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Promise and Peril in the Smart City:
Local Government in the Age of Digital Urbanism

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The Institute on Municipal Finance and Governance (IMFG) is an academic research hub and non-partisan think tank based in the Munk School of Global Affairs at the University of Toronto.

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Executive summary

In the past few years, a growing numbers of urbanists, planners, technology companies, and governance experts have started to use the term "smart city."[1] Some define smart cities in terms of using emerging and established technologies to improve the performance of municipal systems. Others take a more expansive view that embeds these new systems in a broader vision of urban regions characterized by innovation-based economic activity, a highly educated labour force, and policy-making that leverages these new technologies to confront stubborn urban problems.

The market for smart-city technologies – such as cutting-edge networked sensors, big-data repositories, powerful analytics software, and smart grids – has gathered momentum, as leading technology suppliers develop products and services geared to this domain. Entire new communities are being developed using smart-city systems, in some cases as proof-of-concept living labs.

Yet the rapid adoption of consumer and security technologies that do not fall under the conventional "smart city" definition also have far-reaching impacts on municipal systems (such as housing, transportation, and policing), including those that have benefited from new smart-city systems. These include ride- and apartment-sharing apps, autonomous vehicles, and data-driven law enforcement or predictive policing applications.

In other words, the emerging challenge facing municipal policymakers is to determine the degree of investment or procurement in purpose-built smart-city technologies while adapting regulatory and governance systems to respond to changes arising from the adoption of services such as Airbnb and Uber. At the same time, policymakers must consider some unfamiliar issues in responding to smart-city developments, including equity, privacy, algorithmic bias, and data governance.

This Forum paper draws on the insights and professional experiences of four individuals with informed perspectives on these questions:

- Tracey Cook, Executive Director, Municipal Licensing and Standards, City of Toronto;
- Pamela Robinson, Associate Professor, School of Urban and Regional Planning, Ryerson University;
- Peter Sloly, Partner and National Security and Justice Lead, Deloitte Canada;
- Zachary Spicer, Visiting Researcher, Institute on Municipal Finance and Governance.

The report concludes by observing that policymakers must be smart when thinking about the smart city trend and ensure that technologies are not adopted for their promised efficiencies only.

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Promise and Peril in the Smart City:
Local Government in the Age of Digital Urbanism

Introduction

Since 2014, the much-discussed "smart city" agenda has become more than a buzzword for innovation-minded policymakers and large tech companies. The deployment of a broad array of emerging technologies has far-ranging implications – both positive and negative – for the city's urban form as well as its operational, economic, and social relationships to a set of sophisticated data-gathering systems, some internal to government, others not.

The widespread deployment of smart-city systems points to a future in which increasingly centralized big data–based IT systems and networks are crucial actors in the evolution of communities, public spaces, and local and regional governments.

These changes, in turn, pose tough and non-theoretical questions about the relationship between regulatory or governmental authorities and the private entities whose business models either implicitly or explicitly disrupt the way civic officials manage growth. In the Toronto region, several recent inflection points mark the beginning of the smart city era. They include:

- The launch of **Uber** as a ride-sharing service in Toronto in fall 2014. The service quickly disrupted the extensively regulated taxi industry, forcing municipal officials to rewrite rules to provide for both ride-sharing services and conventional taxi industry stakeholders. But the arrival of ride-sharing points to further developments, including the deployment of autonomous vehicles (AVs); minibus services operated by Uber and other ride-sharing firms; built-form and land-use planning accommodations for ride-sharing services; and the impact of induced demand for ride-sharing on transit infrastructure.

- Toronto City Council's decision in fall 2017 to limit and regulate the use of apartments for **Airbnb** and other services offering short-term rentals, one of the first such bylaws in Canada.[2] Airbnb's evolution demonstrates not only the rapid adoption of web- and smartphone-enabled sharing services, but also the way in which these services affect other urban systems, such as the private rental apartment sector, the investment market for condos, the viability of the hotel sector (a large employer of newcomers), and the security of highrise apartments.

- Toronto Global's bid for **Amazon's** second headquarters, using the First Gulf/Lever Brothers property site. While a decision from the Seattle-based e-commerce giant has not been made as of May 2018 (Toronto made the shortlist),

the heavily promoted bidding process revealed a nexus of smart city–related dynamics: the tight relationship between creative cities and tech companies that recruit large numbers of (mostly young) software engineers; mounting evidence that the tech industry has become ever more urban; the role of artificial intelligence–based businesses as a key driver of wealth creation; and, more broadly, growing indications of the disruptive impact of e-commerce on urban retail zones.

