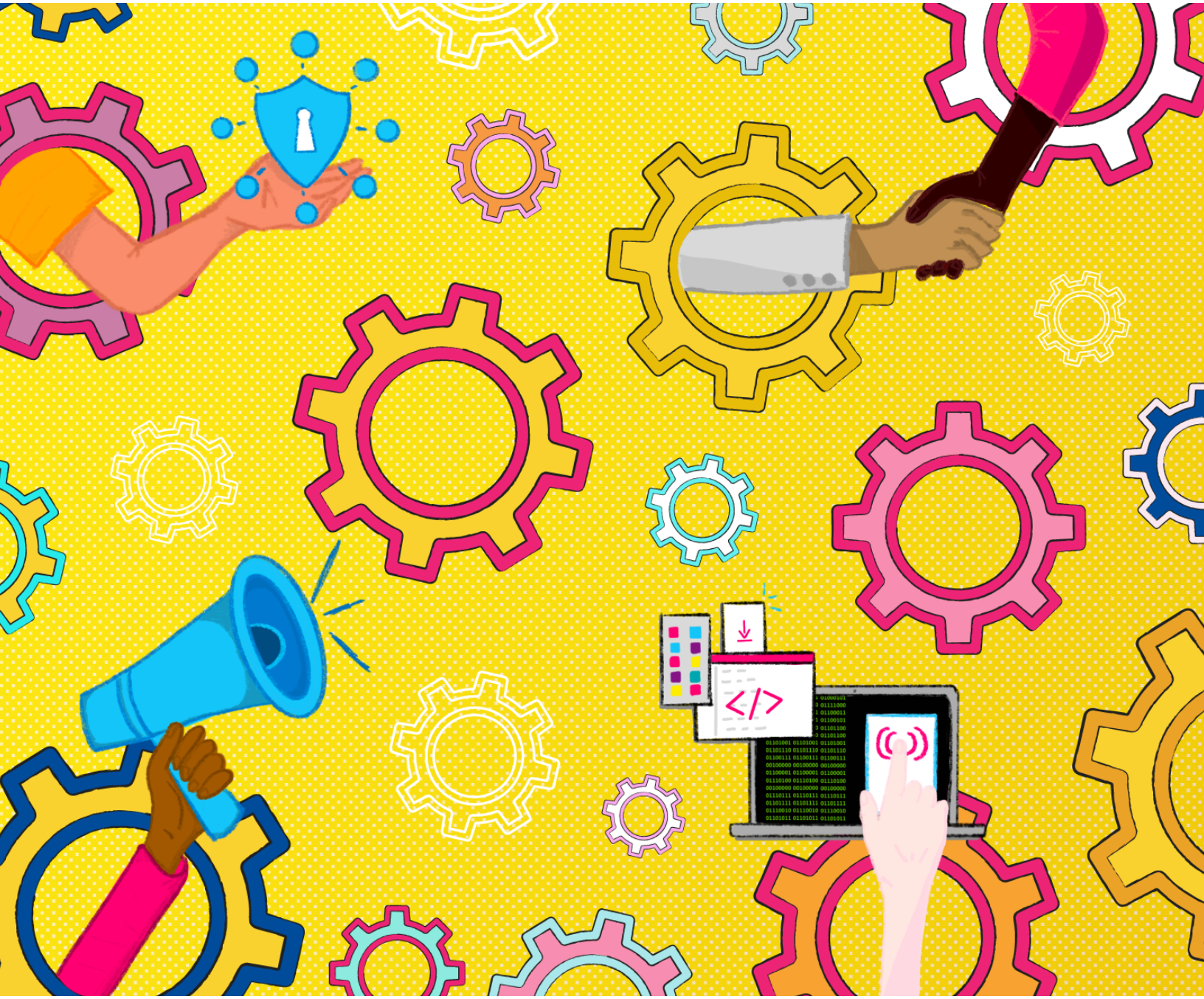
The Skills Algorithm:

Digital Skills Demand Across Canada's Labour Market

Vivian Li, Mahmehr Hamza, Tiffany Kwok | November 2023



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How to Cite this Report
Li, V., Kwok, T., Hamza, M. *The Skills Algorithm: Digital Skills Demand Across Canada's Labour Market*. The Dais, 2023.
https://dais.ca

Graph data in this report can be found at:
https://github.com/thedaisTMU/the-skills-algorithm

ISBN 978-1-77417-077-9

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This work is funded by:

Future Skills Centre | Centre des Compétences futures | Canada

The Future Skills Centre (FSC) is a forward-thinking centre for research and collaboration dedicated to driving innovation in skills development so that everyone in Canada can be prepared for the future of work. We are funded by the Government of Canada's Future Skills Program.

The Skills Algorithm: Digital Skills Demand Across Canada's Labour Market is part of the portfolio of work by the Future Skills Centre, which is funded by the Government of Canada's Future Skills Program.

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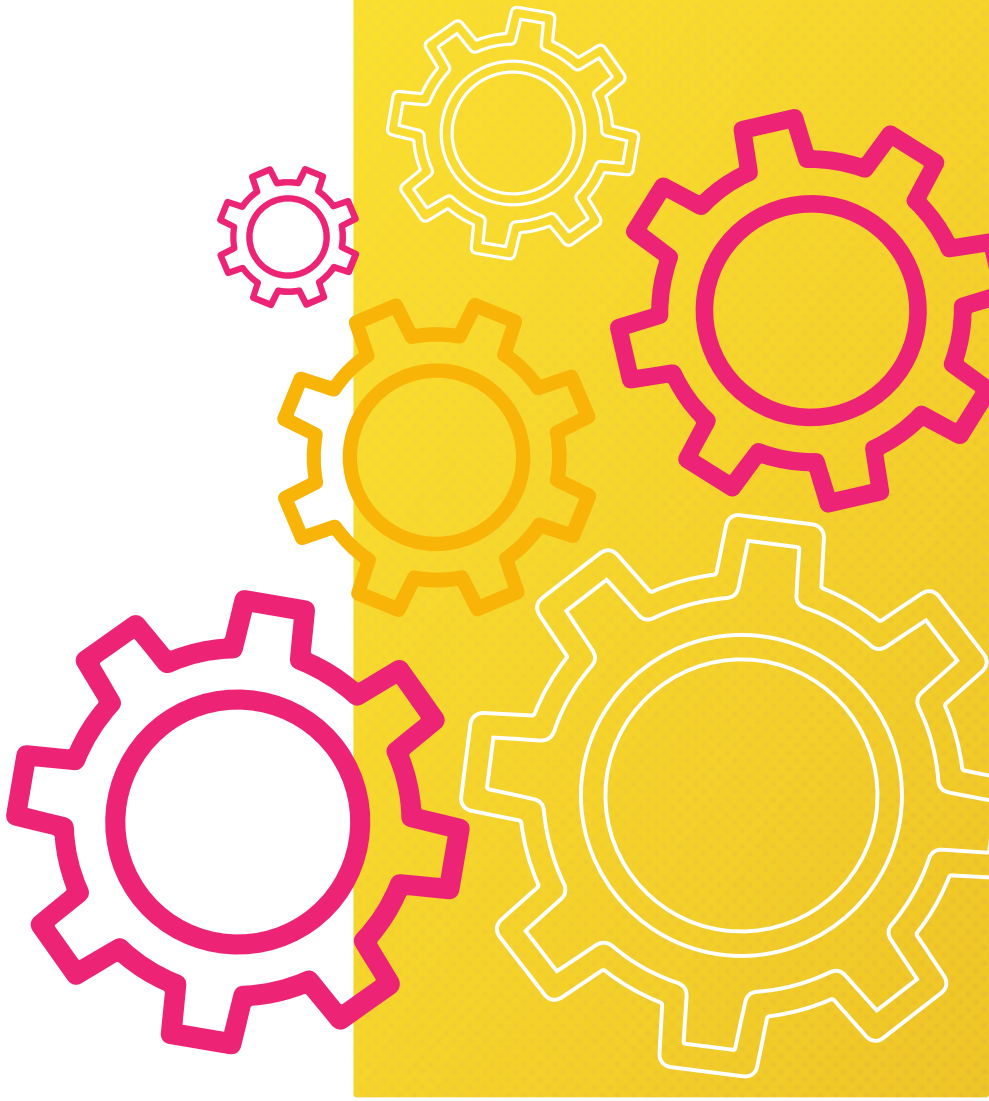
Acknowledgments
Vicinity Jobs



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Foreword from the Future Skills Centre

What does it mean to navigate work in the digital era? As Canada emerges from the pandemic – a period marked by a rapid surge in digital technologies use – the need for an adept workforce comes into sharper focus. This report, "The Skills Algorithm", builds on previous research to provide an important update to the role of digital skills in the Canadian labour market. It offers insights into how our skill requirements have shifted throughout and beyond the pandemic.

By analyzing job postings collected from across Canada between 2020 to 2023, we see that the most in-demand digital skills continue to be for general workforce tasks – low-intensity digital skills that are relevant regardless of sector or industry. It also shows that employers are still seeking hybrid (digital and non-digital) skills, most often general workforce digital skills paired with non-technical skills like teamwork, communication, and time management.

Alongside these broader trends, we continue to see a strong demand for advanced digital skills, especially in the Information and Communication Technology (ICT) fields. High-level digital competencies, such as coding languages C++ and SQL, are highly sought after and will continue to be important going forward.

To meet the changing needs of the labour market, higher education and training programs must also adapt just as swiftly. The report reiterates the importance of a hybrid approach to skills development. While digital skills are rising in popularity, employers are looking for a balance of skill sets that incorporate digital and social-emotional competencies.

The findings laid out in this report call for governments, industries, and education and training partners to establish a continuum of programs to cultivate skills development, from low-intensity to advanced digital skills, and alongside widely applicable non-technical skills. Fostering a skills ecosystem with this range of programming will ensure future learners and workers benefit.

Tricia Williams
Director, Research, Evaluation and Knowledge Mobilization
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Executive Summary

During the COVID-19 pandemic, the use of digital skills and platforms enabled a major shift towards remote work. This rapid change required many industries and workers to adapt to new technological tools and concepts even as digitization had been trending upward before the pandemic. How did workers and employers adapt to shifts in demand for digital skills? And what was the impact on the demand for non-digital skills, such as leadership and problem-solving, across Canada's labour market?

Using data from nine million job postings collected, Canada-wide, from January 2020 to June 2023, this report looks at the evolution of skills during the pandemic, including the emergence of new digital skills trends, and the interaction of different types of skills, and compares these findings with the findings in our previous report, I, Human (2019).[1]

In 2023, a total of 4,964 unique skills appeared across the job postings that were examined, with 2,198 (44 percent) identified as digital skills. A community clustering algorithm was used to organize these skills into six overall clusters (High-tech, Business and management, General office, Communication and interaction, Trades, and Sales and merchandising), based on their co-occurrence with other skills in job postings. Each of the six clusters contained both digital and non-digital skills.

Looking specifically at digital skills, five sub-clusters emerged—three of which were present in the 2019 analysis—summarized in order of digital intensity:

1. **Software/Product Development and Data skills** (e.g., SQL, Java, Python and C++)

2. **Cybersecurity and System Infrastructure skills** (e.g., managing security systems)

3. **Industrial Modelling and Geospatial Software skills** (e.g., computer-aided 3D design tools)

4. **Design and Marketing skills** (e.g., Adobe Photoshop, Google Analytics)

5. **Workforce digital skills** (e.g., Microsoft Office Suite software; enterprise resource planning tools such as SAP and Oracle)

Key Findings:

In analyzing these skills clusters, with a focus on the digital sub-clusters, we found that:

- **There was not a significant overall change in digital skills demand during the pandemic.** The proportion of digital skills listed by employers in job postings actually fell slightly. There was growth in demand for new general workforce digital skills, such as video conferencing platforms. Higher digital intensity skills typical of tech sector workers saw less change in demand. There was also growth in demand for non-digital health, safety, and environmental skills such as the use of protective gear and first aid.

- **The most in-demand digital skills were for general workforce tasks.** Consistent with 2019, the most common digital skill is Microsoft Office Suite (Excel, Word, Access) by a vast margin, in over 20 percent of job postings.

- **Demand for artificial intelligence skills is growing, though still remains a relatively small part of overall skills demand.** The proportion of job postings requiring AI skills grew from approximately 0.6% in early 2023 to 1.7% in September 2023. Other digital skills with significant growth in job posting occurrences included e-charting software in health care, and general workforce skills associated with remote work.

- **Employers are seeking hybrid (digital and non-digital) skills.** Reinforcing the findings of the 2019 study, this analysis revealed the complementarity of digital and non-digital skills. A number of these hybrid skills — teamwork, communication, interpersonal and leadership skills — are transversal and commonly in demand across all or most of the digital skills sub-clusters, though they vary depending on the specific occupational profile.

Policy Recommendations:

These findings suggest perceptions of the pandemic's dramatic acceleration of digital skills demand may have been overblown, and further reinforce evidence that Canadian businesses and organizations have been slow to adopt new technologies. This type of skills-based analysis should also be helpful in revealing digital skills gaps in Canada's labour market, and the education and skills training needs that post-secondary and workforce development systems should be seeking to fill.

The report identifies five key areas for action:

- **Large employers and industry intermediaries should incorporate this type of skills demand analysis into their workforce planning.**

- **Governments should use skills demand analysis to inform education and skills policymaking and the design of skills development funding programs.**

- **Education and training providers should adopt agile approaches when creating programs and curricula to reflect changing skills demands.**

- **Education and training providers, as well as government funders, should use skills demand analysis to focus resources on upskilling for the most in-demand skills.**

- **Canadian policy researchers, educational institutions, and skills partners should conduct further analysis on the links between higher education programming, employer skills demand, and job outcomes.**

Introduction

While digitization of the economy and technological adoption by all manner of organizations have been long-term transformational trends, the COVID-19 pandemic prompted a major acceleration for large segments of the labour force. Workers rapidly shifted to remote arrangements, spending their days on digital video-conferencing platforms like Zoom and Microsoft Teams for meetings, and collaboration tools such as Slack and Trello for planning and managing tasks. With 43 percent of organizations reporting that the pandemic would drive business transformation in the digital space, this placed an increasing onus on workers to possess increasing levels of digital literacy and skills for all workplaces.[2] At the same time, for professionals in technology-oriented occupations, the advancement of technologies such as artificial intelligence drives a similar need for more digitally-intensive skills.

As the pandemic subsides and many in-person activities resume, it is an important moment to assess how the demand for digital skills in Canada's economy has changed, and whether the pandemic-era digitization trends are persisting. This report assesses three questions to understand the nature of digital skills and the trajectory in which they continue to grow: In what ways has the digital skills profile of the average worker changed during the pandemic? Which prominent new digital skills have emerged during this time? Which digital skills have and are likely to continue to remain prevalent?

This report is a follow-up to *I, Human*, a 2019 report by the Brookfield Institute for Innovation and Entrepreneurship (BII+E)[3] that assessed the landscape for digital skills in Canada. It applies similar machine-learning methods to classify skills into clusters to analyze the nature of digital skills over the course of the pandemic, and to identify trends in digital skills that have emerged since the original *I, Human*. In addition, we analyze the interaction between digital and non-digital skills (known as "hybrid skills"), providing insight on the importance of non-technical or soft skills even in digital workplaces and occupations. The report concludes with implications for various stakeholders (government, academia, and workforce development agencies) to provide support for workers to adapt to the evolving landscape of digital skills.

Literature Review

To contextualize the analysis in the report, this section reviews how digital skills are defined, labour market trends for digital skills demand, and relevant government policy and industry initiatives to upskill and prepare workers for the changing skills landscape. We then focus specifically on the evolution of digital skills, and in particular, how the pandemic might have impacted the need for workers to be well-versed in digital technology.

What is a digital skill?

There is a consensus within existing literature that variations exist within digital skills. Work by Huynh and Malli[4] conceptualized digital literacy and skills as a three-layered model:

1. widely applicable baseline digital skills
2. workforce digital skills for specific occupations
3. professional digital skills used in developing digital technologies, products, and services

This layered understanding of digital literacy is shared across jurisdictions. In Canada, Employment and Social Development Canada (ESDC) does not reference the three layers of digital skills specifically, but adapts from O*NET, a US skills taxonomy, in identifying them under "technical" or "analytical" skills categories. The National Skills Commission in Australia does separate skills into buckets (based on digital intensity): baseline digital skills, specific digital skills, and cutting-edge skills.[5] Others do so using different terminologies. For example, the International Telecommunications Union (ITU) distinguishes between three levels of digital skills as basic (foundational skills such as using a keyboard and sending emails), intermediate (using technologies to create content or evaluate technology), and advanced (using these skills for jobs in the IT sector or for tasks such as data analysis).

A study by the UK government and consultancy Ecorys organizes digital skills by their application, categorizing digital skills as belonging to one of three groups: basic digital literacy skill for everyday use (applicable for all people whether they are working or not), a digital skill for the general workforce (a minimum requirement of digital literacy for workers across all sectors to process information), or a digital skill for ICT professions (linked to the development of new digital technologies, and new products and services).[6] Another study by the Brookfield Institute, called Who are Canada's Tech Workers? adapted O*NET to the Canadian context to quantify the digital intensity of occupations. These skills, knowledge, and work activities include interaction with computers, computers and electronics programming, and telecommunications.[7]

Recap of *I, Human* (2019)

In the Brookfield Institute's 2019 report *I, Human*,[8] a rich taxonomy of skills was derived from job postings data, where digital skills were defined as a combination of skills that showed up consistently and uniquely in highly digital occupations, and skills which were defined as software skills. Next, a network analysis defined four digital clusters that tended to appear together. In order of digital intensity, the four clusters developed were Software and Product Development, System Infrastructure, Data Infrastructure, and Workforce Digital Skills. Workforce Digital Skills are the least digitally intensive, but are found to be the most prevalent across the labour market, with almost a third of Canadian job postings requiring them. This includes skills such as Microsoft Office Suite, enterprise resource planning, and project management software.[9] Other digital skills clusters such as System Infrastructure Skills and Software/Product Development Skills are higher in digital intensity, whereas the Data Skills cluster had a clear sub-cluster structure that had connections to the other three clusters, as a bridge between skills with relatively lower and higher digital intensity.

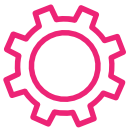
Broad digital skills trends in the labour market

Pandemic-accelerated digitization

As the COVID-19 pandemic began, operational disruptions were felt by organizations across industries, as workers adjusted to work-from-home settings and explored virtual work options. Many occupations that could be conducted virtually leveraged digital technologies to operate during the pandemic. As a result, video conferencing platforms like Zoom and Microsoft Teams experienced a significant surge in adoption, with Teams' daily active users growing from 20 million in 2019 to 270 million in 2022.[10] Other frequently used tools included remote desktop software (e.g., Chrome Remote and Apple Remote Desktop), business messaging apps such as Slack, and project management platforms such as Monday.com.

The implementation of remote work settings varied across sectors and occupations. In the health care sector for example, telehealth was widely adopted. This involved the use of digital information and communication technologies such as live video conferencing and messaging software and electronic health records (EHR) software to access health care services remotely and manage medical records. The use of telehealth came with skills-gap-related challenges, as telehealth diagnostics require both the practitioner and the patient to learn new technologies. A study found that the implementation of EHR enabled rapid deployment of standardized processes, which proved crucial in supporting clinical needs during the pandemic.[11]

Transitioning into the post-pandemic era, the option of remote work has remained for some employers, while others have transitioned to hybrid arrangements requiring employees to work in-person a few days a week or mandating full-time return to the office.[12] [13] In 2022, the degree of remote work in Canada varies across industries. Whereas the majority of workers in the Professional services or Information industries are able to work remotely (hybrid or full-time), it is estimated that 36% of workers across all industries have the ability to work remotely (full-time or hybrid).[14] As a result, companies increased accommodations for remote work where employees can take advantage of a digital workspace that allows them to generate ideas and collaborate with team members.



