Technical Supplement

LABOUR MARKET FORECASTS FOR CANADA'S INCLUSIVE SMART ECONOMY

ICTC CTIC

Research by

The Information and Communications
Technology Council

Canada

This project is funded in part by the Government
of Canada's Sectoral Initiatives program.

Preface

The Information and Communications Technology Council (ICTC) 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.

To cite this report:

Akshay Kotak, *Labour Market Forecasts for Canada's Inclusive Smart Economy* (Ottawa, ON: Information and Communications Technology Council, August 2022).

Researched and written by Akshay Kotak, Manager of Economics, with generous support from Matthias Oschinski, Maryna Ivus, Ryan McLaughlin, Zhenzhen Ye, Rob Davidson, Alexandra Cutean, and the ICTC Digital Think Tank team.

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 Toward an Inclusive Smart Economy for Canada: The Human Talent Engine that Powers Smarter Cities
2. Bringing a "Smart City" to Life: Understanding Talent Development, Attraction, and Retention
3. Technical Supplement: Labour Market Forecasts for Canada's Inclusive Smart Economy

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, 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.

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 are presented in the *Technical Supplement*. There are, however, 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.

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 in this span, and how this will impact job and skills demand. *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 physical locations from labour demand and supply.

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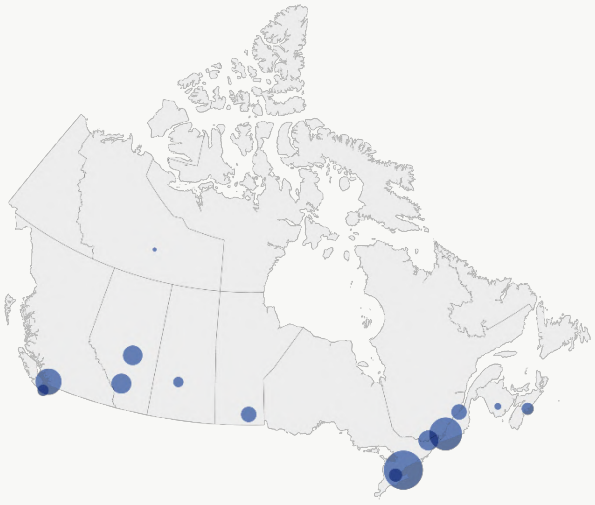
Introduction

This report is a supplement to its two sister publications—*Moving Toward an Inclusive Smart Economy for Canada: The Human Talent Engine that Powers Smarter Cities* and *Bringing a "Smart City" to Life: Understanding Talent Development, Attraction, and Retention*—that focus on key drivers for smart city related labour demand and supply, respectively. This set of reports represents the culmination of a multi-year research initiative on smart cities related jobs, skills, training programs, and the social impacts of smart cities in Canada by the Information and Communications Technology Council (ICTC). The analysis that follows in this report is therefore best viewed in the context of the entire set of reports.

Building on the key insights from the primary research underpinning its two sister publications, and secondary data from Statistics Canada, the Government of Canada, and other public- and private-sector sources, this report includes labour market forecasts focused on projecting short- and long-term labour demand and supply for key smart city related occupations in 14 smart cities across Canada. The census metropolitan areas (CMAs) under focus in this project were chosen to represent geographic reach and a balance of industries in Canada—the list includes the eight largest Canadian urban agglomerations, as well as the largest metropolises from most provinces.



Census Metropolitan Area	Population 2021
Toronto	6.2M
Montréal	4.29M
Vancouver	2.64M
Ottawa - Gatineau	1.49M
Calgary	1.48M
Edmonton	1.42M
Québec City	839.31K
Winnipeg	834.68K
Kitchener - Cambridge - Waterloo	575.85K
Halifax	465.7K
Victoria	397.24K
Saskatoon	317.48K
Fredericton	108.61K
Yellowknife *Census agglomeration*	20.34K

Figure 1: The 14 smart cities considered as part of this study
The size of the circle reflects the population of the CMA. Data from Statistics Canada, Census 2021.

Short-term employment forecasts for the key smart city related occupations in the study focus CMAs are based on the outlook for near-term business cycle factors. Long-term projections are split across the key demand and supply streams, and rely on more granular analysis of the links between industries, occupations, educational streams, the age profiles of the occupational workforce across provinces and cities, and long-term demographic flows, including population and labour force growth, domestic and international migration, and occupational mobility and transitions.

Identifying Key Smart City Occupations

The process of building projections for the demand and supply of labour for key jobs in the smart economies under consideration starts with identifying of these key jobs. This was done through a combination of secondary research and literature reviews, and primary research in the form of focus groups, surveys, interviews, and web scraping. The final list of job titles studied is outlined in Appendix V below. These job titles spanned various themes and job families that have emerged in other smart cities research produced as part of this multi-year project. Appendix VI outlines other key reports published under this research project.

Analysis of the profiles and the technical and human skills needed for these jobs is presented in this study's sister report *Moving Toward an Inclusive Smart Economy for Canada: The Human Talent Engine that Powers Smarter Cities.* The insights presented therein are based on primary and secondary research, including analysis of three years' worth of web-scraped data from job boards across Canada. Building usable long-term forecasts, however, necessitates the use of longer time series data. To better use Statistics Canada data on output, employment, productivity, demographics, and other variables of interest, the key jobs needed to be converted to their corresponding occupation codes.

The shortlisted key job titles were mapped to occupation codes based on documentation from the National Occupational Classification (NOC) System of 2016[1] by directly matching the job title to a code, where feasible, or by matching key skills listed in postings for these jobs with those of the potential NOC codes. Based on this mapping of the job titles of interest, this report narrows its focus to the eight key NOC codes that came up most frequently. While not a comprehensive list, these NOC codes represent over a third of all job titles targeted by web scraping for over the last three years and over 85% of the 230,000+ job postings scraped in 2022 as part of this project.

1 Employment and Social Development Canada, "National Occupational Classification - Canada.Ca," accessed August 2, 2022, https://noc.esdc.gc.ca/.

NOC	Occupation	Smart City Job Titles Mapped
2173	Software engineers and designers	9
5241	Graphic designers and illustrators	6
2174	Computer programmers and interactive media developers	5
2171	Information systems analysts and consultants	4
2172	Database analysts and data administrators	4
2281	Computer network technicians	4
2175	Web designers and developers	3
0211	Engineering managers	2

Figure 2: Key smart city related occupations

Drivers of Demand and Supply

Having identified the main occupation codes corresponding to the most in-demand smart city related roles above, the next step is to build out labour market projections for these occupations across Canada's major smart cities, with a focus on both the short- and long-run employment outlook.

The short-run employment outlook is based on near-term factors and the state of the business cycle. The current outlook on inflation, commodity prices, supply-side volatility due to global geopolitical tensions, and expected monetary tightening in Canada and the U.S. have dampened growth projections in the short run, especially compared to the outlook in late 2021. While the baseline forecast projects modest employment and output growth by end of 2023, most of this is expected to be focused on commodity prices and gains in the sectors that are still below pre-pandemic levels—accommodation and food services, tourism, and travel.

Another factor muddying the waters in the near term is the increase in labour market tightness and churn across industries. Compared to the pre-pandemic average from 2015-2019, the last four quarters have seen an increase in the job vacancy rate across the board. In some sectors like accommodation and food services, fishing and hunting, and construction, this has been coupled with relatively high unemployment, which implies market tightness and difficulty in finding new hires to fill vacancies. In others such as healthcare, professional and technical services, and finance, low unemployment levels imply a high degree of churn.

JOB VACANCY RATE

Pre-pandemic average (2015–19) vs. last four quarters

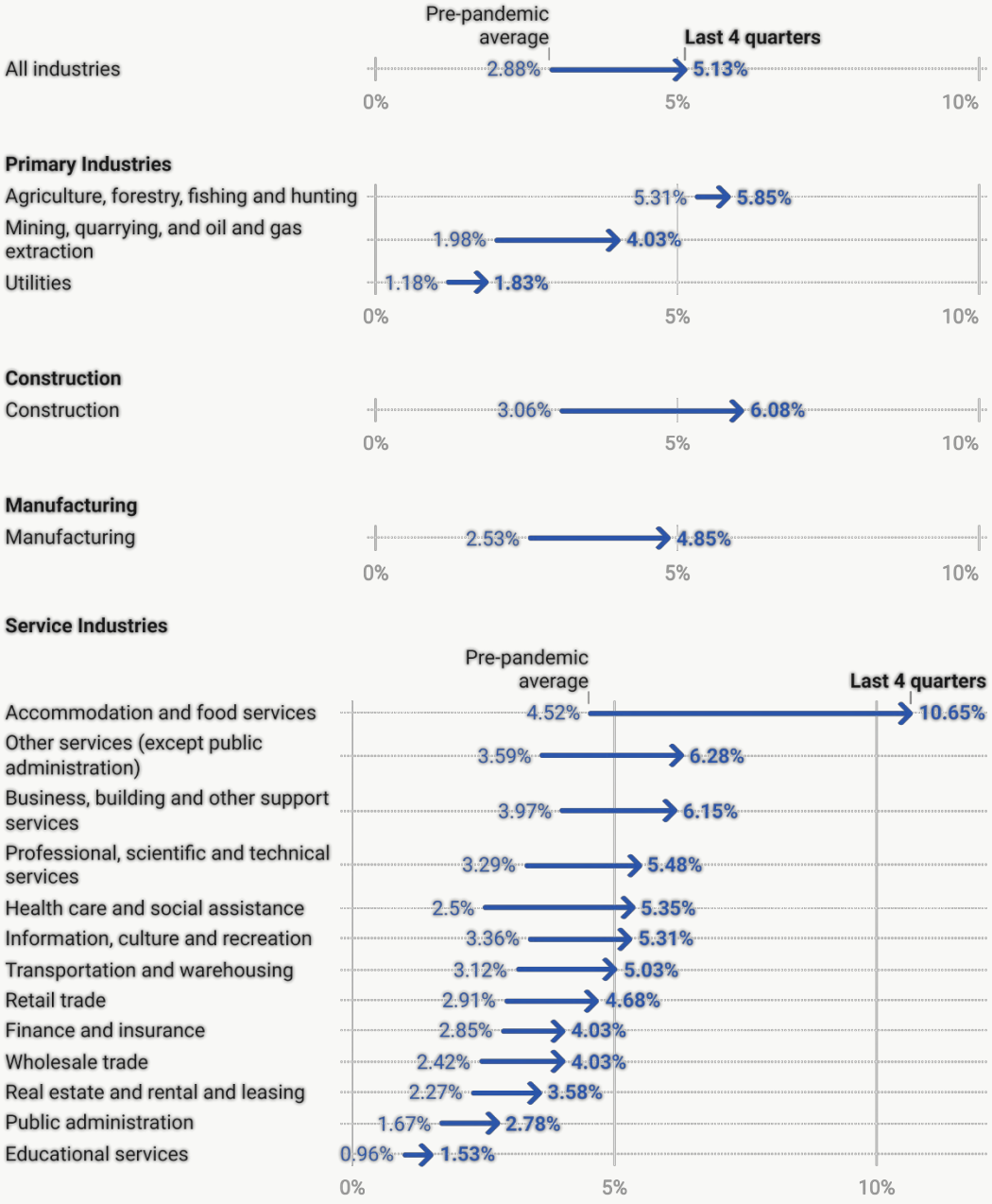


Figure 3: Canada: Job vacancy rate by industry—pre-pandemic average (2015-19) vs. last four quarters. Data from Statistics Canada.

Labour Demand

In the long run, labour demand, especially for the occupations featured in this report, is a function of longer-term trends in productivity, digitization across industries, and demographic changes, including population growth and aging, and other systematic macroeconomic factors such as commodity prices and exchange rates, aggregate demand from key trading partners, and fiscal policy indicators. The two major drivers for job vacancies in the long run are demand for new workers from economic expansion and growth, and replacement demand from labour force outflows such as retirements, emigration, and deaths. The net flow of workers due to occupational mobility and career transitions is handled as a residual on the supply side.

Expansion

The aggregate growth outlook for Canada is informed by long-term demographic trends such as population growth and immigration flows, the growth and composition by age of the labour force, and other domestic and international macroeconomic factors as outlined above. Translating this aggregate growth outlook to expansion demand for occupations involves a few intermediate steps. Analysis of the changing composition of national and provincial economies—based on Statistics Canada's Supply and Use tables, and trends in digitization, investment, and other factor productivity changes—enables the construction of output projections for industries at the provincial level. Combining these projections with an analysis of trends in labour productivity and average hours worked allows for an estimation of expected employment increase by industry while accounting for the changing nature of work and the relative contribution of part-time workers across sectors. Finally, using census data to understand the relative industry composition of each of the occupations studied allows for an estimation of expansion demand for each occupation based on local industry employment outlooks.

