MOVING TOWARD AN INCLUSIVE SMART ECONOMY FOR CANADA

The Human Talent Engine that Powers Smarter Cities

ICTC CTIC

Research by

The Information and Communications
Technology Council

Preface

The Information and Communications Technology Council is a not-for-profit, national centre of expertise for strengthening 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 an expansive network of industry leaders, academic partners, and policy makers from across Canada, ICTC has empowered a robust and inclusive digital economy for over 30 years.

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Abstract

This paper examines the talent needs of Canadian municipalities implementing "smart city" projects, or projects that use technology and data collection to improve urban design and decision-making. It identifies changing labour demand related to municipal projects in energy and environment, mobility, infrastructure, health and wellbeing, government, and the regulatory system. It also discusses municipal motivations and challenges related to smart city project implementation based on conversations with municipal representatives across Canada. Key topics in this paper include the following: a shift in focus to environmental and equity-motivated smart city projects, the return on investment and measuring project success, data collection and privacy regulation, the potential of private-public partnerships to fill municipal talent gaps, and the impact of the COVID-19 pandemic on existing smart project trajectories. The final section details in-demand smart city roles and technical and human/soft skills that workers require.

Key terms:

Smart City	COVID-19	Labour Needs
Talent Demand	Canadian Municipalities	

This report is part of a set of three reports that culminates a multi-year research project on smart cities-related jobs, skills, training programs, and the social impacts of smart cities in Canada conducted by the Information and Communications Technology Council (ICTC).

1   Moving Towards an Inclusive Smart Economy for Canada:
    The Human Talent Engine Needed to Power Smarter Cities

2   Bringing a "Smart City" to Life:
    Understanding Talent Development, Attraction, and Retention

3   Technical Report / Supplement

Studying the labour market implications of smart city development across Canada, this set of reports addresses key issues on both the demand and supply side. The overall structure of the analysis follows a labour market forecasting exercise and includes an assessment of growth outlook and demand drivers for smart city projects, and the implications for the kinds of jobs and skills that will be sought in the short and long term. On the supply side, the study looks at the key building blocks—first-time entrants to the workforce, migration, and the ability of smart cities to attract skilled workers from within and outside Canada, and other factors affecting labour supply, such as career transitions, re-entries to the workforce, and freelance and gig workers.

Understanding the key jobs that will be needed in smart cities over the next 10 years involves assessing how smart cities will evolve and grow and how this will impact job and skills demand. This report, *Moving Toward an Inclusive Smart Economy for Canada,* builds this understanding through a review and assessment of various types of smart city projects across Canada and other comparable economies, the impact of legislation and regulations, and recent shifts in consumer and investor priorities, such as the emphasis on decarbonization, clean energy, and issues of social and environmental equity. This is combined with data analysis and insights from primary sources, including surveys, focus groups, and web-scraped data from job boards.

An assessment of labour supply for smart cities in Canada includes studying education and training pathways for new entrants to Canada's workforce, municipal development, and the ability of cities to attract and retain a talented, diverse workforce. *Bringing a "Smart City" to Life* analyzes these key drivers while also looking at the impact of trends such as the increased prevalence of non-traditional educational pathways, especially for technology jobs; the importance of upskilling and reskilling to help ameliorate labour mismatches and enable workers to transition to high-demand sectors; the role of gig and platform workers in a smart city; and the impact of the shift to remote and hybrid work, and the decoupling of labour demand and supply in some locations.

The quantitative analysis of economic and labour market data, and short- and long-term forecasts for the demand and supply of labour for key occupations in Canadian smart cities is presented in the *Technical Report/Supplement.* There are, however, several salient trends and nuances that complement the statistical analysis in the forecasting report, and these are addressed in greater detail in the two larger reports.

Executive Summary

Building smart cities is an important stepping stone toward achieving an inclusive, smart economy for Canada. Around three-quarters of Canadians (73.7%) live in cities, which provide the infrastructure for people's lives and work—infrastructure that is rapidly becoming more digital, connected, and complex.

Skilled talent is needed to make smart city technology work, adapt, and evolve at the municipal level and beyond. City departments that used to operate in silos are now more interconnected; this requires teams to function better, including enhanced interaction, improved management structures, and better ethical oversight. On this journey, technical skills remain critical, but "human skills" are increasingly important across the board—including in technical roles. Skills like critical thinking, teamwork, negotiation, and communication increasingly enable organizations to be effective, agile, and accountable.

Demand for this type of well-rounded talent remains high across the economy, meaning that municipalities are competing not just with other municipalities but also with technology companies and businesses in other sectors that are digitizing. Moreover, the unexpected arrival of COVID-19 and its large-scale impact meant that funds from existing or impending smart city projects required re-evaluation. Over the last two years, provinces, and municipalities drew on funds to cover emergency employer and worker financial supports, and healthcare funding. As a result, several smart city projects were temporarily put on hold as budgets contracted. To cope with this change, many municipalities embraced partnerships with technology service companies to reduce costs and access the consulting talent that grew more difficult to secure on a full-time basis.

While disruptive in one sense, the pandemic also revamped municipal priorities and processes, and highlighted two immediate needs: measuring success and ensuring sustainability. In this project, ICTC identified six key smart city pillars: smart energy and environment, smart mobility, smart infrastructure, smart health and wellbeing, smart government, and smart regulation. While many smart city projects contain elements of one or more of these pillars, all of them play a role in bringing longevity to short-term investments. Under these pillars, municipalities can build in broader metrics to quantify the return on investment (ROI) and social return on investment (SROI) of projects beyond their completion.

Public consultations held by ICTC in cities across the country uncovered two clear priorities held by Canadians, regardless of location: environmental wellbeing; and diversity, equity, and inclusion (DEI). Although many municipalities are committed to advancing net-zero goals, DEI investments are becoming more commonplace, with recruitment and retention becoming a key focus. More municipalities are forming partnerships and alliances with equity-deserving groups and/or creating internal policies and programs that prioritize hiring from BIPOC (Black, Indigenous, and people of colour) communities, newcomers, and people with disabilities.

Building a robust talent pipeline to power Canadian smart cities requires dedication, sound policies, and a clear line of sight to labour and skill demand. Although the type of labour and skills needed can vary by region and project, several in-demand jobs unique to each of ICTC's smart city pillars emerged in this study. Examples include the following:

Smart Energy and Environment

environmental scientists

data scientists

cybersecurity specialists

environmental, social and governance (ESG) analysts

Smart Mobility

civil engineers

geographic information system (GIS) technicians

urban designers

Smart Infrastructure

telecommunication technicians

electricians

smart grid engineers

sensor technicians

Smart Health and Wellbeing

data scientists

data engineers

machine learning engineers

biostatisticians

lab technicians

Smart Government

business analysts

data analysts

UI/UX developers

blockchain developers

policy analysts

diversity and inclusion managers

stakeholder relations specialists

Smart Regulation

privacy officers

regulatory affairs specialists

legal counsels

research analysts

As Canadian cities and communities evolve and smart city projects become more common pathways toward better connectivity, efficiency, and sustainability, the sourcing and retention of skilled talent becomes critical. Individuals with a blend of core technical skills and strong human skills will increasingly power a Canadian economy that is equitable, environmentally sound, prosperous, and truly "smart."

Introduction

The concept of a "smart city" has existed in its most basic form since at least the 1960s, when the Community Analysis Bureau in Los Angeles began using computational statistical analysis to address urban planning problems.[1] Singapore established its National Computer Board in 1981 to boost, among other things, the efficiency of the government.[2] The 1990s ushered in an acceleration in the adoption of policies that can be considered "smart," even though the cities that adopted them used terms like "sustainable urbanization" or "digital city"[3] to describe them. From the 2000s onward, the concept of a smart city was sufficiently prevalent in urban planning circles that many institutions and academics began defining it. A few prevalent definitions of a smart city include the following:

[A city in which] investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory action and engagement. 99   – Caragliu, Del Bo, Nijkamp, 2009[4]

A developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas; economy, mobility, environment, people, living, and government. Excelling in these key areas can be done … through strong human capital, social capital, and/or ICT infrastructure. 99   – Business Dictionary, 2014[5]

A place where traditional networks and services are made more efficient with the use of digital solutions for the benefits of its inhabitants and businesses. 99   – European Commission[6]

1   Mark Vallianatos, "How LA Used Big Data to Build a Smart City in the 1970s," Gizmodo, June 22, 2015,
           https://gizmodo.com/uncovering-the-early-history-of-big-data-in-1974-los-an-1712551686
2   "National Computer Board," Singapore Infopedia, accessed 2022, https://eresources.nlb.gov.sg/infopedia/articles/SIP_2021-11-15_163036.html
3   Chuanjun Zheng, Jingfeng Yuan, et al. "From digital to sustainable: A scientometric review of smart city literature between 1990 and 2019, " Journal of
           Cleaner Production 258, (2020), accessed 2022, https://doi.org/10.1016/j.jclepro.2020.120689
4   Andrea Caragliu, Chiara F. Del Bo, Peter Nijkamp, "Smart cities in Europe," Serie Research Memoranda 0048 (VU University Amsterdam, Faculty of Economics,
           Business Administration and Econometrics, 2009) https://web.archive.org/web/20141103164709/https://ideas.repec.org/p/dgr/vuarem/2009-48.html
5   "Smart City," Business Dictionary, accessed 2022,
           https://web.archive.org/web/20141104014154/http://www.businessdictionary.com/definition/smart-city.html
6   "What are smart cities?" European Commission, accessed 2022,
           https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

However, it is only in the last five years that smart cities have attained widespread public awareness in Canada, and much of this was driven by two key developments. First, In 2017, Infrastructure Canada announced the Smart Cities Challenge, a competition for Canadian municipalities to receive funding for the most impactful and innovative projects.[7] More than 200 communities from across Canada participated in the challenge in its first year.[8] Second, and also in 2017, Sidewalk Labs' Toronto Quayside development became a widely publicized smart city project.[9] While Sidewalk Labs' project was ultimately cancelled in 2020,[10] it succeeded in further popularizing the topic of smart cities among the Canadian public. Canadian public opinion surveys about smart cities began appearing around this time as well, revealing substantial concerns, specifically around privacy.[11]

The first winners of the 2017 Smart City Challenge painted a diverse portrait of communities across Canada that are using technologies and forward-thinking policies to address a variety of urban challenges. The **City of Montreal** won the $50 million prize category with a proposal focused on improving mobility and access to food among vulnerable populations. Montreal's proposal, which involves collaboration with 36 partners, also involves the establishment of the Social Data Analysis Centre and a Montreal Narratives Observatory. The latter integrates data from various sources, analyzing it to gain an improved understanding of residents' needs and to serve as a lever for collective action.[12] A project focused on food insecurity was pertinent because food insecurity affected more than one in 10 Montrealers in 2019.[13,14]

The **Nunavut Association of Municipalities**, which represents all the 25 municipal governments in Nunavut,[15] won the $10 million prize category for its proposal to reduce the risk of suicide among the Inuit in Nunavut. Suicide rates among the Inuit are five to 25 times the national average, depending on the age/sex sub-demographic and time period studied.[16] The proposal focuses on increasing the accessibility of peer support networks, educational resources, and creative outlooks that promote mental health to all residents of Nunavut.[17]

7   "Infrastructure Canada - Smart Cities Challenge," Infrastructure Canada, March 12, 2018, https://www.infrastructure.gc.ca/cities-villes/index-eng.html

8   "The Government of Canada Announces Winners of the Smart Cities Challenge," Infrastructure Canada, May 14, 2019, https://www.canada.ca/en/office-infrastructure/news/2019/05/the-government-of-canada-announces-winners-of-the-smart-cities-challenge.html

9   "Sidewalk Toronto," Sidewalk Labs, accessed 2022, https://www.sidewalklabs.com/toronto

10   Adam Carter, John Rieti, "Sidewalk Labs cancels plan to build high-tech neighborhood in Toronto amid COVID-19," CBC News, May 7, 2020, https://www.cbc.ca/news/canada/toronto/sidewalk-labs-cancels-project-1.5559370

11   "Most Canadians skeptical about smart cities when it comes to their privacy," CBC Radio, August 26, 2019, https://www.cbc.ca/radio/spark/the-spark-guide-to-smart-cities-1.5107883/most-canadians-skeptical-about-smart-cities-when-it-comes-to-their-privacy-1.5107891

12   "Montreal wins the Smart Cities Challenge!" McGill University, 2019, https://ictcctic.sharepoint.com/:w:/s/WILEnergy/EVvjDsXLQ-BBr_rX6PSAwacBzdhXUXYeZ6wWh4C0wgPQ1w?e=nl44Am

13   Aaron Derfel, "Food insecurity affects more than one in 10 Montrealers, report says," Montreal Gazette, December 13, 2019, https://montrealgazette.com/news/local-news/food-insecurity-affects-more-than-one-in-10-montrealers-report-says

14   "Réduire l'insécurité alimentaire à Montréal," Santé Montréal, December 5, 2019, https://santemontreal.qc.ca/en/professionnels/drsp/actualites/nouvelle/reduire-linsecurite-alimentaire-a-montreal/

15   "Nunavut Association of Municipality (NAM)," Municipality of Pangnirtung, accessed 2022, https://www.pangnirtung.ca/nam

16   William Affleck, Eduardo Chachamovich, Nadia Chawky, et al. "Suicide amongst the Inuit of Nunavut: An Exploration of Life Trajectories," International Journal Environmental of Research and Public Health 17, no. 6 (2020), 1812, accessed 2022, https://www.mdpi.com/1660-4601/17/6/1812

17   "Smart Cities Challenge: Katinnganiq: Community Connectivity and Digital Access for Life Promotion in Nunavut," Katinnganiq (2019), https://katinnganiq.com/app/uploads/2019/04/Final_Smart-Cities-Proposal_Nunavut_English-Revised-4.pdf

The proposal involves a partnership with three major partners: Embrace Life Council (a non-profit suicide prevention organization), Qaujigiartiit Health Research Centre (a health research organization), and Pinnguaq Association (an organization providing technological education and digital exposure to Nunavummiut).[18]

The **City of Guelph and Wellington County** also won the $10 million prize category for a proposal focused on changing the nature of food in Guelph, Ontario. "Our Food Future" aims to grow a circular economy in Guelph. As of January 2022, the initiative was overseeing over 60 active projects. Over the three years since the project began, 77,000 meals have been delivered, 740 families have learned about growing food at home, 50 new circular economic businesses have been established, and 181 businesses have been helped in expanding their circular practices. The project is estimated to have prevented 1,769 tonnes of greenhouse gas emissions to date.[19]

The town of **Bridgewater** in Nova Scotia won the $5 million prize category with a proposal that addresses energy poverty (defined as when a household spends 10% or more of its after-tax income on energy, including fuel and electricity). At the time when the proposal was submitted, 38% of households in Bridgewater experienced energy poverty for a variety of reasons such as aging homes, high energy costs, and high transportation costs. The town's proposal goal is to cut its energy poverty rate by half by 2028.[20] "Energize Bridgewater" follows a multi-pronged strategy toward addressing energy poverty, including connecting those who experience energy poverty with community services, retrofitting homes and buildings to improve energy efficiency, creating a local energy investment hub, providing credits for renewable energy generation, improving energy information systems, and establishing a new bus service.[21]

Just nine months after the winners of the Smart City Challenge were announced, COVID-19 shifted attention away from smart city projects to urgent pandemic response initiatives and sustainable recovery plans.[22] Despite this shift, COVID-19 underscored the importance of many smart city initiatives already underway, particularly those related to data-driven decision-making, digital constituent engagement, sustainable mobility, connected infrastructure, and other innovations to support local communities. As Canada emerges from the pandemic, there is a pressing need to understand the talent needed in both the public and private sector to power these community-driven smart city initiatives.

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18   "Overview: Katinnganiq: Community, Connectivity, and Digital Access for Life Promotion in Nunavut," Katinnganiq, accessed 2022, https://katinnganiq.com/

19   "Circular food economy enables business growth, increases food access, and lowers greenhouse gas emissions," City of Guelph, January 27, 2022, https://guelph.ca/2022/01/circular-food-economy-enables-business-growth-increases-food-access-and-lowers-greenhouse-gas-emissions/

20   Alexander Quon, "Bridgewater, N.S., wins Smart Cities Challenge, earns $5M towards reducing energy poverty," Global News, May 14, 2019, https://globalnews.ca/news/5277366/bridgewater-n-s-smart-cities-challenge/#:~:text=Politics-,Bridgewater%2C%20N.S.%2C%20wins%20Smart%20Cities%20Challenge%2C%20earns%20%245,M%20towards%20reducing%20energy%20poverty&text=A%20town%20of%208%2C700%20people,proposal%20to%20reduce%20energy%20poverty

21   "(Home Page)" Energize Bridgewater, accessed 2022, https://www.energizebridgewater.ca/

22   Christine Long, "Montreal mayor touts post-pandemic 'green recovery plan' with $1.8 billion for city parks," CTV News, May 30, 2021, https://montreal.ctvnews.ca/montreal-mayor-touts-post-pandemic-green-recovery-plan-with-1-8-billion-for-city-parks-1.5436974

This report leverages extensive primary research, including 1,000 responses from multiple surveys with employers, interviews with municipal representatives across provinces and territories, and an analysis of data collected from over 550,000 job postings to unravel the demand for talent to power Canadian smart cities projects.

This paper explores talent demand in smart cities from three angles:

> **Section I** provides an overview of select smart city initiatives in Canada and highlights the roles needed to help power these new initiatives

> **Section II** leverages municipal interviews to characterize talent demand for smart city initiatives in the immediate, medium, and long term, as well as the private-public partnerships that support these projects

> **Section III** focuses on in-demand jobs, using web-scraping to identify key roles and skills for smart cities and the businesses that support them

This report along with the *Smart Cities Supply* report and the *Technical Report/Supplement* collectively mark the conclusion of ICTC's multi-year research initiative *Toward an Inclusive Smart Economy for Canada*. This report occasionally refers to these reports, particularly the *Smart Cities Supply* report, as well as roundtables and taskforces with smart city experts and senior municipal staff, and semi-structured interviews with researchers, subject-matter experts, industry leaders, and municipal staff.

Canadian Smart City Projects

An Overview

Municipalities across Canada are pursuing innovative and digital solutions to address everyday challenges. Often referred to as "smart city" initiatives, these projects use data and information and communication technologies (ICT), either to deliver new municipal services or improve the delivery of existing ones. With more than 200 communities from across Canada having participated in the inaugural Infrastructure Canada Smart Cities Challenge in 2017,[23] the concept of a smart city is entrenched in the consciousness of Canadian cities.

ICTC categorizes smart city projects according to six pillars: smart energy and environment, smart mobility, smart infrastructure, smart health and wellbeing, smart government, and smart regulation.[24] In practice, most smart city projects incorporate aspects of several of these pillars. For example, a public transport project such as a tramway or a transit priority corridor could be considered as belonging to both the smart energy and environment pillar (assuming the project reduces emissions) and the smart mobility pillar.

Embracing smart city policies pushes communities to invest in digital infrastructure, hire workers with a blend of digital and human skills, and more generally, to think about solving problems in new and innovative ways. As such, smart cities are changing the labour needs of municipal organizations and the broader economy. This section provides an overview of select projects to illustrate how implementation of smart city projects can change the types of jobs and skills municipalities need.

