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Review

Building a Workforce for Smart City Governance: Challenges and Opportunities for the Planning and Administrative Professions

Nina David * and John McNutt

Biden School of Public Policy and Administration, University of Delaware, Newark, DE 19716, USA; mcnuttjg@udel.edu

* Correspondence: npdavid@udel.edu

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Abstract: The growth of smart cities and collateral movements offer new and exciting possibilities for the use of information and communication technologies (ICTs) for service delivery, civic engagement, and governance. The exponential growth of ICTs and their use in governance both formally and informally highlights the need for urban planners and public administrators who are trained on how to use ICTs to achieve the public interest, maximize the positive impacts of ICTs, and minimize the negative impacts of ICTs. This presents a challenge for professional education to provide a supporting infrastructure that trains urban planners and public administrators for smart city governance in the 21st century. This paper reviews those challenges and suggests changes in content and delivery options that can be implemented in urban planning and public affairs programs.

Keywords: smart city; smart city governance; smart city workforce; public administration skills; urban planning skills; smart city skills; smart city curriculum

1. Introduction

The growth of smart cities (and the associated smart city movement) is an exciting event in human history. The combination of technology, new forms of human communities, and data have created new possibilities for how we interact, how we plan, how we deliver infrastructure and services, how we develop knowledge, and how we govern. There are, however, a series of details that must be negotiated from a smart city governance standpoint. Technology must be designed, developed, deployed, and equally accessed. Data must be collected, evaluated, and incorporated in decision making. Plans must be written and implemented. In order for all of this to occur, we will require a group of people who have the skills that are needed to create this exciting future. While engineers and scientists will create the technology, there are skills that go beyond what these disciplines can accomplish. We wonder if this group of professionals really exists and, if not, what we need to do to train them. Consequently, we ask what kinds of skills might be needed for smart city governance. We provide a review of the relevant literature and discuss the steps that need to be taken for skills development.

The article has four parts. The first section examines current work on smart cities and collateral movements. This is followed by a consideration of the skillsets needed to plan and implement these strategies. Next, we consider gaps in current training regimes. Finally, we outline a series of strategies for addressing these gaps.

2. The Smart Cities Context

Today, 55 percent of the world's population lives in urban areas [1]. By 2050, over two-thirds of the world's population will live in urban areas [2]. In the United States (US), over 80% of the

population currently lives in urban areas. Between 2000 and 2010, population growth in urban areas in the US outpaced the rest of the country [3]. Further, cities house the majority of people in the US but comprise just 3.5 percent of the land [4]. This growth and spatial concentration of population presents opportunities as well as challenges. For example, depending on how they are planned, urban agglomerations have the potential for efficiencies in the delivery of infrastructure and services but can also result in the exploitation of natural resources, pollution, and greater inequities in terms of the distribution of the benefits and costs of growth and development [5]. The concept of the smart city, then, can be used as a direct response to these challenges [6]—as a collection of "ideas about how information and communication technologies (ICTs) might improve the functioning of cities." [7] and in doing so, advance sustainability. That is, smart cities offer a foundation for how policymakers can better plan for this critical mass of people (e.g., delivering infrastructure and services with greater efficiency); balance environmental, economic, and equity goals, and democratize decision making, while considering the profound impacts of technology on how people live, work, and play [6,8,9].

There is a real concern, however, that smart cities in reality and conceptualizations of smart cities in scholarship, would overemphasize technology at the cost of other important factors that contribute to overall well-being and quality of life [10]. That is, that technology in smart cities would become an end in itself. Consequently, several scholars have operationalized smart cities to be more encompassing. For example, Coe et al. [11] argue that smart cities develop citizens who are able to learn and adapt. Kitchin [12] emphasizes the innovation, creativity, and entrepreneurship aspects of smart cities. Deakin [13] defines smart cities as those than place a premium on the environment and equity; Al Waer and Deakin [14], as those that promote sustainability in addition to other values; and (Chourabi et al. [6]), as those that coordinate their physical, economic, social, and technological infrastructures. Finally, Caragliu et al. [15] classify cities as smart when "investments in human and social capital and traditional and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance." That is, smart cities are those that use technology as the means to solve public problems, in the public interest, and for the public good.