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Growing demand for digital skills

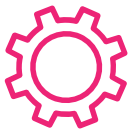
Various international studies forecast growing demand for certain types of highly technical digital jobs. For instance, the World Economic Forum predicts big data analytics, environmental management technologies (as a response to climate change), and encryption and cybersecurity to have the greatest impact on job growth in the next five years.[15] In particular, specialized roles in artificial intelligence (AI) and big data, such as data analysts, scientists, and engineers, and business intelligence analysts are estimated to grow by 30 to 35 percent in the next five years. Their survey of global businesses on the top reskilling focus areas from 2023 to 2027 found the top technology skills identified as AI and big data, Technological literacy, and Design and user experience. Coupled with top cognitive skills such as analytical and creative thinking, these skills are crucial for advanced technology roles that are projected to grow within the next five years.[16]

At the same time, employers perceive that digital skills requirements for the average worker are evolving. Through a series of skills surveys produced by the Business Council of Canada (BCC),[17] employers reported on what they believed the most in-demand skills would be in the next three years. In 2016, employers believed the most in-demand skills included skilled trades, leadership, management, and information technology. In comparison, employers' responses shifted significantly between the 2020 and 2022 surveys, with employers citing analytics, statistics, quantitative analysis, cognitive computing (including artificial intelligence and machine learning), computer science (including programming and software development), and cybersecurity as the most in-demand skills. Furthermore, a higher percentage of employers surveyed reported that post-secondary graduates did not possess the numeracy and technical skills that they need.

Hybrid and transversal skills

Other Canadian studies have examined the demand for hybrid skills, which include non-digital and soft skills such as communication, organizational, interpersonal, problem-solving, and critical thinking skills that complement technical skills.[18] Since the pandemic, the rapid development of new workplace technologies, combined with pandemic-accelerated change, has further raised the importance for workers to develop the hybrid skills necessary to remain flexible and agile to adjust to changing workplaces and evolving technologies.[19]

Hybrid skills are often considered to be transversal, meaning skills that are not unique to a single industry or occupational context. This could include skills such as teamwork, communication, and problem solving. A study by the Organisation for Economic Co-operation and Development (OECD) finds that transversal skills support worker resilience and job flexibility, acting as a buffer against shocks triggered by technological change, economic cycles, and unexpected events such as the pandemic.[20] In addition, certain transversal skills have been associated with positive earnings and employment outcomes. A study of the United Kingdom's online job vacancies data between 2015 and 2019 identifies the top 30 transversal skills, revealing a positive wage and employment return linked with skills such as project management, problem-solving, and people management.[21]

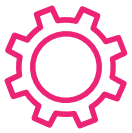


Specialized roles in artificial intelligence (AI) and big data, such as data analysts, scientists, and engineers, and business intelligence analysts are estimated to grow by 30 to 35 percent in the next five years.

Flexibility of digital skills

Digital skills play an important role across the labour market, even for occupations and sectors that are not inherently considered digitally-intensive. The Canadian Information and Communications Technology Council (ICTC) predicts that the number of tech workers outside the tech sector will surpass the number of workers within it.[22]

As digitization grows across the economy, digital skills have also been associated with positive wage and employment impacts. In one study, highly-used, lower-intensity office-based digital skills such as Oracle E-Business Suite applications and Microsoft tools are associated with around 10 percent increase in wages.[23] Conversely, in more digitally-intensive work environments, information processing skills such as literacy, numeracy, and problem-solving skills have also been correlated with a lower likelihood of unemployment.[24]



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Upskilling the workforce

Federal initiatives for upskilling

The federal government has made budget allocations toward skills development for workers. Notable skills development programs funded by the federal government include the Digital Skills for Youth program[25] and the Skills and Partnership Fund, which specifically provides skills training for Indigenous peoples.[26] [27] Programs have focused on different sectors and demographics, including students and youth, newcomers, people with disabilities, Indigenous communities, foreign workers, and women.

Green digital skills are often required for activities such as tracking and optimizing energy and cooling systems, measuring impacts of green technologies, and identifying energy efficiencies within systems and infrastructure. The Government of Canada is planning to establish a Sustainable Jobs Partnership Council to identify skills demand and provide services to support upskilling. Furthermore, the creation of a Sustainable Jobs Training Centre through ESDC is part of a $250 million investment to help workers upgrade or gain new skills, with a specific focus on advancing the federal government's net-zero goals.[28]

Private investment into upskilling

Businesses play a significant role in directly providing upskilling for workers. One initiative to support skills training is work-integrated learning (WIL), a form of experiential learning for students that combines academic studies with workplace experience by providing practical learning opportunities on the job while applying skills developed through their education. Other training options include microcredentials, digital training programs, and partnerships with post-secondary institutions.

However, there are barriers that keep employers from fully adopting upskilling programs. Among some of the barriers cited include a lack of data on what skills are in demand, costs of developing training programs, and difficulty finding appropriate partners to deliver the programs.

Methodology

Job postings data

For our main analysis of skills clusters (and digital sub-clusters), we used job postings data collected by Vicinity Jobs (a big data labour market information company). Job postings data are essentially online advertisements placed by employers (or third-party entities on behalf of employers) seeking candidates who identify themselves as a good fit for an open position in the employer's organization. Vicinity Jobs collected job postings from a variety of online sources, including regional, provincial, and municipal sites. Job postings data was retrieved from sources such as the Government of Canada's Job Bank, large national aggregators such as Indeed, and directly from corporate websites, and government sites such as kwcareers.ca (for jobs in Kitchener-Waterloo) and workBC.ca (operated by the British Columbia government). French language postings are also included, with information on skills and occupation type standardized in English.

Specifically, this study analyzes a total of 10,012,857 job postings that appeared between January 1, 2020 and June 14, 2023. As some job postings did not have the level of information available to extract skills data or granular work requirements, Vicinity Jobs was able to extract skills data for around 9 million of the job postings from this period. When conducting the analysis of digital skills pre-pandemic, we analyzed an additional 2.8 million job postings in 2019.

In addition to skills, each job posting contains the following information:[29] [30]

- Job title and five-digit National Occupational Classification (NOC) code,[31] which assigns each job posting to a standardized Statistics Canada classification of occupations
- Geography, which includes city, district and province
- Employer name
- Date of job posting
- Remuneration at an hourly or annual rate
- North American Industry Classification System (NAICS) code[32]
- Skill level outlining the education level required for this occupation. Categories include:
  - University degree (bachelor's degree, master's degree, or doctorate)
  - Management position (education requirements vary by job)
  - Post-secondary education or apprenticeship program (with the program length either less than two years or between two and three years)
  - Secondary school
  - No formal education requirements
- Certifications required

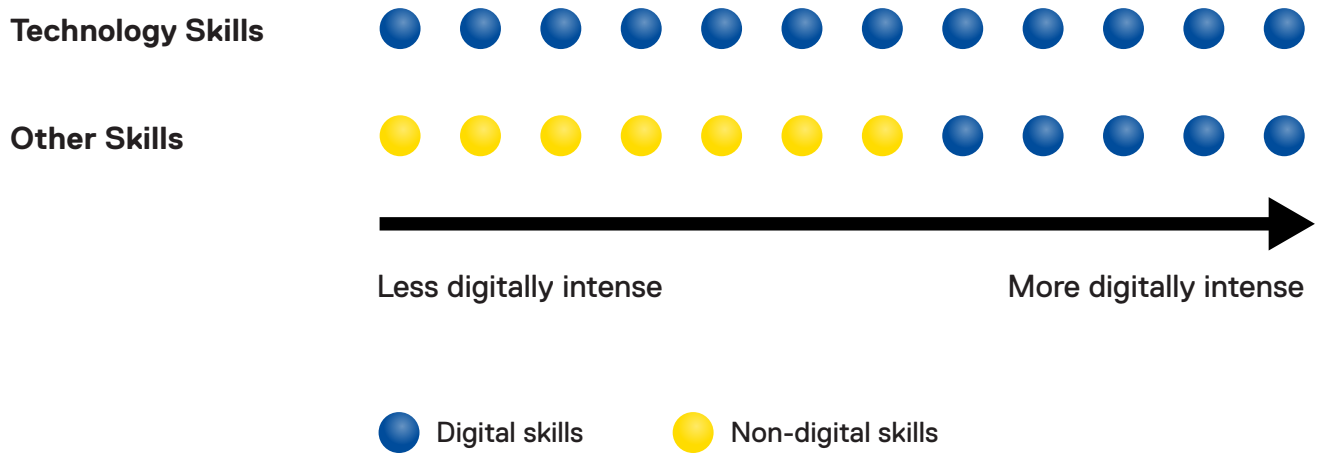
While these data are a very rich source for analysis, there were notable limitations. While job postings data provides some insight on skills demand on a temporal basis, it does not capture labour market trends as a whole. More information about job postings data and its strengths and limitations is included in Appendix A.

Digital skills identification and clustering

Vicinity Jobs categorizes raw textual data from job postings into a standardized list of skills. While there are over 30,000 skills in the Vicinity Jobs taxonomy, 4,964 unique skills across the nine million job postings were requested during this period. Within Vicinity Jobs' categorization, skills were separated into groups and sub-groups. The four groups include Technologies, Social-Emotional Skills, Occupational Skills, and Tools and Equipment. Another 167 sub-groups are provided to categorize skills, which outline more specifically the context in which these skills appear.

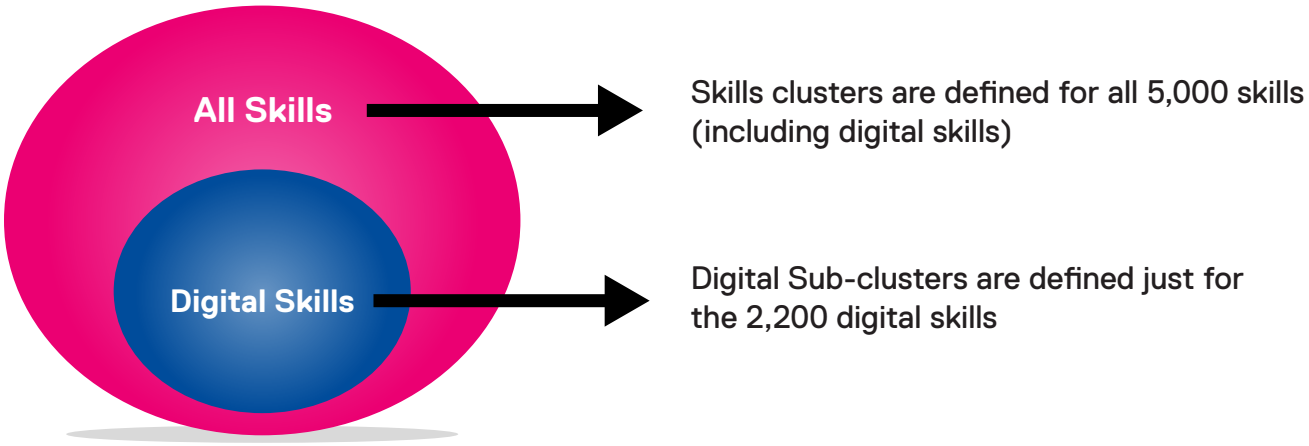
Our definition of digital skills in this study builds on Vicinity Jobs' grouping of technologies skills. We took a combination of steps to arrive at our definition. The first stage consisted of a manual assignment of digital skills from an intuitive assignment of digital skills based on existing Vicinity Jobs sub-categorizations. First, we categorized each skill under the broader Technologies grouping as a digital skill. Second, skills under the four sub-groups (which were external to the Technologies group), including Software and Web Development, Video Production and Computer Graphics, Information Technology and Telecommunications, and IT Infrastructure and Cybersecurity were categorized as digital. Third, with the remaining skills which were not in the Technologies group or sub-groups mentioned previously, skills which matched specific keywords were considered digital.[33] A total of 1,947 out of 4,964 skills were captured and identified as digital in this stage of the process.

Figure 1: Identification of digital skills

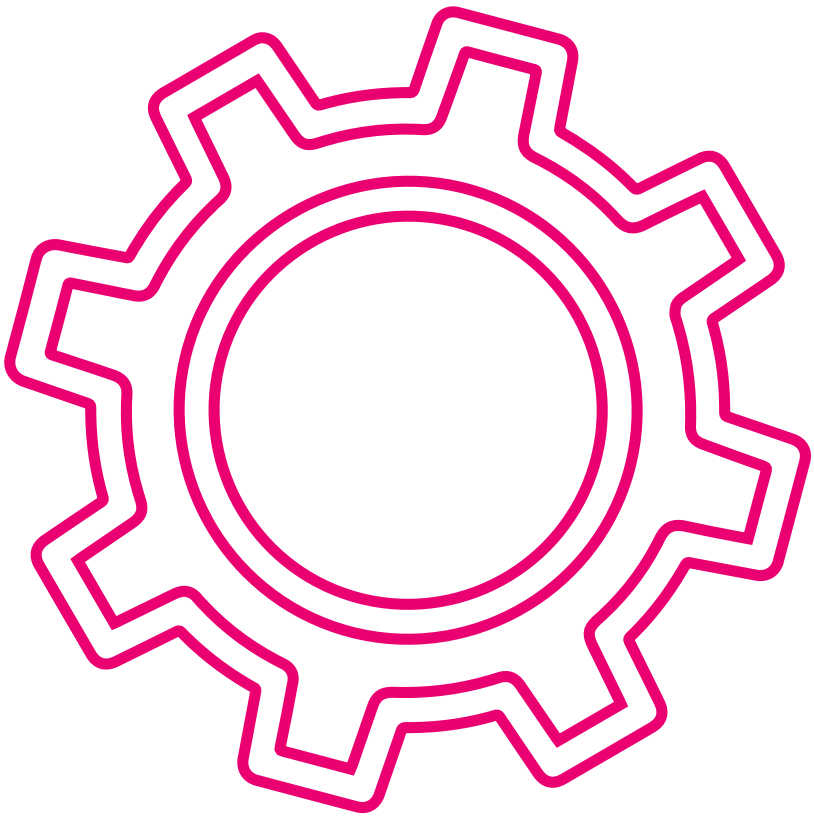


The second stage involved categorizing the remaining skills based on their digital intensity score. Using the definition of digital workers from Who are Canada's Tech Workers?[34] we assigned each job posting (and NOC code) with a digital-intensity score specific to each occupation associated with the job posting. This score is derived from each occupation's proficiency in the four digital skill areas: 1) interaction with computers, 2) computers and electronics, 3) programming, and 4) telecommunications. Next, a skill's digital intensity is assigned by averaging over the digital-intensity score of every job posting that contains the skill. Intuitively, a skill becomes more digital when it appears more frequently in job postings and occupations that are more intensely digital. Similar to *I, Human*, a logistic regression is constructed to understand the likelihood of each skill being digital based on its digital-intensity score. Remaining skills that meet a threshold being 75 percent or higher probability of being a digital skill were considered digital. Through this process, another 251 skills were categorized as digital, leaving us with a total of 2,198 / 4,964 skills.[35]

Figure 2: Digital skills in the context of all skills



Using machine learning, in particular a community clustering algorithm, skills were organized into six overall clusters. A community clustering algorithm creates communities such that skills that are in the same cluster tend to appear in the same job postings, while two skills in different clusters do not commonly appear together. Intuitively, two skills that show up together often tend to be classified by the algorithm as belonging to the same community. While digital skills appeared across all clusters, another five digital sub-clusters were identified when considering only digital skills. Different skills are grouped in different clusters and sub-clusters depending on their co-occurrence with other skills in job postings. For robustness, two community clustering algorithms were tested to generate the clusters and sub-clusters (the Louvain method and the fast greedy method), which generated similar results.[36] For the purposes of this report, we share the results of the Louvain method. In addition, 35 digital skills out of the 2,198 digital skills identified were not able to be categorized into a digital sub-cluster given the lack of interaction with other digital skills; though they are included in the overall clusters, they were not included in any digital sub-cluster.

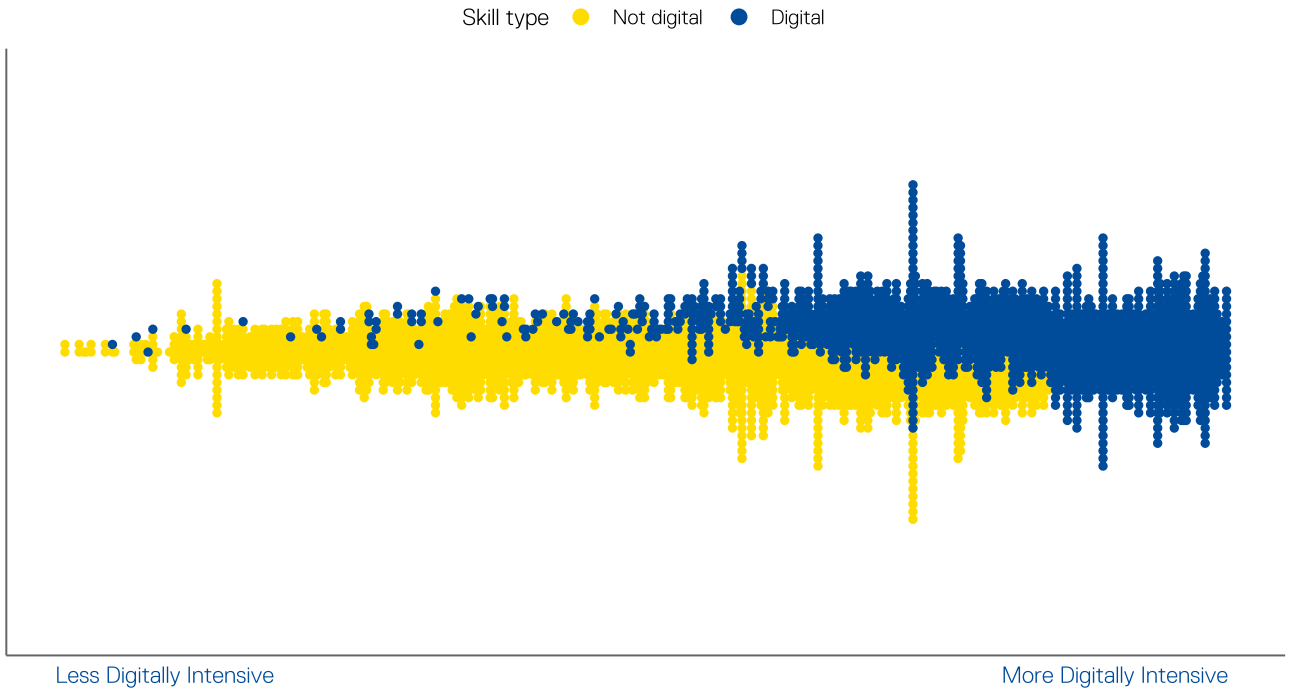


Analysis of Skills Clusters

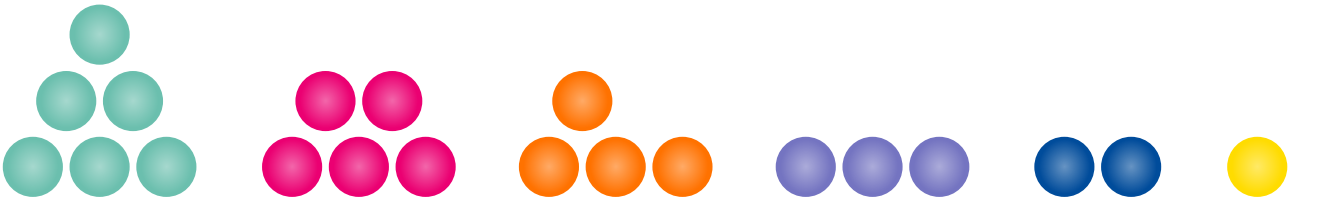
Using nine million job postings from Vicinity Jobs, the analysis revealed six distinct skills clusters across the 4,964 unique skills. Figure 3 shows these skills (digital and non-digital),[37] revealing the range in digital intensity from least to most (left to right). Each dot represents one skill, with blue dots representing digital skills and yellow dots representing non-digital skills.[38] The relative digital intensity of each cluster based on the digital intensity of skills (and jobs the skills appear in) was used to rank them accordingly. We included skills that are categorized as Technologies by Vicinity Jobs in our definition of digital skills, though that does not necessarily mean that all technologies have a high digital intensity. While most digital skills have a relatively higher digital-intensity score compared to the average skill, digital skills at the lower end of the spectrum in digital intensity tend to be less technical and are easier to learn. This includes hardware such as music-editing software, computer touch screens, digital scales, and barcode scanners.