Smart Energy and Environment

As far back as 2011, a poll by the Public Policy Forum found that 65% of Canadians believe the government has a role to play in fighting climate change.[25] In the last several years, however, climate change has become an increasingly urgent priority for Canadians. In 2021, Ipsos found that climate change was one of the top five issues for voters in the 44th federal election. Close to four-fifths (77%) of voters agreed that Canada should do more about climate change.[26]

This growing sense of urgency about climate change may have, in part, been galvanized by a series of catastrophic weather events that incurred substantial costs to both quality of life and the economy. British Columbia (and to a lesser extent Alberta) was impacted by the 2021 Western North America Heat Wave, which captured media attention across the globe and resulted in the deaths of 619 people in B.C. alone.[27]

23   "The Government of Canada Announces Winners of the Smart Cities Challenge," Infrastructure Canada, May 14, 2019, https://www.canada.ca/en/office-infrastructure/news/2019/05/the-government-of-canada-announces-winners-of-the-smart-cities-challenge.html

24   Alexandra Cutean, Trevor Quan, Holly Brown, "Smart City Priority Areas and Labour Readiness of Canadian Cities," Information and Communications Technology Council (2019), https://www.digitalthinktankictc.com/policy-briefs/smart-city-priority-areas-and-labour-readiness-of-canadian-cities

25   "Climate change an issue in Canada: Poll," CBC News, February 22, 2011, https://www.cbc.ca/news/politics/climate-change-an-issue-in-canada-poll-1.989675

26   Darrell Bricker, "Canadians Agree We Need to Do More on Climate, But Divided on Whether Economy Should Suffer as a Result," Ipsos, August 26, 2021, https://www.ipsos.com/en-ca/news-polls/canadians-agree-we-need-to-do-more-on-climate

27   Alyse Kotyk, "Coroners' review reveals true death toll of B.C.'s 2021 heat dome," CTV News, June 7, 2022, https://bc.ctvnews.ca/coroners-review-reveals-true-death-toll-of-b-c-s-2021-heat-dome-1.5936108#:~:text=Extreme%20heat%20in%202021%20claimed,typically%20sees%20during%20that%20time

According to researchers, this heat wave was among the most extreme heatwaves ever recorded globally.[28] Four years earlier, British Columbia experienced its worst fire season on record, in which 12,000 square kilometres of land burned.[29] In 2019, exceptionally severe spring floods in Ontario, Quebec, and New Brunswick resulted in 13,500 "disaster victims" being evacuated in Quebec.[30] These floods occurred just two years after heavy floods in Quebec forced 4,066 people from their homes.[31] According to the Canadian institute for Climate Choices, the number and cost of catastrophic weather events in Canada from 2010 to 2019 was higher than the pervious 27-year period (1983 to 2009). Over the last decade, the average cost of weather-related disasters each year have risen to 5% to 6% of annual GDP growth.[32]

Despite the growing cost of climate change, tensions exist in Canada when environmental policies threaten the economy. According to Ipsos, around a third (35%) of Canadians (up 4% from 2019) believe that everything should be done to fight climate change, even if the necessary policies slow the economy "a bit." An additional half (51%) of Canadians believe that policies need to balance economic considerations with environmental efforts, and 13% feel that there is "no urgency" to fight climate change if it comes at the expense of the economy. In short, the Canadian ideal appears to be a scenario of "green growth" that allows the economy to prosper while mitigating environmental impacts. Whether or not this is truly possible is debatable (especially among the "degrowth" movement[33]), but sustainability is increasingly seen as integral to the wellbeing of the entire Canadian economy, particularly in the wake of COVID-19. For example, in the report *A Healthy Environment and a Healthy Economy* by Environment and Climate Change Canada in 2020 describes a green growth plan that achieves both "environmental goals and economic hopes.[34]

It is within our reach to build back from the pandemic in a way that meets the need to address climate change and to deliver a strong economy that thrives in a low-carbon world to the benefit of all Canadians... The clean economy is an immense opportunity. Global momentum is already accelerating toward this end, and Canadian workers and businesses are well-positioned to be leaders. [This report contains] a plan that achieves both our environmental goals and our economic hopes: clean air, clean water, and long-term secure jobs... It is a plan that seeks to mobilize the full breadth of Canada's ingenuity and resources to reimagine a future that is secure, just, and clean. 99

28   Brenna Owen, "2021 heat wave over B.C., Alberta was among most extreme since 1960s: study," Global News, May 4, 2022, https://globalnews.ca/news/8810459/bc-alberta-2021-heat-dome-research/.

29   "2021 fire season 'tremendously challenging,' but not worst on record: BC Wildfire Service report," Global News, November 4, 2021, https://globalnews.ca/news/8350088/2021-fire-season-tremendously-challenging-but-not-worst-on-record-bc-wildfire-service-report/#:~:text=Total%20 firefighting%20costs%20for%20the,square%20kilometres%20of%20land%20burned.

30   Sara Champagne, "Inondations: plus de 10 000 personnes évacuées," La Presse online, April 30, 2019, https://www.lapresse.ca/actualites/2019-04-30/inondations-plus-de-10-000-personnes-evacuees

31   Rachel Lau, "IN PHOTOS: Flooding ravages municipalities across Quebec, " Global News, May 8, 2017, https://globalnews.ca/news/3434281/in-photos-flooding-ravages-municipalities-across-quebec/.

32   Dave Sawyer, Ryan Ness, et al. "Tip of the Iceberg: Navigating the Known and Unknown Costs of Climate Change for Canada," Canadian Institute for Climate Choices, 2020, https://climateinstitute.ca/reports/tip-of-the-iceberg/

33   Victoria Matterson, "Degrowth: What's behind the economic theory and why does it matter right now?" World Economic Forum, July 15, 2022, https://www.weforum.org/agenda/2022/06/what-is-degrowth-economics-climate-change

34   "A Healthy Environment and a Healthy Economy," Environment and Climate Change Canada (2020), https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf

Helping cities address and reduce emissions is inevitably a large part of a green growth strategy, given the large footprint of cities in both emissions and economic activity. According to the UN Habitat, cities consume 78% of the world's energy and produce more than 60% of global greenhouse gas emissions[35], and the share of emissions and economic activity connected to cities is likely to grow further as the world urbanizes. In 2018, 55% of the world's population lived in urban areas, a figure that is predicted to increase to 68% by 2050.[36] Urbanization is even more intense in Canada: in 2021, nearly three in four Canadians (73.7%) lived in Census Metropolitan Areas (CMAs), which are defined by Statistics Canada as urban centres with a population of 100,000 or more people. In the future, the share of Canadians living in CMAs is expected to continue to grow further, as Canada's population growth is largely driven by immigration[37] and more than 90% of immigrants to Canada settle in CMAs.[38] Smart cities incorporate sustainable and resilient growth agendas that promote the use and support of green technologies and energy, as well as the sustainable use of traditional energies through innovative policies.[39]

The **Blatchford District Energy Sharing System** is one example of how Canadian cities are approaching smart energy projects. Blatchford is a new neighbourhood development located on the site of Edmonton's (AB) former city airport. The community is unique because of its innovative commitment to carbon-neutrality. To meet the neighbourhood's energy needs, Blatchford is generating renewable electricity using geothermal energy. In subsequent phases, the utility will expand by adding a sewer heat exchange to recover more waste heat from the existing sewer network.[40]

Blatchford's geothermal utility allows for energy to be shared and recycled throughout the neighbourhood. The system is designed to remove excess heat from one building and put it back into the grid so that it can be used elsewhere in the complex. In addition, the utility also allows for energy to be stored between seasons to manage seasonal fluctuations.[41] All buildings located in the district are connected to the geothermal utility unless the building is certified to a net-zero carbon standard.[42] While the utility only generated 14 mega-watt hours (MWh) during 2020, energy production has increased and is projected to supply 685 MWh in 2021.[43] Energy efficient building standards will also help the Blatchford project produce approximately 75% fewer greenhouse gases (GHGs), compared to similar communities in Edmonton.[44]

35   "Generating Power," UN Climate Action, accessed 2022,
      https://www.un.org/en/climatechange/climate-solutions/cities-pollution#:~:text=Cities%20and%20Pollution,cent%20of%20the%20Earth's%20surface

36   "68% of the world population projected to live in urban areas by 2050, says UN," UN Department of Economic and Social Affairs, May 16, 2018,
      https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

37   "Canada's growing population driven by immigration," Statistics Canada, March 2, 2022,
      https://www.statcan.gc.ca/o1/en/plus/468-canadas-growing-population-driven-immigration

38   "Canada's large urban centres continue to grow and spread," Statistics Canada, February 9, 2022,
      https://www150.statcan.gc.ca/n1/daily-quotidien/220209/dq220209b-eng.htm

39   Alexandra Cutean, Trevor Quan, Holly Brown, "Smart City Priority Areas and Labour Readiness of Canadian Cities," Information and Communications
      Technology Council (2019), https://www.digitalthinktankictc.com/policy-briefs/smart-city-priority-areas-and-labour-readiness-of-canadian-cities

40   "Blatchford Renewable Energy: 2022-2025 Business Plan," The City of Edmonton (2021)
      https://pub-edmonton.escribemeetings.com/filestream.ashx?DocumentId=113062

41   "District Energy Sharing," Blatchford Renewable Energy, 2022, https://blatchfordutility.ca/district-energy-sharing/

42   "Blatchford Renewable Energy: 2022-2025 Business Plan," The City of Edmonton (2021)
      https://pub-edmonton.escribemeetings.com/filestream.ashx?DocumentId=113062

43   ibid

44   ibid

While some smart energy and environment projects are designed to generate renewable energy, others focus on broader environmental outcomes. One example of such a project is the **SF*park* Project** in San Francisco. This project was developed to modernize parking in the city by using wireless sensors to create a smart parking management system with demand-responsive pricing. Introducing the smart monitoring system to help drivers find open parking spaces reduces traffic and congestion, which in turn reduces GHG emissions.[47] SF*park* started as a pilot project before expanding to the city's entire 28,000 parking meters and 14 city operated garages in 2018.

At the core of SF*park* is a dynamic pricing system, in which the price of parking increases in high-demand areas and decreases in low-demand areas.[48] This system allows the city to manage traffic congestion and reduce GHGs by directing drivers to low-traffic areas. Post-implementation analysis of the pilot project program found that it increased parking occupancy and decreased the amount of time required to find parking from 11.5 minutes to 6.5 minutes.[49]

Many cities in Canada might benefit from a program like SF*park*. Three Canadian cities rank among the nine most congested cities in North America—Vancouver ranks third, with an estimated 75 hours lost in traffic for the average driver each year. Montreal ranks eighth, with an estimated 55 hour lost per year, and Toronto ranks ninth, also with 55.[50] High levels of congestion can be reduced by improving parking; the average motorist in the United States spends an average 17 hours a year looking for parking spots, which costs an estimated US$345 in wasted time, fuel, and emissions per driver each year. In the most congested cities, costs are far higher.[51]

As cities across Canada grow, parking management in high-demand areas can take cars off the road quicker, benefiting drivers and pedestrians, and reducing emissions. Parking management programs also have low regulatory risk, making them easier to implement. The low regulatory risk is due to the type of data parking-sensors needed: these sensors only relay information on whether the spot is empty, meaning they do not need to collect information about users.[52]

47   "SFpark: Pilot Project Evaluation," San Francisco Municipal Transportation Agency, 2014,
      https://www.sfmta.com/sites/default/files/reports-and-documents/2018/08/sfpark_pilot_project_evaluation.pdf

48   Skip Descant, "San Francisco Rolls Out Dynamic Parking Rate Model," Government Technology, 2018,
      https://www.govtech.com/fs/san-francisco-rolls-out-dynamic-parking-rate-model.html

49   "SFpark: Pilot Project Evaluation," San Francisco Municipal Transportation Agency, 2014.
      https://www.sfmta.com/sites/default/files/reports-and-documents/2018/08/sfpark_pilot_project_evaluation.pdf

50   https://www.tomtom.com/en_gb/traffic-index/ranking/?country=CA,MX,US

51   Kevin McCoy, "Drivers spend an average of 17 hours a year searching for parking spots," USA Today online, July 12, 2017,
      https://www.usatoday.com/story/money/2017/07/12/parking-pain-causes-financial-and-personal-strain/467637001/

52   Keri Grieman, "Smart City Privacy in Canada," Samuelson-Glushko Canadian Internet Policy and Public Interest Clinic (CIPPIC), University of Ottawa (2019),
      https://iapp.org/media/pdf/resource_center/Smart_Cities_OPC_2019.pdf

Smart Energy & Environment Labour Demand

The labour needs of smart energy and environment projects vary, based on factors including type of project, location, complexity, and even duration. For Blatchford, the City of Edmonton will need geothermal energy and energy efficiency experts, as well as roles like environmental scientists, geologists, energy modellers,[53] equipment technicians, construction equipment operators, and drilling crew operators.

On the other hand, projects like San Francisco's SF*park* require talent that can develop, roll out, and monitor both a software application and the hardware that supports it. Roles include app developers, data scientists, and cybersecurity specialists, along with technicians and electricians for installing wireless sensors across the city.

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53   "Careers in Geothermal Energy," U.S. Bureau of Labor Statistics, accessed 2022, https://www.bls.gov/green/geothermal_energy/geothermal_energy.htm

Smart Mobility

As more and more people congregate in urban areas, traffic is becoming a mounting concern for municipalities of all sizes. A study conducted in 2017 by data and analytics company INRIX found that traffic congestion costs the United States economy US$305 billion a year, up $10 billion from 2016.[54] This is equivalent to 1.6% of American GDP in 2017, US$21.37 trillion,[55] making the economic cost of traffic comparable in size the entire utilities sector.[56] The costs of traffic and congestion are manifold, including lost productivity, wasted fuel, air pollution, and stress. The cost of lost productivity alone caused by traffic was $87 billion in the United States in 2018.[57] Traffic congestion has also been linked to emotional effects such as nervousness, stress, and aggression[58] as well as physical health effects including back pain, leg pain, headaches, and dizziness.[59]

Smart Mobility involves the adoption of technology and creative thinking to solve transportation problems in municipalities, with the goal of allowing people and goods to arrive at their intended destinations in less time and at reduced costs. Smart mobility includes the development and digitalization of transport processes, the gathering and analysis of data on transportation, and strategic policymaking related to transportation. Important to remember is that technology should be seen as a tool in the urban planner's toolkit and not an obligation. The most effective solutions to transport problems may not necessarily be "high-tech"; tramways, streetcars, transit priority corridors, and bike-sharing programs are all among the "low-tech" smart mobility strategies adopted by cities globally.

54   Benjamin Schneider, "Traffic's Mind-Boggling Economic Toll," Bloomberg online, February 7, 2018, https://www.bloomberg.com/news/articles/2018-02-07/new-study-of-global-traffic-reveals-that-traffic-is-bad

55   "GDP (current US$) – United States," World Bank, 2022, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=US

56   "Percentage added to the Gross Domestic Product (GDP) of the United States of America in 2020, by industry," Statista, 2020, https://www.statista.com/statistics/248004/percentage-added-to-the-us-gdp-by-industry/

57   Sean Fleming, "Traffic congestion cost the U.S. economy nearly $87 billion in 2018," We Forum, March 7, 2019, https://www.weforum.org/agenda/2019/03/traffic-congestion-cost-the-us-economy-nearly-87-billion-in-2018/#:~:text=In%20the%20US%2C%20it%20found,congestion%20to%20be%20%2487%20billion.&text=In%20terms%20of%20lost%20hours,Boston%2C%20Chicago%20and%20Washington%20DC

58   Alalool Abdulla, B. AlHashaikeh, et al. "Traffic congestion and long driving hours: Impact on stress, emotional and physical health among drivers in Sharjah," 9th Asia Pacific Global Summit on Healthcare & Immunology (2017), https://www.iomcworld.org/proceedings/traffic-congestion-and-long-driving-hours-impact-on-stress-emotional-and-physical-health-among-drivers-in-sharjah-49396.html#:~:text=Traffic%20congestion%20lead%20to%20greater,%2C%20and%20dizziness%20(28.8%25)

59   ibid

Numerous communities in Canada are already active in smart mobility initiatives. For example, the City of Kelowna in British Columbia introduced a 5G traffic monitoring pilot project. In partnership with Rogers Communications and the University of British Columbia (UBC), this project was the first of its kind Canada when announced in 2020.[60,61] Leveraging both sensors and the local 5G network, the project's objective is to gather data on how people move around the city centre and identify ways to optimize safety.[62] For example, by studying traffic patterns, the city can develop routes that allow first responders to better respond to emergencies.[63,64] Integral to Kelowna's project is the use of LiDAR-based sensors, which has several advantages over traditional traffic cameras. First, LiDAR can capture consistent data despite changes in lighting or weather, showing how traffic patterns change with different weather and climate. Second, the resolution of imaging is insufficient to show identifying details of citizens, which helps mitigate the regulatory risk surrounding data collection. As was seen in the Toronto Sidewalk Labs project, technologies that can easily identify citizens become subject to higher regulatory scrutiny to ensure that personal details remain safe.[65] The use of LiDAR and its inability to capture personal details strikes a balance between innovative technologies and privacy. Kelowna believes that the data collected will also help develop technology that can instantly deploy emergency vehicles when sensors detect a collision: the city envisions an innovative system that will register the incident when a crash is detected, and dispatch emergency vehicles to the scene without relying on a 911 call from those involved.[66]

Las Vegas has taken a very different approach to smart mobility, which may be of interest to cities in Canada. In addition to pursuing smaller initiatives like launching a series of free ride-hail autonomous taxis,[67] the city partnered with the Boring Company to develop the **Las Vegas Loop**. This project aims to reduce congestion by providing a transportation method via underground tunnels. Although the initial design envisioned an alternative to traditional public transit systems, today the project more closely resembles an underground highway. The first phase of the project opened in April 2021[68] and offered transportation to different exhibition halls at the Las Vegas Convention Center and to Resorts World.[69]

60   Megan Trudeau, "City of Kelowna launching Canada's first 'real-world 5G smart city' solution," Kelowna Now, 2020, https://www.kelownanow.com/watercooler/news/news/Kelowna/City_of_Kelowna_launching_Canada_s_first_real_world_5G_smart_city_solution/

61   Gary Ng, "Rogers Launches 5G Smart City Pilot in Kelowna," iPhone in Canada, 2020, https://www.iphoneincanada.ca/carriers/rogers/rogers-5g-smart-city-pilot-kelowna/

62   Doyle Potenteau, "Pilot project featuring LiDAR sensors, 5G network, to study traffic patterns in downtown Kelowna," Global News, 2020. https://globalnews.ca/news/6999316/pilot-project-traffic-patterns-kelowna/

63   Megan Trudeau, "City of Kelowna launching Canada's first 'real-world 5G smart city' solution," Kelowna Now online, 2020. https://www.kelownanow.com/watercooler/news/news/Kelowna/City_of_Kelowna_launching_Canada_s_first_real_world_5G_smart_city_solution/

64   Rob Munro, "5G is coming to Kelowna with sensors at two downtown intersections," iNFOnews.ca, 2020, https://infotel.ca/newsitem/5g-is-coming-to-kelowna-with-more-cameras-on-downtown-streets/it73694

65   Keri Grieman, "Smart City Privacy in Canada," Samuelson-Glushko Canadian Internet Policy and Public Interest Clinic (CIPPIC), University of Ottawa (2019), https://iapp.org/media/pdf/resource_center/Smart_Cities_OPC_2019.pdf

66   Aisha Malik, "Rogers partners with UBC, City of Kelowna to launch 5G smart city pilot," Mobile Syrup, 2020, https://mobilesyrup.com/2020/05/28/rogers-partners-with-ubc-city-of-kelowna-to-launch-5g-smart-city-pilot/

67   https://techcrunch.com/2022/02/24/motional-and-via-launch-free-autonomous-ride-hail-service-in-las-vegas/

68   "Las Vegas Convention Center (LVCC) Loop," The Boring Company, accessed 2022, https://www.boringcompany.com/lvcc#:~:text=LVCC%20Loop%20connects%20the%20LVCC,operated%20at%20all%20subsequent%20conventions

69   Mick Akers, "Resorts World's new Vegas Loop station 'a milestone'," Las Vegas Review-Journal online, 2022, https://www.reviewjournal.com/business/tourism/resorts-worlds-new-vegas-loop-station-a-milestone-2606173/

Las Vegas City Council has approved expansion of the convention centre loop to the downtown area, with construction expected to begin in 2023.[70] Current planning aims to connect 55 stations around the city to help visitors efficiently reach the most popular Las Vegas destinations.[71] The Boring Company envisions 4,000 vehicles an hour moving through each tunnel artery; this would move approximately 16,000 riders per hour, similar to the 10,000-25,000 riders per hour for traditional bus or transit systems.[72]

Smart Mobility Labour Demand

Smart mobility projects are driven by the goal of developing transit alternatives to improve rider experience while producing better environmental outcomes. Although this will require urban planners to work with data scientists or data analysts to analyze usage patterns across many different modes of transportation (depending on the type of technology being used), other roles will be required to advance and support these innovations. To execute Kelowna's 5G traffic monitoring project, for example, the city will also require traffic control supervisors, civil engineers, urban planners, and telecom equipment technicians.