- **Sidewalk Labs'** bid to develop Quayside with a suite of tech-intensive pilot projects (involving, for example, environmental sensors and AV-based transit) in Toronto's Portlands. Perhaps the most ambitious non-government deployment of smart-city technology, Sidewalk Labs has proposed to build a waterfront community that makes extensive use of information gathered by sensors deployed in the public realm; advance the trials of AV services, which will likely impact municipal transportation and transit systems; reconfigure the regulatory relationship with local government; and build platforms meant to attract investment by civic-tech companies developing their own smart-city innovations**.**

Besides these four examples, the City of Toronto or its agencies have moved ahead in recent years with the deployment of new smart city–type transportation management systems as well as smartphone-like devices that give police officers instant access to a broader range of cross-referenced analytics and real-time data to support crime prevention. Most other large metropolitan areas are making similar moves.

With all disruptive systems – both those procured by government entities as well as those deployed by private firms that also impact urban spaces – critical questions arise that speak directly to both the promise and peril of smart cities:

- Do the benefits outweigh the costs associated with disruption?
- Can these technologies – or the firms that promote them – be held accountable for unintended consequences or inherent biases?
- How can social values like equity and inclusion be part of the discussion about smart cities?
- How does democratic oversight work in cities in which officials depend on highly complex technical systems?

On January 25, 2018, the Institute on Municipal Finance and Governance (IMFG) and the Innovation Policy Lab (IPL) hosted a far-ranging debate to explore the opportunities and risks associated with smart-city technologies and systems. The panelists – Tracey Cook, Executive Director, Municipal Licensing and Standards, City of Toronto; Pamela Robinson, Associate Professor, School of Urban and Regional Planning, Ryerson University; Peter Sloly, Partner and National Security and Justice Lead, Deloitte Canada; and Zachary Spicer, Visiting Researcher, IMFG – explored issues such as regulation, equity, security, and data governance to probe the implications of these rapidly emerging technologies.

What is a smart city?

For much of the industrial and post-industrial age, reformers and innovators have promoted engineered technologies to solve the problems of city living, real or perceived.

In 19th-century London, for example, civil engineers designed an elaborate network of underground sewers and interceptors to capture wastewater and prevent it from flowing into the Thames. The goal was to improve quality of life and public health by enclosing open sewers and preventing the flow of human waste into the city's principal water source.

During the first half of the 20th century, a new generation of reformers, planners, and architects advanced technological or technocratic solutions to problems such as slums, pollution, waste management, and traffic congestion, all with the intent of bringing order to the disordered world of the city.

The present-day metropolis has been described as a highly dynamic "system of systems" – complex spaces in which infrastructure, land-use policies, and private investment from various eras are constantly interacting within a highly fluid social environment, sometimes collaboratively and sometimes at cross purposes.[3]

The notion of the smart city represents merely the most recent layer in this well-established historical pattern, with one important difference: the emphasis now is not on physical assets, but on information technology and social systems.

In his 2014 paper on big data and smart urbanism,[4] Rob Kitchin points out that the phrase "smart city" itself has this dual connotation, and it is worth exploring the overlap.

Since the mid-1990s, urban policymakers have paid close attention to Richard Florida's conceptualization of creative cities as urban regions that value features such as innovation-driven local economies, culture, social tolerance and openness, and quality-of-life amenities such as walkable neighbourhoods.[5]

Creative cities, as the phrase suggests, attract individuals working in a range of intellectually or culturally engaging professions; these include innovation-oriented organizations in the knowledge economy. Creative cities are also smart

cities, aspirationally. "From this perspective," Kitchin notes, "a smart city is one whose economy and governance [are] being driven by innovation, creativity and entrepreneurship, enacted by smart people."[6]

The more common understanding of the phrase, however, refers to the use of emerging information and data-driven technologies to address specific pressures of 21st-century city life. These technologies hold out the promise of optimizing certain urban subsystems, like traffic management, energy consumption, or air-quality controls.

What do smart-city technologies do?