Figure 3

All skills by digital intensity



The clusters identified include a mix of digital and non-digital skills. Some clusters have more digital skills than others, though the skills are less digitally intensive; conversely, other clusters have fewer digital skills that are more digitally intensive, as shown in Figure 4. Some specialized skills, such as medical skills, appeared throughout different clusters, instead of it appearing cogently in their own cluster. The six clusters, in order of highest to lowest digital intensity, are:



High-tech skills

Business and management skills

General office-based skills

Communication and interaction skills

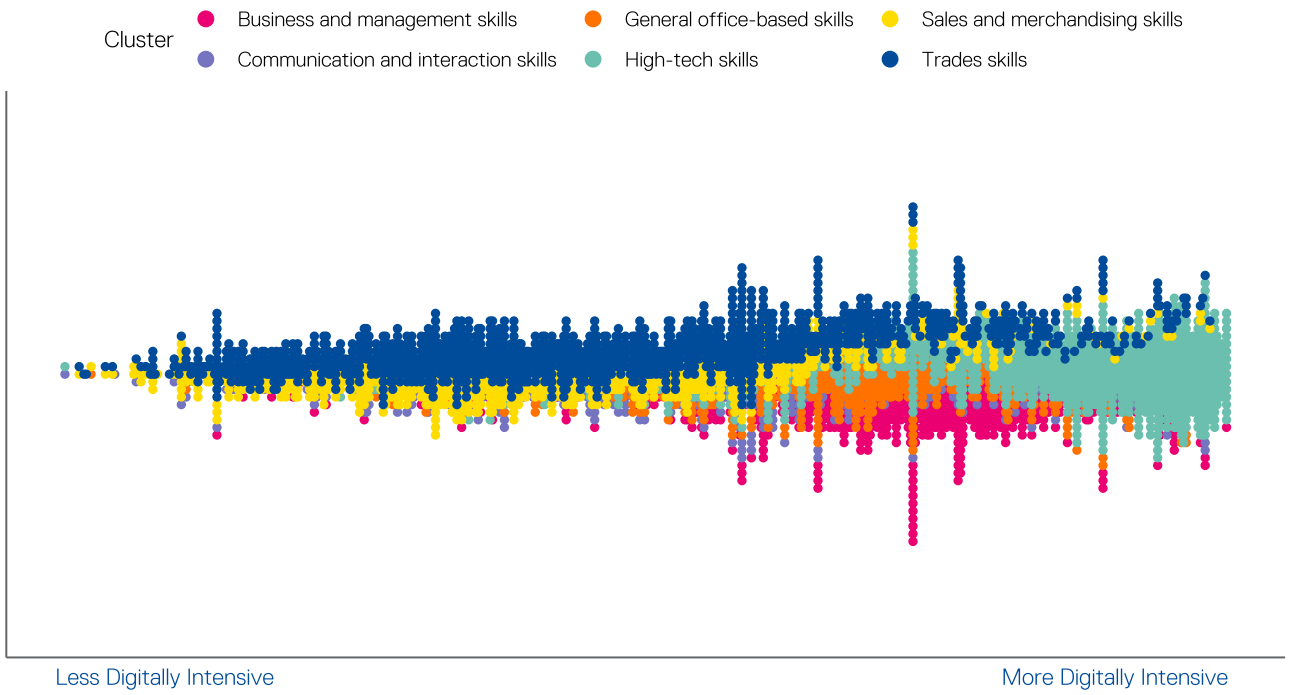
Trades skills

Sales and merchandising skills

Some key statistics on these clusters can be found in Appendix B.

Figure 4

Clusters by digital intensity



In addition to the six overall clusters identified, five digital sub-clusters were formed using digital skills that appeared across all clusters, as seen in Figure 5. In order of most to least digitally intensive, the five digital sub-clusters are:

1. **Software/product development and data skills**, which has a heavy concentration in the skills profiles of tech workers and industries (e.g., SQL, Apache, programming languages such as Java, Python, C++)

2. **Cybersecurity and system infrastructure skills**, which are used to manage security systems and maintain information technology systems (e.g., technical support, information systems)

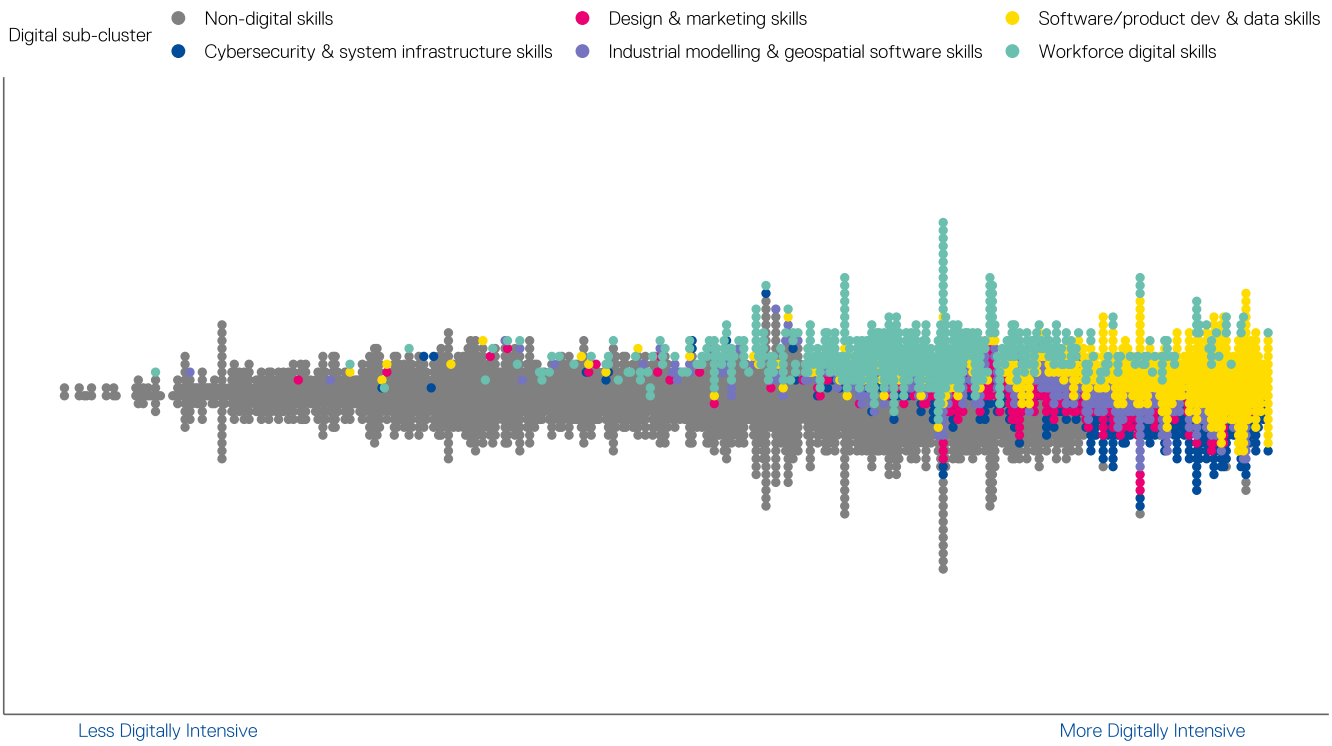
3. **Industrial modelling and geospatial software skills**, which are focused on the visualization of 3D spaces (e.g., computer-aided design (CAD) and AutoCAD)

4. **Design and marketing skills**, which are commonly used by designers and marketing professionals (e.g., Adobe Photoshop, Google Analytics)

5. **Workforce digital skills**, which are lower-digital-intensity skills used by workers across many contexts, occupations and industries (e.g., Microsoft Office suite, email software, enterprise resource planning software such as SAP and Oracle).

Figure 5

Digital sub-clusters by digital intensity



Though these digital sub-clusters feature in the overall clusters, more analysis on these sub-clusters are presented in the analysis of digital skills sub-clusters section.

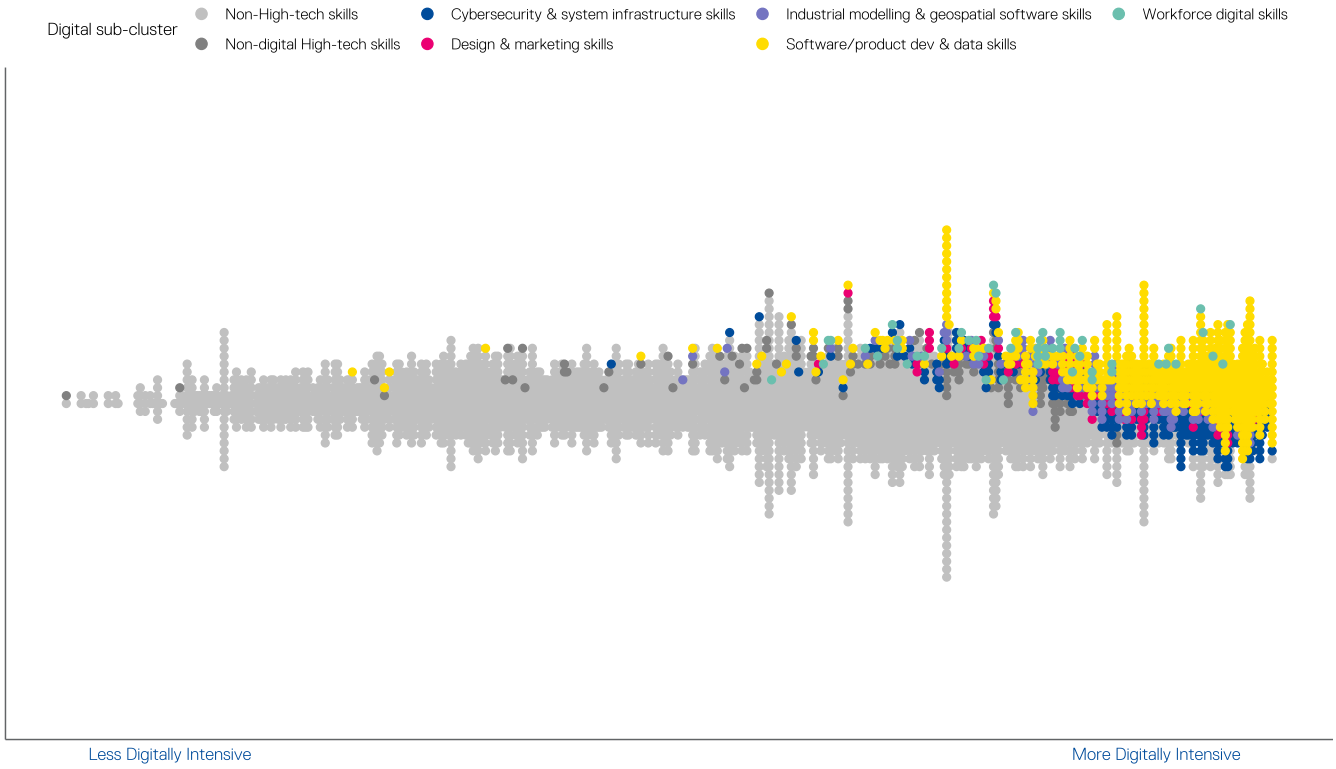
Cluster 1: High-tech skills

This cluster is the most digitally intensive relative to the other skills clusters. Not only does it have the highest digital-intensity score, it contains the greatest number of digital skills (with over a thousand digital skills, comprising 87 percent of the cluster's skills). We observe that this cluster primarily contains highly specialized digital skills used by high-tech workers for the creation of digital products and software, differentiated from the more general types of digital skills required of general office-based workers, as seen in Figure 6.

This cluster primarily contains highly specialized digital skills used by high-tech workers for the creation of digital products and software, differentiated from the more general types of digital skills required of general office-based workers.

Figure 6

Digital skills in the High-tech skills cluster



Programming languages such as Python and C++, as well as skills with cloud computing services such as Amazon Web Services (AWS) and Microsoft Azure are used in a wide set of technological industries and occupations, including highly digital jobs such as data scientists and web developers. Common uses of these programming languages include web and internet development, IT infrastructure, quantum computing, software development, database administration, artificial intelligence, and machine learning. The knowledge of these programming language skills helps create digital products or software that are used across multiple industries. For instance, the finance industry has upscaled its business operations and has seen massive digital transformation in the past couple of years. It has increasingly adopted cloud-based solutions to store, process, and analyze large amounts of data and to improve scalability and reduce costs.[39] Given industry-level data is available for job postings, there is potential for the analysis of the evolution of high-tech skills across industries, such as finance, to support program development or funding initiatives.

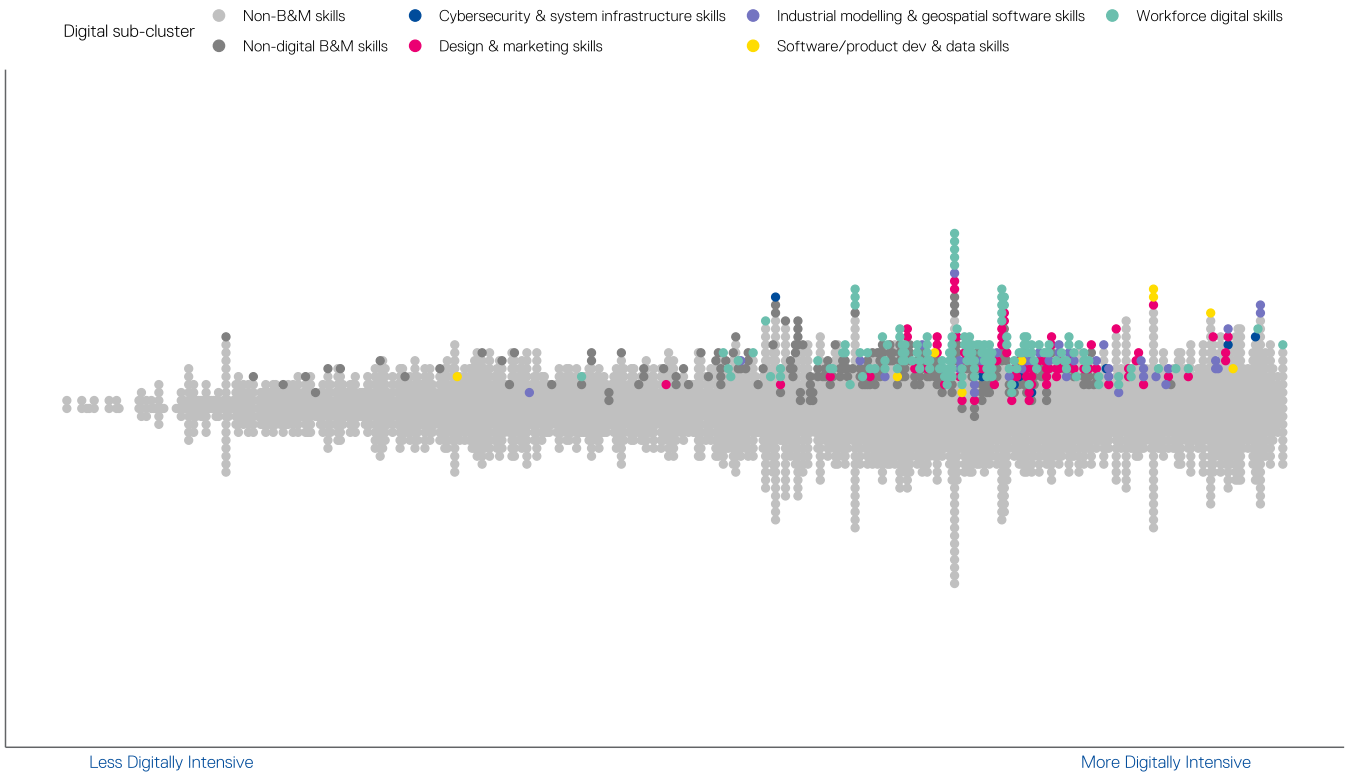
The inclusion of non-digital skills in this cluster alongside high digital intensity skills in this cluster reflect the occupational tasks of tech workers. For example, IT technicians may need skills in resolving technical problems arising in digital platforms and products, alongside knowledge of programming languages (e.g., Python and C++) in order to address any issues arising in the operability of products. Non-digital skills such as troubleshooting and quality assurance are technical forms of problem solving, often applied to repair the functions of products or digital processes on a machine or a system. Combinations of such skills could be in the profiles of software developers, quality assurance engineers, data scientists and machine learning engineers, employed across different industries and sectors.

Cluster 2: Business and Management skills

This cluster contains general workforce skills, typically geared towards jobs which require education credentials at a bachelor's degree or equivalent at minimum. With over half the skills classified as digital, it is the second-most digitally-intensive cluster. Key non-digital skills include transversal soft skills such as leadership, problem solving, analytical skills, and project management, which are among the most prevalent socio-emotional skills that are contained within this cluster. Digital skills in this cluster are moderately digitally intensive, and are generally in the Workforce Digital Skills sub-cluster, as seen in Figure 7. This includes analytics and enterprise resource planning software such as SAP and Oracle, as well as sales software in CRM and e-commerce platforms.

Figure 7

Digital skills in the Business and management (B&M) skills cluster



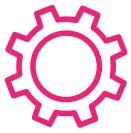
In the context of the pandemic, top skills in using online learning management tools such as Blackboard (including Blackboard Learn and Collaborate platforms to deliver and present content, this appears 2,236 times in job postings) and Moodle (appearing 4,129 times in job postings) were especially useful for teams in school, business and office settings. These tools often provided an alternative to in-person learning and collaboration during the pandemic, and have been used to supplement in-person activities during the recovery from the pandemic. Other tools like the enterprise resource planning (ERP) software and Salesforce software supported businesses during the pandemic, which led to a meteoric rise in e-commerce (that has since subsided).

In addition, there is a concentration of green skills, which could be leveraged for industries in environmental sustainability. This includes climate risk assessments, clean energy, environmental site assessments, and knowledge of renewable energies and a net-zero economy. This has links with tools and equipment that are relevant to a green transition, such as knowledge of electric vehicles, electrical microgrids, and meteorological equipment such as moisture analyzers and hygrometers. Jobs in the field of sustainable finance also rely on digital skills that support activities around the issuance of green bonds, impact investing, microfinance, and sustainable funds.