The Las Vegas project requires building extensive new infrastructure in unusual terrain and will require roles like heavy machine operations and tunnel construction specialists, surveyors, geographers, geologists, and civil engineers. The city will also need specialists with experience designing mobility infrastructure for electric and autonomous vehicles.

70   "The Boring Company's Vegas Loop Expands To DTLV," The City of Las Vegas, June 15, 2022,
       https://www.lasvegasnevada.gov/News/Blog/Detail/boringcompany

71   "The Boring Company's Vegas Loop Expands To DTLV," The City of Las Vegas, June 15, 2022,
       https://www.lasvegasnevada.gov/News/Blog/Detail/boringcompany

72   Sean O'Kane, "Elon Musk's Boring Company finishes digging Las Vegas tunnels," The Verge, 2020,
       https://www.theverge.com/2020/5/14/21257849/elon-musk-boring-company-las-vegas-tunnel-finished-digging

Smart Infrastructure

Given the wide range of private and public activities that depend on infrastructure, investment in such projects can yield strong returns to the economy.[73] In Canada, "investments on the construction and maintenance of infrastructure" represented 0.57% of GDP in 2019, roughly proportional to the 0.55% reported in the United States. Canada was ranked 37th out of 45 countries according to this metric.[74] The "Canadian Infrastructure Report Card 2019" found Canadian infrastructure to be "at risk." It analyzes infrastructure across seven categories (potable water, wastewater, stormwater, roads and bridges, solid waste, culture/recreation/sports facilities, and public transit).[75] Poor road infrastructure alone is estimated to cost Canadians $3 billion a year in vehicle operating costs.[76]

Smart Infrastructure involves the adoption of digital technology to enhance the functionality of traditional infrastructure (e.g., bridges, roads), as well as investments in technological infrastructure such as telecommunications systems (fibre, telephone lines, 5G networks, etc.). The need for digital infrastructure is also being driven in part by consumer and business digital needs. In 2022, the average American household had 22 internet-connected devices,[77] and this figure doubled since the COVID-19 pandemic began.[78] In Canada, the pandemic increased internet use for 75% of people.[79] COVID-19 has been described as pushing companies over a "technology tipping point," accelerating their adoption of digital tools by several years.[80]

With citizens and businesses more reliant on digital devices than ever before, it is no wonder that many cities Canada are investing in digital infrastructure. In 2015, Calgary City Council approved the **Fibre Infrastructure Strategy**. This project envisions developing a reliable fibre-optic network called City Fibre to support the provision of municipal services.

73   "Fiscal multiplier effect of infrastructure investment," Global Infrastructure Hub, December 14, 2020, https://www.gihub.org/infrastructure-monitor/insights/fiscal-multiplier-effect-of-infrastructure-investment/

74   "Global investments on the construction and maintenance of infrastructure as share of GPD in 2020, by selected countries," Statista, 2020, https://www.statista.com/statistics/566787/average-yearly-expenditure-on-economic-infrastructure-as-percent-of-gdp-worldwide-by-country/

75   "Canadian Infrastructure Report Card 2019, "Canadian Infrastructure Report Card (2019), http://canadianinfrastructure.ca/downloads/canadian-infrastructure-report-card-2019.pdf

76   Connie Vitello, "Report indicates poor road infrastructure costs $3 billion annually," ReNew Canada, April 1, 2021, https://www.renewcanada.net/poor-road-infrastructure-costs-canadians-3-billion-annually/#:~:text=Report%20indicates%20poor%20road%20 infrastructure%20costs%20%243%20billion%20annually,-By

77   "Consumers Benefit From Virtual Experiences, but Need Help Managing Screen Time, Security and Tech Overload," Deloitte, August 3, 2022, https://www2.deloitte.com/us/en/pages/about-deloitte/articles/press-releases/connectivity-and-mobile-trends.html

78   Kevin Westcott, Jeff Loucks, et al. "Build it and they will embrace it," Deloitte (2022), https://www2.deloitte.com/us/en/insights/industry/telecommunications/connectivity-mobile-trends-survey-2020.html

79   Howard Bilodeau, Abby Kehler, Nicole Minemma, "Internet use and COVID-19: How the pandemic increased the amount of time Canadians spent online," Statistics Canada, https://www150.statcan.gc.ca/n1/pub/45-28-0001/2021001/article/00027-eng.htm

80   "How COVID-19 has pushed companies over the technology tipping point – and transformed business forever," McKinsey & Company, October 5, 2020, https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever.

City Fibre's flexible design allows local services and agencies to use specialized networks to accommodate their unique needs. As of 2019, revenues from City Fibre surpassed $1 million, and the infrastructure was being used to connect educational institutions, civic partners, business units, and municipal agencies.[81] Other services that connected to the network include traffic cabinets, help phones, security gates, and wireless towers. In 2020, it was estimated that ownership of its own fibre network saved the city $8 million per year in third-party telecommunication costs.[82]

Cities are not the only places in need of digital infrastructure, however. Access to high-speed broadband remains an issue in many areas both in Canada and internationally, particularly outside of city centres. Around 17.8% of Canada's population, 6.6 million people, live in rural areas.[83] People living in rural Canada across all provinces represent a larger population base than residents of all but two provinces - Ontario and Quebec.[84] One major challenge faced by rural residents is poor internet connections and service. Although there have been some improvements since the beginning of the COVID-19 pandemic, rural download speeds remain far behind those in urban areas. From March to December of 2020, rural download speeds averaged 5.5 Mbps, compared to roughly 50 Mbps in urban areas.[85] In its 2021 report Waiting to Connect, the Council of Canadian Academies found that 99% of urban households had broadband internet that meets the government's target speed (50/10),[86] compared to 46% of rural households and 35% of households on First Nation Reserves.[87] Insufficient access to broadband places rural communities at risk: many economic activities are internet based, and lack of broadband connection can delay economic development. Indeed, rural, northern, and remote communities in Canada overwhelmingly identified connectivity as the number one issue impeding their economic growth.[88] COVID-19 also highlighted the difficulties that isolated communities face in accessing healthcare. During the pandemic, people in rural communities were often unable to meet doctors in person due to safety protocols and were also unable to have online appointments due to connectivity issues. As a result, many needed to drive outside of their community—sometimes significant distances—for healthcare.[89]

81   "The City of Calgary Fibre Infrastructure Strategy Annual Update," The City of Calgary (2020), https://pub-calgary.escribemeetings.com/filestream.ashx?DocumentId=123168

82   ibid

83   "Population growth in Canada's rural areas, 2016 to 2021," Statistics Canada, February 9, 2022, https://www12.statcan.gc.ca/census-recensement/2021/as-sa/98-200-x/2021002/98-200-x2021002-eng.cfm

84   "Table 17-10-0009-01: Population estimates, quarterly," Statistics Canada, June 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000901

85   "Canada's Internet Equity Gap: Rural residents suffer with inferior service during pandemic," Canadian Internet Registration Authority, April 13, 2021, https://www.cira.ca/newsroom/state-internet/canadas-internet-equity-gap-rural-residents-suffer-inferior-service-during#:~:text=From%20March%20to%20December%20rural,51.09%20Mbps%20in%20March%202021

86   50 Mbps download speed, 10 Mbps upload speed.

87   "Waiting to Connect: The Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada," Council of Canadian Academies (2021), https://cca-reports.ca/wp-content/uploads/2022/01/Waiting-to-Connect_FINAL-EN_digital.pdf

88   "High Speed Access for All: Canada's Connectivity Strategy," Infrastructure, Science and Economic Development Canada (2019), https://ised-isde.canada.ca/site/high-speed-internet-canada/sites/default/files/attachments/ISEDC_19-170_Connectivity_Strategy_E_Web.pdf

89   Briar Stewart, "How COVID-19 worsens Canada's digital divide," CBC News, September 23, 2020, https://www.cbc.ca/news/canada/british-columbia/covid-19-highlights-urban-rural-digital-divide-1.5734167

With broadband connectivity having profound implications for economic development and quality of life, it is no surprise that many countries, particularly those with large rural populations, are investing in improving connectivity. Northern Ireland is one of the most rural regions in Europe, with approximately 37% of residents living in rural areas,[90] compared to 21% in England[91] and 16% in the United Kingdom as a whole.[92] Northern Ireland also has a wide urban-rural divide in broadband coverage. Ironically, the country offers the greatest penetration of full-fibre (speeds of up to 1 Gbps) coverage in the UK; indeed, full-fibre and ultrafast (300Mbps) coverage is the norm in urban areas such as Belfast. However, 11% of households (and 33% of rural homes) did not have "superfast" connectivity (30 Mbps) in 2019.[93] Broadband connectivity has been suggested for several years as a low-risk, high-reward measure for bolstering Northern Ireland's recovery from the COVID-19 pandemic and promoting economic convergence with the rest of the UK.[94,95] In 2020, the government of Northern Ireland announced "Project Stratum," which provided a $165 million investment for the expansion of broadband networks in rural areas. The government contracted **Fibrus**, a UK-based telecommunications company specializing in rural areas, to complete the project. Upon completion, the project was set to bring speeds up to 1Gbps and broadband services to 76,000 homes that are currently unable to access speeds of 30Mbps or greater.[96] By the end of 2021, Fibrus had delivered broadband connectivity to more than 22,000 locations across 13 towns.[97] In 2022, the government announced that 50,000 more premises would receive new broadband infrastructure.[98] A 2021 report found that accessibility to speeds of at least "superfast" (30Mbps) had grown from 89% of the population to 91% of the population in one year. That is, around 10% of all households that did not have at least superfast internet now have it. The investment has been credited for making the Northern Irish countryside a considerably more attractive place for professionals and families and children; in certain areas, working online was a "daily struggle," and children fell behind by up to two years of school during COVID-19 because they were unable to access online learning resources.[99]

90   Conor Macauley, "People in Northern Ireland's rural areas 'are happier'," BBC News, 2017,
        https://www.bbc.com/news/uk-northern-ireland-41397806#:~:text=About%20670%2C000%20people%20live%20in%20rural%20areas,of%20Northern%20
        Ireland%2C%20some%2037%25%20of%20the%20population

91   "Rural population 2014/2015," UK Department for Environment, Food & Rural Affairs, 2021,
        https://www.gov.uk/government/publications/rural-population-and-migration/rural-population-201415

92   https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=GB

93   Clodagh Rice, "Rural areas still lagging behind for broadband in NI," BBC News, 2019, https://www.bbc.com/news/uk-northern-ireland-50866268

94   Mike Smith, "Why connectivity is spearheading Northern Ireland's recovery," Belfast Telegraph, 2020.
        https://www.belfasttelegraph.co.uk/ad-features/why-connectivity-is-spearheading-northern-irelands-recovery-39257531.html

95   Mike Smith, "Why connectivity is spearheading Northern Ireland's recovery," Belfast Telegraph, 2020.
        https://www.belfasttelegraph.co.uk/ad-features/why-connectivity-is-spearheading-northern-irelands-recovery-39257531.html

96   "£165m broadband improvement contract awarded to Fibrus Networks Ltd," Northern Ireland Department for the Economy, 2020,
        https://www.economy-ni.gov.uk/news/ps165m-broadband-improvement-contract-awarded-fibrus-networks-ltd

97   Amy Murray, Nuala McCann, "Broadband: Are NI's internet issues on the mend?" BBC News, 2022,
        https://www.bbc.com/news/uk-northern-ireland-60038858

98   "Over 10,000 fibre poles planted and 2,000 kilometres of cable installed as a result of Project Stratum," Northern Ireland Department for the Economy,
        March 1, 2022, https://www.economy-ni.gov.uk/news/over-10000-fibre-poles-planted-and-2000-kilometres-cable-installed-result-project-stratum

99   Amy Murray, Nuala McCann, "Broadband: Are NI's internet issues on the mend?" BBC News, 2022.
        https://www.bbc.com/news/uk-northern-ireland-60038858

Smart Infrastructure Labour Demand

There are strong labour demand spillover effects associated with developing smart infrastructure. Smart infrastructure first requires specialized labour to support construction and installation. Different roles are then needed to support roll-out and operations. Similar skill sets are needed for both Calgary's and the Northern Ireland's fibre-optic development projects. The installation of fibre typically requires telecommunications engineers, electricians, cable technicians, and repair workers. In Calgary, there will also be demand for labour to support the local institutions, civic partners, business units, and municipal agencies that build their networks on top of City Fibre.
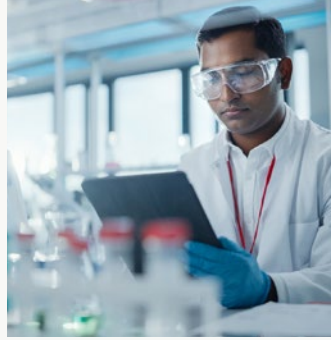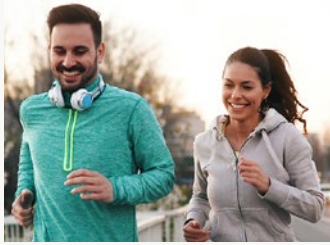
Smart Health and Wellbeing

While policy decisions governing healthcare are generally covered at the national or provincial/state level around the world, the pandemic has prompted municipalities to develop more policies addressing the health and wellbeing of their citizens. The pandemic disproportionately affected cities. While 55% of the world's population lives in urban areas,[100] 90% of the world's COVID-19 cases occurred in cities.[101] Mayors of urban centres were on the "front lines" of the pandemic and often faced different health situations than their counterparts in provinces and the rural areas. Mayors were forced to adopt responsibilities they did not naturally assume before.[102] The City of Vancouver, for example, set up emergency response centres for the homeless to self-isolate, provided hygiene services and supplies to tenants living in single room occupancy hotels and low-income housing, and set up a resident network headquarters for COVID-19 updates in the Downtown East Side.[103]

There is some evidence that COVID-19 has prompted a long-term realignment among cities for prioritizing healthcare and wellbeing. Consulting firm Deloitte found, for example, that 83% of cities have made large technology investments to improve remote diagnosis and treatment, and telehealth services.[104] Federal governments and provincial governments, for their part, appear to be investing in municipal-based health projects. For example, the Government of Canada has announced an investment of $13.4 million for four Toronto-based recipients to advance health innovation, particularly in digital health. The largest recipient is **Toronto Innovation Acceleration Partners** (TIAP). TIAP is affiliated with the MaRS Discovery District and is a membership-based organization of universities, research hospitals, and institutes in Ontario. The funding will be used to expand current programming and create a network to scale high-growth health and life science companies in three key areas: therapeutics, artificial intelligence, and medical technology.

100   "68% of the world population projected to live in urban areas by 2050, says UN," UN Department of Economic and Social Affairs, May 16, 2018, https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

101   Miguel Eiras Antunes, Stephanie Allen, "Smart cities, smarter public health," Deloitte Insights 30, 2022, https://www2.deloitte.com/xe/en/insights/focus/smart-city/building-a-smart-city-with-smart-digital-health.html

102   Enid Slack, "What COVID-19 teaches us about municipal responsibilities and how to pay for them," Municipal World, accessed 2022, https://www.municipalworld.com/feature-story/covid19-municipal-responsibilities/

103   "COVID-19 (Coronavirus): community support," City of Vancouver, accessed 2022, https://vancouver.ca/people-programs/community-resilience.aspx

104   Miguel Eiras Antunes, Stephanie Allen, "Smart cities, smarter public health," Deloitte Insights 30, 2022, https://www2.deloitte.com/xe/en/insights/focus/smart-city/building-a-smart-city-with-smart-digital-health.html

In addition to TIAP, three companies, MindBeacon Holdings Inc., Cyclica Inc., and Healthism Systems, will also receive funding to further develop smart health projects. Investment will enable these companies to scale up their innovations, which include digital mental health treatments, drug discovery software powered by artificial intelligence (AI), and software solutions for patient care.[105] In June of 2022, the Quebec provincial government announced a plan to invest $951 million over three years in health IT. Part of the plan includes an integrated system for sharing electronic records, which will be tested for two years at two sites before being rolled out to other regions of the province.[106]

Canada is not the only country investing in digital health programs. The Australian government has announced a diverse range of policies to grow its digital healthcare sector while remaining focused on equity. Australia will invest AU $18.8 million to fund 21 new biomedical and medical technology projects, with individual projects receiving up to AU $1 million. Successful applicants will focus on developing medical devices, telehealth and telemedicine services, and digitally enabled personalized medicine. To further promote equity, an additional AU $4.5 million will be provided to develop an Indigenous-focused healthcare website that includes various features to make healthcare more accessible and aligned with the unique cultural needs of Indigenous peoples.[107]

Considering the increasing permeation of technology in the healthcare sector, healthcare workers increasingly require higher levels of digitally literacy. To address an impending skill gap, the Royal Melbourne Institute and the Digital Health Cooperative Research Centre have collaborated to create digital health micro-credentials that can be used to upskill current healthcare workers. The credentials are designed to help clinicians integrate technologies into their practice, and design and effectively deploy digital healthcare services. Micro-credentials related to digital health in Canada are available at a handful of educational institutions, including Mohawk College.[108]

105   "Federal Investments to boost Toronto's Health Tech Sector," Federal Economic Development Agency for Southern Ontario, 2020, https://www.canada.ca/en/economic-development-southern-ontario/news/2020/10/federal-investments-to-boost-torontos-health-tech-sector.html

106   Jerry Zeidenberg, "Quebec to invest nearly $1 billion in health IT," Canadian Healthcare Technology, June 30, 2022, https://www.canhealth.com/2022/06/30/quebec-to-invest-nearly-1-billion-in-health-it/

107   "National Digital Health Strategy and Framework for Action," Australian Digital Health Agency, accessed 2022, https://www.digitalhealth.gov.au/about-us/strategies-and-plans/national-digital-health-strategy-and-framework-for-action

108   "Digital Health – 594," Mohawk College, accessed 2022, https://www.mohawkcollege.ca/programs/technology/digital-health-594

Smart Health & Wellbeing Labour Demand

The talent needed to support smart health and wellbeing programs are diverse and sometimes directly related to the type of technology utilized. For example, smart health projects that use predictive methods, such as developing public health services unique to the local population,[109] will typically need machine learning engineers. The broad investment made into Toronto's digital health sector will need to be supported by sufficient data scientists to conduct public health analysis, cybersecurity experts to ensure public and person health records are kept safe, and software developers to design front-facing services for residents. Australia's digital health projects will also require online course designers and experts who have experience meeting the unique needs of its Indigenous population.

