COLLECTIVELY BUILDING THE FRAMEWORK TO SHAPE OUR FUTURE CITIES

A Year of Engagement with the ICTC Smart Cities Taskforces

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Preface

As a not-for-profit, national center of expertise, ICTC strengthens Canada's digital advantage in a global economy. Through trusted research, practical policy advice, and creative capacity-building programs, ICTC fosters globally competitive Canadian industries enabled by innovative and diverse digital talent. In partnership with a vast network of industry leaders, academic partners, and policy makers from across Canada, ICTC has empowered a robust and inclusive digital economy for over 25 years.

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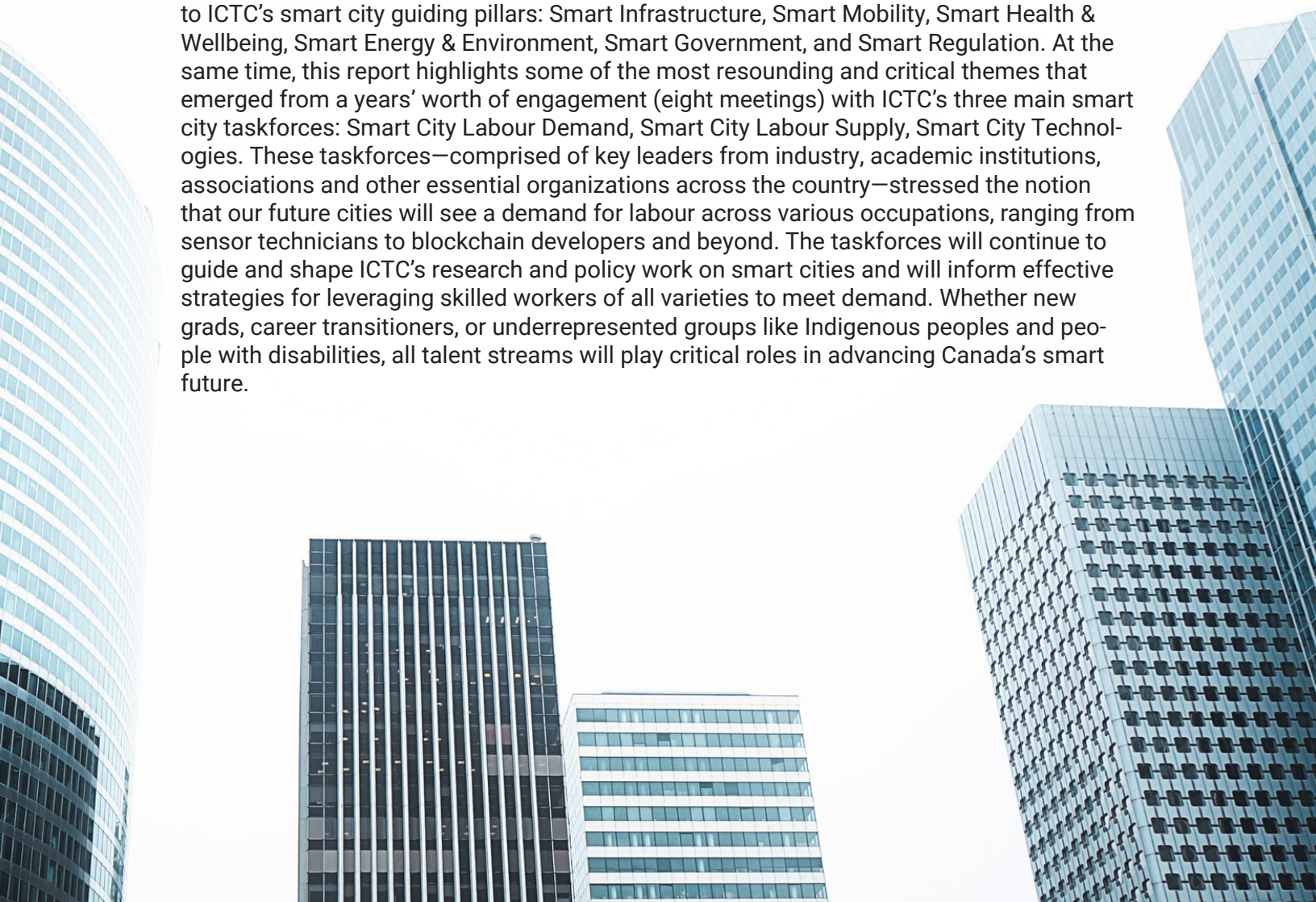
EXECUTIVE SUMMARY

Toward an Inclusive and Vibrant Smart Economy

As the world becomes increasingly urbanized, with cities accounting for the majority of the population growth and economic activity, the topic of smart and sustainable urban development inevitably emerges. With that comes a renewed interest in opportunities for improved efficiency and livability through "smart" interventions, activities, and technological development. Although a universally accepted definition of a "smart city" does not exist, ICTC defines this concept as a community that uses technology to guide operational efficiencies with the aims of improving the quality of life and services for its residents. In Canada, the notion of a smart city is increasingly gaining momentum, with one of the most significant recent developments being the Government of Canada's *Smart Cities Challenge*. Although the winners of this challenge were announced in the spring of 2019, this competition was notable because it helped communities of all sizes and across all regions explore technology-based initiatives that can improve livability. Internationally, many jurisdictions are also engaging in similar challenges and exploring various pathways for the development of future communities.

