

QUARTERLY DIGITAL ECONOMY PULSE:

Digital Adoption in Canada

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PREFACE:

The Information and Communications Technology Council (ICTC) is a neutral, not-for-profit, national centre of expertise with the mission of strengthening Canada's digital advantage in the global economy. For more than 30 years, ICTC has delivered forward-looking research, practical policy advice, and capacity-building solutions for individuals and businesses. The organization's goal is to ensure that technology is utilized to drive economic growth and innovation and that Canada's workforce remains competitive on a global scale.

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ABBREVIATIONS

AI	Artificial intelligence
GDP	Gross domestic product
ICT	Information and communications technology
ICTC	Information and Communications Technology Council
IoT	Internet of Things
IP	Intellectual property
NAICS	North American Industry Classification System
NOC	National Occupational Classification
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
SMEs	Small and medium-sized enterprises
STEM	Science, technology, engineering, and mathematics

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EXECUTIVE SUMMARY

Canada's digital economy is a critical lever for the nation's overall productivity, innovation, and global competitiveness. This briefing, part of ICTC's Digital Economy Pulse series, provides background on the Canadian economy, outlining key opportunities and challenges and how they are influencing the adoption of digital tools.

Despite Canada's significant contributions to global AI research and its high levels of higher-education research and development (R&D) spending, the country faces enduring challenges related to productivity and innovation. Labour productivity growth has remained stagnant, with productivity growth of only 0.9% over the past decade, and real wages are below pre-pandemic levels.

Currently, Canadian businesses, particularly small and medium enterprises (SMEs), are lagging in the adoption of advanced technologies, such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and cloud computing. Large businesses and information and communications technology (ICT) companies are significantly more likely to adopt such technologies. In addition, strategic sectors (including advanced manufacturing, agri-food technology, health and life sciences, clean technology, and resources of the future) are facing ongoing challenges to widespread digital adoption. To improve Canada's overall productivity and innovation indicators, steps must be taken to address barriers to technology adoption, which range from a lack of awareness of when and how technologies can be adopted, unclear returns on investment, to insufficient access to skilled workers.

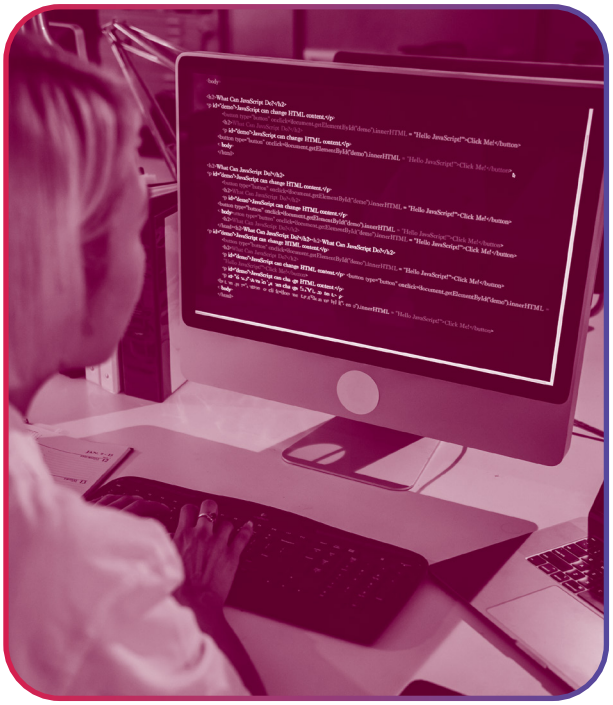
As Canada looks to the next five years, critical steps will include intensifying digital adoption rates, integrating advanced digital technologies across traditional sectors, investing in talent supply, and developing the workforce. The country must reinvigorate its economic engine and build resilience in the face of global economic shifts.

KEY TAKEAWAYS

- Slowing labour productivity growth is largely attributed to weak capital investments, including in advanced technologies and digitization, among Canadian businesses.
- Canadian SMEs lag in adopting advanced technologies, such as IoT, AI, big data analytics, and cloud computing. Large businesses and ICT companies are significantly more likely to adopt such technologies.
- Among SMEs, barriers to advanced technology adoption include lack of awareness, high initial investment costs, unclear returns on investment in the long term, and insufficient access to skilled workers.
- The keys to advancing the competitiveness of important Canadian sectors—such as advanced manufacturing, agri-food technology, health and life sciences, and clean technology—are intensifying digitalization, adopting advanced technologies, and investing in talent pipelines.

INTRODUCTION

Canada's digital economy is a crucial contributor to national growth, productivity, and global competitiveness. As the world moves toward advanced digital technologies, it's important to understand and monitor labour market trends across industries and the ICT sector for effective digital workforce development and planning. While the digital economy continues to grow, the surge in technology hiring that Canada experienced during the pandemic has slowed.



During the COVID-19 pandemic, Canada saw significant investment in digital services. For instance, Canadian businesses quickly adopted e-commerce for contact-free orders and delivery, and the public sector began expanding virtual services, such as telehealth. Many organizations that invested in digitalization have retained their new capabilities, while others are adjusting their workforces to align with consumers who desire both in-person and virtual goods and services.

This report examines the opportunities and challenges facing Canada's economy. Despite the ongoing expansion of the digital economy, issues such as stagnant labour productivity, slow technology adoption among SMEs, and barriers to commercialization persist. Moreover, new technologies—such as automation tools like AI coding assistants—are beginning to disrupt technology workplaces. However, their impact on the labour market is yet to be fully realized or understood.

BACKGROUND: CANADA'S ECONOMY

CANADA'S LABOUR PRODUCTIVITY

The growing prominence of "intangible assets," including digital goods and services, IP, and data, has fundamentally transformed the way wealth is generated in the global economy.[1] Labour productivity, typically measured as GDP per hour worked, is a key indicator of how effectively an economy converts worker effort into valuable output. Many economists link labour productivity with intangible assets in today's global economy.[2]

Canada has historically invested more in natural resource development than in digital goods and services,[3] and its relatively small market and private investment system have made it challenging for Canadian startups to develop, scale, and retain value-producing IP within the country.[4] Consequently, Canada has fallen behind its peer countries in labour productivity. In 2024, the Bank of Canada noted that this trend has reached emergency levels.[5] Canada ranks as the second-least productive country in the G7, with productivity growth of only 0.9% over the past decade[6] and real wages remaining 2.4% lower than they were just before the pandemic (in Q4 of 2019).[7] The long-term outlook for Canada's economic growth appears bleak, with projections for 2030 and 2060 ranking Canada last among Organisation for Economic Co-operation and Development (OECD) member countries.

