Articles

Rethinking the Smart City as an Intelligent City Archway

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Abstract

Urban intelligence is the ability to understand and navigate the physical and digital dimensions of "connected complex urban places". For example, new infrastructures (e.g., sensors, Internet of Things {IoT} devices like smart lamp posts) are needed to capture and represent places in software platforms and on the Internet. New spatial skills and spatial thinking are needed to navigate these new interfaces and networks of places. This paper aims at understanding urban intelligence by exploring variations in how smart cities have been conceptualized; how citizens have been placed within the smart city; and how Canada's smart cities initiative has placed on urban (and highly spatial) problems over digital technologies. The metaphor of the Roman arch is used to describe the interdependency of the building blocks of smart cities. Components (building blocks) of the smart city, be they openness, resilience or inclusion, must all be present, and build towards what we argue is the keystone of urban intelligence. We discuss how these components lead to a new consideration of the smart city, the Intelligent City.

Keywords: Digital Citizenship; Intelligent City; Smart City; Urban intelligence

Introduction

"*The 19th has been an Empire Century, the 20th a Century of State-Nations; the 21st Century will be the Century of Cities*" (Wellington Webb, Mayor of Denver 2009). According to the United-Nations, almost 80 percent of the world's population will live in urban areas by 2050. This dynamic of global urbanization, which affects developing countries even more than developed countries, operates alongside three digital and spatial transformations. First, a Digital Transition changes how we view objects, relationships, values, and space. The American digital humanities scholar, Doueihi (2011) refers to a type of society in which new media (e.g., books, maps, multimedia, and augmented reality) 'dematerialize'—they can no longer be fixed in space or stabilized over time. Second, we are part of a Global Location Age in which personal space has turned into a location for instant capture and sharing of events (Lussault 2007). It recalls a global whole constituted by a hyperlocal version of individual spaces. Third, we are experiencing a spatially- enabled Digital Socialization (Doueihi 2011). Social media and networks have been playing a major role of both providing information and mediating social relations in what has become a hypermodern and hyperlocal society.

The smart city is often where we see these transformations taking place because the smart city emphasizes location-based technologies and, in certain instances, elevates the role of residents of the city. American smart city researcher, Anthony M. Townsend provides a broad definition: smart cities are "*places where information and communication technologies (ICT) are combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems*." (Townsend 2013, p.17). As we will discuss, the

concept of a smart city is much-debated; members of MIT's senseable city lab argue that the concept is perhaps not 'smart-enough' (Roche et al. 2012). The concept can be too closely aligned with technical innovations; the concept is too wedded to the physicality of the city. We will argue for the need for a smart city to embed a new kind of urban intelligence. As urban places increasingly consist of physical and digital spaces, as individual and collective lived experience become increasingly spatial and digital, new kinds of urban intelligence are required to navigate these transformations (Roche 2016). Urban intelligence is the ability to understand and navigate the physical and digital dimensions of "connected complex urban places" (Roche 2016). For example, new infrastructures (e.g., sensors, Internet of Things {IoT} devices like smart lamp posts) are needed to capture and represent places in software platforms and on the Internet. New spatial skills and spatial thinking are needed to navigate these new interfaces and networks of places.

To understand urban intelligence, we begin by exploring variations in how smart cities have been conceptualized; how citizens have been placed within the smart city; and how Canada's smart cities initiative has placed on urban (and highly spatial) problems over digital technologies. We use the metaphor of the Roman arch to describe the interdependency of the building blocks of smart cities. An arch is a "*construction…made of truncated wedge-shaped blocks…that by mutual pressure stay in place, set out in a curved form to span an opening and carry a superimposed load*" (Curl and Wilson 2015, p.32). A keystone piece locks the entire structure into place and enables it to be self-supporting. An arch relies on the weight of each stone to maintain the integrity of the structure. Components of the smart city, be they openness, resilience or inclusion, must all be present, and build towards what we argue is the keystone of urban intelligence. We discuss how these components lead to a new consideration of the smart city, the Intelligent City. The intelligent city explicitly involves the citizenry in the process of achieving an urban intelligence. We conclude by arguing that, only by considering the building "stones" of the smart city, can we move towards a 21st Century Networked Society, as envisioned by so many researchers and practitioners.

Current Framing of the Smart City

The term smart city is often used as a catch-all buzzword for digital technologies that are deployed within the city to ensure efficiencies in public service delivery; the term can be used as a slogan that promises modernity and competitive advantage through technologies; it also can represent an aspiration of those who reside in the city who are facing unprecedented complexity in the processes of urbanization. There is no single agreed-upon definition of the smart city. The smart city is variously characterized as intelligent machines and people, sites of learning and innovation, entrepreneurial, self-promotional, knowledge-intensive, data-driven, technology-driven, connected, mobile, shared, participatory, equitable, resilient, adaptive, sustainable, livable, and green (Albino et al. 2015, Wachowicz et al. 2012, Ching and Ferreira 2015, Hollands 2008, Luque-Ayala and Marvin 2015, Nam and Pardo 2011, Neirotti et al. 2014). The smart city has "normatively attractive" characteristics that make it a "magic concept" that can win plaudits from everyone who hears of it despite operational realities (Zheng and Sieber 2020). Townsend's

definition of smart cities, however, is so broad so as to describe any municipal service, like public Wi-Fi (Halifax Region 2018). Absence of a consensual definition and an operational guideline hinders applications of new technologies and processes in smart cities. What "smart" means needs to be further unpacked, including the epistemological assumptions behind it.

