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Smart Cities and Knowledge Commons

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INTRODUCTION AND OVERVIEW

Why wonder about "smart" technologies and systems? The rhetoric of intelligence is seductive. With the rise of the Internet over the last twenty-five years, massive networked information systems are injecting ever more "intelligence" into the devices that surround us and even, it seems, into every aspect of our lives. If the evidence from broad acceptance of "smart" televisions and "smart" phones is to be credited, on a broad scale people like their "smart" lives. Adding "intelligence" via the Internet of Things, big data, sensors, algorithms, artificial intelligence, automation, and related technologies seems to minimize burdens, maximize productivity, and make us perfectly happy as both citizens and consumers. Smart technology promises to help us and, in the hands of public authorities, to help the government. It seems to anticipate our needs and desires; it seems to make government flexible, responsible, and error-free.

To invert a line from a classic rock song, sometimes you get what you want but can't always get what you need. What's convenient or productive for one person may be harmful for society as a whole. "Smart" technology raises important questions and potential conflicts about individual and collective good that may make us rethink whether "smart" things are so good for the individual, after all. The smart city, the subject of this book, puts those conflicts in stark relief. City life, and the study of city life, is all about the place of individual welfare in a complex social setting.

We'll remove the quotation marks from "smart" from here on, recognizing that the word is a metaphor and that it conceals as much as it reveals. What it conceals is the fact that devices and social systems are rarely structured to optimize efficiency, productivity, or happiness. They aren't smart, even if it's possible to call a device, rather than a living being, smart or dumb. They have functions and meanings; they enable human beings to do certain things and to do them more or less easily or expensively. But optimizing their functions and clarifying their meanings isn't the

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only goal for their designers or for society. Calling something smart conceals the fact that in any given context, including cities (and perhaps especially in cities), we're accustomed to, and expect, significant opportunities to choose and to act however we wish. We can use devices not only as they're intended and designed to be used but also in other ways. And we can behave in ways that we choose and that no one else can see. At least in the United States, Europe, and most liberal democracies, the default operating principle of social governance of people and the resources they share is to leave things largely open, underdetermined, and unmonitored. That enables individuals and groups to develop their own visions for their futures and to engage in self-determination with different outcomes, depending on the context and changing conditions. Calling something smart distracts us from wondering not only about what opportunities to choose and what we might be losing but also about who is making those choices for us, and where, how, and why.

This volume argues for getting past the rhetoric of smart technology and intelligence and for pursuing a different approach. Using the smart city as its focus, it offers a simple thesis: the knowledge, information, and data that constitute smart cities require governance, especially governance of data-focused intelligence and intelligence-enabled control.

Smart city technology has its value and its place; it isn't automatically or universally harmful. Urban challenges and opportunities addressed via smart technology demand systematic study, examining general patterns and local variations as smart city practices unfold around the world. Smart cities are complex blends of community governance institutions, social dilemmas that cities face, and dynamic relationships among information and data, technology, and human lives. Some of those blends are more typical and common. Some are more nuanced in specific contexts. This volume uses the Governing Knowledge Commons (GKC) framework to sort out relevant and important distinctions. The framework grounds a series of case studies examining smart technology deployment and use in different cities. This chapter briefly explains what that framework is, why and how it is a critical and useful tool for studying smart city practices, and what the key elements of the framework are. The GKC framework is useful here and can also be used in additional smart city case studies in the future.

Because the GKC framework for studying resource governance relies on the premise that information, knowledge, and data are key shared resources in a given institutional setting, it's important to set up the usefulness of the GKC framework for smart cities by briefly reviewing relevant perspectives on cities and urbanism generally. That material takes up the next section. The smart city is new because of its reliance on twenty-first-century sociotechnical arrangements and cutting-edge information technology to bring attention to the long-standing informational aspects of the city. A brief summary of the critical changes wrought by the smart city follows the history of research on the city. The chapter concludes by presenting the GKC framework itself, the foundation for the case studies that follow.

FRAMING THE CITY

Studying the "smart" city has to start with understanding the city itself. Research on smart cities characteristically focuses on nuances of the sociotechnical "smart" (Goldsmith and Crawford 2014) and pays less attention to the details of the material "city." But research and writing about smart cities necessarily build on generations of practice and critique with respect to cities generally. Several frames emerge from that literature and inform both smart city research generally and the case studies that appear in this book.