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109   "Building a Learning Health System for Canadians Report of the Artificial Intelligence for Health Task Force," CIFAR (2020), https://cifar.ca/wp-content/uploads/2020/11/AI4Health-report-ENG-10-F.pdf
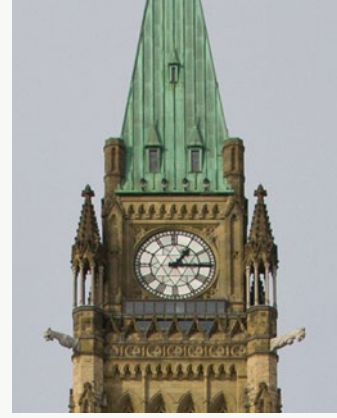
Smart Government

Governments around the world are increasingly investing in digital tools to enhance the provision of services to their citizens. Global government IT spending was US$459 billion in 2019 and was predicted to increase to US$482 billion in 2021.[110] To better understand the type of programs that are the focus of digital government initiatives, a 2021 survey by technological research and consulting firm Gartner found over a third (36%) of U.S. government respondents planned to increase investment in AI and machine learning in 2021.[111] Analysis by Gartner also found chatbots were the most common AI-related measure adopted by governments. A further 59% of government respondents expected that their organization would deploy them within the next three years, and only 16% of those surveyed indicated no interest.[112] Machine-learning-supported data mining was also seen very favourably. While only 16% of respondents had adopted this application of AI, another 69% expected their organization would deploy it within the next three years, and only 15% reported no interest.

With the growing use of online platforms, and the increased reliance on data to facilitate decision-making, government institutions sometimes struggle staying up to date with new developments. Currently, investments in digital technologies tend to focus on the online delivery of government services.[113] Canada historically performed well on measures of e-government. For example, in 2005, Canada ranked first among 22 countries surveyed in North America, Europe, and Asia for "customer service maturity" in the e-government category.[114] However, Canada's position has dropped precipitously in the last decade. In the Electronic Government Development Index in 2020, an index put together every two years by the United Nations,[115] Canada ranked a distant 28th, compared to third place in 2010.

110   "Government IT spending worldwide from 2019 to 2021," Statista, 2021,
       https://www.statista.com/statistics/1154203/worldwide-government-it-spending-forecast/.

111   Susan Moore, "Gartner says government organizations are increasing investment in AI, but their workforce remains apprehensive," Gartner, October 5, 2021, https://www.gartner.com/en/newsroom/press-releases/2021-10-05-gartner-says-government-organizations-are-increasing-

112   ibid

113   Alexandra Cutean, Trevor Quan, Holly Brown, "Smart City Priority Areas and Labour Readiness of Canadian Cities," Information and Communications Technology Council, 2019, https://www.digitalthinktankictc.com/policy-briefs/smart-city-priority-areas-and-labour-readiness-of-canadian-cities

114   https://www.itworldcanada.com/article/canada-achieves-top-e-government-service-ranking/12281

115   "UN E-Government Surveys," UN Department of Economic and Social Affairs, 2020,
       https://publicadministration.un.org/en/Research/UN-e-Government-Surveys

Recently, Quebec launched a broad program for governmental digital transition through the **Centre québécois d'excellence numérique** (CQEN). The CQEN is focused on identifying and implementing digital initiatives that can be utilized over many projects.[116] The program is part of the Government Digital Transformation Strategy 2019-2023, which promotes the development of versatile digital tools for the government. The two main objectives of Quebec's digital transformation are to provide modernized solutions that serve citizens by improving the innovation, efficiency, and transparency of the public administration.[117] These new smart government initiatives aim to facilitate the flow of information and enable citizens to proactively participate in the civic process.

The province also launched **Vitrine numériQc** to help inform citizens of initiatives that arise from the government's Digital Transformation Strategy. On this platform, visitors can explore digital achievements, cultivate an interest in digital literacy, and promote the transmission of knowledge.[118] Both CQEN and Vitrine numériQc work together as an expertise hub and provide timely updates on new programs.

The pursuit of digitizing government is unfolding internationally as well. As of December 2021, the Dubai government achieved its goal of going paperless.[119,120] The objective was to make physical visits to government offices and service centres obsolete by providing access to all government services remotely. The Smart Dubai Office partnered with ConSensys[121] to create a digital identity for Dubai citizens using blockchain. The service allows for smartphone-based authentication to complete activities like signing electronic documents,[122] processing digitalized visa applications, making bill payments, and completing licence renewals. The adoption of blockchain technology to deliver documents and services is estimated to save Dubai US$1.5 billion each year.[123]

Advancements in secure digital identity technology are allowing governments to offer services that need personal verification online. However, as government services digitalize, municipalities across Canada will need to ensure that the digital infrastructure is in place to protect personal information. Given the sensitive nature of citizen data related to government services, municipalities will need guidance to navigate the regulatory landscape of these projects.

116   "Centre québécois d'excellence numérique," Gouvernement du Québec, 2022.
        https://www.quebec.ca/gouvernement/politiques-orientations/vitrine-numeriqc/accompagnement-des-organismes-publics/cqen
117   "Orientations et ambitions de la transformation numérique," Gouvernement du Québec, 2021.
        https://www.quebec.ca/gouv/politiques-orientations/vitrine-numeriqc/strategie-numerique/les-orientations-de-la-transformation-numerique/
118   "Vitrine numériQc," Gouvernement du Québec, 2022. https://www.quebec.ca/gouv/politiques-orientations/vitrine-numeriqc/
119   "Hamdan Bin Mohammed: Dubai Has Become the World's First Paperless Government," Digital Dubai, 2021,
        https://www.digitaldubai.ae/newsroom/hamdan-bin-mohammed-dubai-has-become-the-world-s-first-paperless-government
120   "Digital Dubai: Home," Digital Dubai, accessed 2022, https://www.digitaldubai.ae/
121   "Smart Dubai: Blockchain Case Study for Government in the UAE," Consensys, accessed 2022,
        https://consensys.net/blockchain-use-cases/government-and-the-public-sector/smart-dubai/
122   "The UAE Pass app," United Arab Emirates Government, 2022, https://u.ae/en/about-the-uae/digital-uae/the-uae-pass-app
123   "Dubai Blockchain Strategy," Digital Dubai, accessed 2022, https://www.smartdubai.ae/initiatives/blockchain
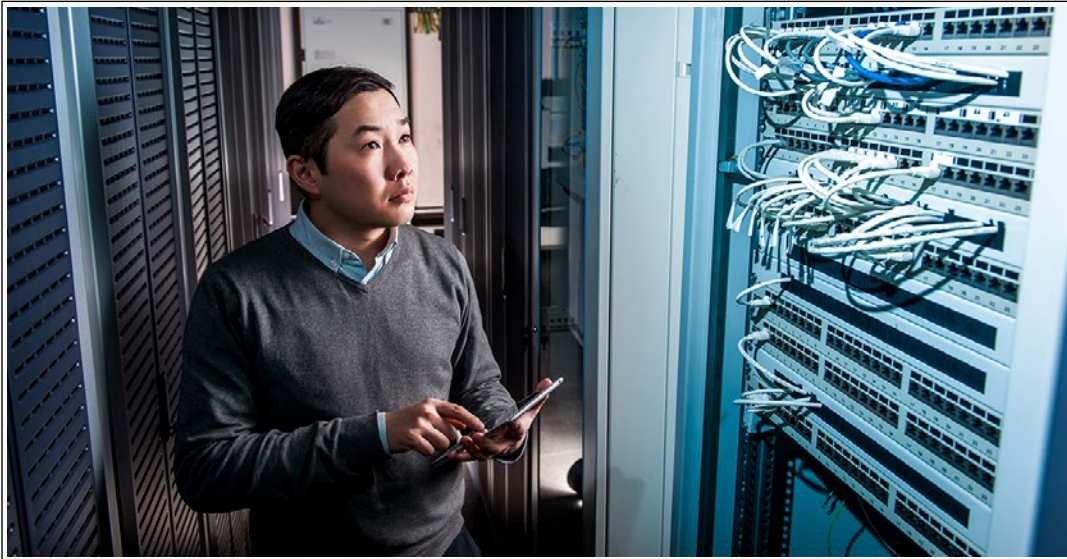
Smart Governance Labour Demand

There are many ways to digitalize government services, and the demand for labour will depend on the type of smart government initiatives being proposed. Quebec's efforts do digitalize its services through the Centre québécois d'excellence numérique will require talent with a broad range of skills. However, cybersecurity experts will be needed to implement these programs safely. In addition, roles like database engineers, website developers, and talent with front-end development skills will be needed to ensure that the data is safeguarded, and that Quebec's population is able to effectively engage with new online services.

The design of Dubai's paperless blockchain-based program required access to technical experts who understood the strengths and limitations of blockchain, including smart-contract experts, blockchain architects, and mobile developers. The roll-out of entirely paperless services also needed software engineers and civil servants to design platforms that allow residents to seamlessly access digital versions of government forms and services.

Smart Regulation

Regulation is required to ensure that marketplaces function while safeguarding the rights and best interests of consumers. As new technologies are developed and are implemented, it is important to understand the impact they may have on the lives of Canadians. Given the data-centric nature of smart cities, regulations and policies are an important topic of discussion. Surveys of Canadian attitudes toward smart cities reveal nuanced views and the need to balance optimism about the capabilities of technology with concerns over privacy and a distrust of private companies. Nearly nine in 10 Canadians (88%) are at least slightly concerned about their privacy in a smart cities context, while over half are either "extremely concerned" (23%) or "moderately concerned" (28%).[125] Close to three-quarters (72%) of Canadians agree that businesses "should not be permitted" to use personal information to create targeted adverts. In addition, nine in 10 Canadians (91%) agree that "the sale of my personal information should be illegal."[126] On the other hand, half of Canadians agree with the use of their personal information for "public uses such as crime prevention or traffic and city planning," provided there are "certain rights and protections guaranteed for data."[127]

For regulation to be effective, regulators must balance a range of interests, which can sometimes conflict. Legislators must pass policies which protect customers and industries all while ensuring that competition and innovation, and are not excessively encumbered. They must also make an effort to anticipate or plan for events that can disrupt the regulatory environment, such as shifting industry needs for labour and labour displacement. Regulators' decisions may consider ethical frameworks as well as citizens' values (such as to what extent citizens value privacy).[128]

125   Sara Bannerman, Angela Orasch, "Privacy and Smart Cities: A Canadian Survey," Smart City Privacy (2022),
       https://smartcityprivacy.ca/wp-content/uploads/2020/02/Bannerman-Orasch-Privacy-and-Smart-Cities-A-Canadian-Survey-v3-2020.pdf
126   ibid
127   ibid
128   Alexandra Cutean, Trevor Quan, Holly Brown, "Smart City Priority Areas and Labour Readiness of Canadian Cities," Information and Communications
       Technology Council, 2019, https://www.digitalthinktankictc.com/policy-briefs/smart-city-priority-areas-and-labour-readiness-of-canadian-cities

New regulations may need to be passed in cities before innovation can flourish. There were no ride-share or transportation network companies (TNC) operating in the Halifax Regional Municipality (HRM)[129] before a new bylaw was introduced on September 22, 2020, despite the high demand for these services. According to a citizen survey of the over 13,400 respondents, 88% stated wanting Uber or Lyft to operate in the region in addition to taxis; 73% cited the additional safety measures offered by ride-sharing services (compared to taxis), as a reason for this choice.[130]

To address this demand, Halifax City Council introduced a number of regulations aimed at promoting the safe implementation of ride-sharing apps, taking into account historical safety concerns facing taxis in the region. [131,132] In addition to a valid driver's licence, ride-share drivers servicing the HRM must have at least three years of driving experience, pass a criminal record and vulnerability sector check, and clear a child abuse registry check to become verified by the ride-sharing company.[133]

A different example from 2020, Portland adopted the most restrictive laws on facial recognition in the United States, banning all private entity and government use of the technology.[134] The ban defines private entities as "any individual, sole proprietorship, partnership, corporation, limited liability company, association, or any other legal entity, however organized."[135] The first ordinance bans the use and acquisition of facial recognition technologies by city bureaus. The second ordinance, effective January 1, 2021, bans private entities from using facial recognition technology in places of public accommodation and includes all of Portland's private entities.[136]

The penalties for non-compliance are severe: individuals are able to pursue litigation against firms that violate the legislation and seek damages of US$1000 per day.[137] Unlike other state biometric privacy laws, Portland's law excludes biometric identifiers, such as voice and fingerprint identification.[138] The law focuses on the potential misuse of the surveillance technology in physical space, but some critics suggest that the narrow specification of where exemptions can be applied introduces concerns for firms working with biometric data.[139]

129   Dave Reage, "Taxi Broker, TNC and Appeals-Related Amendments to By-law T-1000 and Administrative Order 15," Halifax Regional Council, 2020, https://www.halifax.ca/sites/default/files/documents/city-hall/regional-council/200818rc11110.pdf

130   Ibid

131   Steve Bruce, "Ex-Halifax cabbie testifies he didn't know his rights after arrest for sexual assault," Saltwire, 2020. https://www.saltwire.com/halifax/news/local/ex-halifax-cabbie-testifies-he-didnt-know-his-rights-after-arrest-for-sexual-assault-424058/

132   Trevor Nichols, "Halifax Moving Forward With Bylaw To Allow Ridesharing Services Like Uber," Huddle, August 19, 2020, https://huddle.today/halifax-moving-forward-with-bylaw-to-allow-ridesharing-services-like-uber/.

133   Dave Reage, "Taxi Broker, TNC and Appeals-Related Amendments to By-law T-1000 and Administrative Order 15," Halifax Regional Council, 2020. https://www.halifax.ca/sites/default/files/documents/city-hall/regional-council/200818rc11110.pdf

134   "City of Portland proposes a ban on private use of face recognition technologies," Smart City PDX, 2020. https://www.smartcitypdx.com/news/frt-ordinance

135   Ibid

136   Ibid

137   David Oberly, "Time to comply with the nation's newest biometric privacy law: Portland's private sector facial recognition ban," Biometric Update, 2021, https://www.biometricupdate.com/202101/time-to-comply-with-the-nations-newest-biometric-privacy-law-portlands-private-sector-facial-recognition-ban

138   Tom Simonite, "Portland's Face-Recognition Ban Is a New Twist on 'Smart Cities,'" WIRED, 2021, https://www.wired.com/story/portlands-face-recognition-ban-twist-smart-cities/

139   David Oberly, "Time to comply with the nation's newest biometric privacy law: Portland's private sector facial recognition ban," Biometric Update, 2021, https://www.biometricupdate.com/202101/time-to-comply-with-the-nations-newest-biometric-privacy-law-portlands-private-sector-facial-recognition-ban

In 2019, under the Smart City PDX program, Portland also developed a privacy plan to protect its residents' data. The plan stipulates that residents' data must be anonymized and may not be saved.[140]

Smart regulation is an overarching theme in the development of smart cities. Not only do existing regulations affect the development of smart city projects, but new legislation will need to be developed and old legislation amended to ensure that municipal innovation strikes a balance between advancement and safety.
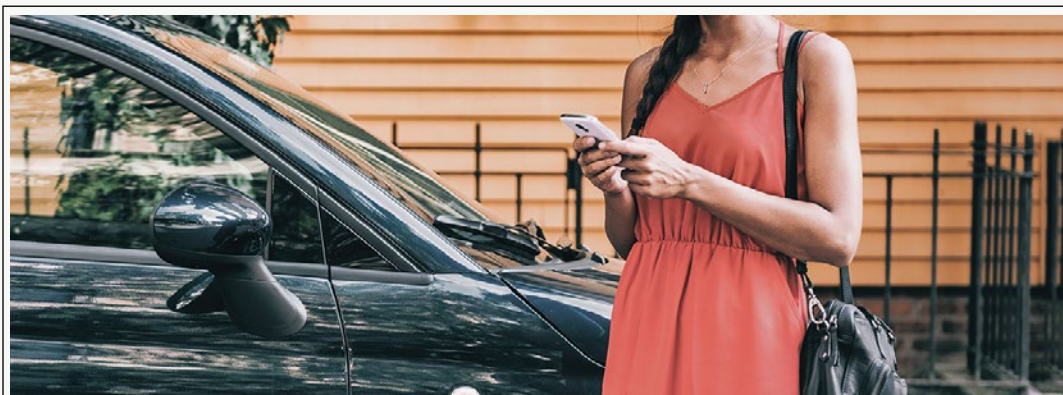
Smart Regulation Labour Demand

Legal experts and policymakers will be needed to support smart regulation, however, once regulations are drafted and enacted, their effect on labour will depend on how they impact other projects and activities in a municipality. In Halifax, the introduction of ride-sharing regulations will affect labour positively if it encourages the ride-sharing services to begin operating in the region. Conversely, Portland's ban on facial recognition technology will negatively affect the demand for individuals who specialize in analyzing biometric data.

140   Ibid

Smart City Project Implementation: From Design to Shovels in the Ground

Interviews with municipal representatives were conducted as part of this study to understand the opportunities and barriers facing smart city projects in Canada. Interviewees were asked about technologies used, stages of development, motivations for undertaking smart city projects, expected ROI, the impact of the COVID-19 pandemic on projects, and the overall labour market implications of projects.

Interviews found that smart city projects in Canada differed greatly by their degree of completion. Some were in the early planning stages, some were at the pilot stage, and others were operational at full capacity. Cities were also pursuing various strategies for adoption, with some actively using new technologies and processes, and others starting with smaller initiatives before moving to larger-scale adoption.

A few core themes emerged from these consultations. First, interviews surfaced that most smart city projects were at least partially motivated by diversity, equity, and inclusion, and improved environmental outcomes. Second, municipalities often noted challenges in accessing stable financing for projects, many of which have longer-term deployment or maintenance needs. To support development of these projects, almost all the cities interviewed mentioned employing consultants or partnering with private sector organizations to secure the needed talent. Municipalities also mentioned difficulties navigating the underlying regulatory structures that govern or impact smart city projects. This challenge was most acutely felt by smaller municipalities with limited access to legal or regulatory expertise. Lastly, the pandemic disrupted many projects, as public health became the primary objective, and limited finances were diverted to support residents. Although a few projects were completed during the pandemic—namely those tied to digital health—this shift placed greater emphasis on longer-term smart city strategies that prioritize clear ROIs and SROIs.

The Importance of the Environment and DEI

Municipalities described a variety of motivations for launching smart city initiatives, but the two most frequently mentioned were DEI (diversity, equity, and inclusion) and the environment. Projects pursued various DEI objectives, including protecting lower-income and vulnerable citizens and improving access to services for Indigenous and First Nations peoples (with consideration for Canada's Truth and Reconciliation Commission's calls to action). Several projects specifically focused on a triple-bottom-line approach: obtaining financial, social, and environmental outcomes. One example where DEI is at the forefront of program design is Pinnguaq Makerspaces. Located in Cambridge Bay and Iqaluit, NU, and Lindsay, ON, Makerspaces provide central hubs for creativity, innovation, and knowledge sharing for Indigenous, rural, remote, and other underrepresented groups. The ability to integrate digital design into these communities is a core offering. Pinnguaq is a founding member of the Katinnganiq Makerspace Network (KMN), one of the partners that won $10 million under the Smart City Challenge.[141]

Projects that were driven by environmental goals are typically diverse and focus on saving energy, developing alternative energy capacities, or reducing GHGs and waste. They also tend to have secondary objectives tied to livability, such as reducing congestion, reducing poverty, and improving air quality. However, several interviewees emphasized the importance of designing projects to solve a local *human* problem (such as creating more efficient public transit, reducing light and noise pollution, improving walk scores, etc.); interventions that started with technology in search of an application were sometimes viewed as problematic, even when the end goal would improve environmental sustainability.

The Talent Crunch

In July 2022, Canada's unemployment rate reached a record low of 4.9%.[142] As job vacancies increase[143] and as the skills required for many jobs continue to change and evolve,[144] there is growing risk of labour shortages across sectors. Cities also face additional unique challenges in attracting talent associated with external factors like cost of living. A recent report commissioned by the City of Toronto found that Toronto's high cost of living was hurting the city's ability to hire and retain talent in various departments.[145] To uncover whether these or other issues impacted the municipalities in this study, interviewees were asked to comment on how various factors affected their labour needs across the short, medium, and long term.