One way forward is to define smart cities in terms of interdependent stages or building blocks. For this we draw on the urban strategist Boyd Cohen, who created an evolutionary taxonomy of smart cities. Cohen identifies three simultaneous generations of Smart Cities. Smart City 1.0: "Technology Driven", refers to cities' projects that were "pulled" by technology (Cohen 2015). Large ICT companies such as IBM or Cisco have initiated large-scale projects to demonstrate that their technological solutions and services answer contemporary issues in cities. The classical illustration of the smart city is the giant urban control center in Rio de Janeiro, Brazil, which suggests that massive amounts of data can be passively collected via integrated sensors and can provide real-time monitoring of transportation, crime, and environmental issues (Ching and Ferreira, 2025). Other examples include urban security in Mexico City, smart mobility in Singapore, and urban development "from scratch" in Songdo. These are aligned with massive advances in hardware, software and data. Globally, billions of devices (IoT), are exchanging data and AI applications are emerging in many domains including public health (e.g., disease surveillance), public safety (e.g., facial recognition in CCTV cameras), environment (e.g., air quality monitoring), and transportation (e.g., traffic lights, transit scheduling) (Ark 2018). By presenting themselves as the managers of urban infrastructure of the 21st Century, private companies hope to leverage these technical advances to capitalize on a global market. The market for smart city goods and services is characterized by an annual increase estimated at 13 percent and an estimated value of US $ 1.4 trillion for 2020, according to a study published by Grand View Research (Grand View Research 2020).

Cohen considers the second generation to be Smart City 2.0, "Technology Enabled, City-Led" (Cohen 2015). Smart City 2.0 arrives when cities realize that, to take advantage of a Digital Transition and a Global Location Age, smartness needs to be considered as a form of governance transformation and social innovation. Accommodating growing populations in urban centers and operating mammoth infrastructures can exacerbate urban problems like inequality, unemployment, air pollution and traffic congestion (Albino et al. 2015). To handle these issues and their complex interactions, it is argued that smart cities should move beyond technology to include people and politics. Barcelona is one of those cities, followed by other European cities like Paris, Nantes, Copenhagen, and Helsinki. Cities realized they could improve their governance and ensure metropolitan prosperity by managing community and citizen engagement through digital innovations (Neirotti et al. 2014). We utilize citizens in a colloquial sense as individuals, or residents, who live and work in this urban space. For example, cities can incorporate self-driving cars to solve the parking problems and address public transportation needs (Peters 2018); cities may work with firms to build intelligent systems to assist doctors in improving (and reducing the costs of) medical care (Ho 2018). "Smart" is more than an efficient response to a set of instructions; smartness can be realized only when the city system satisfies public needs (Nam and Pardo 2011). Cohen argues that cities should designate technology the role of improving quality of life (Cohen 2015). It should be noted that these generations of smart cities are coterminous. Greater focus on public needs does not erase continued emphasis on purely technical solutions.

Cohen has proposed a third generation, a Smart City 3.0, which places citizens at the heart of urban innovation schemes (Cohen 2015). Called "Citizen Co-Creation", Smart City 3.0 is rooted in a larger quest for inclusion, equity and justice. Citizen co-creation is not a new idea, but it is greatly aided by technology. Nambisan and Nambisan, researchers in business administration and health informatics, describe the various ways in which citizens can adopt a much larger role in the functioning of the city:

- As explorers, citizens can identify/discover and define emerging and existing problems.
- As ideators, citizens can conceptualize novel solutions to well-defined problems.
- As designers, citizens can design and/or develop implementable solutions to well-defined problems.
- As diffusers, citizens can directly support or facilitate the adoption and diffusion of public service innovations and solutions among well-defined target populations (Nambisan and Nambisan 2013). We can augment this list with the concept that citizens can act as sensors of their city (Goodchild 2007).

The argument is that citizens tend to be aware of subtle changes in their local surroundings; there are more of these locally-aware amateurs than professionals employed in government. With advanced hardware devices (e.g., smart phones, pollution counters) and new software techniques (e.g., big data analytics, artificial intelligence {AI}) (Zheng and Sieber 2020), citizens can extend our knowledge of the city and offer opportunities to improve critical infrastructure and services in cities. In two examples related to transportation, citizens participate deliberately by reporting deteriorations in the road fabric; we can monitor citizens' movements in space and time to identify deficiencies in public transportation. Notwithstanding legitimate concerns around location-based surveillance and exploitation of free labour; the hope is that a Smart City 3.0 enables a constructive partnership between government officials and the people they govern.

This trend towards citizens collaborating with municipal governments to actualize the smart city aligns with the idea of making the smart city more open (i.e., accountable, transparent and ethical) and inclusive. From this more normative perspective, a smart city is one "*where government, civil society, private sector, the media, academia and residents meaningfully participate in the governance of the city and have shared rights and responsibilities*" (Lauriault et al. 2018, p.11). Cities like Chicago, Barcelona and Guelph, Ontario have begun to incorporate these values.

One objective of this chapter is to explore the importance of spatiality in the process of conceiving and realizing a smart city. Canada launched its own Smart Cities Challenge in 2018. The Smart Cities Challenge was a competition open to cities of all sizes in Canada, with specific tiers of prizes to ensure that small cities (under 30,000 inhabitants) and medium-sized cities (under 500,000 inhabitants) also had opportunities to develop smart city projects. Interestingly, the challenge used the term 'community' instead of city. This was a very broadly defined spatial unit that could apply to municipalities (of all sizes), regional governments, and Indigenous communities (including First Nations, Métis, and Inuit people). The Challenge encouraged

communities "to adopt a smart cities approach to improve the lives of their residents through innovation, data and connected technology" (Infrastructure Canada 2019). More than 150 letters of intention, representing 199 communities, were submitted in April 2018. Interestingly, the challenge's rules required that all applicants justify the relevance of their project's main goal through community engagement and bottom-up "co-construction" of the project (Infrastructure Canada 2017).