Cities from the Bottom Up and the Top Down

One frame is how the city adopts, extends, and refracts bottom-up and top-down governance perspectives. Cities are people in places, evolving over time, managing resources at various scales and in various combinations (Cronon 1992; Rybczynski 1996). Who makes those decisions? Who guides the city? Intuitively, we think of political leaders and the experts they hire. The most celebrated urbanist of the latter part of the twentieth century, Jane Jacobs, pointed out the risks of concentrating too much credit and power for urban success in the hands and offices of political and technocratic elites (Jacobs 1961).

Jacobs' vision of reform, which is still influential today, saw the city not as a machine engineered from above but instead as a complex adaptive system emerging from below, drawing on the wisdom of people experiencing the city in their daily lives, at ground level. Jacobs acknowledged that people in cities often behave selfishly and stupidly. She accounted for diversity in experience and attitude by envisioning the city as a system that is capable of generating and regenerating itself. People in cities could organize themselves via a kind of collective social intelligence, if urban planners and municipal governments would, in effect, allow the city to be as smart as it might be. Jacobs stood up for this vision in opposition to the top-down centralized control exercised by her urban planning adversaries, including most notoriously New York's Robert Moses, who aimed to govern the city in the name of rationality, efficiency, and order.

Top-down and bottom-up perspectives are rarely either/or. People in cities often fail to realize their collective capabilities. Cities become vehicles for oppression and worse; they fail to provide education, health, wealth, and security as they should. Bottom-up governance strategies need to be married productively and fairly to top-down central, perhaps even technocratic management. Does the smart city do that? If so, how, and with what consequences?

Cities as Surveillance

Smart cities today are often critiqued for injecting technologies of citizen surveillance into all manner of practice and places that should remain free of state

intrusion (Sadowski and Pasquale 2015). Asking where and how contemporary information collection is justified lines up with broader, independent histories and critiques of cities as instruments of surveillance and information collection. James Scott provocatively argues that the history of cities can be traced back to the premise that surveilling city residents and collecting information about them, especially for tax purposes, explains the origins of cities in the first place (Scott 2017). That work suggests that certain state-based surveillance functions might be essentially integral to the urban form, rather than contradictory to the aspects of cities that we imagine promote individual freedom and autonomy. It raises a key question: Can cities sustain themselves as institutions without relying in part on technologies of information collection?

The smart city takes this tradition and that question to a technological extreme. If the surveillant city may be, in effect, inescapable, then looking at smart cities as sophisticated surveillance institutions provokes questions about the premises and purposes of different surveillance systems and various urban contexts; about concepts of privacy and private information; about the design and oversight of surveillance instruments; and about relations of trust and authority among urban residents and urban planners and other authorities. Perhaps cities can thrive without deep reliance on surveillance practices. If that's the case, what does a non-surveillant city look like? How does it succeed, and how might it fail?

Cities as Expertise

Since at least the late nineteenth century and the rise of industrial cities, the history of urbanism and urban planning has been a history of expertise – political, administrative, and technocratic. Cities came to be seen as solutions to demands for wealth, health, safety, opportunity, and personal development, as society grew more economically, socially, and politically complex. Cities also came to be seen as posing new problems, often caused by their successes in meeting earlier social demands. Both fueled by and fueling that problem/solution framework, the Progressive political movement of the early twentieth century relied heavily on trained and trusted experts, especially economists and other social scientists (Leonard 2015). Those experts were often educated in newly formed occupational disciplines and professional schools. Degrees in hand, they were primed to lead both governments and businesses away from the era of laissez-faire and toward better outcomes for themselves and for workers and citizens. That meant safer food; safer water; better working conditions; safer and less expensive automobiles; expanded opportunities for education, leisure, and personal fulfillment; and so on.

In significant respects, the smart city today is the apotheosis of this tradition of expert-led governance, promoting the good life. Its proponents inherit expectations that experts trained in design are and ought to be trusted by citizens as the city is planned and built (Knox 2020). Critics of the smart city sometimes focus attention

precisely on ways in which smart city practice reinforces the authority of technocratic expertise (Cardullo and Kitchin 2019). Unsurprisingly, today as in the past, the role of trusted and trained experts calls into question the sources and uses of the trust and power that they have acquired.