While not intended to serve as an exhaustive list, this report provides an understanding of notable smart city developments taking place in Canada and around the world, according to ICTC's smart city guiding pillars: Smart Infrastructure, Smart Mobility, Smart Health & Wellbeing, Smart Energy & Environment, Smart Government, and Smart Regulation. At the same time, this report highlights some of the most resounding and critical themes that emerged from a years' worth of engagement (eight meetings) with ICTC's three main smart city taskforces: Smart City Labour Demand, Smart City Labour Supply, Smart City Technologies. These taskforces—comprised of key leaders from industry, academic institutions, associations and other essential organizations across the country—stressed the notion that our future cities will see a demand for labour across various occupations, ranging from sensor technicians to blockchain developers and beyond. The taskforces will continue to guide and shape ICTC's research and policy work on smart cities and will inform effective strategies for leveraging skilled workers of all varieties to meet demand. Whether new grads, career transitioners, or underrepresented groups like Indigenous peoples and people with disabilities, all talent streams will play critical roles in advancing Canada's smart future.



CANADIAN SMART CITIES

Key Proposals from the Smart Cities Challenge

In Canada, numerous efforts are made daily with the goal of improving resident services and welfare. This includes simple resident-led activities like Free Little Libraries[1], or larger, multi-stakeholder initiatives that can take years to implement, like Ottawa's light rail transit (LRT) system. Although widely different, both the Free Little Library and the LRT can be labelled as "smart" in their own ways.

A first of its kind in Canada, Infrastructure Canada's Smart Cities Challenge encouraged communities from around the country to think about how technology could be used to change the lives of residents for the better. Encompassing both low-tech and high-tech solutions, the following highlights key projects from the Smart Cities Challenge that effectively underscored the importance of the following smart city pillars: Smart Infrastructure, Smart Mobility, Smart Energy & Environment.

- SMART INFRASTRUCTURE: Yellowknife, Northwest Territories. This project focused on smart lampposts to address infrastructure and energy challenges, while offering other benefits such as increased tourism and livability improvements.
- SMART MOBILITY: Surrey and Vancouver, British Columbia. This project tackled new and improved mobility options for the cities of Vancouver and Surrey, including the creation of collision-free, multi-modal transportation corridors.
- SMART ENERGY & ENVIRONMENT: Bridgewater, Nova Scotia. This project focused on the problem of energy poverty, seeking new opportunities for the implementation, use and monetization of green energy solutions.

The following offers an overview of these projects, including potential labour market implications and associated talent needs.

1 "Little Free Library", https://littlefreelibrary.org/

Smart Infrastructure: Yellowknife's Smart Lampposts

Yellowknife, a small city with a population of approximately 20,000, was one of the contenders for Infrastructure Canada's Smart City Challenge. Focusing on what they referred to as 'smart lampposts,' this project—if successful—would involve the development and installation of digitally-connected lampposts with multi-operational functions. These additional functions could include motion activation (lights dimmed and illuminated by sensors), Wi-Fi hotspots, electric vehicle charging stations, as well as interactive tourism kiosks providing essential pieces of information for newcomers to the city. Additionally, the lampposts would collect various data, such as on vehicle, bicycle and pedestrian traffic, while its sensors detect chemical compositions in the atmosphere, including sulphur dioxide and carbon dioxide levels.

This kind of smart, connected infrastructure rooted in data collection and system optimization would result in several improvements for the city of Yellowknife, including improved operations and more effective city planning. One of the highlighted possible outputs of such as project could be a growth in tourism—in this case, sustainable tourism, particularly aurora tourism. The rationale for this possible by-product stems from the reduction in light pollution, which would allow for better viewing of the aurora borealis by eliminating ambient light that is currently emitted from unnecessarily bright streetlights.[2] At the same time, the proposal for this project underlined that such developments can also function to improve livability and produce health benefits. As the smart lampposts can automatically reduce lighting levels during off-peak periods, light pollution that interferes with sleep will be eliminated, and using motion sensors, streets could be well-illuminated when pedestrians or cars are nearby, then dimming in times of low activity.[3]

Labour Market Implications

With new developments such as smart lampposts come new labour market opportunities and labour needs. The following are some digital occupations that may see growth with the development of smart lampposts in Yellowknife:

- Sensor Technicians: Workers in this role would be needed to install, test, monitor, and repair sensor equipment related to connected lampposts, along with their supporting infrastructure.
- Geospatial and Geomatics professionals: Workers in this field would be required to provide expertise on regional mapping and topography, and advice on appropriate locations to inform land-use planning. This is particularly relevant to ensure that new infrastructure projects have minimal disturbances on existing natural habitats and green spaces.

