of ISO and IEC, falls to ISO/IEC JTC 1. Strategic work carried out here (which I discuss in greater detail below), led to the

formation of a new Working Group, 'ISO/IEC JTC 1/WG 11 Smart Cities', which has since overseen the publication of 'ISO/IEC 30182:2017 Smart city concept model — Guidance for establishing a model for data interoperability'. Forthcoming standards include 'ISO/IEC 30145 Smart City ICT reference framework' and 'ISO/IEC 30146 Smart city ICT indicators'. ISO/IEC JTC 1 (2015a; 2015b; 2015d) has also published position papers on big data, the internet of things and smart cities. Within the main body of the ISO, 'TC 268 Sustainable development in communities' has become the *de facto* technical committee for international city standards, even though it was founded with an explicit focus on environmental management for sustainable communities. Higher level co-ordination has been undertaken by the 'ISO Technical Management Board Strategic Advisory Group on Smart Cities' (S_Cities SAG), which has since been replaced by a Standing Task Force.

At a regional level, the European standards bodies CEN (European Committee for Standardization), CENELEC (European Committee for Electrotechnical Standardization) and ETSI (European Telecommunications Standards Institute) ventured into city standards with the 'Smart and Sustainable Cities and Communities Coordination Group'. In 2017, this was replaced by a long-term 'Sector Forum on Smart and Sustainable Cities and Communities', whose role it has been to advise and co-ordinate relevant standards work between the three organisations (CEN-CENELEC and ETSI, 2018). The ANSSC directory identifies the national standardisation efforts of the two main German SDOs, *Deutsches Institut für Normung* (DIN) and *Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE* (DKE), who in 2015 published a roadmap of possible smart city standards work (DIN and DKE, 2015), as well as the British Standards Institute, who have put together a suite of eight city standards (BSI, n.d.-b). In addition to these countries, Anthopoulos (2017) draws attention to city standards developed by the Spanish national SDO *Asociación Española de Normalización* (UNE). UNE have a highly active smart cities technical committee, CTN 178, which is in turn composed of six subcommittees, addressing: infrastructure, indicators and semantics, mobility and transportation platforms, energy and environment, tourist destinations, and government and public services 4.0. As of mid-2018, they have published 24 documents and have a further 27 in development (based on data available at UNE, n.d.). Appendix 2, Table A2.2, presents a list of standards for smart, sustainable and resilient cities currently under the jurisdiction of BSI, IEC, ISO, ITU-T and UNE.

Four other standards networks are described by the ANSSC (2016) directory: 'Global City Indicators Facility', 'Global Infrastructure Basel Foundation', 'Global Protocol for Community-Scale Greenhouse Gas Emission Inventories' and 'Gold Standard Sustainable Cities Programme'. There are many more examples, such as 'City

Table 5.1. The principal city standards initiatives discussed in the thesis.

Standards initiative	Abbreviation	Role
ANSI Network on Smart and Sustainable Cities	ANSSC	city standards information hub
British Standards Institution	BSI	national standards body
City Protocol	CP	non-profit city standards network
ISO/IEC JTC 1 Study Group on Smart Cities	JTC 1/SG 1	smart city standards co-ordination group
ISO/TC 268 Sustainable Development in Communities	TC 268	city standards technical committee
ISO/TMB Strategic Advisory Group on Smart Cities	S_Cities SAG	smart city standards co-ordination group
World Council on City Data	WCCD	ISO 37120 certifier

Protocol' and the US Green Building Council project 'LEED for Cities'. In addition to the fifteen standardisation initiatives, the directory identifies twelve relevant assessment and rating systems, most of which are non-governmental organisations. Indeed, holistically defined, the smart city quickly spills over into other domains of standardisation. A mind map developed by CEN-CENELEC and ETSI (2018) includes standards activities that address a range of city services and infrastructures, such as the built environment, energy, mobility and safety. There is also considerable standards activity around smart-city-related technologies—for example, machine to machine communications and the internet of things (see Guillemin et al., 2014; Rhee, 2016; Roy, 2016). Table 5.1 lists the most important standardisation initiatives discussed in this thesis. All considered, the size of the city standards industry is surprising and suggests that, even if implementation has been circumspect, their material effects will likely continue to grow.

Origins of ISO/TC 268

In the final years of the Second World War, the anti-fascist alliance of the United Nations, created the UN Standards Coordinating Committee. There was at the time a recognition that a lack of technical standardisation had hampered wartime mobilisation, with *The Economist* (1945) reporting that incompatible screw threads alone had cost the Allies £25 million. In October 1945, almost directly after the war, talks began to replace this body with ISO. Murphy and Yates (2009) divide the history of ISO into three phases: gaining capacity, 1947–1964; building a world market, 1964–1986; and expanding scope, 1987–2008. Perhaps most important to its success was the period of rapid growth under the directorship of Swedish civil engineer Olle Sturén in the 1970s. Sturén was a staunch internationalist and believer in values-driven economics. Co-operation with UN agencies, the European Economic Community and the General Agreement on Tariffs and Trade

became a central responsibility during his tenure. Today, ISO is the foremost developer of international voluntary consensus standards.

Within ISO, responsibility for the development of standards falls to its Technical Committees (TCs). These act as forums for deliberation among specialists within a particular and well-defined domain. TC 1, for example, develops and maintains standards for screw threads. TC 10 deals with aircraft and space vehicles. The national standards bodies that make up ISO have the right to observe or participate in the activities of any of the technical committees (ISO, 2016a: section 10.3). Typically, a participating country will establish a national-level mirror committee made up of experts from a variety of stakeholder groups. For example, 'SDS/2 Smart and sustainable cities and communities' is the BSI mirror committee tasked with supporting UK delegates to regional and international city standards initiatives (BSI, n.d.-a). They manage a portfolio of almost 40 standards, including the three under investigation in this thesis. Within a mirror committee, draft standards are read and discussed, and a national position is consolidated. A delegate then represents this position at a higher-level technical committee. These individuals are expected to suspend their personal and professional opinion in the interest of the national perspective. At the time of writing, TC 268 was made up of 37 participating members and 21 observing members (ISO, 2018a). The ISO Technical Management Board (TMB) is responsible for overseeing the technical committees and co-ordinating their standards-making efforts (ISO, 2016a: section 9.3). Proposals to introduce a new technical committee or change the activities of an existing technical committee, must meet the approval of the TMB. Figure 5.1 shows a simplified representation of the ISO governance structure.

In October 2011, TMB Secretary Sophie Clivio circulated amongst the group's members a New Work Item Proposal (NWIP) submitted to it by the Japanese Industrial Standards Committee (JISC). The NWIP, titled 'Smart urban infrastructure metrics', identified a need to harmonise metrics for the evaluation of smart urban infrastructure projects. Appended to the proposal was an extract from a letter addressed to TMB from the authors of the JISC NWIP and two other recent proposals: a Technical Subject Proposal, 'TS/P 224 Sustainable development in communities', submitted by the *Association Française de Normalisation* (AFNOR); and a fast-track proposal for an international standard on global city indicators, submitted by the Global City Indicators Facility (GCIF) (with the support of the World Bank and the United Nations Environment Programme). The letter identified differences between the efforts of the three groups but argued that they were complimentary, covering "different aspects of city and community indicators, infrastructures, and utilities" (ISO, 2011: n.p.). In February the following year, at its 53rd

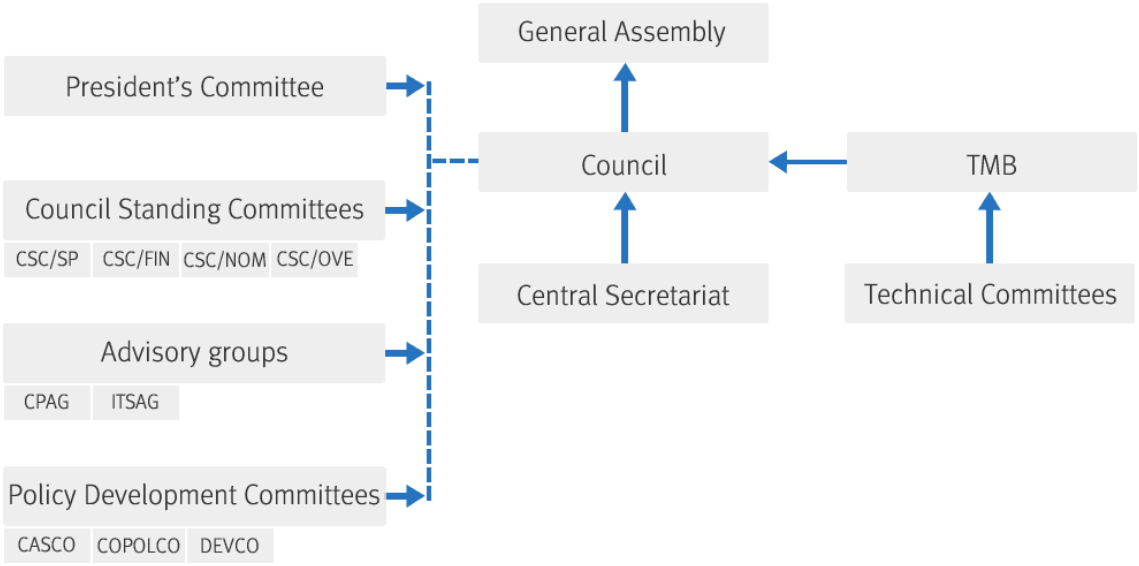

Figure 5.1. Governance structure of ISO. Reproduced from the website of ISO (2018e). CSC: Council Standing Committee; SP: strategy and policy; FIN: finance; NOM: nominations for governance positions; OVE: oversight of the Organization's governance practices; CPAG: Commercial Policy Advisory Group; ITSAG: Information Technology Strategic Advisory Group; CASCO: Committee on Conformity Assessment; COPOLCO: Committee on Consumer Policy; DEVCO: Committee to support Developing Countries.

meeting, TMB established 'ISO/TC 268 Sustainable development in communities' and allocated the secretariat to AFNOR. The JISC and GCIF proposals were incorporated into the remit of this new technical committee, the first as a relatively independent Subcommittee, later titled 'SC 1 Smart community infrastructures', and the second under a Working Group, later 'WG 2 City indicators'. The structure of ISO/TC 268 at the time of its first meeting in July 2012 has been represented in Figure 5.2.

From its beginning, TC 268 was an amalgamation of interests. Representatives from AFNOR were interested in gathering together best practices on management systems for sustainability and resilience. TS/P 224 describes the three types of standards which would constitute the proposed technical committee's programme of work: requirement standards, to be used by a community to demonstrate progress towards sustainability; guidance standards, to aid communities in the achievement of sustainability; and other tools and techniques to support the sustainability management systems (including standards for vocabulary, performance indicators and life cycle costing) (AFNOR, 2011: 2). The requirement standard is described as the cornerstone of the work (AFNOR, 2011: annex 1, p. 2). As a whole, it was intended that the suite of standards be translatable into the "systems, guidelines, supporting techniques and tools" (AFNOR, 2011: 1) specific to local community needs. The approach envisaged by AFNOR is in keeping with ISO Guide 72:2001 'Guidelines for the justification and development of management systems standards', and with other management system standards, such as

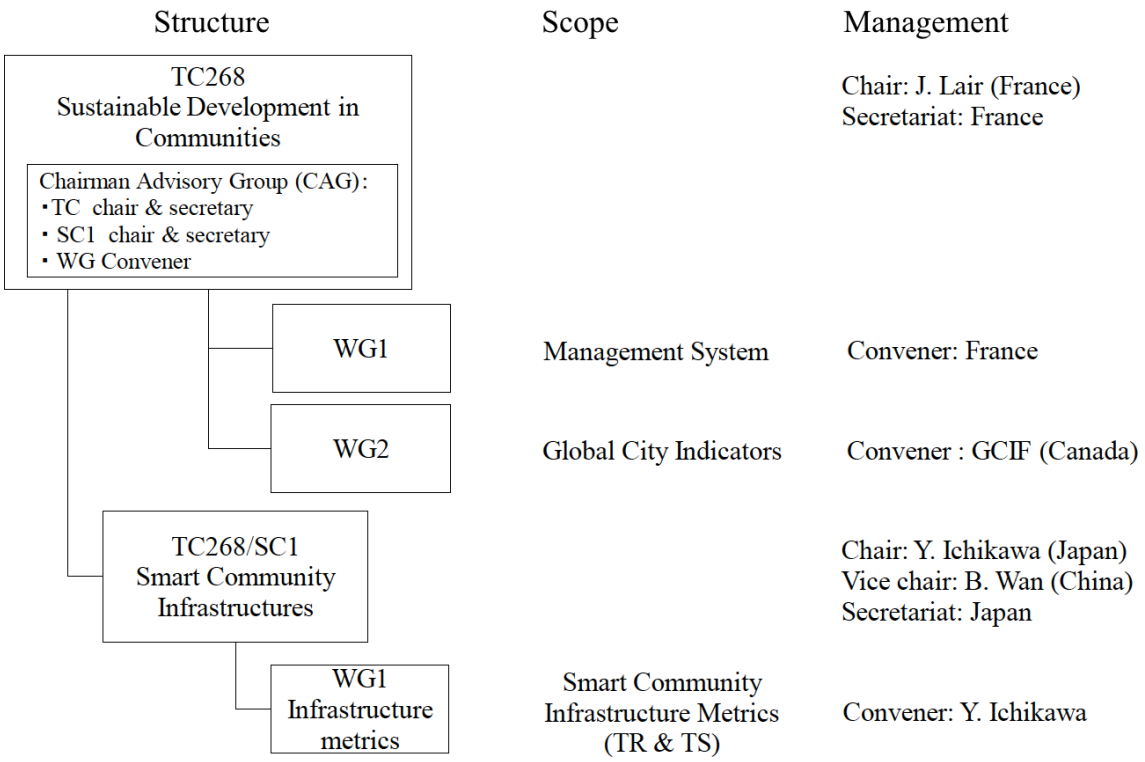

Figure 5.2. Initial structure, scope and management of ISO/TC 268. Adapted from Ichikawa (2011). TC: Technical Committee; SC: Subcommittee; WG: Working Group; TR: Technical Report; TS: Technical Specification.

for quality (the ISO 9000s under TC 176) and the environment (the ISO 14000s under TC 207).

The Japanese standards body were explicitly targeting the evaluation of smart city infrastructure projects. In an annex to its NWIP, titled 'Detailed Justification and additional information', JISC (ISO, 2011: annex 3, p. 1) recognise a range of social and political aspects of the smart city, but suggest that, given their concern with fundamental utilities, it is possible to set these aside and focus on technology. 'Smart' is used narrowly to mean technological "efficiency and environmental performance" (ISO, 2011: n.p.). JISC argue that there is a dearth of systematic indicators for comparing smart city plans and proposals, and that this creates an administrative burden for city governments and companies (ISO, 2011: 2). By standardising assessment tools, some of the barriers to procurement will fall, allowing cities to more easily adopt smart city solutions and stimulating the overall market. They set limits to their proposed scope along a handful of lines (ISO, 2011: annex 3, p. 3): the metrics will be aimed at infrastructure within cities and not at the cities themselves; the metrics will use quantitative and not qualitative data; and the utilities targeted will include energy, water, transportation, waste management, and information and communications technology.

Unlike AFNOR and JISC, GCIF approached ISO with a large amount of prepared material. As part of a World Bank funded project that drew on the experience and expertise of nine North and South American cities, members of GCIF identified a high

variability in urban indicator data. In an effort to correct this, they had helped facilitate the development of 200 urban indicator definitions, with the ultimate goal of them being applied to any city. These were refined and paired down through an iterative feedback process, first to around 125 and then to 75, before being submitted to ISO as a potential international standard. As Patricia McCarney of the World Council on City Data (WCCD), a non-profit spin-off from GCIF, described it to me:

> And we got to 75 that everyone was happy with. We went to ISO […] and said "We have an ISO potential standard here". And ISO wasn't really in the business of cities at that time. They hadn't thought about cities. They were still in the [business of] light bulbs and cell phone parts. So we made a pitch that you need standardised indicators for cities. Cities are it. We made all the demographic arguments and they just didn't really take us too seriously the first round. We came back to Canada. Six months later they phoned and said, "You know that city indicators thing?", the Japanese had come at the same time. (Interview 19, Patricia McCarney, World Council on City Data, February 4, 2016)

While both JISC and GCIF set out to standardise urban metrics, their approaches were quite different. JISC were not interested in the social and political aspects of the city. Their focus was on harmonising the assessment of utility performance in order to reduce procurement overheads. GCIF wanted to measure cities across a number of social, economic and political domains in the hope of building a system for global benchmarking (ISO, 2011). As Ilja Green (interview 13, January 29, 2016) of the City of Toronto insisted (in relation to the final ISO 37120 indicators), the emphasis was on services and quality of life not performance measurement. Had the two groups been deemed too similar, TMB would have taken measures to merge them into a single initiative.

In November 2013, TC 268 published their business plan. It does not attempt to consolidate the three interests. Rather, it sets forth a strategy in keeping with AFNOR's initial technical subject proposal. It describes the purpose of the technical committee as being to develop management systems, and related tools and techniques to support the sustainable development and resiliency of communities (ISO, 2013a: 1). Requirement and guidance standards remain much the same as in the earlier document. The third type of standards (tools and techniques to assist the management systems), is expanded to cover "guidance on related topics" (ISO, 2013a: 16). In this cursory way, AFNOR folded the efforts of JISC and GCIF into the technical committee without compromising the continuity of their vision. Interestingly, smart cities are mentioned only at the end of a list of city movements, "sustainable, green, resilient or smart cities" (ISO, 2013a: 4), all of which are said to be struggling with a lack of harmonised guidance documents.

While the business plan presents a relatively coherent strategy, the heterogeneity of positions within the technical committee re-emerge on certain issues. The case in point is

smart cities. The initial scope of TC 268[6] did not include the word 'smart' and the business plan only mentions it as an aside. In the six years since its establishment, ICT remains largely absent from its standardisation efforts. In part, this is because, of the three original parties, only JISC wished to engage with the smart cities phenomenon, and only then in a limited sense. But it also has to do with the way that ISO, IEC and ITU-T divvy up international standards-making. Historically, IEC has been responsible for electrotechnical standards; ITU-T, standards for telecommunications technologies; and ISO, everything else (ISO, 2013a: 1). These divisions are of course pragmatic rather than absolute. In 1987, ISO and IEC established a joint technical committee, ISO/IEC JTC 1, as a forum for standards at the intersection of information technology, consumer electronics and telecommunications (ISO/IEC JTC 1, 2014). Given these higher structures, it is understandable why ICT was excluded from the remit of TC 268. Smart cities challenge this neat division of labour, however. By promoting holistic and integrated solutions, the smart city transgresses the international SDOs and their domains of specialisation. When TC 268 was established in 2012, it was unclear what role standardisation would play in the development of the smart city and how that work would be co-ordinated and portioned out.

As the smart city grew in popularity between 2012 and 2014, it increasingly came to be associated with the standards-making efforts of TC 268. This was especially due to the publication of ISO 37120 in May 2014 and the associated promotional efforts of WCCD. When I asked Helen Ng (interview 18, World Council on City Data, Febuary 4, 2016) about this, she described two explicit connections between ISO 37120 and the smart city. The first connection is the between smart cities and urban data. The smart city is often taken to involve improvements in the quality, quantity and availability of data. As a result of its efforts to produce comparable urban data, WCCD can be understood as an enabler of the smart city more generally. The second connection has less to do with ICT and more to do with governance. In making cities commensurate, WCCD hopes to facilitate the exchange of best practices. By learning from one another, cities become smarter. This is in keeping with arguments made by advocates of smart growth (Coe et al., 2001) and intelligent cities (Komninos, 2002), important precursors to the more technologically inflected smart city (Hollands, 2008). It is possible to be sceptical of the

[6] ISO/TC 268's initial scope read: "Standardization in the field of Sustainable Development in Communities will include requirements, guidance and supporting techniques and tools to help all kind of communities, their related subdivisions and interested and concerned parties become more resilient and sustainable and demonstrate achievements in that regard. The proposed series of International Standards will thus encourage the development and implementation of holistic, cross-sector and area-based approaches to sustainable development in communities. As appears in the program of work, it will include Management System Requirement, Guidance and Related standards" (AFNOR, 2011).

WCCD approach to smart cities. The head of the US delegation to TC 268, Meghan Housewright (2016), has placed these two visions of the smart city in opposition. On the one hand, a vision of sensors and data analytics, and on the other, an emphasis on smart planning and growth. It is difficult to gauge whether WCCD deny the existence of a debate, or are pragmatically addressing both sides. Either way, their work in the area is ongoing. TC 268/WG 2 is currently developing two standards that extend ISO 37120 indicators to encompass smart and resilient cities, respectively ISO 37122 and ISO 37123. These may include entirely new metrics, or they may act as a home for metrics which migrate out of ISO 37120 during its current review period (interview 18, Helen Ng).

While I have pointed to the early ambivalence of AFNOR with respect to the smart city, Michael Mulquin (interview 8, November 13, 2015), a member of TC 268/WG 3[7], described them as being pushed into the field. On the one hand, he said, AFNOR would love the technical committee to become the recognised international forum for smart city standards. On the other, many of those who joined the committee did so to further sustainable communities, not smart cities. Put differently, there is a tension between the terms 'smart' and 'sustainable'. A compromise appears to have been reached since my interview with Mulquin. In July 2016, TMB approved a change in the title and scope of the technical committee. 'TC 268 Sustainable development in communities' became 'TC 268 Sustainable cities and communities'. The new scope reads:

> Standardization in the field of Sustainable Cities and Communities will include the development of requirements, frameworks, guidance and supporting techniques and tools related to the achievement of sustainable development considering smartness and resilience, to help all Cities and Communities and their interested parties in both rural and urban areas become more sustainable.
>
> Note: TC 268 will contribute to the UN Sustainable Development Goals through its standardization work.
>
> The proposed series of International Standards will encourage the development and implementation of holistic and integrated approaches to sustainable development and sustainability. (ISO, 2016b: resolution 65)

More than the business plan, this statement brings the public face of TC 268 into alignment with the diversity of its internal opinions. It recognises the city as an important site of implementation, rendering it equivalent to communities. But reservations remain.

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[7] Mulquin has been involved with most of the high-level smart city standards co-ordination efforts including: the 'IEC Systems Evaluation Group on Smart Cities', the 'ISO/TMB Strategic Advisory Group on Smart Cities', and the 'ITU-T Focus Group on Smart Sustainable Cities'. He was a technical author for BSI standards PD8100 and PD8101, and TM Forum's Smart City Maturity and Benchmark Model, and an editor for City Protocol and 'ISO/IEC JTC 1 Study Group on Smart Cities'.

Rural as well as urban areas are described as targets of the standards. Furthermore, 'smartness' is itself disentangled from 'the city' and alongside resilience, made ancillary to the achievement of sustainability—the goal is "sustainable development *considering* smartness and resilience" (ISO, 2016b: resolution 65, italics added). TC 268 standards are intended for cities and the countryside, perhaps even for smartness in cities and the countryside, but the technical committee remains a little hesitant when it comes to smart cities.

Beyond the issue of smart cities, there are signs that representatives from AFNOR, JISC and GCIF have recognised their differences and are attempting to co-ordinate their activities. Ng has discussed efforts to integrate and align the committee's standards so as to minimise overlap (Housewright, 2016). This is occurring through joint working group meetings (between TC 268/WG 1 and TC 268/WG 2, and TC 268/SC 1/WG 1 and TC 268/WG 2). Whether these are sufficient to unify the range of positions and agendas within the committee remains to be seen. As Housewright put it: "The devil is in the details of how you actually create a framework for what each group really wants to do and wants to get out of the process. And so I think that that's where we're really having a sticking point now" (Housewright, 2016).

The mix of agendas at TC 268 has been further complicated by the inclusion of several new initiatives. Foremost among these are CPA-I_001 and BSI PAS 181. While these will be the focus of Chapters 6 and 8, I will remark here upon how they were brought into TC 268 as ISO 37105 and ISO 37106 respectively.

The US member body ANSI, while an early observer of TC 268, did not begin participating in its proceedings until early 2015. Since then, they have expressed a vision that is at odds with the technical committee's' official documentation. In a webinar delivered to ANSSC in April 2016, Housewright (2016) described TC 268 as "a lot of different ornaments on a Christmas tree". She argued that while it encompasses many important initiatives, there remains a lack of agreement on what holds everything together—the Christmas tree itself has yet to be defined. It was originally intended that the management system requirement standard would play this role. And arguably AFNOR have fulfilled this intention, with TC 268/WG 1 publishing 'ISO 37101 Management system for sustainable development — Requirements with guidance for use' in July 2016. For the US mirror committee, however, this standard is too abstract to be of practical use and Housewright voted against its publication. In its place, ANSI have promoted 'CPA-I_001 City Anatomy', submitting the NWIP which lead to its adoption as a prospective international standard. ANSI hope that this will be able to unify work within TC 268 by encouraging a systems approach to the city and its infrastructure.

During my interview with Robert Rallo (interview 31, August 26, 2016), a core contributor to CPA-I_001 and its associated standards, he described the route taken by

the standard into ISO. He said that City Protocol have little direct influence on TC 268, but that one of their members, the smart city standards lead at Microsoft, Dave Welsh, was invited to join ANSI's TC 268 mirror committee. It was through this channel that Welsh was able to champion the City Anatomy and campaign for its adoption within TC 268. In 2017, TC 268/WG 3 was renamed 'City anatomy and sustainability terms' and in May 2018 the standard was published as a Draft International Standard, 'ISO/DIS 37105 Descriptive framework for cities and communities'. Voting on the document will terminate in early October.

Like CPA-I_001 and the GCIF indicators, BSI PAS 181 was developed in consultation with cities. Following its publication in 2014, BSI approached ISO about internationalising the standard. According to Michael Mulquin (interview 8), the PAS was initially placed into TC 268/SC 1, where JISC were already overseeing the development of standards for smart infrastructure. The placement did not last. By early 2015, the standard had its own working group, 'WG 4 Strategies for smart cities and communities'. The standard was fast-tracked and published as 'ISO 37106:2018 Guidance on establishing smart city operating models for sustainable communities' in July 2018.

ISO/TC 268 is home for many of the international standards addressed to cities. While highly active, it is anything but coherent. Its originating documents refer to cities and communities; to sustainability, resiliency and smartness; and to management systems, smart infrastructure, performance metrics, global city benchmarking and quality of life. It is best thought of as a composite of initiatives, with differing and at times conflicting agendas. It includes representatives from AFNOR, JISC and GCIF, but also the loose coalitions of interests around CPA-I_001 and PAS 181. As TC 268 has come to be associated with the smart city, it has increasingly become an arena in which these interests jostle for a position on the international stage. Work proceeds under different understandings of what the smart city is and how it will be brought about. For some, this lack of coherence undermines the potential for city standards and can be a source of real frustration. As Michael Mulquin (interview 8) put it: "this is fudges you see, fudge upon fudge". In the next section, I turn to strategic-level efforts to address this by co-ordinating and harmonising smart city standards.

Co-ordinating smart city standards at ISO

Towards the end of 2013, before the publication of the ISO/TC 268 business plan, two ISO affiliated smart city co-ordination groups were established. Both were tasked with investigating the smart cities market and reporting back on potential opportunities for standards work.

In May 2013, the Standardization Administration of China (SAC) submitted a proposal to ISO/IEC Joint Technical Committee (JTC) 1, titled 'China Contribution on possible future work on Smart Cities in JTC 1' (Anon., 2016). In early November, JTC 1 established a 'Study Group on Smart Cities' (JTC 1/SG 1), under the secretariat of SAC. Their terms of reference were to: define the term 'smart cities' and describe its key concepts; document smart city technologies; document and assess the requirements for ICT standards in smart cities; and propose how JTC 1 should respond accordingly (ISO/IEC JTC 1, 2013: resolution 3). These were met in a preliminary report presented to JTC 1 in September 2014.

Meanwhile, the ISO TMB were initiating their own scoping exercises. In September 2013, they established a task force to investigate the co-ordination needs for standards in smart cities, explicitly citing the need to align their strategy with IEC (ISO, 2013b: resolution 112). Following the acceptance of their final report in February the following year, TMB established the S_Cities SAG. They were tasked to: define 'smart cities'; describe the smart cities landscape; review the relevance of existing standards work within ISO; and analyse the opportunities for standards development both within ISO and in collaboration with other SDOs (ISO, 2014c: resolution 36). Again, TMB recommended that S_Cities SAG engage with equivalent smart city co-ordination groups from other SDOs in order to avoid duplication and move towards joint strategic mapping. Leadership of the group was awarded to BSI, whose recommendation of Graham Colclough to the Chair was subsequently approved. In September 2015, ISO/TMB S_Cities SAG submitted their final report.

The overlapping mandates of these two groups are a result of the autonomy that JTC 1 has from TMB and its equivalent body within IEC, the Standardization Management Board (ISO/IEC JTC 1, 2017). This is a reflection of its relative size and importance. At the time of writing, JTC 1 was one of a total of 246 technical committees within the ISO. It included 22 subcommittees and had jurisdiction over more than 14% of the total number of published standards (data from ISO, 2018f; 2018b).

The preliminary report of ISO/IEC JTC 1/SG 1 defines the city as a system of systems (ISO/IEC JTC 1, 2015d). This is understood to entail a process-based approach to society and public infrastructure (including critical utilities and digital services). A city's 'smartness' is defined as its capacity to act in an integrated and coherent way to meet the goals and purposes it has set itself. To enable this, the city will first need to be instrumented. Data from a range of sources and systems will need to be collected, aggregated, visualised and made more easily accessible. This will then be analysed by city managers, planners and citizens to support decision-making, and improve the city's openness and inclusiveness. The report recommends the adoption of a formal concept model to enable a common understanding of the city. This is discussed in terms of systems

engineering: "models facilitate aggregation and heterogeneous system interoperability; as well as fluid, safe, and secure data exchanges, particularly across different system topographies" (ISO/IEC JTC 1, 2015d: 12). Standards will be of further use in facilitating the instrumentation of the city and the integration of city services. Overall, the report adopts an inclusive approach to the ways in which standards can help to improve the smartness of cities, but perceives ICT as a central, enabling component.

Reproduced from the report, Figure 5.3 show the separation of responsibilities between the international SDOs. At one level, it presents a high-level overview of the areas of standards work that pertain to the smart city. At another, red, green, purple and blue circles have been used to mark areas of responsibility for ISO, IEC, ITU-T and ISO/IEC JTC 1 respectively. ISO is allocated: smart cities framework, terms and definitions; management and assessment standards; service standards; and building and physical infrastructure standards. The ICT standards are divvied up among the remaining three groups, with JTC 1 attending to: overarching ICT framework, architecture and information models; network and information security standards; application and support layer standards; data layer standards; and sensing layer standards.

The final report of ISO/TMB S_Cities SAG situates smart cities at a nexus of existential threats to liberal life (ISO, 2015b). Mass urbanisation and climate change are framed as inevitable mega-trends that will manifest in challenges to all cities. The smart city promises to help governments anticipate these threats by preparing for them in the here-and-now. Citing ISO 37101, the report defines 'smartness' as a catalyst for sustainability and resilience (ISO, 2015a: annex 2).

> A Smart City should be described as one that [1] dramatically increases the pace at which it improves its sustainability and resilience, [2] by fundamentally improving how it engages society, how it applies collaborative leadership methods, how it works across disciplines and city systems, and how it uses data and integrated technologies, [3] in order to transform services and quality of life to those in and involved with the city (residents, businesses, visitors). (ISO, 2015b: 6)

A note in the report remarks on the possible addition of 'governments' within the final parentheses. According to Welsh (2015), this was included after a comment from a SAC representative—the state presumably playing a more significant role in the Chinese vision of the smart city. Either way, the emphasis on systems here is not as heavy as it was in the JTC 1/SG 1 definition. Instead of integration, the important thing is the *speed* at which change occurs. Social engagement, collaborative leadership methods, cross-system work practices and improved data technologies are all conceived as ways to contribute to the pace of improvement.

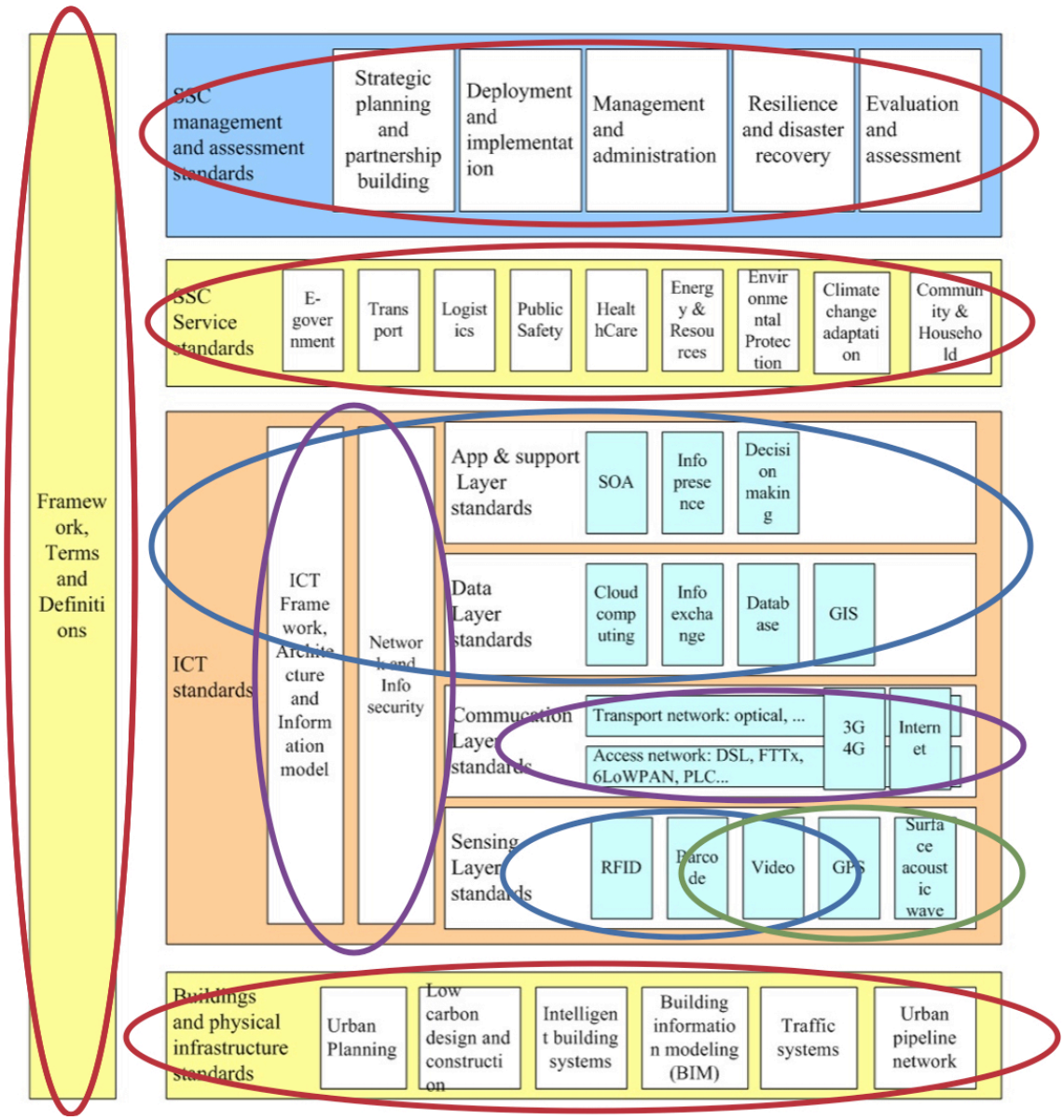

Figure 5.3. Areas of responsibility for smart city standards for ISO (red), IEC (green), ITU-T (purple) and ISO/IEC JTC 1 (blue). Reproduced from ISO/IEC JTC 1 (2015d).

As research for the S_Cities SAG report, a survey was sent out to cities (via 27 national standards bodies) and city networks. Its purpose was to test four hypotheses about the demand for smart city technologies (ISO, 2015b: 12): that a city-needs-led approach is required to develop a functioning smart cities market; that SDOs are not at the forefront of cities' minds; that the pace of technological change is putting pressure on cities and SDOs; and that general society is not sufficiently engaged in city operations. Responses were received from 39 cities (from 15 countries) and 5 city networks (ISO, 2015a: annex 3). Drawing on these data, the report identifies a fundamental disconnect between the management of cities and the content of standards (ISO, 2015b: 15). It reports a desire for city management and indicator systems, but recognises that these would be strongly resisted.

During my interview with the S_Cities SAG Chair, Graham Colclough (interview 5, November 11, 2015), he stressed the importance of high-level standards in encouraging and facilitating the demand for smart city technologies. In the past, standards have operated principally at a technical level, prescribing appropriate design specifications and limits. Increasingly, he asserts, there is a need for standards to function as leadership guides and management frameworks. Concise, well-written summaries are needed to highlight the benefits of smart cities and promote best practices in their implementation. Standard guidelines can help secure the support of city leaders to drive institutional change. Management frameworks are necessary for co-ordinating such change by facilitating communication and integration between specialised bureaucratic departments.

> So if you like we've managed the domains, the verticals of cities through cutting budgets over the last decade or more (and so they are reasonably efficient, there is … a lot to go still), but what we haven't done is actually deal with what is going across the city. So, therefore, the management framework layer provides an organising framework, a means by which the manager of the social services and the manager of place and parking and roads can have a structured dialogue whereby they actually look at the same picture and recognise the interdependencies. (Interview 5, Graham Colclough, ISO/TMB Strategic Advisory Group on Smart Cities, November 11, 2015)

Put differently, technical standards function within the verticals, management frameworks operate horizontally across the city as a whole and leadership guides address those at the top. By urging ISO to develop standards that justify and operationalise the smart city, Colclough hopes to lower the barrier of entry to the smart cities market. Rather than rely upon the services of market research and assurance firms, small and medium-sized cities will be able to access cheap, reliable and flexible documents developed by leading global experts. The demand for smart cities will thus be brought into better alignment with what industry is able and willing to supply. Figure 5.4, reproduced from the report of the S_Cities SAG, visualises Colclough's typology of standards.

The S_Cities SAG report concludes with a series of recommendations to the TMB about the potential for ISO to support the market for city services and technologies. Intriguingly, the word 'smart' is almost entirely absent from this discussion. Instead, cities in general are framed as customers and as a 'unit of change'. The cities market is diagnosed as fragmented as a result of the large number, modest size and individualism of cities. The relationship between cities and corporations is described as symbiotic yet tense. As a third party, the ISO thus has an opportunity to act as a trusted mediator, supporting "open choice for city buyers and an attractive market for suppliers" (ISO, 2015b: 38). To this end, the document recommends that the ISO expand into new areas

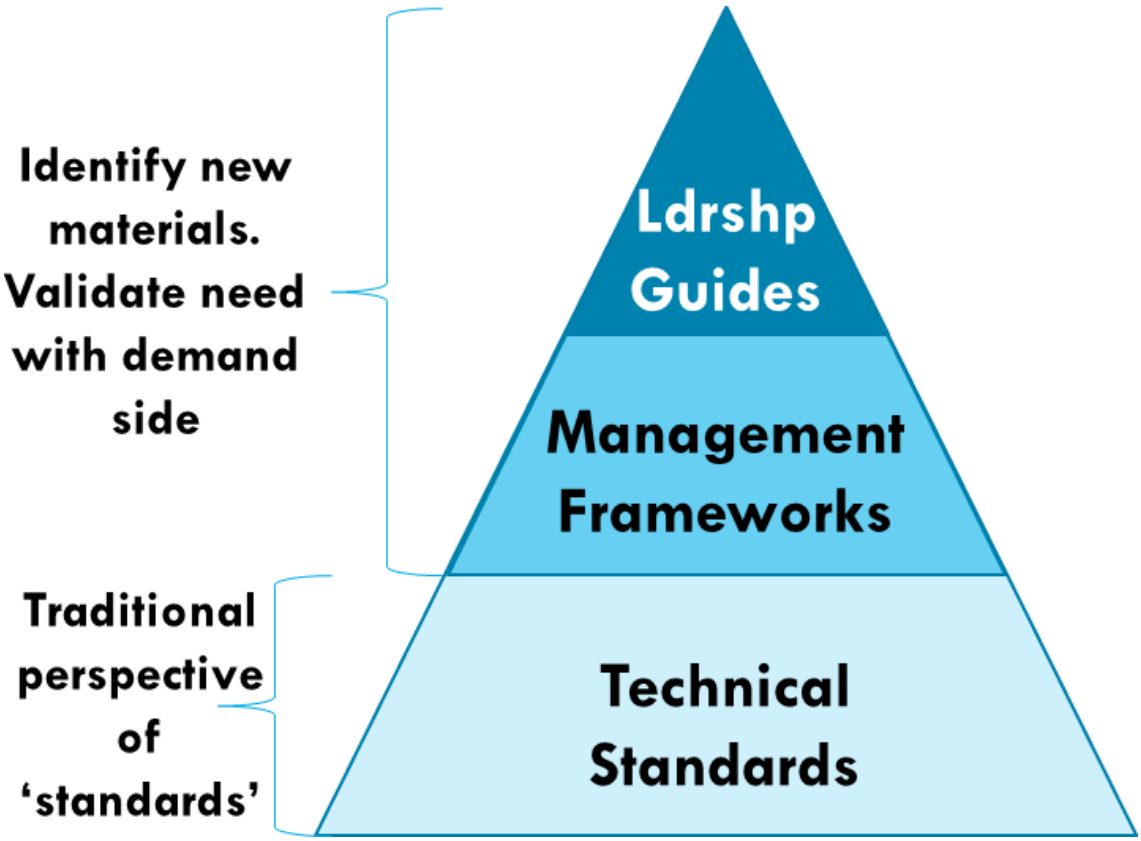

Figure 5.4. Types of standards needed by cities. Reproduced from ISO (2015b).

deemed attractive to cities (such as financing, business models, performance assessment, strategic roadmaps, management frameworks and leadership guides) and that it actively engage in global smart city events.

The JTC 1/SG 1 report specifies areas where JTC 1 should focus its technical expertise, while the S_Cities SAG report emphasises the need for high-level management standards. These recommendations are not incompatible. As a technical committee, JTC 1 should have a relatively well-defined focus. By contrast, the TMB is involved in decision-making for the whole of ISO, determining its new topic areas and minimising the overlap between its technical committees. Even if the smart city exceeds the limits of individual technical committees (such as TC 268 and JTC 1), TMB has the power to contain and co-ordinate a strategy that moves across them. Despite pointing to the need for such action, S_Cities SAG was unable to come to a consensus about how best to achieve this, and so presented three potential models. Indeed, there is some indication that this group was a site of lively debate. One participant, Microsoft's Dave Welsh (2015), remarked in an ANSSC webinar that Graham Colclough was given a "really, really hard time". Another, Michael Mulquin (interview 8, November 13, 2015), said that "it met a lot of resistance". Colclough (interview 5, November 11, 2015) was more sanguine, remarking that it was "a fun puzzle to actually try and manage that process". In this respect too, S_Cities SAG appears to have been different from JTC 1/SG 1.

All told, the overlap between ISO's two smart city co-ordination groups, ISO/IEC JTC 1/SG 1 and ISO/TMB S_Cities SAG, produced disagreement over the definition of smart cities and the framework for co-ordinating future standards development. In the JTC 1/SG 1 report, smart cities are considered in terms of the integration of systems and the standards framework is liberal in what it includes. In the S_Cities SAG report, smart cities are framed in terms of the speed of change and the co-ordinating typology is deliberately simplified in order to impress a point. Whether this difference will undermine the cohesion of ISO city standards, only time will tell.

Conclusion

ISO is composed of a range of interests, opinions and motives. This is a necessary feature of any large and disparate organisation, especially one dealing with expert knowledge. But this also has important ramifications for how the setting of standards is conceptualised. Standards-making should be apprehended as a contested and political practice in which opposing ideas struggle against one another to become the norm. International standards might appear to be robust, consistent and coherent documents—and to be effective they must be—but in the processes of deliberative consensus and co-ordination, some ideas and interests invariably win out over others. And there is a lot to be gained by being successful. The great attraction of international standards is their ability to act as a political technology for propagating ideas, materials and techniques.

With this chapter, I have begun to map out the city standards market. This shows the great breadth and variety of standards initiatives, and the importance of high-level harmonisation between the SDOs. I focused on the principal site of international city standards development, TC 268, teasing out its contingent and contested origins, before applying a similar treatment to ISO's two smart city strategy groups. Despite ongoing debates about the proper direction for ISO with regard to smart cities, its standards development, internal co-ordination and external collaboration continue to evolve. At the time of writing, ISO/TC 268 and its subcommittee have a portfolio of eleven published standards and another twelve on the way (ISO, 2018d; 2018c). In October 2015, JTC 1 established a smart cities Working Group (WG 11) to develop international standards for smart cities (ISO/IEC JTC 1, 2015c: resolution 15). Following a formal review process in February 2016, TMB initiated the 'Standing Smart Cities Task Force' to operationalise the ISO strategy on smart cities (ISO, 2016b: resolution 18). Finally, in July 2016, following the World Smart City Forum in Singapore, the major SDOs (including ISO, IEC, ITU-T, the Institute of Electrical and Electronics Engineers, and the regional-level European standards bodies) formally agreed to co-ordinate their activities in order to avoid duplication (IEC, 2016b). ISO, IEC and ITU-T representatives met in mid-

November 2017 to further discuss their collaboration. In exploring the institutions and organisations that participate in international standards development, I have advanced a broader conception of what their setting involves.

City standards have the potential to affect an infrastructure for smart, sustainable and resilient cities that will shape and constrain future urban life. As they continue to mature, the points of disjunction and disagreement outlined in this chapter will fade from view. The values, assumptions and logics they express will come to be accepted as received wisdom. Their history will be forgotten. There is a tremendous risk that without awareness of the ideas and arguments inherent to these standards, elected officials and civil servants will take them at face value as politically neutral prescriptions. Over the next three chapters, I trace and reveal the fractious origins of CPA-I_001, ISO 37120 and BSI PAS 181. This is not an act of naïve description, but a way of opening up a situated political engagement with city standards and their field of possibilities, which will help provide politicians and policy makers with the tools that they need to make more informed decisions.

6. CPA-I_001: SEEING THE CITY AS A DYNAMICAL SYSTEM

Introduction

In May 2015, residents of Barcelona elected Ada Colau, co-founder of the housing rights organisation *Plataforma de Afectados por la Hipoteca*, as their new mayor. Her rise to power marked a radical shift in the city's politics. Then incumbent Xavier Trias, representing a centre-right coalition of Catalan nationalist parties, *Convergència i Unió* (CiU), had gone to great efforts to position Barcelona as a smart city internationally. Among his initiatives were the Smart City Expo World Conference, a cross-organisational Smart City Commission, a consolidated department for Urban Habitat and the standards network City Protocol (CP) (Olivella, 2012). Through these projects, Barcelona had deepened its relationships with corporations such as Cisco, GDF Suez and Microsoft (see for instance Cisco, 2011; 2012). Colau ran on a platform that was largely in opposition to close industry ties. As one English-language website put it at the time: "Two, very different urban visions went head-to-head in the elections: the professionalized, Smart City of incumbent mayor Xavier Trias, and the city governed by the 'collective intelligence' of its citizens, advocated by Ada Colau" (Baird, 2015). Where the smart city had been grounded in public-private partnerships, it now promised to be more democratic and grassroots-driven (see also Colau, 2017). Colau was quite direct about this difference, stating prior to the election, "we do not see ourselves governing with Trias because we are politically incompatible" (quoted in La Xarxa, 2015). She continued, blaming CiU for the City's recent turn towards privitisation and neoliberalism.

With the commencement of Colau's mayorship in June, Barcelona's smart city initiatives were frozen. A Chief Technology Officer and Digital Commissioner was appointed, whose responsibilities included an assessment of the social impact of the City's smart city projects (Tieman, 2017). By the time of my field trip to Barcelona in late August 2016, some of Trias' initiatives were recommencing, albeit under a more socially-progressive mandate. But CP was not one of these. Already it had aligned itself with regional-level funders. Its prime supporter was no longer the city hall, *Ajuntament de Barcelona*, but the provincial council, *Diputació de Barcelona*, and the government of the autonomous community of Catalonia, *Generalitat de Catalunya*. At the Smart City Event in Amsterdam in June 2016, members considered the possibility of smart regions rather than simply smart cities.

As a standards body, CP makes assertions as to the general applicability of its work. The City Anatomy (CA) presented in the Informational City Protocol Agreement, CPA-I_001, is intended to be timeless, acultural, scalable and generic (CPS, 2015a: 1). It is supposed to be valid for any urban form, regardless of its size, geographical location or historical moment. As such, CP standards should transcend local politics; it should not matter that Colau is of the left while Trias of the centre-right. And yet this organisation was deemed to be too near to Trias to be compatible with the politics of the Colau administration. So what was it about it about the organisation and its standards that marked them as unsuitable? From where did this incompatibility emerge and might it possibly be overcome?

In this chapter, CPA-I_001 is explored as a diagram that is at once too abstract to be of practical use to city governments, and too strict to account for the messy irregularities and dysfunctions of actually existing cities. Three sections and a conclusion follow. I begin by looking at the ideas behind CA and the institutional history of CP. This involves a brief examination of: *The Self-Sufficient City*, a book written by Trias' Chief Architect Vicente Guallart (2014); the connection between CA and the department for Urban Habitat; and the structuring of CP after the Internet Society (ISOC) and Internet Engineering Taskforce (IETF). Having discussed the standard's origins, I turn to a consideration of its formal process of development. CP have, at various times, made versions of CPA-I_001 available on their website. By tracking changes in the standard through time, I reveal the relative stability of the images and the great syncretism of the text. While many public comments are incorporated into the standard, there are also instances where an individual comment causes something of significance to be removed. The process of rough consensus inherited from IETF has many advantages over the more laborious standards development processes of ISO and ITU-T. But it also has the potential to undermine the cohesion and integrity of a text. In the third section, I argue that the CA diagram acts as a container for a range of smart city visions. Within certain parameters, it is indeed highly flexible. It is variously positioned as a framework for knowledge exchange and a catalyst for market development. There are limits, however. CPA-I_001 embraces a functionalist view of the city, and so is unable to recognise the value of communities arising from dysfunction, informality and illegality. This makes it a poor match for Colau's Barcelona. After the withdrawal of public and industry funding, CP faced something of a crisis of identity. In the conclusion, I briefly describe its efforts to find a new sense of meaning and direction at a range of locations and scales.