Figure 1 shows a decade of historical labour productivity in Canada, including the slowdown in labour productivity growth following the 2014 commodity price crash, which resulted in decreased investment in natural resources.[8] Accompanying this steep drop in productivity has been a significant increase in unit labour costs.[9] The lack of investment in labour productivity is particularly challenging, given that the amount of fixed capital invested per worker (i.e., the tools, equipment, and machinery that workers need to do their job) is the most crucial source of labour productivity growth.[10] This situation is essentially limiting the potential growth of GDP per capita in the post-pandemic era.[11]

1 Jonathan Haskel and Stian Westlake, Capitalism Without Capital: The Rise of the Intangible Economy (Princeton University Press, 2018).

2 Jeffrey Mollins and Temel Taskin, "Digitalization: Productivity," Bank of Canada, August 2023, https://publications.gc.ca/collections/collection_2023/banque-bank-canada/FB3-6-2023-17-eng.pdf.

3 Colin Scarffe, "The Position and Length of Canadian Supply Chains," Global Affairs Canada: Office of The Chief Economist, July 2022, https://www.international.gc.ca/trade-commerce/assets/pdfs/economist-economiste/position-length-supply-chains.pdf; John R. Baldwin et al., "Intangible Capital and Productivity Growth in Canada," The Canadian Productivity Review, no. 029 (2012), https://www150.statcan.gc.ca/n1/en/pub/15-206-x/15-206-x2012029-eng.pdf?st=IMaRymJ3.

4 Mairead Matthews and Faun Rice, "Context Matters: Strengthening the Impact of Foreign Investment on Domestic Innovation," ICTC, May 2022, https://ictc-ctic.ca/reports/context-matters.

5 Carolyn Rogers, "Time to Break the Glass: Fixing Canada's Productivity Problem," Bank of Canada, March 2024, https://www.bankofcanada.ca/wp-content/uploads/2024/03/remarks-2024-03-26.pdf.

6 Business Data Lab, "Prompting Productivity: Generative AI Adoption by Canadian Businesses," Canadian Chamber of Commerce, May 2024, https://bdllde.ca/wpcontent/uploads/2024/05/Prompting_Productivity_Report_May_2024.pdf.

7 OECD, "OECD Employment Outlook 2024 – Country Notes: Canada," OECD, July 2024, https://www.oecd.org/en/publications/oecd-employment-outlook-2024-country-notes_d6c84475-en/canada_15eb6bfa-en.html.

8 Dany Brouillette et al., "Total Factor Productivity Growth Projection for Canada: A Sectoral Approach," Bank of Canada, May 2024, https://www.bankofcanada.ca/2024/05/staff-analytical-note-2024-12/#footnote-1; Deloitte, "Hurdles Remain Amid Signs of Recovery: Economic Outlook,"2024, https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/ca-economicoutlook_Fy25_Q1_EN_V6_AODA.pdf.

9 Unit labour cost "measures the cost of labour input required to produce one unit of output and equals labour compensation in current dollars divided by the real output. It is often calculated as the ratio of labour compensation per hour worked and labour productivity. Unit labour cost increases when labour compensation per hour worked increases more rapidly than labour productivity. It is widely used to measure inflation pressures arising from wage growth." Definition in "Indexes of business sector labour productivity, unit labour cost and related measures, seasonally adjusted," Statistics Canada, Table 36-10-0206-01, accessed December 2024, https://doi.org/10.25318/3610020601-eng.

10 Wulong Gu, "Investment Slowdown in Canada After the Mid-2000s: The Role of Competition and Intangibles," Analytical Studies Branch Research Paper Series, no. 474 (2024), https://www150.statcan.gc.ca/n1/en/pub/11f0019m/11f0019m2024001-eng.pdf?st=59cB_xhX.

11 Carter McCormack and Weimin Wang, "Canada's Gross Domestic Product per Capita: Perspectives on the Return to Trend," Economic and Social Reports 4, no. 4 (2024), https://www150.statcan.gc.ca/n1/pub/36-28-0001/2024004/article/00001-eng.pdf.

Increases in labour productivity are essential for long-term improvements in living standards. Over the past two decades, economic performance has been linked to digitalization;[12] advancing digital intensity across all sectors will support sustained labour productivity growth.

Quarterly data for the last five years show that Canadian labour productivity decreased in 17 of the last 20 quarters, with output growth (rate of change in real GDP) also following a downward trend. This indicates a trend toward less output produced per hour worked.[13] Year-over-year labour productivity declines are expected to continue.

From 2017 to 2024, Productivity Stalled in Canada While Labour Costs Surged

Indexes of business sector labour productivity, unit labour cost and related measures, seasonally adjusted

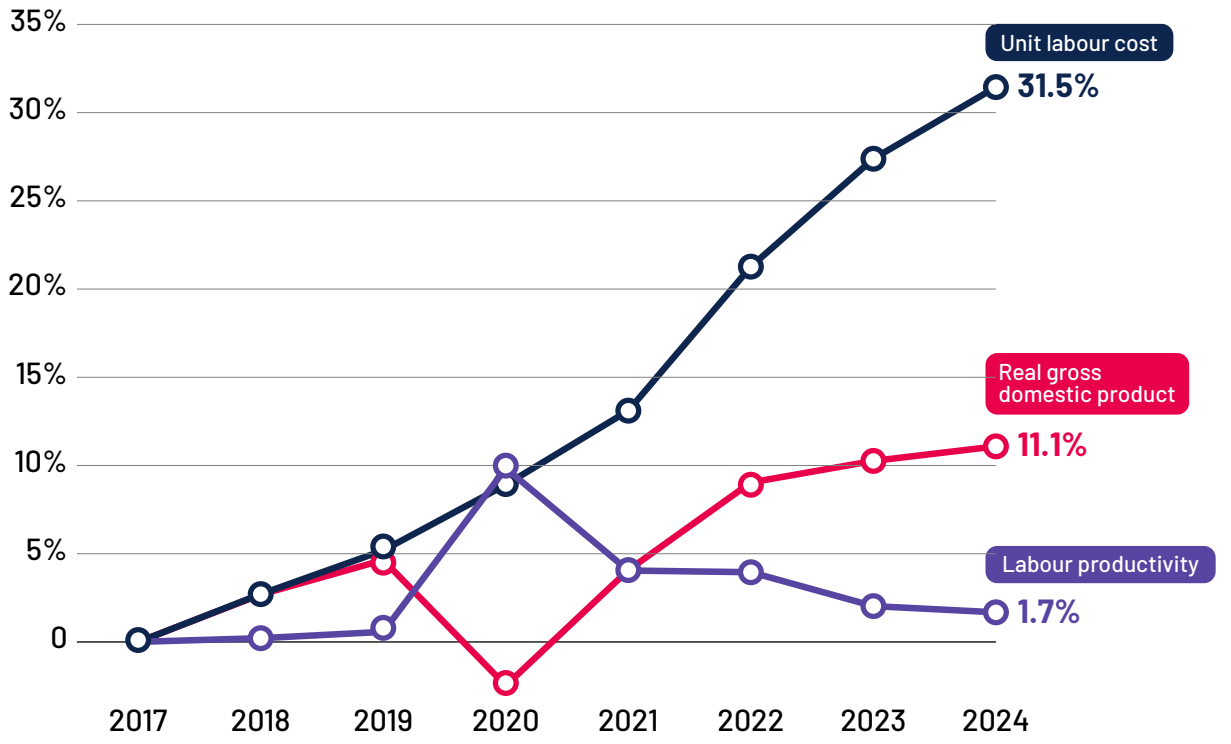


Figure 1: Canada's Labour Productivity. Source: ICTC calculations with data from Statistics Canada's Labour Productivity Measures (quarterly data). Quarterly data averaged annually: Q4 2024 was unavailable, so an average of Q1–Q3 2024 was utilized.