The focus on engagement in the application process suggests a desire on the part of the federal government to move to Cohen's Smart City 3.0. Our cursory analysis of 150 letters of intention reveals the extreme diversity of approaches and projects. Of the 199 communities, 108 chose "Empowerment and inclusion", which represented the most significant focus area which is represented on the top list (Figure 1). Applications did not emphasize technology, as they might under a Smart Cities 1.0 model.

On May 20, 2019, the government awarded four grants. Ten out of 20 finalists listed 'Empowerment and inclusion' (Figure 1) as did three of the four winners. Interestingly, winners were those who proposed innovations in terms of citizen engagement (Zheng 2020).

Figure 1: Smart Cities Participants with Focus on Empowerment and Inclusion. The 53 and 22 refer to two major clusters of participants that can be viewed if the visitor zooms in on the map. (Source: https://www.infrastructure.gc.ca//sc-vi/map-applications.php)

Figure 2 shows the spatial disparity in smart city challenge applications. Even with the steep population density gradient found in Canada, there still is significant concentration of applications and gaps where there are none. At the beginning we discussed three social transformations as well as a generational movement to include the public and not exclusively consider smart cities to be technology driven. All these concerns are connected to a ubiquitous spatiality. Smart cities are both physical and digital; they can never be completely dematerialized as suggested in the Digital Transition. For example, a smart city still has physical sensors that are spatially distributed in a way that serve municipal agendas (e.g., efficiency in traffic flows).

Figure 2: Smart Cities Challenge Finalists with Focus on Empowerment and Inclusion (Source: https://www.infrastructure.gc.ca//sc-vi/map- applications.php)

Several studies in the professional and scientific literature demonstrate the urgency of assessing spatial issues related to justice in the smart city (Commission de l'éthique en sciences et en technologie 2017, Kitchin 2016). The Open Smart Cities Guide created by Open North, proposes a normative approach to smart cities that accounts for the social, non- technical and digital needs of residents (Lauriault et al. 2018). These include the need for transparency and accountability, and collaboration (to improve trust), the notion that technology in the smart city be fit for purpose, and that data governance be mindful of individual and collective needs.

Archway of Intelligent City

Figure 3 shows our archway of an intelligent city. The model aims to develop smart city projects with respect to the ways people live, consume, learn, travel, and interact in urban environments. The choice of the arch is more than a "figure de style". Arches require a careful choice and honing of rocks to ensure fit and balance between components to be self-sustaining. When connected together, arches can form even greater structures, that bridge communities, provide key services, and act as landmarks. In this vein, the archways of the intelligent city provide the scaffold for which residents navigate and interact with place, which incorporates urban intelligence as its keystone.

Too often, smart cities are thought of as solely urban and privileging the needs of the dominant population (Shearmur et al. 2020). And it is too often that people have to adapt to innovations that undergird smart cities. It is important that we are reminded that technology must adapt to people and not the inverse (Palmer 2012).

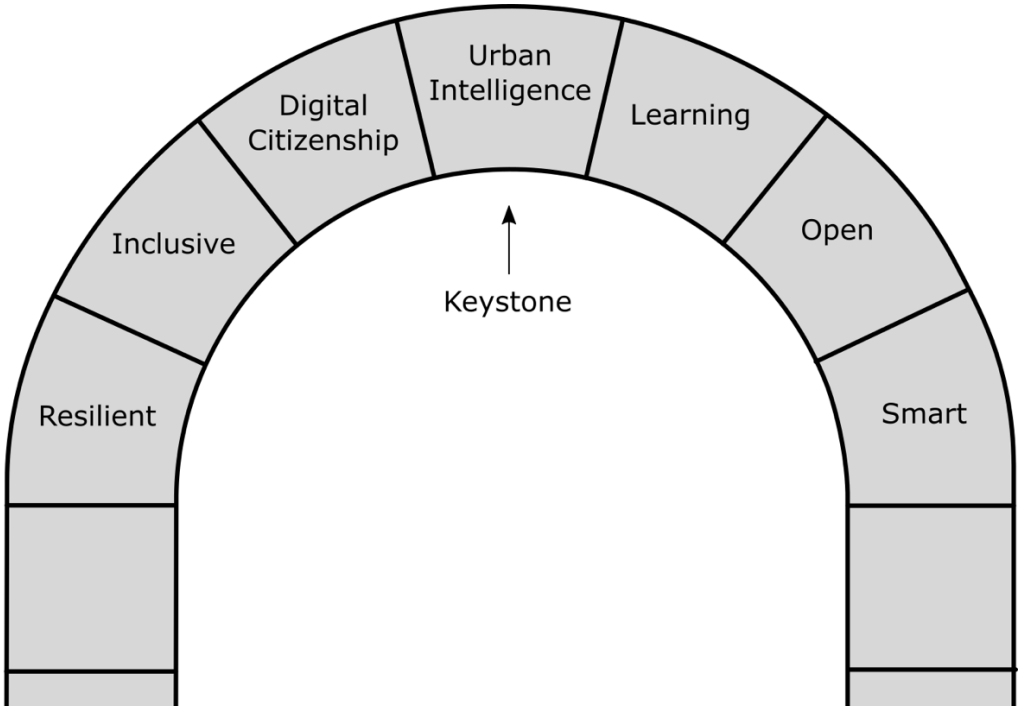

Figure 3: The archway of the Intelligent City

The archway model of the Intelligent City is based on "stones", each representing a fundamental component of the smart city. The strength and sustainability of a smart city relies not only on the individual components, but also on the structure composed by technical and non-technical components that are presented in the model. The model aligns with the Smart City 3.0 proposed by Cohen (2015). It relies on a vision of human-centric Smart City that is ethical, just and scalable. This offers an approach based on an urban digital strategy deeply rooted in the collaborative and co-created urbanity, articulated around three basic stones: smart, open and learning.