Most of the occupations studied in this report are digital and are forecast to have relatively high demand from expansion. Recent research from Statistics Canada has shown that most industries in Canada have seen an increase in the number of digital workers over the last two decades.[2] ICTC's latest job market outlook for Canada's digital economy also found that over the last decade the larger share of growth in digital jobs in Canda has come from an increase in the relative share of

2 Huju Liu and Julien McDonald-Guimond, "Measuring Digital Intensity in the Canadian Economy," Economic and Social Reports 1, no. 2 (February 2021), https://doi.org/10.25318/36280001202100200003-eng.

digital occupations in a broad base of industries outside of the traditional technology sector.[3]

Replacement

Another key factor when studying labour demand for occupations in the longer term is looking at the need to replace older retiring workers from the workforce and accounting for other exits from the workforce in the form of emigration, career transitions and occupational mobility, and working-age mortality. As Canada's population ages, the average age of the workforce across most sectors has increased sharply, and several sectors are likely to face a glut of retirements over the coming decade. Over one-quarter of the workforce in agriculture and forestry, manufacturing, real estate, transportation and logistics, and wholesale trade is 55 or older. While some sectors will likely abate some of this replacement demand by way of productivity gains, most will present significant demand growth for new workers to replace retirees.

3 Akshay Kotak and Maryna Ivus, "Onwards and Upwards - Digital Talent Outlook 2025," Information and Communications Technology Council, August 26, 2021, https://www.ictc-ctic.ca/wp-content/uploads/2021/08/digital-talent-outlook-for-2025.pdf.

SHARE OF WORKFORCE OVER 55 YEARS OLD

2007 vs. 2021

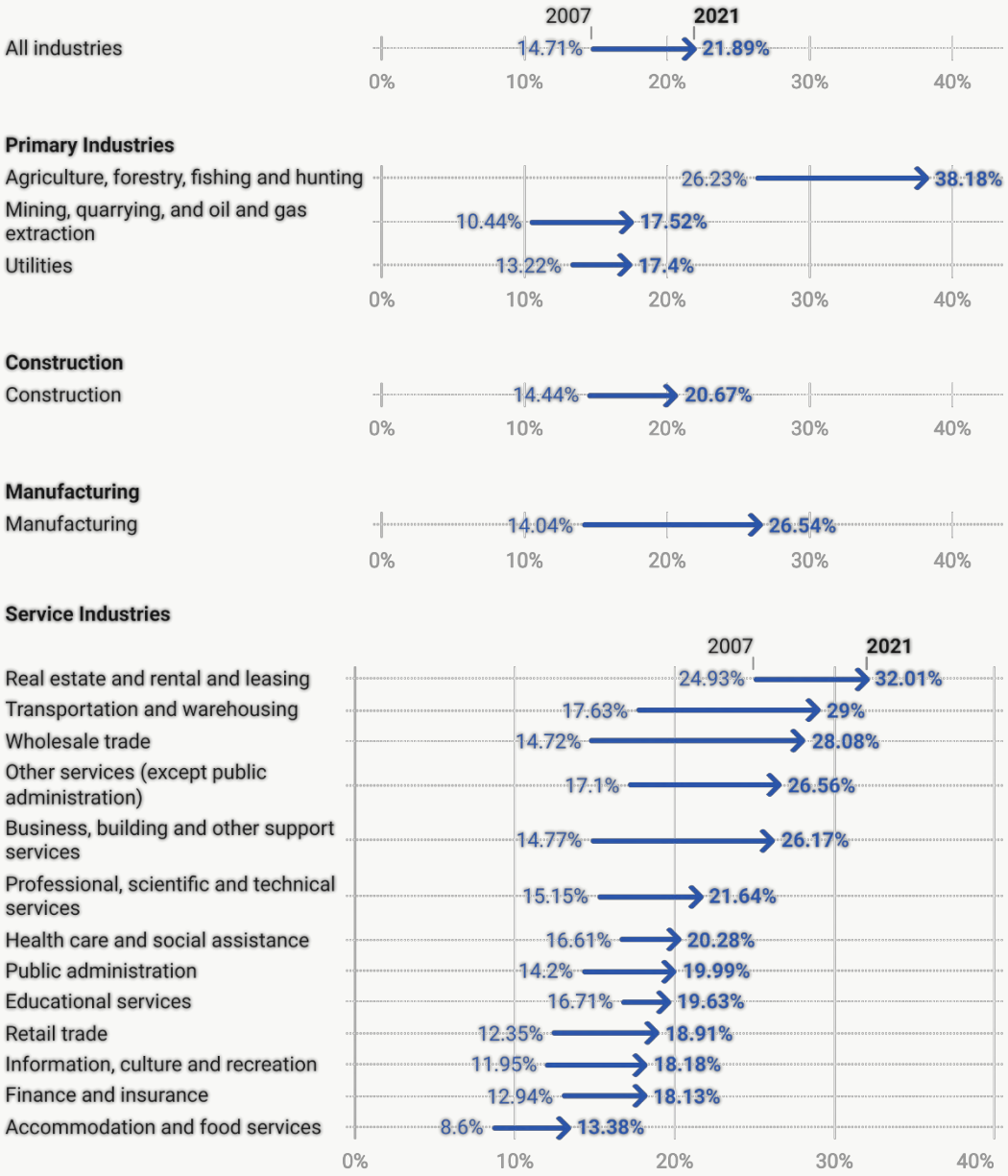


Figure 4: Canada: Share of workforce over 55 years old, by industry: 2007 vs. 2021
Data from Statistics Canada.

Another consideration here is the trend toward longer working lives for workers in several sectors. As average lifespans increase in Canada, the retirement age for most occupations has steadily been increasing over the last two decades.[4] Furthermore, although it is likely to be a slower-moving trend for the current decade, new research suggests that the notion of a typical 40-year career of full-time employment may need to be revisited soon.[5]

Labour Supply

Key streams for the supply of talent are school leavers (new graduates from relevant post-secondary and other educational programs), international migrants, and other domestic re-entrants from career transitions and occupational mobility.

School Leavers

The analysis of school leavers relevant to the occupations in focus is based on analyzing post-secondary enrolments and graduations by province and program of study.

4 Statistics Canada, "Retirement Age by Class of Worker, Annual," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410006001.

5 Joe Pinsker, "The Future of Work Is a 60-Year Career," The Atlantic, December 14, 2021, https://www.theatlantic.com/family/archive/2021/12/future-work-shorter-hours-longer-careers/621003/.

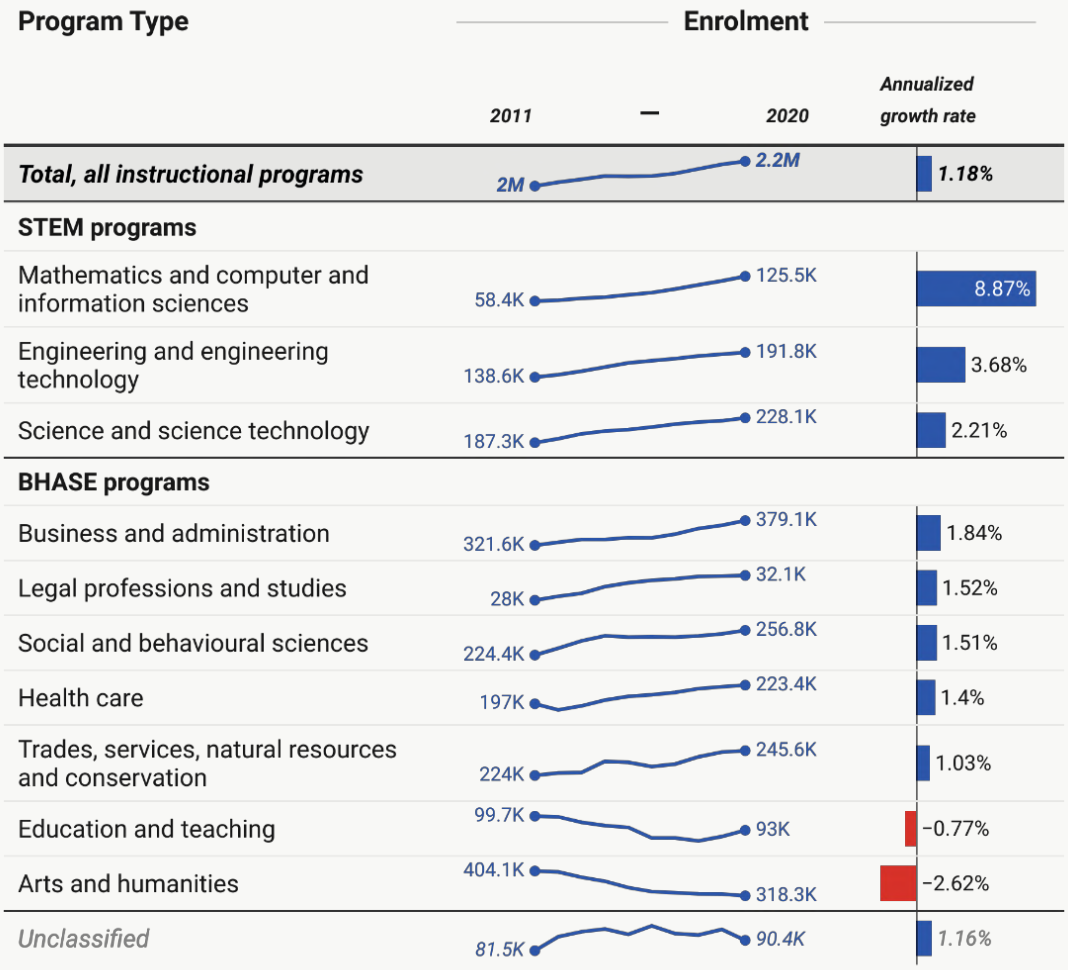


Figure 5: Canada: Post-secondary enrolments, by program type, 2011–20
Data from Statistics Canada.

Census data and other primary research was used to map the correspondence between instructional programs and the occupations in focus. The past decade has seen a surge in enrolments for science, technology, engineering, and mathematics (STEM) programs, which correspond quite highly with the occupations in focus. This is likely a consequence of increased demand for these occupations, and this increase in potential talent base also includes a large number of international

students who are becoming an increasingly important channel of labour supply in Canada.[6]

While most of the occupations studied typically require some level of post-secondary education, given the increasing prevalence of non-conventional educational streams in these occupations, the analysis of school leavers also considers a small fraction of the expected graduations from secondary educational programs over the next decade.

Migration

The increase in expected graduates from relevant educational programs over the next decade bodes well for the talent supply outlook. However, as the projections below illustrate, there is still likely to be a shortfall in supply in many regions. Part of this shortfall will likely be mitigated by Canada's continued attractiveness to international migrants.

6 Eden Crossman, Youjin Choi, and Feng Hou, "International Students as a Source of Labour Supply: The Growing Number of International Students and Their Changing Sociodemographic Characteristics" 1, no. 7 (July 2021), https://doi.org/10.25318/36280001202100700005-eng.

Eden Crossman, Yuqian Lu, and Feng Hou, "International Students as a Source of Labour Supply: Engagement in the Labour Market after Graduation," *Economic and Social Reports* 1, no. 12 (December 2021), https://doi.org/10.25318/36280001202101200002-eng.

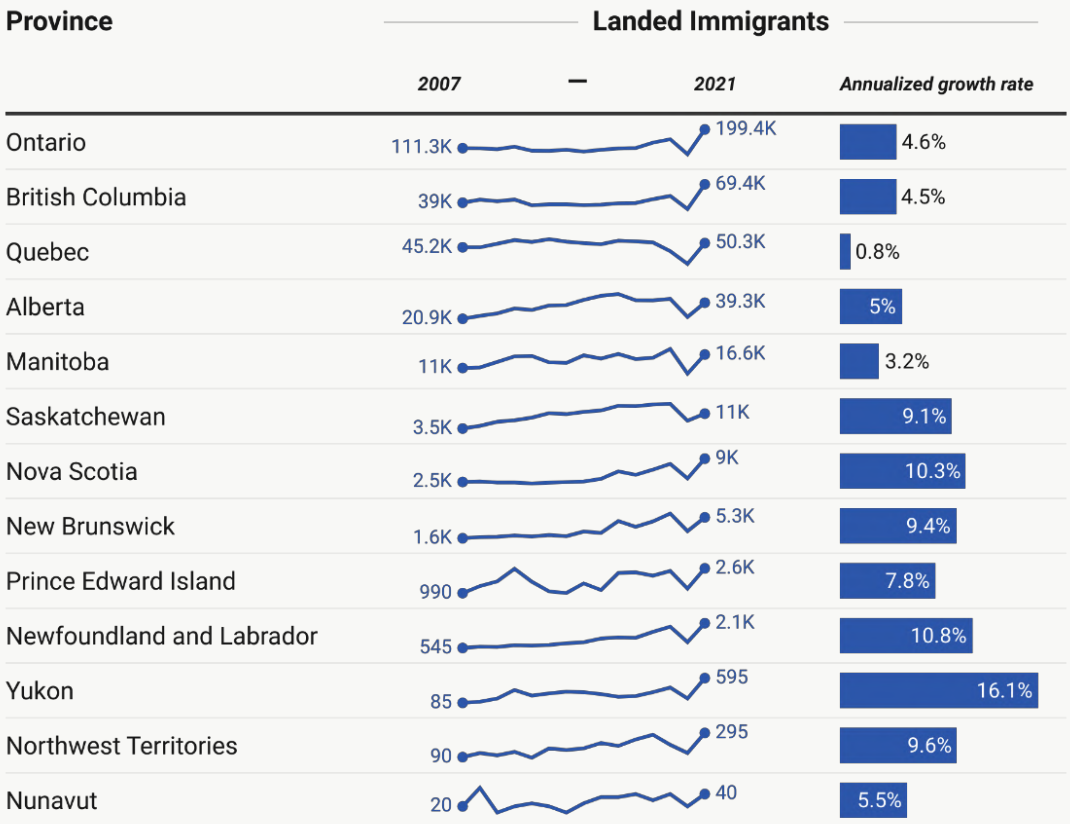


Figure 6: Canada: Immigration, by province/territory, 2007–21
Data from Immigration, Refugees and Citizenship Canada.