141   "Makerspaces," Pinnguaq, accessed 2022, https://pinnguaq.com/makerspaces/

142   "Labour Force Survey, July 2022," Statistics Canada, 2022. https://www150.statcan.gc.ca/n1/daily-quotidien/220805/dq220805a-eng.htm

143   Ibid.

144   "The Future of Jobs Report 2020," World Economic Forum (2020), https://www.weforum.org/reports/the-future-of-jobs-report-2020/in-full

145   "Employee Talent, Retention and Attraction—City Planning," The City of Toronto (2022),
https://www.toronto.ca/legdocs/mmis/2022/ph/bgrd/backgroundfile-227742.pdf

Smaller municipalities such as Summerside noted difficulties acquiring and retaining talent because of competition with larger municipalities such as Toronto. On the other hand, larger municipalities like Toronto also mentioned losing talent to large tech companies or struggling to compete on wages.

Lastly, regardless of size, several municipal interviewees noted a shortage of experienced professionals in emerging fields. Candidates with specializations in areas like electric vehicle charging systems or geothermal heating, for example, were noted as uncommon and difficult to source. To cope with this challenge, municipalities often hired external specialists on a part-time or consulting basis, or they formed partnerships with private sector businesses.

Industry Partnerships

Between 1985 and 2011, public-private partnerships represented 5.3% of public spending on capital projects and repairs. Public-private partnerships for infrastructure development continue to grow, with 286 active projects as of 2019.[146] Private industry plays an increasingly important role in the development of smart city projects, often providing expertise not often found in municipal offices. For example, the next generation of smart mobility will likely require notable technological advancements in transit lines and service equipment as well as data analysis to optimize transit times. Outsourcing some of these operations through public-private partnerships can alleviate the burden on cities.[147] These types of relationships often go beyond simple procurement; instead, projects are co-developed and co-designed, leveraging the expertise of both parties.

Most (95%) of municipalities interviewed required external partners to actualize their smart city projects. The role of partners varied from municipality to municipality. Partners provided services as diverse as planning, consultation, installation, and other specialty services that were often outside of scope of normal city operations and expertise.

[Our partners] have technical expertise that we didn't have internally.... They have done this work before.... There's a small team at the city: just myself and two engineers for in-house support. But we're growing our expertise internally, and we're looking to rely less on external consultants.... [because] we want this to transition from being a consultant-led project to something we handle ourselves. 99

146   "Asking the right questions: A guide for municipalities considering P3s," Canadian Union of Public Employees, 2020, https://cupe.ca/guide-municipalities-p3s

147   Shannon Bouton, Diego Canales, and Elaine Trimble, "Public–private collaborations for transforming urban mobility," McKinsey (2017), https://www.mckinsey.com/business-functions/sustainability/our-insights/public-private-collaborations-for-transforming-urban-mobility

Regulatory Considerations: The Case of Data

Regulations affecting smart cities can be passed by all levels of government. Regulations may cover a variety of areas, including data collection, energy use, environmental impacts, procurement processes, and financial oversight. Regulations have considerable power to inform the incentives associated with developing new smart city projects.[148] Legislation may also affect the costs experienced by both municipalities and private sector partners, which in turn can influence returns on investment and investment. For example, privacy laws dictate how data can be collected, stored, and accessed. Many smart city projects require data to be collected, but the extent of associated risk varies.[149] Projects related to transit efficiency and smart mobility may collect data that is less sensitive than projects related to the health or wellbeing or citizens. Further, governance and relevant legislation changes depending on the type of project. For example, healthcare is typically a provincial remit, whereas energy could fall under both provincial and federal legislation.

Moreover, city contracts with private entities for the delivery of services must comply with specific privacy legislation. In Canada, personal data collected by the private sector is protected by the Personal Information Protection and Electronic Documents Act (PIPEDA). PIPEDA broadly applies to all provinces, with the exception of Alberta, British Columbia, and Quebec.[150,151]

148   Paulo Moisés Costa, Nuno Bento, Vítor Marques, "The Impact of Regulation on a Firm's Incentives to Invest in Emergent Smart Grid Technologies," The Energy Journal 38, no. 2 (2017): 149-174, accessed 2022, http://www.jstor.org/stable/44203661.

149   Sarah Bruch, "Policy Brief No. 164 - Accelerating a Just Transition to Smart, Sustainable Cities," Centre for International Governance Innovation (2021), http://www.jstor.org/stable/resrep30264

150   Keri Grieman, "Smart City Privacy in Canada," Samuelson-Glushko Canadian Internet Policy and Public Interest Clinic (2019), https://iapp.org/media/pdf/resource_center/Smart_Cities_OPC_2019.pdf

151   These three provinces have passed legislation at the provincial level that is substantially similar to the Federal mandate, which gives the provincial legislation president.

Failure to manage privacy concerns in public-private partnerships can be detrimental to the development of smart city initiatives. Some believe that data collection and privacy was a major reason for the exit of Sidewalk Labs from Toronto's Quayside project.[152]

In many cases, regulations have been put in place to protect consumers, promote fair business practices, or correct unintended consequences. However, navigating the various legal rules associated with the development of smart projects can be costly and time consuming for municipalities. Most interviewees consulted in this study noted significant regulatory or policy considerations during the implementation of their smart city project, with a particular focus on those related to privacy and environmental standards. Electricity usage and generation were mentioned by two city representatives, but by far the most identified regulatory consideration was around privacy. Cities were aware that their smart city projects must comply with provincial and federal legislations governing data collection, but how this would be ensured or safeguarded over the longer term was not always clear. Respondents noted the Freedom of Information and Protection of Privacy Acts (FIPPA) and Freedom of Information Act (FOIA) can affect the design and development of data-focused projects; respondents also acknowledged that legislation related to data privacy is subject to change, which can influence projects in the future. Nevertheless, all municipalities acknowledge that responsible use of personal data must be a priority for any smart city project, both current and future.

Security is a huge piece. You don't want someone to steal your tax information through the smart technology [in use]. 99

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152   Karrie Jacobs, "Toronto wants to kill the smart city forever," MIT Technology Review, 2022,
       https://www.technologyreview.com/2022/06/29/1054005/toronto-kill-the-smart-city/amp/

COVID-19 and Smart City Development

The COVID-19 pandemic had a sharp financial effect on municipal revenues across Canada. The Financial Accountability Office of Ontario estimated that the pandemic cost municipalities in Ontario $6.8 billion in lost revenue and pandemic-related expenditures from 2020 and 2021.[153] The City of Toronto has estimated a budget shortfall of $922 million resulting from lost transit revenues and spending relating to COVID initiatives for 2022.[154] To cope with these challenges, provincial governments adopted various strategies: the Government of British Columbia, for example, temporarily allowed municipalities to borrow from the province to support COVID-related expenses and lost revenues.[155]

Most interviewees said that the pandemic delayed their municipality's smart city project by introducing immediate and competing priorities. As cities deployed emergency measures in response to COVID-19, they often faced budgeting challenges. While cities may have wanted to support smart city initiatives throughout the pandemic, their top-of-line priorities frequently pivoted to measures of public health, business support, and economic recovery.

The federal government has announced several programs aimed at supporting municipal recovery. For example, the Canada Community Revitalization Fund awards municipalities up to $1 million to finance community investments, including green infrastructure projects.[156] Ontario announced the Ontario Community Infrastructure Fund, which funds the expansion of broadband infrastructure across the province, and Alberta launched the Municipal Stimulus Program to support recovery.

While these and other programs do not directly stipulate that funding should be spent on smart city projects, municipal representatives said that smart city technology could both augment traditional municipal services and aid recovery from the pandemic by focusing on longer-term resiliency. Additionally, some smart city projects inadvertently gained momentum during pandemic: for example, the Winnipeg Police Service's virtual call centres were established prior to the pandemic but only came into extensive use during the pandemic as part of an effort to reduce in-person interaction.

I've noticed greater understanding of the importance of data and tech…. COVID brought to light many things in the tech world. It's advanced things by about five years. 💬

153   "Ontario Municipal Finances: An Overview of Municipal Budgets and an Estimate of the Financial Impact of the COVID-19 Pandemic," Financial Accountability Office of Ontario, 2020. https://www.fao-on.org/en/Blog/Publications/municipal-finances-2020#_ftn32

154   "2022 COVID-19 Intergovernmental Funding Update," City of Toronto, 2022, https://www.toronto.ca/legdocs/mmis/2022/mm/bgrd/backgroundfile-224105.pdf

155   "How some B.C. municipalities are handling the financial impacts of COVID-19," CBC News, 2020, https://www.cbc.ca/news/canada/british-columbia/kamloops-prince-george-williams-lake-ashcroft-finances-covid-19-1.5543442

156   "COVID-19: Financial support for people, businesses and organizations," Government of Canada, 2022, https://www.canada.ca/en/department-finance/economic-response-plan.html#organizations_helping_canadians

Return on Investment and Financial Impacts

Smart city projects often take place over several years. They have funding requirements in the early stages of planning and development as well as during implementation. In some cases—as was seen throughout the COVID-19 pandemic—municipal budgets previously set aside for smart city projects can get repurposed to cover immediate or higher-priority needs; in these cases, municipalities must turn to external sources of funding to cover development expenses. Other times, additional funds are required once a project is "complete" to support continued operation and maintenance. As Canadian municipalities cannot run deficits by law, many can struggle to generate alternate sources of funding required to support longer-term initiatives.[157]

It's relatively easy to find funding for capital projects like this, but it's challenging to find grants and funding for operations and maintenance, and other long-term overall costs. It's also hard to calculate [those costs]. 🙶

Smart City projects are usually pursued optimistically, rooted in a set of beliefs about the benefits of introducing technology to solve a central problem,[158] That said, projects are usually unproven at scale, which can make both short and long-term return on investment (ROI) difficult to accurately calculate.[159]

Experts generally agree that the riskiest stage of development in a smart city is the pre-construction period.[160] The pre-construction period of an infrastructure project is typically associated with concessional funding, which is not often expected to generate financial returns. However, when a city cannot calculate returns over the lifetime of a smart city project, it may struggle to justify the cost of development and maintenance. Especially when private sector investment or grant funding is sought, uncertain investment returns can create risk aversion. As such, projects with the potential to create meaningful and impactful change over a longer timeframe can end up underfunded. For example, global public funds available for green infrastructure projects are estimated to cover just 15% of the investment required to meet decarbonization targets.[161]

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157   "Protecting Vital Municipal Services," Federation of Canadian Municipalities (2021),
        https://data.fcm.ca/documents/resources/reports/protecting-vital-municipal-services.pdf

158   Paulo Moisés Costa, Nuno Bento, Vítor Marques, "The Impact of Regulation on a Firm's Incentives to Invest in Emergent Smart Grid Technologies,"
        The Energy Journal 38, no. 2 (2017): 149-174, accessed 2022, http://www.jstor.org/stable/44203661.

159   Michael Flynn, John Skowron, "The Challenge of Paying for Smart Cities Projects," Deloitte, (2018).
        https://www2.deloitte.com/global/en/pages/public-sector/articles/smart-cities-funding-and-financing-strategies.html

160   Sarah La Monaca, Katherine Spector, James Kobus "Financing the Green Transition: Addressing Barriers to Capital Deployment," Journal of International
        Affairs 73, no. 1 (2019): 33-48, accessed 2022, http://www.jstor.org/stable/26872777.

161   Ibid.

We don't have an ROI metric on an investment at present. The hope is that once we prove the technology, we can use it to augment data collection that we would potentially have to pay for. The challenge with this project is that we're getting data that we can't get by any other means. So it's difficult to put a dollar value on what this technology is gaining for us because [we can't] say how much it would have cost us to do it another way. 🙶

While municipalities were, at times, unable to provide concrete ROI or payback periods, they often had a qualitative sense of expected savings over time, which also ties into the concept of social return on investment (SROI). SROI is an outcome or impact-based method of measuring non-financial returns on the investment of a project, and it often includes both social and environmental impacts.

Evaluating social returns has grown in popularity in recent decades as demand for more equitable investment by firms and governments increases. It is worth highlighting, however, that there are several challenges that prevent effective measurement of social returns, often impeding its use as a decision metric.[162] To measure a return on investment, social or otherwise, a monetary value must be placed on the return; often, social benefits are subjective, rather than objective, leading to numerous measures of progress, which has resulted in the creation of different metrics. In the absence of uniformity in how social returns are measured, it remains challenging to assess the strength of one project compared to another.

Interviews suggest that although municipalities valued social return on investment, they did not try to quantify and measure it. Instead, projects were evaluated through a heuristic lens. For example, projects that aimed to improve environmental outcomes were evaluated based on the estimated reductions in greenhouse gas emissions; projects designed to improve digital service programs were evaluated according to increased rates of citizen participation in democratic processes and decision-making.

162   Geoff Mulgan, "Measuring Social Value," Stanford Social Innovation Review, 2010, https://ssir.org/articles/entry/measuring_social_value

In-Demand Job Data: Focus on Labour Challenges

To fully understand the labour requirements for a smart, inclusive economy in Canada, ICTC conducted extensive primary research, including employer surveys, interviews with industry representatives, policy roundtables, and focus groups over three years. This research uncovered critical insights on in-demand occupations and labour and skill changes across the Canadian smart economy. As a result, data from 65 key jobs was collected from over 550,000 Canadian company job postings over two and a half years. These jobs have also been mapped to National Occupation Classification (NOC) codes and used to develop short- and long-term labour demand forecasts in the supplemental *Technical Report*.

65 SMART CITY JOBS (2019–2022)

Software Engineer	Biostatistician	Agronomist
Project Manager	Blockchain Developer	Gameplay Programmer
Business Analyst	CAD Technician	Conversation Designer
Cybersecurity Professional	UI/UX Developer	GIS Technician
Full Stack Developer	Pipeline TD	Digital Health Director
Data Analyst	Environmental Scientist	Technical Sales Specialist
Data Engineer	Urban Farmer	Diversity Equity Inclusion Specialist
IT Support	Technical Artist	Site Reliability Engineer
Data Scientist	Systems Integrator	Diversity Equity Inclusion Director
Backend Developer	QA Tester	Telemedicine Assistant
QA Engineer	Computer Technician	Systems Security Technician
Gameplay Designer	Environment Artist	Automotive Service Technician
AR Designer	Game Developer	Database Administrator
Cloud Engineer	Cloud Administrator	Machine Learning Engineer
Cloud Architect	Digital Marketer	Autonomous Driving Software Engineer
Dev Ops	Network Technician	Accessibility Advisor
AI Architect	Resiliency Officer	Telecommunications Technician
Fibre-Optic Technician	Privacy Officer	Sensor Engineering Technician
Ethics Officer	QA Technician	Precision Technology Specialist
Animator	Digital Health Manager	Transportation Planning Engineer
Mobile Developer	Urban Designer	Quantum Researcher
Network Administrator	Industrial Designer	

Primarily, job data was collected over a three-year period to obtain a robust understanding of the full breadth of skills required to succeed in Canada's smart, inclusive economy—this information became especially pertinent in the review of COVID-19 impacts on in-demand roles vis-à-vis the broader labour market.

When it came to in-demand skills for these roles, various digital and technical abilities ranked highly, as well as the ability to adapt to and learn new technology. Yet, these skills were increasingly found to serve as a baseline; more and more, employers emphasize the importance of human skills when recruiting in-demand jobs focused on technology. As a result, data collected from these jobs includes volume of job postings, location, whether they are remote or in person, in-demand technical and digital skills, in-demand business skills, and in-demand human skills. Understanding top technical and human skills offers a comprehensive profile of Canada's most in-demand smart economy jobs.

Top Technical Skills Across Jobs

Technology is a foundational aspect of a smart, inclusive economy. Organizations increasingly look to data to better understand their constituencies and/or clients needs, deploy and evolve a robust technical infrastructure, and design and develop online applications and services to support growth.

DATA SKILLS

Data skills include data collection, curation, management, analysis, visualization, and distribution.

Key skill portfolios for data professionals include:

> Data Management: SQL Server, Oracle, and data warehousing solutions

> Data Analysis: Python, Apache Spark, and Excel

> Data Visualization: Python. Tableau, Power BI, and Excel

> Distribution: Application Programming Interfaces (APIs)

TECHNICAL INFRASTRUCTURE SKILLS

To build resilient, available, and accessible systems, organizations require professionals with technical infrastructure capabilities.

Key skill portfolios for such professionals include:

> Server Management: Linux, Windows Server, Kubernetes, and Docker

> Cloud Services: Amazon Web Services (AWS), Azure, Google Cloud Platform (GCP), Jenkins, and Terraform

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APPLICATION DEVELOPMENT SKILLS

To build impactful and useful applications, organizations source talent with application development skills.

Top skill portfolios for these workers include:

> Front-end Development: JavaScript, TypeScript, and HTML

> Mobile Development: Android, iOS, Kotlin, and Swift

> Backend Development: SQL, Java, Python, C++, C#, Ruby, and Application Programming Interfaces (APIs)

Yet, the technical skills landscape changes rapidly as new technologies and tools emerge. Whether to accelerate organizational digitization or implement automation, these fast-paced changes mean that relevance of a specific technical skill changes too. Not surprisingly, many technical skills increasingly come with a "half-life"; for this reason, learning and development professionals identified resilience and adaptability as the most important skills for 2021, and employers engaged in this study identified lifelong learning as a growing necessity for most workers.

It's a commonly held belief that the average life span of a skill—particularly a hard skill—is five years. Today, it seems that life span is shortening, with new skills emerging at a more rapid pace than in years past. 99 [163]
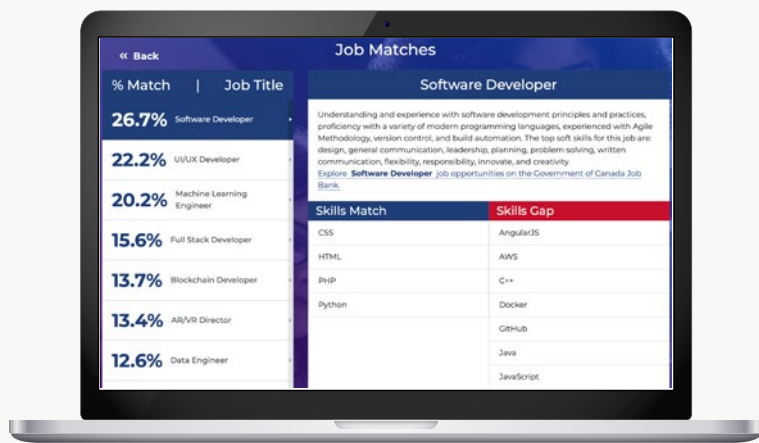
Try the Skill-to-Job Matching Tool for yourself at
https://www.etalentcanada.ca/job-skills-matching-tool/

Job seekers in today's smart economy face an unprecedented level of digitalization and economic uncertainty. Lifelong learning is increasingly becoming a need instead of a "nice to have." Job seekers need up-to-date and granular information on in-demand jobs and the ability to understand how they measure up to these opportunities. ICTC's Skill-to-Job Matching Tool assists job seekers on this journey.

Job seekers can select from a list of industry-validated skills and receive a percentage score assessing their "fit" for these roles, comparing their skills against those identified as the most frequent and most important for in-demand occupations. Vetted skill development courses are recommended to fill skill gaps, charting clear upskilling or reskilling pathways to become job ready.

163   Linkedin Learning, "LinkedIn-Learning_Workplace-Learning-Report-2021-EN-1.Pdf," accessed August 7, 2022, https://learning.linkedin.com/content/dam/me/business/en-us/amp/learning-solutions/images/wlr21/pdf/LinkedIn-Learning_Workplace-Learning-Report-2021-EN-1.pdf. Page 42

Top Human Skills Across Jobs

Human Skills are increasingly important for all roles, including those that are primarily digital or technical. In the ICTC *Survey of Employer Perceptions of Human or Soft Skills* (2021, n = 404, hereafter *Human Skills Survey*), several in-demand skills were highlighted, including the following:

Communications Skills: General interpersonal communication skills enabling smooth transmission of information between organizational employees, active listening skills, writing skills for reports and social media, and oral communication skills for client interaction and presentations.