Origins of City Protocol

Vicente Guallart's (2012) *La ciudad autosuficiente: habitar en la sociedad de la información* was extended and republished in English as *The Self-Sufficient City: Internet has changed our lives but it hasn't changed our cities, yet* (Guallart, 2014). In the years between the book's two editions, City Protocol was founded, in part, to realise some of the ideas it expressed. It is a good place to begin to unearth the material-discursive origins of CP, but it is also important to recognise that much of the book's text was based on Guallart's professional practice. As he remarked during our interview, "We [the Institute for Advanced Architecture of Catalonia] started research in the year 2008, where [we] were asking ourselves what is the relationship between the physical and digital world, and how we can produce a future" (interview 44, January 27, 2017). As a text, *The Self-Sufficient City* is also somewhat difficult to analyse. Guallart is more of an artist than an academic. The book aims to inspire, but makes a lot of unqualified and largely unsupported claims. Furthermore, it is written in a style common to Spanish-language nonfiction wherein arguments are constructed through a series of thematically-linked statements. Bearing these things in mind, it is nevertheless to possible to extract from it some key points.

The fundamental argument pursued by Guallart (2014) is that by bringing cities fully into alignment with the internet (through government, architecture and urban design), it will be possible to radically transform society, making it more self-sufficient and resilient to shock. At the most concrete level, this refers to the incorporation of an information layer into the management of urban systems. Rather than have city departments that are sealed off from one another and the public, information should be shared between them and made more open. This will lead to greater effectiveness and transparency in government. More than this, Guallart (2014: 185) speculates that the development of a cross-departmental urban operating system, or City OS, would ultimately engender more efficient and well-managed services. In both instances, the spread of information is necessary for the achievement of optimal functionality. But Guallart pushes the argument further.

From the structure of the internet, he also identifies an organisational ideal in a distributed network of interconnected nodes.

> We were looking for a model for analyzing cities that would be compatible with the topology of the Internet. A model where the Internet and the city could be fused together. I[t] had to be a multiscalar and self-similar model, like a fractal system, where the parts have the same shape as the whole. It had to be applicable to a living environment for one person or for 10 billion people. It had to be compatible with the concept of a dwelling-city and that of a planet-city. (Guallart, 2014: 40–41)

The network adopted by Guallart does not (explicitly) connect key policy stakeholders across diverse geographies. In this respect, it is unlike governance networks, and the use of networks more generally in social theory (Castells, 1996) and science and technology studies (Latour, 2005). Instead, it draws inspiration from computer networks (and from network science, such as Newman et al., 2006), where nodes and the links between them are handled mathematically. Guallart uses the term as a way to abstract from the physicality of built forms, and consider the city in terms of its connections and functions. The essential topology (as a network) is expected to remain the same, even as its dimensions warp and change in scale[8].

Not only does Guallart draw inspiration from the substance and structure of the internet, he also borrows from it a grammar of rules and patterns. The concept of 'protocol' is used to signify the repeatable methods by which cities are governed and managed. These are implemented at the network level, and so are understood to be transferable between cities of different types and sizes. While Guallart usually uses the term to refer to government-led forms of technical control, it is also stretched to cover other forms of public and political engagement. Direct democracy, for example, is positioned as a protocol which can be executed on the urban operating system (Guallart, 2014: 188). The task of government is to build the framework that will allow any one of these 'new management protocols' to be run.

Armed with the concepts of 'system', 'network', 'information' and 'protocol', Guallart makes his ambitious proposal for a general anatomy of urban structure and function. He frames the problem in heroic terms.

> It is unbelievable that we have gone on for more than five thousand years building cities without any international conventions to define the structure of a city. If we ask a doctor in Lima, in Paris, or in Bombay what systems make up the human body, they will all describe the circulatory system, the nervous system, the respiratory system and all the various systems that constitute human anatomy, and which are studied at medical schools throughout the world. However, architects in those same cities will give different description of the parts or the systems that make up the anatomy of a city. Clearly defining the parts of a system is the first step toward remodeling it. (Guallart, 2014: 35)

Guallart's visualisation of the anatomy of the city performs three interlocking roles. It acts as a framework for understanding the city as a 'system of systems' (a body and its organs) and a multi-scalar network of inter-connected parts. Information flows through the City

[8] It is important to recognise that network theory does not treat 'scale' and 'network' in the same way as does spatial theory. Within human geography, they are usually interpreted as irreconcilable socio-spatial concepts, due largely to their assignation to Marxist and poststructuralist theory respectively. For a lengthy treatment of multi-scalar networks in a systems theoretical vein see West (2017).

OS like oxygen in the blood, providing sustenance and ensuring that the subsystems are managed flawlessly. Secondly, the visualisation presents a language for perceiving and discussing the city in a common way, leading to a high-level of communication and exchange. Skill and knowledge sharing should not only occur within a city, but also between cities, at the scale of the planet-city. And finally, it acts as a protocol, or agreed upon convention, that itself runs on the City OS. Formally developing and spreading standards is thus a crucial aspect of building the internet of cities.

In my interview with Guallart, I asked him about influences. Intellectually, he cited the importance of Ildefons Cerdà, a 19th century Catalan planner responsible for Barcelona's *Eixample* district; Ramon Margalef, a 20th century Catalan ecologist who incorporated information theory into biology (see for example Margalef, 1958); and Nicholas Negroponte, founder of Massachusetts Institute of Technology's Media Lab and one of the first to work at the intersection of computing and architecture (Negroponte, 1970; 1975; see also Steenson, 2017). In terms of aesthetics, he discussed the influence on his work of black and white diagrammatic graphics from China and Japan, particularly in terms of expressing ideas in a clear and simple way. In the 1990s, Guallart designed user interfaces for educational CD-ROMs. He positioned the visual style of the anatomy as a descendent of this work.

While Guallart does discuss City Protocol as an agent of standards development in the English edition of his book, this could only have been added after the organisation's foundation. When Trias was elected as Barcelona's 118th mayor in 2011, Guallart gave up his position at the Institute for Advanced Architecture of Catalonia to become the City's Chief Architect. His work was used to inform the creation of a new department of Urban Habitat, an agglomeration of the previous administration's departments for city planning, urban projects, housing, environment, urban services, metropolitan area services and ICT (Olivella, 2012).

> [W]e use it [the visualisation of the anatomy of the city] in order to create a department called Urban Habitat in the City Council. So the mayor understood that […] houses, building blocks, neighbourhoods, […] energy, water, transportation, *etcetera*, the large infrastructures, and also the environment, all of this is related with the built domain. And then if we want to develop a city following new principles, we need to have a project that integrate all the different layers. […] Barcelona is one of the first city that has under one deputy mayor all these different departments and this gives a lot of power in order to really, to transform the city in some specific directions. (Interview 44, Vicente Guallart, City Protocol, January 27, 2017)

In my interview with Guallart, he positioned his work as a way of establishing and regularising the language used within Urban Habitat. But its role as a framework was also present at this time. In a talk at the Smart City Summit in Milan in July 2012, Luis Olivella

(2012), then director of the City of Barcelona's *Institut Minicipal d'Informàtica*, referred to the anatomy as "our model of a city habitat". He described the city as composed of five infrastructures—water, logistics, mobility and transport, energy, and information—beneath which "transversal information systems […] manage those services in a very integrated form" (Olivella, 2012). Figure 6.1 shows the version of the CA included in Olivella's presentation slides.

In early March 2012, a formal alliance between *Ajuntament de Barcelona* and Cisco was announced by Mayor Trias and Cisco CEO John Chambers (Cisco, 2012). City Protocol was touted as one of three soon-to-be-launched strategic initiatives. It was described as a vehicle for Barcelona to develop a new smart city protocol, and as a certification system dedicated to the measurement of city efficiency and quality. A few months later, Olivella offered a few more details on the City's plans for the new organisation. He defined it as "a global and open movement of cities, industry and academia, which try to obtain a knowledge base of experiences, best practices and projects" (Olivella, 2012). More than developing standards and staging a dialogue between diverse stakeholders, CP was positioned as the nexus at which many of the City's smart city initiatives would meet (see Figure 6.2).

Two weeks later, City Protocol convened for the first time at a workshop in Barcelona. The event was attended by over 200 people, with representatives from 33 city governments, 20 companies, 14 academic institutions and 20 non-governmental organisations (City Protocol, n.d.). Rather than Vicente Guallart, it appeared that the organisation was being driven by Manel Sanromà, CIO of the *Institut Minicipal d'Informàtica* and a professor of applied mathematics at *Universitat Rovira i Virgili*. While also inspired by the internet, his emphasis was far more procedural, focusing on the internet governance bodies the Internet Society and the Internet Engineering Taskforce.

Internet standards are developed far more quickly and informally than the international standards of ISO (Abbate, 1999; Murphy and Yates, 2009). After meeting approval from the IETF steering group, a working group of interested persons publish their standard as a Request for Comment (RFC). Anybody has the possibility to then read and critique the document. Comments are discussed and fed back into the text, with the process repeating until the RFC has stabilised and the community has been given ample time to respond. During this period, it is often the case that the protocol, file format, algorithm, code or other procedure described by the RFC has already been deployed. The spirit of this approach is captured by the phrase 'We reject: kings, presidents, and voting. We believe in: rough consensus and running code' (Russell, 2006). ISOC grew out of IETF as a formalised, parent organisation engaged principally in the promotion and support of internet standards.

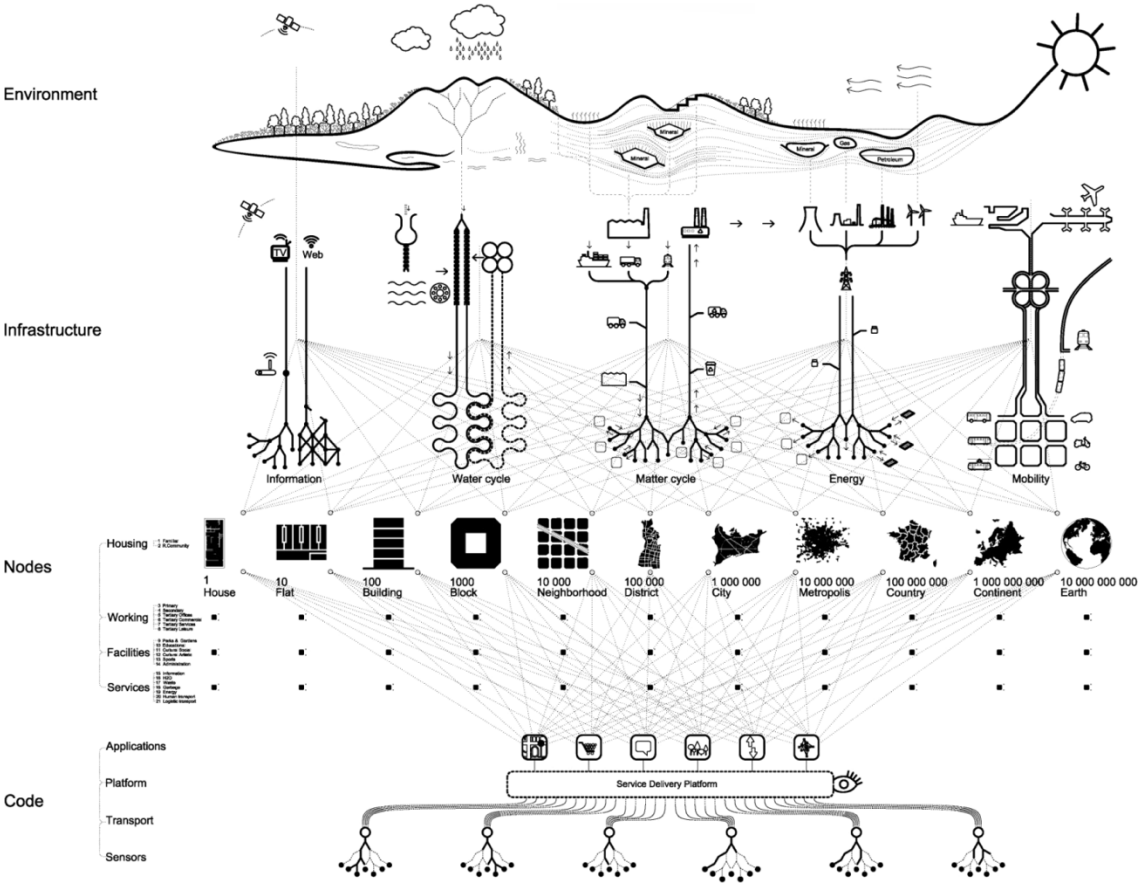

Figure 6.1. Visualisation of the City Anatomy, July, 2012. Reproduced from Olivella (2012).

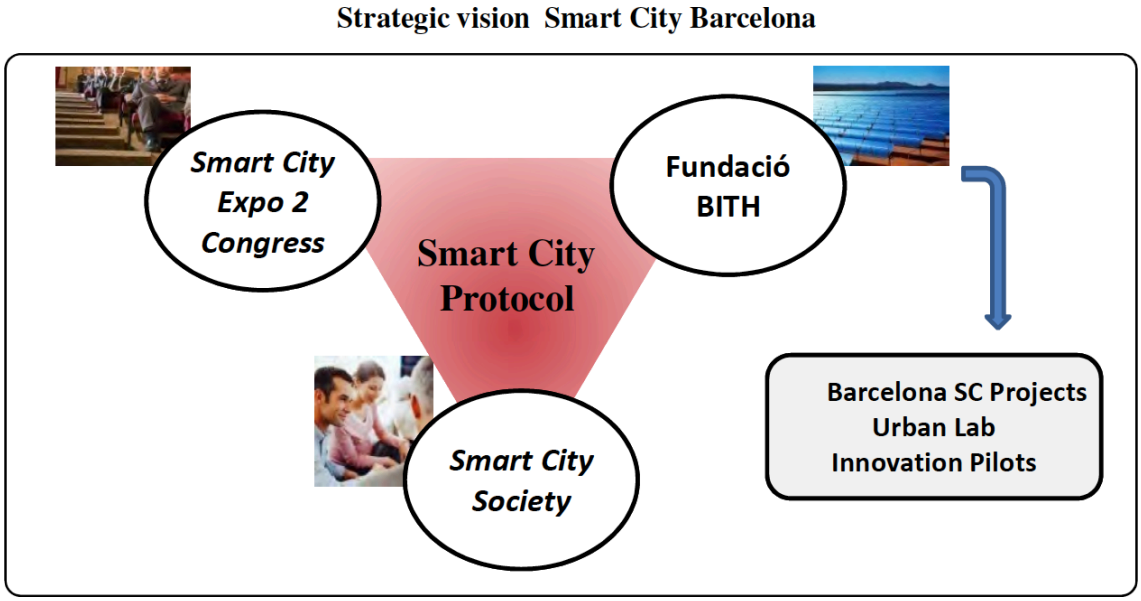

Figure 6.2. City Protocol's central role in Barcelona's smart city vision. Reproduced from Olivella (2012).

As a member of ISOC and friend of Vinton Cerf (co-developer of the TCP/IP protocols), Sanromà seemed to be well-qualified to lead CP. In his closing remarks to the workshop, however, he recognised that standards for cities are quite unlike those for the internet.

> [In] any dictionary [definition of] 'protocol', there are two meanings. The main two meanings are: 'a set of conventions governing the treatment and formatting of data in a communication system'. Well, that fits very well for the Internet Protocol. […] But yet there is another meaning that is: 'the records that show the agreements arrived at by a group of negotiators', by a group of people. That's more in the sense of what we mean by the City Protocol. The City Protocol should be the records, the written documents that reflect the agreements arrived by a community of people interested in the development of cities. (Sanromà, 2012)

Internet protocols are highly specific solutions to narrow technical problems. Sanromà is anticipating that the work of CP will be less technical than IETF, and more eclectic and political in nature. Even if he and Guallart would like the city to be more like the internet, there is a recognition that it is not inherently so. Nevertheless, Sanromà proposed that the governance structure of CP should be modelled after that of ISOC and IETF.

After the workshop, an Interim Steering Committee was set up with the task of establishing the framework within which city standards would come to be developed (City Protocol, 2012). CP was split into two groups, City Protocol Society (CPS) and City Protocol Task Force (CPTF), with the former having a formal membership and administrative duties, and the latter being an open organisation, consisting of domain-specific Task and Finish Teams (later renamed Task Teams). Considerable energy was invested in specifying the bylaws of CPS (2013a) and in formalising the proper working practices of CPTF (CPS, 2013b). A visualisation of the overall (but largely aspirational) structure of City Protocol is shown in Figure 6.3. There also appears at this time to have been an effort to decentre the organisation from its association with Barcelona. In August 2013, the Articles of Incorporation for CPS were filed in California. This document states the group's purpose and activities in broad terms.

> The Corporation's specific purpose is the development of a system to rationalize city transformations that guide and accelerate city-to-city learning, facilitate the responsible adaptation and transformation of cities for the benefit of all urban communities worldwide, facilitate information exchange with related entities, and other relevant activities. The corporation's efforts in support of its specific purpose may include, but are not limited to, fostering the definition of standards, platform integration, evaluation and accreditation of standards and recommendation documents for city transformations, and the development of technologies aimed at urban solutions that promote resource-use efficiency, self-sufficiency, and social and economic progress in cities. (City Protocol, 2013b)

The generality of these final words can be interpreted as a lack of cohesive vision, or as a recognition that CPS and its associated community needed to be able to respond flexibly as it grew.

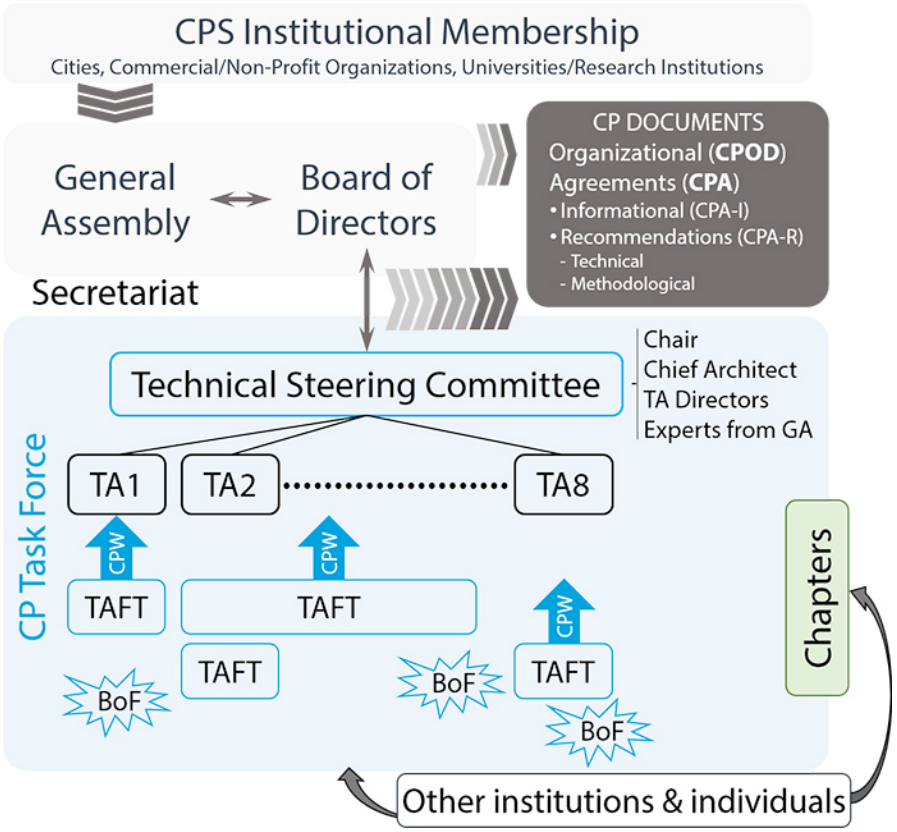

Figure 6.3. Illustration of CP structure and work flow after incorporation. Reproduced from the website of CPS (City Protocol, 2013c). BoF: Bird of a feather; CP: City Protocol; CPA: CP Agreement; CPA-I: Informational CPA; CPA-R: Recommendation CPA; CPOD: CP Organizational Document; CPS: City Protocol Society; CPWD: CPA Working Draft; TA: Thematic Area; TAFT: Task-And-Finish-Team.

After incorporation, Sanromà became the President of CPS and Chair of the Board, and his colleague at *Universitat Rovira i Virgili*, Francesc Giralt, became its Director of Society Affairs (City Protocol, 2013d). Attention then turned towards the standardisation efforts of CPTF, with Guallart's visualisation being used as the basis for the first protocol, CPA-I_001. In the next section, I will look more closely at the events of 2014 and early 2015, as the document was fashioned into a final version. In April 2015, the CP website underwent a considerable redesign, after which the organisation's main governance body appears to have become the Steering Committee of the CPTF, albeit with the same personnel as the Secretariat of the CPS. By the time of my interviews in late 2016, Colau had been appointed the Mayor of Barcelona and Sanromà had moved on to work on other government projects.

Developing the Anatomy of City Habitat

In early April 2014, the CPS Board of Directors approved the charter of the Task and Finish Team for the Anatomy of City Habitat (TAFT ancha), officially commencing a new period of activity. The charter specifies how Guallart's work is expected to function as a standard. The anatomy's twin character is again evoked, however, the emphasis is

now more operational: "It aims to provide a common language for the CP and an organizing framework for all CPTF activities" (CPS, 2014a: 1). Rather than act as a universal medium for bringing cities into alignment with the internet, CA is positioned as an aid to internal organisation. CP is no less ambitious than *The Self-Sufficient City*, but is more strategic in situating itself within the smart city movement. Their work is framed as a response to the 'well rehearsed' challenges of the 21st century: "unprecedented and largely uncontained urban growth, radical demographic changes, impending profound resource shortfalls, accelerating pace of technological change, and a new central role for cities in the global economy" (CPS, 2014a: 1). This enumeration of troubles heightens the need for action. But where Guallart cherishes the flow of information for its own sake, the broader CP does not assume that future threats will dissolve in the face of a well-functioning communications system. Effectively, CA is reconceived as a structure within which more directed and pragmatic information management guidelines will be developed.

The charter lists 30 participants of TAFT ancha, including representatives from seven cities (Amsterdam, Barcelona, Buenos Aires, Dubai, Dublin, Genova and Quito), at least seven companies (including Cisco, GDF SUEZ, Microsoft and SAP SE) and five academic institutions (CPS, 2014a). In late April, Francesc Giralt sent an email to the group's mailing list, inviting contributions to the CPTF's online collaborative platform. He followed this up with a proviso and a few words of encouragement.

> The CPWD-I_ancha might seen at the first glance as a quite finish[ed] document. This is so because a lot of preliminary work was done during the period prior to the CPS constitution and also because the London Workshop 03.14-17.2014 was a very productive event. Nevertleless [sic], it is a working draft and as such has to be critically examined, edited, enriched and extended via our collaborative work during the next 3 months. (Giralt, 2014)

A working document from the start of this period has been released to the public (CPS, 2014d). According to its metadata, it was created on April 25, the same day that Giralt sent his emails. Another publicly released version of the document dated November 13 (CPS, 2014b), can be used to give an indication of the changes that were made to the standard during the period of TAFT development. Unfortunately, it is impossible to determine from these data who contributed what, or whether any important discussions or disagreements guided the evolution of the standard.

Figure 6.4 shows the visualisation of the City Anatomy used in these two documents. The first thing to note is that in comparison to the version presented by Olivella in July 2012 (Figure 6.1), there is a sixth infrastructural subsystem. Where the environment was held somewhat separately from the city in its own discrete layer, there is now a recognition that nature extends into and is coterminous with the built form. Between April and

November 2014, the information subsystem was renamed 'communications network', presumably to avoid confusion with the City OS. Apart from these differences, the top part of the image is consistent with Guallart's vision. The same is not the case for the bottom part. Over the period of TAFT ancha's mandate, 'information' was renamed 'interactions', social functions (such as living, working, shopping and so on) were moved from the society layer into the interactions layer, making their relationship with the City OS more coherent. These alterations reveal a greater precision in the use of the word 'information', consistent with a reimagining of CA as a structure for future work. In my interview with Guallart, however, he was dismissive of these changes, linking them to the visualisation's language rather than its fundamental structure.

> Well the truth is that we have 95% of the drawing done. […] Francesc Giralt [and I] we are discussing some names […] that the middle part between what we call the built domain, and the other thing we called a society, and then the middle level could be information, now we call interactions. So there was some question of naming, because the naming was part of the reason why we were doing this, that we were discussing about. (Interview 44, Vicente Guallart, City Protocol, January 27, 2017)

Over later iterations, the image remained relatively stable. During the period of public consultation, the 'civil society' layer was renamed 'citizens' and was expanded to include families along with organisations and businesses. Between the first and second versions of the published standard, the icon representing the leisure function was changed to one representing transport. Appendix 3 is a high-quality render of the anatomy visualisation consistent with the version released for public comment in mid-November (CPS, 2014c).

Far more substantial changes were made to the standard's text. An executive summary and sections titled 'Core Organizing Activities for City Governance, Evaluation and Transformation' and 'City Anatomy at the Core of City Protocol' were added. While the summary is guided by the prior description of the visualisation, the two sections are entirely new. The first describes how the standard can be used by local governments to develop a systems understanding of cities, and so "guide governance, facilitate evaluation and establish adequate leadership for… successful transformation" (CPS, 2014b: 13). By attending to the relationships between nodes, a comprehensive and cohesive perspective on urban functionality can be developed. While TAFT ancha clearly felt the need to establish the usefulness of the standard, this section is quite tentative and speculative. Phrases such as 'could be illustrated', 'may imply the need', 'a city could start' and 'could also be used' are common. This allows them to imagine use cases without assuming that all cities are the same, but exposes the gap between the the CA's abstraction and the pragmatic needs of cities. Several of my interviewees stressed that CP were too idealistic and academic. The second section briefly states the foundational role that the standard

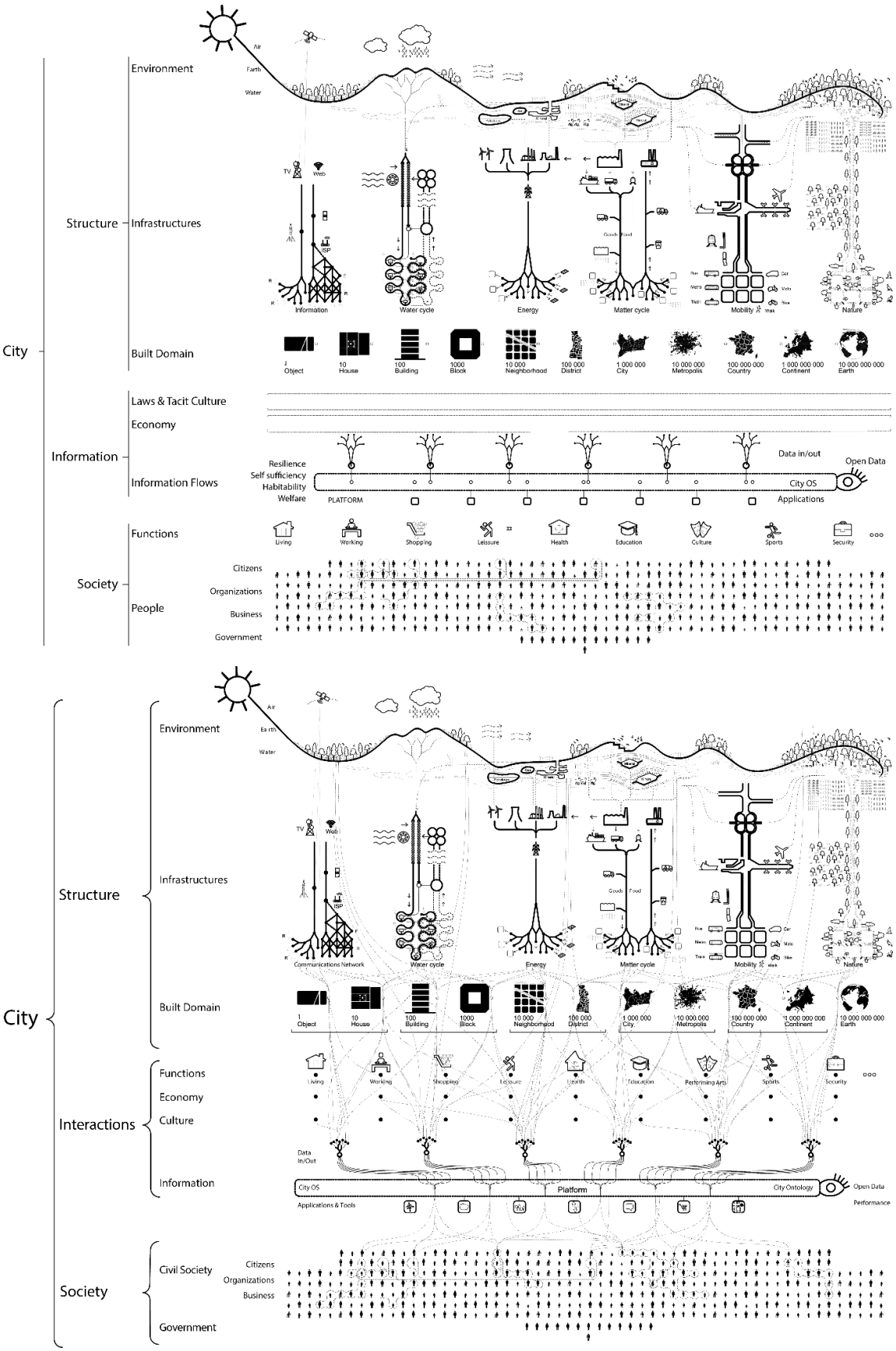

Figure 6.4. Comparison of the visualisation of the City Anatomy, from **(a)** April 25, 2014 (CPS 2014d) and **(b)** November 13, 2014 (CPS 2014b).

will play in future CP work. The focus here is operational and little is done to flesh out the bones of the preceding section.

The TAFT ancha review period came to an end on July 10. Cities were given an additional two weeks to review the standard, the results of which were collected in an online survey (City Protocol, 2014). On November 18, the standard was opened for a 30-day period of public comment, which was later extended until the end of the year. Seven responses were made, one of which was by a member of TAFT ancha. These were released in a document that also includes the response of the CPTF chair, Sue Lebeck, and the action taken by the TAFT co-chairs, Francesc Giralt, Vicente Guallart and Gloria Piaggio (CPTF, 2015). By cross-referencing this document with the version of the standard released for comment (CPS, 2014c) and the amended version published the following year (CPS, 2015a), it is possible to track how public responses were incorporated into the text of the document.

The following differences pertain to the executive statement (CPS, 2015a: i–ii). The first sentence was modified to recognise 'emergent human behaviour'. This was following a comment made by Maria-Cristina Marinescu that the definition was too simplistic and needed to consider the city as a complex system. The difference between simple and complex systems is not incidental. In their academic work, Giralt and Rallo have together published on the turbulent non-linear dynamics of an artificial neural network (Giralt et al., 2000). Reframing city systems in terms of emergence is consistent with their research.

The phrase 'chronic global societal challenges' is incorporated into the standard from a comment made by Graham Colclough. This was not a critique of the anatomy, but a suggestion that the document do more to recognise future risks, so as "to ensure that people get the empowering context and the need for cities/society to take a different (transformative) approach" (CPTF, 2015: n.p.). While such affective and inspirational language is rarely marshalled by CP, it exists within its broader milieu.

In the next paragraph, a small phrase is added about the possibility of using the standard to 'break city silos'. This was included after Rubén Cánovas Mas suggested that 'it could be interesting' in the context of the Internet of Things. Again, this is highly meaningful language. The difference between interconnecting local government departments and completely restructuring them is profound. There are many reasons why public sector employees might object to such change—let alone the clarion call for open municipal data (Kitchin, 2014a). And yet this phrase is added as if it were accepted wisdom. References to silos and silo breaking are very common in the smart city discourse and are part of a broader governance and business management trend that reworks the fundamentals of systems theory for the age of big and open data (see Tett, 2015).

The third paragraph of the executive summary is entirely new and addresses the issue of sustainability. Two individuals noted the absence of this term: Tom Baumann

and Rubén Cánovas Mas. The response from the CPTF chair was to defer to a different CP standard, 'Common Language', which has yet to be developed. The response from the TAFT ancha co-chairs was to include a series of statements explaining why 'self-sufficiency' rather than 'sustainability' had been adopted. While acknowledging the importance of the UN's three principles of sustainable development—economic, social and environmental—the document states: "the reader should also realize that this broad and important concept is a declaration of intentions" (CPS, 2015a: i). By contrast, self-sufficiency—defined as occurring when the rate of resource replenishment is greater than that of resource depletion—is understood to be more measurable and therefore more operational. Given that it is included in the title to Guallart's book, it is no great wonder that this term has been chosen over the far more common one of 'sustainability'. While it is possible to speculate about the connection between self-sufficiency and closed systems, or about the term's connotations of political and economic sovereignty in the context of CiU's separatism, I want to step back from doing so here. The point I wish to make is more procedural. In an instance where two comments of a similar nature were made, the co-chairs decided that the best course of action was to defend their position.

Further into the document, a paragraph relating to short and long term climactic change was radically altered at the request of a single commenter. In the version of the standard released for public comment, climate change is referenced in accordance with the scientific consensus.

> The form [of] territory that existed at the location of cities before they existed [sic], and where natural flows, that have existed since the earth began, continue to take place. This environment is formed by the three basic compartments, air, earth and water, interacting dynamically in a seasonally dependable way. These seasonal patterns currently overlap with large climate fluctuations, which can be linked to anthropogenic sources of pollution. (CPS, 2014c: 3)

In the amended version of the document, the last sentence of this quote has been removed. This occurred at the behest of Scott Dickson, an engineer at Qualcomm, who, in his only comment on the standard, argued against its relevance to the rest of the text.

> I don't see the necessity for this pronouncement, which actually isn't true in the general sense it is stated. Stating conjecture as if it is fact diminishes the credibility of the document.
>
> Yes, human activity can have an impact, and pollution of a sort that is difficult to clean up or reverse is to be avoided (in the opinion of many) for a number of reasons, but large climate fluctuations have been with the planet throughout its history, even before there were humans. There is still some controversy over how much climate fluctuation is due to pollution generated by human activity and how much might be

> due to other factors related to the normal fluctuations the planet has undergone one [sic] many occasions, causing both ice ages and unusual warmth. (CPTF, 2015: n.p.)

In her response, Lebeck suggested either citing the Intergovernmental Panel on Climate Change, or expanding the section to encompass air pollutants such as greenhouse gases. Neither of these suggestions were observed. While the sentence did persist elsewhere in the amended version—being originally present in two sections—by the time of the standard's second publication in late 2015, it had been entirely removed (CPS, 2015b).

It seems likely that the TAFT co-chairs elected to downplay climate change in order to remain appealing to audiences in the United States. Following their incorporation, CPS employed Lebeck to edit, refine and launch the standard from California. As she put it in our interview: "they also, I believe, wanted to become more global" (interview 49, February 17, 2017). Despite their efforts, gaining traction proved difficult. According to another of my interviewees and a former public servant in Massachusetts, "we [the public sector] just get bombarded with companies and ideas and so it's not easy to emerge out of [the] cacophony" (interview 35, James Aloisi, City Protocol, October 10, 2016). CA is not explicitly about climate change and so it does makes sense not to undermine its adoption unnecessarily. Nevertheless, the fact that this decision was made after the end of the TAFT ancha review period calls into question Giralt's claim that the standard was "the result of a consensus reached by cities" (Francesc Giralt, City Protocol, September 14, 2016). Rather than using consensus with the slow and deliberate method of the international standardisation bodies, CP is nearer to the rough consensus of IETF, where a small group of socially homogenous technical experts invariably end up determining the overall direction (Galloway, 2004).

Many changes were made to the text of the standard during the period of public comment. The examples provided reveal important tensions. While the image remained relatively stable, the words used to explain and contextualise it invited feedback and critique. These complimentary components of the document were engaged with differently and moved at different speeds. Procedurally, the response to public comments was inconsistent, diminishing the significance of the more involved discussions undertaken by the TAFT. Public consultation is not a bad thing, but if it is undertaken too quickly, haphazardly or superficially, it risks undermining the consensus-building process. Following on from this, there were clearly worries within CP that the organisation was moving too slowly. When I asked Rallo (interview 31, August 26, 2017) to describe any weaknesses of their work, he responded that it was not well adjusted to the pace of industry. The desire to move fast and remain relevant to corporate sponsors threatens the broader values of public participation and consultation. These tensions explain the eclectic and syncretic nature of the standard as well as its many small contradictions and incoherences.

The limits of the City Anatomy

Over the course of its informal and formal phases of development, the way in which the visualisation of the anatomy of the city was conceived underwent an important shift. For Guallart, its purpose was to unify the language of cities and nurture the spread of information across infrastructural subsystems. Within CP, these ambitions were reworked into a platform for the development of other, more concrete city standards. This interpretive flexibility did not end with the publication of the standard in early 2015. Even amongst those central to CP, it continued to be framed in different ways by different people.

Robert Rallo was heavily involved in the development of the additional CP standards, particularly 'City Anatomy Indicators' (CPS, 2015c) and 'Foundation Ontology for the City Anatomy' (CPS, 2016). When I spoke with him in 2016, he expressed a specific role for the anatomy that was informed by this work.

> [T]he basic idea of the CPS is to establish a reference model, which is the City Anatomy. Then to formalise the model, which is the ontology and the indicators and so on. And at the same time, to create awareness between the different cities […] that [the] model exists, and trying to make them to start using this model. And to express the problems that they have in terms of the City Anatomy reference. (Interview 31, Robert Rallo, City Protocol, August 26, 2017)

On the one hand, this marks something of a return to Guallart's vision. A reference model is a set of interlinked concepts deployed in systems and software engineering to promote clear communication. Rallo imagines CPA-I_001 being used by cities to frame their problems in a consistent and unified way. On the other hand, there is also something new here. The anatomy is positioned as part of a set of tools which cities can use to help diagnose their problems. Rather than simply promoting communication, Rallo understands CP standards as an integrated method for measuring and managing urban systems. What was originally posed as an answer to an architectural need, has now been fully enfolded into the epistemology of system engineering and operations research.

Another core CP member, Sue Lebeck, framed the group's efforts in more expansive terms. She sees similarities between city standardisation today and internet standardisation in the late 1980s and early 1990s. Drawing on her experience with email standards and on her later work facilitating innovation in the software industry, Lebeck described the role CP could play in developing the global smart cities market. In addition to enabling the integration of city services and the diagnosis of urban problems, she argued that CP should collect and formalise the practical experiences of cities.

> On the one hand, you need to have some kind of a rigorous systems view to anchor what you're doing, so that you don't end up all over the map and end up with

> something unwieldy. But at the same time, the way an industry actually develops is by all sorts of experimentation, all sorts of legacy systems evolving as well as brand new things. Practice is what makes it useful, and what makes us get experience on the ground, and what makes the whole conceptual idea grounded in something important and fascinating. (Interview 49, Sue Lebeck, City Protocol, February 17, 2017)

She described this as a principle of 'practice to protocol', in which CPA-I_001 is used to help gather, manage and search for city success stories. But her vision does not end here. Rather than perceiving standardisation in opposition to innovation, Lebeck frames them as potentially complimentary. CP should endeavour to build a platform through which solution providers can serve the needs of cities. Just as TCP/IP enabled computers of different hardware to exchange data packets, acting as a foundation for application level messaging protocols (such as email and XMPP), so should a mediating layer between local government and industry be established. Lebeck's detailed and elaborate vision for CPA-I_001, its supporting standards and the organisation that promotes them, extends well beyond any other encountered during my interviews and associated reading.

Through its many iterations, the City Anatomy has acted as a container for diverse positions and perspectives on city systems, ICT, urban governance and the role of formal standardisation in the development of smart, sustainable and resilient cities. Sometimes, these positions draw on the same material-discursive lineage and so compliment and build upon one another. At other times, however, they clash and contradict, favouring opposing organisational forms or alternate conceptions of the relationship between the public sector and technical expertise. While the standard owes a sizeable debt to systems theory, it has also been framed as an expedient to market competition and as a tool for knowledge exchange. The assumptions and logics of neoliberal rationality and the governance turn are thus both also at play in shaping the field of possibilities from which the standard is formed.

It is not only in the realm of ideas that these differences are evident. Cisco and GDF Suez initially saw CP as an opportunity to invest in Barcelona as a showcase for their products and services. When I spoke with Francesc Giralt about this, he stressed the independence of the organisation.

> City Protocol is a non-profit corporation that serves cities with an agnostic approach. City Protocol is a community of practice that is agnostic. So we do not promote a specific technology or specific solution, because a specific solution may be good for one city and not so good for another one, depending on context. When we talk about city transformation, the context is more important than the product. (Interview 33, Francesc Giralt, City Protocol, September 14, 2016)

The drivers of CP were less interested in the direct promotion of industry solutions than they were in establishing best practices and building a network of city stakeholders. As a result, their source of corporate funding soon dried up.

Despite initial excitement, the adoption of CP standards has been poor. During my interviews, only two cities other than Barcelona were cited as use cases: Amsterdam and Abu Dhabi. In both cases, I failed to find anyone willing to discuss how CPA-I_001 had been applied. Amsterdam have created a heavily-promoted umbrella organisation, under which many small projects have been launched, in the hope that a few will flourish on their own (see Winden et al., 2016). Without concerted and co-ordinated backing, the Amsterdam chapter of City Protocol has floundered. In Abu Dhabi, smart city efforts have targeted citizen happiness, in an effort to counteract their perception in Europe as an oppressive, autocratic city-state. The city has the political capital to properly implement city standards and it has been quite involved in the community. Nevertheless, access restrictions and a carefully controlled public image limit what can be said of their use. On the whole, CP's disjointed narrative and dearth of practical solutions—its agnosticism—has undermined uptake by cities.

For all the abstract flexibility of CPA-I_001, it is also limited as a heuristic tool. Its functional, systems-based perspective lacks much of the vibrancy and diversity which makes cities attractive places to live. This is particularly evident with respect to culture. Positioned within the interactions layer, culture can be "analyzed and measured as flows of information" (CPS, 2015a: 9). Within information theory, the meaning of a communicative act is unimportant—attention is instead given to the predictability of the sequence of symbols by which a message is conveyed (Shannon, 1948). When culture is framed in this way, only its quantities can be grasped. Qualities, the very things which constitute culture in the first place, are lost. Further on, the document acknowledges the ineffabilities and intangibilities of culture.

> Culture refers to language, traditions, beliefs, values, and the way that people organize their concepts of the world, etc. In other words, these are assets in the city anatomy that are not part of the material world or built domain (unlike tangible 'cultural' objects such as museums, monuments, works of art, archeological sites, city landmarks, etc.). Tacit knowledge requires a personal interaction and the buildup of shared understanding and trust among people in a given community. (CPS, 2015a: 11)

Unlike the other components of the interactions layer (functions, economy and information[9]), culture is almost entirely immaterial. As such, only proxy indicators can be used for its measurement: 'percentage of annual city budget allocated to culture', 'World Heritage Sites per 1,000,000 population' and 'annual average number of visitors to city museums' (CPS, 2015c: 17). Language, tradition, values and beliefs elude efforts at inclusion within the model. This speaks to a broader weakness of the systems perspective. Without a proper theory of the role played by meaning in the constitution of the material world, the city cannot be properly grasped.

This limitation of the City Anatomy leaves it unable to recognise value stemming from dysfunction, informality and illegality. Philosophically it is left wanting, as it is with these areas that the most exciting contemporary urban theory grapples (see Tonkiss, 2013). But this also effects the standard in a more immediate way. *Plataforma de Afectados por la Hipoteca* (PAH), the housing organisation co-founded by Colau, helped connect individuals and families affected by mortgages in post-crisis Catalonia (Colau and Alemany, 2014). Marshalling a language of solidarity and common ownership, PAH resisted evictions and rehoused many of those who found themselves without homes. It became hugely influential and was the foundation on which Colau's political party, *Barcelona en Comú*, built its success. Evictions and homelessness are certainly not a good thing from a systems perspective. But as a dysfunction, they can only be addressed by tweaking the relationships between components in the model. There is no capacity to recognise the cultural connections and grassroots politics which arise from systemic failure. In this sense, the politics of Colau are incompatible with those of City Protocol.

Conclusion

There is a tragic irony to CPA-I_001. It is at once too flexible to be of practical use to cities and not flexible enough to remain of use to the city government through which it was founded. In this chapter, I have used material-discursive genealogy to draw out this irony. CPA-I_001 has been revealed as a container for a range of positions associated with systems theory, neoliberal rationality and the governance turn. These include efforts to: improve communication about cities; integrate and circulate information about urban infrastructure; share knowledge, practices, policies and technical solutions for city management; and improve market relations between local governments and technology vendors. But there are clear limits to what the standard is able to contain. Discursive practices that prioritise a place's many and contradictory meanings lie beyond its

[9] The question of the materiality of information is a tricky one to unpack. Hayles (1999) has argued that Norbert Wiener was plagued by indecision on this very issue. Nevertheless, many systems theorists argue that information must be apprehended as entirely physical (see Landauer, 1991).

functional scope. For the government of Ada Colau, that desires a future in which Barcelona is held in common by its residents, CPA-I_001 is too closely associated with the corporate smart city vision of its predecessor. It is no wonder that financial support for the initiative was terminated.

This chapter has also revealed shortcomings of the process of rough consensus. CP was established, in part, as a forum for standards development to keep pace with the smart city market and the urgency with which cities were being encouraged to adopt its technologies. But there are good reasons for prolonged deliberation. As Scott Dickson's intervention demonstrates, speed empowers motivated individuals to have disproportionally large impact. That one aspiring international expert community should defy the consensus of another, far more well-recognised, in the Intergovernmental Panel on Climate Change, should not have occurred. To suppress the existence of climate change, was normatively and operationally undesirable, and subverted the values professed by CP. With neither a strong editorial hand nor a lengthy period of review and revision, the integrity and cohesion of CPA-I_001 was undermined. It did not offer resolutions, but came to express contradictory opinions between different persons. This has detracted from the standard and undermined perceptions of its utility.

Despite its conceptual, procedural and practical limits, CPA-I_001 can be regarded as an explicit programme of the integrative power at work in smart cities. The assumptions, ideas and tensions it contains are indicative of those at work within the broader field of possibilities. Cities are apprehended on a plane of equivalence. The problems they face are general and the result of global rather than local trends. All urban forms are conceived as a system of systems in which structures are connected to society by a predefined set of interactions. The messy irregularities and abnormalities of actually existing cities are invisible to the glossy, high contrast icons of its visualisation. This is the city stripped bare of its dirt and grime; its culture and its politics. And yet the diagram captures the city as it ought to be for those enrolled in the creation of standards for smart, sustainable and resilient cities: well-ordered, fully integrated and responsive to the challenges of the twenty-first century.

When I spoke with then CPS treasurer Jamie Cudden in late 2016, the future of the organisation was uncertain. He said that they were in a financially 'precarious state' following the withdrawal of industry support and that they were trying to decide whether to "wind down or […] give it another year" (interview 37, December 14, 2016). In addition to the reorientation towards Catalonia, CP were also discussing: the possibility of European level funding; emphasising their strength as a network of cities; and the memorandum of understanding they had signed with the US Green Building Council—who were at that time rolling out their own set of standardised urban metrics. Giralt was interested in taking the 'dream' of the internet of cities in a new direction.

> What do you gain by federating all portals? When you do a query, you get access to all data because they are organised the same way in all federated portals. […] And at that moment, a federation with the same city ontology would ensure a complete vision of what is known with a simple click. And if a company wants to develop an application operational [sic] around the globe, it doesn't have to customise the application for each city. It can feed from the data of every city under the same taxonomy; with the same application one person would be able to move across countries, across regions and across cities. (Interview 33, Francesc Giralt, City Protocol, September 14, 2016)

Whether or not CP manages to reimagine itself and create the alliances that it needs to survive, the visualisation of the City Anatomy will continue to be developed in ISO/TC 268 as 'ISO 37105 Descriptive framework for cities and communities'.

7. ISO 37120: THE GLOBAL GOVERNANCE OF LOCAL DATA

Introduction

After achieving ISO 37120 certification for the 2014 calendar year, Nick Casey, Senior Research Analyst at the City of Melbourne, uploaded all of the data generated by the exercise to the city's open data portal (City of Melbourne, 2018b). In keeping with an ethic of data transparency, he included with the indicators and their numerators and denominators, the Excel spreadsheet that had been used in their verification. This document contained information on the provenance of the data and comments from the auditor regarding how to properly interpret and fulfil the indicator specifications. Some months later, Casey received an email from a representative of their ISO 37120 certifier, the World Council on City Data (WCCD), asking that he remove the audit parameters from the website. Whether or not this data should be made open, is a matter of some tension.

WCCD have not always been so controlling of ISO 37120 data. In the final report of the World Bank project that originally gathered and refined the list of indicators, it was asserted that the data they produce would be non-proprietary and open-access (ERM, 2008: v). This was consistent with the genesis and character of the undertaking.

> Being city-lead [sic] – this is a bottom-up effort with an initial team of partner cities. This initiative is not 'owned' by any single entity and is now being 'handed-off' to the intermediary City Indicators Facility. (ERM, 2008: vi)

When I began researching ISO 37120 in 2014, the Global City Indicators Facility (GCIF)—the predecessor to WCCD—were only granting data access to member cities. Upon being asked about this, they said that a decision had been made during the pilot to initially keep the data private, but that they would eventually be opened up (Warburton, 2014). Shortly after this exchange, WCCD (n.d.-a) launched a bespoke, aesthetically pleasing data portal, which included a function to export the indicator data. At the time of writing, however, the WCCD data portal no longer allows users to export data and does not facilitate connections via an Application Programming Interface (API). While it is possible to download visualisations in PNG and PDF file formats, they are covered by a large watermark.

The vast majority of the ISO 37120 indicators are not sensitive. They are aggregated, derivative data, and are unlikely to inherit the legal and ethical restrictions placed on the original dataset. Indeed, Helen Ng, WCCD's Executive Vice President at

the time of our interview, confirmed the importance of accessibility to WCCD's overall vision (see also WCCD, 2016).