After the COVID-induced drop in immigration numbers, Canada welcomed over 405,000 new permanent residents in 2021, which is by far the most in a single year.[7] Immigration levels over the next few years are expected to continue to remain high, owing to an increase in refugee applications in the last year and the COVID-related backlog from 2019-20. Over the next decade, the trend toward increased immigration of skilled workers is likely to continue at the pre-pandemic rate. Immigrants continue to be a driving force in Canada's labour supply and are an important contributor to the talent supply for digital occupations, including those studied in this report.

Ontario (Toronto) and British Columbia (Vancouver) are the top destination for newcomers to Canada. Immigration in Alberta has tended to mirror oil and gas

7 Statistics Canada, "Research to Insights: Immigration as a Source of Labour Supply," June 22, 2022, https://www150.statcan.gc.ca/n1/pub/11-631-x/11-631-x2022003-eng.htm.

sector cycles, with peak immigration coinciding with the oil price boom of 2011-13. A notable trend in the last year has been the relative increase in international migration to the Atlantic provinces—a trend also mirrored in domestic migration flows to the Maritimes in the post-COVID period.

Given that this analysis focuses on the occupational outlook at the city level, supply-side projections also account for the expected net flows of working-age domestic migration to/from each of the CMAs considered. Over the past decade, there has been a net outflow of working-age domestic workers from the larger metropolises. This is likely to continue and perhaps even increase in the post-COVID era as more employers embrace remote or hybrid-work arrangements, especially for the occupations under focus. On the other hand, domestic flows to some cities in smaller provinces with more affordable housing and attractive lifestyle options could see a shift in inflows of domestic workers looking to work remotely.

Occupational Mobility and Other Sources

The final supply stream considered is the net flow of workers into or out of an occupation owing to occupational mobility and career transitions and re-entries. Analysis of job profiles and seniority, job descriptions, vacancies, wages, and occupational transitions determines the expected flows in and out of each of the occupations studied. Engineering managers, for instance, are typically hired only after gaining some experience in other "feeder" occupations and therefore have a higher relative share of supply from this stream compared to school leavers. On the other hand, a large number of new post-secondary graduates seek jobs as Graphic Designers and Illustrators before transitioning into other roles after having gained some skills and experience. As such, this occupational group (NOC 5241) is projected to see a net outflow of workers into other occupations.

Occupational Projections for Key Smart City Occupations

Each of the occupational projections below includes key statistical highlights, including average employment by city for 2021 from the Labour Force Survey, median workforce age by city calculated from Census 2016 data, and key sectors of employment within each city, also calculated from Census 2016. The short-term employment projections presented for each are the baseline forecasts for employment in each of the census metropolitan areas (CMA) of interest, by yearend 2023. These are based on factors informing the short-term economic outlook, as discussed in the previous section.

This report's long-term projections provide a 10-year outlook on the key components of job demand and talent supply. While there is, unsurprisingly, a large amount of regional variability, most of the occupations featured are expected to see considerable demand for new roles as more industries continue to digitize and adopt new technologies. This is coupled with added demand to replace retiring workers as Canada's workforce continues to age. While most of the occupations presented have a relatively young workforce, especially when compared with the national average, there is a growing need to replace retiring workers over the next decade. Finally, on the demand side, the projections also include estimates of additional demand due to other factors such as emigration and in-service mortality.

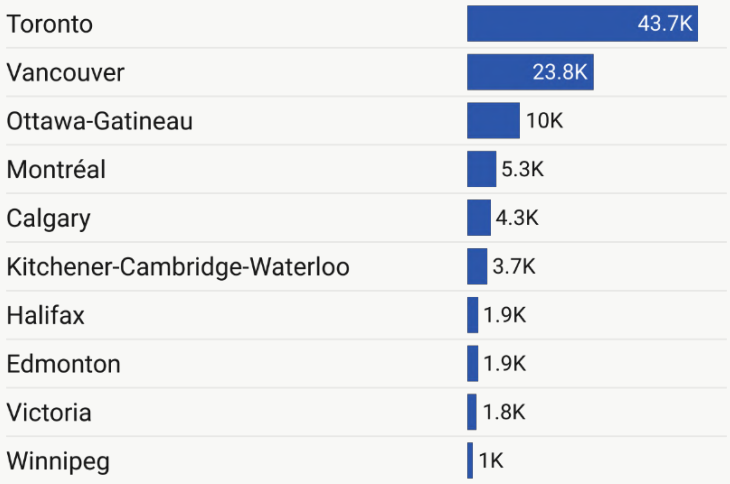
Each of the CMA-level projections of long-term labour supply outlines the 10-year outlook for the three main supply channels—projected school leavers from post-secondary and secondary education programs, international and domestic migration flows, and a residual supply stream based on occupational mobility and net expected flows in to or out of the occupation. While most of the occupations highlighted require some level of post-secondary education, given the increasing prevalence of non-conventional educational streams in these occupations, the analysis of school leavers also considers expected graduates from secondary educational programs. Migration flows include an assessment of expected immigrant inflows and net domestic migration to/from each of the CMAs. Finally, the supply streams also consider the net flow of workers to/from each of the occupations owing to occupational mobility and career transitions.

Analysis of additional supply-side considerations such as the role of non-conventional educational pathways; part-time, gig, and platform workers; the role of municipal development in attracting foreign and domestic workers; and the impact of the shift to remote and hybrid work is covered in greater detail in this

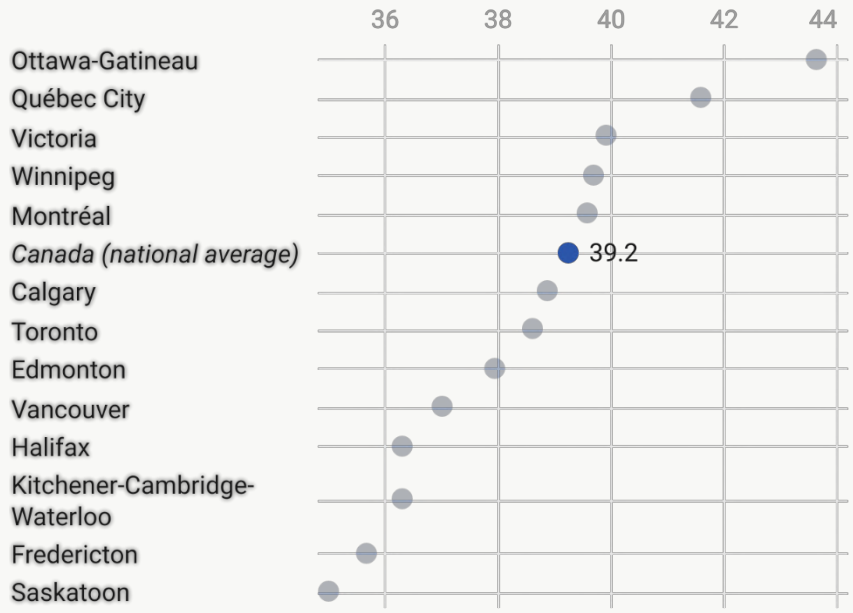
study's sister report, *Bringing a "Smart City" to Life: Understanding Talent Development, Attraction, and Retention*.

Software Engineers and Designers [2173]

Employment in 2021



Median Age of Workforce

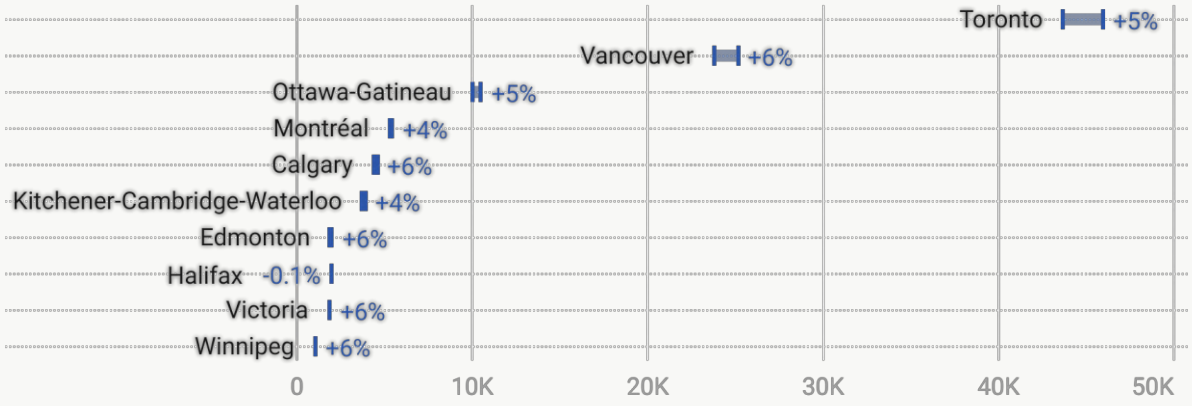


Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	67.1%	26.3%	44.0%	52.2%	49.2%	55.0%	54.4%
Information, culture and recreation	5.6%	15.8%	11.3%	16.1%	14.3%	9.8%	23.2%
Wholesale and retail trade	3.5%	21.1%		5.2%	14.3%	9.4%	3.4%
Manufacturing	8.4%	7.9%	10.1%	12.7%	6.2%	6.0%	5.0%
Finance and insurance			15.7%	6.3%		12.2%	7.7%
Public administration	7.0%	13.2%	14.5%		10.4%		
Mining, quarrying, and oil and gas extraction							
Business, building and other support services							
Educational services							

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria
Professional, scientific and technical services	45.5%	48.7%	48.5%	48.9%	54.2%	60.6%
Information, culture and recreation	8.9%	25.6%	10.1%	8.8%	20.6%	7.9%
Wholesale and retail trade	5.4%	7.7%	9.2%	13.2%	9.1%	9.4%
Manufacturing	6.3%		8.9%	5.5%	6.0%	8.7%
Finance and insurance	17.9%				3.4%	
Public administration		5.1%				6.3%
Mining, quarrying, and oil and gas extraction			9.4%			
Business, building and other support services		5.1%				
Educational services				4.9%		

Short-Term Employment Outlook (2021–23)



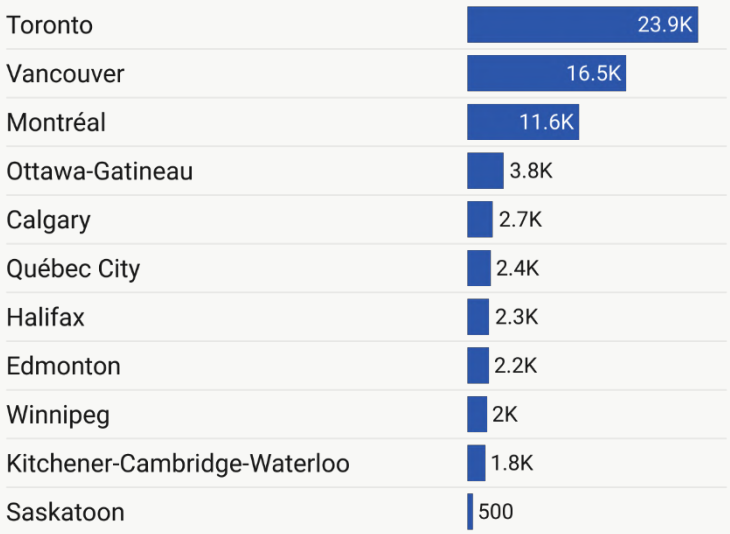
Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	350			1.9K	1.8K	7.7K	650
Retirements	250			400	600	5K	450
Other	30			250	300	1.5K	150
Labour Supply							
School Leavers	500			5.9K	1.9K	7.8K	700
Immigration	600			900	1.7K	12.1K	850
Net Domestic Migration	200			-400	100	-1.7K	10
Other	-200			-2.4K	-1.7K	-6.4K	-200
Outlook	Surplus			Surplus	Shortage	Shortage	Balance