The Political Economy of Cities

Cities are far from immune to influence by interests associated with wealth and power. In many respects, cities are particularly effective expressions of those forces of political economy: Who is in charge, why, and how that changes through time. In the United States, for example, industrial and financial interests underwrote the expansion and governance of major cities and related regions during the twentieth century from New York to Chicago to San Francisco to Los Angeles (Cronon 1992; O'Mara 2019). In the twenty-first century, those firms have yielded in part to heavy influence by the pillars of the knowledge sector, which include not only the information technology firms that now dominate the economies of many US cities but also the research universities that rival or even exceed tech firms in their economic and political influence (Baldwin 2017). The relationship between the public sector and industry can go both ways. Public funding and related public policy have been key contributors to the growth of the contemporary technology industry (O'Mara 2020). In many respects, smart city governance allows public authorities to follow historical patterns of private sector subsidization with outright privatization of public functions, in everything from data storage to traffic management to certain public safety and policing functions. Cities are wealth and power generators, refractors, and accelerators.

Translated into practice on the ground, the political economy of cities deals in resource management. "Resources" include both tangible resources (food, water, physical infrastructures), intangibles (space, mobility, time, labor, trust, security, political influence, happiness), and blends of these that both constitute and shape resources of all sorts and that are simultaneously independent of them, such as knowledge and information (Glaeser 2012) and, of course, money. In different respects, sustaining and governing the city means that those things have to be produced, stored, distributed, and exchanged. The explicit and implicit governance logics of cities are inevitably tied to stories about economic development (Bairoch 1988).

The smart city appears to be a technology-driven opportunity to extend that economic development narrative. Installing smart systems offers opportunities not only for efficient public administration but also for showcasing a city's productive engagement with the forces of private productivity, profit, and employment. The question is whether that equation adds up. Does the smart city promise economic returns above and beyond the benefits of good governance? If so, at what cost?

Cities as Contexts for Freedom and Self-Fulfillment

Individual and collective humanity, of course, lies at the center of both scholarship and practice concerning cities. Long before modern technology prompted us to ask, "what makes cities intelligent?" (Komninos 2013), historians and philosophers of the city were critiquing ways in which the city created and limited opportunities for people to learn, grow, socialize, and otherwise thrive beyond interests in mere subsistence. The literature is as diverse as it is modern (Glaeser 2012) and, in scholars' attention to ancient forms (Mumford 1961), long-standing. At their best, cities are places where individuals can design their own destinies, both as individuals and in social, political, cultural, and economic combinations with others.

When it comes to the individual city resident, smart city practice has no single trajectory, and no single or simple impact. Smart cities appear to do many things at once. Smart city practice may enable a kind of uber-autonomy for the individual, relieving people of the frictions that characterize almost all aspects of urban life. Or smart city technology may deprive people of opportunities to individuate themselves by acts of choosing and socializing (or not) according to their own values and goals. The contrast in perspectives extends to the political sphere, where smart city technology either enables micro-level oversight and accountability of technocratic administration or obscures the loci of power to an extreme extent. Smart city technology equips individuals with sophisticated tools for managing their civic identities. It also equips the public sector with extraordinary powers of observation, surveillance, and more. It extends to social and cultural spheres. Smart city technology may amplify opportunities to explore new avenues for education and socializing with ease but also impose "choice architectures" that compress or even eliminate opportunities for humans to develop and express themselves via patterns that they develop, rather than via patterns scripted by the affordances of "smart" technology (Frischmann and Selinger 2018).

That summary sketches a series of conceptual extremes. On the ground, the smart city is complex. Smart cities challenge us to ask, "how much 'play' should cities give us, and why and how?"

FINDING THE "SMART" IN THE SMART CITY

The preceding section made the point that smart cities prompt us to reexamine long-standing questions about cities. This section focuses on what's new and different in the smart city.

Collecting, recording, and sharing information about urban practices and activities aren't new. One of the most famous uses of bureaucratized information was the system of tally sticks used for centuries by the English Exchequer to track financial obligations, a system whose end led, eventually, to the reckless disposal of unused

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tallies in a fire that consumed the houses of Parliament in 1834 (Goetzmann and Rouwenhorst 2005, 111). Information and knowledge are sometimes underappreciated as key layers of the city, in addition to physical, social, cultural, economic, and political layers. Among contemporary scholars, Richard Florida and Edward Glaeser in particular have drawn attention to what each argues is the new, key role of creativity and innovation, and information and knowledge, in the future of the city (Florida 2014; Glaeser 2012). But information and knowledge layers have been there all along.

Two things seem to be different now, in the rise of the smart city. One is the role of technology itself. The smart city is one institutional manifestation of the emergence of so-called Big Data, featuring massive and massively distributed information systems for collecting, storing, and analyzing data. Residents are connected to each other and to governments and other organizations by fiber and wireless connections. Via sensors and other data-collection techniques, "the people" and their environments are rendered and represented digitally in the bureaucracies of public administration and in the dynamics of everyday life.