> So we wanted this platform so that the information is stored is available to the public and anyone can access it and use it. So the point of the standard is not to rank cities but to have definitions and methodologies there, so that cities can have this data available, so that any researchers, students, anyone can access it. So it is accessibility to information that was really important to us. (Interview 18, Helen Ng, World Council on City Data, February 4, 2016)

And yet this statement is not backed up by the features currently available on the WCCD website. Even in situations where, for legal, political or ethical reasons, certain information can not be made available, this does not prevent the release of data for those cities where this does not apply. There is no technical or logistical reason preventing the WCCD portal from allowing the public to easily export the vast majority of ISO 37120 data.

Contrary to the wishes of Nick Casey and the foundational work of the World Bank, a decision has been made to restrict access to ISO 37120 data. This raises questions about the use and ownership of urban data. What is the value of a small dataset of comparable, local government data? What is obscured by the lack of publicly available ISO 37120 metadata (i.e., the numerators, denominators, confidence intervals, auditor comments, and provenance and licensing information)? And finally, how might WCCD's shifting attitude on open data be accounted for?

I address these questions over five sections and a conclusion. In the first section, I discuss the origins of ISO 37120 and WCCD. I look at the early work of World Bank and the decision to involve Canadian cities; the stewardship of GCIF and its director, Patricia McCarney; and the evolution of the indicators prior to and during their internationalisation at ISO. In the second section, I examine the uptake of ISO 37120, paying particular attention to the third-party auditors tasked with verifying its underlying data. A nuanced and flexible process is revealed, in which cities are slowly but surely brought towards an ideal. Next, I reveal the difficulty of achieving commensurability. Beneath the numbers lies a certain slight-of-hand: that local political jurisdictions can act as a proxy for the city itself. Fundamental spatial and temporal differences, and all sorts of unanticipated legal, regulatory and historical irregularities are effectively internalised into the dataset. Despite acknowledging these problems, many involved the standard's deployment nevertheless perceive it to be a worthwhile activity. In the fourth section, I explore the reasons why governments are interested aggregating city data into a single, representative figure. Having described the material-discursive enactment of ISO 37120, in section five, I return to the questions posed in this introduction. I argue that the standard acts as a steering technology for governing cities in a more distributed but

ostensibly less democratic manner. In addition to benchmarking, WCCD have stated that their data will eventually be used to improve the calculation of city credit ratings, and insurance and reinsurance premiums. This demonstrates both the potential imbrications of the standard with global, financialised capital, and the way in which cities are being enrolled into such relationships. The ultimate value of ISO 37120 data may lie with such calculative and neoliberal forms of governance. In the conclusion, I return to the on-again-off-again relationship of WCCD with open data. By limiting access to ISO 37120 data and metadata, WCCD are failing to fully tell the story behind the indicators. This prevents cities from properly benchmarking themselves, while leaving open revenue streams that may accrue from selling this information to powerful financial institutions.

Origins of ISO 37120 and the World Council on City Data

At the Third World Urban Forum in Vancouver in June 2006, representatives of the World Bank presented a plan to develop a set of urban indicators for comparing cities in different countries (Hoornweg et al., 2007). Where previous attempts to achieve this had failed to establish long-term commitment, the project sought to secure longevity by being city-led from the outset. Despite this promise, it was acknowledged that, for practical reasons, some cities would likely contribute more than others: "Some cities have a more developed culture of measuring performance while others have very weak sources of information" (Hoornweg et al., 2007: 13). By the conclusion of the project in December 2007, nine municipal governments had been directly involved. These were Belo Horizonte, Pôrto Alegre and São Paulo, Brazil; Montreal, Toronto and Vancouver, Canada; Bogotá and Cali, Colombia; and King County, Washington, United States. Representatives from two additional cities, Barcelona, Spain and San José, Costa Rica, offered comments on the indicator definitions and methodologies (ERM, 2008: 15).

Two fundamental tensions emerged from the project's global aspirations. The first lies between the city proper and the city actual. The paper introducing the World Bank project recognises this as a significant obstacle to the realisation of comparable global urban indicators. It describes 'the city' in a general sense as a "set of people and firms linked by economic and social relations in a tight web of physical connection and communication" (Hoornweg et al., 2007: 4). While not incorrect, this conceptualisation is incomplete and instrumental. Many things are missing from it: the infrastructure and built form of the city, its cultural practices and political institutions, its many and vibrant agencies. As if sensing these limits, the authors bemoan the lack of a clear, generic definition of the city. This has important ramifications for project's ambitions.

> [For] city indicators to be comparable on a wide scale, agreement is needed on the criterion that defines a city or urban agglomeration, which would be the specific unit

> of analysis. Developing city indicators is especially challenging in metropolitan areas where the internationally recognized city can be made up of many municipalities. City performance indicators may therefore vary from urban performance indicators, as the term 'urban' will encompass spatially enlarged units. How best to reflect city indicators in cities and their respective urban areas will be an important aspect of this upcoming work plan. (Hoornweg et al., 2007: 5)

An urban agglomeration often defies the borders that have been established to govern its people, forms, flows and functions. There is no easy, universal fit between these geographies; solutions tend to be historically mutable and location-specific.

The second tension concerns the differing needs of developed and developing countries[10]. To be successful the project needed to balance a range of interests. The World Bank wished to be able to better measure and understand city performance. Robust, comparable indicators were envisioned as a key way of informing investments in Latin America, the developing world's most urbanised region (Hoornweg et al., 2007: 3). UN-Habitat, a partner in the project, desired indicators that could be used to identify and observe trends, and measure the outcomes of their interventions. The World Bank sought to build on UN-Habitat's experience in compiling and maintaining a database of urban measures, in association with its 'State of the World's Cities' reports (see for instance UN-Habitat, 2006). Canadian cities became involved as part of a Memorandum of Understanding between the Bank and Infrastructure Canada (Hoornweg et al., 2007, annex 4). This agreement raises a different set of concerns: economic prosperity, sustainable development, and the domestic and international dissemination of best practice. Canada has a strong tradition of performance measurement and benchmarking. For example, Municipal Benchmarking Network Canada pulls together 670 local government indicators from 16 municipalities every year (MBNCanada, 2016). Since their establishment in 1999, they have built capacity by using expert-led panels to continuously debate, analyse and modify the measures (interview 14, Connie Wheeler, Municipal Benchmarking Network Canada, February 1, 2016). The representatives of Canadian cities had considerably more technical experience than those of Latin American cities (see also Hoornweg et al., 2007, annex 5). While their participation may well have lead to a healthy transfer of skills and knowledge, it also helped confuse the purpose of the indicators.

In order to understand how these tensions were negotiated, it is important to discuss the project in a bit more detail. Rather than develop the indicators directly, the World

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[10] The binary between the developed and developing world is a common one in the World Bank and development policy literatures. I am aware that my reinforcement of it here is somewhat problematic. I have elected to persist with the terms in order to draw attention to the diverging capacities of city economies around the world, while also evoking this sector.

Bank commissioned the consulting group Environmental Resources Management (ERM) to do so on their behalf. Two workshops were held, the first in Toronto in September 2006, and the second concurrently in three cities, Bogotá, Montreal and São Paulo, in January 2007. At these events, city employees, together with representatives from CSA Group (formerly the Canadian Standards Association), the Federation of Canadian Municipalities, Infrastructure Canada, and the University of Toronto, discussed the objectives of the project and the challenges it would need to overcome (ERM, 2008: 45–46). After the first workshop, ERM produced a list of indicators used in the nine partner cities (903 in total), supplemented by indicators from related projects, such as UN-Habitat's Global Urban Indicators Database and MBNCanada (another 112). While cities within a country tended to use similar indicators, the countries had few in common. Only thirteen indicators were collected by cities in more than one country and only one indicator, measuring infant mortality rates, was used by cities in all four countries (ERM, 2008: 13). Next, ERM assessed the indicators for their timeliness, comparability, policy-relevance, cost to collect, meaningfulness, understandability and clarity of message (i.e., whether or not they were leading indicators). The 313 indicators which met the selection criteria were further scrutinised and pared down, first by the ERM project managers and then at the second workshop, until a final set of 53 were agreed upon (ERM, 2007; 2008).

While cities were involved in the two workshops, were used to generate the initial list of indicators, and were given the opportunity, through several periods of open document preparation and feedback, to influence the reports, there are nevertheless reasons to question the assertion that the project was city-led. First, given the World Bank's expectation that city participation would be variable, it is not clear to what extent the Latin American cities were involved in the development of the indicators. Not only did they have less experience than Canadian cities, but the documents released by the World Bank project were (with the exception of the website) all in English. Second, ERM stated that there was a lack of comparability between extant indicators from country-to-country. Assuming that this holds true at the global scale, then involvement of four countries from the Americas is not enough to provide the project with a representative sample. This weakens the claim to the generalisability of the indicators. Finally, ERM themselves report that the participation of cities was one of 'input' and 'support'.

> [T]he World Bank and its partner cities engaged in an iterative 'top down' and 'bottom up' process to select the indicators. The top-down part of the process was the research into and lessons learnt from indicator programs around the world, as well as discussions with indicator researchers, international agencies that collect and report indicators, practitioners, and organizations of cities. The bottom-up part of the process was the direct input from our partner cities through workshops, extensive

> conference calls, and e-mails. Partner cities provided in excess of 1,000 hours of professional support. (ERM, 2008: 10–11)

City representatives certainly participated in the creation of the World Bank's urban indicators, however, their involvement was not one of leadership. This undermines any attempt to use the collaboration of a handful of cities to assert that the indicators are something that all cities want and need.

It is now possible to return to a discussion of the two tensions introduced above. By the time the definition and methodology paper was published (ERM, 2007), a decision had been reached as to how to negotiate the problem of city geographies. Rather than aggregate data for an entire urban agglomeration, 'the city' is taken to refer to any local government and some regional and municipal governments. The final ERM report elaborates:

> While there is clearly value to analyzing urban agglomerations and it may be the preferred geographic unit for certain types of analyses, the focus of this initiative is on better understanding and improving city performance. We have therefore focused on single local governments, those units of government that are closest to the public and accountable to their residents for providing a range of services and overall improvements in quality of life. (ERM, 2008: 9)

While it was hoped that this decision would make the indicators more useful for city governments, it left unresolved the tension between the city proper and the city actual. An effort was made to improve the overall comparability of the indicators by setting a minimum population limit of 100,000. This tension is far less easy to overcome than the ERM reports imply, as I will show later in the chapter.

The different concerns of developed and developing countries continue to exist in the indicators selected for inclusion. The two core solid waste indicators provide a useful example: 'percentage of city population with regular solid waste collection' and 'percentage of solid waste: disposed to sanitary landfill; incinerated and burned openly; disposed to open dump; recycled; other'. For the vast majority of developed cities, the first indicator would be both simple to provide data on and unlikely to reveal information that is not already known. Only the second indicator would be expected to provide useful data. For cities in the developing world, the situation is likely to be the reverse. Assuming that appropriate data are available, it is the first indicator which is likely to generate more operational information. In cities with a high degree of informality, it is difficult to imagine that data on different forms of solid waste collection would exist (Schindler, 2017). There is nothing preventing the indicators from serving cities in developed and developing countries in different ways. Nevertheless, this tension does recur at a strategic level. This is, again, something to which I will return.

At the conclusion of the World Bank project, stewardship of the indicators and their supporting website were passed over to a research institute at the University of Toronto. Funding for this group was to be provided by the World Bank's Development Grant Facility, the national government of Canada, the university and member cities (ERM, 2008: 29). At this time, CSA Group also circulated a report explaining the ISO standardisation process and its intention to submit a NWIP titled 'Guidelines for measuring, reporting, and verifying city indicators' (ERM, 2008, annex 5). As was discussed in Chapter 5, the ISO TMB rejected this first proposal, leaving the indicators under the responsibility of the Global City Indicators Facility and its director Patricia McCarney.

In addition to being a trained urban planner, McCarney has experience working for both the World Bank and UN-Habitat, and represented the University of Toronto at the ERM global indicator workshops. She has published in the area of governance studies (McCarney, 2003; McCarney, 2000), has a track record of applied research (McCarney and Stren, 2003) and would be familiar with the (at times conflicting) needs of cities in developed and developing countries. She was a well-qualified choice to take over from ERM and the World Bank.

McCarney's work with the indicators can be divided into three overlapping phases. During the first phase, the Global City Indicators Programme (GCIP) continued to tinker with the indicators and deploy them in new cities. Periodic release of indicator lists (GCIF, 2009; 2011; 2013) can be used to track the changes made over this period. This included the removal of indicators (such as 'average travel speed on primary thoroughfares during peak hours', 'number of cultural establishments per 100,000 population' and 'total solid waste generation per capita'), the addition of several new indicators (such as 'average life expectancy', 'city unemployment rate' and 'number of businesses per 1,000 population'), and the splitting of existing indicators (the solid waste method indicator described above was split into a single core indicator for percentage of recycled waste, and five supporting indicators, one each for the percentage of waste disposed of in a sanitary landfill, disposed of in an incinerator, disposed of in an open dump, burned openly and disposed of by other means). This maturation process is likely to have been made in consideration of member city feedback. By mid-2012, GCIP had a membership of more than 200 cities from 73 countries, reporting on 115 indicators (the core and supporting indicators at this stage had been merged together with more general profile indicators) (GCIF, 2012). Emphasis seems to have been placed on growing the city database as quickly as possible. More than 15% of the reporting cities had a population of less than 100,000 and none of the cities I have spoken with were paying a membership fee at this time. The programme was receiving Ontario state funding from the Ministry of Municipal Affairs and Housing and had formed partnerships with various other organisations, such as the Cities Alliance, the

Inter-American Development Bank, Cisco, Philips and GDF Suez. GCIF also had plans to release 12 policy snapshots that would draw attention to the areas of urban governance addressed by GCIP. Only four—focusing on diversity, prosperity, infrastructure and ageing—were ever released (two of the snapshots remain available on the Global Cities Institute website, GCI, 2017). The next phase of work intervened.

In late 2012, McCarney was appointed the chairperson of ISO/TC 268/WG 2, the working group formed to shape the GCIP indicators into an international standard. Typically, this process takes four to six years. ISO has been under pressure to develop standards more quickly, however, so as to remain competitive with the ICT sector (Murphy and Yates, 2009: 97). In 1987, they introduced an accelerated procedure, allowing standards with a proven record of consultation and deliberation to skip over the preliminary stages (Egyedi, 1996: 108). In acknowledgement of the World Bank, ERM and GCIF preparatory work, the ISO TMB approved the fast-tracking of the standard in February 2012 (ISO, 2012, resolution 25). After further approval of the GCIF NWIP in August, representatives from 20 countries met 6 times to discuss the standard. The wording of the standard was commented upon some 300 times and went through five iterations (McCarney and Ng, 2014). It was published in May 2014 as 'ISO 37120:2014 Indicators for city services and quality of life' (ISO, 2014b). WCCD was founded the same day (Biron, 2017).

Without access to the running documents or meeting minutes, it is difficult to follow exactly what changes were made and under whose recommendation. Nevertheless, by comparing the ISO standard against the most similar indicator list published by GCIF (2011), it is possible to see how the indicators were themselves modified and built upon. Most significantly, new environment and sustainability indicators were added. Examples include 'annual number of trees planted per 100,000 population', 'the percentage of total energy derived from renewable sources, as a share of the city's total energy consumption', and indicators for the concentration of fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and ozone (O_3). These additions are in keeping with the environmental focus of ISO/TC 268, particularly AFNOR (see Chapter 5). Additional health indicators were added to measure 'suicide rate per 100,000 population' and 'number of mental health practitioners per 100,000 population', and a supporting safety indicator was added to give a measure of 'crimes against property per 100,000'. A corruption indicator was also added, 'number of convictions for corruption and/or bribery by city officials per 100,000 population', in keeping with an anti-bribery management system standard, ISO 37001, under development at that time. Few changes were made to the GCIF indicators, except to clarify their definitions and methodologies, and link them to other international organisations and agreements, such as the UN Millennium Development Goals.

The work conducted at ISO was not free from controversy. According to Maria-Lluisa Marsal-Llacuna (interview 36, November 25, 2016), representative of the Spanish standards body, UNE, a conflict emerged over how to define and measure 'sustainability'. On one side, highly developed nations wished the standard to include indicators for environmental quality and the effects of climate change. On the other side, countries from the Asia Pacific region, particularly SAC, argued that sustainability be limited to well-being. Her reflection on the conflict gives an indication of the power and politics involved in the working group.

> Of course there is the rapporteur of the standard, the convener, and the convener decides, supposedly based on consensus, but when there is no consensus the last word is for the rapporteur, [who] in this particular case was Patricia McCarney, the Toronto University professor. And she more-or-less, and her team, made up their own decisions, supposedly acknowledging all views and trying to figure out a consensus, but I can tell you that this sometimes was impossible. (Interview 36, Maria-Lluisa Marsal-Llacuna, *Asociación Española de Normalización*, November 25, 2016)

As the director of GCIF, McCarney had an interest in seeing the indicators through the international standardisation process as quickly as possible. According to Marsal-Llacuna, she used her position as chair of the group to resolve a heated disagreement in a manner accordant with the wishes of developed countries. Her abridgement of the ISO process was in service to a broad conception of sustainability and a perceived need for international governance mechanisms to address climate emissions.

Following the publication of ISO 37120, McCarney began the third phase of work, one of heightened legitimacy and initial consolidation under WCCD, followed by renewed development and growth. When I visited WCCD in early February 2016, core funding from the Ministry of Municipal Affairs and Housing was due to end. They hoped that by charging for ISO certification (7,500 USD for the first year and 5,500 USD for each year thereafter) they would be able to recoup their costs. Their ambition was to certify 100 cities in 2017. On the one hand, in the context of the annual budget of a local government in the developed world, this is not a significant amount of money. As the lead ISO 37120 auditor, John Smiciklas, said: "You know, nobody's going to make a living doing this, from my perspective and the auditor perspective. […] When I bring somebody on, I make them aware that this is very casual work" (interview 38, December 21, 2016). On the other hand, WCCD are the principal promoter and certifier of ISO 37120. Unlike the quality management standard, ISO 9001, for which there exists a marketplace of organisations accredited to certify the standard, in the area of urban indicators a single organisation has managed to establish what is effectively an ISO-sanctioned monopoly.

In the next section, I begin my exploration of the implementation of ISO 37120 by describing its verification and certification processes.

The verification and certification of ISO 37120

ISO 37120 formalises 100 performance indicators for measuring city performance on a range of urban issues (see Appendix 4a, Table A4.1, for a full list). The standard defines the indicators and describes how they are to be generated (ISO, 2014b). It divides them into two types: core and supporting. Core indicators act as a minimum requirement for full certification. Developers of the standard consider them to be readily accessible to all city governments around the world (ERM, 2008; ISO, 2014b). Supporting indicators are intended to be a little more challenging to meet. Different levels of certification are awarded depending on the number of supporting indicators that are met. Figure 7.1 shows the different gradations of ISO 37120 certification offered by WCCD (n.d.-e). The indicators are also arranged into 17 themes, which map onto city sectors and services: economy, education, energy, environment, finance, fire and emergency response, governance, health, recreation, safety, shelter, solid waste, telecommunication and innovation, transportation, urban planning, waste water, and water and sanitation. The weighting of each of the themes and their types are shown in Table 7.1, however, it is important to acknowledge that there is some cross-cutting between themes (ERM, 2008: 16).

By using different levels of certification, WCCD reward cities for the amount of data they submit, not what those data convey. While this is not unproblematic (Schindler and Marvin, 2018), the submitted data are themselves not reduced to a single-figure ranking system. This is explained in the final report to the World Bank.

> The focus here is not to rank cities: in fact, this initiative intentionally does not establish an aggregate score that sums up a city's performance across all of the indicators. There are already plenty of "best cities" and "most livable cities" rankings in various publications… A major focus of this initiative is to instead encourage networking and facilitate sharing of best practices among cities. (ERM, 2008: 27)

ISO 37120 is, as such, a more serious effort to benchmark cities than other popular city indices, such as the Economist Intelligence Unit's 'Global Liveability Ranking'—a sentiment expressed in several of my interviews. The awarding of certification based on submitted data is part of a mechanism designed to grow and improve the ISO 37120 database. While it is unfortunate that this communicates a sense of worth separate from what the data convey, to dismiss the indicators on this basis is to underestimate their actual and perceived value to cities.

Figure 7.1. The multi-level system of ISO 37120 certification offered by the World Council on City Data. Image is from the website of the WCCD (n.d.-e).

Table 7.1. ISO 37120 indicators separated by theme and type. Adapted from ISO (2014b).

Theme	Core	Supporting	Total
economy	3	4	7
education	4	3	7
energy	4	3	7
environment	3	5	8
finance	1	3	4
fire and emergency response	3	3	6
governance	2	4	6
health	4	3	7
recreation	0	2	2
safety	2	3	5
shelter	1	2	3
solid waste	3	7	10
telecommunication and innovation	2	1	3
transportation	4	5	9
urban planning	1	3	4
wastewater	5	0	5
water and sanitation	4	3	7
	46	54	100

When the WCCD data portal was launched in late 2015, it included data on 20 foundational cities: Amman, Amsterdam, Barcelona, Bogotá, Boston, Buenos Aires, Dubai, Guadalajara, Haiphong, Helsinki, Johannesburg, London, Los Angeles, Makati, Mecca, Melbourne, Minna, Rotterdam, Shanghai and Toronto. These cities had different reasons for implementing ISO 37120 and had been involved at different stages of the programme. The City of Melbourne had been one of the more than 200 cities to join the GCIP prior to it becoming an international standard. They were interested in benchmarking themselves against other cities, particularly on liveability, but found existing indices unsatisfactory and unfit for purposes of governance (interview 2, Nick

Casey, City of Melbourne, July 1, 2015). ISO 37120 appeared more authoritative, rigorous and sustainable. Despite some reservations over the standard's rapid development and an inability to be more actively involved, all those I spoke with were enthusiastic about its potential.

The City of Melbourne has been certified three times. Between its first and second years, it moved from a gold level to a platinum level certification. ISO 37120 is only a small part of Nick Casey's workload and in 2014 he prioritised meeting the core indicators. In 2015, many of the procedures previously used to collect, collate and calculate the measures could be quickly and easily replicated, and Casey could afford the supporting indicators more time and effort. By awarding different levels of certification, WCCD lower the barrier to the standard's adoption, while also encouraging cities to improve their status over time. They aim, ultimately, not to rank cities on this basis, but to build their ISO 37120 database, both in terms of the number of cities represented and the number of indicators that each city submits.

Before they are certified, a city must have their data verified by a third-party auditor. From the outset, this was perceived as being crucial to the legitimacy of the programme: "The system will be reliable as long as the auditors are well-known, independent and trusted, and the costs are minimal" (Hoornweg et al., 2007: 13). Despite this, verification began only after the indicators became an ISO standard. In September 2013, experienced ISO 9001 and 14001 auditor John Smiciklas, approached Patricia McCarney about developing a verification procedure. Two important decisions shaped its formation. First, given McCarney's experience with the programme and the amount of specialist, preparatory work that would be required before cities could submit their data, Smiciklas decided that certification would work best if conducted through WCCD.

> With these indicators, the true knowledge about the process really lies with the WCCD. They're the experts and so a process going through them, we decided, was probably the most value, valued by the cities, and would probably be the most cost effective for the cities as well. (Interview 38, John Smiciklas, ISO 37120 auditor, December 21, 2016)

WCCD do not appear to have any accreditation from a national or international SDO to certify ISO 37120. Instead, a private individual (and small business owner) decided that it would be in the interest of cities for them to spearhead the process. While an Austrian non-profit also offer ISO 37120 certification, they have yet to complete certification with their clients (ASIDEES, n.d.; ASIDEES, 2018). Second, Smiciklas also established that it is not the role of the auditor to gauge the accuracy or appropriateness of the data, so much as it is to ensure that the word of the standard is being observed. This allows outwardly inexplicable figures to sneak through and meet approval, as I will return to in the following sections. On the basis of these two decisions, Smiciklas and a colleague produced a

procedural handbook that includes a method for interpreting the data, describes links between the different indicators, and gives hints for how to scan the data and identify common mistakes.

Auditors work with cities on a case-by-case basis to ensure that the indicators meet the specifications of the standard. For each indicator, the auditor assures that a provenance document has been provided, that the submitted figure is consistent with what would be expected for a city of that size and type, that the figure has not changed significantly from the previous year, and that it is within a 95% confidence interval of data submitted by all other cities. If the data does not seem accurate, the auditor must work out why. A recurring example where this occurs is 'commercial air connectivity (number of non-stop commercial air destinations)'. This is calculated as "the sum of all non-stop commercial (i.e. scheduled) flights departing from all airports serving the city" (ISO, 2014b: 82), with only airports within two hours travel distance being included. Often cities submit data for the number of destinations, rather than the number of flights. The result is a figure several orders of magnitude lower than what is to be expected. For other, less clear examples, closer analysis of the data is required. The more knowledgeable and experienced an auditor, the less time the verification takes.

While the ISO 37120 audit may, on the surface, appear to be a rigid, formulaic process, in practice it is quite flexible and sensitive to particular circumstances. In 2014, some of the numbers submitted by the City of Melbourne were on the borderline of acceptability. For example, in his attempt to meet the core air quality indicator, Casey copied a figure from the website of the state-level Environmental Protection Agency. He failed to submit a numerator and denominator. Nevertheless, the figure was accepted.

> It was accepted by the verifiers […] but we have been told if you want to continue reporting this you have got to get the numerators and the denominators, the underlying data, and report that too. "We will accept what you did this year", and they may do it again, but it is pretty clear we need to do it properly. (Interview 2, Nick Casey, City of Melbourne, July 1, 2015)

Put differently, the auditor show clemency in their demand for complete and fully-accurate data.

When I asked Smiciklas about the potential to escalate the requirements placed on cities from year-to-year, he described the process in the following way:

> Somebody who's doing it for the first time, there's a bit of, I'm not going to say leniency, but there's a bit of understanding that they don't fully understand everything, or maybe everything isn't in place yet. By the second year, more of it's in place, and the third year, pretty much everything is in place. So, the cities provide us with better data, they provide us with better sources. They start to understand that

> we're not going to accept this, so we do start pushing back. (Interview 38, John Smiciklas, ISO 37120 auditor, December 21, 2016)

He describes this process as 'auditor experience'. Rather than pursue every technicality and punish cities for minor problems, Smiciklas encourages his colleagues to appreciate the purpose of the system as a whole. Had the auditor been too stringent with Melbourne, they may have prevented them from achieving certification. Instead, Casey was allowed to cut a few corners, with the expectation that his data generation processes be improved in subsequent years. This is understood by cities and does not need to be explicitly stated.

> I think because it's early days and they are establishing the program and they want it to succeed, they are going a little easier on us and allowing us a little more leeway […] I think that leeway is going to run out in a year or two and we will be required, like everybody else, to report the damn thing properly. (Interview 2, Nick Casey, City of Melbourne, July 1, 2015)

In 2015, the City of Melbourne initiated a dialogue with the Environmental Protection Agency in order to gain access to more detailed data.

As well as improving city performance, the audit process itself improves over time. The dataset that the City of Melbourne use to report 'number of homeless per 100,000 population', distinguishes between several categories of homelessness. The parameters used to define and measure homelessness are far from universal, and intersect with all sorts of situated ethical and administrative challenges. Differences abound in the classification of homelessness—whether it includes only those sleeping rough, or takes in individuals in shelters or staying with friends—and in the capacity of public bodies to count the number of each type[11]. These issues are contingent upon local norms and institutional histories of service provision. While global in one sense, homelessness nevertheless materialises as a specific, social phenomenon. In 2014, the ISO 37120 auditors advised that the categories used by the City of Melbourne be combined in one way, but in the next year, they suggested another. The result is a large apparent jump in the figure that does not reflect what actually happened in the city. Despite this initial inconsistency, the auditors have agreed upon the way to interpret Melbourne's data and the number has now stabilised (interview 38, John Smiciklas, December 21, 2016). Far from being an inflexible and regularised procedure, the ISO 37120 audit is fallible and

[11] ISO 37120 defers to a definition of 'homelessness' used by the United Nations Centre for Human Settlements. "Absolute homelessness refers to those without any physical shelter, for example, those living outside, in parks, in doorways, in parked vehicles, or parking garages, as well as those in emergency shelters or in transition houses for women fleeing abuse" (ISO, 2014b: 62). # 8. BSI PAS 181: policy patterns for smart, self-assured leadership

adaptable. It responds to the needs of individual cities so that over time, it might settle into a comfortable relationship with them.

A gap exists between what the verification handbook specifies and what the auditor actually does. Within this gap an additional role for the auditor can be identified: one of mediation. In the interest of helping cities to achieve ISO 37120 certification and encouraging them to continue reporting data in the future, they bend and stretch the rules, making accommodations in anticipation of gradual improvement. Their goal is to promote the purpose of the 'entire system'.

> To me it's kind of like, we use this phrase internally, it's like people who have memorised the bible, and they know every single passage, but what they don't understand is the entire meaning of it […] Let's step back and understand the meaning of [ISO 9001] is about meeting customer requirements, enhancing customer satisfaction. Let's look at the things that impact that, rather than small little technicalities of documents that are out of date. (Interview 38, John Smiciklas, ISO 37120 auditor, December 21, 2016)

ISO 37120 auditors act as mediators in two ways. First, they mediate between the ideal of the standard and the reality of the city. Whether due to an absence data, an inability to access data or simply a running out of time, the auditors show great tolerance for the fallibilities of the cities seeking certification. More than this, however, the auditors also mediate between how the standard is supposed to work and what it actually wants to achieve, that is between its process and its outcome. The ends of promoting urban indicators, outweigh the means of producing them in a universally consistent manner. Far from being cut, dried and standardised, this reveals a process of implementation that is brimming with human meaning and interpretation.

In this section, I have introduced the verification and certification mechanisms at work in the enactment of ISO 37120. Certification is highly visible. Bright, well designed marks are awarded to cities for the number of indicators that they meet. They are encouraged to improve over time, to submit more data and achieve a higher status. It is possible that in the future these certification levels will become more difficult to obtain. Supporting indicators might be 'graduated' to core indicators (ERM, 2008: 10), or their total number might be increased by a subsequent revision of the standard. The auditors, by contrast, are almost invisible. While third-party verification is crucial to the legitimacy of ISO 37120, what the auditors actually do is almost entirely hidden from view. And yet, like the certification marks, their mediation is crucial in understanding and shaping city practices. Together, these two mechanisms are able to address issues in a case-by-case manner. A process of convergence is at work (Bowker and Star, 1999), whereby inconsistencies in the data are slowly brought towards an ideal. Through a foregrounded multi-level certification scheme and a backgrounded process of auditor mediation,

WCCD are cleverly able to attract cities to ISO 37120, while also steadily increase the amount of data they submit and make it consistent with the data submitted by others. Indicator data does become more comparable over time, but it is still not without its foibles. In the next section, I turn to persistent problems which undermine the overall commensurability of ISO 37120 data.

Apples to apples: the commensurability of ISO 37120 data

During my interviews with employees and associates of WCCD it was often said to me that the purpose of ISO 37120 was to produce an apples to apples database of city data. This turn of phrase does important work. It acknowledges the present incommensurability of city data and proposes to rectify this. There are good reasons, both ontological and methodological, why it is difficult to compare cities on a global scale. It was in recognition of the weaknesses of existing indicator programmes that the World Bank began its work in this area. But the phrase also acts to naturalise the very possibility that all cities are comparable. By associating different sorts of cities with different sorts of apples, WCCD imply that cities are discrete, stable and reducible to a set of essential and well-defined features. The ontological critique of the commensurability of cities is suspended and the problem is rendered as one of methodology alone.

As with much other work on future city policies and technologies (see Kitchin, 2015), ISO 37120 is positioned as pragmatic and without ideology or political agenda. This is evident in the way it defines its target as an "urban community falling under a specific administrative boundary, commonly referred to as a city, municipality or local government" (ISO, 2014b: 12). The standard is, put differently, appropriate for "any city, municipality or local government that undertakes to measure its performance in a comparable and verifiable manner, irrespective of size and location" (ISO, 2014b: 12). The city with the highest population in the WCCD dataset is Shanghai, a municipality of 24,151,500 people under direct control of the central Chinese government. At the other end of the scale, with 19,369 people, is the Canadian town of Saint-Augustin-de-Desmaures, which between 2002 and 2006 was part of the municipal government of Quebec City. Where the original World Bank project was aware of the tension between the city proper and the city actual, and set a minimum limit on the size of the city to be included, ISO 37120 is far less discriminating. While this broadens the standard's appeal, it also internalises geographical and regulatory differences into the dataset. Pragmatism might be good for promotion, but in this instance it undermines the purpose of the standard.

Table 7.2. 2016 population levels at locally-significant scales in the cities of Melbourne and Toronto. Melbourne City Centre is a suburb under the jurisdiction of the local governments of Melbourne and Port Phillip. Downtown Toronto is taken to include Wards 19, 20, 27 and 28.

Melbourne, Australia		Toronto, Canada	
Melbourne City Centre	47,285	Downtown Toronto	326,880
City of Melbourne	135,959	Old Toronto neighbourhood	797,642
Inner Melbourne Area	591,679	City of Toronto	2,731,571
Greater Melbourne	4,485,211	Greater Toronto Area	6,417,516

This is most evident in comparisons of mismatched geographical extent. The City of Melbourne is one of 79 incorporated local government areas in the Australian state of Victoria. The Australian Bureau of Statistics defines the region of Greater Melbourne to include 31 of these areas (and parts of a further three adjacent areas). These can be subdivided into 13 outer metropolitan, 14 metropolitan and four inner Melbourne areas. Depending on where the boundary is drawn, Melbourne's population varies: 135,959 for the City of Melbourne, 591,679 for the inner Melbourne areas and 4,485,211 for Greater Melbourne. Compare this to Toronto, Canada. In 1998, the Government of Ontario, hoping to reduce expenditure, dissolved the regional municipality of Metropolitan Toronto and its six constitutive local municipalities: the Cities of Toronto, East York, Etobicoke, North York, Scarborough and York. These governments were consolidated into a single administrative body, a new City of Toronto (the previous City of Toronto became a neighbourhood area now referred to as Old Toronto). With this rescaling of its boundaries, the population of 'Toronto' jumped from 653,734 to 2,385,421. More recent figures place the population of the City closer to 2,731,571, and the population of the Greater Area (consisting of the regional municipalities of Durham, Halton, Peel, Toronto and York) at 6,417,516. Table 7.2 compares the 2016 population levels of Melbourne and Toronto at various scales, according to national census data.

At a certain level of analysis, there are sufficient historical and morphological similarities between Melbourne and Toronto to justify their comparison. The cities are of a similar age, population and geographical area. Both are composed a highly developed commercial core, surrounded by sprawling suburbs. Both are centres of capital, culture and education within their respective nations. Given, however, that ISO 37120 represents local jurisdictional boundaries, the data for these cities are often incomparable. This is not due to population differences *per se*, but rather to the way that that the scale of population relates to the city at large (or what is referred to as the modifiable areal unit problem by Openshaw, 1984).

For example, one of the core transportation indicators, 'annual number of public transport trips per capita', gives radically different results for the two cities. According to the WCCD (n.d.-a) data portal, residents of Melbourne made, on average, 1,009.18 trips

in 2014, while residents of Toronto made 201.9. There is good reason to question the reliability of these figures, however. The indicator is calculated by dividing the number of annual public transport trips originating in the area by its total population (ISO, 2014b: 77). As a vastly greater number of people travel into the City of Melbourne each day than live there, the calculation is top-heavy.

> [W]e have an awful lot of trips coming into the City of Melbourne on a daily basis because of that outsized daily population which includes about 400,000 workers. Then there is on top of that 100,000 or 120,000 residents. Then on top of that we have visitors who are here to tour the city and people who are here for leisure purposes, appointments and other purposes, and then tens of thousands of students… [W]e have a couple of million trips divided by [the residential] population. It ends up with a figure that looks a bit ridiculous and nobody thinks it is particularly helpful when we try to apply that to the Melbourne local government area. (Interview 2, Nick Casey, City of Melbourne, July 1, 2015)

Toronto also has an active tourist industry and two large, centrally-located universities. One would expect the number to be similarly distorted. Given that the population of the City comprises 43.2% of that of the Greater Area (compared to only 2.4% for Melbourne), it is safe to conclude that this effect would be considerably less. The WCCD data visualisation tools do not explain or account for this phenomenon.

Such incomparability not only occurs with respect to disproportionate spatial extents, but also as a result of the way that these geographies intersect with local laws and regulations. Two of the core education indicators describe (as a percentage) the completion rates of primary and secondary students. These are calculated as the total number of students belonging to a school-cohort who complete the final grade, divided by the total number of students who originally enrolled in that cohort, and then multiplying the result by 100 (ISO, 2014b: 21 and 22). Whenever the geographies of the school districts are different from those of the city, it is left up to the judgement of the analyst to fit the data. This is the case within the Victorian school system, where students attending private schools and certain public schools are not required to live in the same jurisdiction in which their school is located. But there is an additional problem.

> Our Department of Education, the state government, they hold onto the data very ferociously because they're protecting confidentiality of children, the students enrolled in the city. So they won't share with us data that matches, even at the very top level […] they won't allow us to have data that combines those two variables of postcode of schooling and postcode of residence. […] So we go with the second best approach, third best even, of just taking census data as our denominator and saying "Well, that's the total population of our municipality, and here is the numerator, is the total population of students enrolled in our municipality, because we can have

> that, and we just can't have where they came from, period". (Interview 29, Nick Casey, City of Melbourne, August 11, 2016)

Fewer students live within the City of Melbourne than attend school there. As a result, the completion rates end up as greater than 100%: 120.68% for primary and 147.02% for secondary. The auditors are aware of this problem, but powerless to affect it: "Most people go 'You can't have more than 100%'. Well, based on the definition of the standard, that is the correct number they are reporting" (interview 38, John Smiciklas, ISO 37120 auditor, December 21, 2016). For the City of Toronto, these numbers are a more reasonable looking 100% and 83.17%. What makes this data incompatible is not the ratio between the population levels of the local authority and the urban agglomeration, but differences in the way cities organise their education services and regulate access to the data generated about them.

Perhaps these differences could be accounted for by changing the definition of the indicator. But doing so for every anomaly would make the standard difficult to navigate and could introduce additional problematic assumptions into the data. Another example illustrates the kinds of locally-specific oddities that such modifications would need to consider. In Australia, voting is mandatory and everyone over the age of 18 is expected to register on the electoral roll. One might anticipate that Melbourne's governance indicator 'number of registered voters as a percentage of the voting age population', would be a high value. But one would not expect this figure to be over 100%. To understand why, requires knowledge of local government by-laws: "our voting system in the City of Melbourne, just the City of Melbourne, operates where businesses have two votes, residents have one vote each" (interview 2, Nick Casey, City of Melbourne, July 1, 2015). This peculiarity falls through the gap between the standard and its implementation. The auditor is bound by the word of the standard and the problem is likely to be too esoteric to be included in the ISO revisions process. As a result, without a deeper dive into the data, the figure cannot be meaningfully compared with any other city, let alone Toronto.

When comparing the cities of Melbourne and Toronto, it makes more sense to use data pertaining to the entire urban agglomeration than it does to their local governments. With a strong knowledge of the history and geography of the cities, and an awareness of the strengths and limitations of the datasets generated about them, meaningful comparisons can be made (for an exemplary study of this nature see Storper et al., 2015). The WCCD data portal invites such analysis, but its feasibility is undermined by the unruly materialities of cities and by the limits of the data that purports to represent them. It could be argued that measurements of the city proper are of little use in the governance of the city actual. This might be the case. But surely reliable comparisons at the wrong scale are better than unreliable comparisons at the right scale.

It is for this reason that the City of Melbourne has also sought certification for the Greater Melbourne region. While this region of contiguous local government areas is consistent with the urban agglomeration, sourcing data to achieve ISO 37120 certification at this scale is not without its challenges. For some of the indicators, where data are available at the postcode scale, auditor approval has been relatively easy to obtain. This includes much of the demographic data, as well as patent and police data. But for indicators relating to public services, such as energy and water use, more work has been required to source requisite data.

> [T]he big difference [was] in terms of workload and difficulty for me. It easily doubled the amount of time that I expected to spend, because not just are we replicating something at two different geographies, but, say the case of water, we're not just going to two companies, but we're now going to like five. And they're new relationships because City of Melbourne hasn't ever had to really deal very much with people who maintain the data at Coliban Water. Now we do. (Interview 29, Nick Casey, City of Melbourne, August 11, 2016)

Casey has not been able to obtain data for all of the core energy indicators and so Greater Melbourne has been awarded an aspirational certification. Improving this award is not seen as a high priority for the municipal government. Although comparisons between urban agglomerations are likely to face fewer of the difficulties discussed in this section, the specificity of the ISO 37120 indicators and the lack of a superintending governmental body can make finding appropriate data difficult.

This limitation on data availability is more pronounced in cities in developing countries. Minna, the capital of Niger State, Nigeria, were involved with GCIP shortly after the conclusion of the World Bank project. In 2014 they made the transition to ISO 37120, becoming the only African city on WCCD's register of foundational cities. Although Minna achieved only an aspirational certification, the general manager of Niger State Geographic Information Systems, Abdul Husaini, expressed optimism about the project and about the possibility of moving up to a bronze level certification in the future. In our interview, he suggested that Minna might be able to improve its data practices in consultation with Makati and Mecca, but was resistant to any effort at comparing the city to one from a developed country.

> But on a very more general scale, I think there is a very, very fundamental difference between developed and developing countries. When you come to show data, the type of data, your collection method. […] [Y]ou can't compare [developed cities] with a city that is even yet to understand which data can we use for this. So, I think we need to appreciate the level, where we are coming from, the rudimentary nature of some of this data and some of these cities […] to be able to move together with every city,

> irrespective of sophistication or elementary nature of that city. (Interview 47, Abdul Husaini, Niger State Geographic Information Systems, February 6, 2017)

Regardless of the scale, there are considerable barriers to the generation of comparable and accurate data for cities in developing countries. For Husaini, this fact alone makes participation in the ISO 37120 indicator programme worthwhile. It is only by being aware of data practices in other countries that his own work might be improved. For everyone else, comparisons between Minna and a city like Melbourne or Toronto, are likely to be highly inappropriate.

There is considerable unease and debate within critical urban studies regarding the ontological nature of 'the city' and the extent to which cities can be compared (Rickards et al., 2016). Even if we accept that all cities contain a set of essential features (cf. Robinson, 2006; 2011) and that it makes sense to apply concepts developed in a limited number of locations to all extant urban agglomerations (cf. Roy, 2011; 2014), there remain substantial methodological challenges to the generation of comparable city data. Variations in local laws and regulations, in institutionally established data practices, and in the geographical and temporal extents of existing data all undermine the feasibility of producing a truly rigorous, apples to apples database (see also Cohen, 2004; Satterthwaite, 2010; Brenner and Schmid, 2013). Even if ISO 37120 is the best candidate to overcome these obstacles, they remain significant. In this section, I have pointed to two obvious examples where direct comparison between cities should be avoided. There is little that Shanghai can learn from Saint-Augustin-de-Desmaures, just as there is little that can be learnt by comparing the data for Minna to those for any city in the developed world. These jurisdictions, and the data they generate, are profoundly different. But I have also conducted a more detailed analysis of Melbourne and Toronto, two cities which not only could be compared, but are already being so. By examining instances where the data are a bit odd, I have revealed fundamental differences in the policies and political geographies of these two cities. Even though Melbourne and Toronto are of a similar population, area and morphology, data about them are often incomparable. This leads me on to the question that I will address in the next section: if ISO 37120 data cannot be trusted to be commensurable, then what can they be used for?

The use of global city indicators

Cities that have achieved full certification with the standard report three principal benefits to having done so. First, the process of collecting and collating information is said to foster data literacy and build community around good data practices: "It makes people interested in data. It is building a culture of data in cities" (interview 19, Patricia McCarney, World Council on City Data, February 4, 2016). Within cities, ISO 37120

strengthens inter-departmental connections and raises awareness of the importance of knowledge exchange. This is in keeping with the systems theoretical assertion that optimal functionality is predicated on strong channels of communication. The legitimacy conferred by an ISO standard is crucial here.

> On one end, most close to my heart, is that it improves our practice and it helps the City of Melbourne and especially the city research branch to develop some kind of a credibility as the people who […] meet a standard and can be considered fairly reliable purveyors of truth on indicators and measurement. (Interview 2, Nick Casey, City of Melbourne, July 1, 2015)

This benefit helps account for the annual reduction in the workload required to achieve certification, and supports associations between the standard and the values of open and transparent government.

Second, ISO 37120 is associated with improved well-being and more efficient public services. The standard is understood as a way of monitoring the city as a whole and identifying areas that could do with greater scrutiny. In Toronto, the standard was connected to evidence-based decision-making and "an environment of continuous improvement" (interview 13, Jessica Stanley, City of Toronto, January 29, 2016). In Boston, emphasis was placed on the value of time series data and longtitudinal analysis.

> I think it will be interesting to compare over time against ourselves regardless of who else joins. […] [H]aving some external thing to respond to with these metrics, if we continue to do our job up here and continue to collect them and send them to ISO, then this set of metrics will be something we can track and hopefully [along with] other efforts throughout the city also build robust longitudinal data sets. […] It is good to have someone to respond to externally even if it is voluntary. (Interview 22, Matthew Resseger, Boston Redevelopment Authority, February 11, 2016)

As with the first benefit, the legitimacy and trust conferred by the international standard is seen to be central to the realisation of its promise. In this case, that promise is largely speculative and the interviewee recognises that "concrete plans are relatively sparse at this point" (interview 22, Matthew Resseger). In Melbourne, the city's ISO 37120 indicators have been integrated into the council plan and annual report (City of Melbourne, 2017; 2018a), and were supplied to the citizen jury that helped craft the Future Melbourne 2026 strategic plan (City of Melbourne, 2016). Cities are eagerly anticipating the change that the standard will drive. Without further evidence, it is difficult to remark upon whether it has actually done so.

Where the first two benefits operate within cities, the third and probably most significant, occurs between them. This is the ability for a city to benchmark its performance against its peers so that it can identify and adopt practices from elsewhere. Benchmarking is used to continually improve the performance of a firm or agency by

measuring products, services and practices, and comparing them against those of competitors in order to identify and adopt best practices (see Camp, 1989). All of the cities that I contacted were interested in being able to do this in a rigorous and repeated way.

> If we want to compare our city against another city we need to get a proper tool and use that tool. And that's why we went to the ISO because when we became aware of it, and then eventually when we were invited to participate, we thought it was an opportunity to not just improve practice here and understanding here, but a real opportunity to help contribute to something that measures and compares cities properly. (Interview 2, Nick Casey, City of Melbourne, July 1, 2015)

Cities are well aware of the difficulties involved in comparing themselves with others and of the limitations of existing programmes that attempt to do this. In this context, ISO 37120 is understood as the best currently available option.

While it is again too early to find strong evidence of the benefits of ISO 37120 benchmarking, there is some indication that it may be just around the corner. Joseph Pennachetti is currently part of the WCCD leadership team. Before this he was as the Chief Financial Officer and then the City Manager of the City of Toronto. He is well-positioned to describe potential applications of the standard.

> [I]t surprised us that our reduction of waste and our diversion of waste is literally one of the highest in the world right now, and so people were coming out saying, "How do you do it? What did you do?" L.A. was higher than us and I was able to find out from L.A. "How did you do this?" […] And one of the goals in Toronto now is to continue the discussions with L.A. to find out how they reduce commercial waste across the city. (Interview 10, Joseph Pennachetti, World Council on City Data, January 26, 2016)

This is confirmed by Ilja Green and Jessica Stanley, the co-ordinators of the City's ISO 37120 implementation. When I interviewed them in early 2016, they had just held their first teleconference with other foundational cities and were keen to begin putting subject-area specialists in contact. In addition to L.A.'s solid waste, they hoped to be able to learn from London's experience in public transport management.

Curiously, by speaking with cities about their experiences with ISO 37120, and then sharing those experiences with other cities, I helped establish connections through which such knowledge exchange may occur. On several occasions—but only ever with explicit permission—I shared contact details between interviewees. Once, ensuing discussions between Melbourne, Toronto and Boston lead to the organisation of a teleconference in which urban foresters were given the opportunity to share data practices.

> Our urban foresters are very interested in being able to benchmark biodiversity in line with the ISO and have something they can play with and compare overseas as well. So we, we arranged a slight chat [with Toronto and Boston] which completely

> failed. The technology was just not up to the task, at all. I was really embarrassed, and the urban foresters just ended up next week anyway connecting just via a series of email chats and getting what they were interested in anyhow. (Interview 29, Nick Casey, City of Melbourne, August 11, 2016)

While it is, as one interviewee put it "difficult to schedule a meeting with Dubai and Melbourne and São Paulo and Boston and Toronto all in one time" (interview 13, Ilja Green, City of Toronto, January 29, 2016), the technical difficulties described by Casey will probably lessen over time. The desire for learning is high. It is likely that ISO 37120 certified cities will continue to strengthen their relationships and orchestrate further interactions. While it was not WCCD who initiated contact on this occasion, they have since begun to establish local data hubs with this end in mind (WCCD, 2017b).

Dublin City Council are also quite interested in being able to benchmark themselves internationally. Nevertheless, they have yet to attempt formal implementation of ISO 37120. When I interviewed Gavin McArdle (interview 1, Maynooth University, June 24, 2015) about this, he was a colleague of mine on the Programmable City project. He had conducted an ISO 37120 feasibility study for the City Council, drawing on experience he had gained during the development of the Dublin Dashboard (Kitchin et al., 2015). While McArdle believed that it should be possible for the city to meet all of the indicators, he said that many would require working directly with the national collection agencies to disaggregate data to the appropriate geographical scale. This is not an easy task and the City has not invested the time and effort it would require.

Internationally recognised cities tend to perceive aspirational certification as a failure and so are hesitant to implement the standard unless they can be assured of a gold or platinum award. Indeed, the danger of looking bad amongst other cities, of somehow not measuring up, is one of the biggest barriers to standardisation. WCCD responds to this by attempting to placate and reassure.