2 Richens, Meaghan, "City of Yellowknife finalist in Smart Cities Challenge," My Yellow Knife Now, June 1, 2018. https://www.myyellowknifenow.com/29871/29871/

3 "Smart Street Lights for Brighter Savings and Opportunities," Intel, accessed January 2020. https://www.intel.com/content/dam/www/public/us/en/documents/solution-briefs/smart-street-lights-for-brighter-savings-solutionbrief.pdf

Smarter Mobility, Together: Vancouver and Surrey's Collision-free Corridors

The cities of Surrey and Vancouver (with a combined population of over one million)[4] proposed to develop 'two collision-free, multi-modal transportation corridors' for Infrastructure Canada's Smart City Challenge. Intertwining smart technologies and autonomous vehicles (AV) for healthier, safer, and more socially connected communities, this mobility re-jig aimed to alleviate traffic congestion, reduce carbon emissions, and offer a broader range of transportation options for residents.

The creation of multi-modal corridors (separated pedestrian, bike, public transit and vehicle traffic lanes) would require notable improvements and enhancements in local infrastructure. This includes the installation of sensors in roads, the development of intelligent traffic signals, and a significantly expanded network infrastructure to support this new level of connectivity. The potential benefits of such a development would have proven significant, expanding far beyond the parameters of mobility itself. The reduction or elimination of collisions would have a significant effect on road safety and, with improved transportation accessibility, could come increased opportunities for economic participation across demographic groups, including people with disabilities or those living in more remote areas.

Labour Market Implications

Smart mobility developments like this, and the eventual adoption of AV technologies will undoubtedly produce widespread impacts on the labour market. For an illustrative example, the everyday use of AVs will lead to the decline of driving jobs (i.e., taxi drivers, truck drivers, bus drivers, as well as a reduction in the need for police to spend time investigating traffic incidents). The reduction or elimination of collisions would also have implications for the insurance industry, which would need to rethink the notion of driver liability. While these are examples of longer-term labour market impacts, the implementation and success of multi-modal transportation corridors in Vancouver and Surrey could also facilitate growth in digital areas such as the following:

- Traffic engineering professionals: this branch of civil engineering uses different techniques to ensure the safe and efficient movement of people and goods in transportation corridors.
- Urban planners and land use planners: urban planners would be required to define future goals, policies, and balance traffic needs against city socioeconomic and environmental requirements.
- Telematics architects: this is an interdisciplinary field encompassing telecommunication, vehicle technologies, road transportation, engineering, and computing. These roles would be necessary to integrate the various components of smart mobility, including autonomous vehicles in the transformation of the transportation system.

4 "Spotlight on Finalists", Infrastructure Canada, June 10, 2019. https://www.infrastructure.gc.ca/cities-villes/spotlight-vedette-eng.html

Combating Energy Poverty in Bridgewater, Nova Scotia with Smart Solutions

The development and use of green energy will become an increasingly critical consideration as climate change creates new global challenges. With these challenges comes the need to develop sustainable solutions for a carbon-neutral future. By 2050, the United Nations estimates that the global population will grow to nearly 10 billion, a figure that is projected to balloon further to over 11 billion by 2100[5]. The demand for green energy and sustainable solutions—whether tied directly to the Sustainable Development Goals or independently—must be a central focus.

Facing challenges associated with access to energy, Bridgewater, a small community in Nova Scotia, tendered a successful bid for the Infrastructure Canada Smart Cities Challenge focused on energy use, availability, and affordability. With approximately 40% of the city's residents experiencing energy poverty—defined as spending more than 10% of household income on energy, compared to the national average of 3%[6] —Bridgewater explored alternatives to combat this challenge, including green energy and energy trading.

With one of the goals of this initiative being the use of cleaner energy alternatives, the city plans to install smart energy monitoring and control equipment in homes. This equipment can find efficiencies by turning off during periods of low demand, for example. Eventually, excess energy collected by households can be stored and resold to residents needing it. This initiative expects to bring 20% of residents out of energy poverty by 2028.[7]

Labour Market Implications

Developments like the above may impact existing and emerging occupations. In the long-term, they can function to slow the demand for employment among traditional energy-related occupations (e.g. coal mining, oil and gas extraction, etc.) but also accelerate the need for clean energy engineers and technicians, along with other digital and technical occupations.

Examples of occupations that may see increased demand with the growing reliance on clean energy in Bridgewater and Nova Scotia as a whole, may include these:

- Electrical technicians: workers in these roles are needed to install and repair energy equipment such as smart energy monitors in homes and buildings.

5 "World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100", United Nations News, June 21, 2017. https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html
6 "Market Snapshot: Fuel poverty across Canada – lower energy efficiency in lower income households", Canada Energy Regulator, August 30, 2017. https://www.cer-rec.gc.ca/nrg/ntgrtd/mrkt/snpsht/2017/08-05flpvrt-eng.html?=undefined&wb-disable=true
7 "Town of Bridgewater, Nova Scotia", Infrastructure Canada, May 8, 2019. https://www.infrastructure.gc.ca/cities-villes/videos/bridgewater-eng.html

- Power engineering technologists: workers in this role are responsible for the operation and maintenance of complex industrial systems like powerplants. Workers with this kind of expertise would be required to find energy efficiency opportunities to lower usage and costs.
- Blockchain developers: the concept of energy trading, one of the proposed eventual activities of this project, requires the development of databases that are secure, transparent and reliable. Community energy trading may be one prime opportunity for blockchain or distributed ledgers to play a central role. Developers with knowledge of blockchain or distributed ledgers would be key in developing the infrastructure needed to support energy trading at the community level.