12 Huju Liu, "Economic Performance Associated with Digitalization in Canada Over the Past Two Decades," Economic and Social Reports 1, no. 2 (2021), https://www150.statcan.gc.ca/n1/en/pub/36-28-0001/2021002/article/00001-eng.pdf?st=_FZQMRS6.

13 "Indexes of business sector labour productivity, unit labour cost and related measures, seasonally adjusted," Statistics Canada, Table 36-10-0206-01, accessed December 2024.

14 "Research to Insights: Challenges and Opportunities in Innovation, Technology Adoption and Productivity," Statistics Canada, July 2024, https://www150.statcan.gc.ca/n1/en/pub/11-631-x/11-631-x2024005-eng.pdf?st=L3jMwtXZ.

RESEARCH AND DEVELOPMENT INVESTMENTS

Figure 2 presents a snapshot of expenditure on research and development (R&D) by businesses, higher education, and governments for 2022. When compared with its international peers, Canada's business enterprise expenditure is significantly lagging, while its higher-education expenditure is elevated. Since 2015, slower labour productivity growth has largely been attributed to weak capital investment.[14]

Percentage of GDP Expenditure on R&D, by Country

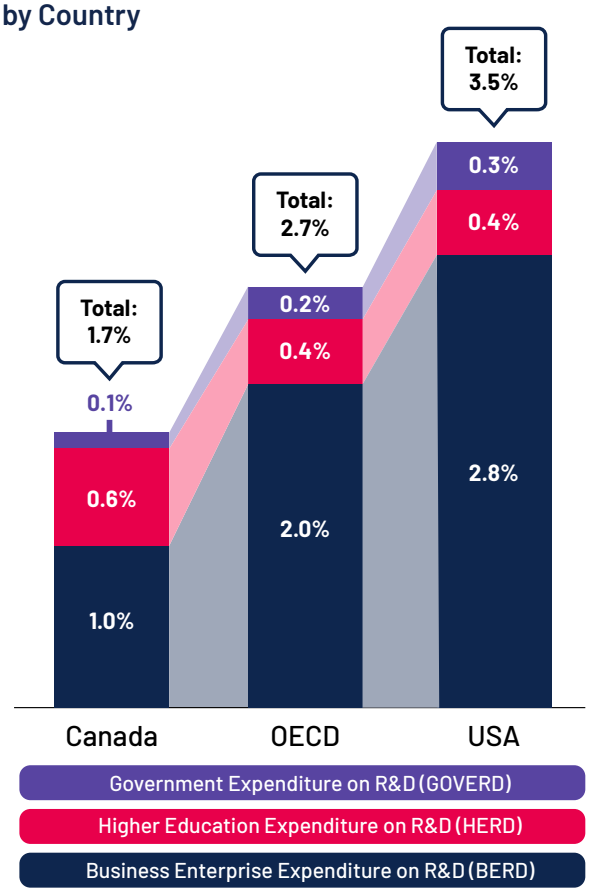


Figure 2: Percentage of GDP Expenditure on R&D in 2022, by Country. Source: Main Science and Technology Indicators from OECD's Data Explorer, https://data-explorer.oecd.org, accessed Dec 2024. Note: The total value may not match the individual values as total and sub-totals are independently rounded.

Canada's higher-education sector invests a greater proportion of its GDP in R&D compared to peer countries. However, this has not led to a corresponding improvement in university technology transfer and commercialization outcomes. A recent report from the World Intellectual Property Organization concluded that Canada is not fully capturing roughly 50% of its technological potential (based on comparing Canada's scientific publications to its patent filings from 2001–2020).[15] The production of patents, particularly influential ones, is linked to productivity growth.[16] Nevertheless, some commentators contend that Canada faces a "patent productivity paradox": while Canada tripled its patent production from 2001 to 2018, productivity growth remained relatively stagnant. That said, Canada also experiences a net out-migration of inventors, which might explain why the country generates patents without corresponding productivity growth.[17]

The Canadian labour force has become more educated over time, and a greater number of science, technology, engineering and math (STEM) graduates have entered the workforce.[18] However, higher levels of education alone have not resulted in productivity gains. Compared to its international peers, Canada generally exhibits strong human capital indicators; however, it requires additional focus on commercialization and IP development.

The small market, an ecosystem characterized by limited venture capital and private equity, and challenges with retaining IP development in Canada are closely interconnected. In areas of Canada where serial entrepreneurs and experienced business talent are scarce, small businesses may find it easier to seek advice from abroad and occasionally pursue premature acquisition rather than scaling up domestically. Tackling this issue by enhancing the conditions for commercialization and scaling is crucial for advancing Canada's innovation ecosystem.[19]

15 The report used a compilation of patent information registries and a scientific citation database. See: World Intellectual Property Organization (WIPO), "Making Innovation Policy Work for Development," WIPO, 2024, p. 61, https://doi.org/10.34667/tind.49284.

16 Bryan Kelly, Dimitris Papanikolaou, Amit Seru and Matt Taddy, "Measuring Technological Innovation over the Long Run," National Bureau of Economic Research, February 2020, https://www.nber.org/system/files/working_papers/w25266/w25266.pdf.

17 Iain Cockburn, Megan MacGarvie, and John McKeon, "Canada's Patent Productivity Paradox: Recent Trends and Implications for Future Productivity Growth," International Productivity Monitor 2023-10, no. 45 (2023): 120–154, https://www.csls.ca/ipm/45/IPM_45_Macgarvie.pdf.

18 Klarka Zeman and Marc Frenette, "Portrait of youth in Canada: Data report Chapter 3: Youth and Education in Canada", Statistics Canada, October 4, 2021, https://www150.statcan.gc.ca/n1/pub/42-28-0001/2021001/article/00003-eng.htm.

19 Mairead Matthews and Faun Rice, "Context Matters: Strengthening the Impact of Foreign Investment on Domestic Innovation," ICTC, May 2022, https://ictc-ctic.ca/reports/context-matters.