Some of the digital skills required in green occupations could include software such as ArcGIS (which supports mapping geographic information), programming languages such as Python and SQL, and computer-aided design (CAD) software. Examples of how digital skills could be leveraged include environmental engineers and scientists using CAD software to visualize environmental data, or by designers, architects, and engineers for site drawings, project plans, and equipment layouts to provide consultation on projects.[40] In addition, the rising popularity of environmental intelligence[41] will make use of software programs such as Envirosuite more commonplace, which uses monitoring systems and analytics to generate insights to pinpoint possible environmental disruptions through factors such as noise, water, air quality, odor, dust, and vibrations. Examples of entities that use this software could include airports, wastewater plants, landfills, construction sites, mining operations and cities.[42]

Cluster 3: General Office-based skills

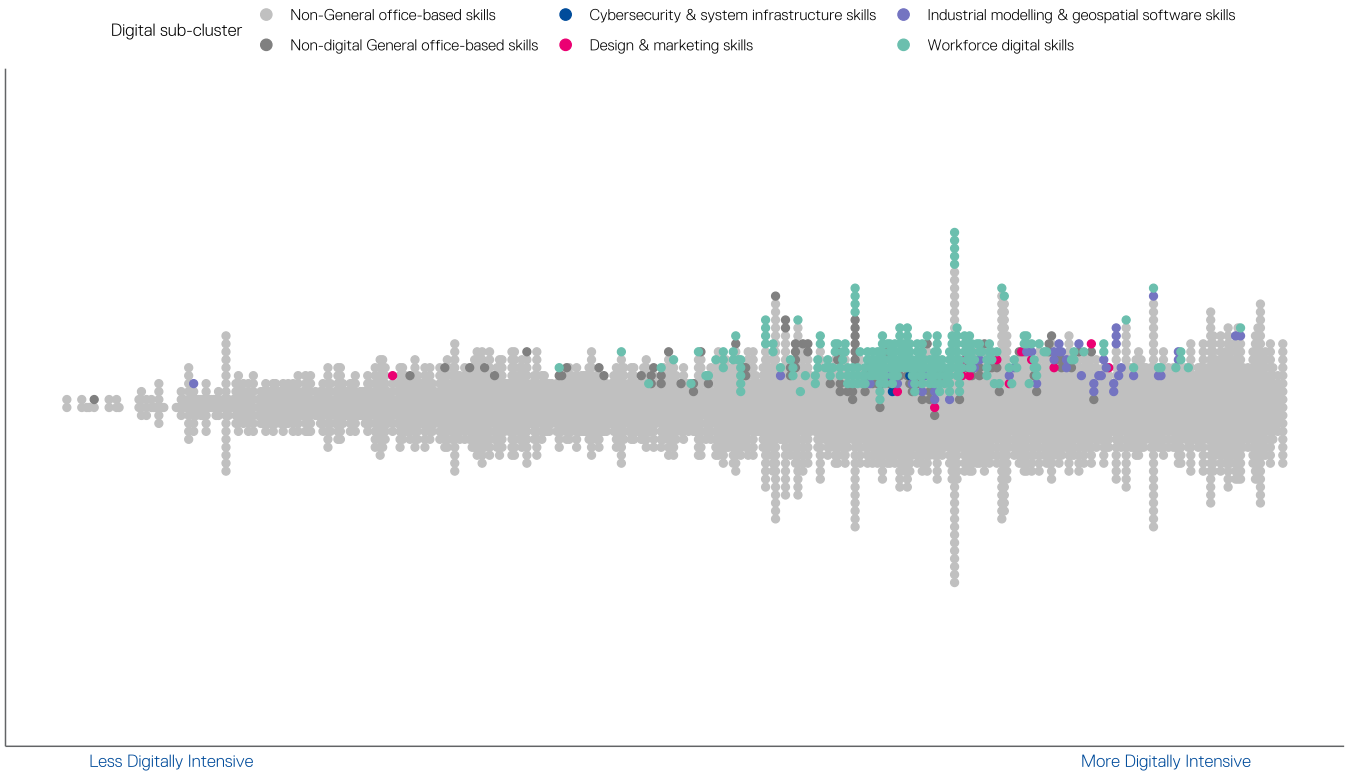
This cluster has a relatively high number of digital skills (76 percent of the skills in this cluster are digital), with Microsoft Suite tools (e.g., Office, Excel, PowerPoint, Outlook, Access), data entry, administration, and reporting tools being the most common. The digital skills highlighted in this cluster have relatively lower digital intensity, and thus tend to be correlated to non-digital workers and occupations. As seen in Figure 8, this cluster is the only one to not have any software/product development or data digital skills, despite being the third-most digitally-intensive cluster. These are often basic digital skills required in corporate roles such as accountants, human resources professionals, and analysts, all of which require some element of in-office work with computers, including for organizing workflows, project management, and keeping track of business operations. While there are some skills in this cluster are more specific to certain fields, they generally have wider applicability across different occupational contexts, which makes these skills a good fit in this cluster (e.g., AutoCAD is typically used for design, but can be used by architects, designers, and civil engineers).



The digital skills highlighted in this cluster have relatively lower digital intensity, and thus tend to be correlated to non-digital workers and occupations.

Figure 8

Digital skills in the General office-based skills cluster



More skills are transversal, applying across the General Office-based cluster and Communication and Interaction Skills cluster (presented next) with a lower concentration in specific industries and occupations. Whereas skills in other clusters such as Business and Management or High-tech Skills are generally used by specific types of workers in specific industries (e.g., a project manager at a bank might use Salesforce, a full-stack developer at a tech start-up might use Python), transversal language or office skills may be necessary in a number of contexts which does not necessarily depend on a worker's occupational task or an industry's output. Common non-digital skills in this cluster include proofreading and meeting minute-taking skills that support administrative and accounting roles. These non-digital skills in this cluster complement digital skills such as Microsoft Suite applications including Excel, Word and OneNote, which are useful for tasks such as data entry, maintaining a general ledger, information filing, and financial reporting.

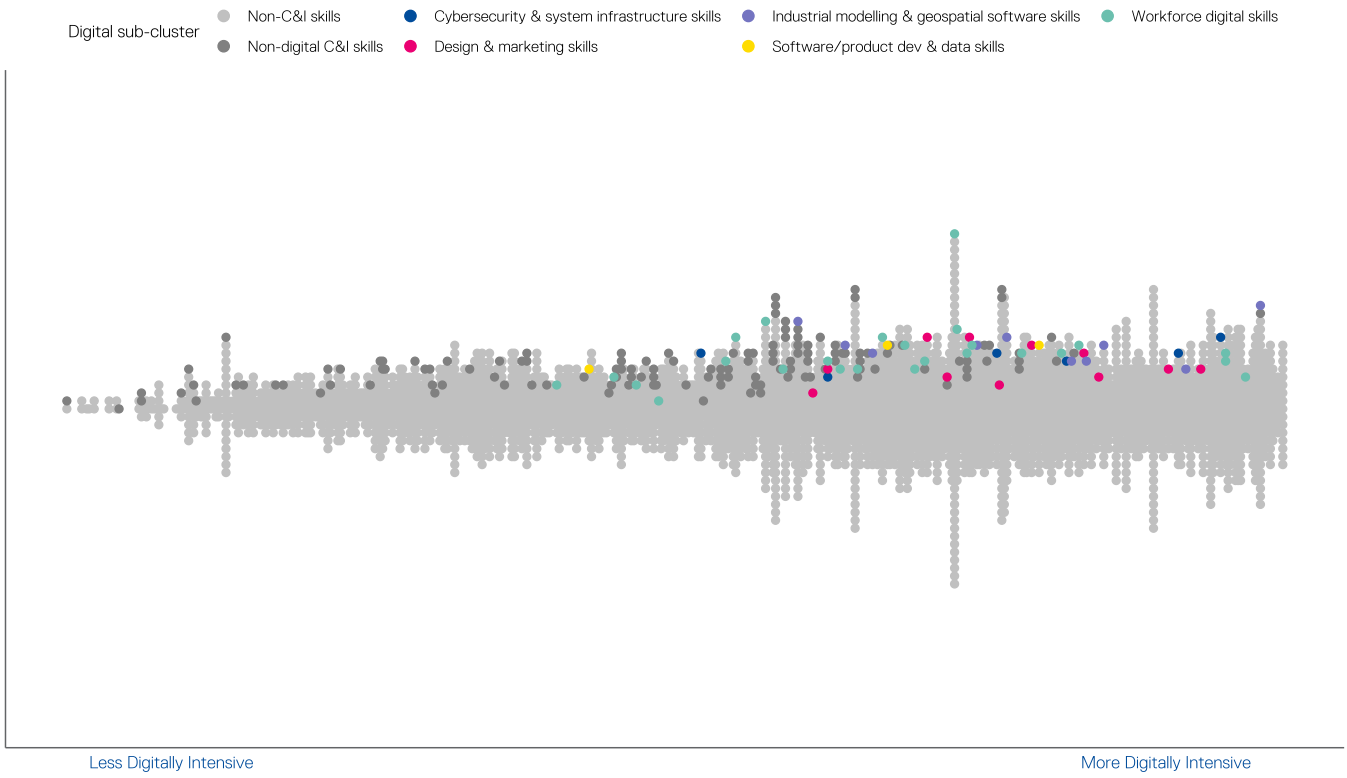
Video conferencing software is prevalent in this cluster. Aptitude in platforms such as Google Meet, Microsoft Teams and Zoom became highly in-demand over the course of the pandemic as it was the default method of communication between teams in corporate and office-based roles. Between 2019 and 2021,[43] growth in job postings containing this skill has more than doubled (a 109 percent increase), with an average annual growth rate of close to 45 percent. In fields such as health care, the ability to conduct virtual consultations were instrumental to curtail the spread of COVID-19.

Cluster 4: Communication and Interaction skills

This cluster includes the lowest number of digital skills, and generally does not contain many digitally-intensive technologies or skills, as seen in Figure 9. A combination of spoken and sign language skills (which are non-digital) are the most common, and includes other auditory communications. Skills in this cluster complement one another in their need for fluency in different languages to communicate with and interpret results. Many digital skills that show up in this cluster tend to be ones that relate to collaboration, such as the WhatsApp chat platform, and Oracle Beehive (an enterprise collaboration software). These skills also tend to have lower-intensity digital skills that appear in this cluster, including WhatsApp.

Figure 9

Digital skills in the Communication and interaction (C&I) skills cluster



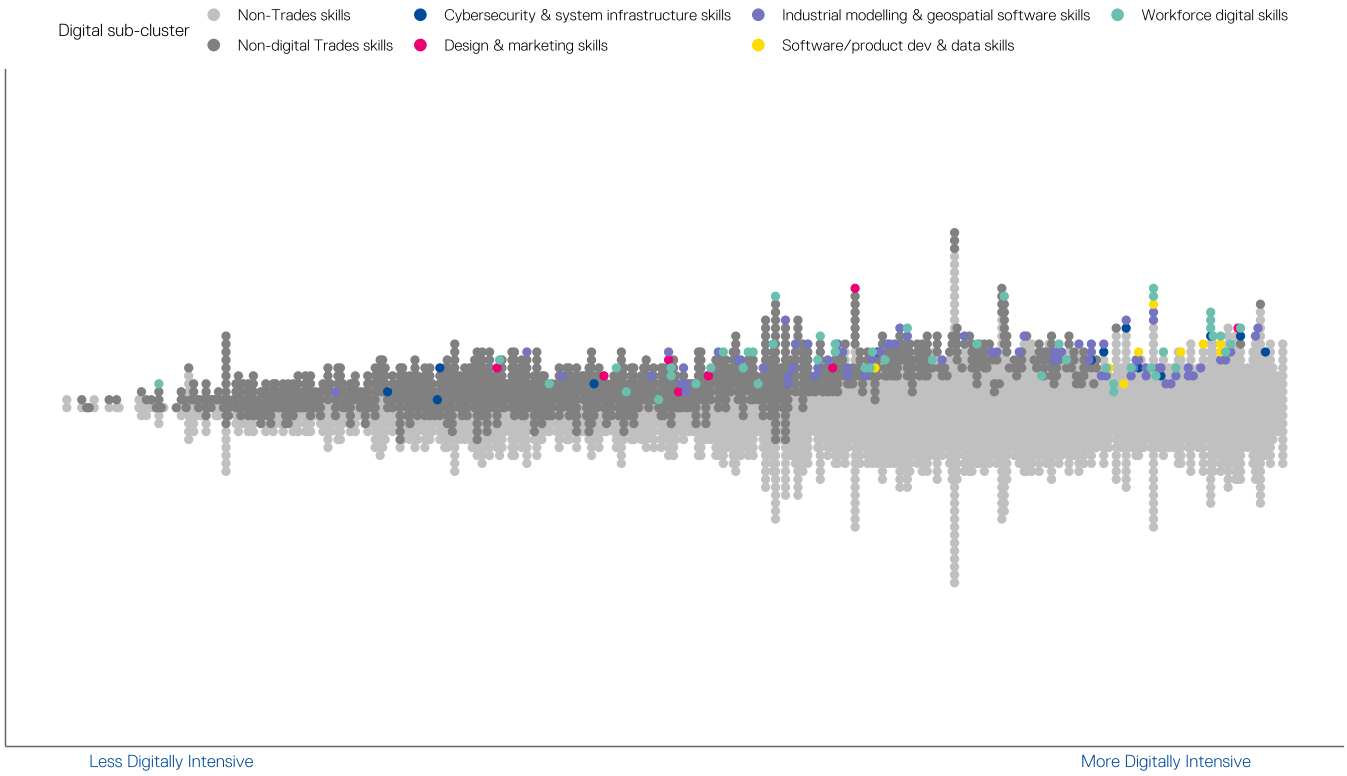
Other digital skills in this cluster are concentrated around software for 3D modeling (Computer-Aided Three-Dimensional Interactive Application, or CATIA), photo imaging (IRIS), sound editing (Audacity) and taxation (Intuit TurboTax). These skills have applications in client-facing tasks for architects, media, marketing, and financial services industry professionals. The ability for workers who are able to communicate with clients who speak different languages would have been vital in conducting business across sectors, especially during the pandemic as access to readily accessible translators may have been hindered by work setting restrictions. Digital tools like WhatsApp were also beneficial in maintaining client communications during the pandemic.

Cluster 5: Trades skills

Though this cluster covers the largest number of skills overall, it also has the highest share of non-digital skills, as seen in Figure 10. They are typically for the skilled trades, of which there are more than 300 defined trades in Canada encompassing sectors such as construction, transportation, manufacturing and industrial, services, and information and digital technology.[44] The skills required are largely hands-on and technical expertise for tasks such as maintenance, manufacturing, construction, mechanical and electrical repairs, plumbing, and installation of machinery.[45] Most of these trades require the knowledge to use machinery and electronic tools such as power tools, HVAC, and welding, which are categorized as non-digital skills.

Figure 10

Digital skills in the Trades skills cluster



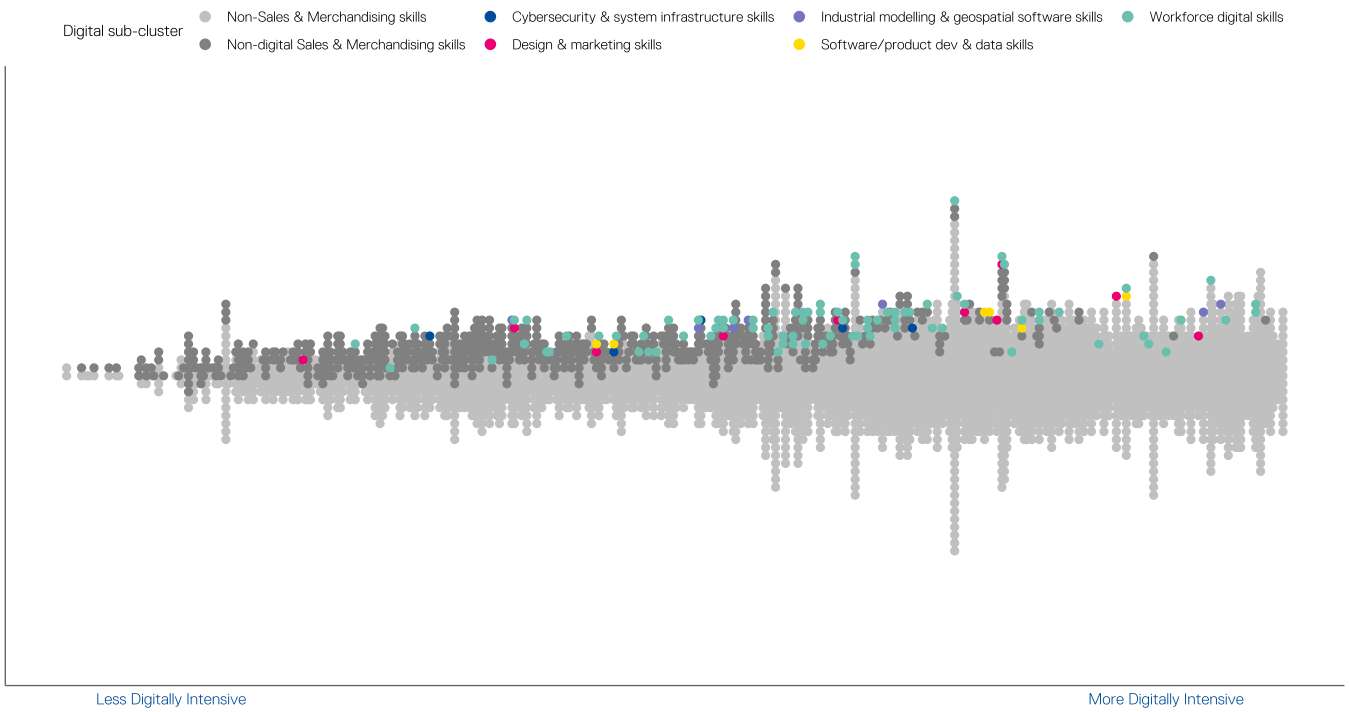
The top five digital skills in this cluster all fall under tools and equipment or analytical/scientific and program testing software, including using channel banks to organize telecommunications lines, hydroelectric generating units, OMICRON Test Universe software (which supports the testing and monitoring of energy meters, voltage regulators, and other electrical devices), Rockwell RSLogix software (otherwise known as Studio 5000 Logix, which is used to design and maintain hardware systems), and radon monitors. Roles that may commonly use these top digital skills include operational and maintenance technicians in hydroelectric power plants, the telecommunications industry, and power quality technicians. These digital skills enable workers to operate technologies and tools that will supplement the accuracy and efficiency of their critical infrastructure maintenance processes.

Cluster 6: Sales and Merchandising skills

This cluster has a high concentration of non-digital skills which tend to be used by workers in hands-on and physical in-person industries such as sales, service, and manufacturing. The digital skills present in the cluster are often focused on tasks such as inventory management, planning and logistics, and resource and facilities management of an enterprise. The most prominent digital skill in this cluster is the use of point of sale (POS) systems. This software is commonly used in e-commerce, retail industries and restaurants to track their merchandising, inventory and sales. Shopify is an example of an e-commerce company that offers POS software to process and enable in-person sales. These digital skills co-exist with non-digital transversal soft skills, like teamwork, communication skills, and customer service, reflecting that skills within this cluster are used mostly in client-facing roles such as cashiers, restaurant and resort workers, and warehouse workers.