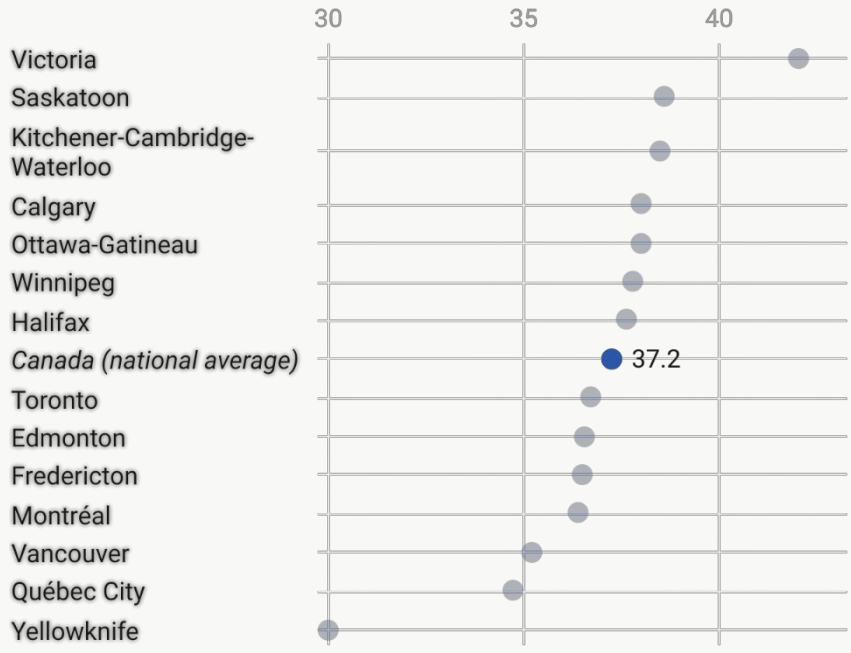
	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand	200		6...	300	6.2K	450	
Retirements	600		1.2K	550	1.9K	150	
Other	30		200	100	500	100	
Labour Supply							
School Leavers	600		1.1K	1K	2.3K	350	
Immigration	300		300	300	5K	400	
Net Domestic Migration	-60		20	40	-40	40	
Other	-210		-800	-490	-3.2K	-50	
Outlook	Shortage		Shortage	Balance	Shortage	Balance	

Graphic Designers and Illustrators [5241]

Employment in 2021



Median Age of Workforce

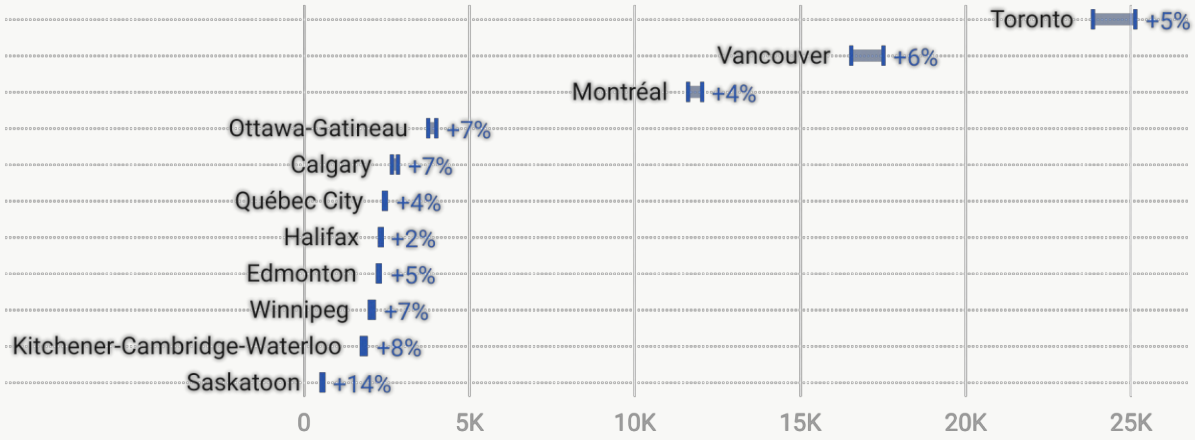


Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	51.7%	41.7%	44.2%	47.3%	44.7%	54.7%	46.1%
Information, culture and recreation	28.2%	16.7%	22.0%	26.1%	18.1%	16.7%	10.3%
Manufacturing	6.7%		10.4%	7.9%	8.3%	9.5%	18.2%
Wholesale and retail trade	4.7%		7.0%	8.9%	4.3%	6.3%	6.1%
Educational services		16.7%		2.0%			
Public administration	2.0%		4.3%		11.5%		
Other services (except public administration)		8.3%					
Finance and insurance						2.5%	6.1%
Health care and social assistance		8.3%					

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Professional, scientific and technical services	41.9%	42.9%	55.4%	47.6%	45.2%	58.8%	66.7%
Information, culture and recreation	12.7%	12.7%	9.2%	10.1%	30.7%	17.6%	22.2%
Manufacturing	21.2%	14.3%	12.0%	13.9%	6.9%	5.3%	
Wholesale and retail trade	8.5%	9.5%	7.1%	5.9%	7.3%		
Educational services		4.8%	4.2%		2.3%	6.1%	
Public administration				6.8%		6.1%	
Other services (except public administration)	3.8%						
Finance and insurance							
Health care and social assistance							

Short-Term Employment Outlook (2021–23)



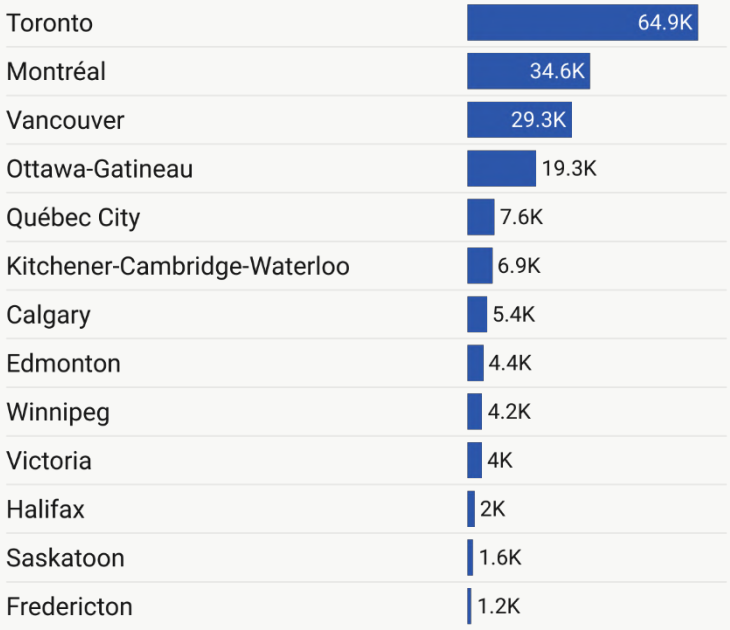
Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	100		450	1.8K	600	3.8K	350
Retirements	500		350	1.1K	500	3.2K	200
Other	30		100	350	150	1.1K	100
Labour Supply							
School Leavers	400		1.1K	5.5K	1.3K	8.3K	750
Immigration	200		70	800	300	1.8K	130
Net Domestic Migration	200		10	-900	100	-1.4K	10
Other	-200		-360	-2.4K	-600	-2.8K	-60
Outlook	Balance		Balance	Balance	Balance	Shortage	Surplus

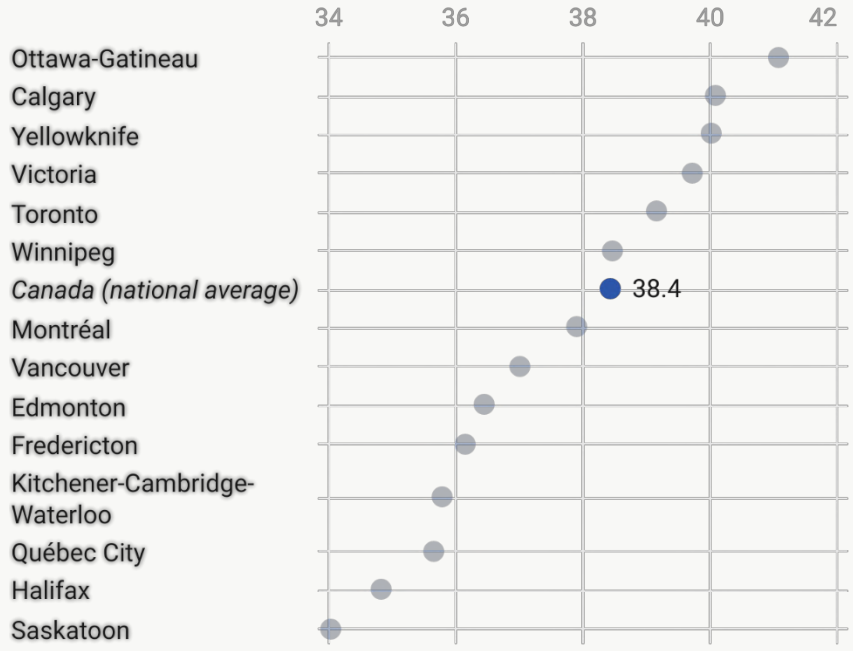
	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand	400	1...	350	300	4.4K		
Retirements	400	250	650	550	1.6K		
Other	40	30	150	150	600		
Labour Supply							
School Leavers	500	1...	1.1K	1K	2.7K		
Immigration	100	10	100	100	3.7K		
Net Domestic Migration	-110	20	20	60	-50		
Other	-50	-90	-580	-380	-2.6K		
Outlook	Shortage	Shortage	Shortage	Shortage	Shortage		

Computer Programmers and Interactive Media Developers [2174]

Employment in 2021



Median Age of Workforce

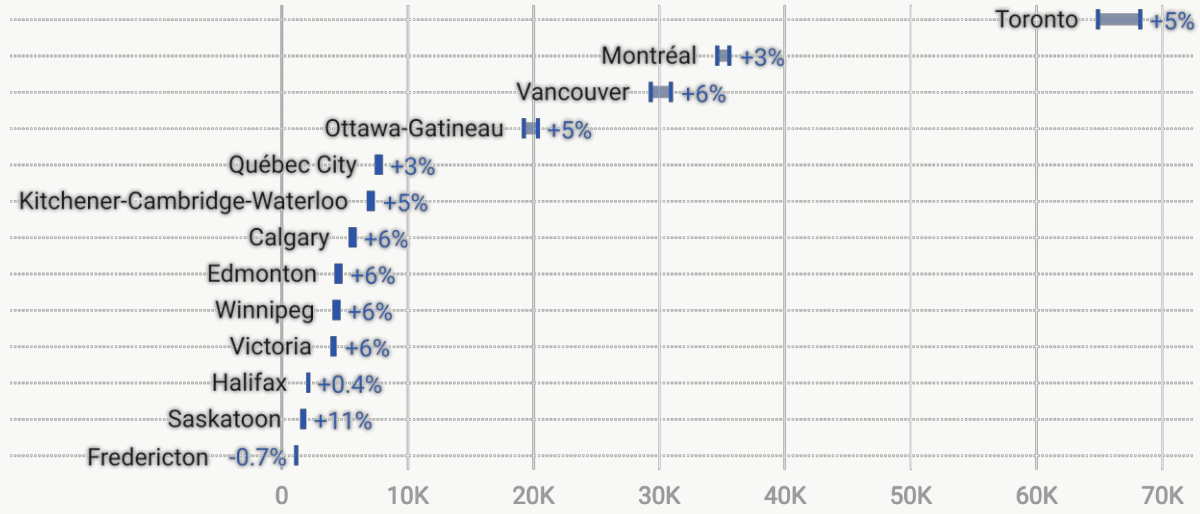


Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	56.7%	37.8%	49.5%	52.6%	37.8%	52.0%	51.4%
Information, culture and recreation	18.3%	8.1%	12.2%	16.4%	9.5%	11.4%	19.7%
Public administration	7.4%	20.7%	10.1%		35.7%		
Finance and insurance			10.7%	7.2%		14.9%	8.8%
Wholesale and retail trade	4.6%	13.5%		5.3%	6.0%	7.0%	4.7%
Manufacturing	4.9%		6.7%	7.0%	2.7%	3.8%	5.8%
Educational services		8.1%					
Mining, quarrying, and oil and gas extraction							
Construction							

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Professional, scientific and technical services	35.9%	47.0%	57.9%	58.0%	54.9%	63.1%	33.3%
Information, culture and recreation	10.4%	12.7%	11.5%	8.9%	21.8%	7.8%	50.0%
Public administration	10.6%	3.7%		5.2%		9.2%	
Finance and insurance	19.0%				5.5%		
Wholesale and retail trade	5.1%		4.8%		5.8%		
Manufacturing		6.7%	4.4%		2.9%	5.5%	
Educational services		17.2%		7.4%		4.8%	
Mining, quarrying, and oil and gas extraction			5.4%				
Construction				4.6%			

Short-Term Employment Outlook (2021–23)