The smart city is operationalized in multiple forms at the intersection of contemporary information technologies – network-based data acquisition via text and numeric datasets and distributed screens and sensors that detect and project images, sounds, smells, and materiality (including but not limited to systems that form parts of the so-called Internet of Things), algorithmic processing, and data analytics – public administration strategies (housing, public health, safety, finance, utilities, transit, and so on), and resident involvement as potential data subjects, potential beneficiaries of data-enabled public services, and potential participants in system design and administration.

The smart city is a system of systems. It includes data gathering, data pools, and data analytics and a broader ethos that embraces technology in public life. In a smart city one typically finds a combination of: (i) government-endorsed, organized, or directed technology deployment; (ii) in tandem with other public functions (such as policing or garbage collection); (iii) the construction and use of systems, such as data pools, algorithms, and analytics controlled or shaped by public administrators, that improve the second in light of the first; and (iv) normative considerations justifying the design and deployment of those systems.

The emphasis on public sector actors can be misleading. By design, smart city practices can be anchored in private sector activity, and they're intended to shape personal and private lives as well as systems of public administration. "Big Data" is often characterized by the "three v's": its velocity, its volume, and its variety (Batty 2016). The speed with which data in the city is collected and shared is enormously faster than in the "ordinary" city. The amount of data that may be collected and shared is vastly greater. And the character of the data that is collected and shared is far more diverse.

The second is the role of governance, and governance specifically with respect to information and knowledge. We mean governance in a broad sense, to include formal and informal systems of rules and guidelines for acceptable and unacceptable behavior in particular contexts, expressed as law, custom, and technological affordances. We highlight the challenge of governance in the smart city specifically because its information governance dimensions are too often undervalued. When governance conversations do appear, they are often limited to concerns for community participation in smart city design (Goodman and Powles 2019; Komninos and Kakderi 2019).

This volume takes the broader view that information governance concerns should be explored in the smart city in multiple respects. The "voice" of city residents is critical but only one part of the story. Focusing too much on "voice" misses the fact that people can't speak to what they don't know or don't understand. The "smart" character of the smart city elides the fact that resident identities and behaviors are necessarily abstracted in smart city processes in the conversion from their material origins to their digital representations. That makes these digital representations controllable, shareable, and analyzable in ways that living humans being often are not. It also makes it easier to keep the collection and manipulation of the data hidden from the people that the data represent.

Another key part is the looseness or tightness of the alignment between law and policy, on the one hand, and lives of people, on the other. Regulation of actual human behavior is messy, imprecise, and contingent always on the fact that individual human beings are mostly capable of independent and at least somewhat unexpected or unpredictable action. Data are, conceptually, precise and fixed, even if data are shaped by processes of their collection, datasets expand, and the uses and meanings are open to interpretation. The smart city is in a sense a sophisticated Wikipedia version of the material city – an "image of the city," to borrow the title of Lynch's famous study of sociocognition among city residents (Lynch 1960) – constructed and managed collaboratively and stored in ICT systems rather than in human brains. Students of the "cognitive city" attempt to operationalize that metaphor (Finger and Portmann 2016). Digital people may live in digital twins (detailed virtual replicas of physical environments), one of the signature technologies of smart city administration (Farsi et al. 2020).

In sum, the "smart" in the smart city means that intelligence lies in and through the data, rather than in and through the people. We know from long experience that people are governed and that people govern. If data somehow represent the people, then data, likewise, demand governance.

Distinguishing the role of information governance from traditional "people" governance – while simultaneously recognizing their linkage – suggests a series of important questions. Does it follow that if the city is smart (or smarter, or better), then it's the people who are smart, as administrators, residents, citizens, workers, students, and so on? In the smart city, are the people smart, so that public

administration can build on their intelligence? Do the people become smart in their thinking or their acting by virtue of administrators using data and algorithms to shape city life? Are the people generally unchanged, and are the administrators getting smart, or smarter?

Research on those questions has often been conceptual and therefore speculative. The smart city is a goal, or a vision, which may follow or may lead to strategies and tactics. The smart city is often characterized in aspirational terms. A city is "smart," it may be said, when it uses contemporary ICTs to make the city better in some respect – more accessible, affordable, efficient, clean, safe, equitable, and so on (Goldsmith and Kleiman 2017). Criticisms of the smart city often recapitulate criticisms of ICT deployments in other contexts. The smart city may be a tool of power, elitism, and exclusion; the smart city is indifferent to local conditions; the "smart" city is disempowering and dehumanizing (Eubanks 2019; Morozov and Bria 2018).