Figure 11

Digital skills in the Sales and merchandising skills cluster



Relative to other clusters, the mix of skills in this cluster are low in digital intensity, as seen in Figure 11. Accordingly, the digital skills that are part of this cluster are mostly considered workforce digital skills such as POS software, and inventory and warehousing software. During the pandemic, the importance of non-digital skills highlighted in this cluster, such as teamwork, communication skills, customer service, flexibility, organizational skills, fast-paced setting, attention to detail, and interpersonal skills, became exceedingly clear. As businesses moved to work remotely and serve customers virtually, core communication and interpersonal skills have remained vital to keep in touch with customer bases, despite the move away from traditional customer service strategies.[46]

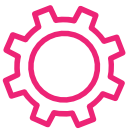
Hybrid skills across clusters

The job postings analysis highlights that employers often seek both digital and non-digital skills when seeking job candidates. Many occupations, including high digital intensity ones, require some degree of non-digital, interpersonal and/or "soft skills" to accompany digital or technical skills. This is exemplified by our analysis on hybrid skills, with skill pairings between digital and non-digital skills signifying the complementary nature of these skills. For instance, digital skills pertaining to Microsoft Suite programs (e.g., Word, Excel, Outlook) commonly appear alongside non-digital, social-emotional (communication and teamwork) and more general occupational skills (e.g., customer service). These trends indicate that the need for digital skills does not supplant the need for non-digital skills, as both are sought out by employers in the labour market.

We present two illustrative examples of frequently appearing hybrid skills pairs across clusters, and profile other frequently appearing hybrid pairs in Appendix C.

Example #1: General Office-based skills and Sales and Merchandising skills

The most frequently appearing hybrid skill pairs are non-digital skills from Sales and Merchandising co-occurring with digital skills from the General Office-based Skills cluster, which collectively co-occur over 20 million times in the dataset. Digital skills in the General Office-based skills cluster include Microsoft Suite tools, accounting software, and Intuit QuickBooks, which are prominently used across office work settings to organize and manage projects and finances. Non-digital skills in Sales and Merchandising include skills such as teamwork, communication skills, and time management, all of which are crucial to managing interpersonal relationships. The pandemic also gave rise to a higher demand in strong communications skills when workers had to adapt to a changing work environment and companies had to speed up their digital transformation to facilitate this transition.

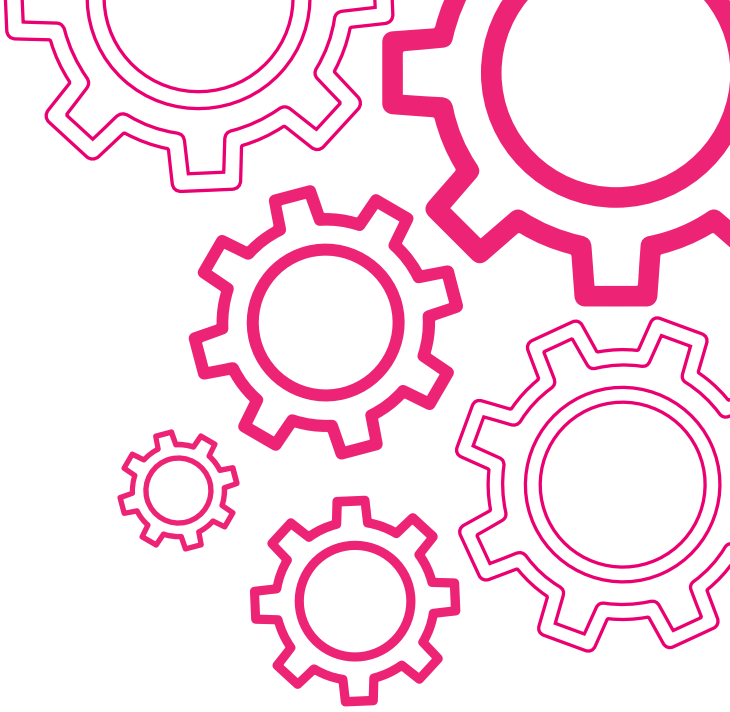


Many occupations, including high digital intensity ones, require some degree of non-digital, interpersonal and/or "soft skills" to accompany digital or technical skills.

Though neither cluster ranks highly on the digital intensity scale, the skills demanded in each cluster have the greatest prevalence across jobs, sectors and occupations. Furthermore, as Figure 12[47] shows, high co-occurring digital and non-digital skills have relatively low digital-intensity scores, compared to other hybrid skills.

Figure 12
Digital intensity of hybrid skills pairs

Given the ease of use, accessibility, and adaptability of Microsoft Suite tools across operating systems, as well as the relative ease to grasp compared to other digital skills, these general workforce digital skills have become the default digital skills for the vast majority of worker contexts for whom their job is not primarily digital. The need for the ability to analyze and comprehend information, then to further distill and communicate information to teams and customers are supplemented with these digital tools. Furthermore, the bundle of tools within Microsoft Office enhance productivity, scheduling, calendar appointments (Outlook), keeping track of numbers (Excel) and cloud storage (OneDrive). Tools like Outlook and Teams require sharp communication skills that enable smooth collaboration between team members, with these skills becoming more important with the rise of remote work.



Outside of Microsoft skills (the top 30 hybrid pairs within these clusters contain Microsoft Suite skills such as Excel, Word and Office, accounting for over 18 million co-occurrences), the top hybrid skills pairings are found in Table 1.

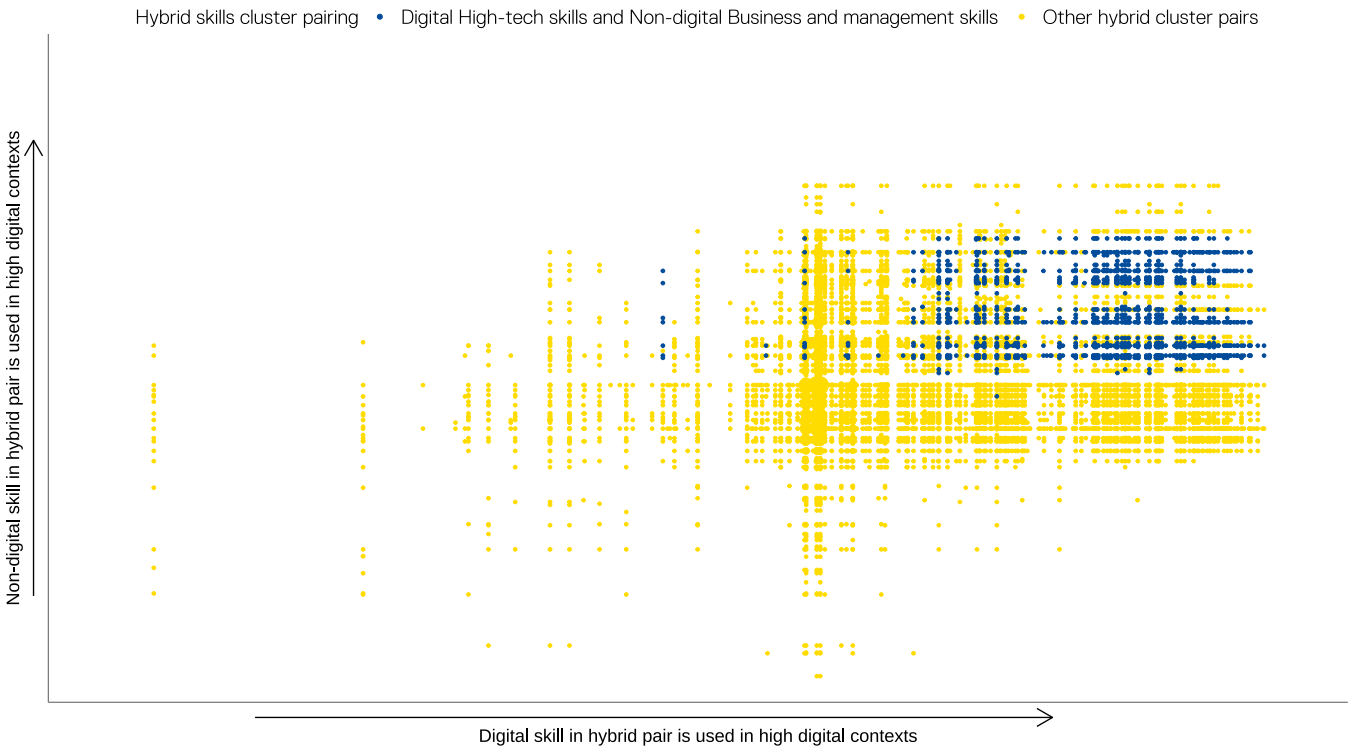
Table 1: Top hybrid skills pairings between digital General Office-based skills and non-digital Sales and Merchandising skills[48]

Digital Skill	Non-digital Skill	Co-occurrences
Accounting software	Communication skills	31,616
Accounting software	Attention to detail	25,823
Accounting software	Teamwork	24,877
Database software	Communication skills	20,442
Intuit QuickBooks	Communication skills	19,453
Human Resource Information System (HRIS)	Communication skills	19,360
Oracle HRIS	Communication skills	19,145
Autodesk AutoCAD	Teamwork	19,052
Database software	Teamwork	18,278
Accounting software	Organizational skills	17,883

Example #2: High-tech skills and Business and Management skills

Hybrid skill pairs from the Business and Management Skills and High-tech Skills clusters have the highest digital intensity rankings (as seen in Figure 13), with skills in Business and Management more concentrated in offices, business management, and corporate settings, and skills in High-tech skills tending to concentrate in software and IT-based roles.

Figure 13
Digital intensity of hybrid skills pairs



Skill pairings such as problem solving and proficiency in structured query language (SQL), and technical support with planning are hybrid skill combinations that require both technical expertise to understand and interpret data and information. On a management level, having leadership skills may just be as important as having technical skills. Not only does a manager need to understand the complexities of the work that their team conducts, it is necessary for managers to know how to provide guidance and oversee the overall direction of tasks. This is where planning and project management skills come into play. Job postings with this hybrid skill cluster may look for individuals who are able to manage IT systems and work with software, on top of performing business operations.

Outside of Microsoft Suite digital skills in the High-tech cluster (which includes Microsoft Azure, SharePoint and Power BI, making up one million of co-occurrences), the top hybrid pairs in these clusters are shown in Table 2.

Table 2: Top hybrid skills pairings between digital High-tech skills and non-digital Business and Management skills

Digital Skill	Non-digital Skill	Co-occurrences
Agile software development	Leadership	46,116
Cloud computing	Leadership	44,169
Information systems	Leadership	42,956
Agile software development	Project management	40,112
Information systems	Planning	38,681
Structured Query Language (SQL)	Leadership	38,438
Technical support	Leadership	38,041
Agile software development	Planning	37,381
Technical support	Problem solving	35,125
Structured Query Language (SQL)	Problem solving	32,985

6 Analysis of Digital Skills Sub-clusters

To recap, this report categorizes "digital skills" as those reflecting the highest digital intensity and/or have applications in technological or digital contexts. In *I, Human* (2019) the precursor report released in 2019, 3,600 digital skills were categorized into four digital sub-clusters from job postings between 2012 and 2018, gathered by Burning Glass Technologies.[49]

Presented in order from most to least digitally intensive (which are almost exclusively in high-tech and digital occupations), the digital sub-clusters in *I, Human* (2019) were:

1. **Software/Product Development skills** are the most digitally intensive, and are primarily used in tech industries for the generation or management of digital products, and includes coding skills such as Python, Java, and C++.

2. **System Infrastructure skills** are specific to certain digital industries such as Information Technology, and pertain to tasks such as setting up cloud computing services, IT support, and managing digital infrastructure. Skills include proficiency with VMware (cloud-computing software) or Windows Server (an operating system supporting the foundation for IT infrastructure).

3. **Data skills** support data gathering and analysis, using more advanced data tools often specifically used by digital workers such as R and Tableau. This sub-cluster acts as a connector between more and less digitally-intensive digital skills.

4. **Workforce digital skills** are generally required of workers throughout the labour market, and across occupations and industries (digital and non-digital), basic data skills such as Microsoft Excel and SAS.

While this report uses Vicinity Jobs data instead of the Burning Glass data used in *I, Human*, the analysis of digital skills sub-clusters found many of the same trends, with some notable differences across the pandemic-era time period. As in the first report, the top digital skills, appearing in the largest number of job postings, are the Microsoft Suite of applications, which are considered low in digital intensity and tend to be ubiquitous Workforce digital skills found across occupations and industries. Microsoft Suite software was the most common by a wide margin, in over 20 percent of job postings (see Table 3). Other digital skills among the top 10 (though all in less than two percent of job postings) span the spectrum of digital intensity, from low (CRM and business software) to medium (technical support and information systems) and high (SQL database software, cloud computing, and agile software development). In aggregate, general workforce digital skills appear in job postings at over twice the rate of software, product development, or data skills (which is the second-most prevalent type of digital skills behind workforce digital skills). A breakdown of the prevalence of digital skills within each sub-cluster is presented in Appendix B.

Table 3: Top 10 digital skills by number of postings that mention them (2020-2023)

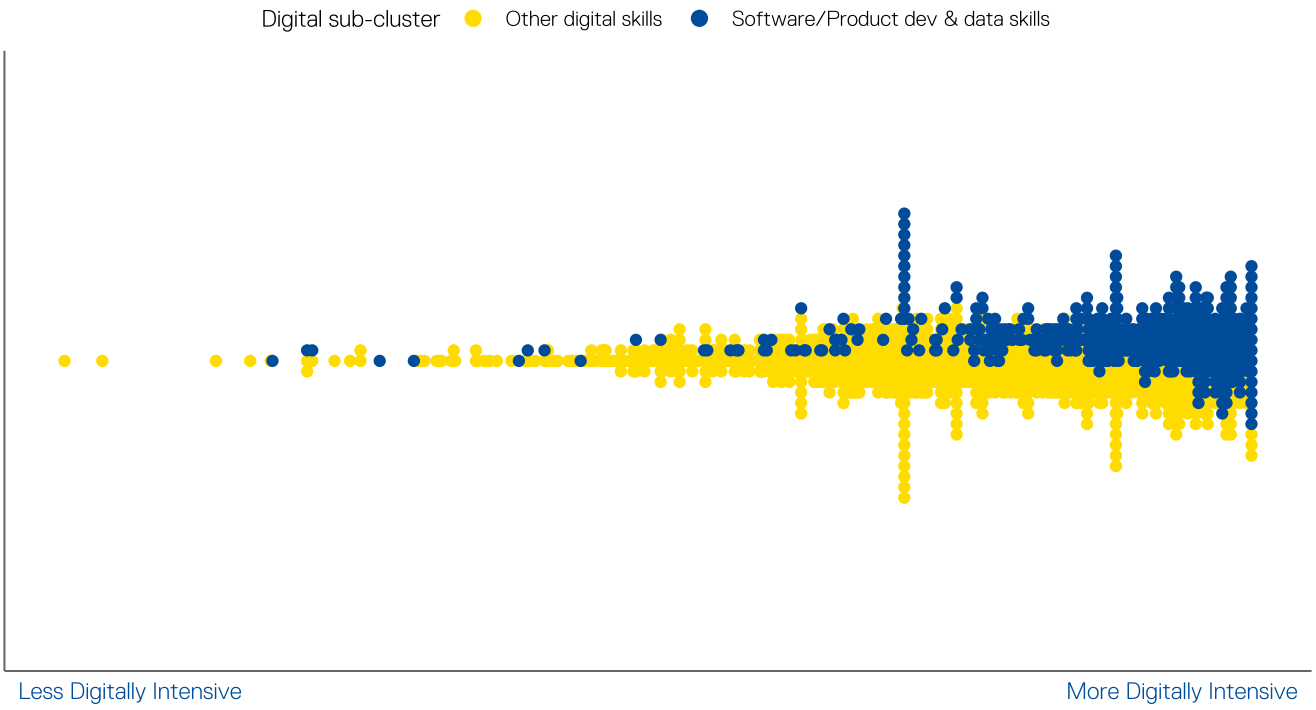
Skill	Description	Overall cluster	Digital sub-cluster	Number of job postings mentioning this skill[50]	Digital intensity category
Microsoft Suite	Office-based software[51]	Mostly General Office-based skills	Workforce Digital Skills	1,842,898 (20.5%)[52]	Low
Customer relationship management (CRM) software	Customer relationship management (CRM) software	Business and Management	Workforce Digital Skills	138,870 (1.5%)	Low
Technical support	Technical systems knowledge and customer service	High-tech	Cybersecurity and System Infrastructure	137,509 (1.5%)	Medium
SAP	Business and customer relations software	Business and Management	Workforce Digital Skills	129,448 (1.4%)	Low
Structured Query Language (SQL)	Database user interface and query software	High-tech	Software/ Product Development and Data	123,524 (1.4%)	High
Information systems	Systems knowledge	High-tech	Cybersecurity and System Infrastructure	121,109 (1.3%)	Medium
Enterprise resource planning (ERP) software	Business processes management software	Business and Management	Workforce Digital Skills	114,630 (1.3%)	Low
Cloud computing	Remote data and file storage software	High-tech	Software/ Product Development and Data	110,166 (1.2%)	High
Agile software development	Software development methodology	High-tech	Software/ Product Development and Data	110,157 (1.2%)	High
Python	Object-oriented programming language	High-tech	Software/ Product Development and Data	85,692 (0.9%)	High

Applying a broader lens to the 2,163 identified digital skills, using the same methodology from *I, Human*, reveals five unique digital sub-clusters, three of which are similar to what was derived in the original report.[53] In order of digital intensity from high to low, the sub-clusters are: Software/Product Development and Data skills, Cybersecurity and System Infrastructure skills, Industrial Modelling and Geospatial Software skills, Design and Marketing skills, and Workforce Digital skills.

Sub-cluster 1: Software/Product Development and Data skills: This sub-cluster contains the second-highest number of digital skills (with a 30 percent share of all digital skills), containing many of the most digitally-intensive skills, as seen in Figure 14.

Figure 14

Digital intensity of Software/Product development & data skills



Skills in this sub-cluster are often useful in the generation of digital products, and have a heavy concentration in the skills profiles of tech workers and sub-industries. More digitally-intensive database interface software and skills such as SQL and Apache are among the most common skills within this sub-cluster. Proficiency in coding languages and object-oriented programming such as Python, Java, C# and R are also prevalent in this sub-cluster.

Skills that have become more prominent during the pandemic, such as applications in artificial intelligence and machine learning, are also key fixtures in this sub-cluster, which has overlaps in coding and data science tools. Cross-referencing to the *I, Human* report, skills in this sub-cluster are mostly a combination of Software/Product Development skills and Data skills.

Skills that have become more prominent during the pandemic, such as applications in artificial intelligence and machine learning, are also key fixtures in this sub-cluster, which has overlaps in coding and data science tools.

Table 4: Top skills in the Software/Product Development and Data skills digital sub-cluster

Skill	Number of mentions
Structured Query Language (SQL)	123,524
Cloud computing	110,166
Agile software development	110,157
Python	85,692
Artificial Intelligence (AI)	73,065

Software/Product Development and Data skills occupational profile:

Software engineering manager

Occupational tasks: A software engineering manager often leads and oversees a product development team's duties. Not only would this require technical expertise and skills to manage product development cycles, check code, and other technical duties, but they must also possess a hybrid selection of non-technical interpersonal skills such as leading and directing personnel in a team, organizing and planning workflows, and have the flexibility to step in and support project duties.