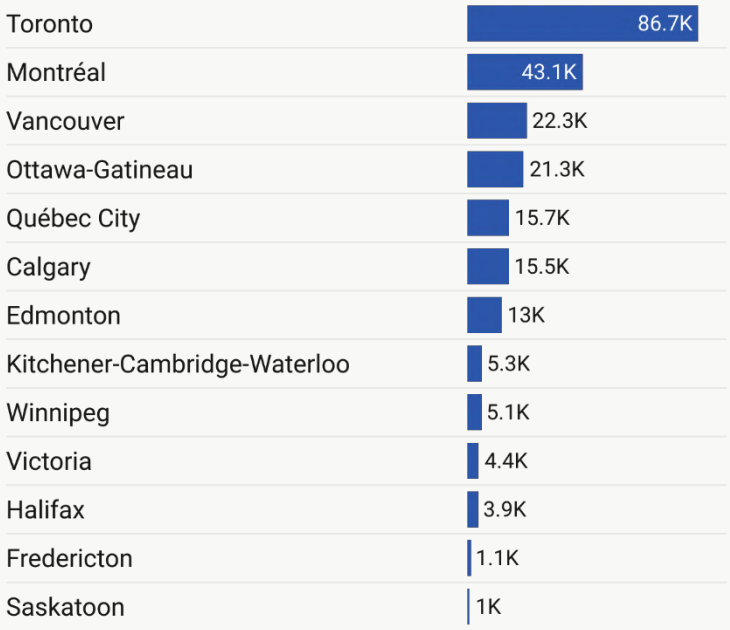
Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	250	100	1.4K	6.2K	3.5K	11.8K	1.3K
Retirements	300	220	550	2.7K	2.3K	6.9K	700
Other	40	20	200	800	750	3K	350
Labour Supply							
School Leavers	500	150	2.5K	12.6K	5K	20.9K	2K
Immigration	800	90	130	1.5K	1.5K	10....	760
Net Domestic Migration	300	20	30	-2.2K	300	-3.7K	30
Other	-600	-90	-660	-3.1K	-1.5K	-5.4K	-650
Outlook	**Surplus**	**Shortage**	**Balance**	**Balance**	**Shortage**	**Balance**	**Balance**

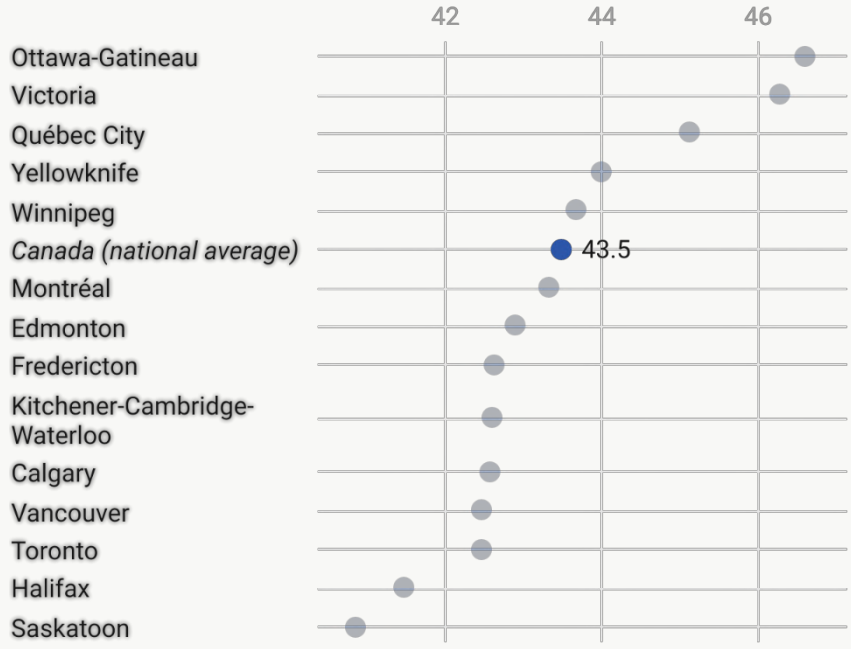
	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand	700	450	1.1K	900	7.8K	1.1K	
Retirements	550	200	1.2K	700	2.4K	550	
Other	90	50	400	250	1.1K	150	
Labour Supply							
School Leavers	1.7K	500	2.6K	2.5K	6.3K	950	
Immigration	400	300	300	300	2.3K	200	
Net Domestic Migration	-240	30	30	100	-100	70	
Other	-310	-120	-740	-480	-2K	-310	
Outlook	**Balance**	**Balance**	**Shortage**	**Surplus**	**Shortage**	**Shortage**	

Information System Analysts and Consultants [2171]

Employment in 2021



Median Age of Workforce

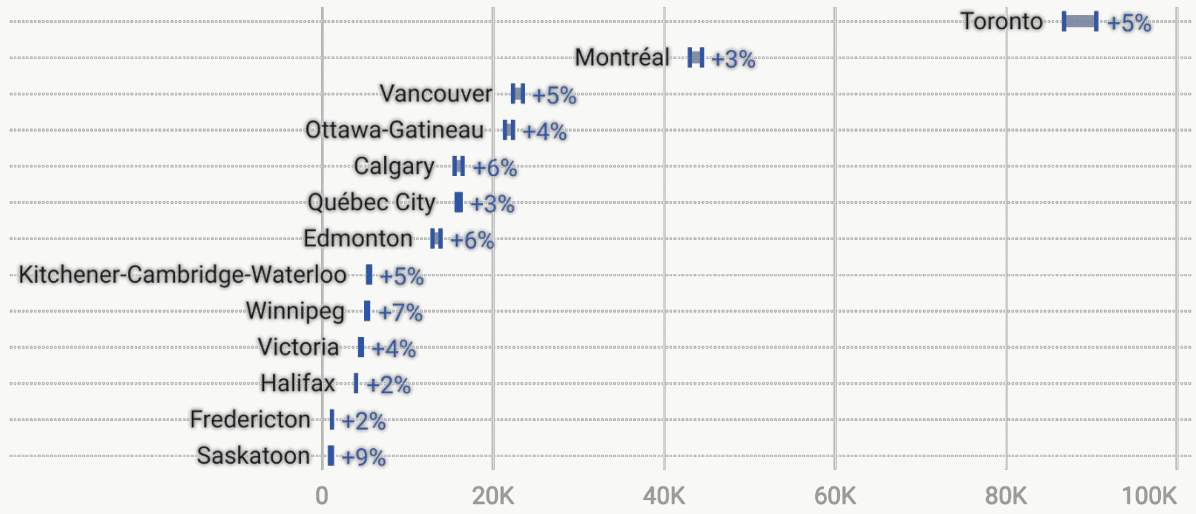


Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	48.3%	33.9%	30.7%	48.3%	31.3%	44.8%	29.3%
Public administration	15.0%	29.9%	42.8%	4.7%	47.5%	5.2%	
Finance and insurance			14.3%	11.2%	3.4%	21.6%	29.5%
Information, culture and recreation	6.4%	9.4%	2.4%	9.8%	4.2%	7.1%	14.5%
Wholesale and retail trade	10.2%			7.0%	3.7%	8.0%	
Educational services	5.0%	11.0%	2.3%				8.3%
Health care and social assistance							
Mining, quarrying, and oil and gas extraction							
Manufacturing							5.6%
Utilities		4.7%					
Transportation and warehousing							

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Professional, scientific and technical services	31.0%	32.5%	43.6%	39.2%	44.4%	45.9%	
Public administration	14.4%		7.0%	18.0%	6.7%	25.1%	76.5%
Finance and insurance	18.0%			8.8%	9.0%	4.6%	
Information, culture and recreation	9.3%	7.6%	6.2%		10.3%		
Wholesale and retail trade	6.6%		6.3%		8.6%		
Educational services		11.5%		6.7%		5.3%	
Health care and social assistance		14.0%		5.6%			11.8%
Mining, quarrying, and oil and gas extraction		7.0%	11.7%				
Manufacturing							
Utilities							
Transportation and warehousing						3.9%	

Short-Term Employment Outlook (2021–23)



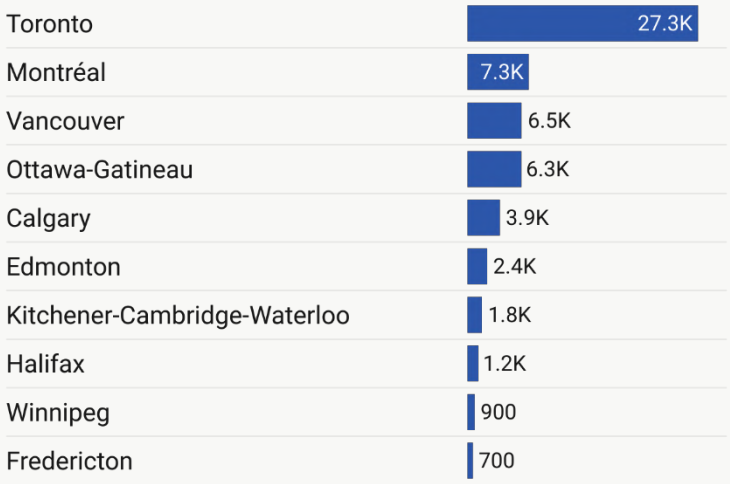
Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	700	130	2.7K	7.6K	3.6K	14.5K	900
Retirements	650	320	2.6K	6.5K	4.2K	14.2K	850
Other	100	20	350	1.3K	1.2K	3.7K	250
Labour Supply							
School Leavers	750	200	2K	10K	3.9K	16.2K	1.5K
Immigration	800	110	160	1.7K	1.8K	12.9K	920
Net Domestic Migration	200	20	50	-2.5K	400	-4.5K	20
Other	50	40	830	1.7K	900	3.6K	200
Outlook	**Balance**	**Shortage**	**Shortage**	**Shortage**	**Shortage**	**Balance**	**Surplus**

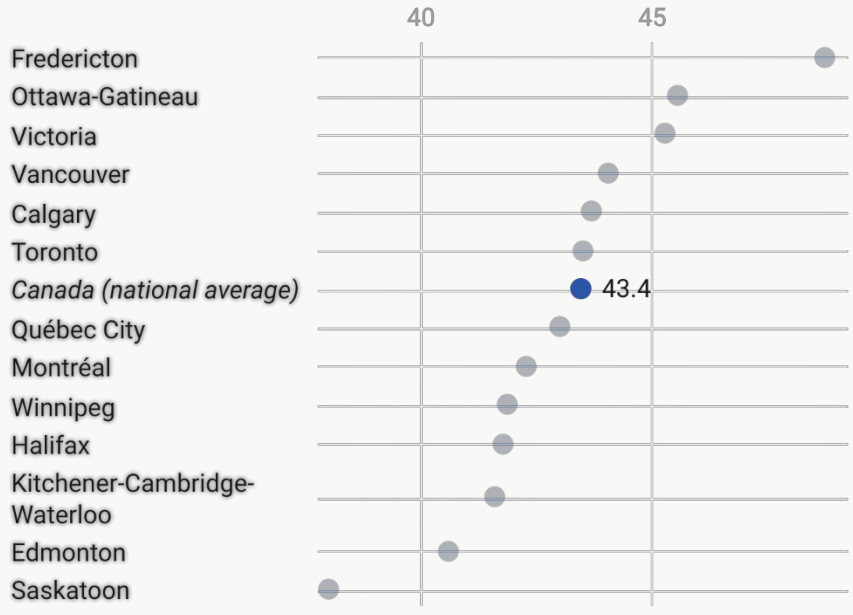
	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand	900	300	2.6K	2.1K	4.7K	950	
Retirements	1K	200	2.4K	2.1K	3.4K	1K	
Other	120	40	650	450	900	150	
Labour Supply							
School Leavers	1.3K	400	2.2K	2.1K	5K	750	
Immigration	400	500	500	500	2.5K	200	
Net Domestic Migration	-320	20	50	190	-80	70	
Other	180	0	580	370	750	130	
Outlook	**Shortage**	**Surplus**	**Shortage**	**Shortage**	**Balance**	**Shortage**	

Database Analysts and Data Administrators [2172]