INVESTMENT IN DIGITAL ECONOMY INFRASTRUCTURE AND TECHNOLOGY TOOL ADOPTION

A growing body of literature suggests that digitalization and emerging technologies, such as AI, could boost economic growth.[20]

One major component of digitalization is digital adoption, which refers to an organization's successful integration of technology into its day-to-day operations and business processes.[21] Digital adoption can encompass the implementation of simple productivity tools (e.g., accounting or word processing software) as well as that of more complex technologies (e.g., cloud computing, AI, IoT technologies). Several conditions are crucial for successful digital adoption, including sufficient existing infrastructure (e.g., affordable, high-speed internet access) and adequate digital literacy and skills of organizational staff and clients. For instance, many businesses in Canada adopted e-commerce technologies to facilitate remote sales during the COVID-19 pandemic. This required public access to devices, broadband (high-speed connections), and high levels of digital literacy for success.[22]

WHERE DOES CANADA STAND?

Compared to peer countries across the OECD, Canada ranks highly on measures of digitalization related to public digital literacy and education. For example, in 2023, 96.9% of Canadian adults had used the internet at least once during the last three months, compared to the OECD average of 92.6%.[23] In addition, Canada has a high proportion of post-secondary graduates with STEM degrees compared to other OECD member countries.[24]

However, with regard to key measures of digital adoption of specific advanced technologies by businesses, Canada lags peer countries. Canada does sit just below the OECD average for the adoption of cloud computing and IoT technologies. However, across 2023 OECD reporting, it had the lowest proportion of businesses that had adopted big data analytics. Importantly, one research contributor—who was familiar with polling Canadian businesses on this topic—commented that nearly half of firms with more than 10 employees reported doing "data analytics," but were simply less comfortable with the term "big data." In addition, Canadian firms represented the 11th lowest proportion when reporting adoption of AI (see Figure 3).

Canada launched an ambitious national plan for AI development in 2017, coordinated by the Canadian Institute for Advanced Research.[25] The funding and initiatives within this plan are largely focused on advancing Canadian AI research, talent, and startup growth.[26]

20 See, for example, Robert Anderton, Vasco Botelho, and Paul Reimers, "Digitalisation and Productivity: Gamechanger or Sideshow?" Working Paper Series, no. 2794 (March 2023), https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2794~6911beee80.en.pdf; Philip Trammell and Anton Korinek, "Economic Growth Under Transformative AI," National Bureau of Economic Research, 2023, https://www.nber.org/system/files/working_papers/w31815/w31815.pdf; Mariarosaria Comunale and Andrea Manera, "The Economic Impacts and the Regulation of AI: A Review of the Academic Literature and Policy Actions," International Monetary Fund Working Papers 2024, no. 065 (2024), https://www.imf.org/en/Publications/WP/Issues/2024/03/22/The-Economic-Impacts-and-the-Regulation-of-AI-A-Review-of-the-Academic-Literature-and-546645.

21 "What Is Digital Adoption?" Business Development Bank of Canada, March 31, 2022, https://www.bdc.ca/en/articles-tools/technology/invest-technology/what-is-digital-adoption.

22 David Wavrock, Grant Schellenberg, and Christoph Schimmele, "Internet-Use Typology of Canadians: Online Activities and Digital Skills," Analytical Studies Branch Research Paper Series, no. 465 (2021), https://www150.statcan.gc.ca/n1/pub/11f0019m/11f0019m2021008-eng.htm.

23 OECD, "Figure 3.1. Internet adoption has increased," in OECD Digital Economy Outlook 2024 (Volume 1): Embracing the Technology Frontier, OECD Publishing, 2024, 90, https://doi.org/10.1787/a1689dc5-en.

24 "New Tertiary Graduates in Science, Technology, Engineering and Mathematics as a Share of New Graduates," OECD Going Digital Toolkit, accessed December 2024, https://goingdigital.oecd.org/en/indicator/43.

25 "The Pan-Canadian AI Strategy," Canadian Institute for Advanced Research, accessed December 2024, https://cifar.ca/ai/.

26 Ibid. ; Graham Dobbs and Jake Hirsch-Allen, "Canada's Plans to Bridge the AI Compute Gap and How It Can Make Industry Policy Inclusive and Sustainable," OECD AI Policy Observatory, April 16, 2024, https://oecd.ai/en/wonk/canadas-ai-compute-gap.