LOOKING ABROAD AND LEARNING

International Smart City Developments

There are a variety of highly promising smart city developments around the world that relate to ICTC's smart city pillars. Many of these projects have been in progress longer than Canadian smart city projects in Canada and can offer insights, lessons and guidelines. The following international smart city projects will be described for the purposes of identifying best practices that can be applied to Canada:

- SMART GOVERNMENT: Singapore. The GovTech project focuses on the digitalization of citizen services, coupled with advanced training in data science and cybersecurity for government workers.
- SMART HEALTH & WELLBEING: Basel, Switzerland. The University Hospital of Basel uses new technologies and digitalized health data to improve patient outcomes and find cost efficiencies.
- SMART REGULATION: Seattle, USA. The Privacy Program.

Singapore: Smart Government

In pursuit of a smart and effective government, Singapore created a Smart Nation and Digital Government Office (SNDGO). Its purpose is to develop safe and secure digital infrastructure while expanding the availability of online government services. Under the SNDGO banner, Singapore's *GovTech* initiative focuses specifically on the transformation of government through the digitalization of government services and citizen initiatives.
There are numerous government services offered online, via the GovTech project. These include:

- SingPass: this is an online system that allows users to securely transact with 60+ government agencies to access hundreds of government services.[8] Services include applying for housing, filing taxes, and managing government healthcare and retirement savings accounts.[9]
- OneInbox: this is a trusted platform for the delivery of government electronic correspondence with individuals and businesses.[10]
- CorpPass: this is an integrated, single login self-service platform for business users to complete corporate transactions like business licensing, paying taxes, and liaising with the IP office.[11]

With the digitization of such services, strong cyber hygiene and sound cybersecurity infrastructure becomes critical. The digitalization of government services—namely to the extent that Singapore has done with 1,600 government services available online—can also accelerate the threat of cyberattacks.[12] Moreover, attacks where access to citizen and government private data may be compromised is a critical concern. Cyberthreats can evolve as quickly as technological advancements, and government digital platforms must remain resilient not only through the detection of existing threats but also to foresee and prevent future cyberattacks. Singapore has created a cyberthreat prevention and response strategy, including extensive training and education for public servants. Examples of public sector cybersecurity training and security measures implemented by the government of Singapore include:

- An IT security awareness program that is mandatory for all public service employees.[13]
- An annual Cyber Safe Ready Conference to enhance cyber awareness for the public service.
- Frequent cybersecurity exercises to sharpen skills related to incident responses for public agencies.[14]
- Increasing internal IT audits and separating connected computers from critical systems.[15]

8 "SingPass – Frequently Asked Questions", Singapore Government, January 20, 2020. https://www.ifaq.gov.sg/SINGPASS/apps/fcd_faqmain.aspx#FAQ_2101382
9 Hio, Lester, "Enhanced SingPass: What you need to know and do", The Straits Time, January 19, 2016. https://www.straitstimes.com/singapore/enhanced-singpass-what-you-need-to-know-and-do
10 "e-Gov2015 Masterplan (2011-2015)", Ministry of Finance Singapore, August 29, 2019. https://www.mof.gov.sg/Policies/e-Government
11 "Welcome to CorpPass", Singapore Government, Accessed January 2020. https://www.corppass.gov.sg/
12 "e-Gov2015 Masterplan (2011-2015)", Ministry of Finance Singapore, August 29, 2019. https://www.mof.gov.sg/Policies/e-Government
13 Sagar, Mohit, "Singapore Government committed to educating all government employees on cybersecurity", Open Gov Asia, April 6, 2019. https://www.opengovasia.com/singapore-government-committed-to-educating-all-government-employees-on-cybersecurity/
14 "MCI's response to PQ on cybersecurity courses", Ministry of Communications and Information Singapore, April 1, 2019. https://www.mci.gov.sg/pressroom/news-and-stories/pressroom/2019/4/mci-response-to-pq-on-cybersecurity-courses
15 Tan, Aaron, "Singapore government to review data security in public sector", Computer Weekly, April 1, 2019. https://www.computerweekly.com/news/252460729/Singapore-government-to-review-data-security-in-public-sector

SMART HEALTH AND HEALTHCARE COST-SAVINGS

A Priority for Basel, Switzerland

Acting as a global leader in online healthcare services and delivery, the University Hospital Basel (USB) has plans to become the world's first digitalized hospital by 2025. Partnering with the University of Basel, key priorities include the implementation of new, patient-friendly technology solutions to create an efficient and modern health care environment.[16] One example of these initiatives is a hospital app that informs patients where to go, what information they need to bring, eating and drinking requirements before medical procedures or imaging, followed by the ability to access diagnostics results.

Other developments in the hospital include telemonitoring of health signs that are evaluated according to criteria such as genetic predisposition, age, current movement, and medications. In-patient bracelets are enabled by QR codes, allowing nurses and doctors to scan and effectively check the patient's medical history and current medications. Virtual Reality (VR) is also used in combination with 3D images produced by MRI machines for diagnostic imaging and surgeries, and patients can even see their 3D diagnostic imaging in a VR room.