Because mobility in both sprawling and dense urban areas is so important for the day-to-day functioning of city-regions, a great deal of early investment in smart-city technology has been directed at transportation infrastructure. Other applications, such as network-connected sensors, are deployed in public spaces to provide real-time monitoring of municipal assets, like vacant parking spaces, and sophisticated algorithms work on large datasets to identify sources of urban risk, such as fires.[7] Smart-city technologies are also being used to make municipal administrative systems more efficient, user-friendly, and accessible, such as the analysis of 311 call data to improve resource allocation.[8]

Nevertheless other applications combine objectives. Richmond Hill is converting its streetlights to LEDs connected in a wireless network to an operations centre (as of March 2018, implementation is nearly complete).[9] Besides reducing energy consumption and allowing for operational savings, the wireless network is a smart system that can be operated remotely to respond to changing light conditions and outages.

The wireless Internet of Things (IoT) network linking the streetlights is also intended to serve as a platform for future operational applications involving decentralized municipal assets, such as traffic lights and water meters. Indeed, the City of Portland, Oregon, and AT&T recently launched a pilot project in which a network of sensors will monitor structural changes – cracks, shifting – on key pieces of infrastructure.[10] Other IoT smart-city applications involve amenities in private spaces, such as elevators.[11]

The dynamics of the market for smart-city technologies

Many smart-city software- and network-based systems have been developed by very large technology companies – IBM, Cisco, SAS, Audi, BMW – that have promoted their products using smart-city branding. Such marketing has exploded in the past five years, as Figure 1 indicates (the bars show the frequency of articles and press releases that contain the words "smart city" and "technology"). These companies have aimed their sales strategies at municipal or regional government procurement agencies.

While estimates on the size of the smart city market vary widely, depending on the technologies included in the calculations, growth rates are robust. As *American City and County* magazine reported recently, the National League of Cities found that two-thirds of U.S. municipalities are investing in smart-city technologies, and a quarter of those without smart-city systems are looking into making investments.[12] International smart cities rankings have added further pressure on local and regional governments to procure these kinds of systems, notes Zachary Spicer (see Box 1).

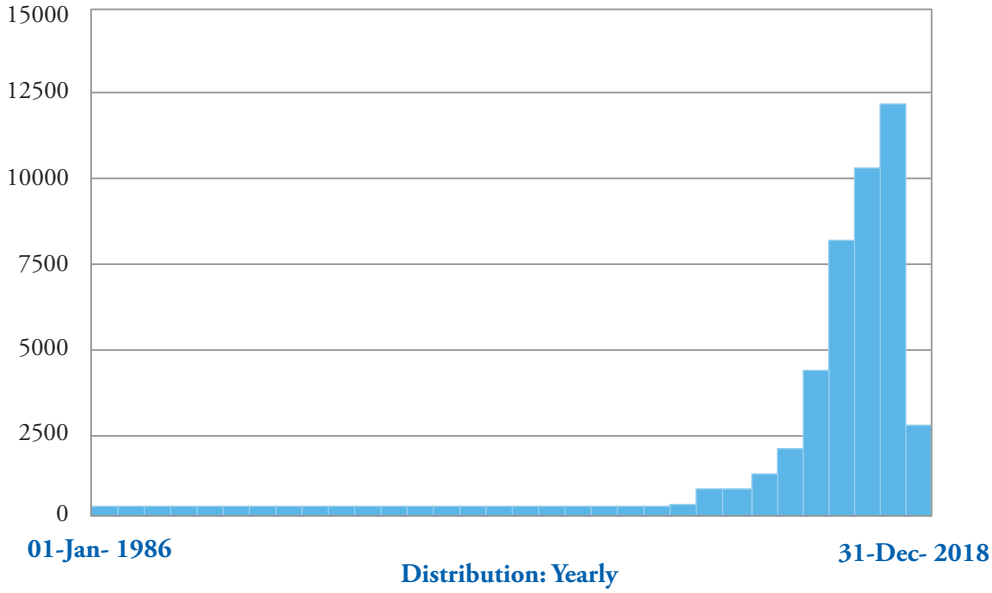
Box 1: Select international smart-city rankings

Several competing smart city rankings evaluate city-regions along a range of metrics – some of them more broad-ranging and others more tech-focused. (The rankings include rankings of rankings.) These include:

- IESE Cities in Motion, University of Navarra (Spain).[13] Its index of 100 cities is based on 10 indicator categories and numerous subindicators: economy, human capital, technology, the environment, international outreach, social cohesion, mobility and transportation, governance, urban planning, and public management. Toronto ranked 11th in 2017, and Vancouver, Ottawa, and Montréal were also represented. New York is number one.
- Resonance Smart City Index.[14] The company, a British consultancy, produces a range of city rankings, but this one focuses on technology and educational attainment. While Seattle ranked first in 2017, five Canadian cities were in the top 10 spots.
- EasyPark Smart Cities Index.[15] Produced by a European parking app company, this 100-city index is very tech-focused, with metrics such as high-speed wireless penetration, number of smart buildings, and smartphone usage. In 2017, Vancouver was the highest ranked Canadian city (11), followed by Montréal (16), Toronto (20), and Ottawa (40). Copenhagen holds the top spot.