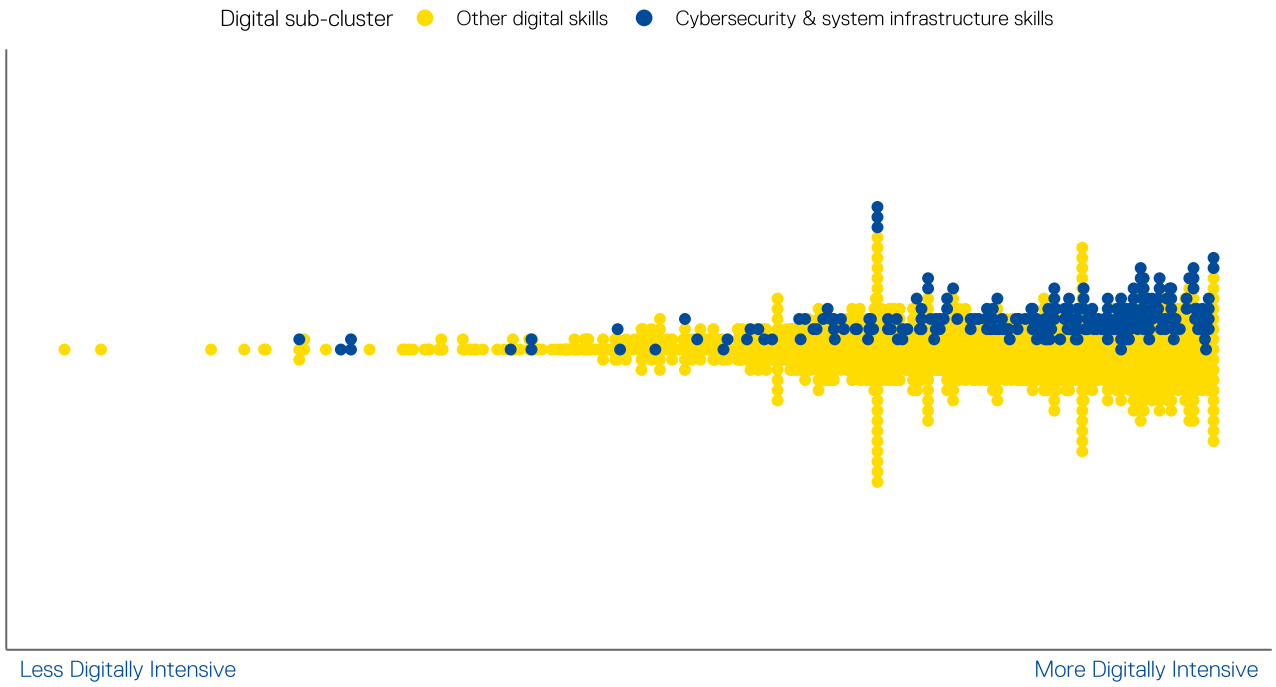
Level of education: These occupations typically require at least a university degree at a bachelor's level, typically in a software engineering or computer science field, or adjacent.

Industries: Software engineering managers typically work at companies that generate digital products such as an app or digital platform.

Sub-Cluster 2: Cybersecurity and System Infrastructure: Despite being the second-most digitally-intensive sub-cluster, this sub-cluster contains a relatively low number of digital skills, with only 13 percent of the total amount of digital skills. Figure 15 visualizes the digital skills in this sub-cluster among all digital skills.

Figure 15

Digital intensity of Cybersecurity & system infrastructure skills



Skills in this sub-cluster are often concentrated in information technology structures and systems, which encompasses cybersecurity systems. This includes knowledge of platforms used to maintain information technology systems such as operating systems software and interfaces such as Microsoft Windows, Linux, IOS and Android, as well as computer servers and hardware systems such as routers. In addition, there are a number of skills for software in network and remote monitoring used to ensure the security of information technology systems, such as anti-virus and penetration testing, firewalls, and network intrusion detection. Furthermore, service-oriented software for customer service and technical support are also included in this sub-cluster. These digital skills are generally associated with IT jobs required in the maintenance and operations of all the above systems and software.

Table 5: Top skills in the Cybersecurity and System Infrastructure skills digital sub-cluster

Skill	Number of mentions
Technical support	137,509
Information systems	121,109
Microsoft Active Directory	39,137
Information Technology Infrastructure Library (ITIL)	33,052
Microsoft operating systems	25,005

Cybersecurity and System Infrastructure occupational profile:

IT technician

Occupational tasks: An IT technician often responds to a variety of different issues and questions that may arise with clients' and companies' usage of technologies. This would require a hybrid set of digital skills such as maintaining hardware and software information technology systems, providing technical support, and non-digital skills such as the ability to accurately and efficiently address client needs and concerns through problem-solving and troubleshooting.

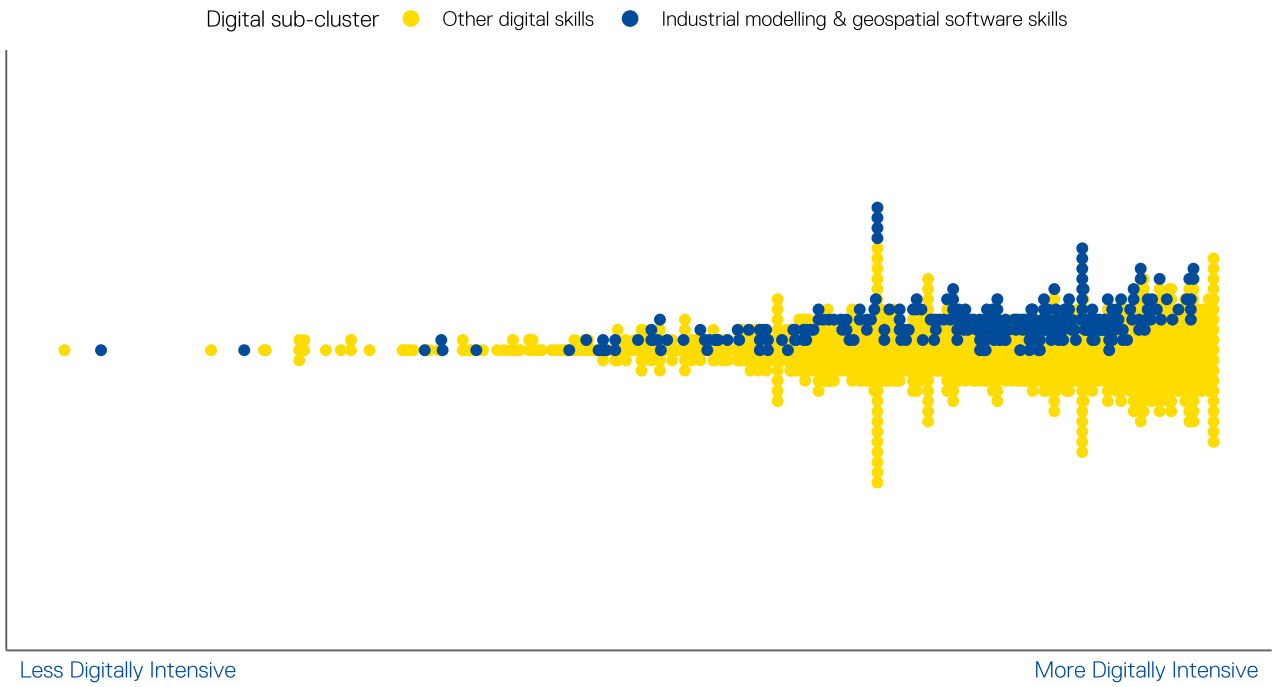
Level of education: These occupations typically require at least a university degree at a bachelor's level, typically in the computer science or information technology field, and on-the-job training.

Industries: IT technicians work across a wide range of industries, but are in high demand at companies that require reinforced protection of valuable assets and data.

Sub-Cluster 3: Industrial Modelling and Geospatial Software: A new addition since *I, Human* (2019), this sub-cluster with 14 percent of all digital skills captures specialized applications of moderate digital intensity that are not generally required of the average worker. Figure 16 shows the digital skills in this sub-cluster among all digital skills.

Figure 16

Digital intensity of Industrial modelling & geospatial software skills



Catering to occupations such as engineers, architects, and geographers, skills for the visualization and design of spaces include 3D modelling software such as computer-aided design (CAD) and computer-aided manufacturing (CAM) software such as Autodesk AutoCAD and Revit, and SolidWorks. Computer numerical control software for manufacturing is also included in this sub-cluster. Knowledge of map creation software such as ArcGIS allows for spatial analysis for professions such as geographers and planners.

Table 6: Top skills in the Industrial Modelling and Geospatial Software digital sub-cluster

Skill[54]	Number of mentions
Autodesk AutoCAD	35,760
Geographic Information System (GIS) systems	27,720
Computer-Aided Design (CAD) software	16,187
Global Positioning System (GPS) software	15,054
Autodesk Revit	13,359

Industrial Modelling and Geospatial Software occupational profile:

Architect

Occupational tasks: An architect is often responsible for designing both the aesthetic and functional aspects of houses, buildings, and other structures. This requires building design knowledge, and digital skills in 3D modelling software in creating designs. Creating functional and well-designed structures also requires a hybrid set of non-digital skills such as attention to detail and organizational skills to meet the contractor/clients' needs.

Level of education: These occupations require, at minimum, a university degree at a bachelor's level in Architecture, from accredited schools of architecture, or the completion of the syllabus of studies from the Royal Architectural Institute of Canada (RAIC). Master's level degrees in architecture have also been increasing in popularity in this field.

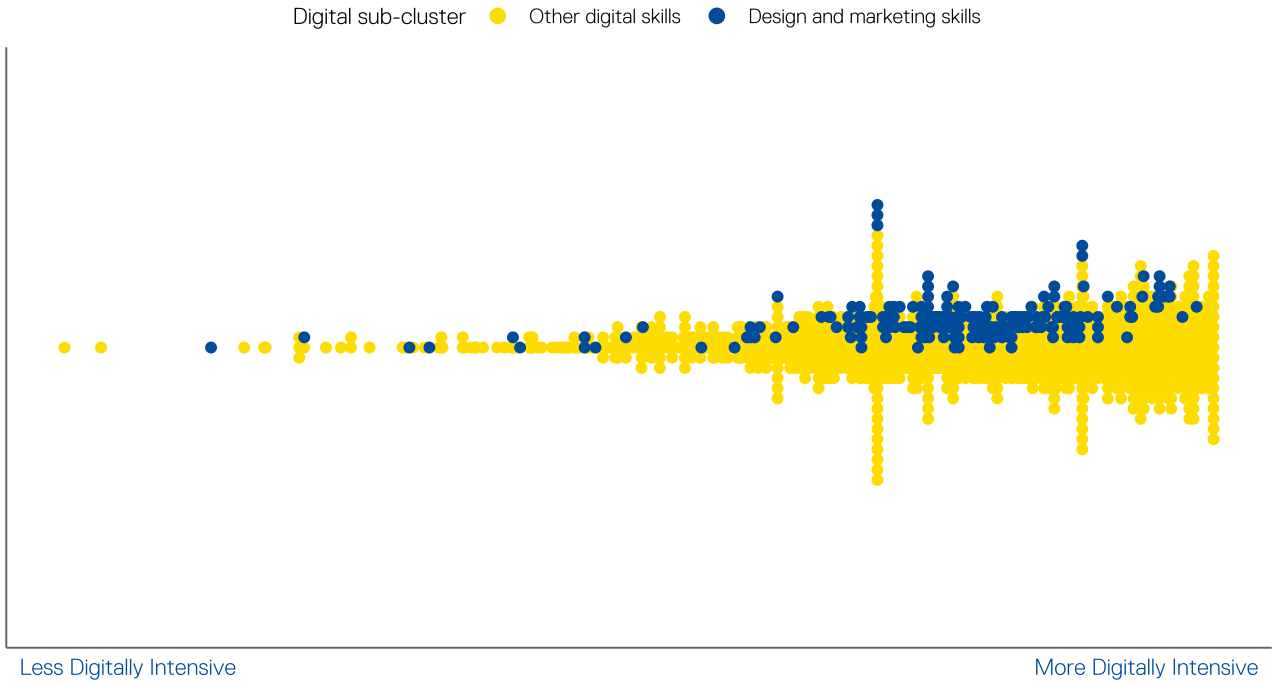
Industries: Architects typically work at companies that provide architectural, engineering, design, construction, and related services.

Sub-Cluster 4: Design and Marketing:

Another new digital sub-cluster, skills in this sub-cluster are predominantly used for the creation and dissemination of digital content, which are often used by designers and marketing professionals. Encompassing approximately 10 percent of all digital skills, skills in this sub-cluster are generally lower digital-intensity, often required of workers in digital and tech industries and occupations. Figure 17 visualizes the distribution of digital skills in this sub-cluster among other digital skills.

Figure 17

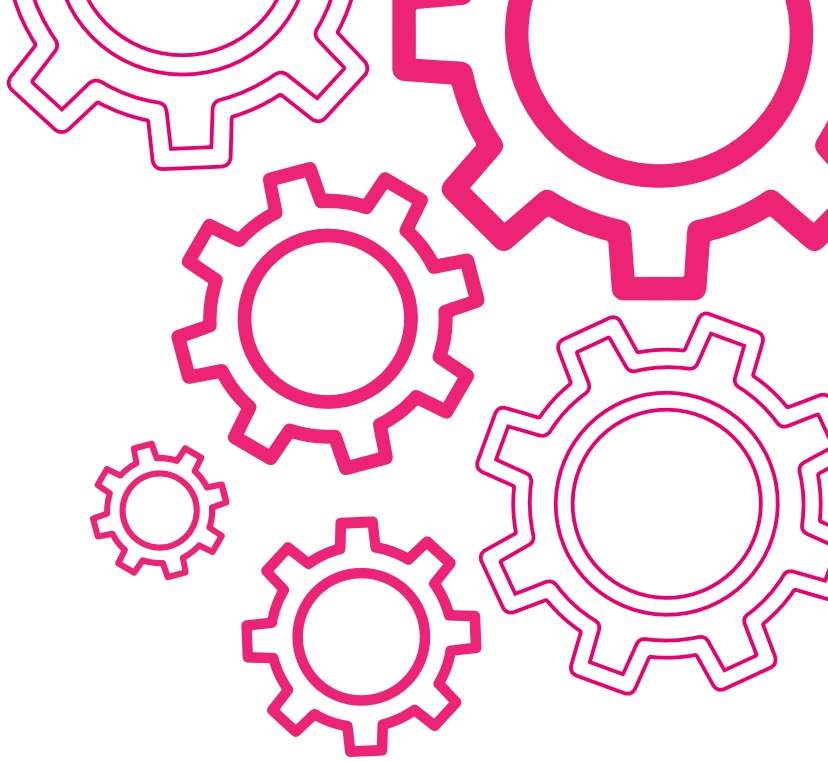
Digital intensity of Design and marketing skills



Graphics and photo imaging software such as Adobe Photoshop, Illustrator and Creative Cloud allow for the creation and editing of videos, visuals, and other media content. Skills that focus on managing channels, presenting graphics, visuals and videos, and managing platforms to publish and communicate messaging such as social media sites and blogs are also included in this sub-cluster. Music and sound editing software skills are included in this sub-cluster, which could complement the use of video content creation software. Skills also include software used in the subsequent tracking of analytics, interactions, and engagement, including IBM Digital Analytics, Google Analytics and Google Ads, and search engine optimization (SEO) software.

Table 7: Top skills in the Design and Marketing skills digital sub-cluster

Skill	Number of mentions
Digital marketing	64,720
Adobe Photoshop	46,540
Graphic design	31,945
Google Analytics	27,184
WordPress	24,698



Design and Marketing Occupational profile:

Marketing and Communications Specialists/Managers

Occupational tasks: A marketing and communications specialist is entrusted with the projection of the overall image of the organization through various mediums of communication, including digital and conventional print mediums. Marketing managers establish distribution networks for products and services, initiate market research studies and analyze their findings, assist in product development, and direct and evaluate the marketing strategies of companies. They help curate the company's brand presence and recognition. In order to perform their task optimally, marketing managers need a hybrid of digital skills such as knowledge of web content management tools (digital marketing), familiarity with tools such as Google Analytics (to assess the reachability of the disseminated digital content), as well as non-digital skills such as marketing expertise, communications and teamwork skills, and exceptional writing skills.

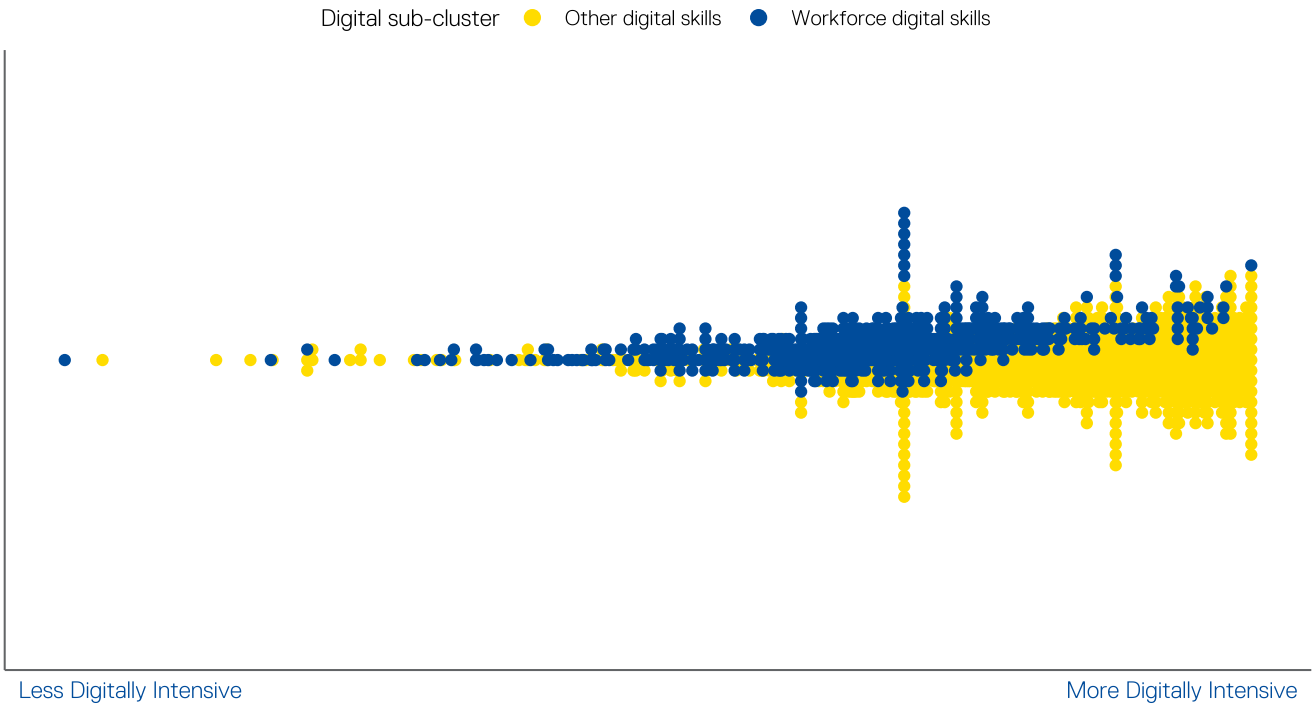
Level of education: Typically, the minimum requirements for this role are a bachelor's degree in Business Administration, Marketing, or Communications, or a college diploma with several years of experience as sales, marketing, or public relations representative. A master's degree or an MBA is preferred for a more senior or specialized role.