This digitization of hospital services and patient care will also allow for the improved collection of data: everything from lab scores, fitness tracker results, and patient history and information can be analyzed for the improvement of health research and patient care. In fact, a recent study of Swiss patients identified that 35% of "pain points" or challenges were a result of insufficient information due to paper-based administration or inefficient flow of data.[17] Technology innovations with the potential to improve healthcare results and affordability is crucial globally, and specifically in Switzerland. After the United States, Switzerland has the second highest health spending as a share of GDP (12.1%) in the OECD.[18] While the Swiss health system is highly regarded for outcomes, there are opportunities to find increased efficiencies to reduce health expenditures via smart solutions like the ones discussed above.[19]

16 "University Hospital Basel Mission Statement", The University Hospital Basel, Accessed January 2020. https://www.unispital-basel.ch/ueber-uns/das-universitaetsspital/
17 "The digital opportunity in the Swiss healthcare system", PricewaterhouseCoopers, February 2019. https://www.pwc.ch/en/publications/2019/Digital-opportunity-in-the-Swiss-healthcare-system.pdf
18 "Health policy in Switzerland", OECD, July 2017. https://www.oecd.org/els/health-systems/Health-Policy-in-Switzerland-July-2017.pdf
19 "Health policy in Switzerland", OECD, July 2017. https://www.oecd.org/els/health-systems/Health-Policy-in-Switzerland-July-2017.pdf

A PRINCIPLES-DRIVEN APPROACH TO PRIVACY FOR A SMART FUTURE

Focusing on Seattle

Seattle's status as a leading global technology hub has made it a natural fit for smart city development. The city's efforts are characterized by a strong focus on transparency and public engagement around privacy issues. The need to protect public privacy came in response to the concerns of residents and city council regarding new technologies such as drones, police body-worn cameras, smart utility meters, city networks and surveillance cameras.

Notably, Seattle had faced significant public backlash from the installation of a wireless mesh network that had the potential to track and log wireless devices that moved through the system. This network was later deactivated and the city formed a Privacy Advisory committee of local experts and academics.[20] Seattle launched an overarching Privacy Program (led by the IT department) in 2015 to define how the city collects, uses, and disposes-data.[21] It is now positioned as a leader in privacy policy and regulations that are crucial to modern smart city development. Some of the key components of their strategy are listed below:

- Chief Privacy Officer (CPO) : Appointed in 2017, the current CPO has experience implementing Privacy Principles within the local government as well as serving as a senior privacy manager for Microsoft.[22] Seattle is notable as one of the few cities with a chief privacy officer, a role that is responsible for establishing privacy guard-rails for how data gathered in the city will be used.[23]

20 "What's Fueling the Smart City Backlash?" Wharton University of Pennsylvania, September 24, 2019. https://knowledge.wharton.upenn.edu/article/whats-behind-backlash-smart-cities/; "Data and Privacy Challenges for Smart City Leaders", City Innovators, Accessed January 2020. https://cityinnovatorsforum.com/data-and-privacy-challenges-for-smart-city-leaders/
21 Brazel, Rosalind, "City of Seattle Hires Ginger Armbruster as Chief Privacy Officer", City of Seattle, July 11, 2017. https://techtalk.seattle.gov/2017/07/11/city-of-seattle-hires-ginger-armbruster-as-chief-privacy-officer/
22 "Seattle Re-Ups Privacy Commitment with Appointment of City Program Expert", Government Technology, July 11, 2017. https://www.govtech.com/people/Seattle-Re-Ups-Privacy-Commitment-with-Appointment-of-City-Program-Expert.html
23 Waddell, Kaveh, "Cities are writing privacy policies", Axios, June 29, 2019. https://www.axios.com/cities-data-privacy-laws-fa0be8cb-234f-4237-b670-10ad042a772e.html

- Privacy Advisory Committee: this external group of local experts, academics, and community representatives was established in 2014. They provide guidance to the city and helped establish a "privacy toolkit" to help educate the city's departments on privacy practices and compliance.[24]
- "Open by Preference" data strategy: this is an extra layer of caution with the aim of being more deliberate about data practices from the outset. An "open by default" policy could mean "publish first, ask questions later," with all datasets be released online, unless there was a clear reason not to do so.[25] It is still the city's preference to publish all its data, but after privacy and security has been accounted for.[26]
- "Strongest-in-nation" surveillance tech transparency ordinance passed in 2017. This first-ever surveillance ordinance in the US also includes an expanded definition of surveillance technology.[27] It also requires conducting community outreach prior to council approval, ensuring the public is aware and informed regarding the use of this technology.[28]
- Holistic approach to privacy: Seattle has benefitted from a coordinated, long-term vision with citywide privacy policy and principles.[29] A collaborative approach (focused on flexibility) is used to educate and train staff. This has helped secure long-term planning and organizational buy-in.[30]

24 Soper, Taylor, "City of Seattle unveils new privacy program to 'build public trust' about use of personal information", Geekwire, October 12, 2015. https://www.geekwire.com/2015/city-of-seattle-unveils-new-privacy-program-to-build-public-trust-about-use-of-personal-information/

25 Faife, Corin, "The Safe Way to Build a Smart City", CityLab, October 2, 2017. https://www.citylab.com/solutions/2017/10/municipal-open-data-smart-city-guidelines-seattle-lessons/541578/