In both Canada and the United States, moreover, demand for this broad category of products and software systems has been further stoked by national "smart cities challenges." During the Obama administration, the U.S. federal smart city competition attracted 78 cities pursuing a $40-million Department of Transportation grant with innovation-minded proposals designed to leverage other public and private investment sources. The pitches by the

Figure 1: Frequency of international articles citing "smart city" by year



43.6K documents for all dates

Source: Global Factiva (Dow Jones database).

seven finalists, all mid-sized cities, involved AV corridors, and Columbus, Ohio, emerged as the winner. Canada's federal government initiated its own $50-million smart cities challenge through Infrastructure Canada in December 2017 as part of a broader innovation agenda (the winning communities will be announced in 2019).[16]

The notion of spurring inter-urban competition has found its greatest expression with Amazon's call for submissions for its second headquarters, which is expected to employ up to 50,000 people. While Amazon, as an e-commerce and logistics giant, is not in the smart-city technology business, the company's strategy in identifying a second city illustrates how cities vying for this kind of direct investment tout smart-city attributes that encompass both technology infrastructure and social capital (i.e., a diverse, well-educated labour force).

In its search for a new home, Amazon has indicated that it is looking for cities with the talent, quality of life, business culture, and locations required to ensure that this second head office will thrive.[17] Implicit in Amazon's proposition is the expectation that the successful bidder will provide the company with a broad social licence to operate – something that can happen only if residents, businesses, investors, and policymakers in the winning region support both the smart city promise and the innovation necessary to bring it about.

Indeed, while urban regions that invest in smart-city technologies come in all shapes and sizes, there seems to be a connection between civic interest in technology solutions and the presence of technology-oriented employers. The Toronto-Waterloo corridor has emerged in recent years as a fast-growing tech hub, with 15,000 tech firms, 200,000 tech workers, and 5,200 tech start-ups.[18] These companies and their employees represent a demanding constituency that will advocate for more efficient and innovative solutions aimed at confronting stubborn urban problems.

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The city as "living lab"

In regions with significant tech clusters, government officials may be more willing to test emerging smart-city technologies

in the living lab of the city rather than buying off-the-shelf systems. In New York, for example, municipal officials are running trials of vehicle-to-vehicle, vehicle-to-infrastructure, and infrastructure-to-pedestrian communications networks, with the goal of reducing collisions as part of the city's Vision Zero safety policy.[19]

The idea of using urban neighbourhoods to test smart-city technologies has become increasingly popular. Many city-regions around the world are piloting various elements of autonomous vehicle systems (including Ontario), in both controlled and real-world settings. In March 2018, however, Uber abruptly halted its Toronto trials after a pedestrian died when she was struck by a self-driving vehicle in Arizona.[20]

There are also a handful of places in which investors are aiming to build smart cities from scratch – a 21st-century echo of earlier "new towns" constructed around urban reform ideals, such as Letchworth, England, the original garden city; Levittown, New Jersey, the prototype post-WWII subdivision; and Celebration, Florida, the ambitious Disney-developed New Urbanist community. (See Box 2 for a Canadian example.)

Microsoft founder Bill Gates spent $80 million last year to acquire 25,000 acres of undeveloped land in Belmont, a suburb of Phoenix, Arizona. The community will eventually have up to 80,000 homes. "The smart city," observed *The Verge*, "will be designed to feature high-speed networks, data centers, autonomous cars and vehicles, new manufacturing technologies, and automated logistics hubs."[21]

The sharing economy and smart cities

In September 2014, shortly after the City of Toronto enacted a new taxi bylaw, Uber, then a San Francisco start-up, began offering its UberX service in Toronto.