> After going through [MBNCanada] for 15 years, Toronto didn't look good in all areas, and we learned in certain areas, and enhanced our service delivery and/or reduced our cost in certain areas once we saw and learned from others. And at the end of the day, what I end up saying to most cities is "You're going to find out you're going to be about 50-50. You're going to look good on half of them, and you're going to look poor, or out of whack, on another half, but that's life. That's the way most cities are". (Interview 10, Joseph Pennachetti, World Council on City Data, January 26, 2016)

The argument proceeds that without benchmarking it is impossible to identify the areas that need improvement. Without looking bad, cities cannot get better. And the WCCD have been successful in convincing some cities of the standard's overall benefit. As of the time of writing, their website reports a total of 87 certifications, for 58 municipal

governments (WCCD, n.d.-b). While WCCD have not have been able to grow as quickly as they would have liked, they have grown.

For those working on ISO 37120 in Boston, the attractiveness of benchmarking only increases as cities continue to come on board. Nevertheless, they recognise that there is little to be gained by comparing themselves to every other city. Careful decisions need to be made about which other cities make for a suitable benchmark. In order to help facilitate this process, each city submits data for an additional 39 profile indicators. Examples include a city's population, its number of households, its average household income, its type of government and its annual average temperature (for a full list of the profile indicators, see Appendix 4, Table A4.2). These are not themselves intended to be used for benchmarking and are not verified to the same extent as are the core and supporting indicators.

While many of the profile indicators present no difficulty for a city, others require considerable work. Matthew Resseger, an economist at the Boston Redevelopment Authority, discussed for 10 minutes the problematic assumptions that went into 'city product per capita'. Essentially, these related to his attempt to apply state level data to the municipality, while also factoring in differences in the composition of economic sectors at these scales. He concluded by remarking on the weaknesses of using that profile indicator to make benchmark assessments: "I wouldn't necessarily look at that one because how anyone else is cooking that up from the data we have at the city level is probably going to vary a lot and could result in wildly diverging GDPs" (interview 22, Boston Redevelopment Authority, February 11, 2016). Without guidance from the standard, WCCD or third-party verifiers, some of the profile indicators risk being inaccurate and unrepresentative. Not only do cities need to be careful when selecting their benchmarks, they also need to be careful about which data they allow to inform that decision.

Those in Toronto's City Manager's Office would prefer that WCCD take steps to minimise the need for such a decision entirely. They worry that cities are being accepted into the programme too quickly, and that this undermines comparability and their capacity to inform indicator definitions and methodologies. They would prefer a rigorous inclusion criteria so that the growth of the dataset is more controlled. This is a sticking point between the City of Toronto and WCCD. The former wants to slow down and ensure that the programme continues to serve cities. The latter is satisfied with the indicators as they are and wants to rapidly expand the programme to secure its financial sustainability. As Pennachetti put it, "that's the way things happen because you're moving so fast" (interview 10, World Council on City Data, January 26, 2016). But this disagreement can also be used to prise apart important differences in the perceived benefits of ISO 37120. It is to this task that the next section is dedicated.

Employees of the City of Toronto have expressed concern over WCCD's drift away from public funding. They worry about the intentions of the organisation and about the future of the indicator programme that they have themselves helped advance.

> So [the programme] was initially funded by the World Bank, then it was sponsored by the Province of Ontario I believe. There has been a number of different sponsors. Now it seems they are going a little bit more corporate and that is not a secret, it is right on their website. And a couple of people have asked us this question. "What does that mean? We are a public entity: what is their involvement with this initiative?" (Interview 13, Ilja Green, City of Toronto, January 29, 2016)

WCCD (n.d.-c; n.d.-d) have announced a foundation partnership with Philips Lighting and a strategic global partnership with Siemens. It seems that in exchange for financial support, WCCD are using their knowledge of the ISO 37120 data to publish impact assessments of smart city technologies (Philips and WCCD, 2017). While the precise nature of these partnerships has not been made public, there is no evidence to suggest that they have had a direct bearing upon the standard or on the decision to limit access to its data. My research indicates that withdrawal of core funding left WCCD scrambling to find a business model to keep their project in operation. Business research and marketing is clearly one aspect of this, but it is not the only one.

WCCD point to two additional benefits of certification not identified by cities. First, they argue that their online portal offers a suite of tools that can assist cities in the visualisation and analysis of their data. While this is undeniable, it is no accident that this was not mentioned outside WCCD. Large, well-funded cities, such as Boston, Melbourne and Toronto, already have in place sophisticated pipelines for data analysis, visualisation and reporting. These tend to rely on specialised desktop software, rather a web browser, and be more flexible and offer greater spatial and temporal detail than the WCCD portal. While smaller municipalities do not have these expertise in house, there are often state agencies and research projects at their disposal that do. The Metropolitan Area Planning Council serves the 101 cities and towns of the greater Boston area. Their Data Services Department undertake work for the smaller municipalities in order to help them make the best use of available data (interview 20, Timothy Reardon, Metropolitan Area Planning Council, February 8, 2016). The Australian Urban Research Infrastructure Network, based at the University of Melbourne, curates a large number of open data sets for analysis by government and academic researchers. Their remit includes the development of a web interface to this data and they have expressed an interest in integrating the ISO 37120 indicators into this (interview 30, Serryn Eagleson, Australian Urban Research Infrastructure Network, August 17, 2016). MBNCanada (2017)

produces an annual report of its indicators. This includes simple visualisations of the data that participating cities can take away and use at their own discretion. There is benefit to the data analysis and visualisation tools offered by WCCD, especially for small municipalities that do not have publicly-funded expertise that they can draw upon. But this offering is neither unique nor cutting-edge.

The second benefit is more innovative. WCCD argue that ISO 37120, and its supplementary standards for smart and resilient cities, ISO 37122 and ISO 37123, will help municipalities to save money and unlock new revenue streams. At the time of writing, their website states that the indicators will help "leverage funding with senior levels of government" (WCCD, n.d.-e). McCarney elaborated on this during our interview.

> When you have good data you can actually leverage funding. So in the case of Canada right now, we have a new liberal government under Prime Minister Trudeau. He has announced a huge infrastructure investment fund, billions of dollars for urban infrastructure investment. How is that government going to make a decision for infrastructure investment of that magnitude across the cities of Canada if you don't have good comparative data? So if you have robust data it defines the investment openings. (Interview 19, Patricia McCarney, World Council on City Data, February 4, 2016)

Third-party verified data gives funding agents confidence in their calculations by lowering perceived risks and decreasing the uncertainty of return on investment. As such, cities which have achieved certification will be more attractive than those which have not. This logic can also be applied to international investment funds and foreign direct investment. It is, furthermore, in keeping with the original aims of the World Bank project to measure the impact of their loans on cities in Latin America.

On an earlier version of their website, WCCD included another financial benefit of the indicators: that they be used to "build creditworthiness and insurance security" (WCCD, 2015). Again, McCarney offered clarification of this idea in our interview, particularly in light of the resilience indicators currently under development as part of ISO 37123.

> If you have good robust data around resilience (how prepared are we? how fast do we recover from shock? how protected are we against our basements flooding?) […] then we can actually use it to save money, because if you lower your insurance premiums by a fraction of a percent it is tens of millions of dollars. So I think the efficiencies of and budget cost savings around insurance you will also start to see as we are building out the resilience indicators. (Interview 19, Patricia McCarney, World Council on City Data, February 4, 2016)

Insurance and reinsurance providers conduct detailed assessments of the likelihood and impact of disastrous events. Again, the logic is that better data will mean greater

confidence in the calculations and a reduced perception of risk. The same can be said for the calculation of creditworthiness by banks and bond ratings by other financial agencies. But where higher levels of government might have an amount of money that they are looking to divvy up, the same is not the case for insurance companies. In the past, risk mitigation has worked by combining together the resources of individuals and organisations such that the economic burden of an unlikely misfortune befalling one is distributed amongst the whole. As more granular and higher-quality data become available, these calculations are no longer looking to combine individuals but split them apart (Bouk, 2015). The exposure of the insurance company, or indeed the overall industry, is unlikely to change. Rather, as the calculations become more personalised, some will pay less for their insurance while others will pay more. Better data does not necessarily mean that a city will save money on its insurance premiums—especially as the number of certified cities increases. ISO 37120 and its supplementary standards, ISO 37122 and ISO 37123, are a sword that could cut both ways.

The financial aspirations of WCCD have the potential to be fundamental to their long-term success. A word of wariness is in order, however. Most of the city representatives I asked about these benefits were lukewarm to the possibility that the standard could save them money. The response of Boston Redevelopment Authority economist Matthew Resseger, was probably the most telling. With a bemused laugh, he said that although it was a good long term goal, "I don't think people thinking of Boston municipal bonds are running to the WCCD at this point" (interview 22, February 11, 2016). Indeed, the work that had been done by WCCD in this area at the time of my Toronto fieldwork was of a preliminary and speculative nature. In my interview with Ng, she said "Right now really we have only spoken to Joe Pennachetti about it and he thinks it is a really important key aspect of what we are doing here. So we are still exploring that" (interview 18, World Council on City Data, February 4, 2016). They did nevertheless intend to hold a series of workshops on the issue.

In bringing far flung municipalities together, the standard helps untether policies, products and services from the particularities of their location. Better data effectively lowers the time and effort required to fit an idea to a new setting. While urban geographers have conceptualised this movement of ideas in terms of policy mobilities (McCann and Ward, 2011) and fast policy (Peck and Theodore, 2015), I have elsewhere adopted a different approach (White, 2016b). In the case of ISO 37120, it is not policies that are made to move, but rather the city which is made more amenable to things from elsewhere. Drawing on Tsing (2012; 2015), I have interpreted comparable indicator data as a medium for the translation of complex systems. Rather than an economy of scale, what is enabled is an economy of translation. But while this might help explain the economic mechanism of global city benchmarking, it does not account for the use of ISO

37120 data in financial calculations. It is for this reason that I want to here theorise the standard as a political technology for steering cities.

The ambitions of ISO 37120 are consistent with neoliberal governance. The standard promises high quality data that can be flexibly applied to a variety of state and non-state needs. Responsibility for the co-ordination and management of the functions of government is dispersed amongst a network of actors. This is in keeping with the governance turn, as described in Chapter 4. But the standard also facilitates the application of microeconomic assumptions, logics and models to urban (re)development and public service operation. Evidence-based policy and decision-making need not be neoliberal in character. However, in the context of a highly financialised moment of global capitalism (Krippner, 2011; Lapavitsas, 2013), the danger is that data released by municipalities in accordance with values of openness and transparency, is stripped of its context and reduced to naked facts. Cities risk becoming ever more entangled with international markets; their forms, functions and futures fragmented into tradeable assets held by firms with little material interest in the livelihoods—let alone democratic will—of a city's inhabitants. By connecting cities, WCCD helps them to learn from one another and manage the complexities of the contemporary world. But by using their data to deepen and improve financial calculations, the standard itself becomes a means of capital accumulation.

ISO 37120 was born out of the desire to enable better monitoring of UN-Habitat and World Bank investments. Although Latin American cities were its initial target, expertise in municipal data came by way of a partnership with Infrastructure Canada. Thus, as the indicators matured, their focus drifted away from cities in developing countries. They became less an instrument for measuring international development, and more a means for improving data practices, opening new channels of communication and learning from others. But the tension between developed and developing countries persists. Cities implement ISO 37120 in order to be able better steer their services. But the standard proliferates the points from which such steering can occur. The liberal values of government transparency and knowledge exchange come to sit uncomfortably alongside a neoliberal logic in which the future of the city is secured by the calculations of profit-maximising firms.

Conclusion

Throughout their involvement in the development and implementation of the global indicators, representatives of the City of Toronto have stressed the importance of being able to properly tell the story of the data they produce (see for example ERM, 2008: 10). Without context, an indicator is just as likely to be misleading as it is illuminating.

> *Ilja Green:* We should be able to have a mechanism where these comments and observations can be shared. In the absence of having these crazy international webinars, we should be able to share our influencing factors that sometimes really influence the result quite significantly.
>
> *Jessica Stanley:* To be able to pick a data point from L.A. and open it up and say, "This is the reference source, these are the influencing factors, this is how we got it", or whatever. That's…
>
> *Interviewer:* Tell the story of the data.
>
> *Jessica Stanley:* Exactly.
>
> *Ilja Green:* Which is really challenging when you are just looking at data visualisation from an open data perspective, you often remove that narrative.
>
> (Interview 13, City of Toronto, January 29, 2016)

Behind the publicly available ISO 37120 data, there exist invisible numerators, denominators, confidence intervals, auditor comments, and provenance and licensing information. Not only is this inaccessible, but WCCD are actively seeking to prevent its disclosure. When Nick Casey uploaded ISO 37120 metadata to the City of Melbourne's open data portal, he was asked to take it down. Without this information, the stories behind the indicator data are impossible to tell. But even those data that are available have had artificial restraints placed upon their access. WCCD have back-peddled on their open data policy and continue to insist on a bespoke web portal that lacks an API. These controls are nothing less than a betrayal of the intentions of the World Bank, and the time and effort that cities have invested in developing and fine-tuning the indicators.

There are other procedural irregularities that threaten the integrity and objectivity of WCCD. After GCIF were allocated the stewardship of the indicators, they continued to develop them alongside cities. ISO were petitioned to adopt them as an international standard, and they were eventually accepted and fast-tracked through the consensus process. Given her involvement in their development, McCarney was allocated the chair of the ISO 37120 working group, where, by one account, she used her position to decide upon contentious issues. Following the publication of the standard, McCarney co-founded WCCD to certify the standard and develop a registry of the cities involved. This new organisation has capitalised on the legitimacy granted by ISO, and has positioned itself as the standard's principle promoter and certifier. WCCD are not accredited to do this by any third-party and the nature of their relationship with the auditors they sub-contract is far from clear. While I repeatedly contacted McCarney to clarify these issues, she has refused to comment.

In this chapter, I have exposed two tensions that weaken the purpose of ISO 37120. The first, between the city proper and the city actual, is negotiated by fixing the indicators

to local governmental geographies, thereby undermining the commensurability of the dataset. While the data are presented as if they were apples to apples comparable, in truth careful decisions need to made about which cities to compare and how to compare them. The second tension, between cities in developed and developing countries, leads to an ambiguity over future uses. Cities typically join the programme in order to be benchmarked against their peers. But in so doing, they are also opened up to a financial calculus that will distribute governance capacity to unelected organisations with limited accountability. In holding back relevant metadata and restricting derivative analysis, WCCD are limiting the ability of cities to benchmark themselves effectively. The most likely explanation for them doing this, is that they have some sense of the value of the information and do not want to foreclose revenue streams based on selling full access. Cities would certainly make for potential customers, but so too would technology companies, international banks and financial firms.

The story of WCCD and ISO 37120 is ongoing. The number of certified cities continues to grow and new standards for smart and resilient city indicators are due to be published soon. In early July 2018, a new version of ISO 37120 was released. The revision tightens up some of the definitions, introduces an additional theme for culture, and adds indicators for affordable housing, vacancy rates, living space sizes, commute times and for energy sources other than electricity (Biron, 2017; Naden, 2018). The WCCD continue to publish reports on the data (WCCD, 2017a), sign declarations and memorandums (WCCD, 2017c; 2017d), and contribute to important international summits (Biron, 2017). In a recent interview, McCarney also emphasised the importance of improving the participation of cities in developing countries.

> One of the biggest parts of our next steps is to start to consider how best to support cities in Africa, Asia and Latin America that require training and support to get their data up to the same high calibre that we're seeing across all the other cities reporting off 37120. We're now actively reaching out to global partners to help support cities in Africa and other regions. (Biron, 2017)

WCCD seem to be going from strength to strength. Hopefully, once this translates into financial stability, they will bring their open data practices into alignment with their open data rhetoric. Cities will only be able to reap the rewards of the indicators that they not only produced, but helped to define, if they are granted full access to ISO 37120 data and metadata.

8. BSI PAS 181: POLICY PATTERNS FOR SMART, SELF-ASSURED LEADERSHIP

Introduction

In January 2017, just over six months after the Brexit referendum, I asked Trevor Gibson, manager at Peterborough DNA and member of the BSI PAS 181 steering group, how the decision to leave the European Union would impact the country's smart city sector. I believed that the decision would complicate standards and regulatory compliance in the UK, and that export opportunities would suffer as a result. Gibson, however, was cautiously hopeful.

> I've heard talk of this within [the] British Standards [Institute]. Maybe for this sort of thing, it could be an opportunity. You know, reaching new markets with some of these ideas, some of this thinking. It might be an opportunity to step that up. It certainly will be a priority for the British government to find very quick ways of making those connections globally. Maybe standards and business interactions that result from standards, smart city or otherwise, might be seen as a way forward. And I'm sure that's the way BSI will look at it internally. (Interview 40, Trevor Gibson, PAS 181 steering group, January 12, 2017)

His hope, and the hope of BSI more generally, is that Brexit will open up new business and trade opportunities in Asia and the Middle East (interview 6, Dan Palmer, British Standards Institution, November 12, 2015; see also BSI, 2018). Indeed, Gibson had already been active in promoting PAS 181 abroad. Along with Graham Colclough, he has delivered a Smart City Leadership Programme through the Foreign and Commonwealth Office in India. Workshops in Bhopal, Indore and Amaravati (the planned capital of Andhra Pradesh) (Gibson, 2014), have introduced smart city governance practices to local leaders in government, business, the third sector and academia (BSI et al., 2015; Future Peterborough, n.d.). Discussions to deploy the workshop in Taipei and Cyprus were also ongoing.

It is not simply that BSI wish to expand their business internationally. Rather, their principal objective is to develop the smart cities market as an export industry for UK businesses. Standards are understood as both a means for achieving this and as a signal of general national competency (interview 6, Dan Palmer, British Standards Institution, November 12, 2015). And yet the challenges facing cities in Asia and the Middle East are unlike those facing cities in the UK. Cities are different; "no two cities are alike and their challenges differ in content, context and scale" (Gibson, n.d.). PAS 181 recognises this repeatedly (BSI, 2014a: 4, 12, 16, 26 and 50). Within urban studies, there is ongoing

debate over whether the scale of urbanisation underway in China and other Asian nations demands new concepts and theories (see Ma, 2002; Roy and Ong, 2011; Wang and Liu, 2014). Nevertheless, the population and urbanisation trends cited by BSI (2014b: 4) are global in nature. It is asserted (contrary to projections of the UN, 2018) that by 2050, 80% of the world's population will live in cities, the same percentage as in Britain today (BSI, 2014a: 1). The argument proceeds as follows. As a highly urbanised country and leader in project management, urban governance and other professional services related to smart cities, the UK is well placed to sell its expertise to rapidly urbanising cities in the developing world (HM Government, 2013: 38). Through their standards, BSI have attempted to distil the experiences of UK cities into a set of flexible guidelines that can be applied anywhere. As Gibson (n.d.) puts it, on offer is "complexity simplified through bite-sized chunks!".

'PAS 181:2014 Smart city framework – Guide to establishing strategies for smart cities and communities' describes a four-part management system for smart city leadership. Its intended audience is not only local governments, but leaders "at all levels and from all sectors" (BSI, 2014a: 2). As a leadership guide, however, it is quite unlike other voluntary consensus standards. Design standards offer precise technical specifications (Timmermans and Berg, 2003: 24–25). Performance standards express tolerable limits for an object's properties and functions. Even most procedural standards detail what processes must be put in place in order, ultimately, to achieve certification. PAS 181 offers advice—it only ever describes what a city *should* do. Despite acknowledging that cities are different, the standard presents the experiences of UK cities before building towards general recommendations (see for example BSI, 2014a: 12). But there is a risk that in publishing guidance in this particular format that advice is taken as an assertion and that suggestions become standardised. PAS 181 blends the worlds of policy and engineering.

> [T]here's quite a deep engineering culture to the standards profession, where things can be systematised into black and white and described and measured and standardised and repeatable and all of that. In the world where I come from, which is around strategy and policy and trying to herd cats, as it were, in a human, complex, messy, contested environment, the world's not like that. But what I think has been quite helpful is trying to mesh some of the two together. (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

This brings me to the questions that this chapter will seek to address. How does PAS 181 make its recommendations amenable, in strategy and style, to cities in Asia and the Middle East? What messy, contested environments does it systematise in black and white? And what is the character of the opportunities that Brexit opens up for future cities?

The chapter is structured in four parts. I begin by exploring the contingent and contested origins of the transformational government guidelines contained in PAS 181. In 2013, the UK Department for Business, Innovation and Skills (BIS) commissioned BSI to develop a suite of smart city standards. PAS 181 was an early outcome of this. But many of the ideas expressed in the standard grew out of work conducted in the Cabinet Office in the early 2000s. I briefly follow the career of technical author Chris Parker in an effort to tease these out. In the second section, I compare PAS 181 to two of its earlier incarnations: CS Transform's (2010) white paper on 'Citizen Service Transformation', and the Transformational Government Framework (TGF) developed by the non-profit standards consortium Organization for the Advancement of Structured Information Standards (OASIS, 2013; 2012). I chart the emergence of its four-part structure and its use of a particular linguistic style, both of which help break the standard into pieces that can be adopted by leaders in part or in whole. Having introduced PAS 181, its institutional setting, its structure and its style, in the third section I analyse its content. Four key policy positions are identified: a holistic approach to cities and citizens; the (re)integration of municipal services; the adoption of agile management practices from the private sector; and a preference for the commissioning of government services. I make explicit the connection between these positions and the Third Way politics of Tony Blair's New Labour government, before using this as a prompt to draw out three tensions: between decentralisation and integration; between citizens and businesses; and between being citizen-focused and leadership-driven. In the fourth section, I argue that in addition to its linguistic style, an important aspect of the standard's strategy is the affect it helps induce. PAS 181 signals a shift in standardisation from formal certification to voluntary compliance, that is, from what must be done to what should be done. The assurance it offers city leaders is of the far gentler and more explicitly emotional sort. I conclude by pointing to the irony that despite being poorly adopted within the UK, PAS 181 is nevertheless being steadfastly promoted on the international stage. It appears that this is due less to the perceived value of the standard, than to strategic ambitions to reaffirm the UK's global reputation in governance and management consultancy. In elevating policy recommendations to the status of an internationally available standard, PAS 181 has turned politics into engineering for economic ends.

Origins of PAS 181

In early 2012, in a climate of economic austerity, UK prime minister David Cameron asked Conservative politician Michael Heseltine for his recommendations on improving national wealth creation. Seven months later, Heseltine (2012) published 'No stone unturned in pursuit of growth', in which he argued for the devolution of state funding

from central government to local enterprise partnerships. Amongst the report's 89 recommendations, was a call for co-operation between BSI, the Technology Strategy Board (TSB) and Research Councils UK to set standards earlier in the process of technological development.

> As we see in all walks of life, those who set the agenda often enjoy a clear advantage over those who simply follow. So it is with technology—the countries that lead the way developing standards for new innovations enable their businesses to take that first mover advantage onto the international stage. (Heseltine, 2012: 101)

Far from being "a form of government intervention or regulation" or "an after thought", standards are understood to be crucial in generating national competitive advantage (Heseltine, 2012: 101–102).

While Heseltine did not specify which technologies were ripe for British standards, the Department for Business Innovation and Skills were quick to respond, incorporating the British Standards Institution into their information economy strategy. In June 2013, they published a report identifying smart cities as a growth sector for the UK economy (HM Government, 2013). A number of efforts to consolidate the country's status as a leading exporter of computer and information services were described. These included TSB's Future Cities Demonstrator Programme, the Future Cities Catapult, and BSI's strategy for smart cities. In addition to the export opportunities these would bring about, BIS were keenly aware of the domestic benefits of an active smart city market (BIS, 2013: 3).

BSI (2013) also published their first position paper on smart city standards in June of that year. In it they identified three sites of possible work: components and devices; systems and services; and city management. While they wished to ensure the interoperability of smart city technologies, a scoping exercise had found ample existing standards *within* service delivery systems (such as education, health and public transportation).

> I think one of the initial thoughts was really that it would all be about interoperability and technical standards. And as we went into it and the more we spoke to cities around the challenges that they are facing, we began to understand that actually the technical stuff wasn't the biggest problem at all. It is much more about the city's capability to deliver some of this. (Interview 6, Dan Palmer, British Standards Institution, November 12, 2015)

Despite these findings, the BSI did recognise a need for interoperability standards *between* systems. Systems and services would benefit from standardised vocabulary, performance metrics and risk management practices, and city management could be improved by standards for global city indicators and a decision-making framework. PAS 180, a smart

city vocabulary, and PAS 181, a smart city framework (SCF), were introduced to attend to some of these needs.

A Publicly Available Specification (PAS) is not a full British standard and is not produced in the same way (BSI, 2012). Instead of establishing a consensus-driven technical committee, BSI appoints a technical author to write the document and a steering committee to provide input to this process. Once the standard has been written, a period of public consultation and review follow. The intended purpose of a PAS is to respond to an industry need in a timely manner. In the case of smart cities, this process was used to formalise the somewhat tentative knowledge of a small number of individuals.

> We are talking about creating standards based on the knowledge that is in people's heads that hasn't yet been fully prototyped and demonstrated. So it is a bit more iterative than: there is something we have to document here. We have to be willing to try to create consensus around what needs to happen based on a number of examples in different cities and drawing out the common factors. So PAS 181 for instance, we actually ended up having extra steering group meetings to establish agreement about really what the content of the standard needed to cover. (Interview 6, Dan Palmer, British Standards Institution, November 12, 2015)

Given the way that a PAS is developed, it can not be assumed that it represents general industry opinion. This has important methodological consequences. To treat a suite of eight such documents as the singular 'British Smart City Standard', as do Joss, Cook and Dayout (2017), is to elide the significance of the differences between them. Instead, it is crucial that research attend to individual technical authors and the context by which their words gain traction.

BSI awarded the technical authorship of PAS 181 to government management consultant Chris Parker. In the 1990s and early 2000s, Parker worked for the UK government, first in the Department of Trade (precursor to the Department of Business, Innovation and Skills) and then in the Cabinet Office, where he was Deputy e-Envoy, responsible for digital government and the knowledge economy, under Prime Minister Tony Blair. The Office of the e-Envoy was founded in 1999 with the task of creating an authoritative, centralised website for government services. Despite its considerable budget, results were mixed. In 2001, controversy emerged when it was discovered that the Office's principle contractor, Microsoft, had developed services that were only accessible using their own software products (Lettice, 2001). While this was soon rectified, the public response to the website was lukewarm. In a National Audit Office report, Dunleavy et al. (2002) blamed poor adoption rates on an emphasis on availability rather than uptake. They also noted that the site lacked up-to-date, high-quality information on central government. Nevertheless in 2004, Parker's boss, Andrew Pinder, declared that his efforts had been a success, citing an Economist Intelligence Unit report that ranked

the UK second in the world for e-readiness (Mathieson, 2004). There are reasons to doubt this assessment, however. E-government projects have proven difficult to measure. Comparative evaluations tend as such to vary in their results (see Margetts, 2006). It was only through considerable independent qualitative research that Dunleavy et al. (2006a) were able to highlight the poor performance of the UK with respect to other developed nations, such as Australia, Canada and Sweden.

In 2004, the Office of the e-Envoy was replaced by a far smaller and less well-resourced department. In response, Pinder, Parker and a few colleagues spun-out a private company, gov^3, in order to sell their knowledge and expertise to an international market. The consultancy appears to have met with significant initial success. In their first two and a half years of operation, they claim to have worked with clients in more than 30 countries, including China, India and the United States (Pinder, 2007). But when the global economic crisis struck, gov^3 were overextended and in July 2009 they went into liquidation (Companies House, n.d.). Determined to persevere, Parker and a fellow director founded a new company, CS Transform. Inheriting the assets and client list from gov^3, this consultancy has proven profitable.

Rather than a city specialist, Parker describes himself as a government transformation specialist; "managing change inside the public sector, particularly across organisational boundaries […] to get different organisations working together in new ways […] and working across public and private sector boundaries in new ways" (interview 26, Chris Parker). He understands governments around the world to be similar enough to warrant the international standardisation of these new ways.

> So when we started in the business, we were very conscious of not wanting to go to countries [and say], "Here, we're from the UK and we can help you". We were saying explicitly, "We're not trying to sell a UK model (G7, rich country, *etcetera*), but we're smart people who have been in your position and we can help". As we got into it, it became clear that actually, whether in China or Croatia or Zambia, there was some real commonality in the challenges that people were facing and some commonality in what seemed to be effective approaches at managing change. (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

CS Transform are a demonstrable example of the export opportunities that BIS and BSI are keen to stimulate with their smart city work. They are a small, highly-specialised and knowledge-driven enterprise, with a diverse international client base and an eagerness to incorporate British standards into the core of their professional practice. But the appointment of Parker as the technical author of PAS 181 did not occur simply on the basis of his consultancy work and government contacts.

In 2010, CS Transform (2010) published a white paper titled 'Citizen Service Transformation: A manifesto for change in the delivery of public services'. It opens by

using the pressures of economic austerity to call for a shift in the way that government is conducted.

> All around the world, governments face huge pressure to do more with less. To raise educational standards to meet the needs of a global knowledge economy. To help our economies adjust to financial upheaval. To lift the world out of poverty when more than a billion people still live on less than a dollar a day. To facilitate the transition to a sustainable, inclusive, low-carbon society.
>
> Responding effectively to these challenges means governments need to be capable of delivering change which is transformational, not incremental. (CS Transform, 2010: 2)

The report argues not simply for a renewed approach to e-government, but for "a much more radical focus on transforming the whole relationship between the public sector and users of public services" (CS Transform, 2010: 2).

This document was picked up by members of the OASIS standards consortium—best known for developing the Standard Generalized Markup Language, a predecessor to the more famous World Wide Web Consortium standards, XML and HTML—where it became the foundation for a new technical committee. The scope of this group was to develop a transformational government framework defining the rules, principles and processes universally applicable to projects of fundamental government change (McRae, 2010a). The group began with a total of 16 participants (McRae, 2010b). They held monthly conference calls and engaged in an active mailing list, working collaboratively on documents passed back-and-forth. While OASIS is, in principle, open, the TGF technical committee was driven by a core group of men of a similar professional background. More than 75% of the total number of emails were sent by just five members. Between them these individuals have extensive public and private sector experience. Each is a British national, however, and has worked with the UK government in some capacity during their career. The differences of view expressed in the mailing list are, as such, not indicative of the breadth of opinion held globally by smart city professionals (let alone stakeholders). Over a 30 month period, the technical committee worked on two documents (OASIS, 2012; 2013). The TGF primer was spearheaded by Parker and published in early 2012. It stays quite close to the CS Transform white paper, reiterating some parts and extending others. The TGF pattern language, which was put together by another member of the TC, is a systematisation of the primer. It was published in mid-2013, at about the same time that the work on PAS 181 was getting under way.

PAS 181 builds on the OASIS standard, adding in material on smartness and sustainability, and situating it within the context of cities and communities[12]. The steering group that assisted in this process included representatives from five UK city councils, and a small selection of state agencies and for-profit and not-for-profit enterprises (BSI, 2014a: iii). BSI were selective in their invitations to join the committee: "they went to people or to cities that they thought would be interested in engaging" (interview 40, Trevor Gibson, PAS 181 steering group, January 12, 2017). In keeping with the national economic strategy, TSB and Future Cities Catapult were present, and the cities that joined (Birmingham, Glasgow, Leeds, Peterborough and Greenwich), appear to have done so via the Future Cities Demonstrator Programme. Large companies from the ICT and construction sector were represented (respectively IBM and Fujitsu, and Balfour Beatty and BuroHappold Engineering), but so too were a couple of smaller startups (Clicks and Links, and Red Ninja). I asked the founder and CEO of Red Ninja about how he became involved.

> I applied to be part of PAS 181 and if I'm honest with you I didn't have any feedback. I said I'm interested in being a part of this and whether there was a administrative error or something incompetence I wasn't [included in] it. And then I had a platform at the inaugural Smart City Conference, one of these conferences in London […] and the person who came on after me was the CEO of BSI. So I just told him that I want to be part of this PAS 181. And then I got an email invitation the next week. (Interview 27, Lee Omar, PAS 181 steering group, June 16, 2016)

Emphasis appears to have been placed on involving a range of stakeholders, but keeping the group small enough to move quickly. Before PAS 181's publication in February 2014, it was sent out to a wider review panel. Unfortunately, no information about the extent or significance of resulting feedback has been made public.

In this section, I have introduced the context in which PAS 181 came together. I have identified the centrality of the Heseltine report and the Information Economy Strategy in defining a smart city agenda that attends to both local growth and foreign export opportunities. BSI was drawn into the mix and directed their efforts less towards technical standardisation, than systems integration and management guidance. They in turn sought established expertise in public-sector digital transformation, appointing Chris Parker, a consultant who cut his teeth during Blair's e-government push in the early

[12] The word 'smart' and its various forms appears 237 times in PAS 181, compared to just three times in the TGF primer and pattern language combined. 'Sustainability' appears less frequently in the PAS, at 13 times, but still significantly more than in the TGF, where it merits only a single mention. The shift from (national, state and municipal) government to cities and communities is evident from the title of PAS 181—and is further supported by the 688 occurrences of 'city' or 'cities' and the 18 occurrences of 'community' or 'communities', compared respectively to just one and ten occurrences in the two TGF documents.

2000s. Despite his former, freely admitted failures (CS Transform, 2010: 2), Parker's policy recommendations have moved from CS Transform into a standards body specialising in structured data formats, and then on to BSI and ISO. In the next section, I consider the development of his transformational government guidelines.

Developing the transformational government guidelines

Much of the structure, style, ideas and central values of PAS 181, can be identified in a nascent form within the CS Transform white paper and the two documents of the OASIS TGF. Both PAS 181 and the TGF primer separate their recommendations into four components: guiding principles; key city-wide governance and delivery processes; a benefit realisation strategy; and critical success factors. To simplify matters slightly, I will treat the benefit realisation strategy as a subcomponent of the success factors. In an email to the TGF TC, Parker (2011) reflected on the relationship between these areas of the standard.

> [O]ne of the things that your work on the patterns has brought out more clearly for me is the extent to which these three elements of the Primer […] address the same issues, but in different ways for different audiences:
>
> - The guiding principles try to distil the core essence of the TGF approach, in a set of business principles which can be intuitively understood and which can form the basis of top leadership commitment across the government to a new sort of approach
> - The four delivery [processes] then set out the meat of the TGF, articulating in detail what needs to be done in order to put the principles into practice
> - The [critical success factors] then cover the same scope of issues, but through the lens of quality assurance and for the benefit largely of those involved in periodic health-checking of the TGF program.

Put crudely, the principles are the values of the standard, the processes are its mechanisms and the success factors its form of assessment. I begin this section by moving through these three components, paying attention to where things have been introduced and where they have remained the same.

CS Transform (2010: 5) laid the groundwork for the guiding principles adopted by the OASIS TGF. All five listed in the former document were moved directly over to the latter, but worded in a slightly different way (OASIS, 2012, pp 13-14). This is shown in Table 8.1. PAS 181 (2014a) used the same format as the TGF, but made notable changes to the principles themselves. Two were dropped (those pertaining to market growth and the management of critical success factors) and three were kept (those reinforcing a citizen focus). Interestingly, there is a shift in language here, from 'citizens' to 'citizens and

businesses'. Whilst this reflects the mandate of BSI, it also somewhat confuses the standard's agenda, something to which I will return in the next section. In addition to these changes, a further nine guiding principles were adopted. These use concepts related to smart cities ('digitization' and 'systems'), open data ('adaptable' and 'reuse'), active citizenship ('jointly owned' and 'inclusive') and strong leadership ("we believe leadership in delivering the vision is needed at all levels"). If we accept Parker's reflection that the guiding principles are indeed the standard's 'core essence', then these changes are quite significant.

This is, at times, born out by the 'meat' of the standard. The delivery process scaffolding was established by the CS Transform white paper. Four processes are elaborated: citizen-centric business management, citizen-centric customer management, citizen-centric channel management and service-oriented technology management. The citizen focus was relaxed by the TGF, where the operative word is 'frameworks'. The primer elaborates these at length and the pattern language restates them in a more formal way. Changes include calls for a 'collaborative stakeholder governance model', a 'common terminology and reference model', and a more detailed 'channel transformation strategy', as well as the splitting of technology management into 'resource management', 'ecosystem participation', and 'realisation and governance'. Table 8.2 makes these differences a little clearer. PAS 181 evolved the model further, combining channel management with citizen-centric service management and including digital assets along with technology. Additions include 'procurement and supplier management', 'mapping the city's interoperability needs', 'delivering city-led service transformation', and an 'open, service-oriented, city-wide IT architecture'. Each of these reinforce the smart cities and open data turn suggested by the guiding principles.

The nine critical success factors identified in PAS 181—strategic clarity, leadership, user focus, stakeholder engagement, skills, supplier partnership, future-proofing, achievable delivery and benefits realisation—are the same nine factors described in the TGF primer and CS Transform white paper. In fact, a slide deck of Andrew Pinder's (2007: 38) from before the collapse of gov[3] lists eight of the factors when visualising the company's approach to strategic risk management. Do-ability (or achievable delivery) even contains a hint of the missing ninth, future-proofing: "Are we making technology choices which give us maximum future flexibility?" (Pinder, 2007: 38). While structurally the same, the critical success factors are developed. The primer describes the nine factors in considerably more detail than the white paper and breaks them into subcategories (OASIS, 2012: 22–24). PAS 181 further formalises this, adding for each of the subcategories a checklist of capabilities. Thus, under (5) skills (a) skills mapping: "We have

Table 8.1. A comparison of the guiding principles of the CS Transform white paper, TGF and PAS 181. Based on CS Transform (2010), OASIS (2012) and BSI (2014a).

CS Transform	TGF	PAS 181
		We believe that a smart city is: visionary, citizen-centric, digital, open and collaborative
		We believe our city needs a vision for its future which is clear, compelling and jointly owned by all key stakeholders
		We believe leadership in delivering the vision is needed at all levels
Be obsessive about understanding your customers	We believe in detailed and segmented understanding of our citizen and business customers	We believe in detailed and segmented understanding of our citizens' and businesses' needs
Build services around customer needs, not organisational structure	We believe in services built around customer needs, not organisational structure	We believe in spaces and services built around citizen needs
Citizen service transformation is done with citizens, not to them	We believe that transformation is done with citizens and businesses, not to them	We believe that transformation is done with and by our citizens and businesses, not to them
		We believe in enabling the ubiquitous and integrated digitization of our city
		We believe in ensuring the inclusive digitization of our city
		We believe in creating spaces and opportunities for new collaborations
		We believe in opening up the city's data to drive innovation and create new value
		We believe in building city systems that are flexible, resilient and adaptable
		We believe in sharing and reuse of city assets and services
Grow the market	We believe in growing the market for transformed services	
Manage and measure the nine critical success factors	We believe in managing and measuring key critical success factors	

Table 8.2. A comparison of CS Transform, TGF and PAS 181 delivery processes. Based on CS Transform (2010), OASIS (2012) and BSI (2014a).

CS Transform	TGF	PAS 181
citizen-centric business management	business management framework	business management
vision > strategy > business mode		city vision
	transformational government leadership	leadership and governance
	transformational business model	transforming the city's operating model
	collaborative stakeholder governance model	stakeholder collaboration
	common terminology and reference model	common terminology and reference model
policy products	development and management of policy products	
transformation roadmap	roadmap for transformation	smart city roadmap
		procurement and supplier management
		mapping the city's interoperability needs

CS Transform	TGF	PAS 181
citizen-centric customer management	customer management framework	citizen-centric service management
marketing and branding	brand-led service delivery	
citizen-centric identity management	identity management	identity and privacy management
		delivering city-led service transformation
citizen empowerment	stakeholder empowerment	empowering stakeholder-led service transformation
citizen-centric channel management	channel management framework	
channel audit	channel mapping	
	channel transformation strategy	digital inclusion and channel management
channel shift strategy	channel optimization	
channel optimisation	channel shift	
cross-channel service management	cross-channel management	
	mixed economy service provision	
service-oriented technology management	technology management framework	technology and digital asset management
	resources management	resources mapping and management
	ecosystem participation	
	realisation and governance	
		open, service-oriented, city-wide it architecture

Table 8.3. A comparison of CS Transform, TGF and PAS 181 critical success factors. Based on CS Transform (2010), OASIS (2012) and BSI (2014a).

CS Transform	TGF primer	PAS 181
strategic focus	strategic clarity	strategic clarity
	all-of-government view	
	clear vision	clear vision
	strong business case	strong business case
	focus on results	focus on results
leadership	leadership	leadership
	sustained support	sustained support
	leadership skills	leadership skills
	collaborative governance	collaborative governance
user focus	user focus	user focus
	a holistic view of the customer	a holistic view of the city's citizen and business customers
	customer-centric delivery	customer-centric delivery
	stakeholder empowerment	stakeholder empowerment
stakeholder engagement	stakeholder engagement	stakeholder engagement
	stakeholder communication	stakeholder communication
	cross-sectoral partnership	cross-sectoral partnership
		engagement with other cities
skills	skills	skills
	skills mapping	skills mapping
	skills integration	skills integration
supplier partnership	supplier partnership	supplier partnership
	smart supplier selection	smart supplier selection
	supplier integration	supplier integration
future-proofing	future-proofing	future-proofing
	interoperability	interoperability
	web-centric delivery	web-centric delivery
	agility	agility and resilience
	shared services	shared services
		support and maintenance

CS Transform	TGF primer	PAS 181
do-ability	achieve delivery	achievable delivery
	phased implementation	phased implementation
	continuous improvement	continuous improvement
	risk management	risk management
benefit realisation	benefits realisation	benefits realisation
	benefits realisation strategy	benefit mapping
		benefit tracking
		benefit delivery

mapped out the skills we need to deliver the smart city programme, and have established clear plans for acquiring and maintaining them" (BSI, 2014a: 47). One omission and a couple of additions were also made. Under strategic clarity, the all-of-government subcategory was removed. Similarly, throughout the documents the phrase 'whole-of-government' was replaced by 'whole-of-city', and there was a slight shift from the word 'holism' (which appeared in one form or another 7 times in the primer and 4 times in the PAS) to the word 'integration' (13 occurrences in the primer and 46 in the PAS). This is in keeping with the shift to smart cities and the particular relevance of systems theory to its discourse. Under stakeholder engagement, a subcategory was added for 'engagement with other cities', and under future proofing was added 'support and maintenance'. A full list of the critical success factors and their subcategories can be found in Table 8.3.

The most significant contribution made by the OASIS TC was the introduction of a more formulaic linguistic style. Pattern language, pioneered by architect and urban planner Christopher Alexander (1979; 1977), identifies common, generic problems and presents an archetypal solution to them. Drawing on a notion of generativity, simple but highly abstracted and disembodied rules are specified with the intention of effecting wide-reaching change. Alexander was influenced by the work of cyberneticians such as Norbert Wiener and Ross Ashby (Pickering, 2010; Steenson, 2017) and concepts of systems, complexity and control are clearly evident in his early work (Alexander, 1964; 1965). In the 1990s, his methodology migrated into software development, where it resonates particularly well with the properties of object-oriented programming languages (Coplien and Schmidt, 1995; Buschmann et al., 1996), and from there was incorporated into agile project management practices (Leitner, 2015). In the context of PAS 181, it gives the recommendations a modularity that allows them to be broken down and applied as they are needed. It is also intended to be machine-tractable, with the ultimate goal of someday automating compliance (OASIS, 2013). While the standard becomes more formal, flexible and fluid, pattern language also erodes the absolute authority that inheres to a definitive and cohesive specification. As one TGF TC working document put it, the style

is "organic not totalitarian" (P. F. Brown, 2011b). PAS 181 is, again, quite unlike other voluntary consensus standards.

Parker was at first uncertain about pattern language, writing to the TGF TC mailing list that he had at times "struggled a little with the concept" (Parker, 2011). Another member of the technical committee was able to win him over with firm examples of their use, however, and a dedicated document was produced to describe them. When it came time to write PAS 181, the patterns and primer were recombined. But the use of patterns was not accepted without resistance from the BSI steering group.

> On the point about the use of the term 'guidance notes', this is […] a deliberate choice in preference to 'patterns'. This is because the stakeholders on the SCF [smart all sort of negative baggage about the original Alexander patterns in the architectural context. And city council people also didn't like the concept, which for most of them smacked of a rigid one-size-fits-all pattern being imposed upon cities. At one stage, I thought this aversion was such […] that we would end up losing any connection with TGF at all. In the end, people became entirely happy with the idea of a series of modular guidance notes which use a common structure to help cities think through their problems in a systematic way and arrive at a specific solution that works for them. But that is not what the term 'pattern' or 'pattern language' conjures up for them, which is why the SCF calls them all 'guidance notes'. (Parker, 2013)

Despite the push-back and the change of name, the style and function of the pattern language remained the same.

There is another more significant difference in the use of pattern language. In the TGF, most of the patterns 'must' be followed (OASIS, 2013: 28). This is to allow for future auditing and certification. PAS 181 is considerably more lenient, only ever stating in its recommendations that cities 'should' do something (BSI, 2014a: 5). While in most cases, this allows for greater differences between cities, there is one important example where this movement is accompanied by the elimination of circumspection. It is worth tracing this back to CS Transform (2010: 6–7). In introducing its recommended business model, the white paper argues for the necessity of an approach that improves cross-government co-ordination. Two models are offered. The first is borrowed from Canada, where structural changes to central government gathered all points of citizen contact within a single institution. This is rejected for being too slow and difficult to implement. The second and preferred model, is to create citizen-focused franchise businesses that work across government departments for a particular segment of the public. In the TGF, this is represented by two patterns (OASIS, 2013: 14–16). The first specifies that a city *must* adopt a transformational business model that goes beyond existing silos to provide citizens with a single location for services, and that it must also be possible for those services to be delivered by for-profit and not-for-profit intermediaries. The second argues that a city

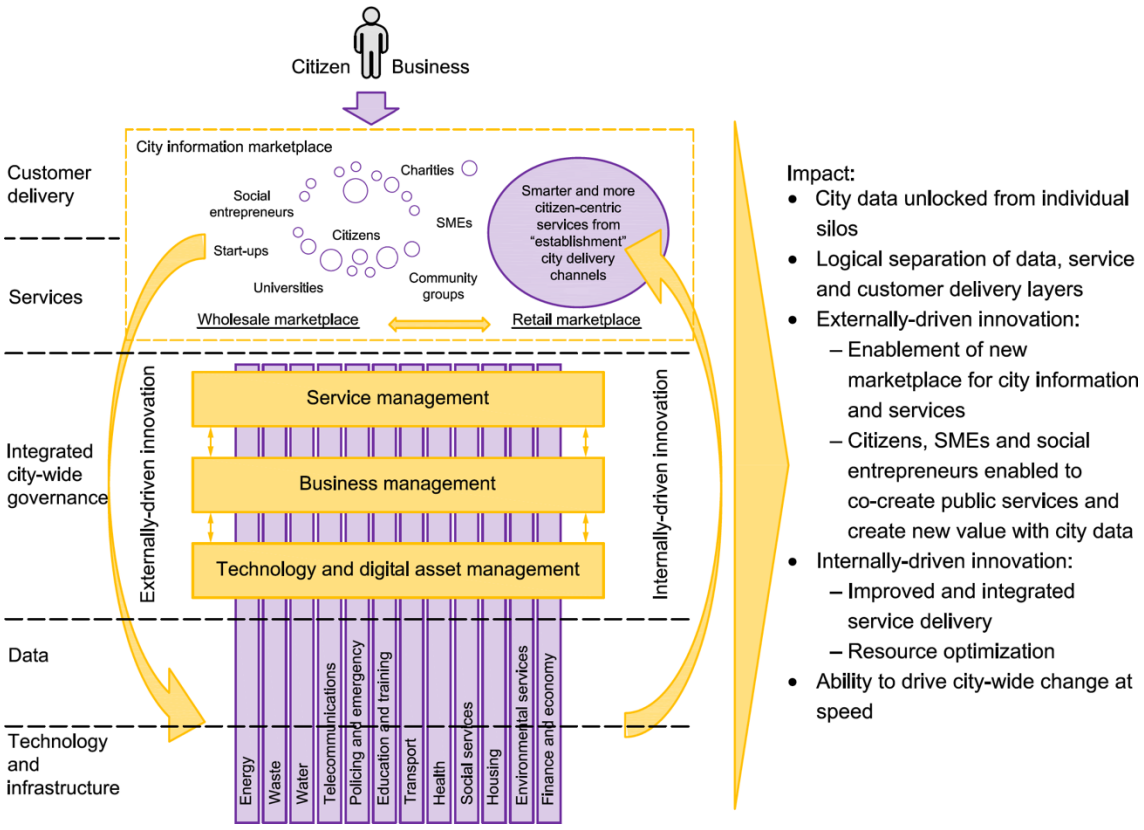


Figure 8.1. Visualisation of the integrated business model. Reproduced from BSI (2014a: 15).

should adopt a specific model to achieve this: the franchise businesses. In the PAS, these patterns are dissolved into one another. Rather than acknowledge that there are multiple solutions to the perceived problem, a single recommendation is advanced: "Smart city leaders should ensure that their city vision includes the need to develop an integrated city operating model, which is focused around citizen and business needs, not just the city's organizational structure" (BSI, 2014a: 16). The visualisation used to explain this operating model is reproduced in Figure 8.1. It contains two forms of integration: a vertical integration within government departments that causes problems and a horizontal integration across departments that fixes them. Explicit discussion of the franchise businesses is moved into a latter pattern on citizen-led service transformation, but the two are clearly linked. By formalising and breaking apart the precursory argument, the pattern language has discarded its small measure of doubt. The simple fact that there may exist many viable solutions to the problem is lost.

In this section, my focus has been on the structure and style of PAS 181, and how this has (or has not) changed over its extended period of development. Much of the standard can be traced back to the 2010 CS Transform white paper—a document written not for city leaders being courted by technology companies, but for governments looking to respond to fiscal austerity. While some things are old, others are new. The use of pattern language is clearly the idea and experiment of one individual involved in the TGF TC (see P. F. Brown, 2011a). Rhetoric of smart and sustainable cities and communities existed

hardly at all prior to the involvement of BSI. Having explored the continuations and disjunctions between versions of the standard, it is finally time to engage more rigorously with what it advocates.