Several trends have contributed to the demand for smart and smarter cities. Politically, as participants in democracy, citizens are demanding more opportunities to participate and communicate with government [16]. As consumers of governmental services, citizens are also demanding greater responsiveness and transparency from government [17]. Technologically, advancements have allowed us to collect big data, employ smart technology for personal use, use technology to achieve greater efficiencies in the built environment, and deploy sensors in buildings, transportation, and other infrastructure systems [8,18,19]. Finally, socially, we have come to rely on the benefits of technology for greater flexibility at work (e.g., telecommuting, flexwork) and interconnectedness in personal life.

2.1. Collateral Movements

Historically, technology has been inextricably linked to the evolution of cities restructuring economic activity, trade, transportation systems, infrastructure systems, buildings, agricultural production, communication, and urban form [20]. The city, therefore, is a techno-politico-socio-economic system and as early as the 1960s scholars contemplated the impact of information and communication technologies on cities [21]. To this end, the concept of the smart city is an extension but also a critical reformulation of historical ideas—the wired city, intelligent city, informational city, invisible city, and network city [14,20,22,23].

Over the past few decades, a number of collateral movements have emerged that share many of the aspirations of smart cities. These approaches add to and broaden the smart cities approach. Civic technology, data for good and public interest technology, represent three major forces that are redefining parts of the technology landscape in which smart cities grow (see Figure 1).

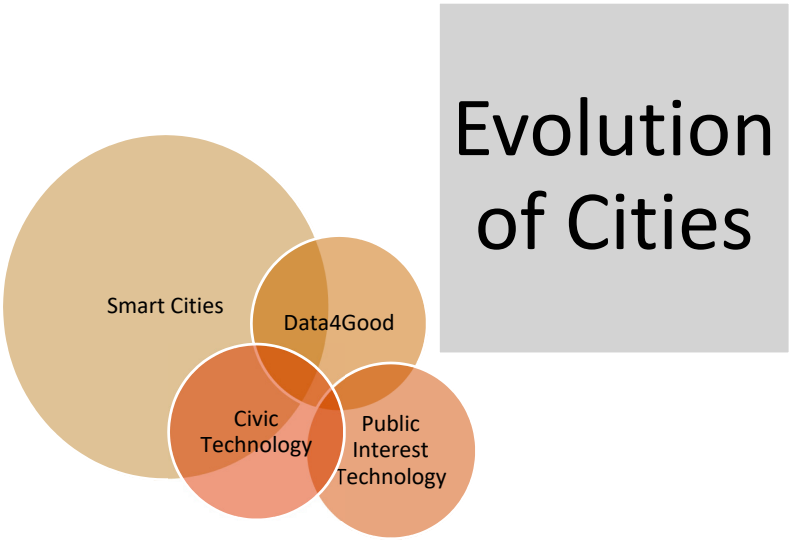

Figure 1. Relationship between the smart cities movement and related colleterial movements.

Civic technology is a worldwide movement that brings together open civic data, technology and civic technology practices to create new technology-based governance institutions [24–33]. An important ingredient is the involvement of skilled volunteers. Civic technology combines cross-sectional actors and constituents with volunteer technologists. According to Living Cities (2012) [26], Civic technology is the following:

Civic technology is the use of digital technologies and social media for service provision, civic engagement, and data analysis, and has the potential to transform cities and the lives of their low-income residents ([26], p.3). Civic technology aims at changing government from outside. It brings technology expertise to the problems that governments and communities face. It also leverages the abilities of communities to reform government. Open civic data is at the core of civic technology, something it shares with a number of movements, including smart cities. Civic technology practices differentiate civic technology from other systems. These include local peer to peer groups of technologists (like the Code for America's Brigades) and Hackathons. The latter brings technologists together around government technology problems that can be solved quickly.

A related movement is data for good. Data4Good is a movement that unites data, volunteer data science and technology workers and organizations that can use such help in the pursuit of social and humanitarian aims [34]. This often brings in citizen data collection (Citizen Science), use of private data (data collaboratives) and open government data. Organizations like Datakind [35] facilitate these exchanges. Datakind provides data science expertise to nonprofits and government to solve real world issues.

The growth of data science is a recent advance. Data Science uses sophisticated mathematical and technological tools (such as predictive analytics, machine learning and Artificial Intelligence) to address huge amounts of data that have become available from administrative records, digital traces and sensors [36]. Data4Good makes these resources and this capacity available to those organizations that cannot afford it.