26 Wood, Colin, "Seattle Calls for its Data to be 'Open by Preference'", Government Technology, February 26, 2016. https://www.govtech.com/Seattle-Data-Open-by-Preference.html

27 "Data and Privacy Challenges for Smart City Leaders", City Innovators, Accessed January 2020. https://cityinnovatorsforum.com/data-and-privacy-challenges-for-smart-city-leaders/

28 "Council Approves Strongest-in-Nation Surveillance Technology Transparency Ordinance", City of Seattle, July 31, 2017. https://council.seattle.gov/2017/07/31/council-approves-strongest-in-nation-surveillance-technology-transparency-ordinance/

29 Maddox, Teena, "How Seattle wants to avoid becoming a 'dumb smart city', TechRepublic, January 20, 2017. https://www.techrepublic.com/article/how-seattle-wants-to-avoid-becoming-a-dumb-smart-city/

30 Carson, Angelique, "How One City's Leading the Pack on Privacy", International Association of Privacy Professionals, Oct 15, 2015. https://iapp.org/news/a/how-one-citys-leading-the-pack-on-privacy/

ENGAGEMENT WITH LOCAL EXPERTS

Smart City Labour Demand, Labour Supply, and Key Technologies: A Year of Taskforce Meetings

Three taskforces were created to provide guidance and recommendations on ICTC's smart cities research. These taskforce members are leaders from industry, educational institutions, economic development agencies, municipalities, and other relevant stakeholder groups (such as organizations that serve people with disabilities or Indigenous communities). The supply taskforce is responsible for considering issues related to the future sources of qualified workers, while the demand taskforce looks at future public sector and private sector needs for workers in smart cities. Lastly, the technology taskforce was established to provide insight on technological trends and impacts for smart cities, and was comprised of companies producing technologies for data collection, analysis, geo-positioning, telecommunications, smart infrastructure, cybersecurity, AI, and more.

Meeting One: Smart Cities Supply and Demand Taskforces

March 12-13, 2019

During the spring of 2019, ICTC hosted the first meetings of its Smart City Labour Demand and Labour Supply Taskforces in Ottawa. The main goals of these meetings were to unpack the notion of a "smart city," outline and discuss ICTC's guiding smart city pillars, and assess the metrics and indicators that make up ICTC's Smart Cities Labour Readiness Index. Other more general objectives of this meeting included investigating new areas and opportunities, and highlighting best practices—both nationally and globally.
A number of key themes and insights were gleaned this initial meeting. The following is an overview of the most important themes and considerations uncovered in this first meeting:

1. **Training, continuous learning and upskilling must become a key part of 'government culture'**

The importance of recreating a "government culture" that includes training and continuous learning was highlighted as essential. With a rise in connectivity and "smart" solutions, taskforce members emphasized the potential for increasing vulnerabilities or attacks, particularly at the level of city infrastructure and services.

At the same time, city residents increasingly demand convenience through expanded digitization of services. However, an increasing reliance on digital government services means larger volumes of personal data held by the cities (and associated companies), which entails additional training for government workers. Singapore was highlighted as an example of a leading government emphasizing a culture of cybersecurity as well as cybersecurity training: this training is mandatory for all government staff. The notion of training and retraining is largely accepted as a "norm" in a digital age.

Taskforce participants felt that ongoing training should also be considered as the "norm" in Canada and built into the culture of government workers. While cybersecurity was highlighted as a key area of focus for this training, taskforce members also emphasized the importance of ethics training and education. Smart City development necessitates the extensive use of data, a lot of it coming from city residents themselves. Training on how to ethically handle, use, and dispose of this data was deemed to be a critical imperative for future government workers. This training was viewed as something that could be coupled with education on diverse community needs and challenges.

2. **Creative work and digital skills are key, but don't short-sell the so-called "low-skilled" workers**

Taskforce members overwhelmingly agreed that a variety of jobs will ultimately be impacted by smart city developments. That is, future labour demand will not rest only with high-skilled digital roles like software developers or data scientists but will be seen in other areas, including so-called "low-skilled" occupations like the trades. Trades workers were deemed especially crucial for the early stages of smart city projects, specifically in the installation of the physical infrastructure required for further digitization. In one example, a taskforce member noted that electricians and cable installers will need to develop new knowledge sets to install new networking and IoT devices and infrastructure—but ultimately, they will still be needed to install it.

Taskforce members also highlighted the citywide disruptions that can be expected from the increasing use of technology and growing automation. With the potential for many tasks (high and low) to be automated, creativity, critical thinking and problem solving will be key skills in all future occupations.

3. **It's time to actively rethink and rebuild education, training, and upskilling**

Along with the new skill requirements and labour demand that is expected occur with smart cities, four taskforce members emphasized the need for our educational institutions to "catch up." This includes the development of new and diverse education, training, and reskilling pathways.

Highlighting the need for heightened collaboration between industry and academic institutions, taskforce members stressed that there is no "one-size-fits-all solution" when it comes to training and education. That is, depending on the depth and type of knowledge and skills required, appropriate pathways may exist through university degrees, colleges diplomas, technical certificates, or even shot-duration programs and bootcamps. Each pathway can apply in different circumstances, but collectively creating the mechanisms to support these pathways is a high priority in the short-term.