Similarly, the character of governance challenges and opportunities has been obscured by the plethora of phrases used to capture what we mean by "smart" city. Related terminology includes "digital communities" (Mendes, Suomi, and Passos 2004), "data enabled cities" (Open Data Institute 2021), and "algorithmic" cities (Psarra 2018). Neutral-seeming references to "civic technology," also known as "civic tech," sometimes replace references to "smart" technology (O'Brien 2018). Smart cities may be characterized as "connected" communities (Nam and Pardo 2011). Prompted in part by work by the sociologist Saskia Sassen, some recent scholarship uses the heading "urban technology" (Adler and Florida 2021), species of what Sassen (2006) called sociodigital formations. IBM gave the "smart city" phrase an important boost in 2009 – the Smart City, featuring initial capitals –with a report advocating that cities get "smarter" by using new pervasive technologies of instrumentation, interconnection, and intelligence relative to a city's core systems (Dirks and Keeling 2009). The role of computers, computing, and other information technology in urban planning and urban geography can be traced back much farther than that (Sui 1997; Wiig and Wyly 2016).

Why the rhetorical pluralism? Governance is, in a word, complex. As Sassen (2006, 208) notes, in part we are asking about the reasons for these systems to exist, in part we are asking about their utility, and in part we are asking about their cultural meanings.

THE GKC FRAMEWORK

If it's possible to do smart cities "right," then the smart city is, in a way, a novel integration, the best of Jacobs' vision of ground-level community engagement married to what's valuable in a vision of central or technocratic management. The smart city is a technology-supported coordinated solution to communal governance problems based on pooled information resources, spanning information and data

resources along with streets, parks, and cultural opportunities. In a broad sense, cities often rely on and are built on commons governance – that is, managing resource flows via structured sharing – in complex community and other social contexts. In the more concrete and specific sense relevant to this volume, cities incorporate knowledge commons, managing information flows via structured sharing of knowledge resources in community settings (Madison, Frischmann, and Strandburg 2010). Knowledge commons governance in the smart city consists of the structured interplay of a city's people and the information and data generated by their sociability, captured and analyzed in particular smart city systems.

The point of using the knowledge commons framing as a starting point is to give both researchers and practitioners a standard baseline for asking empirical questions about smart city origins and practices. That research should be inclusive of multiple research methods and disciplinary and policy perspectives. This section reviews and describes the GKC research framework, which offers a useful way to build on that baseline in this volume's case-based explorations of smart cities.

Knowledge commons refers to systems or institutions for governance of shared knowledge and information resources by members of a group or community. Knowledge resources are broadly defined, where knowledge includes "a broad set of intellectual and cultural resources. . . . We emphasize that we cast a wide net and that we group information, science, knowledge, creative works, data, and so on together" (Frischmann, Madison, and Strandburg 2014, 2). In this sense, knowledge resources may lie at any point along the data, information, knowledge, and wisdom hierarchy (Henry 1974).

Commons, as used in the literature upon which we build here, refers to community management or governance of resources. "The basic characteristic that distinguishes commons from non-commons is institutionalized sharing of resources among members of a community" (Madison, Frischmann, and Strandburg 2009, 841). Commons governance can take many forms and need not involve the kind of complete openness often associated with discussions of "the commons" or "the public domain" in the legal literature. Nor should "commons" be conflated with the type of resources that are managed. Commons refers to a mode of governance rather than to a particular good or type of good.

Commons governance of natural resources is often explored through Ostrom's Institutional Analysis and Development (IAD) framework. Ostrom's work initially emphasized the appropriateness of commons governance for "common pool resources," meaning "a natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use" (Ostrom 2005, 4). In economic terms, common pool resources are rivalrous and nonexcludable. Commons governance of such resources generally aims to address so-called tragedies of the commons, social dilemmas associated with overuse – congestion, depletion, and destruction.

The number and range of possibly relevant social dilemmas is a question for research in a specific context, rather than a premise to be assumed. Commons governance is used by a wide variety of communities to manage many different types of resources and responds to obstacles to sustainable sharing and cooperation. Some of those obstacles derive from the nature of the resources. Others derive from other factors, such as the nature of the community or external influences. Data and information collection and analysis in the smart city offers ample opportunities to explore how commons governance might be used in particular institutional contexts to respond to dilemmas associated with smart city practices. Knowledge commons governance is no panacea for those dilemmas. In practice it is important to recognize that commons governance may itself create further obstacles to sustainable cooperation.