Employment in 2021



Median Age of Workforce

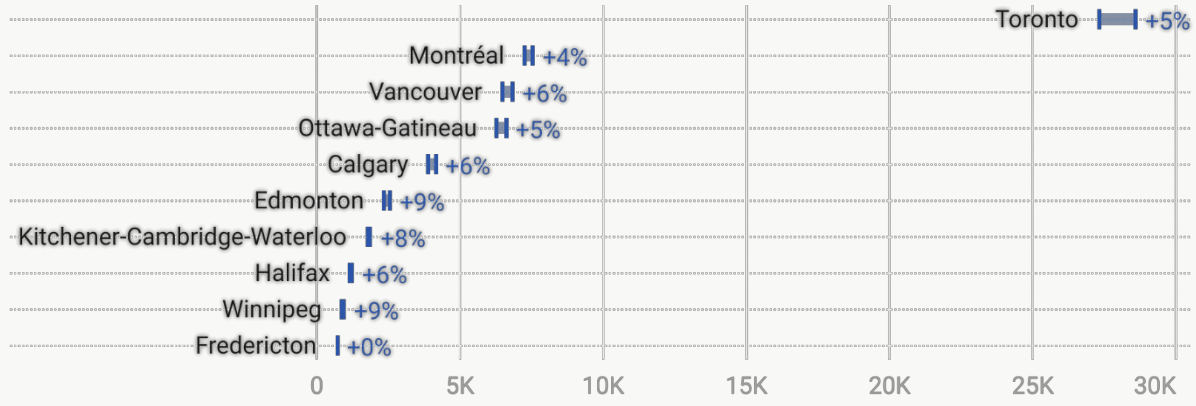


Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	25.0%	11.8%	22.0%	31.7%	18.8%	26.9%	25.3%
Public administration	25.0%	47.1%	41.1%	8.0%	55.9%	7.7%	
Information, culture and recreation	12.5%	23.5%	4.3%	11.3%	5.1%	10.9%	18.7%
Finance and insurance			19.1%	11.3%	3.9%	20.0%	17.6%
Wholesale and retail trade				10.2%		10.0%	8.8%
Educational services		11.8%					
Health care and social assistance	12.5%		2.1%		4.3%		
Mining, quarrying, and oil and gas extraction							
Agriculture, forestry, fishing and hunting		11.8%					
Manufacturing	5.4%						5.5%
Transportation and warehousing							

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria
Professional, scientific and technical services	14.4%	26.3%	30.0%	28.7%	32.2%	37.5%
Public administration	8.9%		5.9%	15.6%	7.6%	37.5%
Information, culture and recreation	10.0%	10.5%	5.5%	9.8%	15.5%	
Finance and insurance	21.1%			12.3%	7.9%	
Wholesale and retail trade	8.9%	15.8%	7.7%	9.0%	7.6%	6.3%
Educational services		21.1%				3.1%
Health care and social assistance						6.3%
Mining, quarrying, and oil and gas extraction			20.5%			
Agriculture, forestry, fishing and hunting						
Manufacturing						
Transportation and warehousing		10.5%				

Short-Term Employment Outlook (2021–23)



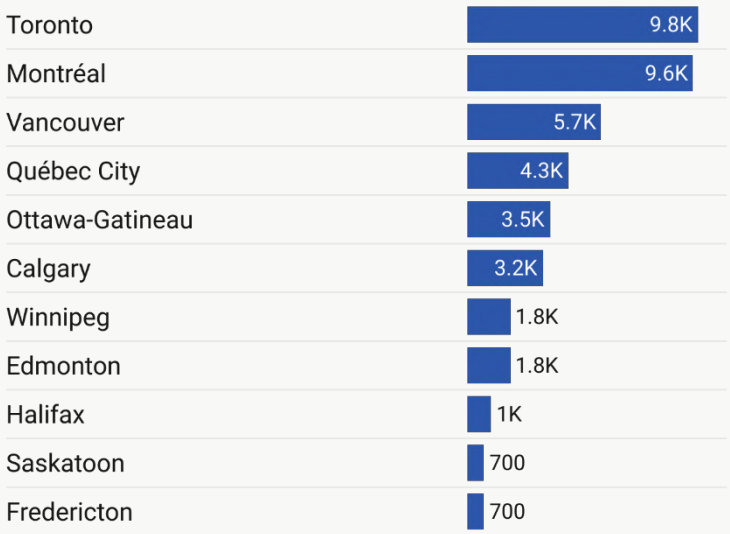
Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	350	100		1.1K	1K	4.3K	250
Retirements	150	300		1.5K	1.2K	4.3K	250
Other	30	20		200	300	1K	100
Labour Supply							
School Leavers	200	30		2.1K	900	3.7K	400
Immigration	150	20		500	500	3.1K	220
Net Domestic Migration	80	10		-500	100	-1.2K	10
Other	10	10		100	100	100	10
Outlook	Shortage	Shortage		Shortage	Shortage	Shortage	Balance

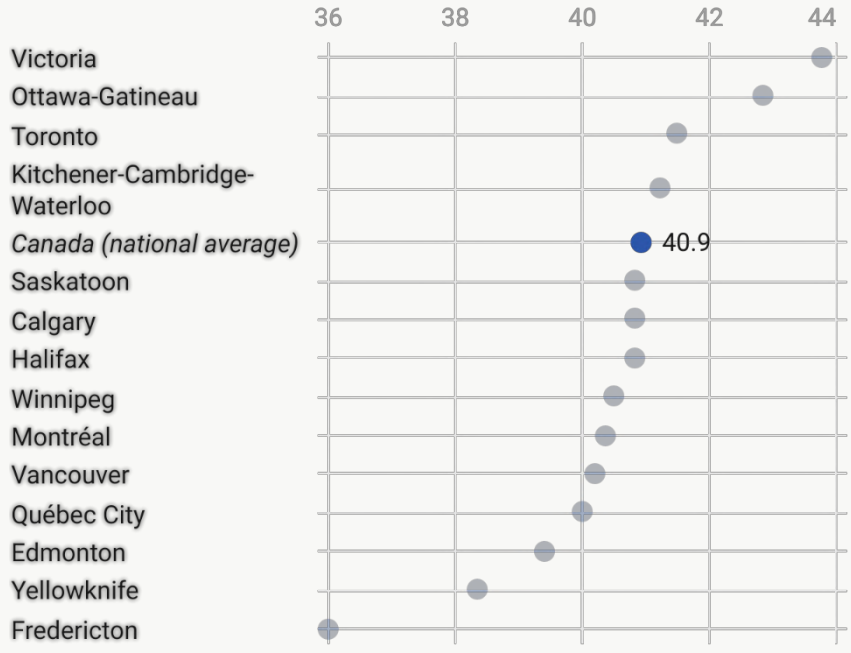
	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand	150		500	300	1.5K		
Retirements	350		1K	650	1.6K		
Other	30		150	150	250		
Labour Supply							
School Leavers	300		500	450	1.1K		
Immigration	100		200	100	700		
Net Domestic Migration	-60		20	60	-20		
Other	10		10	10	10		
Outlook	Shortage		Shortage	Shortage	Shortage		

Computer Network Technicians [2281]

Employment in 2021



Median Age of Workforce

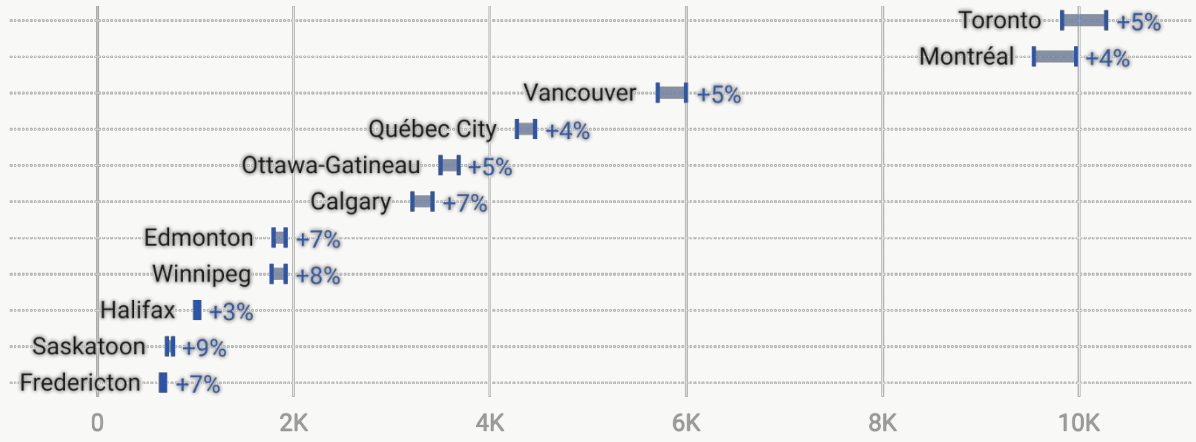


Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	24.3%	25.8%	22.1%	30.1%	20.5%	27.0%	21.0%
Public administration	17.8%	22.6%	30.4%		44.1%		
Information, culture and recreation	19.8%	22.6%		16.2%	6.4%	14.5%	17.8%
Educational services	8.4%	11.3%	7.9%	8.4%	4.8%	6.3%	10.3%
Wholesale and retail trade	7.4%	4.8%	6.5%	10.2%	7.4%	10.4%	9.3%
Finance and insurance			9.1%	7.0%		15.2%	
Mining, quarrying, and oil and gas extraction							
Health care and social assistance							
Manufacturing							10.3%
Business, building and other support services							

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Professional, scientific and technical services	19.6%	17.5%	28.2%	24.4%	29.8%	27.3%	18.8%
Public administration	11.9%	10.0%		13.1%		18.8%	43.8%
Information, culture and recreation	14.8%	18.8%	13.3%	13.6%	17.0%	13.0%	18.8%
Educational services	9.5%	20.0%	7.1%	10.9%	8.0%	12.3%	12.5%
Wholesale and retail trade			7.6%	9.1%	10.0%		
Finance and insurance	13.1%				9.0%		
Mining, quarrying, and oil and gas extraction			11.9%				12.5%
Health care and social assistance						10.4%	
Manufacturing							
Business, building and other support services		6.3%					

Short-Term Employment Outlook (2021–23)



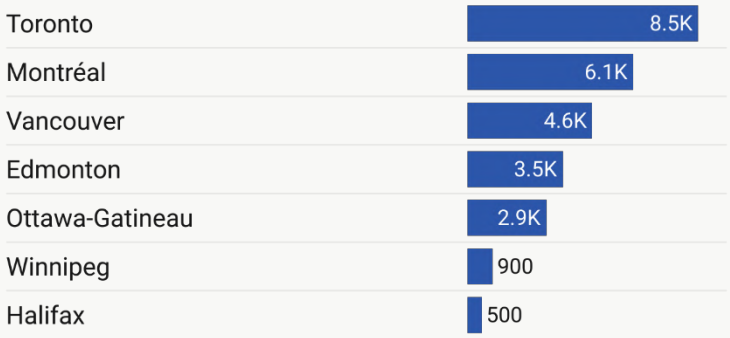
Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	200	50	750	1.6K	500	1.6K	
Retirements	300	180	550	1.1K	400	1.1K	
Other	20	20	100	350	150	450	
Labour Supply							
School Leavers	250	90	450	2.4K	1.1K	4.5K	
Immigration	220	40	80	900	300	2K	
Net Domestic Migration	70	10	10	-900	100	-500	
Other	-80	-30	-200	-1.1K	-300	-2.3K	
Outlook	Balance	Shortage	Shortage	Shortage	Balance	Balance	

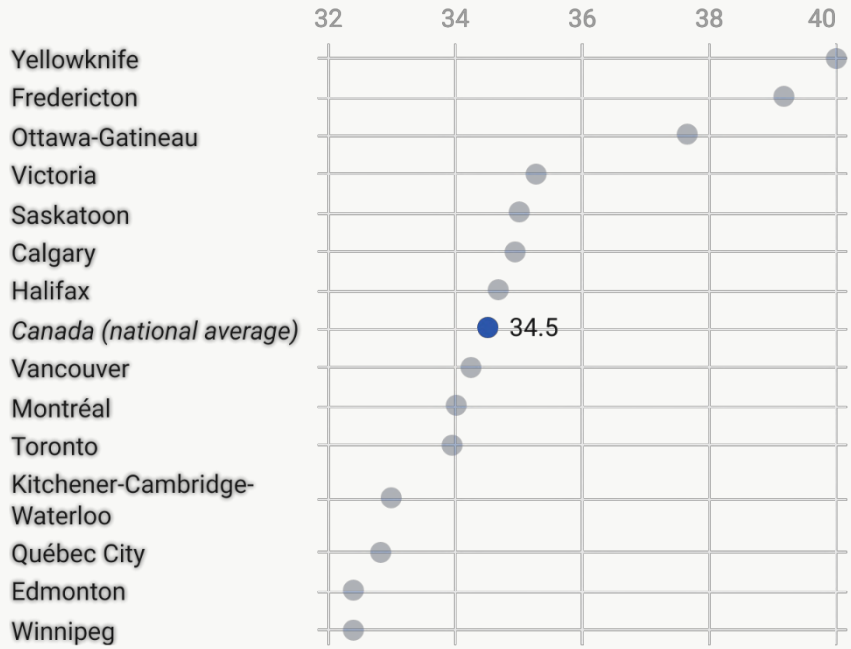
	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand	350	100	550	250	1.3K		
Retirements	550	150	650	550	1.3K		
Other	40	30	150	150	250		
Labour Supply							
School Leavers	400	100	650	600	1.4K		
Immigration	300	100	200	200	600		
Net Domestic Migration	-90	20	20	60	-20		
Other	-140	-40	-370	-300	-580		
Outlook	Shortage	Shortage	Shortage	Shortage	Shortage		

Web Designers and Developers [2175]