Public service technology is a more inclusive title for a series of citizen-led efforts to achieve social change through technology. According to the New American Foundation, it is defined as: Public Interest Technology is a field dedicated to leveraging technology to support public interest organizations and the people they serve. For decades, public interest organizations have worked to improve the lives of the general public. They work on issues that shape our everyday lives, including protecting the environment, human rights, child welfare, and reforming criminal justice.

Many of the practices that public interest technology subsumes include electronic advocacy, online social movements, online organizing and so forth [37]. This exciting new effort engages technology,

consumers and a range of sectors in the effort to change society for the better. The use of technology by citizens to advance their own interest has a long and respected history. Social movements, public interest groups and individual advocates have long used technology.

2.2. The emerging Smart Cities Ecosystem

These three emerging systems have a number of commonalities. First, they create more opportunities for participation and involvement than at least some of the earlier smart cities approaches. This makes them a counterpoint to engineering-based models that are reflective of the "New Public Management" stream of thought [38] and perhaps reflective of Dunleavy et al. [39], who conclude "new public management is dead—long live digital era governance". They also extend implementation in important ways to counter the "Field of Dreams" effect if you build it they will come) approach that has so frequently failed policy makers. Civic technology and Data4Good bring in the use of a revolution of capacity in data and analytics and these are becoming important components of Public Interest Technology. These are already important capacities in the corporate sector much like how big data, the Internet of Things, and the concept of smart cities have been driven to a large extent by industry [40].

In order for managers to make use of these new capacities, an extensive set of skills is critical. These often go beyond what is typically taught in many professional schools. This is, of course, a moving target. What is adequate today will be inadequate tomorrow and often obsolete in a very short period of time.

3. Assessing the Skills Needed

If sustainability can be considered one of the normative goals of smart cities, then the planners' triangle of sustainability suggests that each of the triangle's apexes—the three E's (economy, environment and equity) —have to be balanced to promote sustainable development. That is, sustainability, in this view, is the balance of economic, environmental, and equity goals. We propose (see Figure 2) that at the base of the triangle is the spatial extent of the city—both built and unbuilt. The public—people who inhabit this space—comprise of the middle of the triangle. Government, which is comprised of selected individuals who represent the public in decision making and the institutions through which policy decisions are made, forms the top. This means that sustainable development will require governmental policies that balance the three Es; the inclusion of the public in decision making and a consideration of the impact (particularly the potential disparate impact) of policies on the public; and ensuring that development patterns and aspects of the built environment also strike the balance among economic development, environmental preservation, and equity. Planners plan and coordinate elements of the built environment. They are also concerned with how the public interacts with the built environment. Public administrators play pivotal roles in the governing of the city. They are also concerned with the management of governmental relationships with non-profits and the public. We focus on these two sets of actors and the core skills that they need to plan and govern the smart city. We know that engineering and scientific competencies are needed to create smart cities. These are well understood, although subject to constant changes. In order to create a smart city, however, we argue that planning and administration skills are also needed.

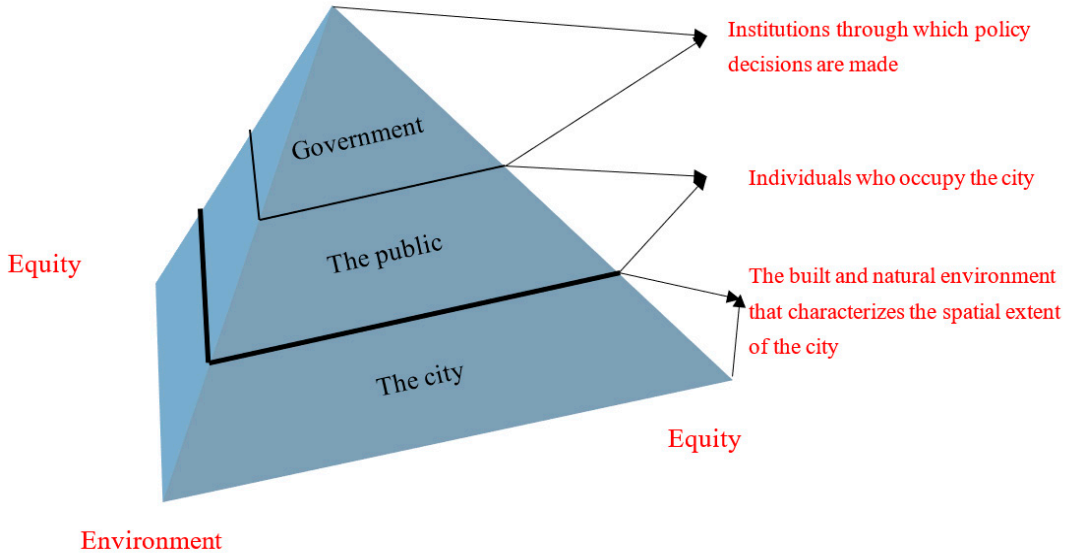

Figure 2. Governing the smart city: Domains of planners and public administrators.