Applied to a specific case study, the GKC framework organizes answers to critical questions that emerge from both the history of cities and the study of knowledge systems: who is governing and who is governed; how; using what tools, techniques, and knowledge; and to what ends? How did the city develop? What are the strengths and weaknesses of the city as a social institution, and how might the benefits of the city be refined and amplified and its costs mitigated? Focusing on smart cities as knowledge commons leads to asking how "smart" urbanism contributes to our understanding of why and how cities thrive and decline. Studying the smart city offers the ability to turn urban geography and economics on its side, if not on its head. The GKC framework drives a deeply contextual approach to urbanism that wonders: what's happening within the critical data and information layers of the city?

The GKC framework supports a systematic investigation of the benefits and drawbacks of sociotechnical solutions to underlying social problems, or dilemmas, without committing the researcher to specific methods, research questions, or disciplinary premises. The framework operates at multiple scales, from the micro to the macro. The GKC framework offers a way to integrate data about background conditions; historical contingencies; resource attributes; community characteristics; cultural and technological affordances; formal and informal rules and norms; money, power, and politics; individual and collective beliefs and behaviors; and diverse levels of access, opportunity, literacy, and expertise. Community characteristics in the city are particularly significant and draw attention to ways in which communities include members, exclude others, and enable or disable effective participation in community governance. Research using the GKC framework complements existing "city as commons" research that builds on Ostrom but that focuses principally on community governance of the city's material resources, especially housing and the environment (Foster and Iaione 2015).

Those themes are organized via the GKC framework into a series of questions for empirical investigation. Relationships among those themes are represented visually in Figure 1.1, which is adapted for knowledge resources from Ostrom's IAD framework.

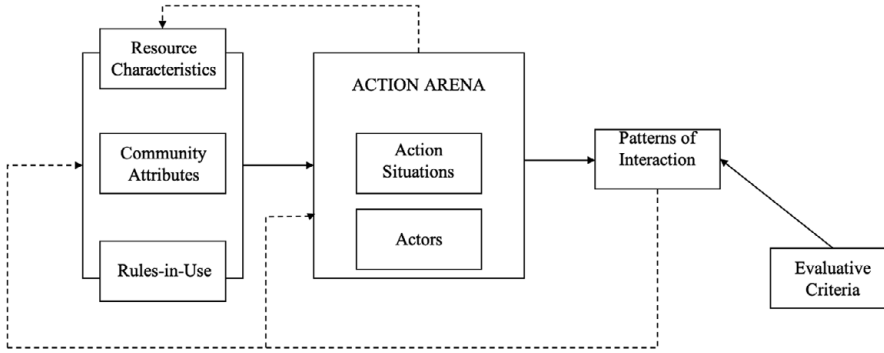

FIGURE 1.1. The GKC framework
Source: Madison, Frischmann, and Strandburg (2010)

Using the IAD framework, Ostrom and colleagues explored patterns of community interactions (McGinnis 2011). Action arenas serve as the core units of IAD and GKC analysis. An action arena is a recurring type of situation in which community actors interact with one another. Interactions in an action arena produce outcomes, denoted here as patterns of interactions, which can then be evaluated according to some community or socially generated criteria. The figure depicts how effects flow among conceptual building blocks. Resource characteristics, community attributes (including members and roles), and sets of governing "rules-in-use" are inputs to an action arena. Patterns of interactions accumulate, feeding back to create new action situations and influencing resource characteristics, community attributes, and rules-in-use. Knowledge resources are often produced and defined by the community. The knowledge outputs of some knowledge commons action arenas must themselves be managed by the community and may be inputs to further knowledge production. This feedback, between a community's activity and its available knowledge resources, justifies community-level analysis, emphasizing questions related to group interactions and outcomes, rather than user-level analysis, emphasizing questions about individual experiences.

The action arena concept is flexible and can be applied at a variety of levels of generality, depending on the questions being researched and the resources of interest. Governance activities themselves, determining rules to govern knowledge creation or flow or community membership qualifications, may constitute an action arena. Analyzing an action arena is meaningful only if one can identify resource characteristics, community attributes, and rules-in-use that are "exogenous" or fixed over a number of action situations within that context and if one can describe meaningful "patterns" in the outcomes of the interactions. If an action arena is defined too broadly, then identifying those elements will not be possible; if an action arena is defined too narrowly, then identifying meaningful patterns among them is not possible.