Uber entered numerous urban markets offering to provide a taxi-like service, but one without conventional intermediaries. Uber drivers were self-employed contractors instead of plate owners or drivers leasing cabs. The service allowed passengers to order rides and pay from a smartphone app, which removed friction from this kind of mobility

Box 2: Toronto's Sidewalk Labs Quayside project

One *tabula rasa* smart city project that has garnered global attention is Sidewalk Labs' proposal to develop the 12-acre Quayside precinct on Toronto's waterfront using emerging and established technologies, including the widespread deployment of sensors in public spaces. The technologies are intended to bring about efficiencies in mobility, energy use, building construction, and air quality. The proponent – a two-year-old start-up headed by former New York City deputy mayor Dan Doctoroff and owned by Alphabet/Google – has conceptualized the venture as "the world's first neighborhood built from the internet up."[22]

Sidewalk Labs and Waterfront Toronto are negotiating a master development agreement for Quayside that may also involve extending some smart-city technologies to the larger Portlands area, which covers 800 acres. Both Sidewalk Labs and Waterfront Toronto have retained the services of privacy experts to evaluate the data-gathering systems that will be deployed in Quayside.

Central to Sidewalk's proposal are two key principles in the evolution of smart cities:

- The widespread deployment of sensors and other data collection instruments that will function as an information-gathering platform designed to document what is happening in this area, that can in turn be used by software developers to design new products and services geared at urban communities;
- An explicit expectation that the regulatory agencies with jurisdiction over development and other municipal services will give Sidewalk plenty of latitude to test its smart-city technologies in a built-from-scratch community that the company has described as an urban "lab" of unprecedented size and potential.

Sidewalk's proposition, which Spicer describes as potentially a "digital gated community," brings into sharp focus a range of questions about the evolution of municipal and regional government in the age of smart-city technology and the digital infrastructure that overlays the physicality of neighbourhoods. For example, who owns the digitized data collected in the public realm? What is the difference between data gathering and surveillance? How do municipalities regulate rapidly emerging consumer technologies that may have unintended consequences for local services and infrastructure? And what is the right balance between encouraging innovative urban technologies and their associated economic activity, and protecting the interests of those who may be excluded from such systems?

The branding of Sidewalk Toronto's project as a "lab" strongly indicates that many of these emerging questions will be subject to a type of on-the-ground trial-and-error process that may precede, or even suspend, policymaking and regulation.

option. Most importantly, Uber rides are priced differently from those offered by almost all regulated taxi services, which have long been governed by metered fares and enforced limits on the supply of plates. Uber provided a faster, cheaper, and easier alternative to taxis and consumers responded enthusiastically.

While the City initially sought an injunction against Uber, Mayor John Tory signalled his desire to allow not just more competition, but innovation-driven competition. Yet Uber's arrival produced winners and losers, with taxi drivers and plate owners in the latter category. It also challenged City officials to bring an antiquated and evidently vulnerable licensing system into the 21st century.

Tracey Cook explains that the process for reforming the licensing framework turned on finding the right balance between competing agendas, that is, increasing transportation options for consumers vs. negative impacts on existing sectors, or creating new income opportunities vs. fostering employment instability. The reforms, moreover, affect different publics differently: consumers, the taxi and ride-sharing industry, and the municipality itself. The result was a modernized taxi bylaw that sought to level the playing field by streamlining regulatory requirements for the cab industry while imposing driver and vehicle standards for ride-sharing services.[23]

Uber's arrival in Toronto challenged City officials to bring an antiquated and evidently vulnerable licensing system into the 21st century.

Of course, Uber, Lyft, and other ride-sharing services have never promoted themselves as smart city companies. Yet since their operations directly affect core municipal functions, ride-sharing could be viewed as an externally imposed smart-city technology. Moreover, beyond the direct implications for the taxi sector and municipal licensing, ride-sharing, according to a growing number of analysts, will likely bring about significant changes in other areas. For example, developers and architects are facing mounting pressure to alter site plans to provide less on-site parking but more generous and safer drop-off and pick-up zones.[24] There is also mounting evidence that ride-sharing may lead to induced congestion and reduced transit usage – both trends that demand responses from municipal and regional governments that have invested millions of dollars in road and transit infrastructure.[25]

The housing system, a core responsibility of local government, has faced similar pressures from the sharing economy and short-term vacation rental firms like Airbnb or VRBO. Originally envisioned as providing a service for tourists, these companies have imposed severe pressure on the long-term rental apartment market, offering landlords and condominium investors lucrative alternatives to conventional tenant arrangements. (According to many accounts, short-term rental units have also raised security and noise concerns in multi-unit residential buildings where such apartments may be rented specifically for holding parties.[26]) In large urban areas like Toronto and Vancouver, the impact on the rental market has been felt in the form of rising rents and reduced vacancy rates for individuals or families seeking apartments.[27] Like ride-sharing, apartment-sharing was not seen as a smart-city technology, but its widespread adoption demanded a robust policy response to address instability in a core municipal system (housing).