Problem Solving: Accurate and efficient assessment of challenges, a structured approach to finding and choosing solutions, documentation and communication of solutions to others, and follow-through to implement solutions.

Collaboration: Leveraging interpersonal skills to advance the realization of common goals and objectives.

Time Management: Effective planning and scheduling, accounting for the unexpected, and optimizing the completion of tasks.

Leadership: Guiding others toward achieving organizational and team goals; demonstrating responsibility, accountability, and empathy toward all stakeholders.

Teamwork: Working effectively with others, understanding and leveraging team member roles and responsibilities, leveraging personal strengths to accomplishing team objectives.

Critical Thinking: When considering an issue or opportunity, curating relevant facts, analyzing potential outcomes and risks, and synthesizing balanced, considered assessments.

Attention to Detail: Efficient and thorough completion of tasks, while considering, evaluating, and preparing for outcomes differing from established goals.

Adaptability: Personal flexibility in plans and work activities; the ability to embrace immediate changes to organizational, team, and individual priorities.

Self-Management: Regulating and managing personal behaviour and actions, developing and practising emotional intelligence techniques.

SURVEY RANKING: HUMAN / SOFT SKILL IMPORTANCE

Skill	Percentage
Design-thinking	5%
Systems thinking	6%
Numeracy	6%
Ability to manage a team	8%
Troubleshooting	8%
Planning	8%
Project management	8%
Strategy	9%
Conflict management	10%
Empathy	11%
Decision-making	11%
Creativity & innovation	12%
Self-management	13%
Leadership skills	14%
Time-management	15%
Adaptability	15%
Attention to detail	16%
Collaboration	16%
Critical thinking	17%
Problem-solving	21%
Teamwork	27%
Communication	30%

Figure 1: Human/Soft Skill Importance, Human Skills Survey, 2021

Employers that responded to the Human Skills Survey place significant emphasis on human skills in the recruitment process. Respondents indicated that candidates are evaluated according to a combination of human and technical skills, with each possessing a similar weight. In other words, employers hiring for digital roles increasingly value human skills as much as technical ones. Likewise, in 2021, the World Economic Forum projected Canada's top five emerging skills for 2025: analytical thinking and innovation, active learning and learning strategies, technology design and programming, critical thinking and analysis, and complex problem-solving.[164] Four out of five skills fall into the category of human skills.

164   World Economic Forum, "Skills-Taxonomy_Final-1.Pdf," accessed August 5, 2022, https://www.reskillingrevolution2030.org/reskillingrevolution/wp-content/uploads/2021/01/Skills-Taxonomy_Final-1.pdf

COMPARING TECHNICAL AND HUMAN/SOFT SKILLS

How much weight do each take up when evaluating a candidate's application?

Technical   Human
Skills   Skills

6%   7%   30%   43%   70%   57%

WEIGHTING   WEIGHTING   WEIGHTING
Under 25%   Under 50%   50% or more
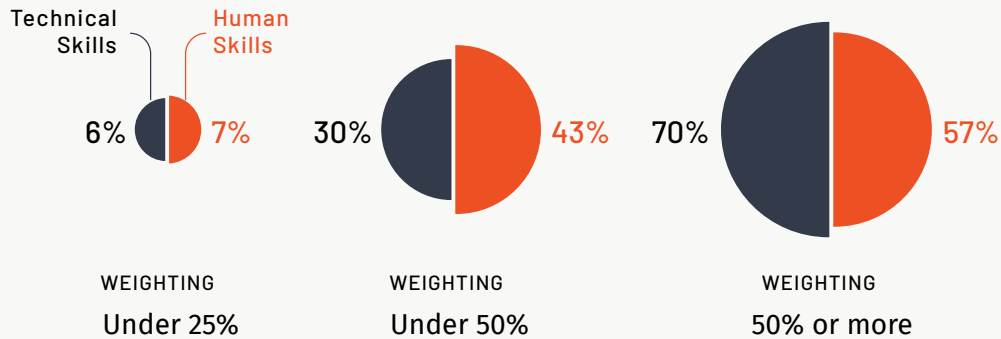
Figure 2: Comparing Technical and Human Skills, Human Skill Survey, 2021

Developing Human Skills: Agile Industry Mindset (AIM)

To help Canadian job seekers cultivate critical interpersonal skills necessary to excel in digitalized working environments, ICTC developed and delivers the 12-week Agile Industry Mindset (AIM) course. AIM is ICTC's proprietary human skills training course that builds self-efficacy and enhances resiliency in participants for agile team operations. There are eight core modules in AIM: The Agile Team, The Art of Communication, The Concept of Self, Emotional Intelligence, Feedback and Assumptions, Design Thinking, Critical Thinking, and Diversity Equity and Inclusion. These modules use a flipped classroom methodology, delivered asynchronously for self-directed learning prior to live sessions on the same topic. The curriculum is compromised of role-playing scenarios, video-based learning, podcasts and VILT (Virtual Instructor-Led Training) sessions.

With human skills being heavily featured in job postings, hiring companies need to assess a candidate's human skills portfolio. Most employers identified the interview process as the primary tool to assess a candidate's human skills, followed by evaluating the resume and deferring assessment to the probation period after hiring. According to LinkedIn's 2019 Global Talent Trend Report, the most common ways to assess soft skills include behavioural questions, reading body language, situational questions, projects, and tech-based assessments.[165] However, LinkedIn suggests that relying on in-the-moment behavioural and situational questions, along with reading body language, can be susceptible to bias and rehearsed responses, whereas standardized interview questions and problem-solving questions can improve assessment.[166]

When do you typically assess a candidate's human/soft skills

Category	Percentage
I don't assess their soft skills	1%
After they have been hired – during their probation period	35%
During the interview process	76%
Before the interview process – when reviewing their cover letter	31%
Before the interview process – when reviewing their resume	34%
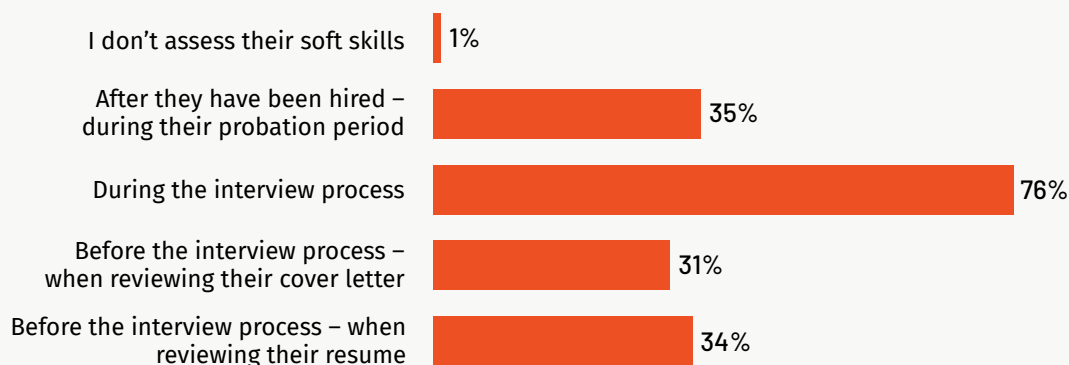
Figure 3: How Employers Assess Job Candidate's Human Skills, Human Skills Survey, 2021

In-Demand Jobs Ranking: 2022 Comparison

Data from more than 230,000 job postings was collected in 2022. This information was used to rank the jobs based on demand and to extract the top technical and human skills. While the initial job posting collection began in 2019 tracking 41 jobs, additional jobs were added intermittently over the next two years to a high of 81 jobs by the start of 2022 (subsequently reduced to 65 jobs, based on volume of postings). The 2022 data was used to rank top jobs and provide an equitable comparison of job totals for this report. Figure 4 shows the top 25 smart economy jobs in 2025, followed by a detailed analysis of the top five in-demand roles and top 20 growing roles.

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165   Linkedin, "Global-Talent-Trends-2019.Pdf," accessed August 5, 2022,
       https://business.linkedin.com/content/dam/me/business/en-us/talent-solutions/resources/pdfs/global-talent-trends-2019.pdf.Page 11
166   Ibid, Pages 12-15.

PERCENT OF ALL 2022 JOB POSTINGS

Job Title	Percent
CAD Technician	0.3%
Systems Integrator	0.3%
Technical Artist	0.4%
UI/UX Developer	0.4%
Biostatistician	0.5%
Network Administrator	0.6%
Mobile Developer	0.7%
Machine Learning Engineer	0.8%
Database Administrator	0.8%
Animator	0.8%
Dev Ops	1.0%
Cloud Architect	1.3%
Cloud Engineer	1.4%
Site Reliability Engineer	1.5%
QA Engineer	1.5%
Backend Developer	1.9%
Data Scientist	2.2%
IT Support	2.7%
Data Analyst	3.3%
Data Engineer	3.6%
Full Stack Developer	6.3%
Cybersecurity	8.9%
Business Analyst	9.0%
Project Manager	17.8%
Software Engineer	22.5%

Figure 4: In-Demand Jobs by Percent of all 2022 Job Postings, ICTC, 2022

Top Five In-Demand Jobs in 2022

1 Software Engineer   3 Business Analyst   5 Full Stack Developer

2 Project Manager   4 Cybersecurity Professional

1   SOFTWARE ENGINEER

This role requires understating and experience with software development principles and practices, proficiency with a variety of modern programming languages, and experience with Agile Methodology, version control, and build automation.

Top Technical Skills	Top Human Skills
Python	Design/Design Thinking
Kubernetes	Interpersonal Communication
C++	Leadership
Linux	Planning
Java	Flexibility
Docker	Problem Solving
SQL	Responsibility
AWS	Written Communication
JavaScript	Creativity
Jenkins	Innovation
Continuous Integration	Teamwork
Application Programming Interfaces (APIs)	Guiding Others
Android	Working Independently
C#	Empathy
Git/GitHub	Confidence
Azure	Decision-Making
TypeScript	Ability to Learn
Ruby	Openness
Kafka	Willingness to Learn
Software as a Service (SaaS)	Time Management

The software engineer/developer is the most in-demand job in Canada's smart economy. The top technical skills for software engineers are programming languages (Python, C++, Java, SQL, JavaScript), followed by infrastructure technologies (Container-related tools—Kubernetes and Docker, operating systems—Linux, and cloud services—AWS and Azure). Application programming interfaces (APIs) are also increasingly important because they enable the development of integrated and cloud-connected systems. Top human skills for this role were interpersonal communications, leadership, and planning. Many software development teams use agile methodology, and cross-disciplinary teams are required to deliver on key objectives and navigate complex team dynamics.

2 PROJECT MANAGER

This role leads project teams to accomplish objectives within project parameters including budget, schedule, and resource constraints.

Top Technical Skills	Top Human Skills
Project Management	Interpersonal Communication
Microsoft Office	Planning
Microsoft Project	Leadership
PowerPoint	Design/Design Thinking
Scrum	Responsibility
Finance	Time Management
Jira	Written Communication
Build Project Management Office (PMO)	Problem Solving
Business Development	Negotiation
Project Management Professional (PMP)	Teamwork
Waterfall Methodologies	Flexibility
Information Technology	Working Independently
Business Administration	Guiding Others
Enterprise Resource Planning (ERP)	Creativity
Visio	Decision-Making
SharePoint	Confidence
SAP	Critical Thinking
CRM	Oral Communication
Kanban	Innovation
Primavera	Conflict Resolution

Project managers play a pivotal role in leading smart city projects. Project management knowledge, followed by project management tools (Microsoft Project, Jira, Primavera) and collaboration tools (Microsoft Office, PowerPoint, Visio, SharePoint) are top technical skills for project managers in the smart economy. Project methodologies are also highlighted with Scrum (core to agile methodology), waterfall methodologies, and Kanban (a popular framework used to implement agile and DevOps software development) appearing on the top technical skill list. Interpersonal skills top the human skills list for project managers, consistent with the need to assemble and communicate with multidisciplinary project teams, as well as communicate project progress to senior management. Planning and leadership skills follow closely.

3 | BUSINESS ANALYST

This role curates and analyzes financial, market, and operational data to inform business decisions.

Top Technical Skills	Top Human Skills
SQL	Interpersonal Communication
Business Analysis	Design/Design Thinking
Operations Knowledge	Planning
Excel	Leadership
Project Management	Written Communication
Finance	Problem Solving
Python	Time Management
Information Technology	Responsibility
Business Systems	Working Independently
Jira	Teamwork
Visio	Flexibility
Information Systems	Decision-Making
Quality Assurance	Creativity
PowerPoint	Critical Thinking
Scrum	Guiding Others
Business Intelligence	Negotiation
Business Administration	Listening
Enterprise Resource Planning (ERP)	Innovation
Tableau	Confidence
Power BI	Oral Communication

Data access and analysis tools are the top business analyst technical skills (SQL, Excel), followed by business domain knowledge (business analysis, operations knowledge, finance, information technology, business systems, ERP). Domain knowledge is critically important to translate data analysis into policy and decision-making. Increasingly, Tableau and Power BI place high on the list of technical skills for business analysts. Although these tools are traditionally the domain of data analysts, data visualization tools have matured to the point where business analysts can leverage them more broadly. Interpersonal communications top the list of business analyst human skills. These skills are important when collecting data from organizational teams and presenting results to senior management. Design thinking is next, highlighting the need to use design techniques when modelling and/or improving business processes.

4 CYBERSECURITY PROFESSIONAL

These roles are usually designated for security professionals that undertake assessments of network and computer systems for vulnerabilities, and devise protections and monitoring tools and services that defend against cyber threats.

Top Technical Skills

Information Security

Certified Information Systems Security Professional (CISSP)

U.S. National Institute of Standards and Technology (NIST) Framework

Linux

Python

Security Information and Event Management (SIEM)

Azure

U.S. Cybersecurity and Infrastructure Security Agency (CISA)

AWS

Windows

ISO 27001 - Information Security Management

Security Operations Centre (SOC)

Intrusion Prevention System (IPS)

Payment Card Industry (PCI) Data Security Standard

SANS Institute

Center for Internet Security (CIS)

Google Cloud Platform (GCP)

Kubernetes

Global Information Assurance Certification (GIAC)

Certified in Risk and Information Systems Control (CRISC)

Top Human Skills

Interpersonal Communication

Design/Design Thinking

Leadership

Planning

Flexibility

Written Communication

Responsibility

Problem Solving

Guiding Others

Innovation

Confidence

Listening

Decision-Making

Teamwork

Working Independently

Time Management

Creativity

Resilience

Negotiation

Ability to Learn

Most cybersecurity job postings prioritize candidates that have industry certifications over specific skills. Hiring organizations do this because certifications provide trusted assessments of cybersecurity skills versus what can be ascertained from resumes and job interviews. Certifications also act as shorthand for a myriad of cybersecurity skills and tools to streamline job postings (Certified Information Systems Security Professional, Global Information Assurance Certification, Certified in Risk and Information Systems Control). Knowledge of cybersecurity frameworks also tops the cybersecurity technical skills list (U.S. National Institute of Standards and Technology [NIST] Framework, U.S. Cybersecurity and Infrastructure Security Agency [CISA], ISO 27001 - Information Security Management). As more organizations and municipalities migrate to the cloud, cloud service provider knowledge is gaining importance for cybersecurity professionals (AWS, Azure, Google Cloud Platform). Interpersonal communication and design thinking top the human skills list for cybersecurity professionals. Flexibility and resilience are also two key skills for cybersecurity employees, particularly those who must work in high-stress situations (e.g. responding to cyberattacks in real time as part of an incident response team).

5 │ FULL STACK DEVELOPER

This role requires capabilities geared to both the front and back end of a website. Expertise is needed with backend programming and databases, and front-end UI development.

Top Technical Skills	Top Human Skills
SQL	Design/Design Thinking
JavaScript	Interpersonal Communication
Kubernetes	Leadership
Python	Planning
Docker	Flexibility
Java	Working Independently
Jenkins	Teamwork
AWS	Problem Solving
Application Programming Interfaces (APIs)	Written Communication
GIT/GitHub	Creativity
Linux	Responsibility
C#	Guiding Others
HTML	Innovation
Azure	Empathy
TypeScript	Confidence
PHP	Time Management
Node.js	Ability to Learn
Continuous integration	Decision-Making
Vue	Listening
C++	Positive Attitude

Full stack developers fill the design and development gaps that exist between the development of front-end user experiences and the backend application access to data and business logic. This is reflected by the programming languages and tools that top the full stack developer's technical skill list (SQL, JavaScript, Python, Java, APIs, C#, HTML, Node.js). As cloud services are added to the full stack portfolio, full stack technology skills lists also include Kubernetes, Docker, AWS, and Azure. Consistent with the role that full stack developers play in designing systems and liaising between front-end and backend development teams, design thinking and interpersonal communication top the human skills list. Next are leadership, planning, and flexibility—all important skills to bridge the gap between front-end and backend development.

Top 20 Jobs Growing in Demand in 2022

DATA ENGINEER

This role processes raw data by developing algorithms and computer software to make the data more useful for an organization.

Top Technical Skills	Top Human Skills
SQL	Design/Design Thinking
Python	Interpersonal Communication
AWS	Leadership
Kubernetes	Planning
Spark	Responsibility
Big Data	Problem Solving
Azure	Guide Others
Java	Flexibility
Jenkins	Written Communication
Data Warehouse	Creativity

As the volume and speed of data collection increases, data engineers play an increasingly important role in an organization's data pipeline, from raw data to business intelligence and application enablement. Data access and manipulation tools top the data engineer technology skills list (SQL, Python, Spark, data warehouses). As more organizational data moves to the cloud, cloud services and tools are also high on the data engineer technology skills list (AWS. Azure, Kubernetes). Design thinking and interpersonal skills top the human skills list.

DATA ANALYST

This role uses programming languages and computer software to analyze large amounts of data for patterns, trends, and forecasts important to an organization.

Top Technical Skills	Top Human Skills
SQL	Interpersonal Communication
Python	Design/Design Thinking
Excel	Planning
Tableau	Leadership
Power BI	Written Communication
Access	Problem Solving
Finance	Working Independently
Business Intelligence	Responsibility
Data Management	Decision-Making
Data Quality	Creativity

Data access and manipulation tools top the data analyst technology skills list (SQL, Python, Excel, Microsoft Access). Data visualization tools follow next on the technology skills list (Tableau, Power BI). Design thinking and interpersonal skills top the human skills list.

IT SUPPORT

This role helps computer and network users with technical issues, covering the gamut of IT services and tools, including operating systems, Internet, networking, applications, and data.

Top Technical Skills	Top Human Skills
Windows	Interpersonal Communication
Linux	Planning
SQL	Leadership
Active Directory	Problem Solving
Information Technology	Written Communication
Microsoft Office	Working Independently
Office 365	Flexibility
Excel	Time Management
Azure	Responsibility
Service Desk Operations	Teamwork

Operating systems top the technical skills list for IT support (Windows, Linux). Interpersonal communication skills top the human skills list for IT support—this is consistent with the significant client interaction associated with the role.

DATA SCIENTIST

This role uses scientific methodologies to explore and explain data by leveraging algorithms, machine learning, and a variety of data analytic tools.

Top Technical Skills	Top Human Skills
Python	Design/Design Thinking
SQL	Interpersonal Communication
Machine Learning	Leadership
Data Science	Planning
Statistics	Decision-Making
Mathematics	Guiding Others
AI	Written Communication
Spark	Creativity
AWS	Innovation
Big Data	Teamwork

Data manipulation tools top the data scientist technical skills list (Python, SQL, Spark). They are followed by techniques and methodologies to analyze and create algorithms from the data (machine learning, AI, big data). Design thinking and interpersonal skills top the human skills list.