Smart, open and learning

Smartness is the first stone. A smart city should be innovative technologically, politically as well as socially. In a smart city, traditional infrastructure, networks, and services are supposedly made more efficient through information and communications technologies (ICTs). We deliberately depreciate "smart" to one of several stones in this intelligent city, to emphasize the role of social processes of cities and because 'smartness' has become too closely associated with ICTs. A smart city is not just a city that leverages ICTs in a specific sector but one that implements ICTs as a driver for the benefit of its communities, in different areas like economy, environment, mobility, or governance (Ratti and Claudel 2016). One vehicle is for governments to politically innovate in terms of accepting new means of gaining information or new modes of participation. This can be technical, for example via sensors and other IoT devices but smartness also can be achieved politically and socially via crowdsourcing. Crowdsourcing, a practice in which the public can contribute ideas and energies to collectively solve urban problems, suggests ways communities or citizens engage in smart city initiatives. There are numerous examples of crowdsourcing: residents can report the location of potholes or pedestrians can download apps that passively sample audio from construction or airplanes that can build a citywide map of noise (Brabham 2009, Kanhere 2013). These demonstrate the concept of citizen-as-sensor and highlights how individual spatialities constitute a domain for solving urban problems. Smartness here is reflected not only in lower cost and higher efficiency in data collected by individuals as they move about the city, but also in finely localized data which may provide sufficient information for better decisions in terms of justice and ethics.

Smartness, however, is a complicated concept. The Smart Cities Challenge applications demonstrate that cities differ in how they regard smartness. For example, smartness in Ottawa and Waterloo is about improving wellbeing for children and youth (City of Ottawa 2018, Region of Waterloo 2018); whereas smartness in Surrey-Vancouver areas and Montreal seek to augment urban transit performance with "smart transportation" (City of Montreal 2018, Cities of Vancouver and Surrey 2018). Many researchers argue that smartness is both a goal to achieve by cities and communities to render their ICT expertise and a way of integrating technologies and data in their governance (Albino et al. 2015, Burchell et al. 2000, Harrison and Donnelly 2011, Nam and Pardo 2011, Neirotti et al. 2014, Viitanen and Kingston 2014). We argue that smartness relies on other characteristics, like openness, to attain its promise.

The second stone in the arch is **openness**. Openness refers to the capacity of an urban community to combine technological innovation with human dynamics and vision to empower people and social movements. As the word suggests, a smart city should open up government data and governance processes to a broader public. Opening the data and making it freely available (as a common public good) without licenses or other restrictions on its usage represents as strong a driver for a smart city as externalizing a government's data production to other parties (e.g., via crowdsourcing) (Dymytrova 2017). Open government means notifying the public of important government meetings and legislation, allowing people to attend government meetings and participate in committees, and making the operations of government accessible. Building on first generation smart cities, a smart city can open up its operations via technological innovations like smart interfaces (e.g., dashboard, common operational platform, integrated web service)

and tools like municipal social media, planning support systems (Lathrop and Ruma 2010, Nam and Pardo 2011, Zheng and Sieber 2020). Opening data and governance is definitionally creating greater transparency, which then should allow for effective public oversight and government accountability (Lathrop and Ruma 2010, McGee and Edwards 2016). In Open North's Open Smart Cities Guide, an open smart city is: "*Participatory, collaborative, and responsive. It is a city where government, civil society, the private sector, the media, academia and residents meaningfully participate in the governance of the city and have shared rights and responsibilities. This entails a culture of trust and critical thinking and fair, just, inclusive, and informed approaches*." (Lauriault et al. 2018, p11).

From this view, citizen empowerment and social progress is rooted in principles of "*accountability, transparency, ethics, equity, openness, human rights, and inclusivity*" (Lauriault et al. 2018, p.27). From this perspective, engineering infrastructure efficiency and economical or managerial progress should not be the key drivers of a smart city. Collaborations among municipal governments and communities, it is argued, are the true driver of urban innovation. Boston's 'participatory urbanism', for example, aims to engage citizens through mobile applications, websites, short message service (SMS), the 'Community PlanIT' gaming platform, the 'Open Government Portal', and the 'Data Boston' portal (Osgood 2013). San Francisco opened its Mayor's Office of Civic Innovation to foster entrepreneurship and host online platforms such as 'ImproveSF' that seeks to enable online collaboration and solicit ideas from the public (Lee 2012). Only when cities invest in human and social capital will those cities reap the desired benefits (Ching and Ferreira 2015). Smart cities researchers, Acedo et al. (2018), argue that understanding social capital can help elucidate the role of place in how a city functions and aids in understanding the way in which social capital creates urban intelligence (Acedo al. 2018). When thinking about the smart city, it should not be "*the city as a single entity*" but rather "*the smartness of its citizens*". By combining openness and smartness, citizens become idea generators rather than recipients (Haque 2012).

The third stone in the arch is **learning**. Combining human dynamics and vision with technologies requires learning and capacity building (Zhuang et al. 2017). A smart city could be considered a learning city from two scales (Gibson 2017). First, a smart city as a set of governmental and non-governmental institutions, learns. A smart city builds on smartness and openness by using the potential of technology (e.g., big data, IoT, or AI) (Batty 2013) and the engagement of urban actors (e.g., via citizens as sensors of their environment or individuals contributing information about the environment via citizen science) (Tuama 2016). Smart cities can learn best practices from each other and convert such learning into innovations (Ching and Ferreira 2015). City and institutional networks have been established to support this form of learning, for example, European Regional Development Fund (www.smartcities.info) and European Smart Cities (www.smart-cities.eu). MIT researchers Ching and Ferreira expand the process of learning to "learning, re-learning, and adaptation" (Ching and Ferreira 2015). A smart city needs not only the capacity to learn from technologies, individuals, and other cities, but also a feedback and assessment system for re-learning and adaptation. This could focus on trial-and-error learning that draws on organizational learning theories (Schön 1983) and performance indicators derived from a city's goals (Cohen 2013).