In March 2016, MaRS Solutions Lab, in partnership with provincial and municipal officials, released a sharing economy framework that offered a strategic approach to regulation in a highly fluid environment (the report deals with both accommodation and transportation).[28] With short-term rentals, the report encouraged policymakers to adopt a 360-degree approach that situates short-term rentals in a broader context that includes a clearer definition of what constitutes housing; enhanced condo regulation; hotel and destination marketing; tax compliance; and the leveraging of short-term rental data in planning policy.

Throughout 2017, Canadian municipalities began regulating short-term vacation rental companies; for example, Toronto created precise rules governing which categories of apartments can be used as short-term rentals. This complex debate also required local politicians to address the income needs of homeowners hoping to rent basement suites to offset their mortgage payments. The abrupt shift in discourse about regulation in this area, interestingly, seems to have spurred a few condo buildings to negotiate access agreements directly with Airbnb.[29]

More broadly, this recent and urgent engagement by public officials reveals how smartphone-enabled consumer technologies that promise seemingly benign services can rapidly produce dramatic unintended consequences capable of undermining both well-established regulatory models and social norms.

Security in the smart city

Peter Sloly stated that in order to be a "smart city," a city must first ensure a security and public safety foundation – a "smart safe city" has effective physical security merged with cyber-security technologies, all supported by effective, progressive police and emergency services.

The impact of smart-city technologies used by cities themselves will vary, with greater or lesser implications for individuals, demographic communities, and neighbourhoods. IoT technologies that find energy savings in public lighting or detect hidden cracks on bridges are unlikely to have unintended consequences. But in domains such as public security and policing, there is compelling evidence that big data systems connected to surveillance and automated law enforcement practices may produce negative outcomes that demand more intensive public scrutiny and oversight.

Sloly observes that police and justice officials, like all other public- and private-sector leaders, are increasingly investing in technology and data management systems. These begin with equipment, which increasingly includes smartphones; sensor-enabled weapons; body-worn cameras; augmented- or virtual-reality wearable devices; and biometric sensors that monitor vital signs and will alert colleagues if an officer has been wounded. Field officers can tap into increasingly large datasets gathered and analyzed by centralized security operations and available instantly to provide them with real-time intelligence about their environment.

A "smart safe city" has effective physical security merged with cyber-security technologies, all supported by effective, progressive police and emergency services.

In a growing number of cities, police agencies are adding predictive policing capabilities to this information flow. These systems, mostly delivered by specialized private firms like PredPol, Palintir, and HunchLab, use sophisticated algorithms that combined data on geographical features, past crime patterns, and other sources to pinpoint areas likely to experience criminal activity. Predictive policing technologies, which have emerged in the past four years or so, are intended to allow law enforcement agencies to direct additional crime prevention resources to areas likely to experience property or violent crime, including stepped-up patrols.

According to law professor Andrew Guthrie Ferguson at the University of Washington, D.C., the latest iteration of these systems goes beyond identifying areas that may see heightened future criminal activity, but also identifies individuals who are deemed by predictive algorithms to be likely to commit crimes.[30]

Mass surveillance and the leveraging of big data, Sloly warns, can have both positive and negative outcomes, even though such technologies were created to improve public safety. Algorithmic bias, for example, has emerged as a significant issue with such systems, and is now subject to intensive scrutiny by civil liberties organizations in Canada and the United States. In December 2017, New York City even created a task force to examine hidden biases in a range of municipal technologies.[31]

There are concerns that algorithmic analysis of trends in police data drawn from street checks may suggest elevated levels of crime in low-income, marginalized, or racialized neighbourhoods, but those findings can be distorted by poor data collection and management, ineffective or unethical practices, and individual or systemic bias – there is a risk of "garbage in–garbage out" which creates negative unintended outcomes (for example under-policing, over-policing, or racial profiling).