BACKEND DEVELOPER

This role develops software for the backend of software systems made up of databases, servers, programming logic, and APIs.

Top Technical Skills	Top Human Skills
Kubernetes	Design/Design Thinking
Docker	Interpersonal Communication
SQL	Flexibility
Python	Planning
Java	Leadership
Application Programming Interfaces (APIs)	Creativity
Linux	Written Communication
AWS	Problem Solving
Jenkins	Teamwork
JavaScript	Responsibility

The backend server orientation of the backend developer job results in container technologies topping the technical skills list (Kubernetes, Docker). These container technologies are followed by data access and manipulation tools (SQL, Python, Java, APIs). Design thinking and interpersonal skills top the human skills list.

QA ENGINEER

This role participates in all aspects of the software development lifecycle to ensure design and development quality meets the requirements of an organization.

Top Technical Skills	Top Human Skills
SQL	Design/Design Thinking
Python	Interpersonal Communication
Jenkins	Planning
Quality Assurance	Written Communication
Selenium	Leadership
Linux	Responsibility
Jira	Creativity
Application Programming Interfaces (APIs)	Flexibility
Java	Problem Solving
Android	Working Independently

Data access and manipulation tools top the QA engineer technical skills list (SQL, Python, APIs, Java). Software automation tools are next on the list (Selenium, Jenkins). Android appears on the list because software applications are tested on multiple platforms, including Android-based smartphones. Design thinking and interpersonal skills top the human skills list.

SITE RELIABILITY ENGINEER

This role manages the performance, availability, emergency response, and capacity planning for the websites of an organization.

Top Technical Skills	Top Human Skills
Kubernetes	Design/Design Thinking
Python	Interpersonal Communication
Linux	Planning
Docker	Leadership
AWS	Responsibility
Jenkins	Flexibility
Terraform	Problem Solving
GitLab	Creativity
Azure	Guiding Others
SQL	Written Communication

Given the broad-based scope of the site reliability engineer role, the skills at the top of the technical skills list cover a blend of data access, container tools, operating systems, and cloud services. Design thinking and interpersonal skills top the human skills list.

CLOUD ENGINEER

This role develops and manages cloud applications and ensures that security and access control mechanisms are in place.

Top Technical Skills	Top Human Skills
Kubernetes	Design/Design Thinking
Python	Interpersonal Communication
Cloud Security	Planning
Docker	Leadership
AWS	Written Communication
Linux	Problem Solving
Azure	Responsibility
Jenkins	Flexibility
Continuous integration	Creativity
SQL	Innovation

As is expected for a cloud engineer, cloud services and technologies top the technology skills list (Kubernetes, Docker, AWS, Azure). Cloud security is also identified as a skill priority. Design thinking and interpersonal skills top the human skills list.

CLOUD ARCHITECT

This role creates, secures, and evolves the technical design for the cloud infrastructure of an organization.

Top Technical Skills	Top Human Skills
Kubernetes	Design/Design Thinking
Python	Leadership
Cloud Security	Interpersonal Communication
AWS	Planning
Azure	Guide Others
SQL	Written Communication
Google Cloud Platform (GCP)	Flexibility
Jenkins	Problem Solving
Docker	Responsibility
Java	Working Independently

Like the cloud engineer list, cloud services and technologies top the cloud architect technology skills list (Kubernetes, Docker, AWS, Azure, Google Cloud Platform). Cloud security again is identified as a skill priority. Design thinking tops the cloud architect human skills list. Next is leadership, which is expected when considering the primacy of the cloud architect's role in cloud design and strategy.

BLOCKCHAIN DEVELOPER

This role leverages blockchain technology platforms to develop distributed blockchain applications.

Top Technical Skills	Top Human Skills
IBM Cloud	Design/Design Thinking
Kubernetes	Interpersonal Communication
SQL	Leadership
Python	Planning
Docker	Creativity
Java	Responsibility
JavaScript	Innovate
Jenkins	Openness
OpenShift	Written Communication
Ethereum	Working Independently

IBM Cloud tops the blockchain developer technical skills list. IBM's cloud-based blockchain platform, Hyperledger Fabric, is an open-source platform for blockchain development. Next on the list is container technology, which is consistent with many blockchain developers using container technologies to deploy their blockchains (Kubernetes, Docker). Design thinking and interpersonal skills top the human skills list.

DEV OPS

This role works with software developers to manage the release and update of software code into production environments.

Top Technical Skills	Top Human Skills
Kubernetes	Design/Design Thinking
Jenkins	Interpersonal Communication
SQL	Planning
Python	Leadership
Azure	Problem Solving
Docker	Written Communication
AWS	Decision-Making
Java	Responsibility
Continuous integration	Teamwork
Linux	Flexibility

Container technologies support application deployment—a key role for Dev Ops professionals—and top the list for Dev Ops technical skills (Kubernetes, Docker). Next is another technology used to streamline and facilitate continuous integration and continuous delivery of applications: automation server technology (Jenkins). Design thinking and interpersonal skills top the human skills list.

ANIMATOR

This role is an artist that creates moving images by hand-drawing or using animation software, primarily for the film and video game industries.

Top Technical Skills	Top Human Skills
Maya	Design/Design Thinking
Python	Interpersonal Communication
Rigging	Leadership
VFX	Planning
MotionBuilder	Creativity
C++	Responsibility
3ds Max	Innovate
CG Animation	Openness
Teradici	Written Communication
Houdini	Working Independently

A variety of animation tools top and dominate the animator technical skills list (Maya, MotionBuilder, 3ds Max, Houdini). Design thinking and interpersonal skills top the human skills list. Next on that list is creativity, which is expected for a creative role such as animator.

DATABASE ADMINISTRATOR

This role monitors, backs up, manages, secures, and updates database systems.

Top Technical Skills	Top Human Skills
SQL	Design/Design Thinking
Information Security	Interpersonal Communication
Linux	Planning
Oracle	Leadership
SQL Server	Written Communication
Python	Problem Solving
Azure	Responsibility
AWS	Working Independently
Windows	Teamwork
MySQL	Flexibility

Databases and database tools top the database administrator technical skills list (SQL, Oracle, SQL Server, MySQL). Next on the list is information security and operating systems (Linux, Windows). Design thinking and interpersonal skills top the human skills list.

MACHINE LEARNING ENGINEER

This role manages data pipelines, performs feature engineering, and develops algorithms using machine learning techniques and technologies.

Top Technical Skills	Top Human Skills
Python	Design/Design Thinking
Kubernetes	Interpersonal Communication
C++	Planning
AI	Leadership
TensorFlow	Working Independently
SQL	Problem Solving
Docker	Creativity
AWS	Innovation
Deep Learning	Teamwork
PyTorch	Experimental Mindset

Programming languages that support machine learning top the machine learning engineer technology skills list (Python, C++). Machine learning engineers also use container technology to deploy consistent and optimized machine learning environments (Kubernetes, Docker). Next on this list are deep learning frameworks that simplify the creation of machine learning models (TensorFlow, PyTorch). Design thinking and interpersonal skills top the human skills list.

MOBILE DEVELOPER

this role designs and develops mobile applications for devices such as smart phones and tablets.

Top Technical Skills	Top Human Skills
Android	Design/Design Thinking
Kotlin	Interpersonal Communication
Swift	Leadership
Java	Planning
JavaScript	Responsibility
Git/GitHub	Problem Solving
SQL	Written Communication
Objective-C	Empathy
Scrum	Creativity
Python	Flexibility

The Android mobile operating system tops the mobile developer technology skills list. Mobile programming languages are next on this list (Android development: Kotlin, iOS development: Swift, Objective-C). Design thinking and interpersonal skills top the human skills list.

NETWORK ADMINISTRATOR

This role uses software and processes to manage the computer network for organizations.

Top Technical Skills	Top Human Skills
Network Security	Interpersonal Communication
Linux	Design/Design Thinking
Cisco	Written Communication
Windows	Leadership
Firewalls	Responsibility
SQL	Working Independently
Wireless Networks	Problem Solving
LAN/WAN	Creativity
Routers	Time Management
VMWare	Teamwork

Network security tops the network administrator technical skills list. Operating systems are next on the list (Linux, Windows). Network technologies follow operating systems on the technology skills list (Cisco, firewalls, wireless networks, LAN/WAN, routers). Interpersonal skills and design thinking top the human skills list.

BIOSTATISTICIAN

This role works with biological systems data by applying statistical and data science methods in fields like medical research.

Top Technical Skills	Top Human Skills
SAS	Design/Design Thinking
Iqvia	Interpersonal Communication
Clinical Data Interchange Standards Consortium (CDISC)	Leadership
International Council for Harmonization of Technical Requirements (ICH)	Oral Communication
Conditional Random Field (CRF)	Planning
SQL	Written Communication
Functional Service Provider (FSP) Models	Sharing Knowledge
Cytel	Working Independently
Excel	Time Management
Ada	Problem Solving

Biotech/clinical research data analysis tools top the biostatistician technology skills list (SAS, Iqvia, Cytel). Next on the list are standard bodies and clinical research techniques (Clinical Data Interchange Standards Consortium, International Council for Harmonization of Technical Requirements, Conditional Random Field, Functional Service Provider [FSP] Models). Design thinking and interpersonal skills top the human skills list.

UI/UX DEVELOPER

This role understands user experience and user interface principles and practices including the ability to assess usefulness, usability, ease in navigation, accessibility, credibility, web principles and standards, including best practices for usability.

Top Technical Skills	Top Human Skills
JavaScript	Design/Design Thinking
HTML	Interpersonal Communication
Java	Leadership
SQL	Planning
Jenkins	Problem Solving
Kubernetes	Written Communication
Git/GitHub	Creativity
TypeScript	Time Management
Docker	Teamwork
Application Programming Interfaces (APIs)	Responsibility

Front-end programming languages and tools top the UI/UX developer technical skills list (JavaScript, HTML, TypeScript, APIs). Design thinking and interpersonal skills top the human skills list.

TECHNICAL ARTIST

This role bridges the gap between artists and programmers to help smooth the multidisciplinary production of creative products.

Top Technical Skills	Top Human Skills
Python	Interpersonal Communication
C++	Design/Design Thinking
Maya	Creativity
C#	Guiding Others
Houdini	Leadership
Rigging	Innovation
VFX	Problem Solving
Unity	Planning
3ds Max	Written Communication
Perforce	Working Independently

Programming languages top the technical artist technical skills list (Python, C++, C#). Next on the list are animation tools (Maya, Houdini, Unity, 3ds Max). Interpersonal communication and design thinking top the human skills list.

SYSTEMS INTEGRATOR

This role integrates sub systems and independent products into functioning systems and services.

Top Technical Skills	Top Human Skills
SQL	Design/Design Thinking
Python	Interpersonal Communication
Linux	Responsibility
Oracle	Planning
Azure	Leadership
Windows	Teamwork
Information Technology	Flexibility
Java	Written Communication
Enterprise Resource Planning (ERP)	Guiding Others
Software as a Service (SaaS)	Problem Solving

Data integration tools top the systems integrator technology skills list (SQL, Python, Java). Operating systems are next on this list (Linux, Windows). Design thinking and interpersonal skills top the human skills list.

CAD TECHNICIAN

This role leverages hardware and software to process and prepare computer-aided design drawings for use.

Top Technical Skills	Top Human Skills
AutoCAD	Design/Design Thinking
Civil 3D	Interpersonal Communication
Excel	Planning
MicroStation	Time Management
Geographic Information System (GIS)	Working Independently
SolidWorks	Leadership
ArcGIS	Written Communication
Computer numerical control (CNC)	Flexibility
exocad	Problem Solving
ProjectWise	Responsibility

Computer-aided design (CAD) software top the CAD technician technology skills list (AutoCAD, Civil 3D, MicroStation, SolidWorks, exocad). Design thinking and interpersonal skills top the human skills list.

Featured Roles – Spearheading Future Demand

While hiring volume is one indicator of labour demand, others include ease of sourcing, degree of specialization, and exogenous factors (such as broader economic forces, policy changes, community and societal needs, etc.) that influence the need for talent in certain areas. The following roles, although not currently seeing large hiring volumes, will be increasingly critical to power and sustain an inclusive smart economy.

DIVERSITY EQUITY INCLUSION MANAGER

This role helps develop diversity, equity, and inclusion policies and programs for an organization.

Top Technical Skills

Human Rights

The Ontario Human Rights Code

Excel

PowerPoint

Social Sciences

Accessibility for Ontarians with Disabilities Act (AODA)

Canadian Certified Inclusion Professional (CCIP)

Collaboration Tools

Social Work

Employee Resource Groups (ERGs)

Top Human Skills

Leadership

Interpersonal Communication

Design/Design Thinking

Planning

Responsibility

Time Management

Flexibility

Teamwork

Guiding Others

Making Decisions

ENVIRONMENTAL SCIENTIST

This role designs and implements programs/projects to protect the environment using their knowledge and tools from the natural sciences.

Top Technical Skills

Health and Safety

Excel

Environmental Sciences

Environmental Engineering

Environmental Site Assessment (ESA)

PowerPoint

Geographic Information System (GIS)

Earth Sciences

Reclamation & Remediation

Hydrogeology

Top Human Skills

Interpersonal Communication

Planning

Written Communication

Working Independently

Time Management

Design/Design Thinking

Leadership

Teamwork

Responsibility

Problem Solving

URBAN DESIGNER

This role plans and oversees urban projects to create new or adapt/revitalize existing urban spaces.

Top Technical Skills	Top Human Skills
Landscape Architecture	Design/Design Thinking
AutoCAD	Planning
Excel	Interpersonal Communication
PowerPoint	Leadership
Rhino	Written Communication
Adobe Creative Suite	Problem Solving
Project Management	Flexibility
Geographic Information System (GIS)	Creativity
Microstation	Working Independently
ARCGIS	Time Management

PRODUCT MANAGER

This role manages the entire lifecycle of a product, including planning, design, and launch.

Top Technical Skills	Top Human Skills
Software Development	Interpersonal Communication
Software as a Service (SaaS)	Design/Design Thinking
SQL	Leadership
Excel	Planning
Jira	Guiding Others
Application Programming Interfaces (APIs)	Ingenuity
Python	Teamwork
AWS	Flexibility
Android	Responsibility
Kanban	Time Management

Note: During smart city roundtables, several municipal officials identified the need to integrate more product management principles into the traditional project orientation. Incorporating a product lifecycle mindset was considered helpful to making projects more sustainable and effective beyond the initial project budget and timeline.

PRIVACY OFFICER

This role creates and oversees data privacy policies and data governance related to privacy.

Top Technical Skills

Excel

EU General Data Protection Regulation (GDPR)

California Consumer Privacy Act (CCPA)

Microsoft Office

Freedom of Information and Protection of Privacy Act (provinces)

Canada's anti-spam legislation (CASL)

International Association of Privacy Professionals (CIPM)

SQL

Personal Health Information Protection Act (Ontario)

Data Governance & Technology

Top Human Skills

Interpersonal Communication

Leadership

Guiding Others

Planning

Design/Design Thinking

Flexibility

Responsibility

Teamwork

Written Communication

Innovation

TELECOMMUNICATIONS TECHNICIAN

This role installs and maintains telecommunications infrastructure, including fibre installation.

Top Technical Skills

Network Security

Fibre Installation

Diagnose Telecommunications Issues

Excel

Health and Safety Protocols

Splicing Cable/Fibre

CCTV Installation and Repair

Install Switch Networks

ATX (Advanced Technology eXtended)

Linux

Top Human Skills

Interpersonal Communication

Ability to Learn

Working Independently

Design/Design Thinking

Oral Communication

Positive Attitude

Leadership

Planning

Written Communication

Interpersonal Communication

Determining Relative Skill Importance

One of the challenges associated with gauging the importance of specific technical skills from job postings is the higher frequency at which certain less critical skills occur. Examples are productivity tools like Microsoft Word and Slack: these skills occur in most software engineer postings but are not significant factors in assessing a candidate. To mitigate this problem, ICTC conducted a series of surveys with HR recruiters, hiring managers, and talent professionals to rank skill importance for each in-demand job.

> ICTC *Survey of Skill Weighting Wave 1* (2020, n = 200)
> ICTC *Survey of Skill Weighting Wave 2* (2020, n = 200)
> ICTC *Survey of Skill Weighting Wave 3* (2021, n = 200)

This information was used to create skill weights and inform the algorithms that power ICTC's Job Skill Matching Tool. Figure 5, for example, shows the relative importance skill scores for network technicians.

NETWORK TECHNICIAN SKILL IMPORTANCE SCORES

Skill	Score
Troubleshooting	5.58
Wireless Networks	5.51
Windows	5.43
IP Networking	5.24
LAN	5.23
Active Directory	4.29
Excel	4.19
Linux	4.07
SharePoint	4.06
SQL	3.80
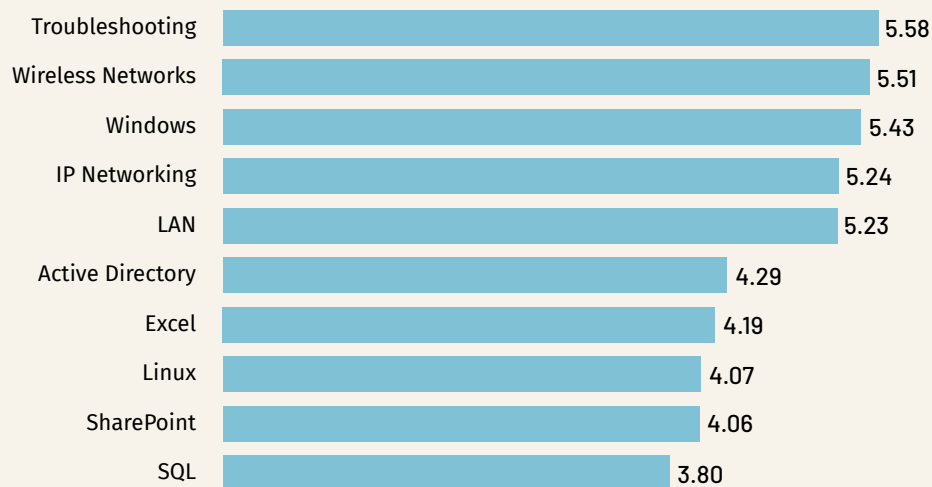
Figure 5: Network Technician Skill Importance, Skill Weighting Survey, 2020

The City View: Job Data Through the Municipal Lens
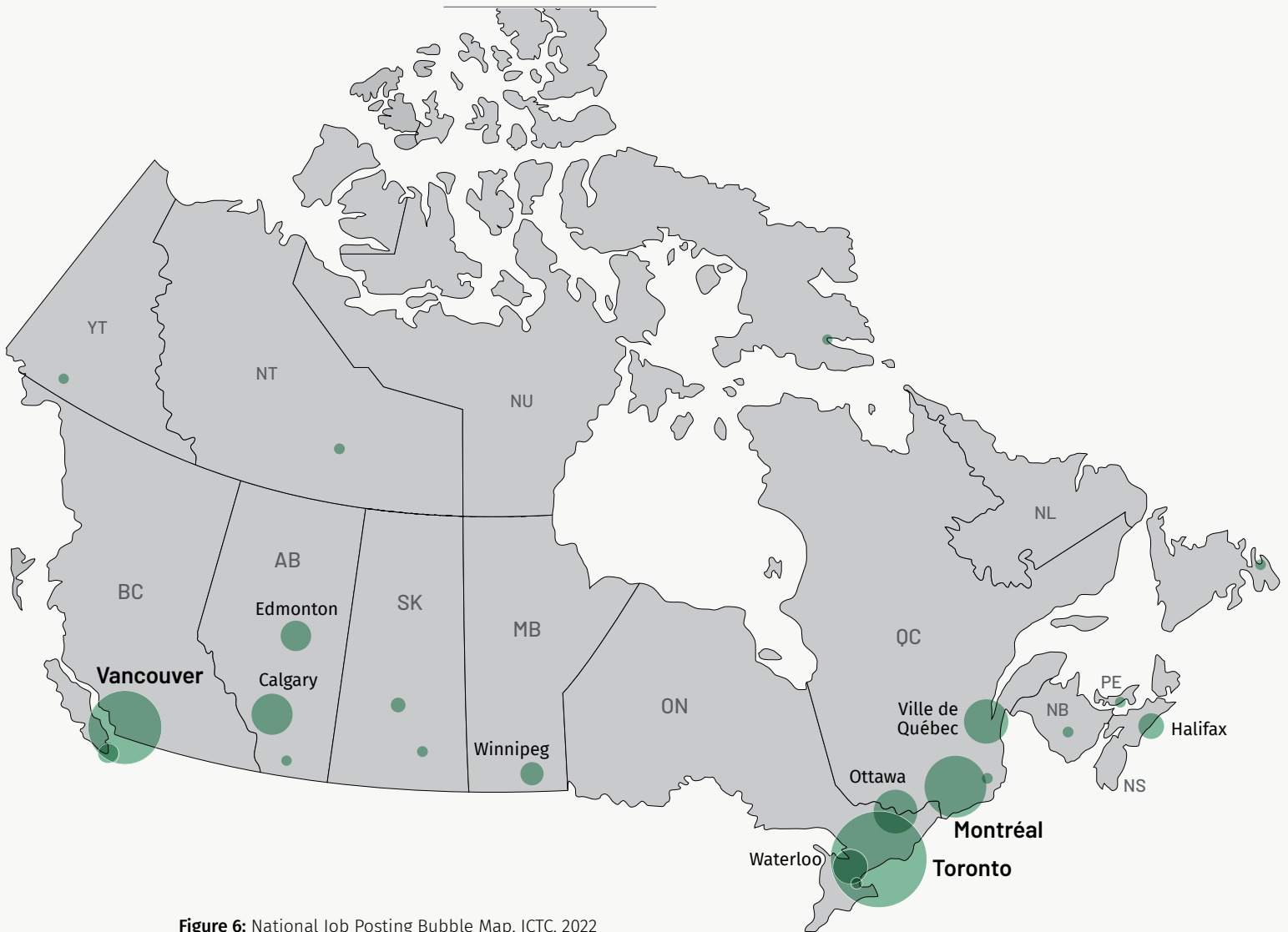
Figure 6: National Job Posting Bubble Map, ICTC, 2022

ICTC collects smart city job data for 22 Canadian cities (at least one city in each province and territory). Collection began in late 2019, with 14 cities in the initial cohort. In 2022, an additional eight cities were added to the original roster. Since 2019, over 550,000 job postings have been collected across these 22 cities.