The IAD and GKC frameworks include a step in which "evaluative criteria" are applied but do not explicitly provide a yardstick for normative assessment. In the classic studies of natural resource commons, the normative goal is often implicitly assumed to be sustainable use of the resource by the community. Applications of the GKC framework to innovation and knowledge production have generally focused on whether the community is successful in terms of its internally defined goals and objectives, while recognizing that the goals of a knowledge commons community could, in principle, be out of step with, or adverse to, the values and objectives of society at large.

For purposes of applying the GKC framework, the high-level GKC framework shown in Figure 1.1 can be unpacked into a more detailed set of research questions shown in Table 1.1.

The GKC framework has focused primarily on community goals and objectives rather than on values from higher-level social contexts or foundational ethical and moral principles. Focusing on governance thus raises key questions: Who should be in charge of deciding what those goals and objectives are, and whether they have been achieved? In the smart city context, how is knowledge commons governance contested or reinforced? It's possible to frame the issue in terms of the contextual "appropriateness" of information flows in the smart city, borrowing from the work of privacy scholars (Sanfilippo, Frischmann, and Strandburg 2018). How is appropriateness evaluated?

One strategy for answering those questions focuses on procedural or sociological legitimacy (Habermas 1996), and the GKC framework as outlined earlier suggests directions for exploring that theme in a specific context. Legitimacy raises governance issues that may be addressed through commons institutions. That analysis would consider the development and application of internal and exogenous rules-in-use relative to both members of the community and outsiders impacted by the activities of the community.

As outlined here, however, procedural legitimacy is not the only criterion that might be applied to commons governance. The framework is open-ended with respect to developing possible alternatives. The GKC framework does not adopt a specific normative stance about the ends of information flow governance or how they should be prioritized. It begins by uncovering and understanding the contextualized goals and objectives reflected in the governance of information flows in each case, the ways in which they reflect the interests of various community members, and how they are addressed in rules-in-use for information flow in light of the larger social environment.

KEY GKC THEMES

Both the visual representation of the GKC framework in Figure 1.1 and the tabular list of research questions in Table 1.1 are simultaneously broad and detailed, so using

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TABLE 1.1. *The GKC framework*

Knowledge commons framework and representative research questions
Background environment
What is the background context (legal, cultural, etc.) of this particular commons?
What normative values are relevant for this community?
What is the "default" status of the resources involved in the commons (patented, copyrighted, open, or other)?
How does this community fit into a larger context? What relevant domains overlap in this context? What social dilemmas does the community face relative to the resources involved?
Attributes
What resources are pooled and how are they created or obtained?
What are the characteristics of the resources? Are they rival or nonrival, tangible or intangible?
Is there shared infrastructure?
What is personal information relative to resources in this action arena?
What technologies and skills are needed to create, obtain, maintain, and use the resources?
What are considered to be appropriate resource flows? How is appropriateness of resource use structured or protected?
Who are the community members and what are their roles?
What are the degree and nature of openness with respect to each type of community member and the general public?
Which noncommunity members are impacted?
What are the goals and objectives of the commons and its members, including obstacles or dilemmas to overcome?
Who determines goals and objectives?
What values are reflected in goals and objectives?
What are the history and narrative of the commons?
What is the value of knowledge production in this context?
Governance
What are the relevant action arenas and how do they relate to the goals and objectives of the commons and the relationships among various types of participants and with the general public?
Are action arenas perceived to be legitimate?
What legal structures (e.g., intellectual property, subsidies, contract, licensing, tax, and antitrust) apply?
What are the governance mechanisms (e.g., membership rules, resource contribution or extraction standards and requirements, conflict resolution mechanisms, and sanctions for rule violation)?

(*continued*)

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TABLE 1.1. (*continued*)

What are the institutions and technological infrastructures that structure and govern decision-making?
What informal norms govern the commons?
What institutions are perceived to be legitimate or illegitimate? How are institutional illegitimacies addressed?
Who are the decision-makers and how are they selected? Are decision-makers perceived to be legitimate?
How do nonmembers interact with the commons? What institutions govern those interactions?
Are there impacted groups that have no say in governance?
Patterns and outcomes
What benefits are delivered to members and to others (e.g., innovations and creative output, production, sharing, and dissemination to a broader audience, and social interactions that emerge from the commons)?
What costs and risks are associated with the commons, including any negative externalities?
Are outcomes perceived to be legitimate by members? By decision-makers? By impacted outsiders?