Canadian Advanced Technology Adoption Compared to OECD

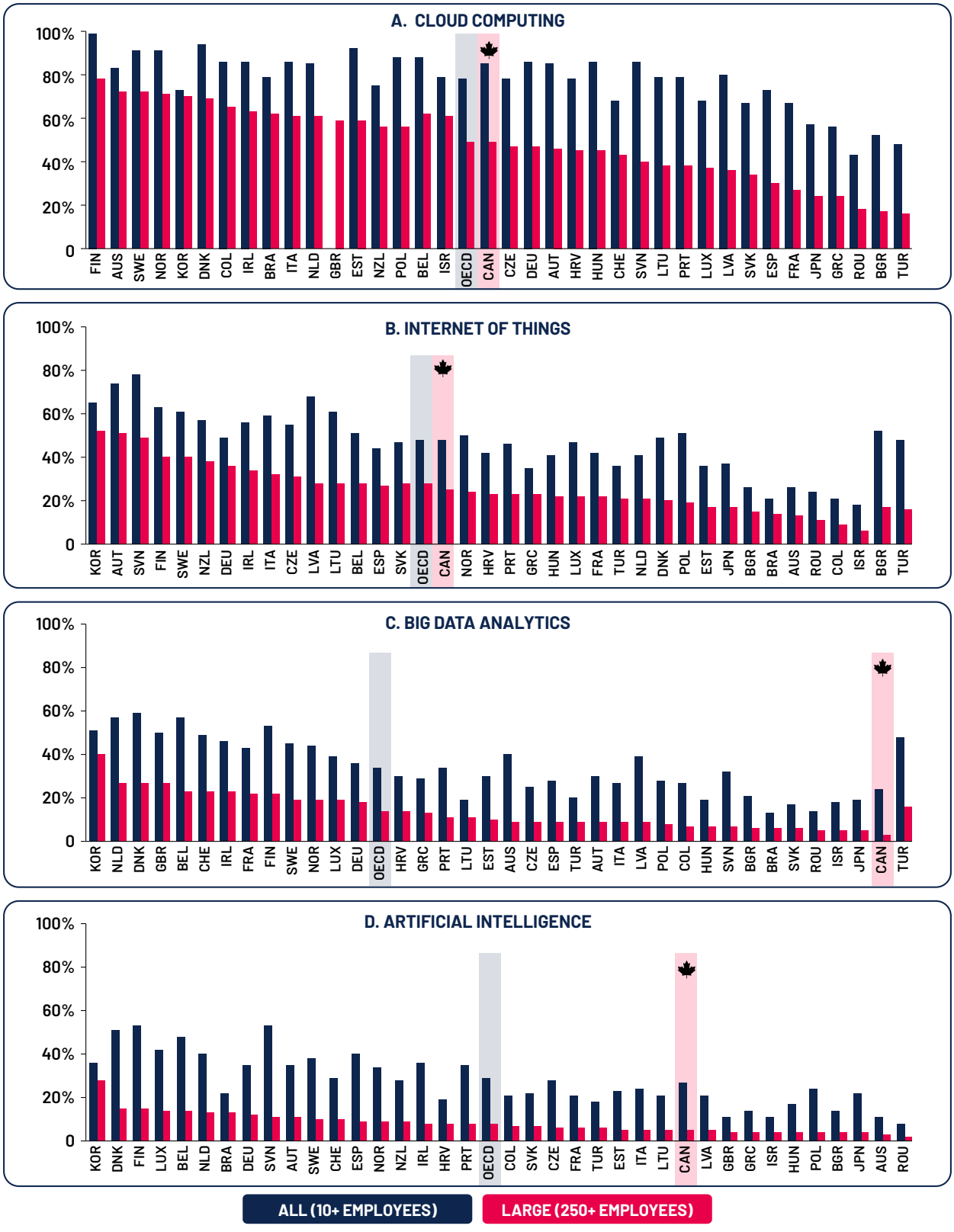


Figure 3: Canadian Advanced Technology Adoption Compared to OECD. Source: Adaptation of Figure 3.10. in OECD Digital Economy Outlook 2024 (Volume 1): Embracing the Technology Frontier, OECD Publishing, Paris, 2024, https://doi.org/10.1787/a1689dc5-en. Figure reproduced with permission from authors.

As such, Canada has become a leader in AI research, producing one of the world's highest per capita volumes of AI research publications.[27] However, its AI computing power[28] and levels of AI adoption remain lower than those of peer countries.[29]

Canada also has more work to do in protecting AI-related IP, commercializing it, and adopting AI solutions across businesses. A recent OECD report suggests that Canada's annual total factor productivity growth (the growth in the productivity of the economy as a whole) could increase by 0.25%–0.6% depending on the level of AI adoption and capabilities.[30] Importantly, Canadian findings indicate that—so far—the quality and type of AI adoption can influence productivity gains: a study undertaken prior to the release of generative AI technologies showed no significant relationship between AI adoption and productivity levels or growth.[31]

BARRIERS TO TECHNOLOGY ADOPTION IN CANADA

Most Canadian businesses are SMEs (businesses with fewer than 500 employees). In 2023, SMEs comprised 86.7% of all employer businesses in the country.[32] SMEs report facing major barriers to technology adoption, such as lack of awareness, high initial investment costs, unclear returns on investment in the long term, and insufficient access to skilled workers.[33]

Large employers in Canada also report facing barriers to adoption, such as the rising cost of inputs required to produce or advance product development.[34] ICTC interviewees indicated that they are weighing their business investment choices more carefully due to less available capital and revenue. A large communications technology employer involved in this study explained that their primary consideration in tool adoption was whether it would generate value, either through revenue or by creating savings on operational and capital expenditures.

Additionally, interviewees commented that privacy, risk, compliance, and IP concerns may also slow the adoption of technologies like generative AI. Several companies reported needing time to train or fine-tune AI systems using their own data instead of using "off-the-shelf" solutions.

Finally, many organizations see a lack of access to skilled workers as a barrier to adopting advanced technologies. Almost half (48%) of Canadian businesses with more than 20 staff members report skilled worker recruitment as a business challenge.[35] Companies may rely on personnel with data engineering, AI, or cyber security experience to help them implement an effective AI or data strategy, but experienced personnel are currently difficult to secure in these fields.

27 OECD, Digital Economy Outlook 2024, (Volume 1): Embracing the Technology Frontier, OECD Publishing, Paris, 2024, https://doi.org/10.1787/a1689dc5-en. Data in Figure 2.4. adjusted by national population.

28 Graham Dobbs and Jake Hirsch-Allen, "Canada's Plans to bridge the AI compute gap and how it can make industry policy inclusive and sustainable," OECD AI Policy Observatory, April 16, 2024, https://oecd.ai/en/wonk/canadas-ai-compute-gap.

29 Angus Lockhart, "Automation Nation? AI Adoption in Canadian Businesses," Toronto Metropolitan University and The Dais, September 2023, https://dais.ca/wp-content/uploads/2023/09/Automation-Nation-AI-Adoption-in-Canadian-Businesses-2.pdf.

30 Total factor productivity, referred to as "multifactor productivity" by Statistics Canada, "measures the efficiency with which all inputs are used in production. It is the ratio of real GDP to combined labour and capital inputs." See "Multifactor Productivity and Related Variables in the Aggregate Business Sector and Major Sub-Sectors, by Industry," Statistics Canada, Table: 36-10-0211-01, accessed January 2025, https://doi.org/10.25318/3610021101-eng; OECD, "Miracle or Myth? Assessing the Macroeconomic Productivity Gains from Artificial Intelligence," OECD Publishing, November 2024, p. 39, https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/11/miracle-or-myth-assessing-the-macroeconomic-productivity-gains-from-artificial-intelligence_fde2a597/b524a072-en.pdf.

31 Viet Vu et al., "Waiting for Takeoff: The Short-Term Impact of AI Adoption on Firm Productivity," Toronto Metropolitan University and The Dais, December 2024, https://dais.ca/reports/waiting-for-takeoff/.

32 Stephanie Tam et al., "Analysis on Small Businesses in Canada, Second Quarter of 2024," Statistics Canada, June 2024, https://www150.statcan.gc.ca/n1/pub/11-621-m/11-621-m2024007-eng.htm.

33 Maryna Ivus et al., "Canadian Agri-food Technology: Sowing the Seeds for Tomorrow," ICTC, September 2021, https://ictc-ctic.ca/reports/canadian-agrifood-technology#report; Rosina Hamoni, Mairead Matthews, and Maya Watson, "Digital Transformation: The Next Big Leap in Healthcare," ICTC, August 2021, https://ictc-ctic.ca/reports/digital-transformation.

34 Stephanie Tam et al., "Analysis on Small Businesses in Canada, second quarter of 2024,"Statistics Canada, June 13, 2024, https://www150.statcan.gc.ca/n1/pub/11-621-m/11-621-m2024007-eng.htm; "Business or Organization Obstacles Over the Next Three Months, Second Quarter of 2024," Statistics Canada, Table 33-10-0809-01, accessed December 2024, https://doi.org/10.25318/3310080901-eng.

35 Ibid.

ADVANCING DIGITAL ADOPTION ACROSS STRATEGIC INDUSTRIES IN CANADA

Digital adoption in Canada varies by industry and is not limited to the technology sector; across Canada, many different types of organizations are driving growth and innovation. In 2017 and 2018, Innovation, Science and Economic Development Canada worked with leaders in six interconnected industries to support Canadian firms through programs like Innovative Solutions Canada and the Strategic Innovation Fund. These initiatives, which are ongoing, seek to accelerate technology adoption and innovation through procurement.[36] Each of these industries is still working to intensify digitalization today.