4. **Where does social return on investment (SROI) fit into the smart city conversation?**

ICTC's Smart City Labour Readiness Index was discussed during these meetings and was met with broad support. A variety of data sources (such as post-secondary institutions and local start-up ecosystems) were suggested as potential participants in measuring talent availability across cities. However, a good question posed in relation to "smart city readiness" was the concept of broader social considerations. Taskforce members suggested investigating possible measures such as environmentally friendly innovation, inclusive innovation (broader economic participation and benefits) as well as social return on investment (including positive social or environmental values in addition to economic benefits), before labelling a city as "ready" to become a smart city. For truly smart and sustainable cities to achieve their fullest potential, it was noted that changing demographics, talent supply shortages, and better integration and participation of traditionally underrepresented groups needed to be fully considered.

Meeting Two: Smart Cities Demand, Supply, and Technologies Taskforces

July 24-25, 2019

In the summer of 2019, ICTC hosted its second round of meetings for the Smart City Labour Demand and Labour Supply Taskforces as well as the first meeting of the Smart City Technologies Taskforce.

Discussions from these meetings covered a wide variety of topics, including an update on the status of smart cities in Canada, data collection and usage, security and privacy, as well as sustainable urban planning considerations. The following is an overview of the most important themes and considerations in this second meeting:

1. **Relationship building is essential for cities to become 'smart'**

In these meetings, taskforce members emphasized the need for stakeholder alignment. Companies and governments must consider societal, health and economic outcomes, while working together to achieve these goals in tandem. However, there exist challenges largely around the lack of knowledge of the opportunities available. Some city officials

struggle to find opportunities to help their departments become more efficient and lack the time and resources to learn about new technologies (and companies offering these technologies). In addition to ongoing education, city officials should pursue opportunities to build relationships with industry.

2. **Building on areas of success and looking at the big picture**

Some smart city developments have found more immediate return on investment (ROIs) than others. Many initial smart city projects that have found success emphasized clear financial, or cost savings that can relieve budgetary pressure. A move to cloud services is a common example of success in this area. However, taskforce members suggested that municipalities should look beyond basic cost-saving measures and focus on bigger issues like improvements to livability in the interest of ensuring smart city projects are effective but also sustainable.

Taskforce members suggested that city employees receive sustainability training to better understand long-term challenges and solutions based on the unique needs of their cities.

3. **Yes, STEM skills are important—but building "human skills" should be mission critical**

On the topic of labour supply and skills, the role of continued upskilling and reskilling was highlighted as essential for future smart cities to meet their full potential. While taskforce members agreed that smart cities and the smart economy will need to access workers with STEM (science, technology, engineering, math) skills, the importance of interdisciplinary learning and "human" skills were also crucial.

Human skills—such as empathy, dialogue, critical thinking, problem solving, and teamwork—were stressed as essential for near and long-term future supply, with work-integrated learning programs and experiences underlined as one key method of building these skills among students during their formal studies. Taskforce members expressly noted that smart cities will embolden the need for human connections, and further highlight the importance of cross-disciplinary skills rather than purely technical kills. Moreover, taskforce members suggested that the human skills would take longer to cultivate compared to technical skills. As one member put it, "A lot of practical technology solutions already exist that don't require high levels of skill. If it's a program to get homeowners to put solar panels on their roofs, then simple solar installation courses could upskill local trades people."

4. **The digital divide is a barrier to long-term smart growth across cities**

Discussions about labour demand also included the adoption of technology solutions and economic activity that factor into future needs for employees of all skill levels. In this discussion, taskforce members brought up the necessary support structure or infrastructure to enable this kind of economic development across cities, specifically connectivity.

Improved connectivity is essential for smart city development, yet poor or unaffordable connectivity in some cities block the economic development and entrepreneurship that is needed to support high-quality employment.

While the focus of these meetings was largely on the needs of cities and urban centres, taskforce members emphasized that many rural and remote communities in Canada face significant connectivity challenges and, as a result, limit their ability to adopt new technologies and the implementation of "smart" solutions.

Meeting Three: Smart Cities Demand, Supply, and Technologies Taskforces

November 26-27, 2019

In the fall of 2019, ICTC held its final meetings of the year for the Smart City Labour Demand, Labour Supply, and Technology Taskforces. These meetings built upon the previous findings and allowed ICTC to discuss research findings, interviews with over 25 municipalities across the country, the results of national surveys, preliminary data on job availability, and skill needs across 15 Canadian municipalities. The following is an overview of the main themes and considerations covered in this third meeting:

1. **It's time to focus on collaboration and engagement—at home and across the pond**

Presenting findings from the interviews with various municipalities across Canada led taskforce members to consider what might be achieved through collaboration with cities facing similar challenges or engaging with vendors of interest. Participants emphasized the need for consultations and public engagements, which helps avoid blind spots and ensure that public interest is considered as well as those of private tech companies working with municipalities.