3.1. Public Administration Skills

From a public administration standpoint, smart city governance will be more complicated than protecting and archiving data as a repository and as record of history. Public administrators will have to adapt and built capacity for data and information governance. That is, thinking about what data and information will be acquired, how will it be acquired, for what purposes, how will it be used, who will use it, and who will be responsible for making these decisions (see Lipchak 2002 as cited in Brown and Toze, 2017 [41]). Mergel [42] argues that first and foremost, public administrators will need to understand the ethics of data collection, storage, and use. Second, that public administrators will have to be agile and sophisticated in terms of understanding how to use the advancements in technology and our ability to harness different types of data (e.g., the Internet of Things) to solve public problems and advance the public good. Learning to make sense of the data, to triangulate different types of data, analyze the data, model the data, interpret the data, harness its predictive potential, and use it in evidence-based policymaking would be important in this regard.

3.2. Urban Planning Skills

From a planning standpoint, smart cities emphasize the integration of technological networks and the built environment; use technology systematically while making concurrent investments in human, social and physical capital; plan for overall sustainability (the balance of environmental, economic, and equity goals); and prioritize the use of technology for inclusive participation and the inclusive use of technology itself.

First and foremost, smart cities are cities. The planning of cities and the associated built environment is the planners' domain. At the very least, planners' stake in smart city initiatives encompasses the following: the use of ICT for observation and surveillance to better understand city dynamics (e.g., infrared imaging, drones); for the analysis of land use patterns and the built environment (e.g., software like UrbanFootprint); to facilitate participatory processes in policymaking (e.g., the use of civic technology platforms); to solve particular problems (e.g., crowdsourcing); to forecast and find the best ways to accommodate incoming disruptive technologies (e.g., infrastructure upgrades for connected and automated vehicles); to promote efficiencies across multiple substantive areas (e.g., buildings; green streets, transportation systems); for informed real-time decision making (e.g., real-time parking) and finally, to contemplate the ethics of ICT use and the impact of ICTs on equity.

4. A Model of Needed Smart City Governance Skills

Ahvenniemi et al. [5] suggest that there are two main streams of smart city discussions: (1) those that are focused primarily on the role of data, information, and technology; and (2) those that are focused on people. That is, while the use of data and technology is central to most conceptions of smart cities [42] such that it is "inseparable" from the idea of a smart city ([5], p. 235), a growing body of literature suggests that in addition to data and technology, investments in human and social capital are important for smart city governance [6,10]. Here, the argument is that technology alone is not enough [43]. Angelidou [43,44] differentiates this as a focus on hard versus soft infrastructure and supply versus demand. Calzada and Cobo [45] interpret these two streams as top-down versus bottom-up. In line with this literature, we argue that to govern and plan in the new smart city ecosystem, an extended group of skills are essential. These generally fall into three categories (Figure 3): Community Skills, Technology Skills and Data Skills.

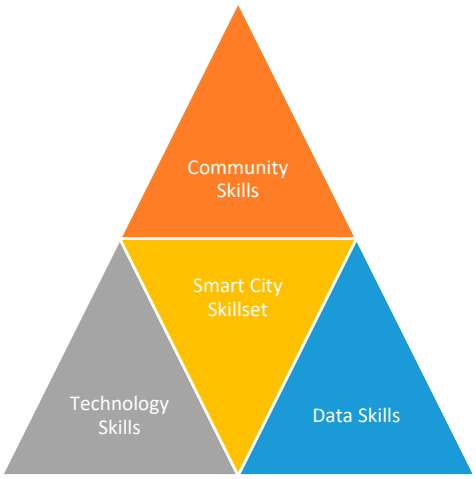

Figure 3. Model of needed smart city skills.