Second, a smart city should enable residents of the city to learn. Lifelong learning represents an essential ingredient in creating sustainable cities and societies (Osborne et al. 2013). These education researchers argue the smart city should "promote... an extension of the fundamental right of all people to education, including education and training to achieve diversity, understanding, cooperation and dialogue between generations" (Osborne et al. 2013). To achieve this goal, people require certain skills, values and attitudes to contribute to the sustainability of cities and address any challenges faced by individuals as they live in the city (Manzoor 2014). In the search for effective long-term solutions to these challenges, increasing numbers of cities are reinventing themselves as learning cities and taking concrete steps to realize that vision. Learning cities are crucial drivers in the achievement of the 2030 United Nation Agenda for Sustainable Development. That today's fast-moving and uncertain world can only be faced by people who are lifelong learners are particularly addressed in Sustainable Development Goal (SDG) 4 ('Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all') and SDG 11 ('Make cities and human settlements inclusive, safe, resilient and sustainable'). Promoting lifelong learning for the sustainable development of cities is, therefore, fundamental for achieving all of the UN Sustainable Development Goals.

At the local level, numerous learning spaces are now associated with smart cities. These include living labs, fab labs, coworking spaces, maker spaces, "third-places", and community learning centers (Ahmed 2014, Morel and Le Roux 2016, Oldenburg 1989). The intent of these spaces is to free up imagination and stimulate innovation. Many of these sites afford physical meeting places (and hardware like 3D printers) and instructional courses. Technologically-enabled social transformations have facilitated learning that is physically grounded in some instances. In other instances, with online courses and learning through social networking, they may be dematerialized in space-time because they are not limited by geographies and times. In turn, this move from physicality to virtuality in learning affords further technological and social innovations (Anderson 2017, Berrebi-Hoffmann et al. 2018, Osorio Bustamante et al. 2015).

Inclusiveness and Resilience

We argue that these three basic stones, smart, open and learning, are the sine qua non conditions for a city to ensure **inclusiveness**. Many researchers regard inclusiveness as an essential component of the smart city (Ahmad et alii 2022, Albino et al. 2015, Hollands 2008, Luque-Ayala and Marvin 2015, Wiig 2015, Zygiaris 2012). However, because smartness is frequently associated with technological innovation, the risks of marginalization and exclusion can be very high (Guillaud 2017). According to smart city researcher Rob Kitchin, data-driven approaches often: "*Fail to recognize that cities are complex, multifaceted, contingent, relational systems, full of contestation and wicked problems that are not easily captured or steered, and that urban issues are often best solved through political/social solutions and citizen-centred deliberative democracy, rather than technocratic forms of governance*" (Kitchin 2016, p.4).

Inclusion has been problematic in the smart city that has relied on the smartness of high tech. Tech solutions, for instance, cannot confront complex power relations. Waterfront Toronto is the largest proposed smart city in North America. Waterfront Toronto has been labelled a

"tragedy" because the partnership between Sidewalk Labs (Alphabet/Google) remains mainly concerned with the role of Alphabet and its capital even as it promotes its capacity to effectuate public consultation (Wylie 2019). The public in a smart city can too easily be relegated to a small portion of smart city development. Recall the stone of open: for inclusiveness, a smart city needs methods to broaden public engagement in governance processes. High tech solutions are not necessarily designed for minorities (e.g., people with disabilities), people with few digital skills and literacy, or individuals who cannot afford the technologies required for interaction (e.g., smartphones).

One example is the need for Europeans remaining in post-Brexit Britain to process their visa application via a supposedly simple and inclusive interface: "*people with Apple devices will not be able to scan their passports and will either have to borrow an Android phone to complete their application or post their passport to the UK Visa and Immigration Service*" (Wheeler 2018, p.2). This is but one of many examples of increased digital inequities in the movement of citizen-government interactions into the digital. The inclusiveness stone also interacts with the learning stone as individuals must understand the various processes affected or introduced by the smart city so as to engage with government. A city cannot be considered smart if enhancing its digital and technical capability comes at the expense of a city's most vulnerable residents.

Inclusion matters from a geographical perspective. Data poverty, also called urban data deserts (Castro 2014), represents one instance of an increasing issue where urban governance and decision making are increasingly subject to data availability. Those with less data available about their neighbourhoods may be less represented in government policies and budgets, while also having less opportunity to engage with government on policy making. The effects on citizen engagement raise the issue of gaps and biases that may affect production, spatial distribution and thematic coverage, and the dissemination of data by municipal governments. To what extent do policy choices, cultural biases (e.g., gender biases) affect the availability or quality of data? To what extent is the data available in a city representative of its population? Few studies have focused on informational poverty. The NYC Data Poverty Research Project (NYU Center for Urban Science 2016) defines Open Data Poverty as "the situation in which one is deprived of the benefits of open data driven by lack of access, use, and representation within data". It demonstrates that poverty in open data, to be fully apprehended, must be treated as the resultant (intersection) of digital and informational fractures.

Focusing on inclusion allows the public to question whether the state is appropriately framing issues in the smart city. For instance, to what extent should information poverty even be a concern? A lack of knowledge about a person or a community is not a type of poverty that necessarily affects individuals acutely as does income and wealth, hunger and homelessness. It does not possess the same weight as these other kinds of poverty. To what extent should marginalized or poor people be compelled to supply data as a condition of any improvement of their conditions? Whom does the removal of an urban data desert actually serve? Also engaging the public may compel governments to balance the collection of data against any privacy breaches. Smart cities are 'data hungry'. Sensors, whether they are located under the road or on someone's phone, collect enormous amounts of high spatial and temporal resolution data about individuals and communities.