ADVANCED MANUFACTURING

Canada's manufacturing industry employs 1.79 million people, produces 60% of the country's exported merchandise, and invests heavily in R&D.[37] Advanced manufacturing refers to the use of technologies (e.g., robotics, additive manufacturing, and big data analytics) to help spur growth in the sector.[38] In 2022, 74.9% of manufacturing companies reported to Statistics Canada that they had adopted at least one advanced technology, such as information control technologies and enterprise resource planning tools.[39] This constituted an increase in technology adoption (up from 69.9% in 2014) in this field.[40]

One interviewee from the aerospace-focused metal manufacturing industry underscored this shift, noting: "We try to stay ahead of the curve when it comes to our use of new technologies, especially on the AI front… we've been developing an AI model to replace our quality monitoring."

Despite this progress, greater investment in technology adoption and skilled workers is needed in the manufacturing sector.[41] Interviewees from industry associations and from post-secondary institutions that are interested in supporting advanced manufacturing mentioned efforts to enhance awareness of opportunities for tool adoption. For example, an advanced manufacturing expert created courses to help manufacturing companies understand the benefits of tools like enterprise resource planning and noted that, "After going through the course, they realize that there are good applications they could use, but before hearing about it, they don't really see how it could benefit their companies."

36 Innovation, Science and Economic Development Canada (ISED), "Report from Canada's Economic Strategy Tables: Seizing Opportunities for Growth," Government of Canada, September 2018, https://ised-isde.canada.ca/site/economic-strategy-tables/en/report-2018/report-canadas-economic-strategy-tables-seizing-opportunities-growth-september-25-2018.

37 Alan Arcand, "Manufacturing Canada's Future," Canadian Manufacturers & Exporters, November 2023, https://cme-mec.ca/wp-content/uploads/2023/11/2023-CME-Report-Manufacturing-Canadas-Future_Final-2_web.pdf.

38 ISED, "Report from Canada's Economic Strategy Tables: Advanced Manufacturing" Government of Canada, 2018, https://ised-isde.canada.ca/site/economic-strategy-tables/en/report-2018/report-canadas-economic-strategy-tables-advanced-manufacturing.

39 Statistics Canada, "Survey of Advanced Technology, 2022," The Daily, July 28, 2023, https://www150.statcan.gc.ca/n1/daily-quotidien/230728/dq230728b-eng.htm.

40 "Table 1: Advanced Technology Adoption Rates by Surveyed Industry, 2014," Statistics Canada, January 7, 2016, https://www150.statcan.gc.ca/n1/daily-quotidien/151211/t001b-eng.htm.

41 CME reports that Canada lags other industrialized countries when it comes to business investment, digitalization, and the adoption of advanced manufacturing technologies. Canada also suffers from relatively low rates of business research and development spending, commercialization, and intellectual property generation. Investment is needed to increase operational efficiency and flexibility, reduce production costs, and improve environmental performance. See Alan Arcand, "Manufacturing Canada's Future," Canadian Manufacturers & Exporters (CM&E), November 2023, 17, https://cme-mec.ca/wp-content/uploads/2023/11/2023-CME-Report-Manufacturing-Canadas-Future_Final-2_web.pdf.

AGRI-FOOD TECHNOLOGY

In 2023, Canada's agriculture and agri-food system employed 2.3 million people and produced approximately 7% of Canada's GDP.[42] The agri-food sector comprises primary agriculture, food and beverage processing, services, and retail and wholesale. Technology enhances each of these sub-industries by making food production safer, sustainable, innovative, and more efficient (e.g., through the development of new food sources or production methods).[43] In 2022, the adoption rate of advanced technologies in the agriculture, forestry, fishing, and hunting sector reached 61.1%.[44] In 2023, Canadian agri-food technology attracted investments of USD $5.4 billion, ranking ninth globally for agri-food technology investment.[45]

In 2018, representatives of the Canadian agri-food sector identified several obstacles their industry needed to overcome to grow effectively and digitalize as planned, including a lack of reliable broadband in rural and remote areas that was limiting food producers' ability to adopt new technologies.[46]

While internet connectivity in rural Canada has improved in recent years, a significant gap in speed and affordability still exists for many communities.[47] Interviewees noted that farmers and producers are often risk-averse when it comes to adopting new technologies and highlighted the need for programming that supports not only startups but also farmers and producers willing to collaborate to deploy new technologies.

Furthermore, a skills gap exists in agriculture. In a 2021 ICTC survey of food producers, about 30% indicated a shortage of skilled labour as a barrier to technology adoption.[48] A subject matter expert remarked that the agricultural workforce is typically "non-technical… very smart people, technical in their areas, but not in tools like AI." The expert added that the sector requires salespeople who can explain "how technology can help growers."

Read more from ICTC

Canadian Agri-Food Technology: Sowing the Seeds of Tomorrow

ICTC's *Canadian Agri-Food Technology: Sowing the Seeds for Tomorrow* report highlights digital adoption as central to strengthening Canada's agri-food sector, showing how precision agriculture, controlled environment systems, advanced food processing, and data-driven technologies can help producers navigate labour shortages, food security pressures, and global competition. The report finds that while many older technologies see high uptake, emergent digital tools often face slower adoption due to barriers such as equipment costs, limited rural connectivity, low perceived return on investment, interoperability challenges, and talent gaps, underscoring the need for targeted strategies to accelerate on-farm and supply chain technology use. It also identifies a growing demand for digital talent — from software developers and data scientists to machine learning experts — and emphasizes that expanding digital adoption across the entire agri-food ecosystem is essential to improve efficiency, sustainability, and Canada's competitive position in global food markets.



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45 AgFunder, "Global AgriFoodTech Investment Report 2024," AgFunder, 2024, https://research.agfunder.com/agfunder-global-agrifoodtech-investment-report-2024-1.pdf.

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HEALTH AND LIFE SCIENCES

In 2021, there were approximately two million healthcare workers in Canada, predominantly employed by the public sector.[49] The private health and life sciences sector includes pharmaceutical companies, medical technology firms, and digital health solutions — employing more than 220,000 individuals across 2,000 life sciences firms across Canada.[50,51] Health and life sciences organizations are rapidly digitizing and adopting new technologies, partly driven by the onset of COVID-19. For instance, by 2021, 94% of Canadian physicians were using virtual care,[52] and in 2022, 62% of healthcare-related enterprises reported advancements in technology adoption.[53] AI tools, such as scribes for clinician notes and precision medicine analysis solutions, are swiftly transforming how healthcare is delivered in Canada.[54]

Health and life sciences companies encounter multiple barriers to scaling, including the regulatory complexities of healthcare procurement across Canada's provinces and health authorities. Additionally, while digital adoption has the potential to enhance healthcare efficiency, healthcare workers are often understaffed and overworked, which makes effective adoption and digital skills training slow processes.[55] To ensure that Canada's health and life sciences sector can address labour shortages and provide high-quality care, organizations across the country are working to improve data interoperability,[56] incorporate digital skills training into medical education, and balance health-data privacy concerns with innovative procurement practices.[57]

Read more from ICTC

Digital Transformation: The Next Big Leap in Healthcare

ICTC's *Digital Transformation: The Next Big Leap in Healthcare* report examines how accelerated digital adoption is reshaping Canada's healthcare ecosystem and enabling more accessible, efficient, and value-driven care. The study highlights key technology-enabled trends — from telehealth and virtual care uptake during the pandemic to the integration of electronic health records, wearables, and emerging analytics like big data and machine learning — and emphasizes that adopting these digital tools can help mitigate cost pressures, expand access in rural and remote areas, and support innovative care models. It identifies adoption gaps and barriers in the Canadian context, including regulatory complexity, culture and capacity challenges, and uneven implementation across regions, and underscores the need for interdisciplinary talent and responsive frameworks to ensure technology adoption translates into better patient outcomes and a robust, digitally-enabled health system.