Industries: Marketing managers work across a broad set of industries (including hospitality, entertainment, finance, technology, and education industries), especially for firms that produce some type of product and are consumer-facing. These companies can either establish a marketing team in-house or outsource their marketing to a marketing agency.

Sub-Cluster 5: Workforce Digital Skills: The least digitally-intensive sub-cluster, these skills are used by workers across all occupations and industries. As a result, this sub-cluster contains the largest share of digital skills (31 percent of total digital skills), as seen in Figure 18.

Figure 18

Digital intensity of Workforce digital skills

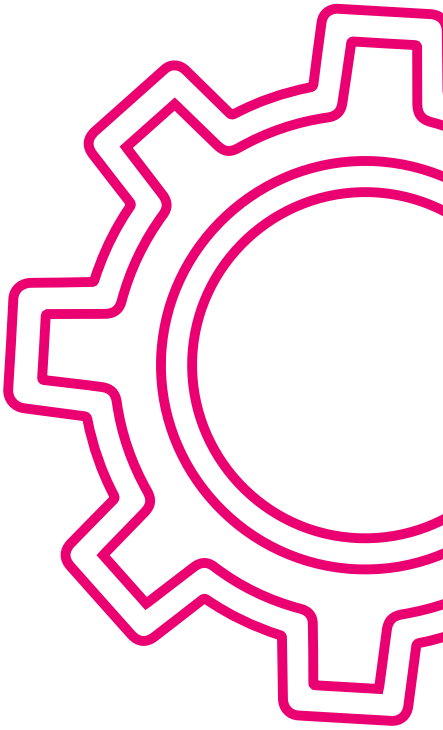


This encompasses more general skills such as Microsoft Office suite software (e.g., Excel, Word, PowerPoint), email and communications software (e.g., Gmail and Microsoft Outlook), and enterprise resource planning software such as SAP and Oracle. In particular, Microsoft Suite skills in this sub-cluster are mentioned over four million times in job postings, which account for almost three quarters of mentions in job postings from digital skills in this sub-cluster. Skills that are more occupation-specific but are generally low digital intensity include:

- Accounting and financial analysis tools such as Intuit QuickBooks and Sage 50
- Human resources software such as Oracle PeopleSoft and ADP Workforce Now
- Medical, dental, and health tools to manage patient information, electronic medical records, and laboratory information systems
- Sales tools such as customer relationship management (CRM) software and point of sale (POS) systems

Table 8: Top skills in the Workforce Digital skills digital sub-cluster

Skill	Number of mentions
Microsoft Suite[55]	4,110,765
Customer relationship management (CRM) software	138,870
SAP	129,448
Enterprise resource planning (ERP) software	114,630
Point of sale (POS) systems	81,503



Workforce Digital Skills profile:

Human Resources Professional

Occupational Tasks: A human resource professional's primary task is to plan, develop, implement, and evaluate personnel and candidates for hire at a company, and to develop labour relations strategies and standards. The position requires a high degree of people management, requiring exceptional interpersonal, teamwork, communication, and leadership skills. For tasks such as managing job descriptions, salary scales, and appraisal measures, human resource professionals must have digital skills with tools such as human resources software such as ADP and Oracle HRS. Other tasks that may require non-digital hybrid skills such as organizational skills and time management include planning and administering staffing, training and development, and employment equity programs.

Level of education: Typically, a minimum requirement for this role is a bachelor's degree or college diploma in human resources or a related field such as business administration, commerce, or psychology, or completion of a professional development program in human resources administration.

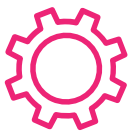
Industries: Most industries require human resource professionals to manage staff relations. This could often exist as an in-house department at a company or organization, or as an outsourced staffing agency to handle tasks such as recruitment.

Digital sub-clusters interaction

When we examine the network structure of how digital skills in Canada are related to each other (Figure 19), we observe that, compared to 2019, there is greater integration between different types of Workforce Digital skills and more specialized digital skills. The Cybersecurity and system infrastructure skills and Industrial modelling and geospatial software skills sub-clusters intertwine and interact closely with many Workforce digital skills, demonstrating the transversal nature of Workforce skills.

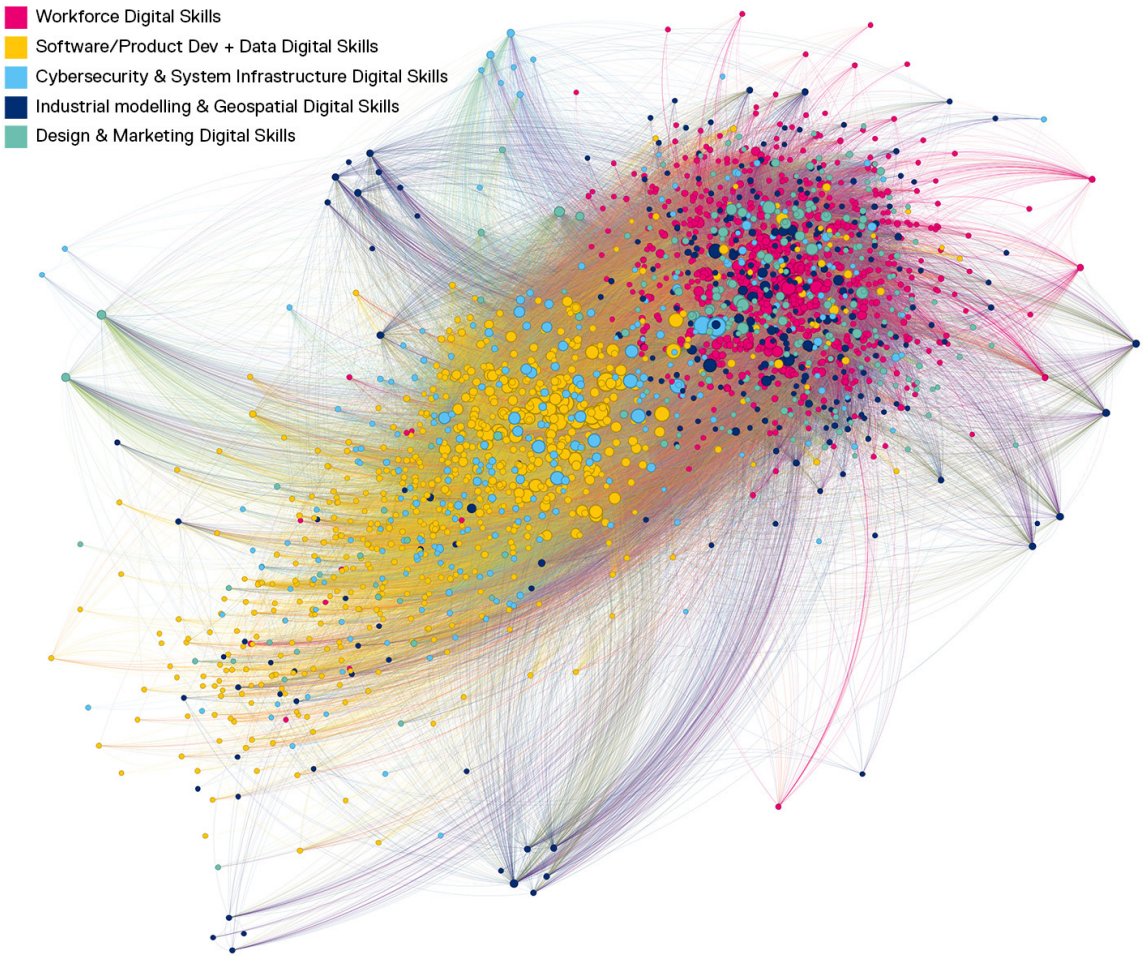
While in this report, the Data sub-cluster was integrated with Software/Product Development (whereas it was separately identified in the original *I, Human* report in 2019), the skills that connect across the sub-clusters (the area where light blue, yellow and pink dots intertwine in Figure 19) still tend to be data skills that come from the Software/Product Development and Data Skills sub-cluster. The Cybersecurity and System Infrastructure sub-cluster also acts as a connector between the two main sub-clusters (Workforce Digital Skills and Software/Data sub-cluster), with skills dispersed across and between them. Meanwhile, the two new sub-clusters (Industrial Modelling and Geospatial Skills, and Design and Marketing Skills) are scattered throughout, with looser linkages to the two larger main sub-clusters.

The emergence of two new sub-clusters in this current report compared to the original *I, Human* report (Industrial Modelling and Geospatial Software, and Design and Marketing) could be the result of skills within jobs that require them showing up more prevalently and consistently in concurrence with other skills within that sub-cluster. The growth in these occupations, along with their specialized subset of skills, strengthen the existence of these sub-clusters. For example, architects, urban planners, and land surveyors increased at an average annual rate of 4.3 percent between 2016 and 2021 (compared to 1.2 percent across all occupations).[56] Similarly, technical occupations in civil, mechanical and industrial engineering saw an average annual increase of 2.7 percent between 2016 and 2021. The increased demand for these jobs may contribute to the increased co-occurrence of their required skills at a significant level for these skills sub-clusters to develop.



The Cybersecurity and System Infrastructure sub-cluster also acts as a connector between the two main sub-clusters (Workforce Digital Skills and Software/Data sub-cluster), with skills dispersed across and between them.

Figure 19
Network Structure of Digital Skills in Canada, 2023



Source: Job postings data from Vicinity Jobs, authors calculations

Changing demand for digital skills during the pandemic

To understand how demand for digital skills changed during the pandemic, we compared job postings from 2019 and 2021. We chose these years for two reasons. First, there was a comparable number of job postings and skills data availability (around 2.4 million job postings, with 14 million skills, in each year). Second, given the initial impact of the pandemic on the labour market in 2020 (with widespread lockdowns resulting in fewer job postings) and the subsequent labour market tightness in 2022 (resulting in an economic rebound and more job postings), 2021 provided the closest approximation of core pandemic conditions against the 2019 pre-pandemic baseline.

Despite widespread evidence and perception that digitization accelerated during the pandemic, this analysis produces a counter-intuitive finding: the proportion of digital skills listed by employers in job postings actually fell during the pandemic.

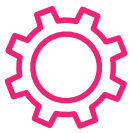
In aggregate across all job postings, 2.5 million digital skills were listed in 2021 at the height of the pandemic, representing 17.5 percent of all skills in job postings. This compares to 2.8 million digital skills listed in 2019 before the pandemic, representing (20 percent) of all skills in job postings. The share of digital skills in job postings continued to decrease in 2022 (14.8 percent). Still, this may not be indicative of the digital skills demand in the labour market in general (see Appendix A for limitations of job postings data). Employers may have increasingly over time prioritized listing only specialized or more technical digital skills in postings compared to baseline digital skills, which have become ubiquitous enough that they have become expected or implied skills from candidates.[57]

In addition, many individual digital skills have shown steady growth. Figure 20[58] show select digital skills which have grown during the pandemic, with further details below about notable trends in the General Workforce Digital Skills and Software/Product Development and Data Skills sub-clusters.

Figure 20
Growth of digital skills during the pandemic (2019 to 2021)

Among more digitally-intensive skills in the Software/ Product development and Data Skills sub-cluster, there are interesting examples of skills demand changes. Skills for database and data visualization software such as Tableau and Microsoft Power BI saw demand in job postings rise from 2019 to 2021 by 15 percent and 71 percent respectively. Skills demand for some cloud-based platforms such as Microsoft Azure and Bullhorn increased, whereas others such as Amazon Web Services decreased slightly. Coding skills in lower digital-intensity languages such as SQL and JavaScript declined slightly in job posting occurrences, while demand for digital skills with higher concentrations in the tech industry such as artificial intelligence and coding skills in C++ and C# increased (by 11, 65, and 83 percent respectively). This likely reflects the growing prevalence of research and development of generative AI products (e.g., Large Language Models such as Google's PaLM 2 and OpenAI's ChatGPT, image generators such as Midjourney and DALL-E, etc).

For less-digitally intensive General Workforce digital skills, skills demand grew for communication platforms such as instant messaging software (e.g., WhatsApp) and online meeting and video conferencing software (e.g., Zoom, Google Meet, Microsoft Teams and Cisco WebEx). For example, the number of occurrences in job postings for video conferencing software skills more than doubled (109 percent), and instant messaging software grew even faster (by 166 percent, albeit from a low baseline in 2019).[59] Information technology and telecommunications infrastructure has shown an increase in demand as well. Across most occupations, including those that primarily require use of computers and those that are more primarily in-person, the increased use of desktop computers and computer terminals for tasks such as tracking inventory, and managing processes, files and information could have been accelerated due to the rise of remote work.



This likely reflects the growing prevalence of research and development of generative AI products (e.g., Large Language Models such as Google's PaLM 2 and OpenAI's ChatGPT, image generators such as Midjourney and DALL-E, etc).

The rise of Artificial Intelligence (AI) skills in the workplace

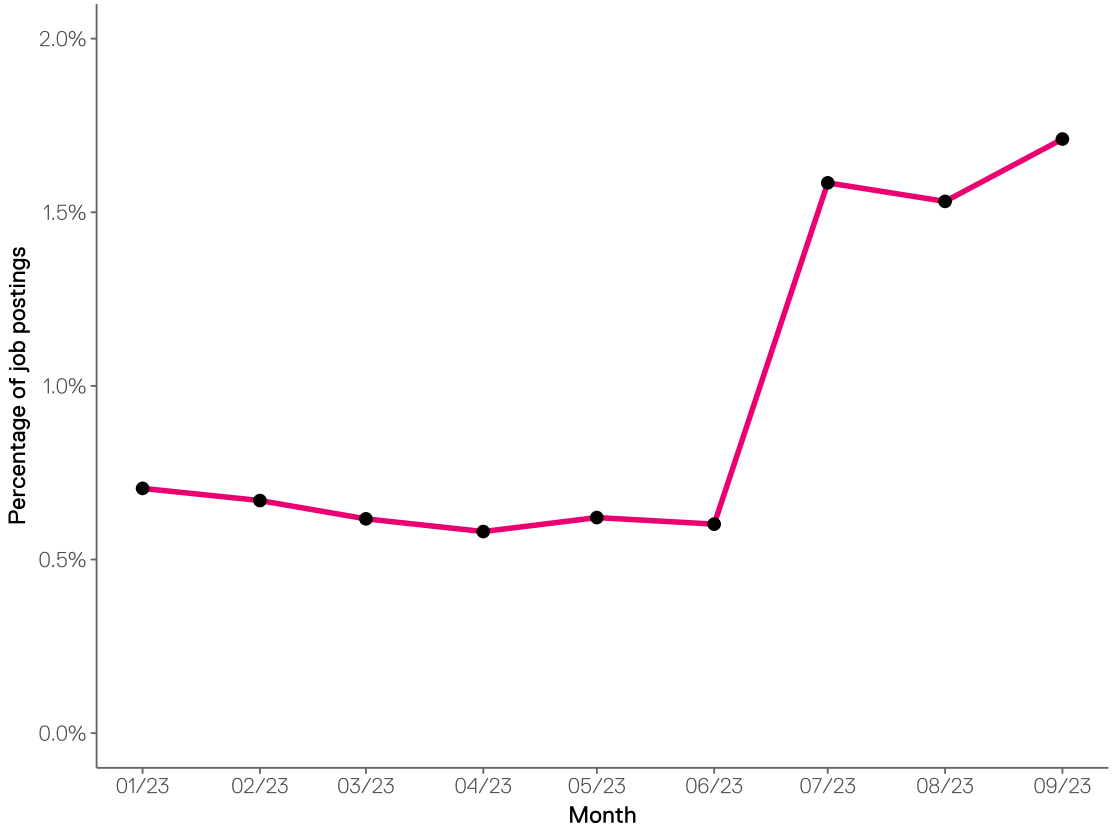
In 2023, the launch of AI products such as ChatGPT, Midjourney and other generative AI tools accelerated an interest in creating new AI products and incorporating AI within existing digital products and platforms. In turn, demand for workers possessing skills which supported the creation or use of AI products also saw a sharp increase. Artificial intelligence skills encompass many different competencies, which includes skills in machine learning, deep learning, natural language processing (NLP), and neural networks.

As seen in Figure 21, AI skills consistently appeared in around 0.6% - 0.7% of total job postings in early 2023. Demand for AI skills accelerated in July 2023, with occurrences in job postings increasing by one percentage point from the previous month to 1.6% of total job postings. Since then, there has been a sustained demand for AI skills in job postings, which reflects the increased interest in integrating AI in products and services. While still a relatively small proportion of the overall labour market, demand for AI skills in September 2023 at 1.7% of total job postings was higher than, for example, demand for skills using Customer Relationship Management (CRM) systems, SAP enterprise software, and Structured Query Language (SQL) and Python programming languages.

The uptick in AI skills demand in July 2023 coincided with the launch of ChatGPT's Code Interpreter plug-in, which enables ChatGPT to write and execute code to analyze datasets, create graphs and visualizations, solve complex math equations, etc.[60] This feature can be used in more novel ways within customer-facing interfaces, as companies such as Kayak, Slack, Instacart and Expedia have incorporated the tool to allow users to generate enhanced recommendations and suggestions.[61]

Figure 21

Job postings demand for skills in Artificial intelligence (as a % of total job postings)

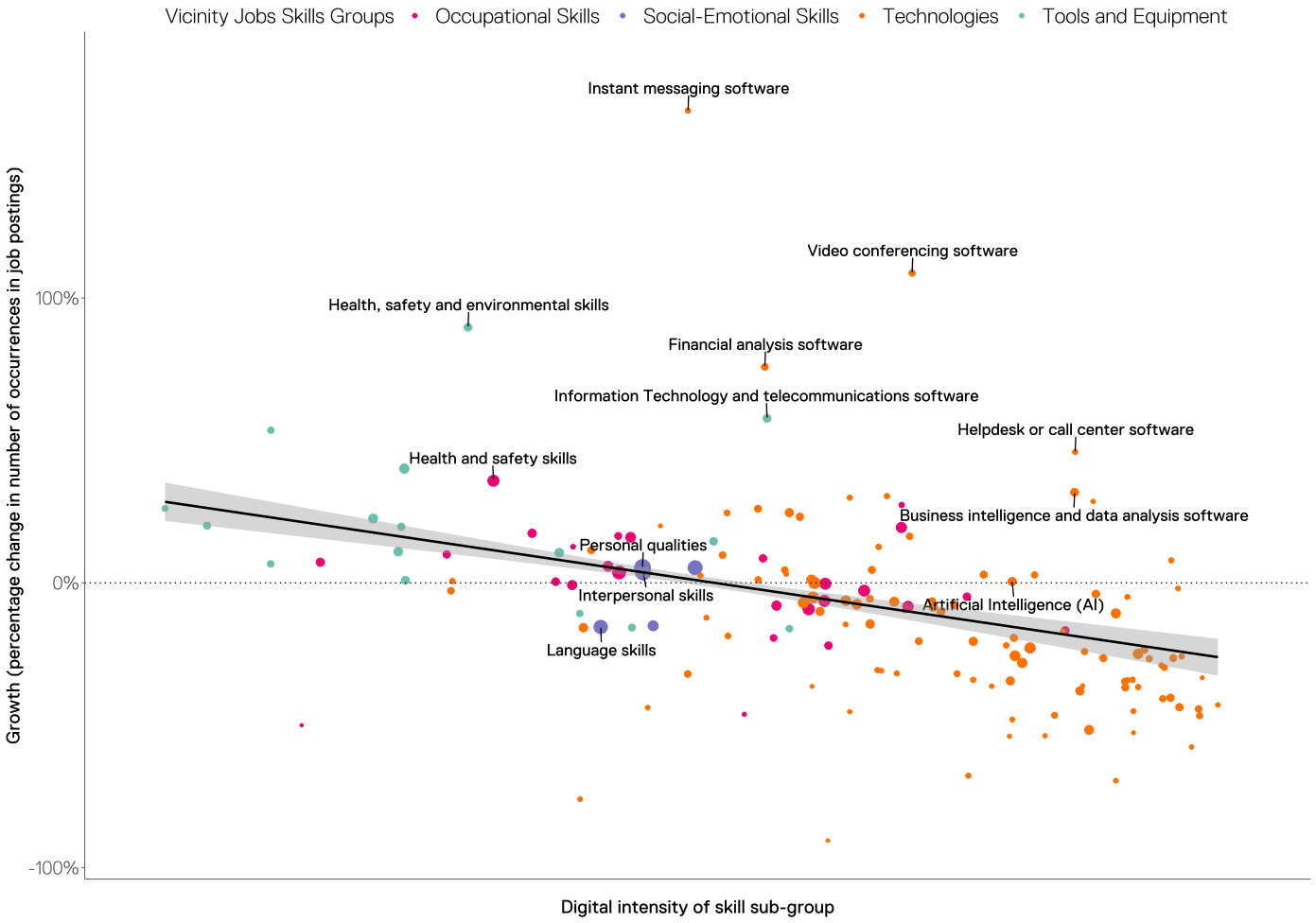


Changing demand for skills by sub-group

Vicinity Jobs data grouped 4,964 skills (both digital and non-digital) into four groups (Technologies, Social-Emotional skills, Occupational skills and Tools and Equipment), and into 167 sub-groups which span across the four groups. The growth of these skills sub-groups during the pandemic (between 2019 and 2021) is shown in Figure 22.