PAS 181 policy patterns: between smart cities and e-government

PAS 181 follows the definition of a smart city established by the vocabulary standard PAS 180: "effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens" (BSI, 2014a: 4). This is not altogether the same as the smart city discussed in the pattern on 'city vision' (BSI, 2014a: 12–13). Here, the Future Cities Demonstrator Programme is used to identify the threats to and desires of UK cities, and to define the characteristics of 'smartness'. The perceived challenges are familiar—urbanisation, climate change and austerity—but the aspirations are less so. Rather than systems integration and efficiency gains, emphasis is placed on quality of life, economic opportunity and community engagement. Whether in terms of embedded sensors, ubiquitous computing or big data, hardly any mention is made of technology. The smart city that emerges is far softer and more social than the vision often advanced by the private sector (see Greenfield, 2013). It is possible to questions the range of views generated by the Demonstrator Programme. Arup, who were also recruited to conduct BIS's smart city research (BIS and Arup, 2013a; 2013b), worked on nine of the 29 demonstrator submissions. Furthermore, Taylor Buck and While (2015) have argued that insufficient time was allowed for cities to properly engage government and citizen stakeholders, and that as a result there was a lack of diversity and innovation amongst them. That said, the Demonstrator Programme did involve a significant number of UK cities and should not be discounted for being an unrepresentative sample of broader opinion. The focus of cities appears to be on *what* a smart city should be, whereas the definition adopted by the standard emphasises *how* the smart city should be achieved. This raises the matter of PAS 181's model of citizenship.

'Citizen' is broadly understood by the standard to include "residents, businesses, visitors and commuters" (BSI, 2014a: 4). There is genuine interest in structuring service delivery around citizen needs and in ensuring that proper research is conducted to determine what those needs are. The franchise business model is predicated on this occurring, as was conveyed in my interview with Parker.

> Organisationally speaking there is a centre of gravity within the borough council, an organisation which is focused on elderly people which is their adult services directorate. But elderly people in the borough also consume services from other parts of the council, from the housing department and what have you, as well as the wider

> public sector, for health, mental health and community services, *etcetera*. So without trying to reorganise and create a new organisation […] let's put in place a small team who champion [the] old, and whose job is to understand all the data that's relevant, look across the various services that all different city commissary partners are offering to elderly people, think how could those be brought together in a more integrated and useful way for those customers. (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

In addition to adopting a citizen-centric approach, the standard also encourages cities to take seriously and properly fund a stakeholder collaboration programme. Not only should this keep citizens informed, it should also offer inclusive opportunities for engagement and participation. Five categories of stakeholder are identified: promoters, investors, deliverers, consumers and external stakeholders. This is not intended as an exhaustive list, merely as an indication of the variety of opinions that are to be taken into consideration.

But there are two peculiarities with this model of citizenship (see also Joss et al., 2017; Cardullo and Kitchin, 2018; Shelton and Lodato, 2019). The first is that it is passive. Citizens are researched, affected and informed, but seldom are they truly involved. While they are the ultimate beneficiary of the standard, they are not enlisted in its production or implementation. There is, at times, a paternalistic tone to the document. The second peculiarity is the assumption that transformational change can be enacted with everyone's approval and to everyone's benefit. Political disagreement and contestation go unnoticed. The exception that proves the point is the enfolding of dissent into the stakeholder typology: promoters include all elected officials and "any stakeholder with a negative agenda (negative promoters)" (BSI, 2014a: 19). PAS 181 paints a simplistic picture of public deliberation and debate, reducing the messiness of politics to an obligatory phase of managed consultation. It is only by adopting a passive and non-political approach to citizens that the standard is able to maintain the tension between what cities want and what it recommends.

Another tension in the standard's approach to smart cities lies between management-driven and technology-driven change. In the pattern on 'transforming the city's operating model' (BSI, 2014a: 14–16), there is a return to real-time open data, a familiar component of smart cities. The standard argues for joined-up communication and co-ordination across government silos, central to which is performance data "available in real time and on an open and interoperable basis" (BSI, 2014a: 16). It is argued that the continuous flow of data will enable city services to be integrated and optimised, and that by releasing data to the public, citizens will innovate in their own right. That this will occur, once the pieces are in place, is taken for granted. In a later pattern, 'open, service-oriented, city-wide IT architecture' (BSI, 2014a: 38–39), leaders are called upon to ensure that changes instigated by the city remain responsive to future

technological developments. This is to be achieved by managing the transition to an open, interoperable and modular platform of city services, assets and data. In both of these examples, emphasis is placed on organisational and managerial change rather than the specifics of technological deployment. This is a common theme throughout the standard.

> Although many of the principles and methodologies established by the SCF are relevant within specific vertical sectors of cities (smart grids, smart mobility, smart health, etc.) the focus is very much on the issues and challenges involved in joining all of these up into a whole-city approach. (BSI, 2014a: 3)

It remains unclear how exactly the recommended management and leadership practices will lead to the real-time open data that will produce the smart city vision outlined by UK stakeholders. Cities and citizens must trust that the standard has their best interests in mind.

The argument that cities are burdened by their bureaucratic structure is not new to the material-discourse of smart cities. In Chapter 4, I disclosed its origins in the post-war movement of military expertise into municipal government, identifying its use in the New York departmental restructure of the late 1960s. It is true that this argument has been revived in recent years, but the smart city is an outgrowth of this and not its instigator.

> Most governments are structured around a set of vertically-integrated silos or stovepipes—agencies, departments, ministries. By and large, it is these silos which the governments of developed countries have spend [sic] billions of dollars on 'e-enabling' since the 1990s. […] Governments in developed countries are now grappling with the legacy of thousands of fragmented, silo-focused websites (270,000+ in the US public sector, over 9,000 gov.de sites in Germany, and over 3,000 gov.uk sites in the UK). An increasing number are now seeking to make a fundamental strategic shift, towards a holistic, citizen-centred approach, driven at the whole-of-government level. (CS Transform, 2010: 3)

Not only was CS Transform ahead of the smart city in their denunciation of government silos, they also anticipated its shift to smart citizens (see Hill, 2013; Hemment and Townsend, 2013). As such, attention must be paid not only to the intersection between PAS 181 and the smart city, but to their often disregarded predecessor.

Many of the key features of PAS 181 descend from the Third Way rhetoric of e-government (Dunleavy et al., 2006b; Margetts and Dunleavy, 2013). These include its holistic view of citizens, the reintegration of services, agile government and a commissioner model of service provision. Having already discussed the first three of these, it remains only to introduce the last.

The commissioner model is expressed most clearly in the guidance note on 'procurement and supplier management' (BSI, 2014a: 20–23). The standard asserts that local authorities are coming to identify themselves less as a deliverer of services than as

their commissioner. It then describes practices designed to help these authorities to strategically manage their supplier relationships. Rather than large capital investments, PAS 181 favours short-term contracts (or on-demand purchasing) based on well-defined outcomes, modular components and open standards. Crucially, these smart procurement practices are contrasted, not with the direct delivery of public services, but with procurement practices which lock government into long term contracts and stymie innovation. When I asked Parker about this, he allowed that the commissioner model was implicit to a lot of what PAS 181 was trying to achieve.

> PAS 181 probably doesn't explicitly describe or recommend that you should be a commissioner rather than a provider. Which is an interesting point because I absolutely believe it's right. Certainly, in the UK context it's like established wisdom, it's [an] unquestioned assumption really […] And I guess the reason for that is, it's just too big an elephant to eat for one organisation, even if that organisation is a city municipality, many of these issues are best solved through market mechanisms. Elected city leaders have got an important role in shaping markets and [acting as a commissioner] can impact on private sector decision-making. (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

Put differently, PAS 181 assumes that the role of a smart city is not to directly provide public services, but to manage a competitive marketplace through which this can occur. That this might be an issue of economic and political debate the standard fails to mention.

The denial of political dissension leads to three contradictions. Each of these lies at one of the intersections between government, industry and people. The first is between integration and privatisation. The argument for the horizontal integration of services rests on the assertion that traditional government departments are highly specialised, inward-looking, overly protective of their assets and resistant to change. While there is perhaps some truth to this, the history of departmental restructuring since the 1980s tells a more complicated story (Dunleavy and Hood, 1994; Dunleavy et al., 2006b). In the UK, the application of neoliberal rationality to the organisation of government involved the proliferation of small, specialised departments, and the promotion of a marketplace of providers. Public utilities were splintered into tiers of differential provision (Graham and Marvin, 2001). The hope was that people would act more like rational consumers and that competition would lead to innovation and efficiency gains. What resulted instead was confusion and growing inequality.

> And typically, in a non-smart environment, it's the poor citizen's job to muddle through that and make the connections and so on. So where you've got issues like customer needs or cross-cutting themes that cut across organisations you need to find some way of getting your organisational structure to work together effectively to

> address those. (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

The desire to reintegrate services in the UK, whether at the level of a consumer-facing website or in terms of government data, has more to do with the effects of New Public Management reforms than it does with any inherent departmental protectionism or conservatism. The privatisation implicit to the commissioner model of service provision leads to the fragmentation of services. It is, as such, at odds with their integration.

The second contradiction lies between citizens and businesses. Despite defining citizens to include businesses, they are nevertheless frequently referenced together. The word 'citizen' appears 76 times in PAS 181. Of these, 34 are shortly followed by the word 'business' or an equivalent; as in 'citizens and businesses' and 'citizens, communities and the private and voluntary sectors'. This is very much in keeping with the third way rhetoric of New Labour. Rejecting the socialism of the 'old left' and the neoliberalism of the 'new right', it forwarded a revisionist conception of social democracy in which government intervention works to bolster and ameliorate *laissez faire* capitalism (Giddens, 1998). In his analysis of New Labour rhetoric, Fairclough (2000) has pointed to the significance of phrases constructed with the turn 'not only … but also', arguing that this treats as equivalent terms otherwise regarded as different. Within PAS 181, citizens and businesses are consistently presented in this way. There is no acknowledgement that they could be in conflict. Indeed, they are sometimes positioned as mutually reinforcing—as in the phrase "citizens' needs, and the cultural and organizational business changes needed to deliver them" (BSI, 2014a: 44). Political theory aside, there is overwhelming empirical evidence that the needs of citizens are not the same thing as the needs of businesses. To treat them as such is ahistorical and asociological.

The final contradiction is between being leadership-driven and citizen-centric. PAS 181 is a standard for leaders. Its recommendations are explicitly directed at 'smart city leaders' and at the problems they face. Nevertheless, it also advocates for an approach that is driven by citizen needs. 20 of the occurrences of the word 'citizen' are in 'citizen-centric'. The standard acknowledges that leaders and citizens can come to odds, stating that one of the challenges of smart city leadership is:

> managing the tension between the desire, on the one hand, to move faster by learning from successful approaches in other cities and, on the other hand, the need to develop bottom-up approaches that have strong local ownership and buy-in. (BSI, 2014a: 9)

But this tension is not fundamental to the logic of the standard, it is merely something to be managed. Two things are of note here. The first is the similarity between this contradiction and the one between privatisation and reintegration. Both concern a desire to simultaneously spread and centralise power and responsibility. But where the first

attends to the relationship between government and industry, here the focus is on that between government and people. The second thing of note is the resonance with the politics of Tony Blair. While Blair often discussed citizens, he was known to be fastidious in his approach to party leadership and governance (Fairclough, 2000). Strong leaders and a managerial focus are at odds with the devolution of power (O'Reilly and Reed, 2010). Despite championing citizens, PAS 181 was developed by a small number of specialised experts. More democratic forms of standards development have been proposed (Marsal-Llacuna and Wood-Hill, 2017), but have failed to gain traction.

E-government emerged in the 1990s, partly as a response to the growing popularity of the internet and to its promise to decrease the marginal cost of citizen communications. But it cannot be separated from the broader social and political environment of the time. In this section, I have argued that many of the ideas championed by PAS 181 are the same ideas that animated New Labour more than a decade ago. The biggest difference between now and then, is that today they lack a democratic mandate. No longer political slogans, they have become standardised best practices from which all dissent has been erased. In a conscious move in the opposite direction, I have drawn attention to five issues of contention: between the smart city agenda of PAS 181 and that of UK cities; between management-driven and technology-driven change; between privatisation and reintegration; between citizens and businesses; and between being leadership-driven and citizen-centric.

PAS 181 as an assuring technology

Upon its publication in 2014, PAS 181 was made freely available on the website of the BSI (n.d.-b). It has since been downloaded in more than 60 countries and BSI has received enquiries about it from all over the world (interview 6, Dan Palmer, British Standards Institution, November 12, 2015). As a PAS, however, the purpose of the document is only to offer recommendations: "It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it" (BSI, 2014a: iv). It is, moreover, difficult to imagine how one would go about certifying that a city or organisation has implemented it correctly.

> When you're looking at PAS 181, where it's saying, for example, you should put together a cross-sectoral leadership team to own and drive forward your smart city strategy, that is certifiable and verifiable, but it, and it's a more qualitative and, therefore, probably labour intensive task to do so. So is the value there and who would see value in bearing that cost if you know what I mean? Cities would have an interest in quality assuring what they're doing, but that's slightly different from auditing quality and consistency of… I think one of the things we're certainly going to be, as PAS 181 goes into ISO, one of the things that is in my mind is: can we

> develop some metrics to underpin […] how close to PAS 181 implementation is a city? (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

Given that it is only a guide, it is not surprising that uptake of the standard within the UK has been poor (interview 40, Trevor Gibson, PAS 181 steering group, January 12, 2017). Cities have complained that PAS 181 is full of jargon and lacks practical case studies of how it could be applied (interview 51, Pippa Gardner, PAS 181 steering group, August 24, 2017). Nevertheless, it is being actively promoted and seems to have found an international audience. In this section, I use this movement to think about the standard as a political technology for assuring city leaders.

There is a perception that one of the biggest barriers to the smart city market is that authorities find it too risky. Many small and medium sized cities are waiting to see what occurs in larger cities before making a decision about where to invest. In this context, standards become a way of ameliorating their feeling of unease.

> Looking at the smart cities market as a whole, one of the big challenges is a lack of confidence, a fear of being locked into a long term solution with a big vendor which could become inappropriate, and a sense that it is quite a radical change from what the city is doing at the moment. And that all carries risks. Following a known set of standards that encapsulate the factors is a way of addressing that risk. So what we are trying to do is to set out good practice which will reduce the risks for cities that are undertaking smart city projects. (Interview 6, Dan Palmer, British Standards Institution, November 12, 2015)

Despite the fact that Publicly Available Specifications represent the knowledge of only a handful of experts, there is something trustworthy about them being voluntary standards. For Parker, this is because the process of standardisation acts as marketplace for the refinement of ideas.

> I think the value that we see people in the marketplace seeing from it, are that there is a reassurance about it, the fact that it's been through a standards developing process and all of the peer review, and consultation and so on that's associated with that. If you compare the content of PAS 181 to the white paper I mentioned, that we published in 2009 or so, you can clearly see the links between the two, and one was, as it were, the father of the other. But there is something about the trust that people [have] in the marketplace. (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

Even if PAS 181 is based on a manifesto published eight years ago by individuals with a patchy record of government and market success, it is perceived to be authoritative and reassuring. Even in the event that it is unable to instigate material changes within a city, its affect is something worthwhile—something that will improve consumer confidence,

increase the demand for smart city goods and services, and ultimately stimulate the market.

PAS 181 does not have a certification programme attached to it and cities are actively discouraged from claiming compliance. As such, it is left to private consultants to use the PAS to bolster their expertise and educational workshops. CS Transform have worked with the Government of Dubai to implement a holistic approach to their data and asset management model (Parker, 2015; 2016). The Smart City Leadership Programme has taught governance practices based on PAS 181 in the UK and abroad. A pamphlet for the latter, includes 'personal fulfilment' amongst its deliverables, writing that it is able to give participants "an increased sense of passion and purpose, as part of the city's leadership team" (BSI et al., 2015). Rather than dismiss this as an insignificant piece of marketing, I want to take seriously the affects induced by the standard. Auditors act to assure organisational conformance to accounting practices, financial regulation and quality documentation. Without the weight of a legal obligation or a rigorous set of testing conditions, smart city consultants are nevertheless attempting to instil confidence in a particular set of practices. In addition to circulating ideas and steering cities, standards are acting as a political technology for assuring city leaders.

Conclusion

Just as the UK is turning its back on the European Union, BSI are pursuing a mandate to promote national management and governance expertise in Asia and the Middle East. That these expertise, in the case of PAS 181, were forged under the administration of a vocal europeanist in Tony Blair, is an irony entirely lost. The standard is in fact bleached of all politics. Its concept of citizenship is a passive one; the citizen is at the core of its recommendations, but is not granted the voice to directly influence or resist them. The recommendations themselves—to integrate government services, to deploy franchise businesses acting across government departments, and to improve procurement management practices—refer to neither the particular political decisions that led to the problems they address, nor to the range of possible political decisions by which those problems could be rectified. The danger here is not simply in the prescription of principles and processes for government. Political lobbying is nothing new. The danger is that PAS 181 is read as authoritative and impartial precisely because it is a dry, boring standard.

This tendency is exacerbated by the standard's use of pattern language. PAS 181 gains a modularity and flexibility from its linguistic style. Cities do not face the same challenges as one another and Alexander's methodology, in theory at least, promises to recognise this fact. But there are limits to what pattern language can achieve. As it is based upon the same functionalist ontology that underpins systems theory, it suffers from many

of the same shortcomings. It instrumentalises social and cultural difference. Contestation becomes stakeholder input to be measured, managed and channelled into a productive output. Utilitarian principles of efficiency and optimisation have little regard for the reasons why people do not want to change. Ultimately, pattern language imbues PAS 181 with an engineered formalism. Its arguments are systematised in black and white, and deprived of the shades of doubt that they may otherwise have expressed. Patterns normalise politics as pragmatic common sense, assuring city leaders of the solutions to universal problems.

There are, moreover, uncomfortable neocolonial overtones to the use of PAS 181 to inform government practices in India. In the eighteenth and nineteenth centuries, infrastructure was integral to European colonial expansion (Darwin, 2008). The territorial occupation of key military outposts and thoroughfares was allowed and reinforced by the construction of a privatised network of steamships, railways and communication technologies, which helped bring distant parts of the world together. While the sovereign power of empire was dismantled in the twentieth century, there remain significant differences between the cities and infrastructure of Europe, and those of Asia and the Middle East. Contemporary studies of urban infrastructure in the Global South point to the importance of informal sociality and incremental change in sustaining and providing for everyday life (Simone, 2004; McFarlane, 2008; Silver, 2014). These observations are often used to argue for the development of Southern theory (Lawhon et al., 2014; Roy, 2015)—that is, theories developed in the Global South for the Global South. To assume that PAS 181 will map on to cities and infrastructure in India is naïve and potentially dangerous. Not only is it unlikely to address the particularity of the problems faced, such efforts are also politically unsavoury. The bloody history of British rule in this part of the world (see for example Tharoor, 2016) casts a shadow over any UK consultancy that wishes to intervene on Indian governance practices.

I have, in this chapter, focused a great deal on the individuals and organisations that helped put PAS 181 together. Because of the way in which a PAS is formulated, individuals are significant in this case. But I am not interested in them so much as in the broader apparatus that reinforces their discursive practices. My goal has not been to expose certain people as fallible, but rather to impress upon the standard the politics which it has attempted to deny. Nevertheless, in concluding, there is one final contradiction that bears mentioning. In establishing the mandate for greater collaboration in standards development, both the Heseltine report and the BIS Information Economy Strategy stressed the importance of local renewal through devolved power. On this front, neither BSI nor the UK smart city agenda have succeeded. Funding for UK smart cities has focused on a small number of high profile projects, with the hope that these will jump start an entire industry. On the whole, this has not occurred, and many municipalities

have resisted incorporating the concept into their planning strategy (Dixon et al., 2017). Not deterred by domestic failure, there remains a keen focus on generating international opportunities for UK management consultancies. My research shows this to be the case for BSI's smart city standards, just as research on the Future Cities Demonstrator Programme suggests much the same thing there (Taylor Buck and While, 2015). So long as BSI remain focused on fomenting foreign business relationships, rather than involving citizens in a genuine and meaningful dialogue, any potential for democratic engagement will remain unrealised. Smart cities should be open to a range of voices and opinions, not only those interested in service optimisation and market growth.

9. Conclusion

Findings of the empirical research

The previous five chapters have explored the materials, individuals, institutions, traditions and trajectories on which city standards presently rely. While city standards are complex, contingent and often self-contradictory, they are nevertheless consistent with assumptions and logics that seek to preserve the normal operation of liberal capitalism. In this conclusion, I summarise my findings, and link them to the aims and objectives identified in the introduction and to my theoretical underpinnings and literature review. I begin by re-stating the generation and content of city standards.

The ISO programme for smart, sustainable and resilient cities is the result of diverse organisations attempting to grapple with the material needs and desires of city institutions, infrastructures and inhabitants. Far from being based upon a universal consensus, ISO has staged debates and fumbled through. ISO/TC 268 is essentially a consolidation of five separate interests. The French national standards body, AFNOR, has focused on the concept of sustainability and the development of environmental management standards for communities. JISC, the Japanese SDO, spearheads a subcommittee of the TC dedicated to standards for smart city infrastructure. While it has developed indicators to help measure such projects, these are of a different scope and ambition to the indicator working group lead by Patricia McCarney of GCIF and WCCD. ISO 37120, ISO 37122 and ISO 37123 define global indicators for sustainable, smart and resilient cities. Not content with the way that these initiatives fit together, the American national standards body, ANSI, introduced protocols developed at City Protocol (the foundation of which is CPA-I_001) in order to systematise and syncretise international city standards. A draft of ISO 37105 was published in July 2018. Finally, BSI have promoted their own city standards through various ISO committees and groups. Within TC 268, they initiated the working group that has internationalised PAS 181 as ISO 37106.

Importantly, this technical committee was not founded to address smart cities, even though its members now promote it in this way. City standards grew out of a need for local governments and intergovernmental organisations to measure and manage sustainable growth and governance. Embedded sensors, microprocessors, real-time data and city dashboards were not initially included in this, but came to be as excitement around smart cities grew in 2013 and 2014. At this time, ISO undertook strategic initiatives to co-ordinate and harmonise their activities in this new market. The final report of the 'ISO/TMB Strategic Advisory Group on Smart Cities' stressed a demand for leadership guides and management frameworks, rather than technical standards. This

is consistent with the standards work of CP, BSI and the working groups directly under TC 268, but does not account for the flurry of technical standards development at ITU-T SG20, TC 268/SC 1 and UNE. While efforts have been made to distribute the responsibility for different sorts of smart city standards amongst the international SDOs, this is threatened by the desire for holism inherent to the smart city. As a political technology for propagating ideas, materials and techniques, city standards promise a great deal for those who are able to successfully shape and influence them. The quiet shuffling and jostling between groups and subject areas revealed by my research, serves as a background for the case studies which follow.

CPA-I_001 is an outgrowth of smart city efforts at the City of Barcelona. I have traced its origins and analysed its development, all in service of showing what the standard is trying to achieve and how. The standard strives to establish a universal way of seeing and discussing human settlements in all their forms and functions. It does this by abstracting from the city in particular to the city in general, seeking out urban systems and the connections between them, and visualising them in a clean and intuitive manner. Despite its lack of success, I have argued that CPA-I_001 can be thought of as an explicit programme of power within the smart city. It exemplifies a manner of seeing the city through the integrated operation of systems.

There are, admittedly, resonances between this approach and my own. The city is conceived holistically in a way that breaks with the ontological prioritisation of human bodies and experiences, foregrounding instead topological connection and transfer. But there are significant areas of dissonance. Its ultimate goal is to measure, manage and optimise urban systems, and the components and relations of which they are composed. As such, it is blind to qualities that can not be easily grasped or represented at an interface between nodes. Meaning, culture and political antagonism are all ancillary to technical refinement and efficiency gains. The positive project of holism gives way to a normative project of integration. My claim that CPA-I_001 is an archetype of smart city power, is supported by the excitement that the standard initially generated within the community and by the efforts of ANSI to make it the centrepiece of ISO's work in the area.

ISO 37120 predates CPA-I_001 and is more pragmatic in its goals and strategy. Nevertheless, in its separation of the city into distinct and quantifiable themes, it fits within the latter's ontology. I have described ISO 37120's foundations in the World Bank and the University of Toronto, examined how it is being verified and certified by WCCD, and assessed the commensurability of the data it has generated for Melbourne and Toronto. My description of the standard's site of enactment revealed two tensions: one over unreconciled urban geographies, the other concerning the divergent capacities of city economies. Despite attempts to suppress them, these tensions continue to undermine the hopes of the city governments that pursue annual certification. The perceived benefits of

performance management and benchmarking were juxtaposed with financial benefits identified by WCCD. Ambiguity around the ultimate use of data lead to my theorisation of ISO 37120 as a technology of neoliberal governance. The power of government to analyse and steer the city is redistributed to a network of public and private actors. Municipalities are expected to measure themselves, adopt best practices and reduce public expenditure. But they will not be alone in doing this. By making their data publicly available, governments will receive help from both established technology companies and motivated groups of citizens. WCCD is reticent about committing fully to the principles of open data, however, preferring to maintain some control over how the standard is used. They envisage the data and metadata becoming inputs to calculations of risk assessment. If this occurs, the form and future of the city will be further financialised into assets and derivatives to be traded on global markets. WCCD thinking is thus underpinned by a neoliberal rationality in which cities are believed to be best secured by the profit-maximising decisions of perfectly informed, rational agents. More than simply improve the communications channels between city systems, this case study demonstrates how smart city integration and optimisation is expected to occur.

As with CPA-I_001, the poor uptake of BSI PAS 181 placed limits on my study of the standard's enactment. In this case, I approached it through private consultancy work undertaken in India with the assistance of BSI and the Foreign and Commonwealth Office. This was, nevertheless, sufficient to highlight the neocolonial politics of the standard. By connecting PAS 181 to Tony Blair's e-government strategy, I showed how it came to be and upon what assumptions and assertions its recommendations rest. Differences between the desires of government, industry and people are elided. All are presumed to be enthusiastic about smart cities and all are expected to act in concert to bring its ends about. There is no suggestion that the integration of services runs counter to their privatisation, that businesses might act against the democratic will of the population, or that a focus on strong leadership may work against citizen-centric decision-making. Political difference is suppressed. The standard acts on behalf of the passive citizen, finessing their interface with government and campaigning for a marketplace of services fit for all purchasing powers. What was once New Labour policy, has been freed of any equivocation and repackaged as a best practice for all and sundry. And for what end? To help British management consultants capture a share of the growing global market for smart city services.

But PAS 181 lacks a reliable enforcement mechanism. It is for this reason that I theorised it as a political technology for assuring city leaders. In my interviews and in the promotional materials of the consultancy group active in India, it was claimed that the standard helps ease uncertainty and doubt. Even as neoliberalism hollows out the capacity for government to act in the public interest, it elevates the figure of the leader, who, like

the CEO, is able to quickly determine the right course of action with only a cursory glance at the key performance metrics (Davies, 2017). PAS 181 attempts to give leaders the confidence to act in the face of uncertainty.

Taken together, the case studies reveal four things that city standards hope to achieve. First, they hope to facilitate inter-city communication and knowledge exchange. The developers of city standards recognise that discussions of smart, sustainable and resilient cities are often undermined by a lack of agreed upon assumptions, definitions and ambitions for the future. They seek to address this by establishing a common language and conceptual framework, and by using standards as a vehicle for promoting successful use cases. For CPA-I_001, this can be traced back to Vicente Guallart's proposal for a universal urban structure to be used in the planning and design of cities. It was presented in different terms at the founding event of City Protocol, when Manel Sanromà defined 'protocol' as a record of agreements amongst a group of peers, and persists throughout the promotional materials of the City Anatomy. Similarly, WCCD have positioned ISO 37120 data as a language for comparing cities in different countries and finding solutions to common urban ailments. The desire of city governments in Boston, Melbourne and Toronto to benchmark themselves against their global peers, identify best practices and share their experiences, gives empirical support to this claim. While I have argued that there are ontological and methodological limits to a universal language of cities, it is clear that these standards have successfully fostered inter-city communication.

Second, city standards hope to integrate urban systems and data generated about them. Cities are perceived as fragmented. The government departments responsible for public infrastructure and services are seen to be isolated, inward-facing, overly protective of data and resistant to change. By promoting an ethic of open data and knowledge exchange across the city as a whole, standards aim to unlock efficiencies in urban management and promote innovative technological solutions from industry. This imperative has been expressed in different ways by each of the case studies. The City Anatomy champions a system of systems approach to cities and was complicit in the formation of the amalgamated department of Urban Habitat within *Ajuntament de Barcelona*. ISO 37120 indicators are whole-of-city aggregations of data from a range of city sectors and services. Cities have applauded its ability to establish relationships and promote transparency within government, even as WCCD have not fully embraced open data. Finally, PAS 181 promotes joined up government and a holistic approach to citizen engagement. Its franchise business model is motivated by a desire to simplify services without radically altering departmental structures. The desire to integrate cities is not unique to city standards, nor indeed to future cities, and I have gone to lengths to place it within the historical literature. It is far too early to determine whether or not city standards will be successful in this endeavour.

Third, they hope to make city data internationally comparable. Presently, city data is wildly irregular as a result of differing social and legal traditions, institutional structures, and geographical and demographical particularities. City standards imagine comparable data as a precursor to global city benchmarking, the promotion of best practices, the leveraging of funding and the securing of critical infrastructure. CPA-I_001 has been used as the foundation for indicators to measure and compare cities, and for the development of an ontology for machine learning algorithms that utilise such data. In addition, members of CPS have ruminated about using the standard to interconnect city data through a network of federated, big data portals. Proponents of big data sometimes argue that its great quantity obviates the need for high quality. Through their actions, WCCD offer an implicit critique of this position. They employ a sophisticated data verification and assurance mechanism, designed to slowly bring ISO 37120 data towards a common ideal. The result is a relatively small and consistent database of urban indicators. In contrast to both approaches, I have argued that meaningful (and measured) inter-city comparisons can only be made with full and proper knowledge of the provenance and quality of urban data. While these standards may make city data appear more comparable, they also frustrate the normative decision over whether such data ought to be compared.

Finally, city standards hope to spread tools and techniques for managing cities in a leaner and more responsive way. City leaders and managers are positioned as crucial to the acceleration of smart, sustainable and resilient cities, but are felt to be lacking in the resources and know-how necessary to drive change. By formalising and legitimising administrative tools, city standards hope to empower leaders to act in a more directed and strategic manner. The smart city strategy and harmonisation efforts of ISO emphasise a need for management frameworks and leadership guides that lower the cost of entry into the smart city market. Specific government departments are not to be the focus of this work, so much as their interfaces and overarching structures. CP and WCCD promote a culture of measurement, comparison and data-driven decision making. PAS 181 implicitly recognises the limits of this by adopting a far more qualitative approach. It targets city leaders both inside and outside government with well-defined patterns to redress recurring problems. While PAS 181 may imbue the confidence to act, this is achieved by engineering the politics out of best practices. On the whole, city standards assume that elites can replace ethics, values and ideology with unbiased analysis and generic solutions.

Even though CPA-I_001, ISO 37120 and PAS 181 were developed through consensus-based processes, they invariably reflect the assumptions, biases and beliefs of the handful of experts who can afford them time and attention. Far from expressing the most rational or technically-optimal solution, they are vehicles for political ideas. CPA-

I_001 frames public engagement not in terms of solidarity and debate, but as a protocol to be executed on the material and social infrastructure of the city. Faced with a social movement that grew out dysfunction, informality and illegality, its vision of urban order was found wanting. The ISO 37120 indicators, while pragmatic and relatively flexible, internalise tensions that undermine their comparability and lead to questions over their ultimate use. Even if cities implement the standard with values of transparency and openness in mind, WCCD have placed limits on their access to data. The standard may do less to help cities improve public service provision and management, than bring them into highly financialised circuits of global capital. Finally, in identifying the origins of BSI PAS 181 recommendations in the New Labour policies of the early 2000s, I have revealed its passive account of citizenship and social change, and denial of political conflict. It is worrying indeed that its depoliticised governance practices are consciously being spread to local governments in former British colonies.

The ethics of my methodology have encouraged me to stay close to the data that I have collected and produced. In accordance with this, I have resisted critiquing city standards from the outside, preferring to generate a more intimate perspective through the process of interpretive analytics. In the next section, I intervene upon the field of possibilities described in Chapter 4. My aim is to further unstandardise the standards, by reinforcing arguments that pluralise non-standard bodies and subject positions.

Reconfiguring the field of possibilities

Standards-making is an intensely political act, but the politics of a standard do not cease with its publication. Through circulation and implementation, a standard both relies upon and reinforces its conditioning apparatuses, reworking their terms in subtle but nonetheless significant ways. Thus, rather than impose upon those involved in city standards my opinions or recommendations as a somehow external, somehow disinterested expert, I here call attention to existing but minority positions in order to broaden the extent of the field's politics. I take my lead in this strategy from feminist scholars (such as Hayles, 1996; Kember, 2003) who, in the context of the mid-1990s dispute between scientific empiricism and cultural studies, attempted to engage ethically and politically with their research topic without abandoning a poststructuralist epistemology. Three arguments are pursued: an invitation to think with non-linear rather than linear systems; a suspicion of the logic of silo busting; and a priority for local indicators rather than global benchmarking. Each of these queries a core supposition of one (or more) of the three material-discursive apparatuses.

The more teleological and deterministic areas of systems theory tend to treat the system not as a prop to think about the world, but as an essence that transcends and

precedes worldly manifestation. Hayles (1999) conceives this as a shift from the Platonic backhand to the Platonic forehand. With the Platonic backhand, data are drawn upon to infer simplified abstractions. In the case of the City Anatomy, observations about the form and function of urban infrastructure are used to develop a model for thinking about cities in general. All theorising necessarily involves this movement. The problem occurs when the abstraction is treated as an authentic and inceptive form, such that "complexity appears as a 'fuzzing up' of an essential reality rather than as a manifestation of the world's holistic nature" (Hayles, 1999: 12). 'System' becomes no longer a metaphor for thinking about the city, but the city is actually treated as an expression of an essential system (or system of systems). When this shift occurs, the model becomes a real simulation of how things unfold. The city is granted purpose and its state becomes predictable.

Rather than attempt to undo this logic by exposing it to metaphysical critique, a more effective move may be to call attention to a counter-trend within systems theory: namely, complexity theory (Gleick, 1987; Waldrop, 1992). Here, the system is conceived as open rather than closed (such that it exists within an environment with which it exchanges matter, energy and information) and the dynamics are understood to be non-linear rather than linear (such that a model's variables do not change at an even rate with respect to one another). Bringing complexity theory to thinking on urban systems does not undermine the Platonic forehand, but it does work against its effects. When the city is conceived as open rather than closed, it is understood to have an active and interactive relationship with its immediate environment. Mutual exchange rather than self-sufficiency is prioritised. When the model of the city is based on non-linear dynamics, its variables become highly dependent upon their starting conditions. Slight changes in input values will, with time, produce wildly different outputs. This undermines the determinacy of systems theory and significantly alters what can be said about its purpose.

One of the pivotal members of City Protocol thinks about systems in this way. For Francesc Giralt, the dynamics of cities are inherently non-linear and therefore predictable only over a short period of time. But this does not mean that it is useless to model them.

> I thought if a city is a non-linear system (a highly non-linear system of systems and interactions), then there should be strange attractors, which in a city will not be like something that you have to imagine in a multi-dimensional space as a vector, but something that physically exists. Then you realise that strange attractors in cities are their public spaces. […] [S]quares, parks, recreational areas, where people meet and […] develop a sense of community by interaction. (Interview 33, Francesc Giralt, City Protocol, September 14, 2016)

Rather than use the model to determine how the city will behave and thus how it can be controlled, Giralt is suggesting that modelling can be used to inform planning for the use of public spaces. When complexity is introduced to the application of systems theory to

cities, the result is a more modest appreciation of the kinds of outcomes that can be achieved.

The imperative to bust departmental silos in favour of a holistic and integrated approach, is common to all three of my case studies. But silo-busting means different things within each of the three material-discursive apparatuses. Systems theory undermines the Cartesian apprehension of discrete, preformed objects in space by foregrounding functional co-ordination. When everything is a system, bureaucratic specialisation is perceived as a suboptimal way to organise and control activities. A more effective response would be in keeping with the order and purpose of the city as a dynamic, interactive whole. Neoliberalism is largely ambivalent about what form a government takes, focusing instead on how it can proliferate and improve competition. On the one hand, this confers a suspicion of publicly run utilities and a preference for their liberalisation. For the neoliberal, city silos engaged in the provision of services should be broken up and replaced by a marketplace of private providers. On the other hand, the neoliberal is also inclined to use microeconomic logics to interpret the behaviour of public sector employees. Thus, corporate management tools can be used to decrease costs within and between government departments (either by creating incentive structures in keeping with economically rational behaviour, or by decreasing the amount of time spent on deciding what to do and how to do it). Finally, the frame of governance perceives the silo as an outdated organisational form that is unable to deal with the complexity of the contemporary world. Here, the inefficiency is not functional or economic, but managerial. By creating divisions within a city government, knowledge becomes specialised at the expense of the cohesion and responsiveness of the city as a whole. A diffuse network of state and non-state actors is a far better way to respond to complex problems.

In questioning the assumed logic of silo busting, my purpose is not to impede the capacity of a city to organise its services and respond to threats. Rather, I see this argument as tied to efforts to deliberately undermine trust in the ability of public employees to serve the public interest. I do not take it for granted that competition is always the best way to organise distribution. Nor do I consider dispersed, loosely co-ordinated action the only way to solve dynamic, multifaceted problems. As such, my resistance to the argument of silo busting is a resistance to the automatic deferral to markets and networks—which, I believe, typically represent fewer people and are less accountable than a democratically elected government.

Two suspicions of silo-busting arose in my interviews. The first took the form of an appeal to evidence-based policy. Rather than assume that integration is always efficient than bureaucratic specialisation, one smart cities professional urged for caution and for the development of quantitative evaluation mechanisms.

> Frankly speaking, no one knows if these famous integrated projects (or integrated approach) that we always say that a smart city project should have, that if this approach works or delivers something, or what exactly does it deliver. […] We really don't know, I think, or we don't have yet a proven way to measure or prove or evaluate […] what an integrated project means and what does it deliver. (Interview 50, Nikolaos Kontinakis, EUROCITIES, May 24, 2017)

Put differently, integration is only warranted if and when there is a solid case for it, based on the best available data. I interpret this scepticism as a form of scientific empiricism that is broader than, but in keeping with, systems theory.

The second suspicion was presented to me by Chris Parker, technical author of BSI PAS 181. While related to the first, it is more pragmatic, assuming that the structure of a city government serves a rational purpose.

> The problem is not silos or organisational structures. […] You've got a sort of functional organisational structure and that provides people with a career structure to work within and decision-making structures and all of that. And whenever we've on a consulting basis worked with a city or whatever we almost never recommend organisational restructuring as being part of what you need to do. You need an organisational structure. You've got one. Fine. (Interview 26, Chris Parker, PAS 181 technical author, March 18, 2016)

Here, resistance to silo busting is not based on a need for evidence but on the belief that specialisation is often the result of functional and organisational optimisation. I interpret this as a Coasian approach, in which government is understood as a way of reducing transaction costs by internalising (social and economic) relations. Rather than decry state bureaucracy as an exception to the free market, later neoliberals such as Coase (1937; 1960) and Stigler (1971) considered it as an actor within the economy, and applied microeconomic logics to an assessment of its forms, processes and outcomes. Perceived opportunities or threats need not be addressed by restructuring or downsizing, but by subtler, more sophisticated management techniques. It is thus that my interlocutor recommends cities to "work within [their] existing organisational structure, but embed within that a new virtual business structure which is based around user needs rather than organisational constructs" (interview 26, Chris Parker, March 18, 2016).

The final argument finds me once again shifting my allegiance, this time to argue against a technique of governance by drawing on the values of scientific empiricism. Benchmarking is used to continually improve the performance of a firm or agency by measuring products, services and practices, and comparing them against those of competitors in order to identify and adopt best practices. It is, as such, an attractive tool for those sympathetic to principles of governance. It recognises that problems are not unique, but are encountered over and over again by different actors. By benchmarking,

firms can diagnose areas where they are weak and learn from (and potentially collaborate with) others in order to improve. Rather than being centralised, management is thus exercised through a web of interrelated actors held together by common data points. This is especially true when benchmarking is applied to the public sector by a third-party, as is the case for ISO 37120 and WCCD.

Performance assessment and benchmarking have been criticised for standardising a narrow band of acceptable practices—such as profit-driven self interest (Brown, 2015) or metric-based medicine (Adams, 2016)—at the expense of local ways of perceiving, knowing and caring. I encountered a similar criticism of ISO 37120 in my interviews. An epidemiologist I spoke with cautioned against the validity of international comparison based on the indicators 'number of in-patient hospital beds per 100,000 population' and 'number of physicians per 100,000 population'.

> Okay, yes, that is nice, it might be a handy thing just to have off on the side. Is it a measure of how we are doing health wise? I don't think so. Health is about something else. It is not about the number of doctors you have got. It can impact in a negative way if you only have one doctor in the whole city of Toronto, but there are so many other things that are much heavier hitters. Maybe we should be looking at […] the slum lord and those kinds of things. That's impacting on health. What are those kind of things that help us to know that we are doing better, what gives context maybe to some of these numbers or slightly different health related ones? (Interview 12, epidemiologist, Toronto Public Health, January 28, 2016)

The interviewee's position is that the chosen metrics are unable to account for social determinants of health (such as economic status, living conditions, health insurance costs, and so on). While this individual might argue that international benchmarking overrides local knowledge, they would not want to do away with metrics altogether. They would prefer health indicators that are tuned to specific problems encountered within well-defined geographic limits. Put differently, the opposition is to benchmarking, not performance assessment. In this way, the interviewee is seeking to align evidence-based medicine with a more sophisticated understanding of the distribution of morbidity and mortality.

Opting to argue with complexity theory, scientific empiricism and Coasian neoliberalism on specific issues is not the same thing as agreeing with them. My goal in doing so, has been to reconfigure the field of possibilities, and create space for more democratic and polyphonous future cities.

City governments should recognise the importance of standards and become involved in their generation. The national standards bodies of Britain, Canada, Spain and the US have all been active in producing city standards, and in establishing affiliated groups and mirror committees. The participation of cities within these bodies varies,

however. SDS/2, the BSI city standards mirror committee, includes representatives from more than 50 organisations (BSI, n.d.-a). Of these, only three are local governments: the City of Edinburgh Council, the Peterborough City Council and the Royal Borough of Greenwich. The situation in Canada is even worse. When I spoke with the employees of the City of Toronto tasked with implementing ISO 37120, they could not think of a single city representative on that country's ISO/TC 268 mirror committee. City standards are shaping future cities, and it is important that local governments play a role in this. Ireland has recently become a full participating member of ISO/TC 268 (ISO, 2018a). It is beholden upon the four Dublin authorities to liaise with the The National Standards Authority of Ireland and ensure that they have representatives placed on the mirror committee.

In cities that cannot become involved in standards-making, it is crucial that standards be read as political documents with political origins. The material-discursive apparatuses discussed in this thesis, can be used as a guide for achieving this.

Standards and the study of future cities

There are several areas of academic research upon which this thesis intervenes. Some have been explored within the body of the text, others have been flagged for further discussion, and still others require more reading and research. In this section, I present the strongest theoretical, conceptual and methodological contributions as a way of summarising the work, drawing together some concluding remarks and pointing out directions that research on city standards may go in the future.

Methodologically, my enquiry into city standards is founded on Foucault's genealogy. I have addressed the limits of this approach, not by defending Foucault, but by reworking his ideas through those of Barad. The result is a tentatively realist approach to the construction of matter and meaning. As a new materialist (Coole and Frost, 2010; Dolphijn and van der Tuin, 2012b), Barad attempts to take seriously the agency of things, without rejecting a relational ontology (cf. Harman, 2011; Bryant, 2011; Bogost, 2012). In this respect, my methodology is not altogether unlike ANT (Latour, 2005; Law, 2004), with the key difference being the attention afforded to the wider context of study—what Barad calls the field of possibilities. I am not the first person to apply the new materialism to social scientific research. Nevertheless, I hope that my close reading of Foucault and Barad has lead to a useful and original interpretation of their methods and style.

I have analysed not only the presence of city standards, but the history that they invoke. I did not begin my thesis with the intention of reading Warren Weaver, Norbert Wiener, Friedrich Hayek, Ronald Coase, James Rosenau and Jan Kooiman. Rather, I was turned towards these writers in an effort to comprehend my case studies. The chapter

on the context of city standards is not constructed as a neat, unidirectional narrative, but is called upon to interpret recurring themes encountered in the data. This manner of exploring the materials and meanings of a performative event, is a small contribution to social scientific research methodologies.

My material-discursive genealogy makes two further and more specific contributions to the way that the spatiality of standards is perceived and studied. The first entails a movement from STS to human geography. While geographers have studied global standards (see for example Dunn, 2003; Freidberg, 2004; Christopherson and Lillie, 2005; Mutersbaugh, 2005; DeSombre, 2006; Klooster, 2010; Ouma, 2010; Bresnihan, 2016) and are certainly no slouches when it comes to innovative spatial methodologies (see Whatmore, 2002; Cook, 2004), few within the discipline have theorised the globality of standards. In most studies, standards are simply out there, somewhere in circulation. What is taken to be important is the manner in which they touch down and interact with particular places, regions and territories. Standardisation, as a long process of development, circulation and implementation, is left largely unproblematised and unexplored. Often, a scalar opposition between the local and the global hangs over this work. Two notable exceptions are Mutersbaugh (2005) and Klooster (2010), for whom the twists and turns taken by standards on their way towards global use, play a central role. Nevertheless, what this means for their spatiality is not thought through. Even Barry's (2006) 'technological zones', probably the concept best suited to the task, struggles to describe the partial and discontinuous deployment of global standards. In drawing on STS, particularly the feminist writers Star (1990), Haraway (1991; 1997) and Barad (2007), I hope to have made a contribution towards geographical enquiry on this topic.

If human geography can benefit from STS, the reverse is also true. The 'scale' debates of the last two decades (beginning with Marston, 2000; Brenner, 2001) have led to a number of fruitful experiments with spatial methodologies (summarised by Jones et al., 2017). Contrary to the myopic claims of Latour (2016), geographers have long worked to break free of a Euclidean conception of space and provincialise global politics. The concept of 'site' is only one way in which this has been done (Schatzki, 2002; Thrift, 2009; Woodward et al., 2010). While geographers have yet to apply such topological methodologies to standards research, they are of considerable influence in other areas of the discipline. For its part, the blossoming of STS in the 1980s involved granting epistemic attention to the principal site of scientific knowledge production: the laboratory. In taking up the question of how and where science is made, STS became less universal, and more regional and place-based in its mode of enquiry. As Law and Mol (2001) argue, this brought a new spatial focus to the field. However, 'site' was soon overshadowed by the

theoretical and empirical potential of 'network'. In returning 'site' to STS via geography, I hope to be able to add to the growing interest in more eventful methodologies.

Theoretically, the thesis positions iteration as a form of power. Rather than approach standards in terms of their movement, I have foregrounded their iterative enactment. For Barad (2007), bodies are continually materialised and identified through the repetition of their formative practices. This is encapsulated by the concept of 'iterative citationality' which is borrowed from Butler (1993), who in turn adopts it from Derrida (1974; 1988). Iteration is not simply the repetition of the same. Rather, it signifies the difference or modification entailed in repetition. While an iteration necessarily carries something of the same, such that it can be recognised, it nevertheless opens up the possibility for something new (Cuddon, 2013: 373). Derrida understood this principally as an operation of words and concepts. Thus, in speaking we cite previous utterances and ideas. But through Butler and Barad the term takes on new meanings. Specifically, it refers to the working and reworking of power on bodies, and to the configuration and reconfiguration of cuts on manifolds.

Following Foucault, I have treated power not as something that one body holds over another, but as an alignment of relations that reinforce action, and grant it potency and certainty. Power is thus conceived as both relational and processual—it occurs between things as an event or a doing. But power is also exercised in different and overlapping ways. In *Discipline and Punish*, Foucault followed the historical shift from one type of power to another (Foucault, 1977). To grossly simplify, punishment is a direct and violent display of force. It is enacted by the state onto the body of an individual as a way of ensuring that others do not transgress. Discipline is more indirect. It operates through institutions, such as military barracks, prisons, schools and hospitals, producing docile bodies that conform to prescribed norms of behaviour. In following the displacement of the first by the second, Foucault was able to offer an original and thought-provoking interpretation of the origins of the liberal state. Picking up on this narrative, Deleuze (1992) proposed an epochal shift towards a third type of power, that of control. Rather than discipline individuals through state institutions, the population is measured, connected and controlled through mediating networks. This concept of power is more lenient but also more pervasive, operating on ever finer and more molecular details.

Despite suggesting that smart city power is integrative, it is not my wish to propose that city standards signify a new periodisation of power. Integrative power is not unique to smart cities, but permeates future city imaginaries, and contemporary management and governance practices. Its proper theorisation lies well beyond the scope of this thesis. Instead, I want to make the more modest claim that the manner in which standards produce ordering effects—that is, through the circulation, iteration and enactment of rules and values—is a particularly potent *form* of contemporary power.

I take my lead in this from Anderson (2017), who, in a recent progress report on cultural geography, describes some of the ways in which power is currently being observed and diagnosed. He makes a distinction between modes and forms of power. Modes of power specify the ways in which materialities and immaterialities are woven into forceful occurrences. He offers as examples "dispossession, precaritization, expulsion, abandonment, destitution, attrition, invisibilization and extinction" (Anderson, 2017: 504). This is much more specific than the historical shifts theorised by Foucault and Deleuze. But power also takes multiple forms; which I understand to refer to the shape (or geography) of the workings of power. Examples include "networks, assemblages, apparatuses, meshwork, nexus, fluids, flows [and] fire" (Anderson, 2017: 506). What is important here, is not what power enables to be done, but *how* that thing is executed. Given that standards produce effects of such great variety, it would be futile to single out their multiple and enmeshed modes. Instead, what I am interested in is the shape of standardisation.

The iterative form of power is not reducible to standards. It is both more extensive and more abstract. In order to appreciate how it functions, it is important that it be given some historical and material context. Older and more established powers, whether exercised by a sovereign state or its institutions, are seen to be insufficient in addressing complex, global problems. For some, it is the internet and ICT that threaten the *status quo*. For others, it is financialised capital. Within the smart city discourse, the threat is usually framed in terms of the unstoppable processes of urbanisation that are set to overwhelm existing public services and infrastructure. Whatever is claimed to be the cause of the threat, is, in some sense, irrelevant to my argument—such forces being discordant with the ontology advanced in Chapter 3. What is important is the perception that economic and technological advancements of modernist society have somehow turned against it, and are undermining its foundations (see Beck, 1992; 2009). Whether through a lack of mechanisms to rectify this, or a lack of faith in the capacity of those mechanisms to succeed, state power seems (on its own) unable to secure liberal life. It is this lack that iterative power seeks to address.