Employment in 2021



Median Age of Workforce

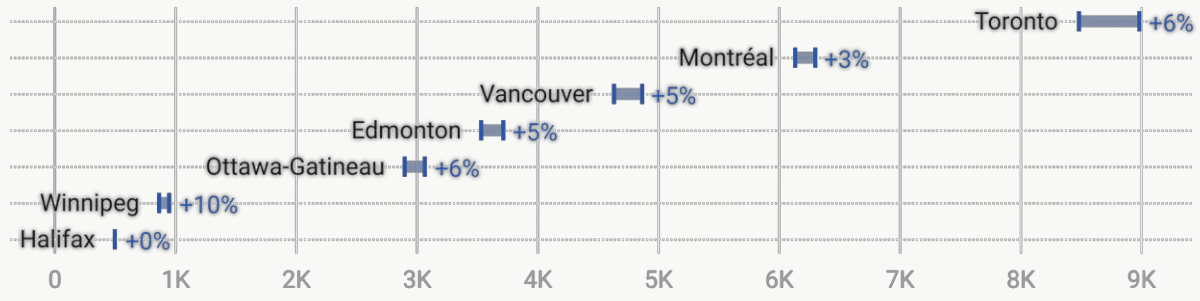


Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	73.6%	56.3%	56.0%	60.1%	38.2%	56.5%	52.0%
Public administration	4.2%	12.5%	13.5%		36.6%		
Information, culture and recreation	9.7%	18.8%	6.4%	12.1%	6.2%	11.7%	15.0%
Wholesale and retail trade	2.8%		4.3%	8.9%	4.3%	7.5%	6.0%
Educational services	5.6%	12.5%		3.4%		4.8%	9.0%
Finance and insurance			9.2%	3.0%		5.9%	10.0%
Manufacturing		12.5%					
Other services (except public administration)					4.0%		
Transportation and warehousing							

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Professional, scientific and technical services	58.4%	73.1%	57.9%	55.0%	64.5%	70.6%	
Public administration	5.6%			10.0%		4.9%	60.0%
Information, culture and recreation	5.6%		7.3%	5.7%	9.2%	9.8%	
Wholesale and retail trade	9.0%	7.7%	7.9%	12.1%	8.8%	6.9%	
Educational services		15.4%	7.9%		4.2%	2.9%	
Finance and insurance	6.7%				2.8%		
Manufacturing							
Other services (except public administration)				4.3%			
Transportation and warehousing			3.9%				

Short-Term Employment Outlook (2021–23)



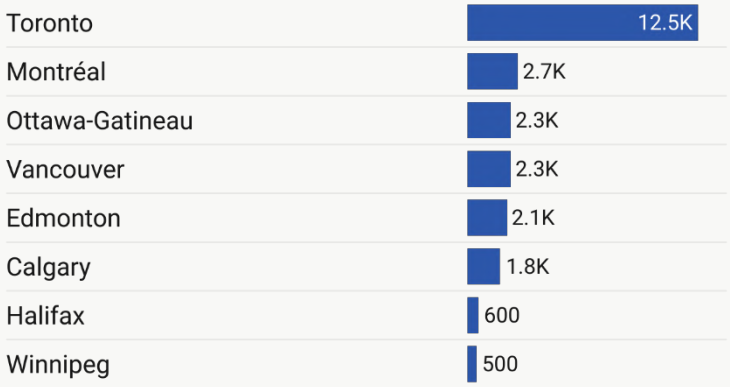
Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	100			1.4K	600	1.9K	
Retirements	100			650	250	800	
Other	20			200	150	400	
Labour Supply							
School Leavers	200			2.2K	950	4K	
Immigration	100			400	300	2K	
Net Domestic Migration	60			−600	100	−500	
Other	−80			−1.1K	−400	−1.3K	
Outlook	Surplus			Shortage	Balance	Surplus	

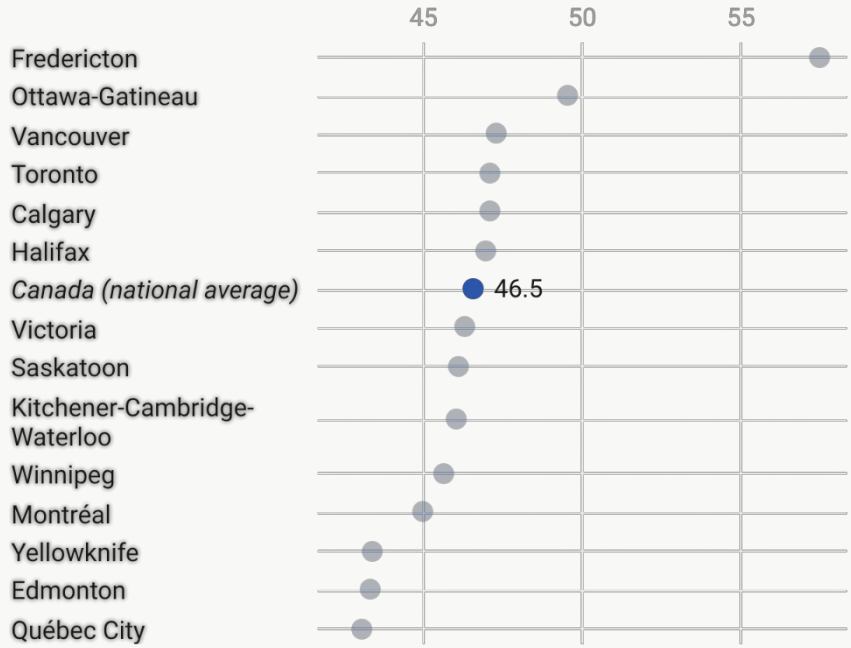
	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand				700	1.2K		
Retirements				150	800		
Other				150	200		
Labour Supply							
School Leavers				500	1.3K		
Immigration				100	1.1K		
Net Domestic Migration				60	−20		
Other				−450	−700		
Outlook				Shortage	Shortage		

Engineering Managers [0211]

Employment in 2021



Median Age of Workforce



Key Sectors of Employment

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Professional, scientific and technical services	26.9%	50%	38.9%	36.5%	32.2%	37.8%	34.6%
Manufacturing	19.4%		31.5%	36.7%	12.3%	27.2%	34.6%
Public administration	13.4%				23.2%		
Mining, quarrying, and oil and gas extraction							
Utilities	10.4%	33.3%	7.4%			5.3%	5.6%
Construction			13%	4.4%		5.5%	
Transportation and warehousing			3.7%		7.6%		
Educational services		33.3%					
Wholesale and retail trade				4.2%	8.5%	7%	
Information, culture and recreation	7.5%			4%			4.7%
Finance and insurance							5.6%

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Professional, scientific and technical services	25.8%	38.2%	38.4%	40%	42.9%	41.2%	
Manufacturing	33.3%	8.8%	7.9%	16.2%	17.2%	11.8%	
Public administration		11.8%		5.9%		17.6%	60%
Mining, quarrying, and oil and gas extraction		8.8%	27.4%	7.6%			40%
Utilities	7.6%		5.6%		5.8%		
Construction		14.7%	4.3%	11.9%	7%		
Transportation and warehousing	9.1%					14.7%	
Educational services							
Wholesale and retail trade	9.1%						
Information, culture and recreation					6.4%		
Finance and insurance							

Short-Term Employment Outlook (2021–23)

Long-Term Projections (2021–31)

	Halifax	Fredericton	Québec City	Montréal	Ottawa-Gatineau	Toronto	Kitchener-Cambridge-Waterloo
Labour Demand							
Expansion Demand	50			350	300	1.6K	
Retirements	200			850	700	3.1K	
Other	20			100	150	450	
Labour Supply							
School Leavers	50			400	100	450	
Immigration	40			300	100	800	
Net Domestic Migration	60			-200	100	-500	
Other	180			1.3K	600	3.6K	
Outlook	Balance			Surplus	Shortage	Shortage	

	Winnipeg	Saskatoon	Calgary	Edmonton	Vancouver	Victoria	Yellowknife
Labour Demand							
Expansion Demand	50		150	200	400		
Retirements	300		850	650	1.3K		
Other	20		150	100	150		
Labour Supply							
School Leavers	50		50	50	100		
Immigration	100		100	100	300		
Net Domestic Migration	-40		10	50	-10		
Other	170		1.3K	820	1.1K		
Outlook	Shortage		Balance	Balance	Shortage		

Conclusion

By combining insights from primary research from its sister publications and secondary data on the Canadian economy and labour market, this report provides short- and long-term labour market forecasts for key smart city related occupations in 14 smart cities across Canada. The set of occupations studied are, unsurprisingly, primarily digital technology-based roles that usually require at least some post-secondary education. The occupations span a breadth of industries, with a strong skew toward the service sectors, and a fair amount of regional variation. Given long-term trends in digitization over the past decade and the increase in those trends in the aftermath of the COVID-19 pandemic, most of the occupations featured in this study are expected to see continued strong demand for new jobs in the coming decade. Most of the occupations have a younger workforce than the national average (across all industries), and there is some variation across cities. That said, there is a growing need to replace retiring workers, which will remain a sizable channel for job openings, coupled with job demand through economic expansion.

On the supply side, school leavers will continue to be a major supply channel for most of the occupations studied, given the relatively early-career nature of most roles. Post-secondary graduates remain the largest single source of labour supply, but the increasing prevalence of micro-credentials and other non-traditional educational pathways are likely to contribute to supply as well, both from new graduates and workers looking to transition to a new career through reskilling or upskilling. Immigration will also continue to be a key supply channel, especially for the largest Canadian cities that are most attractive to newcomers. Finally, domestic migration flows are likely to see some changes in the next decade as more employers, especially for the occupations under focus, embrace remote and hybrid work arrangements. This relative decoupling of the sites of labour demand and supply provides a fascinating area for further study with implications on a wide range of policy issues, including municipal design and development, talent attraction, taxation, immigration policy, and even labour market data collection and analytics.

Appendices

I. Research Methodology

The forecasts contained in this report have been built with a combination of primary and secondary research. Details about surveys, interviews, and focus groups used to harvest insights and compile the final list of job titles of interest are outlined in the appendices to the sister reports of this study, *Moving Toward an Inclusive Smart Economy for Canada: The Human Talent Engine that Powers Smarter Cities,* and *Bringing a "Smart City" to Life: Understanding Talent Development, Attraction, and Retention*.

Once these job titles were mapped to occupation codes, short-term employment projections were built using a vector autoregressive model incorporating key macroeconomic variables, including output growth, prices and interest rates, labour market conditions, and other financial market indicators.

VAR is a stochastic process model used to capture the linear interdependencies among multiple time series. In a VAR model, each variable has an equation explaining its evolution as a function of its own lagged values, the lagged values of other endogenous and exogenous variables, and the error term. VAR models do not require an understanding of the causal relationship between the variables within the model, merely the knowledge that the variables are interrelated. Model specification (variables, lags) are chosen based on minimization of the Schwarz-Bayesian and Hannan-Quinn Information Criteria (SBC and HQC).

Long-term projections for the occupations were built using a Manpower Requirements Approach-based model for the demand and supply of labour in these occupations across the geographies of interest. The macroeconomic scenario underpinning this analysis was built out using a vector autoregressive model incorporating projections of fiscal and monetary policy indicators, prices and exchange rates, and longer-term demographic and industry trends. This was combined with macroeconomic projections from other secondary sources as listed below. Specific time series of industry, occupation, and provincial shares of aggregate variables were projected out using simpler, non-causal, smoothing methods with relevant constraints (e.g., summation to 1) as appropriate. Trends in labour productivity and average hours worked by industry and province were also projected by averaging a variety of smoothing methods and filters. Projections of school leavers were built using time-series models to tease out graduation rates by educational streams. Models of demographic growth and change were based on population projections released by Statistics Canada following Census 2016. Domestic migration flows were projected from Statistics Canada estimates, and immigration projections were built by combining data on near-term immigration

targets and projections from Immigration, Refugees and Citizenship Canada (IRCC), and longer-term trend analysis from past immigration data released by IRCC.

II. Secondary Data Sources

The forecasts presented in this report were built using custom labour force data tables ICTC purchased from Statistics Canada, in combination with several datasets from Statistics Canada, other datasets and projections compiled by the Government of Canada, and other public and private sector organizations.

These include growth projections and macroeconomic outlooks,[8] and data on output,[9] labour force and employment,[10] labour productivity,[11] the structure of the

8 Bank of Canada, "Monetary Policy Report – July 2022," accessed July 29, 2022, https://www.bankofcanada.ca/2022/07/mpr-2022-07-13/.

Department of Finance Canada, "Overview: Economic Context | Budget 2022," April 7, 2022, https://budget.gc.ca/2022/report-rapport/overview-apercu-en.html.

International Monetary Fund, "World Economic Outlook Database, April 2022," IMF, accessed July 29, 2022, https://www.imf.org/en/Publications/WEO/weo-database/2022/April.

Deloitte Canada, "Economic Outlook – June 2022," Deloitte Canada, accessed July 29, 2022, https://www2.deloitte.com/ca/en/pages/finance/articles/economic-outlook.html.

RBC Economics, "Forecast Tables & Statistics," accessed July 29, 2022, http://www.rbc.com/economics/economic-data/index.html.