Original Cities

Halifax	Toronto	Edmonton
Fredericton	Waterloo	Vancouver
Ville De Québec	Winnipeg	Victoria
Montreal	Saskatoon	Yellowknife
Ottawa	Calgary	

Cities added in 2022

Charlottetown	Regina
St. John's	Lethbridge
Sherbrooke	Whitehorse
Hamilton	Iqaluit

The three cities with the highest number of job postings during this period are Toronto, Vancouver, and Montreal. As shown by Figure 7, there was a drop in aggregate job postings for these three cities during the early months of the COVID-19 pandemic, with a recovery in job posts beginning early in 2021.

JOB POSTING COUNTS BY CITY

Figure 7: Job Postings Counts for Montreal, Toronto, and Vancouver, ICTC, 2022
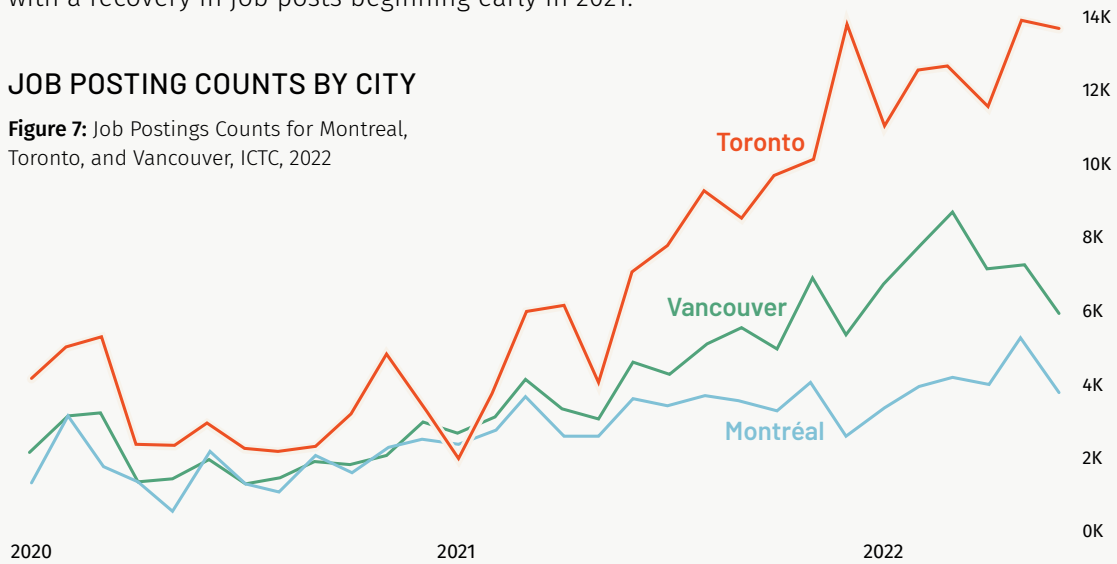
The COVID-19 job count pattern was not unique to Canada's largest cities; Calgary, Waterloo, and Winnipeg also demonstrated the same drop and recovery (seen in Figure 8).

JOB POSTING COUNTS BY CITY

Figure 8: Job Posting Counts for Waterloo, Winnipeg, and Calgary, ICTC, 2022

Let's Talk Smart Cities

Q Has the last year highlighted new (or pressing) concerns for the city?

homelessness affects community health; our need to effect reconciliation in our NPO sector.

"Silo" mentality and more so due to C19

Health security + role of tech in streamlining services/sourcing supply

Responsive public policy in a time of crisis

I think the pandemic did highlight some of our hyper dependencies and advanced dossiers like working at home in a way it would have taken decades otherwise. There has been loss, let's not squander opportunities.

on the positive, businesses realized how fast they actually could pivot and change business strategies

the curtain was pulled back on the lack of agility for government both provincial and federal

we get health assets - vaccines and PSE's, at the end of the line. Other provinces are able to get fed attention, we cannot.

Does data/ science drive policy...?

Lack of interconnectivity among hospitals, care homes, emergency & social services. Communication systems would be helpful. Cohesive intake would track community members in need.

Virtual network events are more competitive and zoom burn out is a real thing!

Anyone else dealing with high connectivity fees?

I think it brings more of a spotlight on the granularity and efficacy of existing logistical systems for the delivery of good and services.

Yes . . . high connectivity and lack of connectivity remains a major issue in our province - both rurally and up north

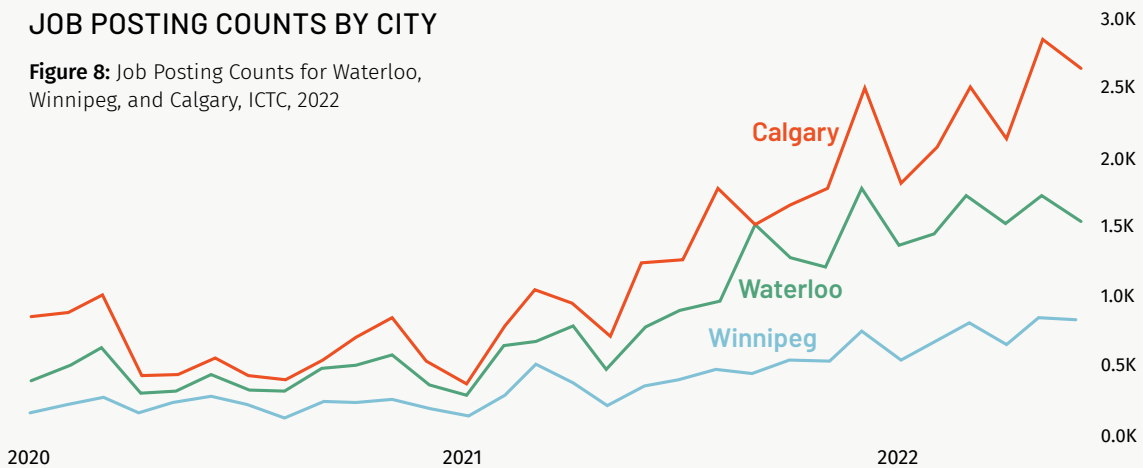Security and Homeless. We need to be more aware of how to improve those issues as a community through technology.

Digital divide

Accountability and oversight of senior centers is imperative. How could technology assist in monitoring the health and safety of residents?

mechanisms for newcomers to connect professionally and personally * innovative ways to keep the community connected * connections with medical services *

Disadvantage groups being left behind as the shift to technology has accelerated and they are not always able to access the new technologies or processes

Urban density may now be challenged, WFH has shown that people can live/work anywhere so this may challenge some tech/strategy investment and need for major cities

Between November 2020 and February 2022, (ICTC) partnered with organizations across Canada to hold smart city community engagement sessions. Each session began with one or two presentations by local community groups and ended with a group discussion. During the discussion, attendees identified what challenges and opportunities technology creates in their communities and shared how technology impacts their lives.

Community consultations identified several opportunities for smart technologies to improve the lives of citizens. Most importantly, participants in each of the sessions highlighted the need to focus smart city projects on improving lives, rather than introducing technology to simply improve municipal efficiencies or for other reasons.

Every jurisdiction has its own needs, with unique citizen preferences and regional challenges. However, despite the heterogeneity of each community, trends emerged across the types of programs most important to the prosperity and wellbeing of the region. At the forefront of these conversations was livability. Livability can be broadly defined as the delivery of municipal services, mobility and transit, housing, environment, and access to healthcare services. While this definition may differ by regions, these pillars—smart governance, smart mobility, and smart health and wellbeing—were important to all the participants involved in these sessions.

COVID-19's effect on work, and the move toward remote work, shifted populations away from city centres and to municipalities that historically had seen slower population growth. Many municipalities across Canada were not designed to accommodate such a drastic shift in population. Participants voiced optimism that new smart governance and smart health measures could help support this change.

The transit and mobility dimension of livability was repeatedly mentioned as an area where smart technology could be used to improve the lives of citizens. A few municipalities have already begun piloting smart mobility projects, and participants are excited about the prospect of improving public transit, making cities less car-centric while improving safety for cyclists and pedestrians.

Q If you had the ability to set the city's top three goals for the 2022-23 year, what would they be?

Increased housing availability (reduce barriers to developments)

better long term development plan that is data driven

1. Better traffic light coordination, 2. digitally enhanced outdoor recreation spaces, 3. seamless payment experience

Better transportation in Greater Victoria and coordinated transportation system

1) Affordable and available accommodations for thousands of foreign students. 2) Ease of transport. 3) More grocery stores in walkable distances.

Protection of our green and natural spaces!!

A more transparent regional plan (set areas / zones that allow high density developments and thus less back and fourth with developers and councils in approvals

Increase public health, increase education, and increase access to good information.

Better digital health system

Free internet on road.... :) That's a real smart city (India has many such cities where internet on road is free).

Amalgamate municipalities (unlikely) but perhaps start with integrated departments (1 police unit, 1 fire department etc.) for more efficiency

1. A clear plan on density growth and managing additional road traffic 2. more affordable access to/publicly shared active transport options 3. disaster mitigation strategies

better long term development plan that is data driven

access to healthcare and mental health

The conversations did uncover concerns as well. Repeatedly, across almost all the sessions, privacy was the most important issue. Participants were aware that many smart city projects need access to data to optimize services. Ensuring personal data was kept safe and secure took precedent over development of novel services. Additionally, participants were concerned that Canada and its municipalities lagged international jurisdictions in the quality of data offered through open-data portals. Participants noted that access to timely data promoted transparency and accountability.

There is demand for smart city projects, and subsequently, there will be demand for labour with the necessary skills to advance these projects across Canada. While the types of skills needed often overlap, each of the six smart city pillars have unique labour requirements, depending on the specific project. Data scientists, telecommunication experts, cybersecurity specialists, as well as talent with digital literacy skills will be necessary as Canadian municipalities look to improve the lives of their citizens.
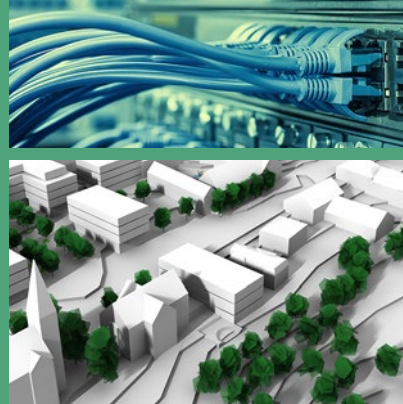
Conclusion

This paper explores smart city and smart city-related labour demand and the associated technical and human skills that are essential for successful smart city development. A foundational consideration for municipalities working on smart city initiatives with private sector partners and technology suppliers is the need to effectively embed resident-centric best practices into their projects. Rigorous resident and stakeholder consultations on projects ensure that the benefits of data-informed insights, digital engagement with services, and innovative applications will translate into more livable cities that provide its denizens a better, more equitable experience of city life.

Currently, as Canadian municipalities emerge from the COVID pandemic and grapple with constricted budgets and priorities that are shifting toward green and environmental concerns, they face numerous challenges to smart city development. A core challenge is navigating the increasing demand for digital talent in the Canadian economy, which makes it difficult for municipalities to source suitable talent—specifically software developers, project managers, cybersecurity professionals, and data professionals.

Also, municipalities often cannot offer the high wages that some private sector technology companies do, nor can they always ensure that new hires work with state-of-the-art technologies that would allow them to remain technically competitive for career advancement. Moreover, municipalities often have inflexible legacy procurement processes that can exacerbate smart city development progress. As a result, many municipalities are turning to local technology service companies under consulting contracts or partnerships so as to overcome the obstacles of securing in-house talent.

Going forward, several important areas of ongoing study suggest themselves in connection with smart city development in Canada. As cloud-based systems replace traditional in-house hardware and accelerated digitization impacts all facets of municipal ecosystems, new skills will supplant current in-demand skills. Understanding this evolution in labour needs and tracking, for example, the balance between the importance of technical and human skills will become important labour market intelligence. Moreover, as some skills wane and others wax, mapping academic and industry-generated training, upskilling and reskilling options could prove useful for Canada's digital workforce supply-and-demand balance.

Further, as employers look to fill talent shortages, people from groups that are currently underrepresented in tech will play a more important role. Effective diversity, equity, and inclusion policies need to become more nuanced and effective so that organizations can benefit from a diverse workforce, which research shows is good for business and for the bottom line. In turn, more equitable hiring strengthens the fabric of society.

As municipalities continue to digitalize and increasingly leverage cloud services and third-party platform solutions, rigorous cybersecurity and data governance related to privacy will be needed. Privacy was repeatedly noted as a top concern by this study's municipal participants. Keeping abreast of the ever-changing cyber-threat landscape, along with data oversight, will present significantly expanded opportunities for these roles alongside the many other technical and complex interdisciplinary roles that are needed to advance smart cities projects in Canada.

Appendix A:
Research Methods and Tools

This report marks the end of a multi-year study on smart cities in Canada. Along with its sister report on labour supply in smart cities, it explores the in-demand jobs, skills sought by employers, and demand challenges faced by municipalities and their smart city counterparts in the broader inclusive, smart economy. This project it draws on extensive primary and secondary research and was overseen by a Smart Cities Demand Taskforce, as referenced and acknowledged in the introduction.

Secondary Research

Literature review

The qualitative and quantitative portions of this project are supported by a thorough review of available literature. The literature review helped shape research methodology and questions and provides information to help further validate findings in the report. The initial literature review helped identify taskforce participations, focus group participants, and interviewees for the research.

Primary Research

Surveys Informing this Study

Several surveys, listed below are featured in the study.

Name	Population	Abridged name	Data Collection	Sample
ICTC Skill Weighting Survey, Wave 1	Hiring Decisionmakers Across the Economy		2020	200
ICTC Skill Weighting Survey, Wave 2	Hiring Decisionmakers Across the Economy		2020	200
ICTC Skill Weighting Survey, Wave 3	Hiring Decisionmakers Across the Economy		2021	200
ICTC Survey of Employer Perceptions of Human or Soft Skills	Hiring Decisionmakers Across the Economy	Human Skills Survey	2021	200
Total				**1,000**

Job Posting Data Collection

From 2019 through 2022, over 565,000 job postings have been collected. National job posting websites were scraped to collect data to establish job counts and skill analysis.

Smart Cities Supply Taskforce

Over the course of the Inclusive Smart Economy project (2019 – 2022), the Smart Cities Demand Taskforce met bi-annually (on average), at first in person and then virtually. It comprised 27 members from municipal government, smart city consulting organizations, immigration organizations, organizations that specialize in workplace diversity and career transitions, and other members of industry and civil society. Taskforce members were advised on research directions and methods and heard reports of findings and offered commentary. Some taskforce meetings were held as generative, discussion-based focus group sessions, and these were incorporated into the study's qualitative thematic analysis.

Interviews

ICTC analyzed input from a wide cross-section of municipalities, including all of Canada's major metropolitan areas and numerous small and mid-sized cities. This was done to provide a diversity of voices and experiences. There was at least one interviewee from all but two of Canada's provinces (Newfoundland and Labrador, Saskatchewan), as well as an interviewee from the Northwest Territories. Representatives from the following cities were interviewed:

> Edmonton, AB

> Yellowknife, NWT

> Sault Ste. Marie, ON

> Kelowna, BC

> Surrey, BC

> Summerside, PEI

> Guelph, ON

> Fredericton, NB

> Ottawa, ON

> Winnipeg, MB

> Halifax, NS

> Hamilton, ON

> Langford, BC

> Calgary, AB

> Waterloo, ON

> Toronto, ON

> Montreal, QC

> Vancouver, BC

Interviewees represented a wide cross-section of roles in their municipalities, including Chief Digital Officer, Director of Renewable Energy Systems, Manager of Intelligent Cities Team, Director of Municipal Services, Borough Mayor, and Director of Strategic Policy and Planning. Interviewee involvement in smart city initiatives ranged from participatory roles in large committees to central roles in spearheading adoption.

Projects mentioned by interviewees differed greatly by their degree of completion. Some were in the early planning stage, some were pilot projects, and others were operational at full capacity. Cities were also pursuing various strategies for adoption. Some were actively using new technologies and processes, while others were starting with smaller initiatives to try it out before large-scale adoption.

Research Limitations and Opportunities for Further Investigation

The methods used in this study have several limitations. First, since COVID-19 has greatly disrupted municipal operations and strategic planning, it proved challenging to connect with some cities and obtain adequate representation from all cities that have smart city projects. Next, the surveys of employers were conducted through online panels and are limited to respondents with internet access. Where reference population distributions were available from Statistics Canada or other sources, responses were appropriately weighted. However, there isn't always a reasonable estimate of the underlying distribution of the populations being studied, and in this case conclusions from the sample are limited to respondents and cannot necessarily be taken as representative of employers across Canada. Further, the topic of smart cities demand is of significant scope, and there are several opportunities for further investigation that this study does not address. Examples include assessing and monitoring labour demand by city and priority area over time, better understanding the evolution of human skill needs over time, understanding the prevalence and evolution of remote work after COVID-19, and other topics, including municipal economic development, resettlement, retention, and affordability.