Last, a smart city must respond to an urban context characterized by dramatic and radical transformations and stresses such as climate change, demographic pressure, energy transition, food security, urban territories (Obringer & Nateghi 2021). Cities are under pressure to increase their **resilience** in the face of rapid change (Meijer and Rodríguez Bolívar 2016). Based on the pioneer definition of the Rockefeller Foundation, Meerow et al. (2016, p.39) define urban resilience as "*the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity.*". Resilience is particularly challenging for the smart city because place is a key driver of urban dynamics (Roche 2016). Place refers to the infrastructure—the roads and bridges, and the sewers and subways—as well as the attachment of people—the historical roots of people—to where they live and work (Landry et al. 2017, World Bank 2010). Urban engineering infrastructures are increasingly connected and integrated through ICTs and digital services so they are more vulnerable to hackers and various technical problems. Place-based resilience also is challenging for a smart city that must maintain basic services to a population with increasingly reliance on physical services, like roads (for delivery of e-commerce goods), communication with family and friends (via social media), and online services such as information about economic assistance after a disaster.

Urban resilience is not unproblematic. A focus on resilience in smart cities can "vaccinate... citizens and environments so that they can take larger doses of inequality and degradation in the future" (Kaika 2017). Certainly, smart cities may render environmental monitoring more efficient and responsive. But the technologies themselves may further environmental degradation (e.g., the environmental sensors can be made of toxic materials). More importantly, there is a long history of "green new deals" that essentially gentrify cities and externalize impacts to the poor (e.g., e-waste shipped to developing countries; toxic landfills located in areas occupied by poor people of colour). The poor often live in areas that are the least resilient because they often are the least expensive places to live (e.g., in flood zones). Netherlands urban planner Marisa Kaika argues that, instead of fixing problems, resiliency demands that people and places become even more resilient on top of the stresses they already face like precarity of jobs and housing (Kaika 2017). This demands that resilience is not the sole focus of a smart city but instead operates in coordination with other stones in the arch.

Urban resilience needs to link with the three smart city's basic stones mentioned previously, and with openness. For this purpose, Open North suggests five recommendations and implementation approaches for urban policymakers to improve urban resilience related to openness and especially open data: "*1) couple open data and urban resilience efforts to build a culture of openness; 2) assess and address similarities and differences in urban resilience work between low- and high-income countries globally; 3) close the open data capacity gap; 4) develop an agile approach to managing urban resilience; and 5) cultivate business opportunities that address urban resilience issues*" (Landry et al. 2017, p.9). Approaches based on civic tech applications or crowdsourcing methods, related to the smartness stone, can not only contribute to opening data production, diffusion and governance, but also enable local residents to geolocate places they are concerned with and maintain communication with their relatives.

The resilience of the smart city is not solely the realm of IoT and data analytics to develop solutions to urban problems. The ability of a smart city to cope with today's major challenges ultimately depends on the resilience of the urban population itself. According to the United Nations, resilience requires "*the ability to resist, absorb and accommodate to the effects of a hazard, in a timely and efficient manner*" (United Nations 2012, p.3). Thus, resilient cities are those in which their citizens, businesses, and infrastructures have the capacity to withstand, adapt, and recover in a timely manner from hazards they face, either planned or unplanned. This capacity can involve the closing of digital divides and developing of skills (learning), to develop urban residents into digital citizens. Following this idea, Han & Kim (2021) offer a critical reflection about Smart Cities and their relationship to the challenges of adopting sustainable lifestyles by citizens. Their meta-analysis highlights the importance of promoting the emergence of a new, intelligent, sustainable citizenship. Keeping in mind this capacity, the building blocks of the Intelligent City invite us to move from a smart city to an urban intelligence.

From the Smart City to Urban Intelligence and the Intelligent City

Returning to those three digital transformations, the intelligent city operates within virtual and physical spaces. This occurs at two scales: the individual interacting with the city and the collective city.

The Individual: Digital Citizenship

New York City urbanist, Shannon Mattern argues that the literature on smart cities tends to position residents of the city "*as sources of data feeding the algorithms. Rarely do we consider the point of engagement—how people interface with, and experience, the city's operating system*" (Mattern 2014, p.1). To become intelligent, a city needs to move beyond residents as cogs moving in physical space and time. In the context of a digital transition and digital socialization, an intelligent city needs to address what we are terming digital citizenship. A digital citizen may very well interact with the city through other means than walking or driving. They may communicate or crowdsource content online; they may "see" the urban fabric through mapping platforms. Interaction with municipal government may no longer be the sole domain of paper forms and physical office spaces; the presence of city government also extends into the digital (e.g., e-government).

Considerable work has attempted to define what digital citizenship should be, what a digital citizen should learn to be fully engaged, and how the individual and the state handles digital identity (Choi et al. 2017). We situate our notion of digital citizenship in a report from the 'Commission de l'éthique en sciences et en technologie' of the Government of Quebec, which published entitled "Ethics and Cybercitizenship: A Youth Perspective" (Commission de l'éthique en science et en technologie 2018). This official commission report defines the cyber or digital citizen as a person who receives information from and interacts online with other citizens as a way of engaging and participating in democratic life. As importantly, digital citizenship is framed as rights-based: the individual should enjoy the rights and freedoms guaranteed by the country

in which he or she lives, even if these rights and freedoms are undermined by other parts of the digital world like other countries or private sector platform providers.

The overall question asked in this report is "How can we make the digital world a public space in which individuals can exercise their rights and fulfil their duties as citizens?". Five answers are proposed, which demonstrates how digital citizenship interacts with other stones in the arch. The first answer aims at establishing measures to combine freedom of expression with quality of information. It is essential that the information diffused to the general public be complete, accurate and relevant, so as to promote critical and objective thinking.