Source: Adapted from Sanfilippo, Frischmann, and Strandburg (2018)

them in the context of a specific case study risks obscuring key themes that the framework aims to address. Earlier knowledge commons research has taken preliminary steps to identify those themes by synthesizing the implications of knowledge case studies completed to date (Sanfilippo, Strandburg, and Frischmann 2021). They're listed just below for clarity. Researchers and practitioners applying the framework and analyzing cases, while bearing these questions in mind, can and should tailor their applications to their own specific interests and goals.

1. Knowledge commons governance is often a recursive phenomenon, by which information and data production dynamically constitute and reconstitute the community (or communities) producing that information and data. Exploring the character of relevant communities, including their origins, internal dynamics, and reliance on formal and informal sources of authority and integration, is a complex but critical undertaking. Knowledge commons systems, like the commons governance systems studied by Ostrom and others, may be nested hierarchically, with smaller or more limited commons systems inhabiting larger commons ecologies, and may be arranged polycentrically. Research should be attentive to the potential for effective knowledge commons

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governance in group settings that are not defined as stereotypical small-scale, homogenous communities. Knowledge commons governance brings to the fore possible sociotechnical attributes of community design and governance.

2. Knowledge commons governance relies on community governance strategies to respond to social dilemmas involving knowledge resources. Identifying and describing relevant social dilemmas, and understanding the possible contributions of multiple social dilemmas, is often the first step in applying the GKC framework.
3. Knowledge, information, and data are central resources in studying knowledge commons governance, but they are not the only relevant resources, and they are not the only resources that might be subject to relevant social dilemmas. Research should focus on patterns by which knowledge commons governance and other systems (such as law) contribute to resource construction and to the production and collection of multiple types of resources.
4. The pragmatics of community formation and participation bear heavily on eventual normative assessment of knowledge commons governance in a particular setting. Relevant variables include the degree of self-awareness and participation in resource governance by community members; the constitution of trust relationships among community members; the timing and character of the adoption of a knowledge commons governance model by the community; and possibilities for exit from the system by individuals and groups. Those considerations all exist on spectra, and knowledge commons governance may emerge and evolve over time.

CONCLUSION

As in earlier volumes collecting case studies of knowledge commons governance (Frischmann, Madison, and Strandburg 2014; Sanfilippo, Frischmann, and Strandburg 2021; Strandburg, Frischmann, and Madison 2017), we emphasize that research using the GKC framework is still emerging and evolving but that the breadth of its possible utility is just coming into view. Knowledge sharing and knowledge pooling has roots in practices dating back centuries, but it is a fundamental feature of twenty-first-century economy and society. Knowledge sharing requires governance, a fact that also has roots in history but that is especially essential today. We refer to governance of knowledge sharing as knowledge commons. Understanding knowledge commons requires sustained and systematic empirical research. The GKC framework is designed as a foundation for that research that spans specific research traditions and fields.

The smart city, with its lofty rhetorical ambitions, political and operational complexity, and sometimes hidden costs, is a natural fit for GKC research.

Designers of smart city systems aim to capture the long-standing informational characteristics of the city as data to serve a variety of ends, from transportation management to land use to public health to policing and public safety. The marriage of the city's traditional materiality and datafication enabled by modern computing appears to be a match made in heaven. The smart city appears to be the better city. Is it? Everything depends on how the information is used: how data collection and analysis systems are designed and deployed, by whom, and for what purposes. Those are the topics that the GKC framework aims to explore, with nuance tailored to whether the case study targets one smart city system in particular or the concept of the smart city as a whole, in a particular place.

This chapter has laid out the case for applying the GKC framework in three brief steps. First, it reviewed traditional and historical perspectives on urbanism and the city as important and critical contexts for understanding the turn to the smart city. Second, it described that turn itself, highlighting the features of the smart city that should cause both researchers and practitioners to pause and reflect on the pragmatics and wisdom of deploying smart city technology rather than continuing with other governance modes. Knowledge sharing and knowledge pooling are critical elements in the turn to the smart city. Third, it outlined the GKC framework itself. Each of the case studies in this volume rely in some respect on material summarized in that three-part sequence.

Finally, in part because this work is primarily descriptive, like its predecessors, we note again that this approach requires its own knowledge commons to succeed. That is, it requires an expanded research community that uses and extends the framework and shares research results across cases and sectors. The structure of the GKC framework facilitates comparison across cases. We are optimistic that with greater investment in cases and greater analysis of cross-case comparisons, generalizable lessons and implications will emerge. The "Key Themes" section earlier highlights one early version of those patterns. The smart city theme here is useful in this additional respect, by bringing out details of knowledge commons in a setting that differs in many key respects from the focal areas of earlier work, including research and practice in medicine and health, and practices in privacy and security.

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