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CLEAN TECHNOLOGY

Clean technology "refers to any process, product, or service that reduces environmental impacts." In 2021, nearly 190,000 Canadians were employed in the cleantech sector, and clean technology contributed $34 billion to the Canadian GDP.[59] In 2022, 33.4% of Canadian businesses reported adopting some form of clean technology, most commonly in waste management, reduction, or recycling (26.9%) or in air or environmental protection or remediation efforts (10.8%).[60]

Rapid advancements in digital innovation within clean technologies have created new markets, industries and companies related to clean technology.[61] However, cleantech organizations report challenges in raising capital and finding employees with the right skills.[62] As digital technologies converge with novel environmental solutions, "digital-green skills" are emerging.[63] Examples of roles requiring these skills include those that tackle activities like greenhouse gas accounting, environmental consulting, green IT adoption, sustainable software engineering, clean and renewable energy production and management, retrofitting the built environment, and advancing sustainable design and clean transportation.[64]

The digital economy is responsible for a growing share of emissions,[65] and industry leaders in this study emphasized the need for ICT companies to seriously consider their emissions. They suggested regulations such as mandatory disclosure. One interviewee said, "Climate change is not going to disappear… We know that new generations and the workforce are going to be more sensitive to that, [and] customers as well. We need to get ready for that regulation and those consumer and workforce trends and adapt as businesses." The ICT sector will encounter increasing climate change regulations due to the expansion of environmental, social, and governance reporting, and Canada must continue to support clean technology innovation. These will be critical in enabling companies to derive insights, optimize processes, and monitor their environmental impacts.

Read more from ICTC

Advancing Environmentally Sustainable ICT in Canada

ICTC's *Advancing Environmentally Sustainable ICT in Canada* policy brief highlights the critical role that responsible digital adoption plays in enabling clean technology innovation while minimizing the environmental footprint of ICT itself. As cleantech solutions increasingly rely on digital tools — from data-driven energy management and smart infrastructure to advanced monitoring and automation — the brief emphasizes the importance of integrating sustainability considerations across the full ICT lifecycle, including procurement, deployment, energy use, and end-of-life management. It identifies gaps in awareness, skills, and standards that can slow the adoption of environmentally sustainable digital technologies, and calls for coordinated action by industry and policymakers to embed sustainable ICT practices into innovation strategies. By aligning digital adoption with environmental performance, the brief underscores how cleantech can leverage digital technologies to scale solutions, reduce emissions, and accelerate Canada's transition to a low-carbon economy.



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RESOURCES OF THE FUTURE

In 2022, Canada's natural resources sector employed approximately 1.7 million people, both directly and indirectly, producing about 19.2% of the Canadian nominal GDP (which refers to the GDP before adjustments for inflation).[66] In light of climate change, urbanization, and global development, among other challenges, resources of the future must be cleaner and more efficient.

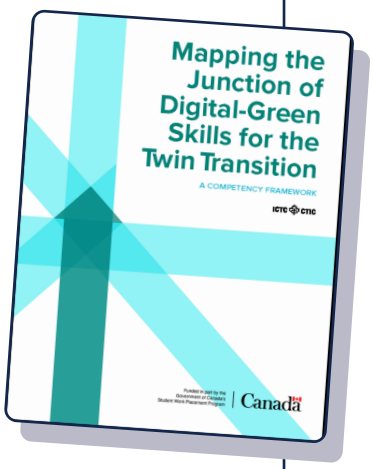
Digitalization and sustainability are often referred to as the "twin transition," necessary for reducing emissions and the impacts of economic growth.[67] Canada is greening its energy trade and pursuing international agreements to supply clean hydrogen and electric vehicles to global partners.[68] Consequently, the Government of Canada released its Canadian Critical Minerals Strategy in December 2022. The strategy sets out a plan for Canada to become a global supplier of choice for responsibly sourced, critical minerals that are essential for clean and digital technologies.[69]

In 2022, 87% of Canada's total energy production originated from emission-intensive industries, including crude oil, natural gas liquids, and feedstocks (52%); natural gas (31%); and coal, peat, and oil shale (5%).[70] While renewable energy production has been gradually increasing (from 904 petajoules in 1971 to 2121 petajoules in 2022), its share of Canada's overall energy production has declined (from 14% to 9% over the same period).[71] Although more than half (55.3%) of companies in mining, quarrying, and oil and gas extraction report adopting advanced technologies to improve efficiency or sustainability, this sector had the lowest adoption rate in 2022.[72] Interviewees indicated that more work is needed in Canada to transition the natural resource economy to one that is well-prepared to address climate change and zero-emission targets. An economic subject matter expert stated, "the country needs to reverse the trend away from fossil fuels and conventional energy. I think there will be quite a big talent need in that area."

Read more from ICTC

Mapping the Junction of Digital-Green Skills: A Competency Framework

ICTC's *Mapping the Junction of Digital-Green Skills for the Twin Transition* competency framework frames digital adoption as a critical enabler of Canada's clean and sustainable economy, outlining the competencies workers and organizations need to effectively implement digital technologies in support of environmental goals. Using a national digital-green competency framework, the report identifies how tools such as data analytics, digital monitoring systems, and emerging technologies are being applied across clean tech, manufacturing, construction, and public administration to improve efficiency, reduce emissions, and support sustainable production. It highlights the importance of transferable skills — including digital literacy, data interpretation, and climate awareness — to ensure that digital adoption translates into measurable environmental and economic outcomes, and provides a practical foundation for aligning workforce development, training, and policy with Canada's twin digital and green transitions.



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DIGITAL INDUSTRIES

Digital industries typically experience higher rates of advanced technology adoption compared to other sectors. ICTC's Digital Economy Employer Survey (2024) compared business trends in the digital economy with those of the Canadian economy through a questionnaire modelled after Statistics Canada's Canadian Survey on Business Conditions (see Appendix A for additional details). Both surveys asked respondents whether they planned to use AI tools over the next 12 months: respondents to ICTC's Digital Economy Employer Survey were significantly more inclined to do so (55.9% versus 17.6% in the general economy—see Figure 4).