Second, the digital world must make its stakeholders accountable, which resonates with recommendations for an Open Smart City. As smart cities are part of a digital transition, the report authors argue that citizens need to learn a kind of dematerialized etiquette, a "cybercivility", which calls on citizens to adopt a digital responsibility to enable a "collective co-existence". This also is important because civility in physical space, where one "reads" observable cues of individuals and cannot participate anonymously, does not necessarily translate to a digital realm of trolling and hyper partisanship. Smart cities must themselves be responsible by regulating platform companies and holding them accountable for abuses related to their platforms or business models.

The third way refers to Internet transparency. The blackboxed opacity of the digital transition raises ethical issues in terms of legitimacy, trustworthiness of network and software (AI in particular), and imbalances of power between digital companies and their users (individuals, groups, and even governments). Without applying some corrective to opacity and lack of trust, why should individuals engage online or in person? Fourth, governments must protect user privacy. All users should have access to meaningful, open, and intelligible information regarding the processing, storage, use and dissemination of their personal data.

The fifth proposal, possibly the most important as well as the most complex, stresses the importance of closing digital divides and therefore holds implications for the learning stone. Having equitable access to the data, platforms, and engagement opportunities afforded by the smart city can depend in large part on their level of digital skills and literacy. Better digital literacy can equip individuals to understand and contend with physical and digital places. We argue in the next section that efficient management of citizens' activities in place and time demands attention to spatial thinking capacities and use spatial skills. As the digital world is, to a great extent, a spatial one, this contributes to a collective urban intelligence.

The Collective: Urban Intelligence

At the top or keystone of the arch, we place urban intelligence. Urban intelligence draws and relies upon the other supporting stones. For example, crowdsourcing (smart) assists in generating urban intelligence from the accumulated contributions of residents. Urban intelligence is aided by open meetings and open data, which allows the public to contextualize and augment information. Urban intelligence should benefit from inclusiveness, as a diversity of voices strengthens the collective intelligence and indeed resilience of an urban system. Learning is

obviously implicated as a key capacity building activity. A smart city should enhance a community's capacity to understand the complexity of a specific system's dynamics. Via crowdsourcing and participation in open meetings, community members can identify the relevant relationships among urban components (those among all relationships that help analyze and make sense of these systems) and assist in their understanding of the system from different perspectives and at different geographic scales (i.e., neighbourhood, city, nation, and globe).

The Inclusion and Learning components are obviously central to the development of collective urban intelligence, without which the connections between communities and smart city technology could contribute to reinforcing existing power imbalances and inequities. Technological deployment in urban areas, if it is not accompanied by citizen awareness measures, protection of the most fragile communities and consideration of already existing digital divide issues, can contribute to accentuating them rather than resolve them (Ahmad et alii 2022). Chang et al (2021), for instance, highlight the impacts of the accelerated digital transition of Telehealth, during the Covid19 pandemic, on the accentuation of the digital divide, despite the positive effects in terms of accessibility to care for communities capable of seizing digital opportunities. The accelerating digital technology could impose "copy-cat form" in city and neighbourhood design and organization (Abusaada & Elshater 2020), thus contributing not only to a form of urban standardization that is a source of inequity, but also to an impoverishment of urban variety, irreplaceable source of inclusion.

As an example, in response to these issues, the Quebec government is currently funding a digital capacity program for the community sector. Centraide of Greater Montreal and Open North are piloting DATAide program (Centraide of Greater Montreal, 2024). DATAide aims to help community organizations undertake and succeed in their digital shift. DATAide also represents an opportunity to adapt digital transformation to the principles and values of the community environment. DATAide is made up of an awareness webinar, a training component and a leadership support laboratory. A grant program is also available. This kind of project allows us to draw out several guiding lessons for practitioners and government. First of all, smart city project has to be developed with the aim of contributing to the development of a digital culture within the community and of encouraging ethical practice. Secondly, and this is very in line with the "learning" component of the Archway model, smart city initiatives should support learning and strengthen the skills of organizations in their use of technologies, as well as citizen digital literacy. Last but not least, in order to be really contributive to more inclusive and sustainable city, smart city should support the contribution of local and community organizations in the development of applications with strong social utility.

For us, urban intelligence requires we recognize the importance of spatiality in the smart city, not merely the location of the city and its inhabitants, but the ubiquity and continuousness of location as well as the dynamics of people and objects traversing that space. London-based urbanist, Adam Greenfield talks of an "everyware" paradigm, which speaks of the ubiquity of smart devices (e.g., smart homes, smart appliances, smart clothing, and IoT connected street signs), which are "*in more different kinds of places, at a greater variety of scales*" (Greenfield 2006, p.46). Greenfield's paradigm aligns with Tobler's first law of geography "*Everything is related to everything else, but near things are more related than distant* things" (Tobler 1970,

p.237). Urban intelligence helps us understand how physical distance can inform relationships (e.g., that a downtown may have activities and resources more similar than the suburbs from which workers commute to the city). Urban intelligence also points to the role of spatiality in many of the stones, both positive and negative. For example, digital divides can be inter-city or intra-city. Spatial differences exist in terms of open data availability and resilience (e.g., vulnerability to climate change as a consequence of a city's location). The strength of stones is more fulsome in some places than others.