But this is not enough to demarcate it from other forms of power. It is also important to describe the logic that it amplifies. This is founded on the assumption that problems (or disorders) are not unique, but recur in different spaces and times. These are classified as the same, similar or of a type, and therefore soluble to a definitive solution. Social complexity is not denied, but used to motivate a response to its anticipated outcomes. Standards are particularly well suited to this logic. So long as repetition is understood to be an effective way of addressing generic problems (i.e., to achieve a desired order), they will play a significant role in the enactment of power. Unlike Deleuze's networks of control, iterative power does not interconnect (in)dividuals. Instead, its effects are

produced by continuously cutting agencies apart. It is only through performative differentiation of bodies from manifolds, that the borders between things come to be, and it is through repetition, that ordering effects become ever more powerful. The temporal trajectories so often associated with standardised infrastructure, can be conceptualised as the alignment of vectors on a field of social and material relations.

Another contribution made by the thesis, is to open up a line of critical research into the affective capacities of assurance. Geographical research on affect has garnered significant attention as part of the non-representational turn triggered by the work of Thrift (2004a; 2008). Affect is here treated as an intensity of (immaterial) emotive forces that put bodies and subjects into motion. While Barad's agential realism does not explicitly take on such a notion of affect, there are resonances between her ontology and those evoked by Thrift, based as they are upon "an 'inhuman' or 'transhuman' framework in which individuals are generally understood as effects of the events to which their body parts (broadly understood) respond and in which they participate" (Thrift, 2004a: 60). Bringing affect into Barad's philosophy would require further broadening of the concept of 'discursive practices' to include not only meanings that are thought and said, but those that are felt and conveyed through bodily perception and gesture. This would lead to research that is more phenomenological in nature than what I have conducted with respect to city standards. Nevertheless, the frequent reference made by my interviewees to the legitimacy, dependability and trust imbued by standards, leads me to believe that this would be a fruitful approach.

I want to sketch a tentative picture of what this line of research might be concerned with. It could begin by recognising how uncertainty features in each of the three material-discursive apparatuses of systems theory, neoliberal rationality and the governance turn. In Shannon's (1948) information theory, uncertainty is a measure of the amount of entropy in a sequence of symbols. In cybernetics, Wiener (1948) arranged the terms somewhat differently, defining information as *negative* entropy. What is crucial in both cases is the order or pattern of a transmitted message (Kline, 2015). 'Uncertainty' is thus given a technical inflection that strips it of any sense of anxiety or discontent. It was this sense of the word that Hayek (1945) seized upon in his theorisation of the economy as a communications system. Here, price plays the role of information and uncertainty becomes a necessary outcome of competitive markets—far from being feared, Hayekian uncertainty should be revered as the only guarantor of individual freedom. But as Davies (2017) points out, for neoliberals, democracy seems to stir in the population the animal spirits that *homo economicus* has sought to repress. It is this political sense of uncertainty, rendered as an uneasiness with the prospects for liberal life, that is seized upon by governance scholars. Social complexity has generated the very conditions—rapid

urbanisation, climate change, fiscal austerity, *etcetera*—that seem to imperil its future. 'Uncertainty' is thus returned full circle to its emotive origins.

But what has this to do with standards? There is a roundabout and slightly tongue-in-cheek way of answering this question. For Deleuze and Guattari (1987), the metaphor of the refrain is used to describe a rhythm that eases trouble and doubt. Through the repetition of something familiar, the self is enfolded into the world. The refrain is an affective territorialisation of worried subjectivities.

> A child in the dark, gripped with fear, comforts himself by singing under his breath. He walks and halts to his song. Lost, he takes shelter, or orients himself with his little song as best he can. The song is like a rough sketch of a calming and stabilizing, calm and stable, center in the heart of chaos. (Deleuze and Guattari, 1987: 311)

In the maw of urban uncertainty, standards seem to be acting as a refrain for city leaders. Their principles and prescriptions are not particularly new; city leaders are likely to know them or at least to have heard them before. But in being repeated, they engender stabilising emotions associated with order, regularity and certainty. Like the child humming alone in the dark, the leader is comforted by the feeling that everything will be fine.

Investigations into the affective potential of standards would seize on the twin meanings of the word 'assurance'. Trust in standards is largely contingent upon compliance testing by third-party auditors. The industry for such accounting and assurance services is massive, powerful and thoroughly entwined with the global governance of capitalism. But its importance rests not only upon the quantification of products and processes, but also on the qualification of emotions concerning proper business conduct. The calming affects of voluntary standards might thus be contrasted with the angering affects that government regulations seem to induce. In geography, neoliberal affect is usually explored in terms of precarity, expulsion and abandonment (Anderson, 2016). It is important that research continues into the anxiety, loneliness, depression and cruel optimism afflicted on neoliberalised subjects (see Berlant, 2011; Povinelli, 2011). Nevertheless, in deepening social and economic inequalities, the current mode of capitalism produces positive and well as negative affects. A recognition of these will improve our understanding of how neoliberalism works and might be opposed. But such research might itself be construed as a political intervention that shows up the doubt and uncertainty that elites work so hard to suppress. The neoliberal vision of perfect rationality rests uneasily upon emotional foundations (see also Davies, 2015).

My final and perhaps most significant contribution is to stress the importance of standards and standardisation for contemporary urban studies. In Chapter 5, I argued that the field has yet to come to terms with recent activity in this area. Existing research has had an institutional focus (Arias, 2015; March and Ribera-Fumaz, 2016) or has

attended almost exclusively to the content of published documents (Joss et al., 2017; Schindler and Marvin, 2018). Important questions concerning the origins, assumptions, logics, circulation, implementation and effects of city standards have yet to be given serious attention, critical or otherwise. By addressing these issues in a sustained manner, I hope to make them a matter of concern for urban studies. The market for city standards is large and continues to grow. While I have started to explore what this means, there is considerable scope for more research.

This is not the first call for such attention. More than 15 years ago, Amin and Thrift (2002) argued that the permeation of new technologies into the forms and functions of urban life was transforming the central object of urban studies.

> [W]e can no longer think of cities in the old, time-honoured ways. The advent of software signifies the rise of new forms of technological politics and new practices of political invention that we are only just beginning to comprehend as political: politics of standards, classifications, metrics, and readings. (Amin and Thrift, 2002: 127)

While the role played by software in the governance and everyday life of the city has become an active topic of study (see for instance Thrift and French, 2002; Graham, 2005; Kitchin and Dodge, 2011; Kitchin, 2014b), the same cannot be said of the standards that prescribe how this is expected to occur (cf. Thrift, 2004b; Dodge and Kitchin, 2005). What is more, it would be a mistake to limit research on standards to software and ICT. As this thesis has shown, voluntary consensus standards are also being used to shape measurements, markets and management practices with and beyond such technologies. These topics should be disentangled and each given their due attention.

There are at least three further reasons why city standards should become a matter of concern for urban studies. First, they respond to and reinforce the emergence of the whole-of-city focus. Standards have long affected cities, but the notion of standards for cities is relatively new. Whether due to the reflexive threats of modern society, to the role played by population density in post-industrial capitalism, or to the calcification of agency at other levels of government, the city has been positioned as the foremost arena in which political change in the twenty first century will be enacted. Standards play into this trend and are well poised to affect its performative outcomes. Second, and building on this, standards are increasingly being used to propagate ideas, materials and techniques between city governments. There is a substantial literature that follows and describes the global transfer and adoption of policies and practices (Peck, 2011; McCann and Ward, 2011; Peck and Theodore, 2015). But in the context of the iterative form of power described above, city standards strip particular urban policies of their politics and spread them with a rare alacrity, cohesion and scope. Finally, standards do ultimately represent a narrowing of urban futures. While there is no simple, single logic to city standards, they are acting as a site of international contestation over the form and character of smart,

sustainable and resilient cities. Through processes of standardisation, the openness of the future is being reshaped along lines acceptable to liberal capitalism. This involves struggle over meanings of 'complexity' and 'uncertainty', and over how the city is to be conceived, measured and governed. In these and other ways, my research draws attention to the importance of city standards for urban studies.

To this end, I hope that Baradian metaphysics might contribute to a rethinking of the city as an emergent site of intensive material-discursive enactment. On several occasions during the thesis, I have eluded to ongoing and often heated debates in urban theory (see for instance Brenner et al., 2011; Roy, 2015; Rickards et al., 2016; Storper and Scott, 2016). In one sense, these arguments are nothing new (see Thrift, 1993). Urban thinkers have long sought to identify the essence of cityness and the causal factors, if any, that drive its development and growth. Recently however, these debates have flared up once more, due in no small part to the role played by Chinese urbanisation in stabilising the global economy after 2008 (Harvey, 2012). What 'the city' is or whether it can be defined at all, where 'the urban' stops and 'the rural' begins, whether considering cities as a process of urbanisation solves these problems, and what role such theories play in political (particularly decolonial) struggles, are all pressing concerns for urban studies.

I do not intend my position in these debates to abolish others. I am interested in the role played by capital in the production of the built environment, and have a deep respect for Lefebvre (1991), Harvey (2006) and those seeking to build on their work. I am not interested in overcoming Marxist urban theory, nor in pretending that I have discovered some new way of thinking about urban life (cf. Farías and Bender, 2010; Blok and Farías, 2016). Nevertheless, there is no disguising the fact that my approach departs from Marixst urban theory in some fundamental ways. In prioritising immanent and unfolding relations rather than dialectical forces, my ontology is at odds with most economic and cultural readings of Marx's work. Nevertheless, I want to pull back from the assertion that standards invalidate other approaches to urban theory. Different theories respond to markedly different challenges, and have different strengths and weaknesses. They lead to conflicting conclusions, but as someone interested in developing a perspectival (rather than absolute) account of truth, I cannot believe that these, by necessity, nullify one another.

The approach that I am interested in contributing to, builds on applications of assemblage and topological thinking to critical urban studies (McFarlane, 2011; Secor, 2013) to define the city according to its densities and intensities of life (McFarlane, 2016; Anderson, 2017). As the city is conceived outside a Cartesian scaffolding, it becomes impossible to quantify with any great precision. Cityness is simply more intense and dense with life than non-cityness. But there is also a certain freedom afforded by such an approach. It remains possible to consider problems of diversity, propinquity,

agglomeration and congestion, but one is also freed of the need to determine absolutes and find definitive, universal solutions. This is a relatively new way of theorising cities and more work needs to be done to think through what it would mean for urban planning, policies and politics. What I hope Barad's metaphysics can offer such an approach, is a way of recouping performative and normative aspects of structuralist social theories, without undermining the core conceptualisation. Material-discursive apparatuses of bodily production are real in the sense that they produce material, social, spatial and temporal effects in the world. Without accepting their assumptions, it is, nevertheless, possible to ally with them in an entwined becoming of a better city.

Re-placing city standards

Some commentators have expressed frustration at the multiplicity and conceptual ambiguity of future city visions (see for instance Hollands, 2008). Smart, sustainable and resilient cities descend and emerge from a range of sources and literatures. Their meanings are not fixed but shift; the work that they perform differs depending on who recruits them and why. Far from seeing this as a weakness, I regard it as a strength. Cities are a composite of all sorts of human and non-human agencies, moving and relating with different speeds and spatialities. This diversity is part of what makes them so attractive and exciting. That visions of the future city should reflect this, is no cause for alarm. Discourse is always interfolded with materiality, and while there is certainly a place for terminological clarity, it is important not to forget the heaving, messy and contested reality that this represents.

City standards seek to anticipate uncertainties by narrowing and regularising future cities and the political technologies with which they are being constructed. My ethical position has rested on troubling the certainty of this anticipatory moment. I have followed my case study standards closely in order to reveal what Russell (2014: 16) refers to as the obfuscation of their founding conflicts and contingencies. Every standards developer makes choices about what to keep and what to set aside. In exposing the rationale behind these decisions, I have presented a conceptual and theoretical toolkit that can be used to understand the politics of city standards and to challenge their truth claims. My ultimate aim has been to unstandardise the standard, and recalibrate it to the many and conflicted visions of the future that exist within cities.

On a more theoretical level, this involves a shift from a politics of anticipation, to a politics of an open future. Smart cities and city standards are often presented as a response to the existential threats of the twenty-first century: mass urbanisation, an ageing population and global climate change. The solutions that they offer seek to prepare for these threats in the here-and-now, in order to limit the damages that they are expected to

cause (White, 2016a). The problem occurs when the urgency of this moment is used to curtail democratic decision-making and debate. Without denying the significance of the challenges posed by these threats, I have argued for an approach that is comfortable with conflict and contradiction. As Guy and Marvin (1999: 273) put it, "the role of research is to keep alive a multiplicity of pathways by opening a wider discourse and dialogue about the types of future we might be able to create". Preserving this politics of possibility is a crucial way of revitalising the promise and poetics of infrastructure.

REFERENCES

Abbate, J. (1999) *Inventing the Internet*. Cambridge and London: The MIT Press.

Adams, V., ed. (2016) *Metrics: What counts in global health?* Durham and London: Duke University Press.

AFNOR (2011) Proposal for a new field of technical activity in Communities. *Association Française de Normalisation* [online]. Available at: https://share.ansi.org/shared%20documents/News%20and%20Publications/Links%20Within%20Stories/ISO%20TSP%20224%20(Sustainable%20development%20in%20communities).pdf (accessed 31 October 2018).

Agamben, G. (2009) *What Is an Apparatus? And other essays*. Translated by D. Kishik and S. Pedatella. Stanford, CA: Stanford University Press.

Alder, K. (2002) *The Measure of All Things: The seven-year-odyssey that transformed the world*. London: Abacus.

Alexander, C. (1964) *Notes on the Synthesis of Form*. Cambridge, MA: Harvard University Press.

Alexander, C. (1965) A City is Not a Tree. *Architectural Forum*, 122(1), 58–62.

Alexander, C. (1966) A city is not a tree. *Design*, 206.

Alexander, C. (1979) *The Timeless Way of Building*. New York: Oxford University Press.

Alexander, C., Ishikawa, S. and Silverstein, M. (1977) *A Pattern Language: Towns, Buildings, Construction*. New York: Oxford University Press.

Amadae, S. M. (2003) *Rationalizing Capitalist Democracy: The Cold War Origins of Rational Choice Liberalism*. Chicago and London: The University of Chicago Press.

Amin, A. (2014) Lively Infrastructure. *Theory, Culture & Society*, 31(7/8), 137–161.

Amin, A. and Thrift, N. (2002) *Cities: Reimagining the Urban*. London: Polity.

Anand, N., Gupta, A. and Appel, H., eds. (2018) *The Promise of Infrastructure*. Durham; London: Duke University Press.

Anderson, B. (2016) Neoliberal affects. *Progress in Human Geography*, 40(6), 734–753.

Anderson, B. (2017) Cultural Geography I: Intensities and forms of power. *Progress in Human Geography*, 41(4), 501–511.

Anon. (2016) WG 11 Smart Cities. *Standing Document 2 on History of ISO/IEC JTC 1*.

ANSI (2016) *Directory of Smart and Sustainable Cities Standardization Initiatives and Related Activities*. American National Standards Institute Network on Smart and Sustainable Cities (ANSSC).

Anthopoulos, L. G. (2017) *Understanding Smart Cities: A Tool for Smart Government or an Industrial Trick?* Cham, Switzerland: Springer.

Arapostathis, S. (2008) Morality, Locality and 'Standardization' in the Work of British Consulting Electrical Engineers, 1880–1914. In I. Inkster, ed. *History of Technology, Volume Twenty-eight*. London and New York: Continuum. 53–74.

Arias, R. M. (2015) *Policy knowledge exchange in a cities' network : An introduction to the City Protocol*. PhD thesis.

Arthur, W. B. (1989) Competing Technologies, Increasing Returns and Lock-in by Historical Events. *The Economic Journal*, 99, 116–131.

ASIDEES (2018) *RE: Some questions regarding your ISO 37120 certification procedure* [email]. Message to J. M. White. Sent 12 July 2018.

ASIDEES (n.d.) ISO 37120 Certification. *Association for Sustainable Innovative Development in Economics, Environment and Society* [online]. Available at: https://asidees.org/index.php?id=iso37120_certification (accessed 31 October 2018).

Baird, K. S. (2015) From 'Smart City' to 'collective intelligence': Radical change in Barcelona. *Smart Cities Dive* [online]. Available at: https://www.smartcitiesdive.com/ex/sustainablecitiescollective/smart-city-collective-intelligence-radical-change-brewing-barcelona/1078466/ (accessed 31 October 2018).

Barad, K. (1996) Meeting the Universe Halfway: Realism and Social Constructivism without Contradiction. In L. H. Nelson and J. Nelson, eds. *Feminism, Science, and the Philosophy of Science*. Dordrecht: Kluwer Academic Publishers. 161–194.

Barad, K. (2003) Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter. *Signs: Journal of Women in Culture and Society*, 28(3), 801–831.

Barad, K. (2007) *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, NC: Duke University Press.

Barad, K. (2012) On touching—The inhuman that therefore I am. *Differences: A Journal of Feminist Cultural Studies*, 23(3), 206–223.

Barber, B. R. (2013) *If Mayors Ruled the World: Dysfunctional Nations, Rising Cities*. New Haven and London: Yale University Press.

Barnes, C. and Mercer, G., eds. (1997) *Doing Disability Research*. Leeds: Disability Press.

Barnes, T. J. and Farish, M. (2006) Between Regions: Science, Militarism, and American Geography from World War to Cold War. *Annals of the Association of American Geographers*, 96(4), 807–826.

Barry, A. (2001) *Political Machines: Governing a Technological Society*. London: Athlone.

Barry, A. (2006) Technological Zones. *European Journal of Social Theory*, 9(2), 239–253.

Bartky, I. R. (2007) *One Time Fits All: The Campaigns for Global Uniformity*. Stanford, CA: Stanford University Press.

Batty, M. (1976) *Urban Modelling: Algorithms, Calibrations, Predictions*. Cambridge: Cambridge University Press.

Batty, M. (1995) The Computable City. In R. Wyatt and H. Hossein, eds. *4th International Conference on Computers in Urban Planning and Urban Management*. The University of Melbourne, Australia. 1–18.

Batty, M. (2013) *The New Science of Cities*. Cambridge, MA: The MIT Press.

Beck, U. (1992) *Risk Society: Towards a New Modernity*. Translated by M. Ritter. London: Sage Publications.

Beck, U. (2009) *World at Risk*. Translated by C. Cronin. Cambridge and Malden: Polity Press.

Ben-Joseph, E. (2005) *The Code of the City: Standards and the Hidden Language of Place Making*. Cambridge and London: The MIT Press.

Ben-Joseph, E. and Szold, T. S., eds. (2005) *Regulating Place: Standards and the Shaping of Urban America*. New York and London: Routledge.

Bennett, J. (2010) *Vibrant Matter: A Political Ecology of Things*. Durham and London: Duke University Press.

Berlant, L. (2011) *Cruel Optimism*. Durham and London: Duke University Press.

Berlant, L. (2016) The commons: Infrastructures for troubling times. *Environment and Planning D: Society and Space*, 34(3), 393–419.

Berry, B. J. L. (1964) Cities as Systems Within Systems of Cities. *Papers in Regional Science*, 13(1), 147–163.

Bevir, M. (2010) *Democratic governance*. Princeton and Oxford: Princeton University Press.

Bicchieri, C. (2017) *Norms in the Wild: How to Diagnose, Measure, and Change Social Norms*. Oxford and New York: Oxford University Press.

Bijker, W. E., Hughes, T. P. and Pinch, T. J., eds. (1989) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. Cambridge and London: The MIT Press.

Bijker, W. and Pinch, T. (2011) Preface to the Anniversary Edition. In W. E. Bijker, T. P. Hughes, and T. J. Pinch, eds. *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. Anniversary ed. Cambridge and London: The MIT Press. xi–xxxiv.

Biron, C. L. (2017) How ISO Standards for City Data are Starting to Make an Impact. *Government Technology* [online]. Available at: http://www.govtech.com/data/How-ISO-standards-for-city-data-are-starting-to-make-an-impact.html (accessed 31 October 2018).

BIS (2013) *Smart Cities: Background paper*. London: Department for Business, Innovation and Skills.

BIS and Arup (2013a) *Global Innovators: International Case Studies on Smart Cities*. London: Department for Business, Innovation and Skills.

BIS and Arup (2013b) *The Smart City Market: Opportunities for the UK*. London: Department for Business, Innovation and Skills.

Blind, K. (2004) *The Economics of Standards: Theory, Evidence, Policy*. Cheltenham: Edward Elgar.

Blok, A. and Farías, I., eds. (2016) *Urban Cosmopolitics: Agencements, assemblies, atmospheres*. Oxon and New York: Routledge.

Bogost, I. (2012) *Alien Phenomenology, Or, What It's Like to be a Thing*. Minneapolis and London: University of Minnesota Press.

Boltanski, L. and Thévenot, L. (2006) *On Justification: Economies of Worth*. Translated by C. Porter. Princeton and Oxford: Princeton University Press.

Bork, R. H. (1978) *The Antitrust Paradox: A Policy at War with Itself*. New York: Basic Books.

Bouk, D. (2015) *How Our Days Became Numbered: Risk and the rise of the statistical individual*. Chicago and London: The University of Chicago Press.

Bowker, G. (1993) How to be Universal: Some Cybernetic Strategies, 194370. *Social Studies of Science*, 23(1), 107–127.

Bowker, G. C. and Star, S. L. (1999) *Sorting Things Out: Classification and Its Consequences*. Cambridge and London: The MIT Press.

Boyer, M. C. (1996) *Cyber Cities: Visual Perception in the Age of Electronic Communication*. New York: Princeton Architectural Press.

Boyle, M., Mcwilliams, C. and Rice, G. (2008) The spatialities of actually existing neoliberalism in Glasgow, 1977 to present. *Geografiska Annaler, Series B, Human Geography*, 90(4), 313–325.

Braidotti, R. (2006) Posthuman, All Too Human: Towards a New Process Ontology. *Theory, Culture & Society*, 23(7–8), 197–208.

Braidotti, R. (2013) *The posthuman*. Cambridge and Malden: Polity Press.

Braun, B. P. (2014) A new urban dispositif? Governing life in an age of climate change. *Environment and Planning D: Society and Space*, 32(1), 49–64.

Brenner, N. (1999) Globalisation as Reterritorialisation: The Re-scaling of Urban Governance in the European Union. *Urban Studies*, 36(3), 431–451.

Brenner, N. (2001) The limits to scale? Methodological reflections on scalar structuration. *Progress in Human Geography*, 25(4), 591–614.

Brenner, N., Madden, D. J. and Wachsmuth, D. (2011) Assemblage urbanism and the challenges of critical urban theory. *City*, 15(2), 225–240.

Brenner, N., Peck, J. and Theodore, N. (2010) Variegated neoliberalization: Geographies, modalities, pathways. *Global Networks*, 10(2), 182–222.

Brenner, N. and Schmid, C. (2013) The 'Urban Age' in Question. *International Journal of Urban and Regional Research*, 38(3), 731–755.

Brenner, N. and Theodore, N. (2002) Cities and the Geographies of 'Actually Existing Neoliberalism'. *Antipode*, 34(3), 349–379.

Brenner, N. and Theodore, N. (2003) *Spaces of Neoliberalism: Urban Restructuring in North America and Western Europe*. Malden, MA: Blackwell Publishing.

Bresnihan, P. (2016) *Transforming the Fisheries: Neoliberalism, Nature, and the Commons*. Lincoln and London: University of Nebraska Press.

Brown, P. F. (2011a) Government Transformation – what's the deal with patterns? *Pensive Peter* [online]. Available at: https://pensivepeter.wordpress.com/2011/03/17/government-transformation-whats-the-deal-with-patterns/ (accessed 31 October 2018).

Brown, P. F. (2011b) Guide to Working Draft 02: Recommended next steps. *Organization for the Advancement of Structured Information Standards* [online]. Available at: https://lists.oasis-open.org/archives/tgf/201103/pdf00003.pdf (accessed 31 October 2018).

Brown, W. (2015) *Undoing the Demos: Neoliberalism's Stealth Revolution*. New York: Zone Books.

Brunsson, N. and Jacobsson, B., eds. (2000) *A World of Standards*. Oxford: Oxford University Press.

Bryant, L. R. (2011) *The Democracy of Objects*. Open Humanities Press.

BSI (2012) *PAS 0:2012 Principles of PAS standardization*. London: The British Standards Institution.

BSI (2013) *The Role of Standards in Smart Cities, Issue 1 (June 2013)*. London: British Standards Institution.

BSI (2014a) *PAS 181:2014 Smart city framework to establishing strategies for smart cities and communities*. London: BSI Standards Limited.

BSI (2014b) *The Role of Standards in Smart Cities, Issue 2 (August 2014)*. London: British Standards Institution.

BSI (2018) *Brexit and standards: Position statement*. London: British Standards Institution.

BSI (n.d.-a) SDS/2 - Smart and sustainable cities and communities. *BSI Group* [online]. Available at: https://standardsdevelopment.bsigroup.com/committees/50267187 (accessed 31 October 2018).

BSI (n.d.-b) Smart city standards and publications. *BSI Group* [online]. Available at: https://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/ (accessed 31 October 2018).

BSI, Opportunity Peterborough and UrbanDNA (2015) *The Smart City Leadership Programme*. British Standards Institution.

Burawoy, M., Blum, J. A., George, S., Gille, Z., Gowan, T., Haney, L., Klawiter, M., Lopez, S. H., Ó Riain, S. and Thayer, M. (2000) *Global Ethnography: Forces, Connections, and Imaginations in a Postmodern World*. Berkeley and London: University of California Press.

Burgin, A. (2012) *The Great Persuasion: Reinventing Free Markets since the Depression*. Cambridge and London: Harvard University Press.

Busch, L. (2000) The moral economy of grades and standards. *Journal of Rural Studies*, 16(3), 273–283.

Busch, L. (2011) *Standards: Recipes for Reality*. Cambridge and London: The MIT Press.

Buschmann, F., Meunier, R., Rohnert, H., Sommerlad, P. and Stal, M. (1996) *Pattern-Oriented Software Architecture: A System of Patterns*. Chichester: John Wiley & Sons.

Butler, J. (1990) *Gender Trouble: Feminism and the Subversion of Identity*. New York: Routledge.

Butler, J. (1993) *Bodies That Matter: On the discursive limits of 'sex'*. New York and London: Routledge.

Butler, J. (2010) Performative Agency. *Journal of Cultural Economy*, 3(2), 147–161.

Büscher, M., Urry, J. and Witchger, K., eds. (2011) *Mobile Methods*. London and New York: Routledge.

Byles, D. (2014) Growing the Cities Market by enabling common solutions. *YouTube* [online]. Available at: https://www.youtube.com/watch?v=3E3RpGMKbhg&feature=youtu.be&t=52m20s (accessed 31 October 2018).

Caldwell, B. (2004) *Hayek's Challenge: An Intellectual Biography of F.A. Hayek*. Chicago: University of Chicago Press.

Callon, M. (1986) Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. In J. Law, ed. *Power, action and belief: A new sociology of knowledge?* London: Routledge. 196–223.

Callon, M. (1991) Techno-economic networks and irreversibility. In J. Law, ed. *A Sociology of Monsters: Essays on Power, Technology and Domination*. London and New York: Routledge. 132–161.

Camp, R. C. (1989) *Benchmarking: The Search for Industry Best Practices That Lead to Superior Performance*. Milwaukee, WI: ASQC Quality Press.

Candan, A. B. and Kolluoğlu, B. (2008) Emerging Spaces of Neoliberalism: A Gated Town and a Public Housing Project in İstanbul. *New Perspectives on Turkey*, 39, 5–46.

Cardullo, P. and Kitchin, R. (2018) Being a 'citizen' in the smart city: Up and down the scaffold of smart citizen participation. *GeoJournal* [online]. Available at:

https://link.springer.com/article/10.1007/s10708-018-9845-8 (accessed 31 October 2018).

Carpo, M. (2011) *The Alphabet and the Algorithm*. Cambridge and London: The MIT Press.

Carse, A. (2017) Keyword: Infrastructure a Humble French Engineering Term Shaped the Modern World. In P. Harvey, C. B. Jensen, and A. Morita, eds. *Infrastructures and Social Complexity: A Companion*. London and New York: Routledge. 27–39.

Castells, M. (1996) *The Rise of The Network Society*. Oxford and Cambridge: Blackwell.

CEN-CENELEC and ETSI (2018) CEN-CENELEC-ETSI Sector Forum on Smart and Sustainable Cities and Communities. *CEN-CENELEC* [online]. Available at: https://www.cencenelec.eu/standards/Sectors/SmartLiving/smartcities/Pages/SSCC-CG.aspx (accessed 31 October 2018).

Chang, H.-J. (2014) Economics: The User's Guide. New York: Bloomsbury Press.

Christopherson, S. and Lillie, N. (2005) Neither global nor standard: Corporate strategies in the new era of labor standards. *Environment and Planning A*, 37(11), 1919–1938.

Cidell, J. (2009) Building Green: The Emerging Geography of LEED-Certified Buildings and Professionals. *Professional Geographer*, 61(2), 200–215.

Cisco (2011) Cisco Collaborates With Barcelona to Support '2020 Vision' for Sustainable Urban Management and Economic Growth. *Cisco Newsroom* [online]. Available at: https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=5918850 (accessed 31 October 2018).

Cisco (2012) Barcelona and Cisco Announce Strategic Initiatives to Transform the City into a Global Urban Reference Model. *Cisco Newsroom* [online]. Available at: https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=680179 (accessed 31 October 2018).

City of Melbourne (2016) Future Melbourne 2026. *City of Melbourne* [online]. Available at: https://participate.melbourne.vic.gov.au/future/creating-future-melbourne-2026-plan (accessed 31 October 2018).

City of Melbourne (2017) Annual Report 2016–2017._City of Melbourne_ [online]. Available at: https://www.melbourne.vic.gov.au/sitecollectiondocuments/annual-report-2016-17.pdf (accessed 31 October 2018).

City of Melbourne (2018a) Annual Plan and Budget 2018–2019._City of Melbourne_ [online]. Available at: https://www.melbourne.vic.gov.au/sitecollectiondocuments/annual-plan-budget-2018-19.pdf (accessed 31 October 2018).

City of Melbourne (2018b) Indicators of quality of life and city services by year. *Melbourne Data* [online]. Available at:

https://data.melbourne.vic.gov.au/Economy/Indicators-of-quality-of-life-and-city-services-by/e6er-4cb3 (accessed 31 October 2018).

City Protocol (2012) City Protocol Index. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20120727034628/http://www.cityprotocol.org:80/index.html (accessed 31 October 2018).

City Protocol (2013a) Anatomy of City Habitat. *YouTube* [online]. Available at: https://www.youtube.com/watch?v=zs_sNEfzvVY (accessed 31 October 2018).

City Protocol (2013b) Articles of incorporation. *City Protocol* [online]. Available at: http://cityprotocol.org/pdf/CA%20City%20Protocol%20Society%20Articles%20of%20Incorporation%20-%20Scan%20As%20filed%208-30-13.pdf (accessed 31 October 2018).

City Protocol (2013c) Task Force. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20131106200906/http://cityprotocol.org:80/cptf.html (accessed 31 October 2018).

City Protocol (2013d) The Society Secretariat. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20131129053739/http://cityprotocol.org:80/secretariat.html (accessed 31 October 2018).

City Protocol (2014) City Anatomy Evaluation Survey. *SurveyMonkey*. Previously available at: https://www.surveymonkey.com/s/P29TP8L.

City Protocol (2015) What is City Protocol? *YouTube* [online]. Available at: https://www.youtube.com/watch?v=rv3wuyOjlRA (accessed 31 October 2018).

City Protocol (n.d.) About us. *City Protocol* [online]. Available at: http://cityprotocol.org/about-us/ (accessed 31 October 2018).

Coase, R. H. (1937) The Nature of the Firm. *Economica*, 4(16), 386–405.

Coase, R. H. (1960) The Problem of Social Cost. *The Journal of Law & Economics*, 3, 1–44.

Coe, A., Paquet, G. and Roy, J. (2001) E-Governance and Smart Communities: A Social Learning Challenge. *Social Science Computer Review*, 19(1), 80–93.

Cohen, B. (2004) Urban growth in developing countries: A review of current trends and a caution regarding existing forecasts. *World Development*, 32(1), 23–51.

Colau, A. (2017) Barcelona Smart City: Red española de ciudades inteligentes. *Red Ciudades Inteligentes* [online]. Available at: http://www.redciudadesinteligentes.es/index.php/municipios/ciudades/20-barcelona (accessed 31 October 2018).

Colau, A. and Alemany, A. (2014) *Mortgaged Lives: From the housing bubble to the right to housing*. Translated by M. Teran and J. Fuquay. Los Angeles: Journal of Aesthetics & Protest.

Companies House (n.d.) GOV3 LIMITED - Filing history. *Companies House* [online]. Available at: https://beta.companieshouse.gov.uk/company/05126620/filing-history (accessed 31 October 2018).

Conzen, M. R. G. (1960) *Alnwick Northumberland: A Study in Town-plan Analysis*. London: George Philip.

Cook, I. (2004) Follow the Thing: Papaya. *Antipode*, 36(4), 642–664.

Coole, D. and Frost, S., eds. (2010) *New Materialisms: Ontology, Agency, and Politics*. Durham and London: Duke University Press.

Cope, M. (2010) Coding Transcripts and Diaries. In N. Clifford, S. French, and G. Valentine, eds. *Key Methods in Geography*. London: Sage. 440–452.

Coplien, J. O. and Schmidt, D. C. (1995) *Pattern Languages of Program Design*. Edinburgh and London: Addison-Wesley.

CPS (2013a) Bylaws of the City Protocol Society. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20140411154418/http://cityprotocol.org/pdf/CPOD-01_Bylaws.pdf (accessed 31 October 2018).

CPS (2013b) *City Protocol Agreements Process and Requirements*. City Protocol Society. Previously available at: http://www.cptf.cityprotocol.org/Organizational%20Documents/CPOD05_CP%20Agreements%20Process%20and%20Requirements.pdf.

CPS (2014a) *Ancha TAFT charter*. City Protocol Society.

CPS (2014b) *CPA-I_001_Anatomy: Anatomy of Urban Habitat: A Framework to support City Governance, Evaluation and Transformation*. City Protocol Society.

CPS (2014c) *CPA-I_001_Anatomy_V1.0_public-comment: City Anatomy: A Framework to support City Governance, Evaluation and Transformation*. City Protocol Society.

CPS (2014d) *Visual of the Anatomy of City Habitat*. City Protocol Society.

CPS (2015a) *CPA-I_001_Anatomy: City Anatomy: A Framework to support City Governance, Evaluation and Transformation*. City Protocol Society.

CPS (2015b) *CPA-I_001-v2_Anatomy: City Anatomy: A Framework to support City Governance, Evaluation and Transformation*. City Protocol Society.

CPS (2015c) *CPA-PR_002_Anatomy Indicators: City Anatomy Indicators*. City Protocol Society.

CPS (2016) *CPA-PR_003_Anatomy Ontology: Foundation Ontology for the City Anatomy*. City Protocol Society.

CPTF (2015) City Anatomy Public Review and Response. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20150514113804/http://www.cptf.cityprotocol.org:80/ancha/CPA-I_001_Anatomy_Public_Review_Response.pdf (accessed 31 October 2018).

Crang, M. and Thrift, N., eds. (2000) *Thinking Space*. London and New York: Routledge.

CS Transform (2010) *Citizen Service Transformation: A manifesto for change in the delivery of public services*.

Cuddon, J. A. (2013) *A Dictionary of Literary Terms and Literary Terms*. 5th ed. Chichester: Wiley-Blackwell.

Cullen, G. (1961) *The concise townscape*. New York: Van Nostrand Reinhold Company.

Dardot, P. and Laval, C. (2013) *The New Way of the World: On Neoliberal Society*. London: Verso.

Darwin, J. (2008) *After Tamerlane: The global history of empire since 1405*. New York: Bloomsbury Press.

Daston, L. and Galison, P. (2007) *Objectivity*. New York: Zone Books.

David, P. A. (1985) Clio and the Economy of QWERTY. *The American Economic Review*, 75(2), 332–337.

David, P. A. and Bunn, J. A. (1988) The economics of gateway technologies and network evolution: Lessons from electricity supply history. *Information economics and policy*, 3(2), 165–202.

David, P. A. and Greenstein, S. (1990) The Economics Of Compatibility Standards: An Introduction To Recent Research. *Economics of Innovation and New Technology*, 1(1–2), 3–41.

Davies, W. (2014) Neoliberalism: A Bibliographic Review. *Theory, Culture & Society*, 31(7/8), 309–317.

Davies, W. (2015) *The Happiness Industry: How the Government and Big Business Sold Us Well-Being*. London and New York: Verso.

Davies, W. (2017) *The Limits of Neoliberalism: Authority, Sovereignty and the Logic of Competition*. Revised ed. Los Angeles: Sage.

de Jong, M., Joss, S., Schraven, D., Zhan, C. and Weijnen, M. (2015) SustainableSmartResilientLow carbonEcoKnowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. *Journal of Cleaner Production*, 109, 25–38.

Deleuze, G. (1992) Postscript on the Societies of Control. *October*, 59, 3–7.

Deleuze, G. and Guattari, F. (1987) *A Thousand Plateaus: Capitalism and Schizophrenia*. Translated by B. Massumi. London: Continuum.

DeNardis, L. (2009) *Protocol Politics: The Globalization of Internet Governance*. Cambridge, MA: The MIT Press.

DeNardis, L., ed. (2011) *Opening Standards: The global politics of interoperability*. Cambridge and London: The MIT Press.

Derrida, J. (1974) White Mythology: Metaphor in the Text of Philosophy. Translated by F. C. T. Moore. *New Literary History*, 6(1), 5–74.

Derrida, J. (1988) Signature Event Context. Translated by A. Bass. In *Limited Inc*. Evanston, IL: Northwestern University Press. 1–23.

DeSombre, E. R. (2006) *Flagging Standards: Globalization and Environmental, Safety, and Labor Regulations at Sea*. Cambridge, MA: The MIT Press.

DIN and DKE (2015) *The German Standardization Roadmap: Smart City, version 1.1*. Berlin and Frankfurt: DIN e.V. and DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE.

Dixon, T., Wetering, J. van de, Sexton, M., Lu, S.-L., Williams, D., Duman, D. U. and Chen, X. (2017) *Smart Cities, Big Data and the Built Environment: What's Required?* London: Royal Institution of Chartered Surveyors.

Dodge, M. and Kitchin, R. (2005) Codes of Life: Identification Codes and the Machine-Readable World. *Environment and Planning D: Society and Space*, 23, 851–881.

Dolphijn, R. and van der Tuin, I. (2012a) 'Matter feels, converses, suffers, desires, yearns and remembers': Interview with Karen Barad. In *New Materialism: Interviews & Cartographies*. Ann Arbor, MI: Open Humanities Press. 48–70.

Dolphijn, R. and van der Tuin, I. (2012b) *New Materialism: Interviews & Cartographies*. Ann Arbor, MI: Open Humanities Press.

Dourish, P. and Bell, G. (2011) *Divining a Digital Future: Mess and Mythology in Ubiquitous Computing*. Cambridge and London: The MIT Press.

Dowding, K., Dunleavy, P., King, D., Margetts, H. and Rydin, Y. (2000) Understanding Urban Governance: The Contribution of Rational Choice. In G. Stoker, ed. *The New Politics of British Local Governance*. Basingstoke and London: Macmillan Press. 91–116.

Dreyfus, H. L. and Rabinow, P. (1983) *Michel Foucault: Beyond Structuralism and Hermeneutics*. Second. Chicago, IL: The University of Chicago Press.

Dunleavy, P. and Hood, C. (1994) From old public administration to new public management. *Public money & management*, 14(3), 9–16.

Dunleavy, P., Margetts, H., Bastow, S., Callaghan, R. and Yared (2002) *Government on the Web II*. LSE Research Online.

Dunleavy, P., Margetts, H., Bastow, S. and Tinkler, J. (2006a) *Digital Era Governance: IT Corporations, the State, and E-Government*. Oxford and New York: Oxford University Press.

Dunleavy, P., Margetts, H., Bastow, S. and Tinkler, J. (2006b) New Public Management Is DeadLong Live Digital-Era Governance. *Journal of Public Administration Research and Theory*, 16(3), 467–494.

Dunn, E. C. (2003) Trojan pig: Paradoxes of food safety regulation. *Environment and Planning A*, 35(8), 1493–1511.

Easterling, K. (2014) *Extrastatecraft: The Power of Infrastructure Space*. London and New York: Verso.

Edwards, P. N. (2010) *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. Cambridge and London: The MIT Press.

Egyedi, T. M. (1996) *Shaping Standardization: A study of standards processes and standards policies in the field of telematic services*. PhD thesis. Delft: Technische Universiteit Delft.

ERM (2007) *Global City Indicators: Definitions and Methodologies*.

ERM (2008) *Global City Indicators Program Report*.

Evans, J. P. (2011) Resilience, ecology and adaptation in the experimental city. *Transactions of the Institute of British Geographers*, 36(2), 223–237.

Fairclough, N. (2000) *New Labour, New Language?* London and New York: Routledge.

Farías, I. and Bender, T., eds. (2010) *Urban Assemblages: How Actor-Network Theory Changes Urban Studies*. London and New York: Routledge.

Ferlie, E., Ashburner, L., Fitzgerald, L. and Pettigrew, A. (1996) *The New Public Management in Action*. Oxford and New York: Oxford University Press.

Fincham, B., McGuinness, M. and Murray, L., eds. (2010) *Mobile Methodologies*. Basingstoke and New York: Palgrave Macmillan.

Finlayson, A., Bevir, M., Rhodes, R. A. W., Dowding, K. and Hay, C. (2004) The Interpretive Approach in Political Science: A Symposium. *British Journal of Politics and International Relations*, 6(2), 129–164.

Flood, J. (2010) *The Fires: How a Computer Formula, Big Ideas, and the Best of Intentions Burned Down New York City-And Determined the Future of Cities*. New York: Riverhead Books.

Florida, R. (2005) *Cities and the Creative Class*. New York and London: Routledge.

Flynn, T. (2005) Foucault's Mapping of History. In G. Gutting, ed. *The Cambridge Companion to Foucault*. New York: Cambridge University Press. 29–48.

Flyvbjerg, B. (2006) Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, 12(2), 219–245.

Forrester, J. W. (1961) *Industrial Dynamics*. Waltham, MA: Pegasus Communications.

Forrester, J. W. (1969) *Urban Dynamics*. Waltham, MA: Pegasus Communications.

Fortun, M. and Schweber, S. S. (1993) Scientists and the Legacy of World War II: The Case of Operations Research (OR). *Social Studies of Science*, 23(4), 595–642.

Foucault, M. (1972) *Archaeology of Knowledge*. Translated by A. M. Smith Sheridan. London and New York: Routledge.

Foucault, M. (1977) *Discipline and Punish: The Birth of the Prison*. Translated by A. Sheridan. London: Penguin Books.

Foucault, M. (1978) *The History of Sexuality, Volume 1: An Introduction*. Translated by R. Hurley. New York: Pantheon Books.

Foucault, M. (1980a) Prison Talk. Translated by C. Gordon, L. Marshall, J. Mepham, and K. Soper. In C. Gordon, ed. *Power/Knowledge: Selected Interviews and Other Writings, 1972–1977*. New York: Pantheon Books. 37–54.

Foucault, M. (1980b) The Confession of the Flesh. Translated by C. Gordon, L. Marshall, J. Mepham, and K. Soper. In C. Gordon, ed. *Power/Knowledge: Selected Interviews and Other Writings, 1972–1977*. New York: Pantheon Books. 194–228.

Foucault, M. (1984) Nietzsche, Genealogy, History. In P. Rabinow, ed. *The Foucault Reader*. New York: Pantheon Books. 76–100.

Foucault, M. (1991) Politics and the study of discourse. Translated by C. Gordon. In G. Burchell, C. Gordon, and P. Miller, eds. *The Foucault Effect: Studies in Governmentality*. Chicago, IL: The University of Chicago Press. 53–72.

Foucault, M. (2007) *Security, Territory, Population: Lectures at the Collège de France, 1977–78*. Translated by G. Burchell. M. Senellart, ed. Basingstoke: Palgrave Macmillan.

Foucault, M. (2008) *The Birth of Biopolitics: Lectures at the Collège de France, 1978–79*. Translated by G. Burchell. M. Senellart, ed. Basingstoke and New York: Palgrave Macmillan.

Fougner, T. (2008) Neoliberal Governance of States: The Role of Competitiveness Indexing and Country Benchmarking. *Millennium: Journal of International Studies*, 37(2), 303–326.

Freidberg, S. (2004) *French Beans and Food Scares: Culture and Commerce in an Anxious Age*. Oxford and New York: Oxford University Press.

Friedman, M. (1953) *Essays in Positive Economics*. Chicago, IL: University of Chicago Press.

Furusten, S. (2000) The Knowledge Base of Standards. In N. Brunsson and B. Jacobsson, eds. *A World of Standards*. Oxford: Oxford University Press. 71–84.

Future Peterborough (n.d.) Smart City Leadership Programme: Shaping Smart City Leaders. *Future Peterborough* [online]. Available at: http://www.futurepeterborough.com/project/smart-city-leadership-programme/ (accessed 31 October 2018).

Galison, P. (1994) The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision. *Critical Inquiry*, 21, 228–266.

Galloway, A. R. (2004) *Protocol: How control exists after decentralization*. Cambridge and London: The MIT Press.

Gane, N. (2013) The Emergence of Neoliberalism: Thinking Through and Beyond Michel Foucault's Lectures on Biopolitics. *Theory, Culture & Society*, 31(4), 3–27.

Garland, D. (2014) What is a 'history of the present'? On Foucault's genealogies and their critical preconditions. *Punishment & Society*, 16(4), 365–384.

GCI (2017) GCI Policy Papers. *Global Cities Institute* [online]. Available at: http://www.globalcitiesinstitute.org/gci-policy-papers (accessed 31 October 2018).

GCIF (2009) Indicators revised: Core and supporting. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20111129155534/http://www.cityindicators.org/Deliverables/Indicators%20revised%20-core%20and%20supporting_8-31-2009-1743191.pdf (accessed 31 October 2018).

GCIF (2011) Core and Supporting Indicators. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20111119211644/http://www.cityindicators.org:80/Deliverables/Core%20and%20Supporting%20Indicators%20Table%20SEPTEMBER%202011.pdf (accessed 31 October 2018).

GCIF (2012) Newsletter No. 4. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20160410123040/http://www.cityindicators.org/Deliverables/Newsletter_August_Final%20Smallest_9-19-2012-1618895.pdf (accessed 31 October 2018).

GCIF (2013) List of Indicators. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20160426162644/http://cityindicators.org/Deliverables/List%20of%20Indicators%20Final%20copyright_2-5-2013-118833.pdf (accessed 31 October 2018).

Gibbon, P. and Henriksen, L. F. (2011) On the Pre-history of ISO 9000: The Making of a Neo-liberal Standard. In S. Ponte, P. Gibbon, and J. Vestergaard, eds. *Governing through Standards: Origins, Drivers and Limitations*. New York: Palgrave Macmillan. 130–158.

Gibson, T. (2014) *RE: Consent form* [email]. Message to J. M. White. Sent 3 August 2017.

Gibson, T. (n.d.) If each city's Smart journey is unique, how can Smart City Standards help? *Future Peterborough* [online]. Available at: http://www.futurepeterborough.com/author/trevor-gibson/ (accessed 31 October 2018).

Giddens, A. (1998) *The Third Way*. Cambridge and Malden: Polity Press.

Giedion, S. (1958) Aesthetics and the human habitat. In *Architecture, You and Me: The diary of development*. Cambridge, MA: Harvard University Press. 93–98.

Giralt, F. (2014) *Re: TAFT_ancha* [email]. Message to ancha mailing list (ancha@cptf.cityprotocol.org). Sent 25 April 2014.

Giralt, F., Arenas, A., Ferre-Gine, J., Rallo, R. and Kopp, G. A. (2000) The simulation and interpretation of free turbulence with a cognitive neural system. *Physics of Fluids*, 12(7), 1826–1835.

Glaeser, E. (2011a) A Time for Radical Centrists. *Economix Blog* [online]. Available at: http://economix.blogs.nytimes.com/2011/04/26/time-for-the-radical-centrists-to-step-up/ (accessed 31 October 2018).

Glaeser, E. (2011b) *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier and Happier*. New York: The Penguin Press.

Gleick, J. (1987) *Chaos: Making a New Science*. New York: Viking.

Goldsmith, S. and Crawford, S. (2014) *The Responsive City: Engaging Communities Through Data-Smart Governance*. San Francisco, CA: Jossey-Bass.

Graham, S., ed. (2004) *The Cybercities Reader*. London and New York: Routledge.

Graham, S. (2005) Software-sorted geographies. *Progress in Human Geography*, 29(5), 562–580.

Graham, S. and Marvin, S. (1996) *Telecommunications and the city: Electronic spaces, urban places*. London: Routledge.

Graham, S. and Marvin, S. (2001) *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*. London: Routledge.

Greenfield, A. (2013) *Against the smart city*. New York City: Do projects.

Greenstein, S. and Stango, V., eds. (2006) *Standards and Public Policy*. Cambridge: Cambridge University Press.

Gregory, D. (1980) The Ideology of Control: Systems theory and Geography. *Tijdschrift voor Economische en Sociale Geografie*, 71(6), 327–342.

Guallart, V. (2012) *La ciudad autosuficiente: Habitar en la sociedad de la información*. Barcelona: RBA Libros.

Guallart, V. (2014) *The Self-Sufficient City: Internet has changed our lives but it hasn't changed our cities, yet*. New York: Actar Publishers.

Guillemin, P., Berens, F., Carugi, M., Barthel, H., Dechamps, A., Rees, R., Cosgrove-Sacks, C., Clark, J., Arndt, M., Ladid, L., Percivall, G., Lathouwer, B. D., Liang, S., Vermesan, O. and Friess, P. (2014) Internet of Things Global Standardisation of Play. In O. Vermesan and P. Friess, eds. *Internet of Things: From Research and Innovation to Market Deployment*. Leuven, Belgium: River Publishers. 1–56.