4.1. Technology Skills

From a public administration standpoint, this means planning and management as opposed to skills in coding and developing technology. This ought to include a basic understanding of the development process but more from the perspective of contracting and procurement. Managers need to know how to implement and evaluate a range of technologies and to deal with the issues that attend such systems. They also need to understand what technology products are available and are likely to become available. Most of the technology that is used in public affairs was developed for other reasons and are repurposed for a new role. Facebook is popular among social change advocates but was obviously developed for other uses. A critical technology skill is learning how to make that transition. How do we take applications developed for one use and adapt it for another purpose? In simple cases, this could be a simple set of processes. More complex uses may require changes in the actual technology.

From an administration standpoint, public managers would also have to make crucial decisions on how to coordinate innovation across multiple agencies, actors, and elements of the bureaucracy. For example, Lee et al. [46] find that innovation in terms of technology development is unevenly distributed across domains (e.g., transportation, disaster preparedness, and crime vs. facility management, education, and health). Here, public administrators would have to think about technology integration and coordination across domains. Similarly, decisions would have to be made about how to coordinate technology development and deployment with the private sector and to think about the governmental role in incubating innovation. Public administrators would have to be trained on how to make these crucial decisions and how to pro-actively plan for smart technology.

From a planning standpoint, planners would have to understand how technology impacts the built environment. For example, consider connected and automated vehicles (CAVs). CAVs could generate significant benefits including safer roadways, lower emissions, and mobility for the those with disabilities, seniors, and children. But CAVs could also lead to costs such as vehicle miles traveled, reduced revenue for states and municipalities, divestment in public transit, and transportation inequities [47,48]. Further, CAVs could impact aspects of the built environment (e.g., right-of-way width; walkability; land use patterns; and parking) [49,50]. CAVs, therefore, represent a major change—a disruption—in mobility, and the balance of benefits and costs will vary depending on how communities "plan" to confront them. As such, it is planners' responsibility to not only anticipate the impacts of CAVs but also proactively use planning institutions like comprehensive plans to strike that balance. This means that planners would have to be trained to understand the intersection of technology and built environment. Courses in comprehensive planning would need to include discussions of how technology might affect other aspects of development like walkability, sprawl, public transit options, parking requirements and so on. The same applies to incorporating, for example, broadband-related strategies (which would be essential for any aspiring smart city) in the comprehensive plan [8].

Planners would also have to be trained to consider the geographic and spatial impacts of technology. For example, the impacts of potential uneven technology diffusion (including access and use) on housing, transportation, neighborhoods, gentrification, etc. [43,51]. Further, the focus on smart growth, growth management, and new urbanism in planning has re-energized discussions around place versus space. That is, the built environment as the embodiment of an identity that is distinct and unique versus the geography of nowhere [52,53]. This means that planners would have to be trained to balance "the centrifugal forces of technology with the centripetal [forces] of human interaction in physical space" ([53], p. 199). Planners would have to be trained to ensure that technology is used to support other planning goals such as compact communities, walkability and so on. Here, planners would need to consider technology deployment on existing urban cores versus greenfield sites; how to mitigate barriers relating to aging infrastructure in existing urban areas; how to use technology for redevelopment (see the 22@Barcelona District brownfield redevelopment) and how to think about the usefulness of technology in the planning of human interactions with the built environment (see the Amsterdam Climate Street).

4.2. Community Skills

Engaging different groups of stakeholders is important and in this emerging space, critical for those in public administration. The needed community skills include advocacy, coalition building, resource mobilization, negotiation and marketing. As much as ICTs have allowed citizens greater access to government, public managers have a role to play in ensuring that this access is equal to all citizens, and that this access is meaningful. Here, public managers, particularly in smart cities should have a mandate to enhance governmental transparency [17]. Further, transparency and access to government do not guarantee two-way communication and dialogue. Similarly, urban intelligence, which is a crucial aspect of smart cities, needs the active participation of a diverse ecosystem of stakeholders. For network effects to occur, smart cities also need a high volume of users of intelligence and information services [51]. This means that public management would have to be transformed fundamentally to be more interactive and citizen-centric. Fifty years after Arnstein's [54] seminal piece, two-way communication is still not the norm in public administration. ICTs have the potential to change this but public administrators need the skills that will allow them to harness this potential.