Furthermore, in Statistics Canada's 2022 Survey of Advanced Technology, three of every four professional, scientific, and technical service enterprises had adopted an advanced technology.[73] The digital economy significantly contributes to the Canadian GDP and employs a large proportion of Canadians.[74] Digital adoption is one crucial element driving value in this sector.

Plans to Adopt AI: Digital Economy Versus General Economy

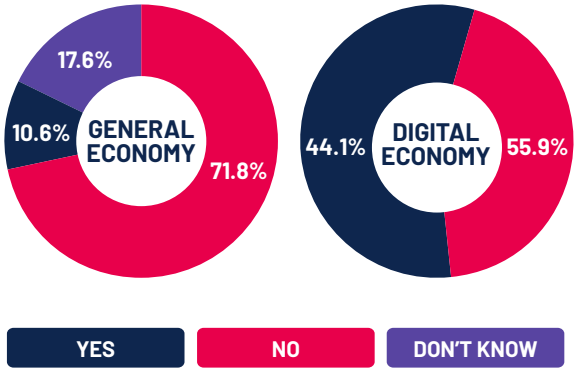


Figure 4: Plans to Adopt AI: Digital Economy Versus General Economy. "Over the next 12 months, does this business or organization plan to use artificial intelligence (AI) in producing goods or delivering services?" Data Source: ICTC's Digital Economy Employer Survey and Statistics Canada's Canadian Survey on Business Conditions, 2024.

Read more from ICTC

Digital Economy Pulse: Productivity and Employment Trends in Canada

ICTC's *Digital Economy Pulse: Productivity and Employment Trends in Canada* underscores how the adoption and integration of digital technologies continue to drive growth, productivity, and competitiveness in Canada's digital industries. The report finds that employment in Canada's digital economy has grown faster than the rest of the economy, with digital adoption linked to stronger revenue performance and optimism among firms, and that productivity in the ICT sector remains significantly above the national average — illustrating the value of technology-enabled transformation. It also highlights persistent demand for specialized digital talent, including software engineers, data scientists, and cybersecurity specialists, reflecting how deeper technology adoption across sectors fuels labour market shifts and innovation opportunities. By showing that digital transformation is both broadening job opportunities beyond the traditional ICT sector and strengthening core digital industries, the briefing positions accelerated digital adoption as essential to sustaining Canada's economic momentum and global competitiveness.



73 Ibid.

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DIGITAL ADOPTION AND CANADA'S ECONOMIC OUTLOOK

Canada has demonstrated economic resilience in the face of global challenges. However, major obstacles remain to secure long-term growth and global competitiveness.

While immigration and digital adoption have helped drive economic expansion, issues like weak labour productivity, low business investment, difficulties commercializing innovation, and challenges in retaining IP continue to hold Canada back.

Cultivating a local environment that facilitates and encourages businesses to integrate emerging technologies (such as AI, big data analytics, IoT technologies, and cloud computing) will be vital for boosting both productivity and efficiency across industries. Canada must address the barriers preventing this and bridge the gaps through enhanced innovation, increased capital investment, and stronger workforce development initiatives.

Investing in Canada's digital talent pipeline through employment support, upskilling, and targeted work placements is essential for building a future-ready workforce. Expanding work placements for youth and newcomers to support digital transformation projects in SMEs will provide emerging talent with practical, work-integrated experience while helping small businesses accelerate technology adoption and innovation.

APPENDIX A: RESEARCH METHODS AND TOOLS

ICTC employs a mixed-methods approach to collect and analyze both primary and secondary research. Its key research tools are listed below.

Literature Review and Secondary Data

The secondary research component of this study focused on analyzing existing data and literature. This included qualitative reviews of the sectors under consideration as well as reviews of key events occurring in the global and Canadian economies from 2022 onward. This research also relied heavily on secondary data obtained from other organizations, including Statistics Canada, the Bank of Canada, and the OECD. Publicly available growth forecasts for the Canadian and other major economies (produced by the OECD, IMF, Canadian banks, and others) informed our economic models and forecasts. Analyzing the aforementioned datasets was useful for tracking macroeconomic and labour market trends, monitoring supply trends, and analyzing business growth in innovative areas.

Digital Economy Employer Survey

In summer 2024, ICTC conducted a survey via the market research vendor Leger. The survey targeted technology companies and businesses that employ technology talent, aiming to gain insight into their current business conditions, expectations, labour challenges, and the skills and competencies they seek in new hires. Through this research, ICTC also sought information about the strategies respondents implemented to address labour gaps. The survey was designed based on Statistics Canada's Canadian Survey on Business Conditions, enabling a meaningful comparison of metrics between the general economy and digital economy when the Statistics Canada dataset was used as a control group and responses from the digital economy survey as a treatment group. Insights from the survey informed assumptions about the digital economy's outlook relative to the general economy, which subsequently aided in generating employment forecasts.

Representatives from 406 companies completed the survey. All respondents were senior executives with significant influence on key decisions related to hiring and business strategy. These included founders, executives, and managers with oversight of operations, finance, or human resources (HR). The survey was targeted at digital businesses across Canada, which were screened for eligibility based on whether they employ technology professionals or produce, design, manufacture, or sell technology.

Limitations: Overall, the quality of survey responses was very high, with most respondents completing all questions. However, low response rates in certain regions and sectors remain a limitation. While the survey received 406 responses, there were no participants from Nunavut or the Yukon. Additionally, several questions included in the survey pertained to workforce challenges and skills, but are absent from the Statistics Canada business conditions survey. This intentional misalignment in question sets was carried out because ICTC has a primary interest in workforce development issues and seeks tailored insights from technology companies and organizations that hire technology talent. However, this approach also has the drawback of limiting comparability with the results from Statistics Canada's business conditions survey.

Key Informant Interviews

From July 2024 to October 2024, ICTC conducted 26 semi-structured key informant interviews with a mix of subject matter experts and large employers from industries across Canada. A diverse group of participants and organizations were chosen to ensure a wide range of perspectives and input for the report. The interviewed organizations varied in size, location, business maturity level, revenue, and employment needs. ICTC aimed to identify trends in the digital economy while seeking context for developments in digital adoption, investment, hiring and workforce needs, talent availability, in-demand roles and skills, as well as challenges, opportunities, and weaknesses.

Limitations: ICTC aimed to engage a sample of participants who could address hiring and adoption trends across the economy. However, due to the vast number of sectors undergoing digitalization, representation from industries outside of technology was limited.

Advisory Committee

A project advisory committee was established to guide this study and assess and validate the results. The advisory committee consisted of 12 members from industry, industry associations, government, and academia, all with connections to the digital economy and/or innovation areas covered in this study. The committee convened three times throughout the duration of this study. The committee was consulted during the production of this report to discuss the digital economy labour market, its talent needs, and the level of adoption of emerging technologies in the Canadian digital economy.

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