Guy, S. and Marvin, S. (1999) Understanding Sustainable Cities: Competing Urban Futures. *European Urban and Regional Studies*, 6(3), 268–275.

Habermas, J. (1987) *Knowledge and Human Interests*. Translated by J. J. Shapiro. Cambridge and London: Polity Press.

Hall, P. (1988) *Cities of Tomorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century*. Third Edit. Malden, MA: Blackwell.

Halpern, O. (2014) *Beautiful Data: A history of vision and reason since 1945*. Durham and London: Duke University Press.

Hammond, D. (2002) Exploring the Genealogy of Systems Thinking. *Systems Research and Behavioral Science*, 19(5), 429–439.

Hammond, D. (2003) *Science of Synthesis: Exploring the Social Implications of General Systems Theory*. Boulder, CO: University Press of Colorado.

Haraway, D. J. (1988) Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies*, 14(3), 575–599.

Haraway, D. J. (1990) A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s. In L. J. Nicholson, ed. *Feminism/Postmodernism*. New York and London: Routledge. 190–233.

Haraway, D. J. (1991) *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York: Routledge.

Haraway, D. J. (1997) *Modest_Witness@Second_Millennium.FemaleMan_Meets_OncoMouse*. New York and London: Routledge.

Harding, S. G. (1986) *The science question in feminism*. New York: Cornell University Press.

Harman, G. (2011) *The Quadruple Object*. Winchester and Washington: Zero Books.

Harvey, D. (1989) From Managerialism to Entrepreneurialism: The Transformation in Urban Governance in Late Capitalism. *Geografiska Annaler: Series B, Human Geography*, 71(1), 3–17.

Harvey, D. (2005) *A Brief History of Neoliberalism*. Oxford: Oxford University Press.

Harvey, D. (2006) *The Limits to Capital*. London and New York: Verso.

Harvey, D. (2012) *Rebel Cities: From the Right to the City to the Urban Revolution*. London and New York: Verso.

Hawkins, R. W., Mansell, R. and Skea, J., eds. (1995) *Standards, Innovation and Competitiveness: The Politics and Economics of Standards in Natural and Technical Environments*. Aldershot: Edward Elgar Publishing.

Hayek, F. A. (1944) *The Road to Serfdom*. London and New York: Routledge.

Hayek, F. A. (1945) The Use of Knowledge in Society. *The American Economic Review*, 35(4), 519–530.

Hayek, F. A. (2014) Degrees of Explanation. In B. Caldwell, ed. *The Collected Works of F. A. Hayek, Volume XV: The Market and Other Orders*. Chicago and London: University of Chicago Press. 195–212.

Hayles, N. K. (1996) Consolidating the Canon. In A. Ross, ed. *Science Wars*. Durham and London: Duke University Press. 226–237.

Hayles, N. K. (1999) *How We Became Posthuman: Virtual bodies in cybernetics, literature and informatics*. Chicago and London: The University of Chicago Press.

He, S. and Wu, F. (2009) China's Emerging Neoliberal Urbanism: Perspectives from Urban Redevelopment. *Antipode*, 41(2), 282–304.

Heims, S. J. (1993) *Constructing a Social Science for Postwar America: The Cybernetics Group, 1946–1953*. Cambridge, MA: The MIT Press.

Hemment, D. and Townsend, A., eds. (2013) *Smart Citizens*. Manchester: FutureEverything.

Heseltine, M. (2012) *No stone unturned in pursuit of growth*. London: Department for Business, Innovation and Skills.

Heyck, H. (2015) *Age of System: Understanding the Development of Modern Social Science*. Baltimore, MD: John Hopkins University Press.

Higgins, V. and Larner, W., eds. (2010) *Calculating the social: Standards and the reconfiguration of governing*. Basingstoke: Palgrave Macmillan.

Hill, D. (2013) On the smart city; Or, a 'manifesto' for smart citizens instead. *City of Sound* [online]. Available at: http://www.cityofsound.com/blog/2013/02/on-the-smart-city-a-call-for-smart-citizens-instead.html (accessed 31 October 2018).

HM Government (2013) *Information Economy Strategy*. London: Department for Business, Innovation and Skills.

Hodson, M. and Marvin, S. (2017) Intensifying or transforming sustainable cities? Fragmented logics of urban environmentalism. *Local Environment*, 22(sup1), 8–22.

Hollands, R. G. (2008) Will the real smart city please stand up? *City*, 12(3), 303–320.

Hoornweg, D., Nuñez, F. R., Freire, M., Palugyai, N., Villaveces, M. and Herrera, E. W. (2007) *City Indicators: Now to Nanjing*. World Bank.

Hoos, I. R. (1972) *Systems Analysis in Public Policy: A Critique*. Revised ed. Berkeley, CA: University of California Press.

Housewright, M. (2016) ANSSC Webinar: ISO TC 268 Sustainable Development in Communities. *ANSI Webex* [online]. Available at: https://goansi.webex.com/ec3300/eventcenter/recording/recordAction.do?theAction=poprecord&siteurl=goansi&entappname=url3300&internalRecordTicket=4832534b0000000457f6d62253291966f5ba907528ec1b49847c45dc2fa203f790490064bfa2b90e&renewticket=0&isurlact=true&format=short&rnd=9269341651&RCID=36aea0d84a6bea0d1b85f29ac3998671&rID=47515772&needFilter=false&recordID=47515772&apiname=lsr.php&AT=pb&actappname=ec3300&&SP=EC&entactname=%2FnbrRecordingURL.do&actname=%2Feventcenter%2Fframe%2Fg.do (accessed 31 October 2018).

Hubbard, P. (2004) Revenge and Injustice in the Neoliberal City: Uncovering Masculinist Agendas. *Antipode*, 36(4), 665–686.

Hughes, A. C. and Hughes, T. P., eds. (2000) *Systems, Experts and Computers: The Systems Approach in Management and Engineering, World War II and After*. Cambridge and London: The MIT Press.

Hughes, T. P. (1994) Technological Momentum. In M. R. Smith and L. Marx, eds. *Does Technology Drive History?: The Dilemma of Technological Determinism*. Cambridge and London: The MIT Press. 101–113.

Hughes, T. P. (1998) *Rescuing Prometheus: Four Monumental Projects That Changed Our World*. New York: Pantheon Books.

Ichikawa, Y. (2011) ISO/TC268/SC1 Smart Community Infrastructures. *International Telecommunications Union* [online]. Available at: https://www.itu.int/en/ITU-T/jca/ictcc/Documents/docs-2013/YoshiakiIchikawa_JCA_Feb2013.pdf (accessed 31 October 2018).

IEC (2014a) *Internet of Things: Wireless Sensor Networks*. International Electrotechnical Commission.

IEC (2014b) *Orchestrating infrastructure for sustainable Smart Cities*. International Electrotechnical Commission.

IEC (2016a) *IoT 2020: Smart and secure IoT platform*. International Electrotechnical Commission.

IEC (2016b) Significant milestone for Smart City development. *International Electrotechnical Commission* [online]. Available at: http://www.iec.ch/newslog/2016/nr2416.htm (accessed 31 October 2018).

IEC (2018) SyC Smart Cities Work programme. *International Electrotechnical Commission* [online]. Available at: http://www.iec.ch/dyn/www/f?p=103:214:5982174298290::::FSP_ORG_ID,FSP_LANG_ID:13073,25 (accessed 31 October 2018).

Iggers, G. G. (2005) *Historiography in the Twentieth Century: From Scientific Objectivity to the Postmodern Challenge*. 2nd ed. Middletown, CT: Wesleyan University Press.

Imrie, R. and Street, E. (2011) *Architectural Design and Regulation*. Chichester: John Wiley & Sons.

Inkster, I., ed. (2008) *History of Technology, Volume Twenty-eight*. London and New York: Continuum.

ISO (2011) Letter to the ISO member bodies. *ISO/IEC JTC 1/SC 34* [online]. Available at: http://www.jtc1sc34.org/en/c/document_library/get_filec9f6.pdf (accessed 31 October 2018).

ISO (2012) Resolutions adopted by the Technical Management Board in 2012. *International Organization for Standardization* [online]. Available at: https://isotc.iso.org/livelink/livelink/fetch/-15620806/15620808/15623592/15768654/TMB_resolutions_-*2012*%28Resolution_1-148%29.pdf?nodeid=15768229&vernum=-2 (accessed 31 October 2018).

ISO (2013a) Business plan: ISO/TC 268 Sustainable Development in Communities. *International Organization for Standardization* [online]. Available at: http://isotc.iso.org/livelink/livelink/fetch/2000/2122/687806/ISO_TC_268_*Sustainable_development_in_communities*.pdf?nodeid=16488152&vernum=-2 (accessed 31 October 2018).

ISO (2013b) Resolutions adopted by the Technical Management Board in 2013. *International Organization for Standardization* [online]. Available at: http://isotc.iso.org/livelink/livelink/fetch/-15620806/15620808/15623592/15768654/TMB_resolutions_-*2013*%28Resolution_1-132%29.pdf?nodeid=15768967&vernum=-2 (accessed 31 October 2018).

ISO (2014a) *ISO 18091: Quality management systems for the application of ISO 9001:2008 in local government*. Geneva: ISO copyright office.

ISO (2014b) *ISO 37120: Sustainable development of communities for city services and quality of life*. Geneva: ISO copyright office.

ISO (2014c) Resolutions adopted by the Technical Management Board in 2014. *International Organization for Standardization* [online]. Available from: http://isotc.iso.org/livelink/livelink/fetch/-15620806/15620808/15623592/15768654/TMB_resolutions_-_2014_%28Resolution_1-128%29.pdf?nodeid=16383402&vernum=-2 (accessed 31 October 2018].

ISO (2015a) *Annexes to final ISO Smart Cities SAG report*. ISO Technical Management Board.

ISO (2015b) *ISO/TMB Smart Cities Strategic Advisory Group Final Report*. ISO Technical Management Board.

ISO (2016a) ISO Statutes. *International Organization for Standardization* [online]. Available at: https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/statutes.pdf (accessed 31 October 2018).

ISO (2016b) Resolutions adopted by the Technical Management Board in 2016. *International Organization for Standardization* [online]. Available at: http://isotc.iso.org/livelink/livelink/fetch/-15620806/15620808/15623592/15768654/TMB_resolutions_-*2016*%28Resolution_1-141%29.pdf?nodeid=17504269&vernum=-2 (accessed 31 October 2018).

ISO (2018a) Participation: ISO/TC 268 Sustainable cities and communities. *International Organization for Standardization* [online]. Available at: https://www.iso.org/committee/656906.html?view=participation (accessed 31 October 2018).

ISO (2018b) Standards Catalogue: ISO/IEC JTC 1 Information technology. *International Organization for Standardization* [online]. Available at: https://www.iso.org/committee/45020/x/catalogue/p/1/u/1/w/1/d/0 (accessed 31 October 2018).

ISO (2018c) Standards Catalogue: ISO/TC 268/SC 1 Smart community infrastructures. *International Organization for Standardization* [online]. Available at: https://www.iso.org/committee/656967/x/catalogue/p/1/u/1/w/1/d/0 (accessed 31 October 2018).

ISO (2018d) Standards Catalogue: ISO/TC 268 Sustainable cities and communities. *International Organization for Standardization* [online]. Available at: https://www.iso.org/committee/656906/x/catalogue/p/1/u/1/w/1/d/0 (accessed 31 October 2018).

ISO (2018e) Structure and governance. *International Organization for Standardization* [online]. Available at: https://www.iso.org/structure.html (accessed 31 October 2018).

ISO (2018f) Technical Committees. *International Organization for Standardization* [online]. Available at: https://www.iso.org/technical-committees.html (accessed 31 October 2018).

ISO/IEC JTC 1 (2013) Resolutions Adopted at the 28th Meeting of ISO/IEC JTC 1, 4–9 November 2013 in Perros-Guirec, France. *International Organization for Standardization* [online]. Available at: http://isotc.iso.org/livelink/livelink?func=ll&objId=16310833&objAction=Open (accessed 31 October 2018).

ISO/IEC JTC 1 (2014) ISO/IEC JTC 1: Vision, Mission and Principles. *International Organization for Standardization* [online]. Available at: https://www.iso.org/files/live/sites/isoorg/files/developing_standards/docs/en/jtc1_mission_brochure_2014_final.pdf (accessed 31 October 2018).

ISO/IEC JTC 1 (2015a) Big Data: Preliminary Report 2014. *International Organization for Standardization* [online]. Available at: https://www.iso.org/files/live/sites/isoorg/files/developing_standards/docs/en/big_data_report-jtc1.pdf (accessed 31 October 2018).

ISO/IEC JTC 1 (2015b) Internet of Things (IoT): Preliminary Report 2014. *International Organization for Standardization* [online]. Available at: https://www.iso.org/files/live/sites/isoorg/files/developing_standards/docs/en/internet_of_things_report-jtc1.pdf (accessed 31 October 2018).

ISO/IEC JTC 1 (2015c) Resolutions Adopted at the 30th Meeting of ISO/IEC JTC 1, 26–31 October 26, 2015 in Beijing, China. *International Organization for Standardization* [online]. Available at:

http://isotc.iso.org/livelink/livelink?func=ll&objId=17410252&objAction=Open (accessed 31 October 2018).

ISO/IEC JTC 1 (2015d) Smart Cities: Preliminary Report 2014. *International Organization for Standardization* [online]. Available at: https://www.iso.org/files/live/sites/isoorg/files/developing_standards/docs/en/smart_cities_report-jtc1.pdf (accessed 31 October 2018).

ISO/IEC JTC 1 (2017) ISO/IEC Directives, Part 1: Consolidated JTC 1 Supplement 2017 specific to JTC 1. *International Organization for Standardization* [online]. Available at: http://isotc.iso.org/livelink/livelink/fetch/2000/2122/4230450/9482942/JTC_1_Supplement_2017.pdf?nodeid=17804526&vernum=-2 (accessed 31 October 2018).

ITU-T (2015) Focus Group on Smart Sustainable Cities. *International Telecommunications Union* [online]. Available at: https://www.itu.int/en/ITU-T/focusgroups/ssc/Pages/default.aspx (accessed 31 October 2018).

ITU-T (n.d.) ITU-T Recommendations under Study Group 20 responsibility. *International Telecommunications Union* [online]. Available at: https://www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=20 (accessed 31 October 2018).

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Vintage Books.

Jakobs, K., ed. (2000a) *Information Technology Standards & Standardization: A Global Perspective*. Hershey and London: Idea Group Publishing.

Jakobs, K. (2000b) *Standardisation Processes in IT: Impact, Problems and Benefits of User Participation*. Braunschweig: Vieweg & Sohn.

Jessop, B. (1995) The regulation approach, governance and post-Fordism: Alternative perspectives on economic and political change? *Economy and Sociology*, 24(3), 307–333.

Jessop, B. (1997) Capitalism and its future: Remarks on regulation, government and governance. *Review of International Political Economy*, 4(3), 561–581.

Jessop, B. (2002) Liberalism, Neoliberalism, and Urban Governance: A State-Theoretical Perspective. *Antipode*, 32(3), 452–472.

Jones, D. S. (2012) *Masters of the Universe: Hayek, Friedman, and the Birth of Neoliberal Politics*. Princeton and Oxford: Princeton University Press.

Jones, J. P. III, Leitner, H., Marston, S. A. and Sheppard, E. (2016) Neil Smith's Scale. *Antipode*.

Joss, S., Cook, M. and Dayot, Y. (2017) Smart Cities: Towards a New Citizenship Regime? A Discourse Analysis of the British Smart City Standard. *Journal of Urban Technology*, 24(4), 29–49.

Joyce, P. (2003) *Rule of Freedom: Liberalism and the Modern City*. London and New York: Verso.

Kaika, M. and Swyngedouw, E. (2000) Fetishizing the Modern City: The Phantasmagoria of Urban Technological Networks. *International Journal of Urban and Regional Research*, 24(1), 120–138.

Katz, B. and Bradley, J. (2013) *The Metropolitan Revolution: How Cities and Metros Are Fixing Our Broken Politics and Fragile Economy*. Washington, DC: Brookings Institution Press.

Katz, M. L. and Shapiro, C. (1994) Systems Competition and Network Effects. *Journal of Economic Perspectives*, 8(2), 93–115.

Kember, S. (2003) *Cyberfeminism and Artificial Life*. London and New York: Routledge.

Kickert, W. J. M., Klijn, E.-H. and Koppenjan, J. F. M., eds. (1997) *Managing Complex Networks: Strategies for the Public Sector*. London: Sage Publication.

Kitchin, R. (2014a) *The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences*. London: Sage Publications.

Kitchin, R. (2014b) The real-time city? Big data and smart urbanism. *GeoJournal*, 79(1), 1–14.

Kitchin, R. (2015) Making sense of smart cities: Addressing present shortcomings. *Cambridge Journal of Regions, Economy and Society*, 8(1), 131–136.

Kitchin, R., Lauriault, T. P. and McArdle, G. (2015) Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. *Regional Studies, Regional Science*, 2(1), 6–28.

Kitchin, R. and Dodge, M. (2011) *Code/Space: Software and everyday life*. Cambridge, MA: The MIT Press.

Kitchin, R. and Tate, N. (2000) Thinking about research. In *Conducting Research in Human Geography: Theory, Methodology and Practice*. New Jersey: Prentice Hall. 1–27.

Klein, N. (2007) *The Shock Doctrine: The Rise of Disaster Capitalism*. New York: Picador.

Kline, R. R. (2015) *The Cybernetics Moment: Or Why We Call Our Age the Information Age*. Baltimore, MD: John Hopkins University Press.

Klooster, D. (2010) Standardizing sustainable development? The Forest Stewardship Council's plantation policy review process as neoliberal environmental governance. *Geoforum*, 41(1), 117–129.

Knight, F. H. (1921) *Risk, Uncertainty and Profit*. Boston and New York: Houghton Mifflin Company.

Knorr, K. D. (1977) Producing and reproducing knowledge: Descriptive or constructive? Toward a model of research production. *Social Science Information*, 16(6), 669–696.

Komninos, N. (2002) *Intelligent Cities: Innovation, Knowledge Systems and Digital Spaces*. London and New York: Routledge.

Kooiman, J. (1993a) Governance and Governability: Using Complexity, Dynamics and Diversity. In J. Kooiman, ed. *Modern Governance: New Government-Society Interactions*. London: Sage. 35–48.

Kooiman, J. (1993b) Social-political governance: Introduction. In J. Kooiman, ed. *Modern Governance: New Government-Society Interactions*. London: Sage. 1–6.

Kooiman, J. (2000) Societal Governance: Levels, Modes and Orders of Political Interaction. In J. Pierre, ed. *Debating Governance: Authority, Steering, and Democracy*. Oxford and New York: Oxford University Press. 138–164.

Kooiman, J. (2003) *Governing As Governance*. London: Sage Publications.

Koopman, C. (2013) *Genealogy as Critique: Foucault and the Problems of Modernity*. Bloomington and Indianapolis: Indiana University Press.

Kostof, S. (1991) *The City Shaped: Urban Patterns and Meanings Through History*. London: Thames & Hudson.

Kostof, S. (1992) *The City Assembled: The Elements of Urban Form Through History*. London: Thames & Hudson.

Krippner, G. R. (2011) *Capitalizing on Crisis: The political origins of the rise of finance*. Cambridge and London: Harvard University Press.

Krivý, M. (2016) Towards a critique of cybernetic urbanism: The smart city and the society of control. *Planning Theory*.

Kuhn, T. S. (1962) *The Structure of Scientific Revolutions*. Chicago, IL: The University of Chicago Press.

Kula, W. (1989) *Measures and men*. Translated by R. Szreter. Princeton, NJ: Princeton University Press.

Landauer, R. (1991) Information is physical. *Physics Today*, 25.

Lapavitsas, C. (2013) *Profiting Without Producing: How finance exploits us all*. London: Verso.

Larkin, B. (2013) The Politics and Poetics of Infrastructure. *Annual Review of Anthropology*, 42, 328–343.

Larner, W. and Walters, W., eds. (2004) *Global governmentality: Governing international spaces*. London and New York: Routledge.

Latour, B. (1987) *Science in Action: How to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press.

Latour, B. (1990) Drawing things together. In M. Lynch and S. Woolgar, eds. *Representation in Scientific Practice*. Cambridge, MA: The MIT Press. 19–68.

Latour, B. (1993) *We Have Never Been Modern*. Translated by C. Porter. Cambridge, MA: Harvard University Press.

Latour, B. (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Latour, B. (2016) Onus Orbis Terrarum: About a Possible Shift in the Definition of Sovereignty. *Millennium: Journal of International Studies*.

Latour, B. and Woolgar, S. (1979) *Laboratory Life: The Social Construction of Scientific Facts*. Berverly Hills, CA: Sage.

Laurence, P. L. (2006) Contradictions and Complexities: Jane Jacobs's and Robert Venturi's Complexity Theories. *Journal of Architectural Education (1984-)*, 59(3), 49–60.

Law, J. (2004) *After Method: Mess in social science research*. London and New York: Routledge.

Law, J. and Mol, A. (2001) Situating technoscience: An inquiry into spatialities. *Environment and Planning D: Society and Space*, 19(5), 609–621.

Lawhon, M., Ernstson, H. and Silver, J. (2014) Provincializing Urban Political Ecology: Towards a Situated UPE Through African Urbanism. *Antipode*, 46(2), 497–516.

La Xarxa (2015) Ada Colau: 'Mai farem res que faciliti un govern de CiU a Barcelona'. *La Xarxa: Comunicació Local* [online]. Available at: http://www.laxarxa.com/actualitat/politica/noticia/ada-colau-mai-farem-res-que-faciliti-un-govern-de-ciu-a-barcelona (accessed 31 October 2018).

Lefebvre, H. (1991) *The Production of Space*. Translated by D. Nicholson-Smith. Oxford and Cambridge: Blackwell.

Lefebvre, H. (2004) *Rhythmanalysis: Space, Time and Everyday Life*. Translated by S. Elden and G. Moore. London and New York: Continuum.

Leitner, H. (2015) *Pattern Theory: Introduction and Perspectives on the Tracks of Christopher Alexander*. CreateSpace Independent Publishing Platform.

Lemke, T. (2015) New Materialisms: Foucault and the 'Government of Things'. *Theory, Culture & Society*, 32(4), 3–25.

Lettice, J. (2001) MS-built UK 'Government Gateway' locks out non-MS browsers. *The Register* [online]. Available at: https://www.theregister.co.uk/2001/05/28/msbuilt_uk_government_gateway_locks/ (accessed 31 October 2018).

Levine, M. E. and Forrence, J. L. (1990) Regulatory capture, public interest, and the public agenda: Toward a synthesis. *Journal of Law, Economics, & Organization*, 6, 167–198.

Levinson, M. (2006) *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger*. Princeton and Oxford: Princeton University Press.

Levitt, S. D. and Dubner, S. J. (2006) *Freakonomics*. Revised ed. London: Penguin Books.

Liebowitz, S. J. and Margolis, S. E. (1995) Path Dependence, Lock-In, and History. *The Journal of Law, Economics, & Organization*, 11(1), 205–226.

Light, J. S. (2003) *From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America*. Baltimore and London: The Johns Hopkins University Press.

Light, J. S. (2008) Taking Games Seriously. *Technology and Culture*, 49(2), 347–375.

Lilienfeld, R. (1978) *The Rise of Systems Theory: An Ideological Analysis*. New York: John Wiley & Sons.

Longhurst, R. (2010) Semi-structured Interviews and Focus Groups. In N. Clifford, S. French, and G. Valentine, eds. *Key Methods in Geography*. Los Angeles: Sage. 103–115.

Lynch, K. (1960) *The Image of the City*. Cambridge and London: The MIT Press.

Lynch, K. (1981) *A Theory of Good City Form*. Cambridge, MA: The MIT Press.

Ma, L. J. C. (2002) Urban Transformation in China, 1949–2000: A Review and Research Agenda. *Environment and Planning A*, 34(9), 1545–1569.

MacKenzie, D. and Wajcman, J., eds. (1985) *The Social Shaping of Technology: How the refrigerator got its hum*. Milton Keynes and Philadelphia: Open University Press.

MacLure, M. (2013) Classification or Wonder? Coding as an Analytic Practice in Qualitative Research. In J. Ringrose and R. Coleman, eds. *Deleuze and research methodologies*. Edinburgh: Edinburgh University Press. 164–183.

March, H. and Ribera-Fumaz, R. (2016) Smart contradictions: The politics of making Barcelona a Self-sufficient city. *European Urban and Regional Studies*, 23(4), 816–830.

Margalef, D. R. (1958) Information theory in Ecology. *International General Systems Yearbook*, 3, 36–71.

Margalef, R. (1963) On Certain Unifying Principles in Ecology. *The American Naturalist*, 97(897), 357–374.

Margetts, H. (2006) E-Government in Britain. *Parliamentary Affairs*, 59(2), 250–265.

Margetts, H. and Dunleavy, P. (2013) The Second Wave of Digital Era Governance: A quasi-paradigm for government on the Web. *Philosophical Transactions of The Royal Society*, 371(1987).

Marsal-Llacuna, M. L. and Wood-Hill, M. (2017) The Intelligenter method (III) for 'smarter' standards development and standardisation instruments. *Computer Standards and Interfaces*, 50(August), 142–152.

Marston, S. A. (2000) The social construction of scale. *Progress in Human Geography*, 24(2), 219–242.

Mathieson, S. A. (2004) What a way to run the country. *The Guardian* [online]. Available at: http://www.theguardian.com/technology/2004/sep/02/internet.egovernment1 (accessed 31 October 2018).

Matutes, C. and Regibeau, P. (1996) A selective review of the economics of standardization: Entry deterrence, technological progress and international competition. *European Journal of Political Economy*, 12(2), 183–209.

MBNCanada (2016) About us: Who we are and what we do. *Municipal Benchmarking Network Canada* [online]. Available at: http://mbncanada.ca/about-us/ (accessed 31 October 2018).

MBNCanada (2017) 2016 MBNCanada Performance Measurement Report. *Municipal Benchmarking Network Canada* [online]. Available at: http://mbncanada.ca/app/uploads/2017/11/MBNCanada_2016_Performance_Measurement_Report.pdf (accessed 31 October 2018).

McCann, E. and Ward, K., eds. (2011) *Mobile Urbanism: Cities and policymaking in the global age*. Minneapolis and London: University of Minnesota Press.

McCarney, P. L. (2000) Thinking about governance in global and local perspective: Considerations on Resonance and Dissonance between Two Discourses. *Urban Forum*, 11(1), 1–29.

McCarney, P. L. (2003) Confronting Critical Disjunctures in the Governance of Cities. In P. L. McCarney and R. E. Stren, eds. *Governance on the Ground: Innovations and Discontinuities in the Cities of the Developing World*. Washington, DC: Woodrow Wilson Center Press. 31–55.

McCarney, P. L. and Ng, H. (2014) ANSI Webinar: ISO 37120 on City Indicators. *ANSI Webex* [online]. Available at: https://goansi.webex.com/ec3300/eventcenter/recording/recordAction.do?theAction=poprecord&siteurl=goansi&entappname=url3300&internalRecordTicket=4832534b00000004901340227l8e1ff8904aa99b837c6993c0ff8186ebd97d40f452a7750918ca9e&renewticket=0&isurlact=true&format=short&rnd=9399557841&RCID=ca418081419360fc7fe06955ae6395b5&rID=34054432&needFilter=false&recordID=34054432&apiname=lsr.php&AT=pb&actappname=ec3300&&SP=EC&entactname=%2FnbrRecordingURL.do&actname=%2Feventcenter%2Fframe%2Fg.do (accessed 31 October 2018).

McCarney, P. L. and Stren, R. E., eds. (2003) *Governance on the Ground: Innovations and Discontinuities in the Cities of the Developing World*. Washington, DC: Woodrow Wilson Center Press.

McFarlane, C. (2008) Governing the Contaminated City: Infrastructure and Sanitation in Colonial and Post-Colonial Bombay. *International Journal of Urban and Regional Research*, 32(2), 415–435.

McFarlane, C. (2011) Assemblage and critical urbanism. *City*, 15(2), 204–224.

McFarlane, C. (2016) The geographies of urban density: Topology, politics and the city. *Progress in Human Geography*, 40(5), 629–648.

McRae, M. (2010a) Call for Participation: OASIS Transformational Government Framework (TGF) TC. *Organization for the Advancement of Structured Information Standards* [online]. Available at: https://lists.oasis-open.org/archives/tgf/201009/msg00000.html (accessed 31 October 2018).

McRae, M. (2010b) Eligible Voting Members. *Organization for the Advancement of Structured Information Standards* [online]. Available at: https://lists.oasis-open.org/archives/tgf/201010/msg00005.html (accessed 31 October 2018).

Miles, S. H. (2004) *The Hippocratic Oath and the Ethics of Medicine*. Oxford and New York: Oxford University Press.

Mills, S. (2003) *Michel Foucault*. London and New York: Routledge.

Mirowski, P. (1997) Machine Dreams: Economic Agents as Cyborgs. *History of Political Economy*, 29(S1), 13–40.

Mirowski, P. (1999) Cyborg Agonistes: Economics Meets Operations Research in Mid-Century. *Social Studies of Science*, 29(5), 685–718.

Mirowski, P. and Plehwe, D., eds. (2009) *The Road from Mont Pèlerin: The Making of the Neoliberal Thought Collective*. Cambridge and London: Harvard University Press.

Mitchell, W. J. (1995) Soft Cities. In *City of Bits: Space, Place and the Infobahn*. Cambridge, MA: The MIT Press. 106–131.

Murphy, C. N. and Yates, J. (2009) *The International Organization for Standardization (ISO): Global governance through voluntary consensus*. London and New York: Routledge.

Mutersbaugh, T. (2005) Fighting standards with standards: Harmonization, rents, and social acountability in certified agrofood networks. *Environment and Planning A*, 37(11), 2033–2051.

Naden, C. (2018) Stronger cities for the future: A new set of International Standards just out. *International Organization for Standardization* [online]. Available at: http://www.iso.org/cms/render/live/en/sites/isoorg/contents/news/2018/07/Ref2305.html (accessed 31 October 2018).

Negroponte, N. (1970) *The Architecture Machine: Toward a more human environment*. Cambridge and London: The MIT Press.

Negroponte, N. (1975) *Soft Architecture Machines*. Cambridge and London: The MIT Press.

Newman, M., Barabási, A.-L. and Watts, D. J., eds. (2006) *The structure and dynamics of networks*. Princeton and Oxford: Princeton University Press.

Nietzsche, F. (1999) *The Birth of Tragedy and Other Writings*. Translated by R. Speirs. R. Guess and R. Speirs, eds. Cambridge: Cambridge University Press.

Nivola, P. S. (1999) *Laws of the Landscape: How Policies Shape Cities in Europe and America*. Washington, DC: Brookings Institution Press.

OASIS (2012) Transformational Government Framework Primer Version 1.0. *Organization for the Advancement of Structured Information Standards* [online]. Available at: http://docs.oasis-open.org/tgf/TGF-Primer/v1.0/cn01/TGF-Primer-v1.0-cn01.pdf (accessed 31 October 2018).

OASIS (2013) Transformational Government Framework (TGF) Pattern Language Core Patterns Version 1.0. *Organization for the Advancement of Structured Information Standards* [online]. Available at: http://docs.oasis-open.org/tgf/TGF-PL-Core/v1.0/os/TGF-PL-Core-v1.0-os.pdf (accessed 31 October 2018).

O'Connell, J. (1993) Metrology: The Creation of Universality by the Circulation of Particulars. *Social Studies of Science*, 23(1), 129–173.

Olivella, L. (2012) Barcelona Urban Habitat: The vision, approach and projects of the City of Barcelona towards smart cities. *YouTube* [online]. Available at: https://www.youtube.com/watch?v=BFmlp229RCU&feature=youtu.be&t=31m40s (accessed 31 October 2018).

Ong, A. and Collier, S. J., eds. (2005) *Global Assemblages: Technology, Politics and Ethics as Anthropological Problems*. Malden, MA: Blackwell Publishing.

Openshaw, S. (1984) *The modifiable areal unit problem*. Norwich: Geo Books.

O'Reilly, D. and Reed, M. (2010) 'Leaderism': An Evolution of Managerialism in UK Public Service Reform. *Public Administration*, 88(4), 960–978.

Ostrom, E. (1991) *Governing the Commons: The Evolution of Institutions for Collective Actions*. Cambridge: Cambridge University Press.

Ouma, S. (2010) Global standards, local realities: Private agrifood governance and the restructuring of the Kenyan horticulture industry. *Economic Geography*, 86(2), 197–222.

Oxford English Dictionary (2018a) "Governance, n." Oxford University Press.

Oxford English Dictionary (2018b) "Standard, n. And adj." Oxford University Press.

Panerai, P., Castex, J. and Depaule, J. C. (2004) *Urban Forms: The Death and Life of the Urban Block*. Translated by O. V. Samuels. I. Samuels, ed. Oxford and Burlington: Architectural Press.

Parker, C. (2011) RE: [Tgf] TGF Pattern Language work. *Organization for the Advancement of Structured Information Standards* [online]. Available at: https://lists.oasis-open.org/archives/tgf/201106/msg00007.html (accessed 31 October 2018).

Parker, C. (2013) RE: [Tgf] SMART CITIES FRAMEWORK. *Organization for the Advancement of Structured Information Standards* [online]. Available at: https://lists.oasis-open.org/archives/tgf/201309/msg00011.html (accessed 31 October 2018).

Parker, C. (2015) RE: Request for new items. *Organization for the Advancement of Structured Information Standards* [online]. Available at: https://lists.oasis-open.org/archives/tgf/201510/msg00003.html (accessed 31 October 2018).

Parker, C. (2016) Dubai use of the TGF. *Organization for the Advancement of Structured Information Standards* [online]. Available at: https://lists.oasis-open.org/archives/tgf/201510/msg00003.html (accessed 31 October 2018).

Peck, J. (2010) *Constructions of Neoliberal Reason*. Oxford and New York: Oxford University Press.

Peck, J. (2011) Geographies of policy: From transfer-diffusion to mobility mutation. *Progress in Human Geography*, 35(6), 773–797.

Peck, J. (2016) Economic Rationality Meets Celebrity Urbanology: Exploring Edward Glaeser's City. *International Journal of Urban and Regional Research*.

Peck, J. and Theodore, N. (2015) *Fast Policy: Experimental statecraft at the threscholds of neoliberalism*. Minneapolis and London: University of Minnesota Press.

Peck, J., Theodore, N. and Brenner, N. (2010) Postneoliberalism and its Malcontents. *Antipode*, 41(S1), 94–116.

Philips and WCCD (2017) The Citywide Benefits of Smart & Connected Public Lighting: Assessed through WCCD ISO 37120 Data. *Cities Today* [online]. Available at: https://cities-today.com/issue/citywide-benefits-smart-connected-public-lighting/?action=download (accessed 31 October 2018).

Philo, C. (2000) Foucault's geography. In M. Crang and N. Thrift, eds. *Thinking Space*. London and New York: Routledge. 205–238.

Philo, C. (2012) A 'new Foucault' with lively implications or 'the crawfish advances sideways'. *Transactions of the Institute of British Geographers*, 37(4), 496–514.

Pickering, A. (1995) *The Mangle of Practice: Time, Agency, and Science*. Chicago and London: University of Chicago Press.

Pickering, A. (2010) *The Cybernetic Brain: Sketches of another future*. Chicago and London: The University of Chicago Press.

Pigou, A. C. (1932) *The economics of welfare*. 4th ed. London: Macmillan.

Pinch, T. J. and Bijker, W. E. (1984) The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology might Benefit Each Other. *Social Studies of Science*, 14(3), 399–441.

Pinder, A. (2007) Information Society development: Learning from success, avoiding the pitfalls. *Instytut Wiedzy i Innowacji* [online]. Available at: http://instytut.info/wp-content/uploads/2016/08/Gov3_Presentation.ppt (accessed 31 October 2018).

Ponte, S., Gibbon, P. and Vestergaard, J., eds. (2011) *Governing through Standards: Origins, Drivers and Limitations*. Basingstoke and New York: Palgrave Macmillan.

Porter, T. M. (1995) *Trust in Numbers: The pursuit of objectivity in science and public life*. Princeton, NJ: Princeton University Press.

Posner, R. A. (1976) *Antitrust Law: An Economic Perspective*. Chicago, IL: University of Chicago Press.

Povinelli, E. A. (2011) *Economies of Abandonment: Social Belonging and Endurance in Late Liberalism*. Durham and London: Duke University Press.

Prigogine, I. and Stengers, I. (1984) *Order Out of Chaos: Man's New Dialogue with Nature*. New York: Bantam.

Rabinow, P. (1989) *French Modern: Norms and Forms of the Social Environment*. Chicago and London: Chicago University Press.

Ragin, C. C. (1992) Introduction: Cases of 'What is a case?'. In C. C. Ragin and H. S. Becker, eds. *What is a case? Exploring the foucadations of social inquiry*. Cambridge: Cambridge University Press. 1–17.

Rasch, W. and Wolfe, C. (1995) Introduction: The Politics of Systems and Environments. *Cultural Critique*, (30), 5–13.

Rhee, S. (2016) Catalyzing the internet of things and smart cities: Global city teams challenge. *2016 1st International Workshop on Science of Smart City Operations and Platforms Engineering (SCOPE) in Partnership with Global City Teams Challenge (GCTC), SCOPE - GCTC 2016l Workshop on Science of Smart City Operations and Platforms Engineering (SCOPE)*.

Rhodes, R. A. W. (1996) The New Governance: Governing Without Government. *Political Studies*, 44, 652–667.

Rhodes, R. A. W. (1997) *Understanding Governance: Policy Networks, Governance, Reflexivity and Accountability*. Buckingham and Philadelphia: Open University Press.

Richardson, G. P. (1991) *Feedback Thought in Social Science and Systems Theory*. Philadelphia, PA: University of Pennsylvania Press.

Rickards, L., Gleeson, B., Boyle, M. and O'Callaghan, C. (2016) Urban studies after the age of the city. *Urban Studies*, 53(8), 1523–1541.

Robinson, J. (2006) *Ordinary cities: Between modernity and development*. London and New York: Routledge.

Robinson, J. (2011) Cities in a World of Cities: The Comparative Gesture. *International Journal of Urban and Regional Research*, 35(1), 1–23.

Rose, G. (1997) Situating knowledges: Positionality, reflexivities and other tactics. *Progress in Human Geography*, 21(3), 305–320.

Rosenau, J. N. (1992) Governance, order, and change in world politics. In J. N. Rosenau and E.-O. Czempiel, eds. *Governance without government: Order and change in world politics*. Cambridge: Cambridge University Press. 1–29.

Rosenau, J. N. (2003) *Distant Proximities: Dynamics Beyond Globalization*. Princeton and Oxford: Princeton University Press.

Rosenau, J. N. (2009) Introduction: Global governance or global governances? In J. Whitman, ed. *Palgrave advances in global governance*. Palgrave advances. Basingstoke and New York: Palgrave Macmillan. 1–6.

Rossi, A. (1982) *The Architecture of the City*. Translated by D. Ghirardo and J. Ockman. Cambridge, MA: The MIT Press.

Rowe, P. G. (1995) *Modernity and Housing*. Cambridge, MA: The MIT Press.

Roy, A. (2011) Slumdog Cities: Rethinking Subaltern Urbanism. *International Journal of Urban and Regional Research*, 35(2), 223–238.

Roy, A. (2014) Worlding the South: Toward a post-colonial urban theory. In S. Parnell and S. Oldfield, eds. *The Routledge Handbook on Cities of the Global South*. London and New York: Routledge. 9–20.

Roy, A. (2015) What is urban about critical urban theory? *Urban Geography*, 37(6), 810–823.

Roy, A. (2016) Smart City: Do we have enough standards? *IEEE Standards University* [online]. Available at: https://www.standardsuniversity.org/e-magazine/november-2016-volume-6-issue-4-smart-city-standards/smart-city-enough-standards/ (accessed 31 October 2018).

Roy, A. and Ong, A., eds. (2011) *Worlding Cities: Asian Experiments and the Art of Being Global*. Chichester: Wiley-Blackwell.

Russell, A. (2006) 'Rough Consensus and Running Code' and the Internet-OSI Standards War. *IEEE Annals of the History of Computing*, 28(3), 48–61.

Russell, A. L. (2014) *Open Standards and the Digital Age: History, Ideology, and Networks*. New York: Cambridge University Press.

Ruth, M. and Franklin, R. S. (2014) Livability for all? Conceptual limits and practical implications. *Applied Geography*, 49, 18–23.

Sadowski, J. (2016) *Selling Smartness: Visions and Politics of the Smart City*. PhD thesis. Arizona State University.

Salmons, J. (2015) *Qualitative Online Interviews: Strategies, Design, and Skills*. Second. Los Angeles: SAGE Publications.

Sanromà, M. (2012) The City Protocol: An outline Modus Operandi. *YouTube* [online]. Available at: https://www.youtube.com/watch?v=z3yxJXNj9BM (accessed 31 October 2018).

Sarton, G. (1927) *Introduction to the History of Science*. Huntington, NY: Robert E. Krieger Publishing Company.

Satterthwaite, D. (2010) Urban Myths and the Mis-use of Data that Underpin them.

Schaffer, S. (1992) Late Victorian Metrology and Its Instrumentation: A Manufactory of Ohms. In R. Bud and S. E. Cozzens, eds. *Invisible Connections: Instruments, Institutions and Science*. Bellingham, WA: SPIE Optical Engineering Press. 23–56.

Schaffer, S. (1997) Metrology, Metrication, and Victorian Values. In B. Lightman, ed. *Victorian Science in Context*. Chicago and London: The University of Chicago Press. 438–474.

Schatzki, T. R. (2002) *The Site of the Social: A philosophical account of the constitution of social life and change*. University Park, PA: The Pennsylvania State University Press.

Scheer, B. C. (2010) *The Evolution of Urban Form: Typology for Planners and Architects*. Chicago and Washington: American Planning Association.

Schindler, S. (2017) Towards a paradigm of Southern urbanism. City, 21(1), 47–64.

Schindler, S. and Marvin, S. (2018) Constructing a universal logic of urban control?: International standards for city data, management, and interoperability. *City*, 22(2), 298–307.

Schmidt, S. K. and Werle, R. (1998) *Coordinating Technology: Studies in the International Standardization of Telecommunications*. Cambridge and London: The MIT Press.

Scofield, J. H. (2009) Do LEED-certified buildings save energy? Not really… *Energy and Buildings*, 41(12), 1386–1390.

Scott, A. J. and Roweis, S. T. (1977) Urban Planning in Theory and Practice: A Reappraisal. *Environment and Planning A*, 9(10), 1097–1119.

Scott, J. C. (1998) *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. New Haven and London: Yale University Press.

Secor, A. (2013) 2012 Urban Geography Plenary LectureTopological City. *Urban Geography*, 34(4), 430–444.

Sedgwick, E. K. (1993) Queer Performativity: Henry James's The Art of the Novel. *GLQ: A Journal of Lesbian and Gay Studies*, 1(1), 1–16.

Sennett, R. (1970) *The Uses of Disorder: Personal Identity and City Life*. New York and London: W. W. Norton & Company.

Shannon, C. E. (1948) A mathematical theory of communication. *Bell system technical journal*, 27(3), 379–423.

Shapin, S. and Schaffer, S. (1985) *Leviathan and the air-pump: Hobbes, Boyle, and the experimental life*. Princeton, NJ: Princeton University Press.

Shelton, T. and Lodato, T. (2019) Actually existing smart citizens: Expertise and (non)Participation in the making of the smart city. *City*, 23(1), 35–52.

Shelton, T., Zook, M. and Wiig, A. (2015) The 'actually existing smart city'. *Cambridge Journal of Regions, Economy and Society*, 8(1), 13–25.

Silver, J. (2014) Incremental infrastructures: Material improvisation and social collaboration across post-colonial Accra. *Urban Geography*, 35(6), 788–804.

Simmons, D. (2015) *Vital Minimum: Need, science, and politics in modern France*. Chicago and London: The University of Chicago Press.

Simone, A. (2004) People as Infrastructure: Intersecting fragments in Johannesburg. *Public Culture*, 16(3), 407–429.

Smith, K. E. (2006) Problematising power relations in 'elite' interviews. *Geoforum*, 37(4), 643–653.

Soja, E. W. (1989) *Postmodern Geographies: The Reassertion of Space in Critical Social Theory*. London and New York: Verso.

Southworth, M. and Ben-Joseph, E. (2003) *Streets and the Shaping of Towns and Cities*. Washington, DC: Island Press.

Star, S. L. (1990) Power, technology and the phenomenology of conventions: On being allergic to onions. *The Sociological Review*, 38(S1), 26–56.

Star, S. L. (1991) Power, technology and the phenomenology of conventions: On being allergic to onions. In J. Law, ed. *A Sociology of Monsters: Essays on Power, Technology and Domination*. London and New York: Routledge. 26–56.

Star, S. L. and Lampland, M. (2009) Reckoning with Standards. In M. Lampland and S. L. Star, eds. *Standards and their stories: How quantifying, classifying, and formalizing practices shape everyday life*. Ithaca and London: Cornell University Press. 3–24.

Steenson, M. W. (2017) *Architectural Intelligence: How Designers and Architects Created the Digital Landscape*. Cambridge and London: The MIT Press.

Stigler, G. J. (1971) The Theory of Economic Regulation. *Bell Journal of Economics and Management Services*, 2(1), 3–21.

Storper, M., Kemeny, T., Makarem, N. and Osman, T. (2015) *The Rise and Fall of Urban Economies: Lessons from San Francisco and Los Angeles*. Stanford, CA: Stanford University Press.

Storper, M. and Scott, A. J. (2016) Current debates in urban theory: A critical assessment. *Urban Studies*, 53(6), 1114–1136.

Strauss, A. L., Fagerhaugh, S., Suczek, B. and Wiener, C. (1985) *Social Organization of Medical Work*. Chicago, IL: University of Chicago Press.

Sullivan, J. R. (2012) Skype: An Appropriate Method of Data Collection for Qualitative Interviews? *The Hilltop Review*, 6(1), 54–60.

Talen, E. (2012) *City Rules: How Regulations Affect Urban Form*. Washington, DC: Island Press.

Tavernor, R. (2007) *Smoot's Ear: The Measure of Humanity Hardcover*. New Haven and London: Yale University Press.

Taylor, P. J. (2004) *World City Network: A Global Urban Analysis*. London and New York: Routledge.

Taylor Buck, N. and While, A. (2015) Competitive urbanism and the limits to smart city innovation: The UK Future Cities initiative. *Urban Studies*.

Tett, G. (2015) *The Silo Effect: The Peril of Expertise and the Promise of Breaking Down Barriers*. New York: Simon & Schuster.

Tharoor, S. (2016) *An Era of Darkness: The British Empire in India*. New Delhi: Aleph Book Company.

The Economist (1945) UNSCC. *The Economist*, 286–287.

Thévenot, L. (1984) Rules and implements: investment in forms. *Social Science Information*, 23(1), 1–45.

Thévenot, L. (2009) Governing Life by Standards: A View from Engagements. *Social Studies of Science*, 39(5), 793–813.

Thrift, N. (1993) An Urban Impasse? *Theory, Culture & Society*, 10(2), 229–238.

Thrift, N. (2000) Entanglements of Power: Shadows? In J. P. Sharp, P. Routledge, C. Philo, and R. Paddison, eds. *Entanglements of Power: Geographies of domination/resistance*. London and New York: Routledge. 269–278.

Thrift, N. (2004a) Intensities of Feeling: Towards a spatial politics of affect. *Geografiska Annaler: Series B, Human Geography*, 86(1), 57–78.

Thrift, N. (2004b) Remembering the technological unconscious by foregrounding knowledges of position. *Environment and Planning D: Society and Space*, 22(1), 175–190.

Thrift, N. (2007) Overcome by Space: Reworking Foucault. In J. W. Crampton and S. Elden, eds. *Space, Knowledge and Power: Foucault and Geography*. Aldershot and Burlington: Ashgate. 53–58.

Thrift, N. (2008) *Non-Representational Theory: Space, politics, affect*. London and New York: Routledge.

Thrift, N. (2009) Different atmospheres: Of Sloterdijk, China, and site. *Environment and Planning D: Society and Space*, 27(1), 119–138.

Thrift, N. and French, S. (2002) The automatic production of space. *Transactions of the Institute of British Geographers*, 27(3), 309–335.

Tieman, R. (2017) Barcelona: Smart city revolution in progress. *Financial Times* [online]. Available at: https://www.ft.com/content/6d2fe2a8-722c-11e7-93ff-99f383b09ff9 (accessed 31 October 2018).

Timmermans, S. and Berg, M. (2003) *The gold standard: The Challenge of Evidence-Based Medicine and Standardization in Health Care*. Philadelphia: Temple University Press.

Timmermans, S. and Epstein, S. (2010) A World of Standards but not a Standard World: Toward a Sociology of Standards and Standardization. *Annual Review of Sociology*, 36(1), 69–89.

Tollefson, C., Gale, F. and Haley, D. (2008) *Setting the standard: Certification, Governance, and the Forest Stewardship Council*. Vancouver: The University of British Columbia.

Tonkiss, F. (2013) *Cities by Design: The Social Life of Urban Form*. Cambridge and Malden: Polity Press.

Townsend, A. M. (2013) *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*. New York: W. W. Norton.

Tsing, A. L. (2012) On Nonscalability: The Living World Is Not Amenable to Precision-Nested Scales. *Common Knowledge*, 18(3), 505–524.

Tsing, A. L. (2015) *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton and Oxford: Princeton University Press.

UN (2018) *World Urbanization Prospects: The 2018 Revision, Key Facts*. New York: United Nations, Department of Economic and Social Affairs, Population Division.

UNE (n.d.) Busca tu norma. *Asociación Española de Normalización* [online]. Available at: https://www.une.org/encuentra-tu-norma/busca-tu-norma (accessed 31 October 2018).

UN-Habitat (2006) *State of the World's Cities 2006/7*. London: Earthscan.

Varela, F. G., Maturana, H. R. and Uribe, R. (1974) Autopoiesis: The organization of living systems, its characterization and a model. *Biosystems*, 5(4), 187–196.

Waldrop, M. M. (1992) *Complexity: The Emerging Science at the Edge of Order and Chaos*. New York: Touchstone.