Similarly, although there is a growing list of civic technology and ICT-enabled participation platforms [55,56], Batty et al. ([7], p. 492) argue that current forms of participation, from a planning standpoint, "still remain inert and somewhat passive". Still, no online tool can come close to replicating the complexity and nuances of face to face collaboration, interaction, and engagement. Therefore, planning programs would have to contemplate how to teach future planners about why, when, and how to use online platforms. While we might assume that online platforms and civic technology tools

reach a wider range and more diverse set of citizens, Smith et al. (2008) [57] found that those who participate in governance in person are also those who participate online. What about the digital divide? Planning theory and other courses in the planning curriculum that typically train planners to think about the power of and unequal access to information would have to provide a space for planners to also contemplate how technology might favor some over others and how it might particularly impact low-income communities and communities of color. To that end, smart city planners would need the skills to build community capacity for ICT use.

4.3. Data Skills

Public managers have always used data to make decisions. The rise of open data and collaborative data, combined with new and powerful data analysis skills has led to a new arena. When this is added to citizen-led data efforts, the challenges to keep up are substantial. Managers will need the ability to access data, analyze it and build consensus around data-driven plans and policies. The rise of Data Science as a power in the policy world is likely to make this a much more complex area. Data science brings many new capacities to public service that are significant and important. On balance, there are many other data skills that are relatively new that can complement public affairs work. These include Data Storytelling, the development of new types of databases and data visualization. There is also an important translation dimension that makes data analysis useful to managers and policy makers.

Lee et al. [46] find that city hall generally acts as a uni-directional provider of data and information. They argue that although municipal governments recognize that there is value in interactive forms of information and data generation, they lag behind in providing opportunities for two-way data exchanges including real time engagement and crowdsourcing. Similarly, although municipal governments recognize that data transparency is needed for open innovation, making decisions on levels of data transparency are not always easy. Public administrators, therefore, would also have to be trained to "strike a balance between open data transparency, encouraging third-party app development, and strategic constraints on data availability" [46]. Finally, data itself is not neutral. Neither is access to data or the capacity to use data. Data can embody value judgements—it can be political—its use and distribution can reinforce existing structural inequalities. In this regard, both public administrators and planners would have to be trained on "the interrelation between political communities of citizens and urban data-infrastructures [which is] at the heart of urban governance in an information age" [58].

From a planning perspective, technological advancements mean that planners have access to new data that they might not have had access to before. For example, it is possible now to use cameras to capture the dynamic use of the built environment (e.g., pedestrian counts, near misses at intersections, etc.) much like Whyte's (1980) [59] seminal work. Such cameras will and should raise concerns about object identifiability and the ethics of where this data would be stored and how it would be used (e.g., could it be used in the solving of crime?). However, such observational data about the use of physical space, in addition to perception data through surveys could allow planners to understand how and why people interact with the built environment in the ways they do. This technology might also allow planners to pilot built environment interventions by doing experiments in the field, and collect data of how the public responds to the intervention in real space and real time. But how would planners combine this kind of observational data with other mechanisms for participation? How might short-term and potentially real-time data be used for long-range planning? From a data standpoint, planners would have to build a skill set that centers on the urban intelligence function—that will allow them to integrate different methods and techniques for the study of the built environment.

The question that arises from this discussion is "to what extent do current planners and managers have the needed competencies to practice successfully in this coming environment?". The next section will address this problem.

5. Current Pathways to Public Service

There are many ways that people come to government employment. Two of the most important sources are graduates of public administration and urban planning programs. There are also people who come from a variety of paths who acquire these skills on the job. These might be described as Accidental Techies.

Accidental Techy Skills: Many of those who are involved in planning communities have an eclectic skillset developed through employment and training in unrelated professions. In some cases, they have a strong background in the skills and technologies that their particular organization uses. This type of practice wisdom has limitations. Very little of it is theoretically or empirically grounded and it is strongly anchored to a given place and a certain time. Changing conditions can quickly make these skills obsolete.

Public Administration Skills: MPA programs are a major producer of city and state managers. They typically teach courses management, finance, policy and human resources. Some of these programs also teach courses in technology, although some do not. Hu (2018) [60] notes that: Survey findings suggest that current IT education fails to keep pace with rapid changes in IT overall. Approximately 27 per cent of the fifty-two graduate programmes surveyed neither offer individual courses on IT nor do their core courses cover IT topics.