There have been well-documented recent examples of problematic police use (or misuse) of geographic information obtained from social media networks like Facebook and Twitter. For example Geofeedia, a data analytics firm, marketed its services to hundreds of police agencies. Its approach was to take geographical information drawn from these social media feeds and sell it to police agencies to assist, for example, in physically tracking the locations of protestors or other individuals who have appeared on police radars. Social media companies stopped providing Geofeedia with this information when the American Civil Liberties Union publicized the practice.[32]

While a range of commonplace technologies now constantly gather real-time information on individuals (through smartphones, fitness trackers, and closed-circuit television cameras), municipal agencies that deploy smart-city technologies that gather and analyze information about the movement of residents in public space should subject those systems to privacy screens and regulatory oversight to ensure the anonymization of data and other basic privacy practices. By and large, the policy environment at present lags behind the pace of technology development and deployment.

Smart-city governance

Smart-city technologies do not merely mean more efficient ways of delivering municipal services. Rather, these digital tools and the new sorts of data that they generate have the power to profoundly alter the way cities look and function.

Therefore, the dawn of the smart cities era points to a parallel debate – still in its infancy but critically important – about the role of local government as the principal actor in the formation and management of urban space.

In general, all new smart-city technologies should raise questions of balance and equity as well as efficiency. If a technology reduces operating costs, are the savings used to cut property taxes (with benefits to property owners) or to offset the cost of running social or recreational services? Does improving the movement of vehicles by optimizing traffic lights make streets more dangerous for cyclists and pedestrians, whose movements cannot be captured by GPS? As Zachary Spicer asks: Who, precisely, are we building smart cities *for,* and who will be excluded?[33]

He offers one way of answering this question: examining broadband access. Higher-income, better-educated households and individuals have more access to high-speed internet and smartphones than those at lower incomes or with lower levels of educational attainment. Similarly, there is an age gradient: older people are less connected than younger people. So if a municipality invests in smart-city technologies that provide access to consumer services through online portals or apps, the benefits will accrue to those groups with better online access or competency.

Who, precisely, are we building smart cities for, and who will be excluded?

Spicer points to some cases that confront the inclusion question by directing smart-city investments to marginalized groups and those less well-positioned to benefit from technology gains. In Columbus, Ohio, for example, the City is using $50 million from the Smart City Challenge to launch a pilot project using AV minibuses to provide better transit service in lower-income neighbourhoods, where families are cut off from access to health care, education, and employment zones. The City's stated goal was to leverage these improved transit services to significantly improve access to health and maternal care services for young, low-income families without access to private vehicles, and, as a result, reduce infant mortality by 40 percent by 2020.[34] (Questions have arisen recently about the slow pace of the rollout and how it will affect Columbus's goal.[35])

More generally, such policy choices seem to demand new forms of governance systems and frameworks to evaluate the impact of complex technologies. Pamela Robinson points out that there are few useful governance models, because municipalities focus their planning on the physical features of urban spaces. New approaches should address several core principles:

- *Data ownership***.** For information collected in public spaces, who will own it, for how long, and under what terms and conditions?[36]
- *Transparency***.** In spaces such as Quayside, which will be fitted out with a network of sensors and thus will function differently from other neighbourhoods, how will people be made aware that they have entered a data-gathering environment?
- *Consent***.** If a private entity is collecting and aggregating data from individuals passing through public spaces, should those individuals first provide their consent, and how will that process work in practice?

As Robinson argues, such technologies need to be inclusive, which is to say that smart city data governance policies must ensure that experimental or functional smart-city systems do not leverage data in socially exclusionary ways. "We haven't started to have that conversation," she says.

Conclusion

Even a cursory survey of the wide variety of smart-city technologies shows that these systems – coupled with other established or emerging consumer products and services (such as ride-sharing and autonomous vehicles) – have the potential to dramatically alter the urban landscape, for both good and ill. Cities, of course, change constantly: fluidity and socioeconomic dynamism have always been the hallmark of successful urban spaces. One need only reflect on the impact of three relatively basic technologies – elevators, steel-frame construction, and the combustion engine – to appreciate the way certain inventions can drastically alter the face of the city.

Mindful of this history, policymakers, technology providers, and citizens now face the challenge of devising democratic and inclusive approaches to assessing smart-city products and services, and the governance systems required for communities that use these systems. We should embrace the smart city promise of optimized urban systems, but, as Robinson points out, we need to do so in constructively critical ways. In other words, we need to be smart about smart cities.

Endnotes

1 The phrase can be traced back to the "smart growth" movement that sprang up in the 1970s.

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