Walters, W. (2004) Some Critical Notes on 'Governance'. *Studies in Political Economy*, 73(1), 27–46.

Wang, F. and Liu, Y. (2014) How unique is 'China Model': A review of theoretical perspectives on China's urbanization in Anglophone literature. *Chinese Geographical Science*, 25(1), 98–112.

Warburton, S. (2014) *RE: Access to Global City Indicators - Indicators* [email]. Message to T. P. Lauriault. Sent 18 July 2014.

Wartenberg, T. (1990) *The Forms of Power: From Domination to Transformation*. Philadelphia, PA: Temple University Press.

WCCD (2015) About us. *World Council on City Data*. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20150201062138/http://www.dataforcities.org/about_us.html (accessed 31 October 2018).

WCCD (2016) Terms of Use for Open City Data. *World Council on City Data* [online]. Available at: http://www.dataforcities.org/assets/res/Terms%20of%20Use%20for%20Open%20City%20Data.pdf (accessed 31 October 2018).

WCCD (2017a) 'A more sustainable, inclusive and prosperous future is in the hands of cities worldwide,' says WCCD President & CEO Patricia McCarney. *World Council*

on City Data News [online]. Available at: http://news.dataforcities.org/2017/07/a-more-sustainable-inclusive-and.html (accessed 31 October 2018).

WCCD (2017b) WCCD Announces the Launch of Local Data Hubs Around the World at the United Nations. *World Council on City Data News* [online]. Available at: http://news.dataforcities.org/2017/07/wccd-announces-launch-of-local-data.html (accessed 31 October 2018).

WCCD (2017c) WCCD CEO and Governor of Niger State sign MOU to establish the Minna-WCCD Local Data Hub. *World Council on City Data News* [online]. Available at: http://news.dataforcities.org/2017/07/wccd-ceo-and-governor-of-niger-state.html (accessed 31 October 2018).

WCCD (2017d) WCCD Global Cities Summit Adopts 'The Dubai Declaration 2017'. *World Council on City Data News* [online]. Available at: http://news.dataforcities.org/2017/03/dubai-declaration.html (accessed 31 October 2018).

WCCD (n.d.-a) Data Portal. *World Council on City Data* [online]. Available at: http://open.dataforcities.org/ (accessed 31 October 2018).

WCCD (n.d.-b) Global Cities Registry for ISO 37120. *World Council on City Data* [online]. Available at: http://www.dataforcities.org/global-cities-registry/ (accessed 31 October 2018).

WCCD (n.d.-c) Philips Lighting. *Wayback Machine* [online]. Available at: https://web.archive.org/web/20170909214059/dataforcities.org/philips/ (accessed 31 October 2018).

WCCD (n.d.-d) Siemens. *World Council on City Data* [online]. Available at: http://www.dataforcities.org/siemens/ (accessed 31 October 2018).

WCCD (n.d.-e) What is the WCCD? *World Council on City Data* [online]. Available at: http://www.dataforcities.org/wccd/ (accessed 31 October 2018).

Weaver, W. (1948) Science and Complexity. *American Scientist*, 36(4), 536–544.

Weaver, W. (1949) Recent Contributions to the Mathematical Theory of Communication. In *The Mathematical Theory of Communication*. Urbana, IL: University of Illinois Press. 1–28.

Welsh, D. (2015) ANSSC Webinar: ISO TMB SAG smart cities report and recommendations. *ANSI Webex* [online]. Available at: https://goansi.webex.com/ec3300/eventcenter/recording/recordAction.do?theAction=poprecord&siteurl=goansi&entappname=url3300&internalRecordTicket=4832534b00000004db15954d5cdcbdba83f21bfd675c5183fcb409e259c1d956619c1d45628e6d3c&renewticket=0&isurlact=true&format=short&rnd=2113109139&RCID=c42c943559e18e85ced87ac276c6ba09&rID=43317442&needFilter=false&recordID=43317442&apiname=lsr.php&AT=pb&actappname=ec3300&&SP=

EC&entactname=%2FnbrRecordingURL.do&actname=%2Feventcenter%2Fframe%2Fg.do (accessed 31 October 2018).

West, G. (2017) *Scale: The Search for Simplicity and Unity in the Complexity of Life, from Cells to Cities, Companies to Ecosystems, Milliseconds to Millennia*. New York: Penguin Press.

Whatmore, S. (2002) *Hybrid Geographies: Natures, Cultures, Spaces*. London: Sage Publications.

White, J. M. (2016a) Anticipatory logics of the smart city's global imaginary. *Urban Geography*, 37(4), 572–589.

White, J. M. (2016b) *ISO 37120, a medium for economies of translation*. Unpublished paper presented at: 4S/EASST Conference. Barcelona, 31 August – 3 September 2016.

White, J. M. (2017) Rethinking the Spaces of Standardisation through the Concept of Site. *Tecnoscienza: Italian Journal of Science & Technology Studies*, 8(2), 151–174.

Whitehand, J. W. R. (1987) *The Changing Face of Cities: A Study of Development Cycles and Urban Form*. Oxford: Basil Blackwell.

Wiener, N. (1948) *Cybernetics: Or Control and Communication in the Animal and the Machine*. Cambridge, MA: Technology Press.

Williams, R. (1983) *Keywords: A vocabulary of culture and society*. Revised ed. New York: Oxford University Press.

Wilson, A. (1968) Models in Urban Planning: A Synoptic Review of Recent Literature. *Urban Studies*, 5(3), 249–276.

Winden, W. van, Oskam, I., Buuse, D. van den, Schrama, W., Dijck, E.-J. van and Frederiks, M. (2016) *Organising Smart City Projects: Lessons From Amsterdam*. Amsterdam: Hogeschool van Amsterdam.

Wise, M. N., ed. (1995) *The Values of Precision*. Princeton, NJ: Princeton University Press.

Wolfe, C. (1995) In Search of Post-Humanist Theory: The Second-Order Cybernetics of Maturana and Varela. *Cultural Critique*, 30(The Politics of Systems and Environments, Part I). 33–70.

Wolfe, C. (2010) *What is Posthumanism?* Minneapolis and London: University of Minnesota Press.

Wolfe, R. (2014) Repetition-Compulsion: World-Historical Rhythms in Architecture. *e-flux*, 54, 1–11.

Woodward, K., Dixon, D. P. and Jones, J. P. III (2009) Poststructuralism/Poststructuralist Geographies. In R. Kitchin and N. Thrift, eds. *International Encyclopedia of Human Geography, Volume 8*. Amsterdam and Oxford: Elsevier. 396–407.

Woodward, K., Jones, J. P. III and Marston, S. A. (2010) Of eagles and flies: Orientations toward the site. *Area*, 42(3), 271–280.

Yanow, D. (2000) *Conducting interpretive policy analysis*. Thousand Oaks, CA: Sage.

Yin, R. K. (2009) *Case Study Research: Design and Methods*. 4th ed. Thousand Oaks, CA: Sage Publications.

APPENDIX 1

Table A1.1. Information on interviews conducted during the research.

No	Date	Name(s)	Location	Case
1	24/06/15	Gavin McArdle	Skype	ISO 37120
2	01/07/15	Nick Casey	Melbourne	ISO 37120
3	09/07/15	Yuriy Onyshchuck	Melbourne	ISO 37120
4	10/07/15	David Hassett	Melbourne	ISO 37120
5	11/11/15	Graham Colclough	London	PAS 181
6	12/11/15	Dan Palmer	London	PAS 181
7	13/11/15	Maria-Lluisa Marsal-Llacuna	London	general
8	13/11/15	Michael Mulquin	London	general
9	26/11/15	Mark Bennett	Dublin	ISO 37120
10	26/01/16	Joe Pennachetti	Skype	ISO 37120
11	27/01/16	Peter Viducis	Toronto	ISO 37120
12	28/01/16	@@Oona Chaplin##	Toronto	ISO 37120
13	29/01/16	Ilja Green and Jessica Stanley	Toronto	ISO 37120
14	01/02/16	Connie Wheeler	Toronto	ISO 37120
15	02/02/16	Harvey Low	Toronto	ISO 37120
16	02/02/16	Mark Fox	Toronto	ISO 37120
17	03/02/16	Bruce MacGregor	Toronto	ISO 37120
18	04/02/16	Helen Ng	Toronto	ISO 37120
19	04/02/16	Patricia McCarney	Toronto	ISO 37120
20	08/02/16	Timothy Reardon	Boston	ISO 37120
21	09/02/16	Jonathan Lee	Boston	ISO 37120
22	11/02/16	Matt Resseger	Boston	ISO 37120
23	12/02/16	Nigel Jacob	Boston	general
24	23/02/16	Brian Donnellan	Dublin	general
25	03/03/16	Holly St Clair	Skype	ISO 37120
26	18/03/16	Chris Parker	Skype	PAS 181
27	16/06/16	Lee Omar	London	PAS 181
28	24/06/16	Thomas Mullin	Skype	PAS 181
29	11/08/16	Nick Casey	Melbourne	ISO 37120
30	17/08/16	Serryn Eagleson	Melbourne	ISO 37120
31	26/08/16	Robert Rallo	Tarragona	CPA-I_001
32	31/08/16	Enric Marti	Barcelona	CPA-I_001
33	14/09/16	Francesc Giralt	Skype	CPA-I_001
34	28/09/16	Ian Cowan	Dublin	general
35	12/10/16	James Aloisi	Skype	CPA-I_001
36	25/11/16	Maria-Lluisa Marsal-Llacuna	Skype	ISO 37120

No	Date	Name(s)	Location	Case
37	14/12/16	Jamie Cudden	Dublin	CPA-I_001
38	21/12/16	John Smiciklas	Skype	ISO 37120
39	10/01/17	Peter Finnegan	Dublin	CPA-I_001
40	12/01/17	Trevor Gibson	Skype	PAS 181
41	18/01/17	Vatsal Bhatt	Skype	general
42	20/01/17	Paul Wilson	Skype	PAS 181
43	24/01/17	Michael Batty	Skype	general
44	27/01/17	Vicente Guallart	Skype	CPA-I_001
45	03/02/17	Michael Batty	Skype	general
46	06/02/17	Remco Perotti	Skype	CPA-I_001
47	06/02/17	Abdul Husaini	Skype	ISO 37120
48	16/02/17	Noora Saeed Al Suwaidi	Skype	CPA-I_001
49	17/02/17	Sue Lebeck	Skype	CPA-I_001
50	24/05/17	Nikolaos Kontinakis	Skype	general
51	24/08/17	Pippa Gardner	Skype	PAS 181

APPENDIX 2

Table A2.1. List of city standards organisations (based on ANSI 2016).

Name	Type
ANSI Network on Smart and Sustainable Cities (ANSSC)	standardization initiative
British Standards Institution (BSI)	standardization initiative
CEN-CENELEC Smart and Sustainable Cities and Communities Coordination Group (SSCC-CG)	standardization initiative
German Institute for Standardization (DIN)	standardization initiative
Global Infrastructure Basel Foundation	standardization initiative
Global City Indicators Facility	standardization initiative
Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)	standardization initiative
Gold Standard Sustainable Cities Programme	standardization initiative
IEC Systems Evaluation Group on Smart Cities	standardization initiative
ISO Climate Change Coordinating Committee	standardization initiative
ISO Technical Management Board Advisory Group on Smart Cities	standardization initiative
ISO/IEC JTC1 Study Group on Smart Cities	standardization initiative
ISO/TC 268, Sustainable Development in Communities	standardization initiative
ITU Focus Group on Smart Sustainable Cities	standardization initiative
World Council on City Data (WCCD)	standardization initiative
Architecture 2030 / 2030 Districts®	assessment and rating system
Audubon International	assessment and rating system
EcoDistricts	assessment and rating system
Enterprise Green Communities	assessment and rating system
Envision™ Sustainable Infrastructure Rating System	assessment and rating system
Green Land Development	assessment and rating system
LEED for Neighborhood Development (LEED-ND)	assessment and rating system
Living Community Challenge	assessment and rating system
STAR Communities	assessment and rating system
Sustainable SITES Initiative™ (SITES®)	assessment and rating system
Transformative Tools	assessment and rating system
Walk Score	assessment and rating system
AECOM Global Cities Institute	corporate-led initiative
Capgemini	corporate-led initiative
Cisco Smart+Connected Communities Solutions	corporate-led initiative
Citi	corporate-led initiative
Cityzenith	corporate-led initiative
Ericsson	corporate-led initiative

Name	Type
Esri	corporate-led initiative
GDF Suez Barcelona	corporate-led initiative
General Electric	corporate-led initiative
GSMA	corporate-led initiative
Hitachi	corporate-led initiative
IBM	corporate-led initiative
Intel	corporate-led initiative
McKinsey & Company	corporate-led initiative
Microsoft City Next	corporate-led initiative
Oracle	corporate-led initiative
Philips	corporate-led initiative
Schneider Electric	corporate-led initiative
Siemens	corporate-led initiative
Smart Cities Council	corporate-led initiative
Streetline, Inc.	corporate-led initiative
Toshiba	corporate-led initiative
TransitScreen	corporate-led initiative
U.S. Chamber of Commerce Foundation	corporate-led initiative
Veolia	corporate-led initiative
World Business Council for Sustainable Development	corporate-led initiative
Xerox Transportation Solutions	corporate-led initiative
American Institute of Architects	professional association
American Planning Association	professional association
American Public Transportation Association	professional association
American Public Works Association	professional association
American Society of Civil Engineers	professional association
American Society of Landscape Architects	professional association
Green Building Certification Institute	professional association
International Association of Public Transport (UITP)	professional association
International Society of City and Regional Planners	professional association
Urban Land Institute	professional association
U.S. Green Building Council	professional association
World Green Building Council	professional association
Agile Cities	multi-stakeholder NGO initiative
C40	multi-stakeholder NGO initiative
CityWorks	multi-stakeholder NGO initiative
Center for Neighborhood Technology	multi-stakeholder NGO initiative
CEOs for Cities	multi-stakeholder NGO initiative
Chesapeake Crescent Initiative (CCI)	multi-stakeholder NGO initiative
Cities Alliance	multi-stakeholder NGO initiative
City Protocol Society (CPS)	multi-stakeholder NGO initiative

Name	Type
Code for America	multi-stakeholder NGO initiative
Community Indicators Consortium	multi-stakeholder NGO initiative
The Future Cities Institute	multi-stakeholder NGO initiative
Great City	multi-stakeholder NGO initiative
Institute for Sustainable Communities	multi-stakeholder NGO initiative
Institute for Transportation & Development Policy	multi-stakeholder NGO initiative
International Making Cities Livable, LLC	multi-stakeholder NGO initiative
Meeting of the Minds	multi-stakeholder NGO initiative
New Cities Foundation	multi-stakeholder NGO initiative
Renewable Cities	multi-stakeholder NGO initiative
Smart Growth America	multi-stakeholder NGO initiative
Smart Growth Network	multi-stakeholder NGO initiative
The Sustainable Environment Resource Institute aka Cities Network Campaign	multi-stakeholder NGO initiative
World Resources Institute	multi-stakeholder NGO initiative
World Urban Campaign	multi-stakeholder NGO initiative
World Urban Forum	multi-stakeholder NGO initiative
Alliance for Innovation	state and local government initiative
Chicago Lakeside Development	state and local government initiative
Compact of Mayors	state and local government initiative
ICLEI Local Governments for Sustainability	state and local government initiative
International City / County Management Association	state and local government initiative
Local Government Commission	state and local government initiative
National Association of City Transportation Officials	state and local government initiative
National Association of Counties	state and local government initiative
National Association of Development Organizations	state and local government initiative
National League of Cities	state and local government initiative
New York & Connecticut Sustainable Communities	state and local government initiative
Regional Plan Association	state and local government initiative
Resilient Communities for America	state and local government initiative
San Francisco Department of the Environment	state and local government initiative
UN Global Compact Cities Programme	state and local government initiative
United Cities and Local Governments	state and local government initiative
Urban Sustainability Directors Network	state and local government initiative
WeGO	state and local government initiative
Arizona State University	academic initiative
Columbia University's Institute for Data Sciences and Engineering	academic initiative
Cornell NYC Tech	academic initiative
Global Cities Institute	academic initiative
Harvard Kennedy School Data-Smart City Solutions	academic initiative
London School of Economics Cities Programme	academic initiative

Name	Type
Massachusetts Institute of Technology	academic initiative
New School for Public Engagement	academic initiative
New York University Center for Urban Science and Progress	academic initiative
OpenData500	academic initiative
Penn Institute for Urban Research	academic initiative
Renewable Cities	academic initiative
University of Alabama at Birmingham	academic initiative
University of Porto	academic initiative
Brookings Institution	think tank
Urban Institute	think tank
Woodrow Wilson International Center for Scholars	think tank
Data.gov	US federal government initiative
National Institute of Standards and Technology (NIST)	US federal government initiative
Partnership for Sustainable Communities	US federal government initiative
Sandia National Laboratories	US federal government initiative
U.S. Agency for International Development	US federal government initiative
U.S. Department of Energy	US federal government initiative
U.S. Department of Housing and Urban Development	US federal government initiative
U.S. Department of State	US federal government initiative
U.S. Department of Transportation (DOT)	US federal government initiative
U.S. Environmental Protection Agency	US federal government initiative
White House	US federal government initiative
Delhi Mumbai Industrial Corridor	other national government initiative
Reference Framework for European Sustainable Cities	other national government initiative
European Innovation Partnership on Smart Cities and Communities (EIP-SCC)	other national government initiative
APEC Energy WG, Energy Smart Communities Initiatives, Knowledge Sharing Platform	intergovernmental organization initiative
Cities Climate Finance Leadership Alliance	intergovernmental organization initiative
Global Sustainable Cities Network	intergovernmental organization initiative
APEC Energy WG, Energy Smart Communities Initiatives, Knowledge Sharing Platform	intergovernmental organization initiative
Cities Climate Finance Leadership Alliance	intergovernmental organization initiative
Global Sustainable Cities Network	intergovernmental organization initiative
United Nations	intergovernmental organization initiative
United Nations Environment Programme (UNEP)	intergovernmental organization initiative
United Nations Human Settlements Programme (UN Habitat)	intergovernmental organization initiative
United Nations Office for Disaster Risk Reduction (UNISDR)	intergovernmental organization initiative
World Bank	intergovernmental organization initiative

Name	Type
100 Resilient Cities	philanthropic initiative
Bloomberg Philanthropies	philanthropic initiative
Funders' Network for Smart Growth and Livable Communities	philanthropic initiative
Georgetown University Energy Prize	philanthropic initiative
IBM's Smarter Cities Challenge	philanthropic initiative
IEEE Smart Cities Initiative	philanthropic initiative
Knight Foundation Knight Cities Challenge	philanthropic initiative
Cities Today	news and information exchange
The Citistates Group	news and information exchange
Financial Times	news and information exchange
Greener Cities and Communities	news and information exchange
MESH Cities	news and information exchange
Next City	news and information exchange
Places	news and information exchange
Planetizen	news and information exchange
SustainableCitiesCollective	news and information exchange
Sustainable Communities Online	news and information exchange
UBM's Future Cities	news and information exchange
City-Data	data aggregator

Table A2.2. A list of national and international standards for smart, sustainable and resilient cities. Data has been collated from BSI (n.d.), IEC (2018), ISO (2018b, 2018a) ITU-T (n.d.), and UNE (n.d.).

Standard	Responsibility
PAS 180:2014 Smart cities. Vocabulary.	BSI
PAS 181:2014 Smart city Framework. Guide to establishing strategies for smart cities and communities.	BSI
PAS 182:2014 Smart city concept model. Guide to establishing a model for data interoperability.	BSI
PAS 183:2017 Smart cities. Guide to establishing a decision-making framework for sharing data and information services.	BSI
PAS 184:2017 Smart Cities. Developing project proposals for delivering smart city solutions. Guide.	BSI
PAS 185:2017 Smart Cities. Specification for establishing and implementing a security-minded approach.	BSI
PD 8100:2015 Smart cities overview. Guide.	BSI
PD 8101:2014 Smart cities. Guide to the role of the planning and development process.	BSI
PNE 178101-5-2 Redes de los Servicios Públicos. Parte 5.2: Redes de energía. Gas	CTN 178/SC 1
PNE 178102-10 Sistemas de telecomunicación. Parte 10: Sistema de Gestión de Residuos, SGR	CTN 178/SC 1
PNE 178102-2 Sistemas de telecomunicación. Parte 2: Centros de Proceso de Datos, CPD	CTN 178/SC 1
PNE 178102-4 Sistemas de telecomunicación. Parte 4: Sistema de Información Ciudadana, SIC	CTN 178/SC 1
PNE 178102-5 Sistemas de telecomunicación. Parte 5: Sistema de Telecontrol	CTN 178/SC 1
PNE 178102-6 Sistemas de telecomunicación. Parte 6: Sistema de Seguridad y Emergencia, SSE	CTN 178/SC 1
PNE 178102-7 Sistemas de telecomunicación. Parte 7: Sistema de Transporte Inteligente, STI	CTN 178/SC 1
PNE 178102-8 Sistemas de telecomunicación. Parte 8: Sistema de Gestión de Tráfico, SGT	CTN 178/SC 1
PNE 178102-9 Sistemas de telecomunicación. Parte 9: Sistema de Abastecimiento y Saneamiento de Agua, SAS	CTN 178/SC 1
PNE 178103 Convergencia de los Sistemas de Gestión-Control en una Ciudad Inteligente	CTN 178/SC 1
PNE 178107-10 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 10: Telecontrol	CTN 178/SC 1
PNE 178107-11 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 11: Aspectos de Privacidad	CTN 178/SC 1
PNE 178107-12 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 12: Aspectos de Seguridad	CTN 178/SC 1
PNE 178107-7 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 7: Cableado estructurado	CTN 178/SC 1

Standard	Responsibility
PNE 178107-8 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 8: Redes Móviles Públicas	CTN 178/SC 1
PNE 178107-9 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 9: Comunicaciones mediante cable eléctrico, PLC	CTN 178/SC 1
PNE 178109 Estación inteligente y conexión con la plataforma de ciudad inteligente	CTN 178/SC 1
PNE 178110 Semántica aplicada a Turismo	CTN 178/SC 1
PNE 178203 Indicadores de derechos de los ciudadanos	CTN 178/SC 2
PNE 178302 Interoperabilidad de puntos de recarga. Requisitos mínimos para considerar interoperable una infraestructura de recarga de vehículos eléctricos	CTN 178/SC 3
PNE 178304 KPIs para la caracterización, monitorización y mejora de la logística urbana o distribución última milla	CTN 178/SC 3
PNE 178305 Guía de recomendaciones para la gestión inteligente de territorios rurales	CTN 178/SC 3
PNE 178306 Movilidad accesible en Ciudades Inteligentes	CTN 178/SC 3
PNE 178403 Sensorización ambiental. Sistema de Control de Contaminación Atmosférica	CTN 178/SC 4
PNE 178404 Sensorización ambiental. Sistema de Control de Contaminación Acústica	CTN 178/SC 4
PNE 178405 Sensorización ambiental. Sistema de Riego Inteligente	CTN 178/SC 4
PNE 178601 Territorios Rurales Inteligentes. Definición, atributos y requisitos	CTN 178/SC 6
UNE 178101-1:2015 Redes de los Servicios Públicos. Parte 1: Redes de aguas	CTN 178/SC 1
UNE 178101-2:2018 Redes de los Servicios Públicos. Parte 2: Redes de residuos	CTN 178/SC 1
UNE 178101-3:2016 Redes de los Servicios Públicos. Parte 3: Redes de transporte	CTN 178/SC 1
UNE 178101-4:2015 Redes de los Servicios Públicos. Parte 4: Redes de telecomunicación	CTN 178/SC 1
UNE 178101-5-1:2015 Redes de los Servicios Públicos. Parte 5-1: Redes de energía. Electricidad	CTN 178/SC 1
UNE 178102-1:2015 Sistemas de telecomunicación. Parte 1: Red Municipal Multiservicio	CTN 178/SC 1
UNE 178102-3:2015 Sistemas de telecomunicación. Parte 3: Sistema de Comunicaciones Unificadas, SCU	CTN 178/SC 1
UNE 178104:2017 Sistemas Integrales de Gestión de la Ciudad Inteligente. Requisitos de interoperabilidad para una Plataforma de Ciudad Inteligente	CTN 178/SC 1
UNE 178105:2017 Accesibilidad Universal en las Ciudades Inteligentes	CTN 178/SC 1
UNE 178107-1:2015 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 1: Redes de Fibra Óptica	CTN 178/SC 1
UNE 178107-2:2015 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 2: Redes inalámbricas de área amplia, WMAN	CTN 178/SC 1
UNE 178107-3:2015 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 3: Redes inalámbricas de área local, WLAN	CTN 178/SC 1

Standard	Responsibility
UNE 178107-4:2015 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 4:Redes de Sensores, WSN	CTN 178/SC 1
UNE 178107-5:2015 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 5: Redes Móviles de Seguridad y Emergencia, SSE	CTN 178/SC 1
UNE 178107-6:2016 IN Guía para las infraestructuras de Redes de acceso y transporte. Parte 6: Radioenlaces	CTN 178/SC 1
UNE 178108:2017 Requisitos de los edificios inteligentes para su consideración como nodo IoT según la Norma UNE 178104	CTN 178/SC 1
UNE 178201:2016 Definición, atributos y requisitos	CTN 178/SC 2
UNE 178202:2016 Indicadores de gestión en base a cuadros de mando de gestión de ciudad	CTN 178/SC 2
UNE 178301:2015 Datos Abiertos (Open Data)	CTN 178/SC 3
UNE 178303:2015 Gestión de activos de la ciudad. Especificaciones	CTN 178/SC 2
UNE 178401:2017 Alumbrado exterior. Grados de funcionalidad, zonificación y arquitectura de gestión	CTN 178/SC 4
UNE 178402:2015 Gestión de servicios básicos y suministro de agua y energía eléctrica en puertos inteligentes	CTN 178/SC 4
UNE 178501:2018 Sistema de gestión de los destinos turísticos inteligentes. Requisitos	CTN 178/SC 5
UNE 178502:2018 Indicadores y herramientas de los destinos turísticos inteligentes	CTN 178/SC 5
IEC 63152 ED1 Smart Cities - City Service Continuity against disasters - the role of the electrical supply	IEC/SyC Smart Cities/PT 63152
IEC 63205 ED1 Smart Cities Reference Architecture (SCRA)	IEC/SyC Smart Cities/WG 3
IEC TS 63188 ED1 Systems Reference Document - Smart Cities - Smart Cities Reference Architecture Methodology (SCRAM)	IEC/SyC Smart Cities/WG 3
PNW SYCSMARTCITIES-50 Smart City System- Vocabulary (chapter for electropedia)	IEC/SyC Smart Cities/WG 1
PNW TS SYCSMARTCITIES-49 Systems Resource Document (SRD) - Smart City Standards Inventory and Mapping	IEC/SyC Smart Cities/WG 3
PNW TS SYCSMARTCITIES-51 Systems Reference Document (SRD) - Smart City System - Methodology for concepts and taxonomies building	IEC/SyC Smart Cities/WG 1
ISO/IEC 21972 An upper level ontology for smart city indicators	ISO/IEC JTC 1/WG 11
ISO/IEC 23423 Smart cities — Guide to establishing a decision-making framework for sharing data and information services	ISO/IEC JTC 1/WG 11
ISO/IEC 30145-1 Smart City ICT reference framework — Part 1: Smart city business process framework	ISO/IEC JTC 1/WG 11
ISO/IEC 30145-2 Smart City ICT reference framework — Part 2: Smart city knowledge management framework	ISO/IEC JTC 1/WG 11
ISO/IEC 30145-3 Smart City ICT reference framework — Part 3: Smart city engineering framework	ISO/IEC JTC 1/WG 11

Standard	Responsibility
ISO/IEC 30146 Smart city ICT indicators	ISO/IEC JTC 1/WG 11
ISO/IEC 30182:2017 Smart city concept model — Guidance for establishing a model for data interoperability	ISO/IEC JTC 1/WG 11
ISO 37100:2016 Sustainable cities and communities – Vocabulary	ISO/TC 268
ISO 37101:2016 Management system for sustainable development – Requirements with guidance for use	ISO/TC 268
ISO 37106:2018 Guidance on establishing smart city operating models for sustainable communities	ISO/TC 268
ISO 37120:2018 Indicators for city services and quality of life	ISO/TC 268
ISO/AWI TS 37107 Maturity framework for sustainable and smart-enabled communities	ISO/TC 268
ISO/CD 37123 Indicators for resilient cities	ISO/TC 268
ISO/DIS 37104 Guidance for practical implementation in cities	ISO/TC 268
ISO/DIS 37105 Descriptive framework for cities and communities	ISO/TC 268
ISO/DIS 37122 Indicators for Smart Cities	ISO/TC 268
ISO/TR 37121:2017 Inventory of existing guidelines and approaches on sustainable development and resilience in cities	ISO/TC 268
ISO 37153:2017 Maturity model for assessment and improvement	ISO/TC 268/SC 1
ISO 37154:2017 Best practice guidelines for transportation	ISO/TC 268/SC 1
ISO 37157:2018 Smart transportation for compact cities	ISO/TC 268/SC 1
ISO/CD 37156 Guidelines on Data Exchange and Sharing for Smart Community Infrastructures	ISO/TC 268/SC 1
ISO/CD 37160 Electric power infrastructure – Measurement method for quality of thermal power station infrastructure and requirement for plant operation and maintenance practice	ISO/TC 268/SC 1
ISO/CD 37161 Guidance on smart transportation to save energy consumption in transportation services in cities	ISO/TC 268/SC 1
ISO/CD 37162 Smart transportation for new towns	ISO/TC 268/SC 1
ISO/DIS 37155-1 Framework for integration and operation of smart community infrastructures – Part 1: Opportunities and challenges from interactions in smart community infrastructures from all aspects through the life-cycle	ISO/TC 268/SC 1
ISO/DIS 37159 Smart transportation for rapid transit in and between large city zones and their surrounding areas	ISO/TC 268/SC 1
ISO/FDIS 37158 Smart transportation using battery-powered buses for public transportation systems to realize the city centers with zero-emission of greenhouse gases and small particles, the quiet environment and safe bus rides	ISO/TC 268/SC 1
ISO/TR 37150:2014 Review of existing activities relevant to metrics	ISO/TC 268/SC 1
ISO/TR 37152:2016 Common framework for development and operation	ISO/TC 268/SC 1
ISO/TS 37151:2015 Principles and requirements for performance metrics	ISO/TC 268/SC 1
Y.4000: Overview of the Internet of things	ITU-T/SG20
Y.4001: Machine socialization: Overview and reference model	ITU-T/SG20
Y.4002: Machine socialization: Relation management models and descriptions	ITU-T/SG20

Standard	Responsibility
Y.4003: Overview of smart manufacturing in the context of the industrial Internet of things	ITU-T/SG20
Y.4050: Terms and definitions for the Internet of things	ITU-T/SG20
Y.4100: Common requirements of the Internet of things	ITU-T/SG20
Y.4101: Common requirements and capabilities of a gateway for Internet of things applications	ITU-T/SG20
Y.4102: Requirements for Internet of things devices and operation of Internet of things applications during disasters	ITU-T/SG20
Y.4103: Common requirements for Internet of things (IoT) applications	ITU-T/SG20
Y.4104: Service description and requirements for ubiquitous sensor network middleware	ITU-T/SG20
Y.4105: Requirements for support of ubiquitous sensor network (USN) applications and services in the NGN environment	ITU-T/SG20
Y.4106: Requirements and functional model for a ubiquitous network robot platform that supports ubiquitous sensor network applications and services	ITU-T/SG20
Y.4107: Requirements for water quality assessment services using ubiquitous sensor networks (USNs)	ITU-T/SG20
Y.4108: NGN service requirements and capabilities for network aspects of applications and services using tag-based identification	ITU-T/SG20
Y.4109: Requirements for the support of machine-oriented communication applications in the next generation network environment	ITU-T/SG20
Y.4110: Service and capability requirements for e-health monitoring services	ITU-T/SG20
Y.4111: Semantics based requirements and framework of the Internet of things	ITU-T/SG20
Y.4112: Requirements of the plug and play capability of the Internet of things	ITU-T/SG20
Y.4113: Requirements of the network for the Internet of things	ITU-T/SG20
Y.4114: Specific requirements and capabilities of the Internet of things for big data	ITU-T/SG20
Y.4115: Reference architecture for IoT device capability exposure	ITU-T/SG20
Y.4116: Requirements of transportation safety services including use cases and service scenarios	ITU-T/SG20
Y.4117: Requirements and capabilities of the Internet of things for support of wearable devices and related services	ITU-T/SG20
Y.4118: Internet of things requirements and technical capabilities for support of accounting and charging	ITU-T/SG20
Y.4119: Requirements and capability framework for IoT-based automotive emergency response system	ITU-T/SG20
Y.4120: Requirements of Internet of things applications for smart retail stores	ITU-T/SG20
Y.4121: Requirements of an Internet of Things enabled network for support of applications for global processes of the Earth	ITU-T/SG20
Y.4200: Requirements for the interoperability of smart city platforms	ITU-T/SG20
Y.4201: High-level requirements and reference framework of smart city platforms	ITU-T/SG20
Y.4250: Sensor control networks and related applications in a next generation network environment	ITU-T/SG20

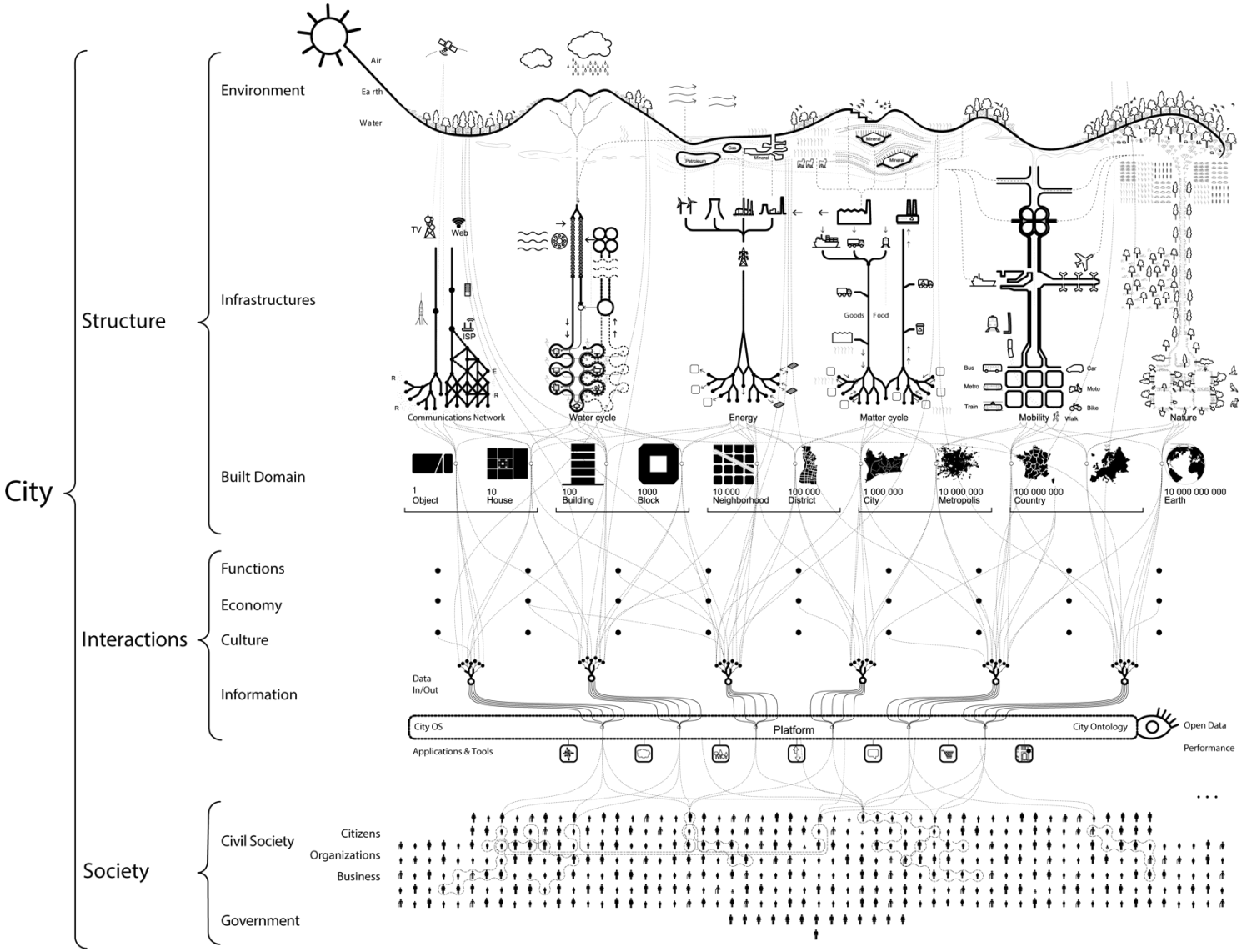
Standard	Responsibility
Y.4251: Capabilities of ubiquitous sensor networks for supporting the requirements of smart metering services	ITU-T/SG20
Y.4252: Energy saving using smart objects in home networks	ITU-T/SG20
Y.4400: Framework of the web of things	ITU-T/SG20
Y.4401: Functional framework and capabilities of the Internet of things	ITU-T/SG20
Y.4402: Requirements and functional architecture for the open ubiquitous sensor network service platform	ITU-T/SG20
Y.4403: Functional requirements and architecture of the next generation network for support of ubiquitous sensor network applications and services	ITU-T/SG20
Y.4404: Framework of object-to-object communication for ubiquitous networking in next generation networks	ITU-T/SG20
Y.4405: Architecture of a system for multimedia information access triggered by tag-based identification	ITU-T/SG20
Y.4406: Functional requirements and architecture of the NGN for applications and services using tag-based identification	ITU-T/SG20
Y.4407: Framework of networked vehicle services and applications using NGN	ITU-T/SG20
Y.4408: Capability framework for e-health monitoring services	ITU-T/SG20
Y.4409: Requirements and architecture of the home energy management system and home network services	ITU-T/SG20
Y.4410: Architectural overview of next generation home networks	ITU-T/SG20
Y.4411: Overview of application programming interfaces and protocols for the machine-to-machine service layer	ITU-T/SG20
Y.4412: Requirements and reference architecture for audience-selectable media service framework in the IoT environment	ITU-T/SG20
Y.4413: Requirements and reference architecture of the machine-to-machine service layer	ITU-T/SG20
Y.4414: Web of things service architecture	ITU-T/SG20
Y.4415: Architecture of web of objects based virtual home network	ITU-T/SG20
Y.4416: Architecture of the Internet of things based on next generation network evolution	ITU-T/SG20
Y.4417: Framework of self-organization network in the IoT environments	ITU-T/SG20
Y.4418: Functional architecture of gateway for Internet of things applications	ITU-T/SG20
Y.4450: Overview of Smart Farming based on networks	ITU-T/SG20
Y.4451: Framework of constrained device networking in the IoT environments	ITU-T/SG20
Y.4452: Functional framework of web of objects	ITU-T/SG20
Y.4453: Adaptive software framework for Internet of things devices	ITU-T/SG20
Y.4454: Platforms interoperability for smart cities	ITU-T/SG20
Y.4455: Reference architecture for Internet of things network service capability exposure	ITU-T/SG20
Y.4456: Requirements and functional architecture for smart parking lots in smart cities	ITU-T/SG20
Y.4457: Architectural framework for transportation safety services	ITU-T/SG20
Y.4500.1: oneM2M – Functional architecture	ITU-T/SG20

Standard	Responsibility
Y.4500.2: oneM2M – Requirements	ITU-T/SG20
Y.4500.4: oneM2M – Service layer core protocol specification	ITU-T/SG20
Y.4500.5: oneM2M management enablement (OMA)	ITU-T/SG20
Y.4500.6: oneM2M management enablement (BBF)	ITU-T/SG20
Y.4500.8: oneM2M – CoAP protocol binding	ITU-T/SG20
Y.4500.9: oneM2M – HTTP protocol binding	ITU-T/SG20
Y.4500.10: oneM2M – MQTT protocol binding	ITU-T/SG20
Y.4500.11: oneM2M – Common terminology	ITU-T/SG20
Y.4500.12: oneM2M base ontology	ITU-T/SG20
Y.4500.13: oneM2M – Interoperability testing	ITU-T/SG20
Y.4500.14: oneM2M – LwM2M interworking	ITU-T/SG20
Y.4500.15: oneM2M – Testing framework	ITU-T/SG20
Y.4500.20: oneM2M – WebSocket protocol binding	ITU-T/SG20
Y.4500.22: oneM2M – Field device configuration	ITU-T/SG20
Y.4500.23: oneM2M – Home appliances information model and mapping	ITU-T/SG20
Y.4500.32: oneM2M- MAF and MEF Interface Specification	ITU-T/SG20
Y.4551: Service description and requirements for multimedia information access triggered by tag-based identification	ITU-T/SG20
Y.4552: Application support models of the Internet of things	ITU-T/SG20
Y.4553: Requirements of smartphone as sink node for IoT applications and services	ITU-T/SG20
Y.4700: Deployment guidelines for ubiquitous sensor network applications and services for mitigating climate change	ITU-T/SG20
Y.4701: SNMP-based sensor network management framework	ITU-T/SG20
Y.4702: Common requirements and capabilities of device management in the Internet of things	ITU-T/SG20
Y.4800: Requirements and functional architecture of an automatic location identification system for ubiquitous sensor network applications and services	ITU-T/SG20
Y.4801: Requirements and common characteristics of the IoT identifier for the IoT service	ITU-T/SG20
Y.4802: Multimedia information access triggered by tag-based identification - Registration procedures for identifiers	ITU-T/SG20
Y.4803: Information technology – Automatic identification and data capture technique - Identifier resolution protocol for multimedia information access triggered by tag-based identification	ITU-T/SG20
Y.4804: Multimedia information access triggered by tag-based identification - Identification scheme	ITU-T/SG20
Y.4805: Identifier service requirements for the interoperability of smart city applications	ITU-T/SG20
Y.4806: Security capabilities supporting safety of the Internet of things	ITU-T/SG20
Y.4900: Overview of key performance indicators in smart sustainable cities	ITU-T/SG20
Y.4901: Key performance indicators related to the use of information and communication technology in smart sustainable cities	ITU-T/SG20

Standard	Responsibility
Y.4902: Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities	ITU-T/SG20
Y.4903: Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals	ITU-T/SG20

APPENDIX 3

Figure A3.1. High quality render of the City Anatomy. Consistent with the version released for public comment in mid-November (CPS 2014).



APPENDIX 4

Table A4.1. List of ISO 37120:2014 performance indicators (adapted from ISO 2014).

Indicator	Theme	Type
City's unemployment rate	economy	core
Assessed value of commercial and industrial properties as a percentage of total assessed value of all properties	economy	core
Percentage of city population living in poverty	economy	core
Percentage of persons in full-time employment	economy	supporting
Youth unemployment rate	economy	supporting
Number of businesses per 100,000 population	economy	supporting
Number of new patents per 100,000 population per year	economy	supporting
Percentage of female school-aged population enrolled in schools	education	core
Percentage of students completing primary education: survival rate	education	core
Percentage of students completing secondary education: survival rate	education	core
Primary education student/teacher ratio	education	core
Percentage of male school-aged population enrolled in schools	education	supporting
Percentage of school-aged population enrolled in schools	education	supporting
Number of higher education degrees per 100,000 population	education	supporting
Total residential electrical energy use per capita (kWh/year)	energy	core
Percentage of city population with authorized electrical service	energy	core
Energy consumption of public buildings per year (kWh/m^2)	energy	core
The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption	energy	core
Total electrical energy use per capita (kWh/year)	energy	supporting
Average number of electrical interruptions per customer per year	energy	supporting
Average length of electrical interruptions (in hours)	energy	supporting
Fine particulate matter (PM2.5) concentration	environment	core
Particulate matter (PM10) concentration	environment	core
Greenhouse gas emissions measured in tonnes per capita	environment	core
NO2 (nitrogen dioxide) concentration	environment	supporting
SO2 (sulphur dioxide) concentration	environment	supporting
O3 (Ozone) concentration	environment	supporting
Noise pollution	environment	supporting
Percentage change in number of native species	environment	supporting
Debt service ratio (debt service expenditure as a percentage of a municipality's ownsource revenue)	finance	core
Capital spending as a percentage of total expenditures	finance	supporting
Own-source revenue as a percentage of total revenues	finance	supporting

Indicator	Theme	Type
Tax collected as a percentage of tax billed	finance	supporting
Number of firefighters per 100,000 population	fire and emergency response	core
Number of fire related deaths per 100,000 population	fire and emergency response	core
Number of natural disaster related deaths per 100,000 population	fire and emergency response	core
Number of volunteer and part-time firefighters per 100,000 population	fire and emergency response	supporting
Response time for emergency response services from initial call	fire and emergency response	supporting
Response time for fire department from initial call	fire and emergency response	supporting
Voter participation in last municipal election (as a percentage of eligible voters)	governance	core
Women as a percentage of total elected to city-level office	governance	core
Percentage of women employed in the city government workforce	governance	supporting
Number of convictions for corruption and/or bribery by city officials per 100,000 population	governance	supporting
Citizens' representation: number of local officials elected to office per 100,000 population	governance	supporting
Number of registered voters as a percentage of the voting age population	governance	supporting
Average life expectancy	health	core
Number of in-patient hospital beds per 100,000 population	health	core
Number of physicians per 100,000 population	health	core
Under age five mortality per 1 000 live births	health	core
Number of nursing and midwifery personnel per 100,000 population	health	supporting
Number of mental health practitioners per 100,000 population	health	supporting
Suicide rate per 100,000 population	health	supporting
Square meters of public indoor recreation space per capita	recreation	supporting
Square meters of public outdoor recreation space per capita	recreation	supporting
Number of police officers per 100,000 population	safety	core
Number of homicides per 100,000 population	safety	core
Crimes against property per 100,000	safety	supporting
Response time for police department from initial call	safety	supporting
Violent crime rate per 100,000 population	safety	supporting
Percentage of city population living in slums	shelter	core
Number of homeless per 100,000 population	shelter	supporting
Percentage of households that exist without registered legal titles	shelter	supporting
Percentage of city population with regular solid waste collection (residential)	solid waste	core

Indicator	Theme	Type
Total collected municipal solid waste per capita	solid waste	core
Percentage of the city's solid waste that is recycled	solid waste	core
Percentage of the city's solid waste that is disposed of in a sanitary landfill	solid waste	supporting
Percentage of the city's solid waste that is disposed of in an incinerator	solid waste	supporting
Percentage of the city's solid waste that is burned openly	solid waste	supporting
Percentage of the city's solid waste that is disposed of in an open dump	solid waste	supporting
Percentage of the city's solid waste that is disposed of by other means	solid waste	supporting
Hazardous Waste Generation per capita (tonnes)	solid waste	supporting
Percentage of the city's hazardous waste that is recycled	solid waste	supporting
Number of internet connections per 100,000 population	telecommunication and innovation	core
Number of cell phone connections per 100,000 population	telecommunication and innovation	core
Number of landline phone connections per 100,000 population	telecommunication and innovation	supporting
Kilometres of high capacity public transport system per 100,000 population	transportation	core
Kilometres of light passenger public transport system per 100,000 population	transportation	core
Annual number of public transport trips per capita	transportation	core
Number of personal automobiles per capita	transportation	core
Percentage of commuters using a travel mode to work other than a personal vehicle	transportation	supporting
Number of two-wheel motorized vehicles per capita	transportation	supporting
Kilometres of bicycle paths and lanes per 100,000 population	transportation	supporting
Transportation fatalities per 100,000 population	transportation	supporting
Commercial air connectivity (number of non-stop commercial air destinations)	transportation	supporting
Green area (hectares) per 100,000 population	urban planning	core
Annual number of trees planted per 100,000 population	urban planning	supporting
Areal size of informal settlements as a percentage of city area	urban planning	supporting
Jobs/housing ratio	urban planning	supporting
Percentage of city population served by wastewater collection	wastewater	core
Percentage of the city's wastewater that has received no treatment	wastewater	core
Percentage of the city's wastewater receiving primary treatment	wastewater	core
Percentage of the city's wastewater receiving secondary treatment	wastewater	core
Percentage of the city's wastewater receiving tertiary treatment	wastewater	core
Percentage of city population with potable water supply service	water and sanitation	core

Indicator	Theme	Type
Percentage of city population with sustainable access to an improved water source	water and sanitation	core
Percentage of population with access to improved sanitation	water and sanitation	core
Total domestic water consumption per capita (litres/day)	water and sanitation	core
Total water consumption per capita (litres/day)	water and sanitation	supporting
Average annual hours of water service interruption per household	water and sanitation	supporting
Percentage of water loss (unaccounted for water)	water and sanitation	supporting

Table A4.2. List of ISO 37120:2014 profile indicators (adapted from ISO 2014).

Indicator	Theme
Total city population	people
Population density (per square kilometre)	people
Percentage of country's population	people
Percentage of population that are children (0-14)	people
Percentage of population that are youth (15-24)	people
Percentage of population that are adult (25-64)	people
Percentage of population that are senior citizens (65+)	people
Male to female ratio (number of males per 100 females)	people
Annual population change	people
Population dependency ratio	people
Percentage of population that are foreign born	people
Percentage of population that are new immigrants	people
Percentage of residents who are not citizens	people
Total number of households	housing
Total number of occupied dwelling units (owned & rented)	housing
Persons per unit	housing
Dwelling density (per square kilometre)	housing
Average household income (USD)	economy
Annual inflation rate based on average of last 5 years	economy
Cost of living	economy
Income distribution (Gini Coefficient)	economy
Country's GDP (USD)	economy
Country's GDP per capita (USD)	economy
City Product per capita (USD)	economy
City Product as a percentage of Country's GDP	economy
Employment percentage change based on the last 5 years	economy
Type of government (e.g. local, regional, county)	government
Gross operating budget (USD)	government
Gross operating budget per capita (USD)	government
Gross capital budget (USD)	government
Gross capital budget per capita (USD)	government
Region	geography and climate
Climate type	geography and climate
Land area (Square kilometres)	geography and climate
Percentage of non-residential area (square kilometres)	geography and climate
Number of native species	geography and climate
Annual average temperature (Celsius)	geography and climate
Average annual rain (mm)	geography and climate
Average annual snowfall (cm)	geography and climate