Some programs also offer community and data skills. From a theory perspective, early public administration and the New Public Management do not prize community skills. While there is some support in the New Public Service, it is hard to believe that this is a strong suite of MPA (Master of Public Administration) education. Most programs incorporate a research methods and a very basic statistics course (up to multiple regression), the incorporation of data science is still years away. Several public affairs schools have analytics programs (the University of Southern California and Georgetown come to mind) but this is hardly the norm.

Urban Planning Skills: Planning programs typically teach technology skills, data skills and community skills. Although planners rely significantly on data and technology skills for their work (Dawkins), they might not possess the skills of those who are experts in urban science or urban informatics or civic analytics. That is, they might not be trained in data mining, machine learning, artificial intelligence, and/or programming [61]. This is perhaps particularly true of older planners.

Limitations: What this means is that going forth there is a real need for a coherent approach to educating professionals to work in this space. This means providing (in addition to a range of general administration and planning skills) specific skills in community, technology and data. While this appears to be an easy issue to address, the complexity of a response soon become clear.

6. Options for the Future

Clearly, education needs a way to address these emerging forces. This is not as simple as it might first seem. Many of the people who will manage and plan smart cities are already credentialed. The staff of many professional degree programs do not have skills that future graduates will need. The rising cost of higher education is a bar to many in public service who would like to add to their skills. Higher education has always been a difficult system to change and that is unlikely to change. We propose a series of strategies to address the need for trained professions who can build the dream of smart cities. Some of these strategies could work well together over the course of a career.

6.1. Strategy One-Reinforce Existing Programs

This strategy involves adding additional substance to existing traditional programs in public administration and urban and community planning. This usually means (1) changing curriculum, (2) augmenting faculty skills and (3) building relationships with leading-edge organizations. Meaningful curriculum change is difficult. There are competing needs and program size is often constrained by economic and recruiting issues. One option is to create new specialist programs within the program

(e.g., The University of Illinois and Chicago Circle Public Affairs school has a program in Civic Analytics) or joint degree programs.

Planners are generalists and most employers would prefer to hire generalist planners [62,63]. That said, most planning programs do offer specializations and specializations like Geographic Information Systems permeate into other areas of specialization like land use planning and transportation [64]. Planning programs and the curricula they offer matter—Dawkins (2016) [62] found that practicing planners do "use" the knowledge gained through professional degree programs. This means that there is value in curricular innovations in the area of ICTs. Planning programs could consider how to innovate across the curriculum in the following: the use of citizen science for participatory governance; the use of urban data/intelligence to better understand cities; the use of cities as laboratories given the range of possibilities with sensor and camera deployments, and simulations; the use of ICTs to improve decision making across substantive areas; and the ethics and equity implications of the use of ICTs (see Batty et al., [7]).

Less disruptive and easier to implement might be an ICT specialization that overlaps with other areas of specialization as needed. Since public administration and urban planning are professional degree programs with national accrediting bodies, Network of Schools of Public Policy, Affairs, and Administration (NASPAA) and the Planning Accreditation Board might have to revisit curriculum standards.

Not all faculty can teach this material and those that can are often expensive to recruit and hire. This might mean that faculty will need retraining. Another option could be partnerships with academic departments that have the capacity to or already offer such courses. The top ten public administration programs, for example, rely on disciplines like geography, political science, and computer science to offer "advanced informatics classes, such as system design, telecommunication, GIS analysis, and even government information management" [40]. However, Ni and Chen (2016) [65] argue that there might be value in home units offering such options directly so that students learn to apply this material in the public affairs context. A third option is recruiting adjuncts with these skills—this is not out of the norm for public administration programs [66].

Organizations that work in this space can also be useful partners. They can provide insight on practice and can provide both internships and a pool of well-trained adjuncts. Even if professional academic programs change completely, it will not be enough. Much of the existing workforce was trained at an earlier period and their knowledge and skills must be upgraded. This will mean that professional schools will be responsible for maintaining the knowledge and skills of their graduates. This could mean continuing education or formal refresher efforts that involve a substantial amount of commitment. Organizations like the American Institute of Certified planners would have to play a role in developing continuing education credit opportunities focused on ICTs for planners who are already in the workforce. The Public Interest Technology Movement offers potential as it aims to encourage the development of public interest technology programs at the University level [67]. This is a national effort designed to create public interest technology at leading-edge universities.