Moreover, taskforce members noted that Canada need not approach this challenge in a vacuum. For example, one taskforce member stated that is worth considering international frameworks such as the United Nations' 17 Sustainable Development Goals (SDGs)[31] when building smart city strategies. Canada can engage with and learn from international jurisdictions that have faced similar challenges and implemented successful solutions.
A recurring theme across the discussions was that Canada cannot afford to work in isolation, nor does it have to reinvent the wheel: lessons learned and solutions developed should be brought in from jurisdictions that lead in smart city development, such as Singapore, Estonia, Sweden, Finland, or South Korea.

31 "#Envision2030: 17 goals to transform the world for persons with disabilities", United Nations – Department of Economic and Social Affairs, accessed January 2020. https://www.un.org/development/desa/disabilities/envision2030.html

2. **Building a data governance structure should be a top priority**

Related to the need for engagement and consensus, taskforce members stressed the importance of developing foundational policies related to data privacy and data ownership.

The Sidewalk Labs project was cited as an example for why this framework is necessary by many participants. Concerns over privacy and the risk of surveillance from both governments and private companies with this project resulted in a call for better privacy protections and a guiding framework in this area. Several taskforce members believed that ownership of data should remain with the end user, its sharing needs to be consensual, and the value created by the data should be shared with the end user.[32]

Further accelerating the need for this framework were concerns over corporate incentives for the use of data compared to data used for the public good, as well as the need to ensure that Canadian data was kept in Canada (and subject to Canadian privacy protection rules). Security, privacy, and ethical challenges around data usage is likely to be a continued area of contention, but there was a strong emphasis from the taskforce on the need to enable innovation through data usage and sharing. Many taskforce members believed that data should be shared as openly as possible with appropriate safeguards. While misuse of data is a risk, it is also a risk to forego the benefits of sharing data. A framework, including standards and protocols, related to open data will also be a key consideration should data sharing become a common practice.

3. **All-hands-on deck: urgent collaboration needed to boost talent supply**

A growing digital talent shortage coupled with newly emerging challenges expressly tied to smart cities led taskforce members to identify the need for a multifaceted, 'all-hands-on-deck' approach to building and supporting future talent pipelines. This included collaboration between education institutions, private industry boot camps, foreign worker onshoring, and government work training incentive programs. There will also be a need for dedicated technical workers comfortable in developing and adopting technology applications, but this will occur in tandem with the need to prioritize the reskilling, upskilling, and retraining for mid-level talent, and existing workers. Although it is challenging to predict the specific skill needs required in the future, taskforce members asserted that this uncertainty should not quell efforts to plan for them.

4. **The infrastructure of smart cities: overhaul or just revamping?**

In the context of infrastructure needs for future cities, many participants felt that existing assets can have "smart" functionalities built in—that is, existing infrastructure could be repurposed to meet smart city needs. New infrastructure is not always needed. For example, currently, physical infrastructure can be digitally modelled in 3D (known as digital twinning) for the purpose of understanding performance and maintenance issues before they happen. The use of this technology on existing physical infrastructure may be a key

32 Stastny, Paul, "Glimmering Smart Cities, Yes, But to What End? Insights from ICTC's Smart Cities Forum in November", Information and Communications Technology Council, December 19. 2019. https://www.ictc-ctic.ca/ictc-smart-cities-forum-november/

component that determines whether that piece of infrastructure is still usable and can be revamped to be more sustainable or ‘green’, or if something new needs to be built in its place.

Other forms of new technology that can be used in existing physical buildings include technology for sequestering carbon dioxide in the manufacturing of concrete products, as well as using circular systems design. This augmentation of new and emerging technologies with existing physical infrastructure was underlined as an essential consideration when planning future cities.

CONCLUSION & NEXT STEPS

Many communities in Canada and around the world are implementing smart city projects with the help of new digital technologies. While there are shared characteristics like the use of data and greater digital connectivity, the case studies examined in this paper illustrate the wide variety of opportunities. Efficiency, environmental sustainability, livability and improved citizen wellbeing can be achieved through these projects under different thematic pillars, including Smart Government, Smart Infrastructure, Smart Mobility, Smart Regulation and others.

The projects and activities—both in Canada and abroad—in this paper highlight key initiatives undertaken to support a better quality of life for the residents of those cities. The wide range of use cases in this paper demonstrates the vast possibilities as well as the need to consider the unique characteristics of different municipalities. Smart city developments may be based on specific technologies (such as smart lampposts), strategies (whether in e-government, health, or energy management) or overarching goals such as the focus on digital privacy.

It is crucial to ensure that these developments reflect the challenges and expectations of the local community rather than simply adopting new technology because it is available. As this is a long-term project, ICTC will continue to monitor new developments and initiatives both in Canada and internationally.

While this series of smart city meetings covered a substantial amount of material, several broad themes emerged:

- A continued need to address skills training (both technical and soft skills) for workers of all levels. This will require coordinated efforts from the public and private sector.
- Collaboration, engagement, and relationship building (involving citizens, businesses, and governments) will be necessary to successfully integrate these new digital technologies.
- Implementing these changes can involve many different dimensions at a municipal level; for example, this could include considering environmental impacts, social ROI metrics, data governance structures, or physical infrastructure.

ICTC's smart city taskforces will continue to play a critical role by providing insights and validating ICTC's ongoing research in this space while supporting the ultimate goals of understanding the essential elements that Canadian cities need to effectively plan for their smart future. The next smart city taskforce meetings are planned for spring 2020.