Urban intelligence requires that we transition from the city as location or space to city as place. Place ascribes meaning or value to a location; place is a space formed out of human experience (Tuan 1977). We spoke earlier of the need for a city to learn and relearn. Taylor, a US professor of education, argues for "learning locative literacies", the ways in which ubiquitous mobile technologies change the way we read and write the city (Taylor 2017). The growing complexity of smart cities requires we add a mobile intelligence, which leverages urban stakeholders' ability to decrypt the genesis of places and their spatial practices (Roche 2016). Intelligent cities are then not only about data or representation, but also about sending and decoding the sense of places and understanding complex relationships (correlation, cause and effects) between physically and digitally connected places (Roche 2016, Acedo et al. 2018). New York City architects, Massey and Snyder, described how activists could rewrite the spatial codes of the city, for example with the Occupy Movement in challenging the norms and legislation of how spaces like urban parks were used, redefining them as "temporary autonomous zones" and promoting those redefinitions of physical space on social media (Massey and Snyder 2012). Activists therefore imposed a new place aesthetic upon these spaces.

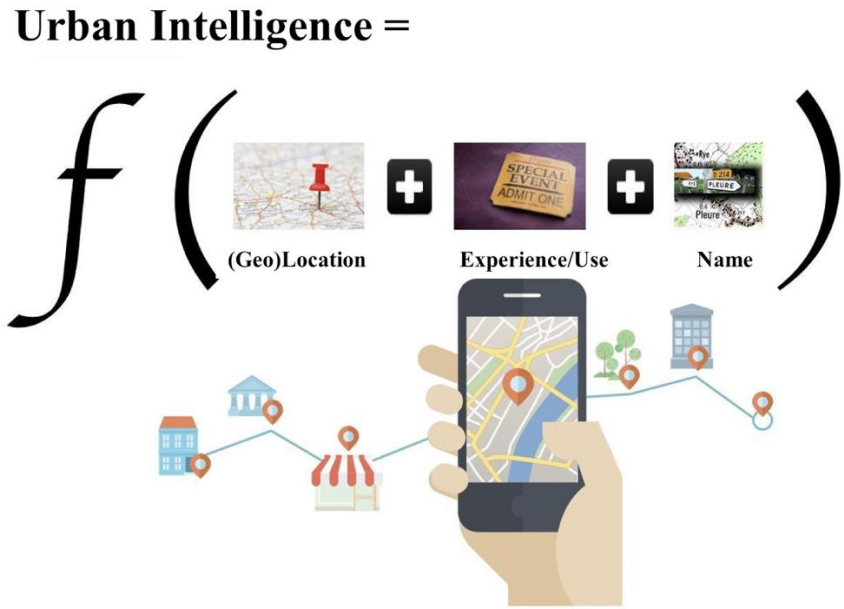

Figure 4: Urban Intelligence

From this perspective, intelligent cities are place-based and place plays an essential role in urban intelligence. Acedo et al. explore urban intelligence by using the spatial relationship between sense of place (i.e., geolocation + experience + name) and social capital (here, the valuation of social relations) at both an individual and collective (aggregated) level (Acedo et al. 2018). The authors conducted a web map-based survey of residents in Lisbon, Portugal, considered a smart city "lighthouse" in Europe. Residents were asked to map their sense of place (i.e., "place attachment, place identity, and place dependence") and social capital ("relationships between human collectives ... and the analysis of their values to individuals") (Acedo et al. 2018). The authors connect collective/individual spatialities, urban places, urban intelligence in the context of smart cities. The intelligent city can therefore be considered an intelligence of urban place (Figure 14), where urban stakeholders develop the ability to identify what is happening in the city and to react properly in a relevant time frame, as part of their spatial capital which relies both on digital literacy and on spatial skills and spatial thinking capability (Roche 2014, 2016). The spatial skills and spatial thinking capability, according to French geographer, Michel Lussault, are wide-ranging, including the action of performing orientation and navigation, scaling up and down, using proportional reasoning, moving one's body in space, visualizing, and perspective-taking (i.e., considering the perspective of someone who is in a different location, locating objects and people, and remembering location of objects and people) (Lussault 2009).

An urban intelligence, which emphasizes place, reveals the convergence of the three transformations introduced at the beginning of the chapter, digital transition, global location age, and digital socialization. A GPS pattern of the urban traveller is both physical in the original and dematerialized in a digital trace (Taylor 2017). They contain a hyperlocational footprint of the lived experience of the city that can immediately be shared with others in and outside the city. Cities evoke digital socialization. Contemporary urban spaces are considered to be comprised more of networks of places than of continuous and homogenous areal spaces (Roche 2016); they also are hybrids of digital information and physical matter (Feick and Roche 2012, Zook amd Graham 2007).

Conclusion

In this paper we proposed a model of an intelligent city illustrated by an archway of seven stones. Five stones (smart, open, learning, inclusive and resilient) are structured as a foundation. Another stone (digital citizenship) helps us understand the multiple scales at which the intelligent city functions. Urban intelligence is the keystone, which is reinforced by these stones. Our model is locationally scalable. At the urban (local) scale, the components of the intelligent cities help inhabitants to capitalize on their hybrid physical and digital environment. At the global (earth) scale, the intelligent city is not an isolated transformation of urban areas. Instead we see the archways of the intelligent city and across a long line of municipal transformations from the industrial revolution to a city rooted into the networked society through the connections of digital infrastructures and social relations (Castells 2000).

We hope this paper opens a dialogue on what is desired and achievable in the smart city and what constitutes place in a digitally enabled urban space. What is special about the

physicality of the smart city and the way we characterize it? How do we ensure that best practice models of the smart city do not emphasize technology alone at the expense of local context and the engagement of local people? What new skills are required to navigate within the smart city? Implicit in all the stones is the need for spatial thinking and reasoning capabilities as the basis of digital citizenship. Spatiality and smartness share common components, in particular networks and nodes (centres of activity), the importance of topology (relationships), the importance of mobility, and the scalability of activities, knowledge and intelligence. Individual cities and their inhabitants must decide even as they join other cities in a global network of smart cities.

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