TD Economics, "Latest Forecast Tables," accessed July 29, 2022, https://economics.td.com/ca-forecast-tables.

9 Statistics Canada, "Gross Domestic Product, Expenditure-Based, Canada, Quarterly," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610010401.

Statistics Canada, "Gross Domestic Product (GDP) at Basic Prices, by Industry, Monthly," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610043401.

Statistics Canada, "Gross Domestic Product (GDP) at Basic Prices, by Industry, Provinces and Territories," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610040201.

10 Statistics Canada, "Labour Force Characteristics by Industry, Annual," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410002301.

11 Statistics Canada, "Labour Productivity and Related Measures by Business Sector Industry and by Non-Commercial Activity Consistent with the Industry Accounts," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610048001.

economy,[12] demographics,[13] school leavers,[14] international migration,[15] domestic migration flows,[16] and other detailed snapshots of the Canadian labour market by province and census metropolitan area.[17]

III. Research Limitations and Opportunities for Further Investigation

While every effort was made to ensure that the research underlying this report was as exhaustive as possible, a few limitations exist. The appendices to the sister reports of this study outline potential biases in primary research methods used to compile the list of relevant job titles. Furthermore, mapping job titles to occupation codes does not always imply a clear-cut correspondence, especially for novel and rapidly evolving job descriptions that are often found in technology roles. Additionally, while the job titles being scraped may match occupation codes, the occupation themselves often cover larger swathes of job types that may not all correspond to smart economy related roles. The development of the new and

12 Statistics Canada, "The Daily — Supply and Use Tables, 2018," accessed July 29, 2022, https://www150.statcan.gc.ca/n1/daily-quotidien/211109/dq211109b-cansim-eng.htm.

13 Statistics Canada, "Components of Projected Population Growth, by Projection Scenario," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710005801.

Statistics Canada, "Mortality Rates, by Age Group," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310071001.

14 Statistics Canada, "Postsecondary Enrolments, by Detailed Field of Study," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710018202.

Statistics Canada, "Postsecondary Graduates, by Detailed Field of Study and International Standard Classification of Education," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710018301.

Statistics Canada, "Number of Students in Regular Programs for Youth, Public Elementary and Secondary Schools, by Grade and Sex," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710000701.

Statistics Canada, "Number of Graduates from Regular Programs for Youth, Public Secondary Schools, by Age and Sex," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3710000801.

15 Immigration, Refugees and Citizenship Canada, "Canada - Admissions of Permanent Residents by Province/Territory of Intended Destination, Intended Occupation (NOC4) and Landing Year, 1991-2020," accessed July 29, 2022, https://open.canada.ca/data/en/dataset/ad975a26-df23-456a-8ada-756191a23695/resource/c3922ae3-9a47-4d9f-8dc0-5a270f889d61.

Immigration, Refugees and Citizenship Canada, "Canada - Admissions of Permanent Residents by Province/Territory and Census Metropolitan Area (CMA) of Intended Destination," accessed July 29, 2022, https://open.canada.ca/data/en/dataset/f7e5498e-0ad8-4417-85c9-9b8aff9b9eda/resource/81021dfd-c110-42cf-a975-1b9be8b82980.

16 Statistics Canada, "Components of Population Change by Census Metropolitan Area and Census Agglomeration, 2016 Boundaries," accessed July 29, 2022, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710013601.

17 Statistics Canada, "Data Tables, 2016 Census," accessed July 29, 2022, https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/dt-td/index-eng.cfm.

improved National Occupational Classification (NOC) system of 2021,[18] with its more granular structure and improved taxonomy around skills and training should allow for a more thorough and focused assessment in future studies.

IV. The Limits of Forecasts

As with all forecasting exercises, there needs to be an understanding of the underlying assumptions and process when interpreting the results. The long-term projections presented above are baseline estimates based on assumptions around the macroeconomic outlook for the Canadian and provincial economies, the changing structure of the economy including long-term trends of digitization and technology adoption across industries, and other demographic trends, including population growth and aging, immigration flows, and domestic migration flows.

While short-run business cycle factors are not significant considerations in the long-run projections, there are a few additional caveats that need to be highlighted for the CMA-level granular forecasts presented in this report. These include the fact that occupational labour market data at the city level is often suppressed, especially for smaller cities with fewer professionals, and this necessitates making assumptions or relying on older snapshots of the local economy.

The forecasts above are built on assumptions and projections grounded in a detailed picture of the economy from the 2018 Supply and Use tables, and city-level labour market snapshots from the 2016 Census detailing demographics, educational background, and other details at the occupational level. While ICTC made some adjustments to these snapshots to account for changes that have occurred since that data was gathered, especially those brought about by the COVID-19 pandemic, these are based on other primary research and ICTC insights and cannot currently be compared with a more up-to-date, granular picture of the economy until labour force analysis from Census 2021 is released later this year.

Furthermore, as non-traditional educational pathways become increasingly commonplace, especially for the occupations under focus in this study, and career transitions become more common, this adds more noise in the estimation of labour supply for these occupations. This is compounded by the increasing prevalence of remote work, especially in the occupations this report focuses on,

18 Employment and Social Development Canada, "NOC 2021 - Canada.Ca," accessed August 2, 2022, https://noc.esdc.gc.ca/Structure/Noc2021.

and the relative decoupling of place of residence and place of work, i.e., the location of labour demand and supply.[19]

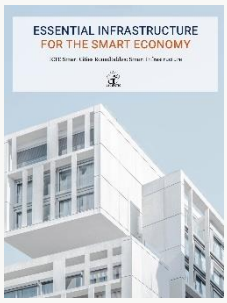
Finally, granular forecasts such as those presented in this report are inherently more noisy, and granular data are more sensitive to idiosyncratic factors that cannot easily be forecasted. That said, this is still an important exercise to assess how well Canadian smart cities are placed to handle talent needs in the next decade and to help better plan how we move forward.

19 Tahsin Mehdi and René Morissette, "Working from Home for an Employer Located in Another Province or Territory," Economic and Social Reports 2, no. 1 (February 2022), https://doi.org/10.25318/36280001202200200001-eng.

V. Smart City Job Titles

Health Tech	biostatistician
	digital health director
	digital health manager
	digital health support associate
	telemedicine assistant
	telemedicine coordinator
AgTech	agriculture service technician
	agronomist
	crop sales specialist
	cultivation technician
	GIS technician
	precision technology specialist
	urban farmer
Clean Tech / Energy	digital grid engineer
	energy modeler
Sustainability & Urban Design	urban designer
	sustainable development consultant
	resiliency officer
	environmental scientist
Smart Mobility	automotive service technician
	autonomous driving software engineer
	EV engineering manager
	EV project engineer
	systems integrator
	transportation planning engineer
Software / Web Development & Operations	back end developer
	backend developer
	dev ops
	full stack developer
	mobile developer
	QA engineer
	QA technician
	QA tester
	UI developer
	UX developer
	software developer
	software engineer
	site reliability engineer
	blockchain developer
	IT support
Data Science	data analyst
	data engineer
	data scientist
AI/ML & Human-Computer Interaction	AI architect
	AI engineer
	conversation designer
	machine learning engineer
	human-computer interaction researcher
Hardware Design & Development	CAD technician
	computer technician
	fibre optic technician
	industrial designer
	mechanical engineering technician
	sensor engineering technician
	telecommunications technician
AR/VR & Gaming	animator
	AR designer
	AR/VR artist
	AR/VR director
	character rigger
	environment artist
	game developer
	gameplay designer
	gameplay programmer
	pipeline supervisor
	pipeline technical director
	technical artist
	VR designer
Cloud Computing & Databases	cloud administrator
	cloud architect
	cloud engineer
	database administrator
	database manager
Technical Managers	project manager
	product manager
Business & Support Roles	business analyst
	technical sales engineer
	technical sales specialist
	digital marketer
Ethics & DEI	accessibility advisor
	diversity equity & inclusion specialist
	ethics officer
	privacy officer
Security (Data, Network, Cyber)	cyber security specialist
	network administrator
	network technician
	systems security technician
	quantum researcher

VI. Other Reports in the ICTC Smart Cities Series

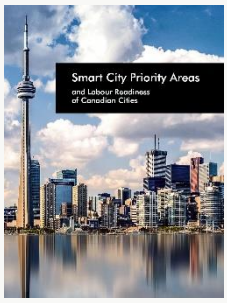


Cutean, Alexandra, and Tyler Farmer. **"Essential Infrastructure for the Smart Economy ICTC Smart Cities Roundtables: Smart Infrastructure."** Ottawa, ON: Information and Communications Technology Council (ICTC), February 2020.

https://www.digitalthinktankictc.com/policy-briefs/essential-infrastructure-for-the-smart-economy

Cutean, Alexandra, Rosina Hamoni, and Trevor Quan. **"Collectively Building the Framework to Shape Our Future Cities: A Year of Engagement with the ICTC Smart Cities Taskforces."** Information and Communications Technology Council (ICTC), March 2020.

https://www.digitalthinktankictc.com/policy-briefs/collectively-building-the-framework-to-shape-our-future-cities

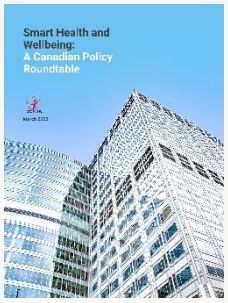


Cutean, Alexandra, Trevor Quan, and Holly Brown. "**Smart City Priority Areas and Labour Readiness of Canadian Cities."** Ottawa, ON: Information and Communications Technology Council (ICTC), August 2019.

https://www.digitalthinktankictc.com/policy-briefs/smart-city-priority-areas-and-labour-readiness-of-canadian-cities

Farmer, Tyler, Mairead Matthews, and Faun Rice. **"Procurement Office or 'Living Lab?' Experimenting with Procurement and Partnerships for Smart Cities Technologies in Canada."** Ottawa, ON: Information and Communications Technology Council, February 2021.

https://www.digitalthinktankictc.com/reports/procurement-office-or-living-lab

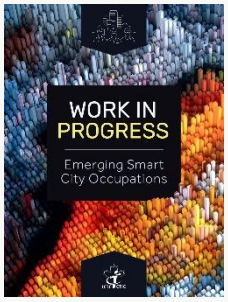


Hamoni, Rosina, Mairead Matthews, and Maya Watson. **"Smart Health and Wellbeing: A Canadian Policy Roundtable."** March 2022.

https://www.digitalthinktankictc.com/policy-briefs/smart-health-and-wellbeing

Ivus, Maryna, and Peter Taillon. **"Smart Mobility in the Future City ICTC Smart Cities Roundtable on Smart Mobility in Canada."** Ottawa, ON: Information and Communications Technology Council (ICTC), June 2021.

https://www.digitalthinktankictc.com/policy-briefs/smart-mobility-in-the-future-city



Kotak, Akshay, and Khiran O'Neill. **"Work in Progress: Emerging Smart City Occupations."** Ottawa: Information and Communications Technology Council, August 2021.

https://www.digitalthinktankictc.com/reports/work-in-progress

Martell, Tracy, and Trevor Quan. **"Smart Developments at Home and Abroad: Smart Cities Monitoring Report 2019-2020."** Ottawa, ON: Information and Communications Technology Council, September 2020.

https://www.digitalthinktankictc.com/policy-briefs/smart-developments-at-home-and-abroad

Matthews, Mairead, and Khiran O'Neill. **"Smart Cities, Smart Government ICTC Policy Roundtable on Smart Government in Canada."** Ottawa, ON: Information and Communications Technology Council (ICTC), July 2021.

https://www.digitalthinktankictc.com/policy-briefs/smart-cities-smart-government

Matthews, Mairead, and Faun Rice. **"Designing Smart and Sustainable Communities: ICTC Smart Cities Roundtables, Smart Energy and Environment."** Ottawa, ON: Information and Communications Technology Council, February 2021.

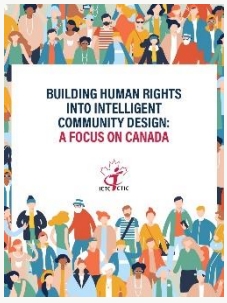
https://www.digitalthinktankictc.com/policy-briefs/designing-smart-sustainable-communities

Quan, Trevor, and Zhenzhen Ye. **"Lessons from Abroad: Smart Cities Developments from the European Region."** Ottawa, ON: Information and Communications Technology Council (ICTC), April 2022.

https://www.digitalthinktankictc.com/policy-briefs/lessons-from-abroad

Rice, Faun. **"Transformative Technologies for Smart Canadian Cities."** Ottawa, ON: Information and Communications Technology Council (ICTC), September 2019.

https://www.digitalthinktankictc.com/policy-briefs/transformative-technologies



Rice, Faun, Maya Watson, and Phil Dawson. **"Building Human Rights into Intelligent Community Design A Focus on Canada."** Ottawa, ON: Information and Communications Technology Council (ICTC), April 2022.

https://www.digitalthinktankictc.com/policy-briefs/building-human-rights-into-intelligent-community-design

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