6.2. Strategy Two-Free Standing Specialized Degrees

This is a more difficult strategy than revamping or piggybacking on existing professional programs. It means creating a faculty and designing a program. One excellent example is the Emerson College graduate degree in Media design (https://www.emerson.edu/programs/media-design-ma) [68], designed around civic media and technology and part of their well-regarded engagement lab.

6.3. Just-in-Time learning

The creation of online learning means that there are a substantial number of opportunities for both degree programs and individual learning. These include formal educational programs, Massive Online Open Courses (MOOCs), online courses, tutorials and so forth. The number of possibilities means that the cost of search can be considerable for individual learners so it might be useful to establish systems

that can recommend specific courses. This could be a function of professional associations or even an emerging professional role.

6.4. Informal Credentials

Informal credentials might mean (1) Bootcamps, (2) Peer-To-Peer Learning, (3) Certification Testing, (4) Badges and (5) Tutorials and Brief Classes. Bootcamps are short-term, intensive, educational experiences that allow participants to gain all of the basics of a skill. While many of these were created outside the academy, many colleges and universities have invested in this type of instruction. Peer-To-Peer Learning might be considered an apprenticeship approach, but learning exchanges are often reciprocal in nature. Organizations like Code for America's Brigades frequently train their members. Certification testing and Digital Badges provide credentialing for existing knowledge. They can occasionally translate into more formal credentials. Finally, Tutorials and short courses provide skill instruction that might result in some type of credential. These are sometime employment related. Like Just-In-Time Learning, navigating this space can be confusing and difficult.

6.5. Creating a Mix of Strategies

While it is true that existing programs will need to change, that will not be enough. There is a large group of workers that will need to have their skills enhanced and extended. In a short period of time, even today's graduates will be in the same boat. Fortunately, there is a substantial collection of resources to solve the problem. Sadly, those resources are in no particular order.

The answer might be that a new role exists for professional schools and the professional associations that organize a profession. This new role will include assessing the emerging needs for knowledge and skills and the guide professionals toward the resources that would be likely to meet their needs. If professional associations perform this function, it could be funded through dues. If professional schools perform this function, it might be a fee-for-service arrangement. Another way to look at this would be graduate education as a service, much in the way that software is sold as a service rather than as a product. Professional education might need to consider its role in the profession, often lost in the dialog about multiple masters and the university.

7. Conclusions

The smart city offers tremendous opportunities for the emergence of better governing and decision making at the city level. It also supports a renaissance in service delivery, relationships between cities and their residents and the integration of civil society with city life. While there are certainly people who hold that the development of technology will lead to universal benefits, research does not support that position [69]. Just providing new technologies does not automatically lead to social change or change in government. That requires a complex process using many actors.

Planners and public administrators play central roles in the decision makers structures of cities. The growth and development of smart cities depends, to an extent, on their skills. They are the people responsible for making both every day and long-term decisions in cities and must understand how, why, if, should, and when to use technology. Cities are complex systems. As such, the governing of cities is multifaceted. Even more so, the governing of a smart city. Planners and administrators as a workforce should be taught how to leverage and plan for technology in a way that is systematic, comprehensive, interconnected, and long-term. The world is changing, and we need to change with it. This, however, is a moving target. Not only does technology change, but there are contemporaneous changes in society. Technology is quickly evolving and provides new capabilities. It also requires new capacities from government to work successfully. At the same time, the expectations of the people are changing. Conditioned by their experience with technology and other social institutions, city residents demand a different level of performance for government.

In some ways, this has led to the collateral movements that we discussed. Civic technology, Data4Good and Public Interest Technology can be thought of as efforts to pressure governmental

change. On balance, they can be seen as residents providing collaboration with government. In either case, this signals a clear message to those who feel that government can control the development of smart cities without the involvement of the people. These developments run counter to the way that many urban professionals were trained. Older models of governance often marginalize the role of residents and minimize their contributions. Professionals trained in this tradition will need new knowledge and skills. Much of this is underway. The Public Interest Technology Movement for Universities (https://www.newamerica.org/public-interest-technology/about/) [70] is an evolving group of universities pledged to create public interest technologists.

Professional programs will need to step up to the plate. Preparing students for yesterday's practice simply is not enough. We need professionals who can work with a cross-sector network-oriented reality. The development of smart cities, combined with collateral movements such as Civic Technology, Data4Good and Public Interest Technology promises a new trajectory for the evolution of our urban world. We will need new professionals to make it a reality.

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