Figure 22

Growth of skills sub-groups during the pandemic (2019 to 2021)



Overall, there were two notable trends in skills demand during the pandemic. First, as illustrated in Figure 22, there is a slight correlation with the digital intensity of a sub-group of skills and its growth during the pandemic, with an associated 0.21 percent increase in growth during the pandemic correlated with a one percent decrease in a skill sub-group's digital intensity.[62] This suggests the shift to remote work for typically in-person workers necessitated lower-intensity general workforce digital skills, whereas higher digital intensity skills that were already used by digital and/or tech workers saw less direct change in demand resulting from pandemic factors such as the shift to remote work. Second, non-digital health, safety, and environmental skills displayed significant demand growth, including knowledge of first aid, Occupational Health and Safety Act standards, and use of protective gear such as gloves and face masks/shields. This presumably reflects pandemic-induced growth in demand for these skills across all workplaces, as well as heightened demand for essential workers in health care and other industries. Table 9 presents all of the fastest highest growth skill sub-groups from 2019 to 2021.

This suggests the shift to remote work for typically in-person workers necessitated lower-intensity general workforce digital skills, whereas higher digital intensity skills that were already used by digital and/or tech workers saw less direct change in demand resulting from pandemic factors such as the shift to remote work.

Table 9: Top growing skill sub-groups during the pandemic (2019-2021)[63]

Skill sub-group	Example skills
Charting software	Patient charting software, Lucidchart, graphing software
Instant messaging software	WhatsApp, Slack, Facebook Messenger, Instagram
Video conferencing software	Cisco WebEx, Microsoft Teams, Zoom, Google Meet
Health, safety and environmental	Material Safety Data Sheets, fire extinguishers, face masks, caulk boots, face shields
Financial analysis software	Financial planning software, real estate application contract transmission software, Oracle Hyperion Planning, auditing software
Information Technology and telecommunications	Computer terminals, routers, desktop computers, modems
Forestry and agriculture	Chainsaws, chippers, incubators, tractors
Helpdesk or call center software	Zendesk, ServicePRO
Lifting equipment	Forklift, pallet jacks, lift trucks, hoists, cranes
Health and safety	Knowledge of: • Occupational Health and Safety Act • first aid • hazardous materials • National Safety Code of Canada

7 Summary of Findings

From the extensive research and data analysis in *The Skills Algorithm*, some key findings emerge:

1. Six broad skills clusters are formed across all occupations. Captured from 9 million job postings from 2020 to 2023, these skills clusters—spanning the highest digital intensity (high-tech skills) to the lowest (sales and merchandising skills)—are shaped by the occupational tasks that require them, from high tech skills for software development to trades skills used for construction or automotive jobs. Each skills cluster contains a mixture of digital and non-digital skills, with each skill varying in digital intensity.

2. Analyzing only the digital skills, five sub-clusters were identified. Digital skills, representing 2,198 of the 4,964 total unique skills (or 44 percent), are typically those with the highest digital intensity. These digital skills sub-clusters remained relatively consistent with the four identified in the precursor report *I, Human* (2019), though two new sub-clusters emerged: Industrial Modelling and Geospatial Software and Design and Marketing.

3. The most in-demand digital skills were for general workforce tasks. Among all digital skills, the low digital intensity skills for using Microsoft Suite programs (Excel, Word, Access) were the most common in job postings by a vast margin, consistent with the 2019 study. Other digital skills with significant growth in job posting occurrences included artificial intelligence and others for high digital intensity occupations, e-charting software in health care, and general workforce skills associated with remote work.

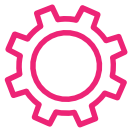
4. There were notable changes in skills demand during the pandemic. Amid public health concerns, the pandemic induced a change in the skills profiles of workers through digitization and remote work. While the proportion of digital skills listed by employers in job postings fell during the pandemic, there was also small but significant growth in demand for lower digital intensity general workforce skills such as use of Zoom and Microsoft Teams video conferencing platforms, whereas higher digital intensity skills typical of tech sector workers saw less change in demand. There was also growth in demand for non-digital health, safety, and environmental skills such as the use of protective gear and first aid.

5. Employers are seeking hybrid (digital and non-digital) skills. Reinforcing the findings of *I, Human* (2019), this study revealed the complementarity of digital and non-digital skills, reflected in employer demand expressed in job postings. A number of these hybrid skills—teamwork, communication, interpersonal and leadership skills—are transversal, commonly in demand across all or most of the digital skills sub-clusters, though they vary depending on the specific occupational profile.

Implications for policy, workforce planning and education

The analysis and findings of this study are important for government policymakers focused on education and labour market development, industry and organizational leaders, practitioners in human resources and workforce planning, and postsecondary administrators and system leaders, among other audiences. This section outlines key implications and some actionable opportunities that emerge from *The Skills Algorithm*, focused on the strategic alignment of skills demand in the economy with the current and future labour supply pipeline.

The report presents a detailed picture of the skills demand in the Canadian labour market to 2023, zooming in on and differentiating the various categories of digital skills. The findings suggest a few significant implications for policy, workforce planning, and education in Canada.



The most ubiquitous demand from employers continues to be for low digital intensity general workforce skills. These types of skills should be recognized as the new "baseline" for most jobs in our modern economy.

First, the skills employers are seeking from workers are evolving at pace, and the workforce disruption and accelerated digitization of the pandemic has amplified this process in some ways. This likely reflects the emergence of new jobs in some instances, but more significantly that the occupational profiles of existing jobs are shifting to reflect demand for new digital and non-digital skills. The present and future talent pipeline to the labour market, higher education, training and skills development program providers must be adapting just as quickly to keep up.

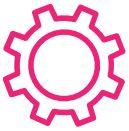
Second, there continues to be significant demand for high digital intensity skills in the ICT industry and other sectors of the economy, reflected in the high-tech skills cluster and across the Software/Product Development and Data and the Cybersecurity and System Infrastructure digital skills sub-clusters. Demand for some of these high intensity digital skills, such as in AI coding skills in C++ and C#, have been growing briskly. Yet, the most ubiquitous demand from employers continues to be for low digital intensity general workforce skills. These types of skills should be recognized as the new "baseline" for most jobs in our modern economy.

Third, public narratives and the education and workforce policy discourse has been highly focused on the need to develop digital skills for today's economy, prioritizing education and training in the STEM disciplines (typically more aligned to medium- and high-intensity digital skills). This report does not discount the importance of developing that talent pipeline, but it reinforces the finding that employers are seeking workers with a blend of digital and non-digital skills—and notably with hybrid and transversal skills like teamwork, communication, leadership, and project management.

For the report's various audiences, a few actionable opportunities or recommendations emerge:

1. **Large employers and industry intermediaries should incorporate this type of skills demand analysis into their workforce planning.** For major Canadian employers like governments and banks, sector associations, chambers of commerce and other intermediaries that support small and medium enterprises (SMEs), leveraging this type of analysis will allow more responsiveness to the changing skills profiles of jobs and their workforce. Open access to granular skills-demand data, and do-it-yourself tools like Labour Market Information Council's Canadian Job Trends Dashboard presenting this skills data, would be key enablers. Furthermore, this analysis could be done at a more granular geographic and industry level, which enables workforce planners and employers to provide more targeted workforce preparation and skills training. The Dais and other research and advisory organizations with expertise in Labour Market Information (LMI) analysis can offer support.

2. **Governments should use skills demand analysis to inform education and skills policymaking and the design of skills development funding programs.** The federal, provincial, and territorial governments set policy and funding for postsecondary policy and student aid programs, employment and training systems, and a variety of skills development and upskilling programs. Governments should explore how skills demand analysis can inform policymaking, and where it can be used to incentivize funding programs to achieve better outcomes for learners, workers, employers, and the workforce broadly.

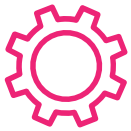


Governments should explore how skills demand analysis can inform policymaking, and where it can be used to incentivize funding programs to achieve better outcomes for learners, workers, employers, and the workforce broadly.

3. Education and training providers should adopt agile approaches to adapting programs and curricula to reflect changing skills demands. Recognizing that workforce skills demand trends will continue to evolve rapidly and unpredictably, education and training providers should incorporate skills demand data into program planning to stay on top of skills trends, inform the ongoing adaptation of existing curricula, and the launch of new programs. This ensures graduates are equipped for the evolving job market and ensure responsiveness to labour market demands from employers or to respond to the changing industrial composition of the Canadian economy.

4. Education and training providers, and government funders, should use skills demand analysis to focus resources on upskilling for the most in-demand skills. Microcredentials and other alternative credentials have been proliferating, offering short programs for postsecondary students and increasingly upskilling professionals, focused narrowly on development of a skill or competency, often with industry or employer partners. Providers, employers and learners will all benefit where these programs are aligned to timely information on workforce skills demand and gaps.

5. Canadian policy researchers and education and skills partners should conduct further analysis on the linkages between higher education programming, employer skills demand and job outcomes. Academic institutions, industry, government, skills data providers, and non-profit intermediaries all play a role in helping to close the skills development knowledge gap. The Dais at Toronto Metropolitan University is eager to continue this work, building on the findings and implications of *The Skills Algorithm*.



Recognizing that workforce skills demand trends will continue to evolve rapidly and unpredictably, education and training providers should incorporate skills demand data into program planning to stay on top of skills trends, inform the ongoing adaptation of existing curricula, and the launch of new programs.

Conclusion

As Canada has emerged from the pandemic, stakeholders in higher education and skills development, governments, industry, and other sectors continue to seek out workers with a mixture of digital and non-digital skills. Using Vicinity Jobs data, this report identifies the constants from our original analysis in *I, Human* (2019), as well as evolutions in skills demand and the newly emergent digital skill trends.

The pace at which skills demand has changed—and demand for digital skills in particular— reinforces the pressing need to support current workers to adapt to these changes, as well as to prepare future workers further upstream in the education system. The report illuminates the broad spectrum of skills, and offers lessons about, among other things, the need to differentiate across digital and non-digital skills, and low- to high-intensity digital skills. Most importantly, it highlights the potential of data analysis to inform more agile and collaborative policy, workforce development, and education planning in support of Canada's learners, workers, and economy.

Appendices

Appendix A: Vicinity Jobs Data

Table A.1 breaks down the total number of job postings by year, and the number of postings with skills data. There is a higher share of job postings containing skills data over time, which signifies better quality job postings data. An increase in skills ratio signifies that job postings have become more descriptive over time, or a greater need from employers for a wider range of skills.

Table A.1: Descriptive statistics of Vicinity Jobs postings by year

Year	Number of job postings	Number of postings with skills data	Total skills in job postings	Average number of skills listed per job posting[64]
2016	930,973	552,021	2,611,689	4.73
2017	1,316,641	1,119,260	7,030,296	6.28
2018	2,635,139	2,370,498	13,886,079	5.86
2019	2,757,830	2,437,410	14,323,849	5.88
2020	2,038,614	1,751,026	9,674,306	5.52
2021	2,808,399	2,452,646	14,204,478	5.79
2022	3,658,890	3,360,065	22,572,367	6.71
2023[65]	1,506,954	1,423,162	10,255,347	7.21

not used in main analysis of clusters used in main analysis of clusters

Limitations of job postings data

The Labour Market Information Council (LMIC) has analyzed the robustness of using job postings data (specifically Vicinity Jobs data) in calculating labour demand. Some limitations to using job postings data that were identified include the representativeness of job postings data (given that not all job openings are posted online), the lack of indication on how important a skill is for an occupation (and subsequently, how much of a factor it is in determining whether a candidate gets hired), some implicit skills are not listed, etc. More information about Vicinity Jobs data and their limitations can be found on LMIC's website.[66]

Online job postings data only captures a subset of new job demand in the labour market, as it only contains job postings posted publicly through the internet; in-person recruitment and internal postings in companies and organizations are not captured. The magnitude of the prevalence of hiring in these contexts are unknown. In addition, skills trends in existing occupied jobs are not captured through job postings data. While these limitations do not allow us to tell the aggregate movement of skills trends in the labour market as a whole, it provides us with a sense of comparative skills movements intertemporally within the labour market.

Other limitations of online job postings data could include those in white-collar occupations and industries, which often lean toward high-skilled computer-based and digital roles, and for those who have a university education. LMIC has conducted a study of the representativeness of online job postings data compared to Statistics Canada's Job Vacancy and Wage Survey (JVWS).[67] It was found that occupations that require only a secondary school level of education, occupation-specific training, or on-the-job training tend to be underrepresented online. This results in occupations[68] within Sales and Service and Trades and Transportation having a lower share of online postings, and an undercounting of skills demand in those types of jobs as a result.

Furthermore, skills that are "implicitly assumed" or unobservable have a higher chance of being unlisted when an employer puts out a job posting, which tend to be soft social-emotional skills rather than hard digital skills.[69]

Furthermore, LMIC has found that online job postings underrepresent jobs in metropolitan areas such as Toronto, Montreal and Vancouver. However, the share of job postings in each province is roughly representative of JVWS estimates. Other measures of representativeness can be found in their LMI Insight Report no. 36.[70]

Mis-categorization of skills in job postings

The methodology in which skills and job postings are captured leads to the likelihood of some level of some mis-categorization. As skills are categorized based on textual analysis of keywords in the job postings, certain skills such as Excavator, Magma, Ferret, Kant, and Pascal (to name a few) were falsely captured in certain job postings. To correct for this, some skills have been removed from our analysis based on a manual assessment of the job postings which contained them. Furthermore, we assume the number of these mis-classifications to be relatively small, and not at a scale which distorts the results of our findings.

Job postings information

The exhaustive list of parameters which are available across job postings is presented below. Not all job postings have enough detailed information across these parameters that could be collected by Vicinity Jobs.

- Job title
- Employer (the employer name as listed in job posting, and the employer name associated with the Vicinity Jobs' profile for the employer)
- Location (town/city)
- District region
- Economic Development Region
- Province
- Date when the posting was retrieved
- Hourly wage
- Minimum and maximum in wage range offered (identified as hourly wage or annual wage)
- 5-digit NOC occupation code
- Occupational and Skills Information System (OaSIS) code[71]
- Sub-occupation code (expands upon OaSIS codes)
- 6-digit NAICS industry code
- Training, Education, Experience and Responsibilities (TEER) category [72]
- Experience required
- Level of education required
- Classification of Instructional Programs (CIP) requirements[73] (on a 2-digit or 4-digit level)
- Whether the occupation was advertised by the employer or through a job board
- Website source where the job posting was found
- Job type (full-time or part-time)
- Job duration (temporary or permanent)
- Certifications required
- Skill requirements (a list of skills retrieved from the posting)
- Includes name of skill, Vicinity Jobs skill group, and Vicinity Jobs skill sub-group
- Standardized job title
- Primary language the posting was published in
- English or French language requirement

Appendix B: Detailed Clusters and Sub-clusters

Threshold identification for digital skills

In order to identify digital skills based on digital intensity, two thresholds were tested. In addition to skills identified as digital skills based on Vicinity Jobs' groupings and sub-groupings, a subset of the remaining skills in the seventy-fifth percentile of digital intensity and fiftieth percentile of digital intensity was analyzed. 2,098 digital skills were identified under the seventy-fifth percentile threshold, whereas 2,458 were identified using the fiftieth percentile threshold. Two rounds of validation were conducted where a random sample of 100 skills were selected and manually identified as digital or non-digital. The manual assignment of digital skills was then matched up against how the skills were identified in both threshold identification methods. The seventy-fifth percentile threshold was identified as the optimal threshold which minimized the number of false positives and false negatives (with 93 percent agreement with the manual assignment of digital skills).

Table A.2: Validation results from the threshold assignment of digital skills

Threshold	False positives	False negatives
50th percentile	9%	1%
75th percentile	1%	6%

Overall skill clusters

Table A.3: Overall skills clusters ranked from most to least digitally intensive

Clusters	Number of skills	Number and percentage of digital skills	Average digital intensity score
High-tech skills	1,317	1,155 (87.7%)	73.26
Business and Management skills	563	316 (56.1%)	141.98
General Office-based skills	478	365 (76.4%)	154.47
Communication and Interaction skills	201	65 (32.3%)	215.77
Trades skills	1,579	168 (10.6%)	263.54
Sales and Merchandising skills	822	128 (15.6%)	277.65

Digital sub-clusters

Table A.4: Digital sub-clusters summary statistics (2020-2023)[74]

Digital clusters	Average digital in digital intensity score	Number of skills	Number of occurrences in job postings	Skills examples
Software/ Product Development and Data skills	53.75	664	2,172,962	Coding languages (e.g., Python, R, Java, C++), Database software (e.g., Oracle, SQL), Artificial Intelligence (e.g., Deep learning, Machine learning, Natural language processing, Neural networks), Web development/ design software (e.g., Agile, UI Design), Cloud computing
Cybersecurity and System Infrastructure	75.99	280	598,573	Network administration and communications, Operating systems software, Information systems software, Customer service and support software (e.g., tech support)
Industrial Modelling and Geospatial Software	102.65	314	279,234	Computer-aided design (CAD) software (e.g., Autodesk Revit, AutoCAD, Civil 3D), Computer-aided manufacturing (CAM) software, Industrial and control and Computer numerical control (CNC) software, Map creation software (e.g., ArcGIS)
Design and Marketing	107.50	219	427,709	Web design software, Adobe Photoshop, Adobe Illustrator, Social media sites (including blogs)
Workforce Digital skills	147.54	683	5,609,491	Accounting software, Office suite systems (e.g., Adobe Acrobat, Adobe Reader), Spreadsheet software (e.g., Microsoft Excel, Google Sheets), Word processing software, Presentation software (e.g., PowerPoint, Google Slides), Enterprise resource planning software (e.g., SAP), electronic mail software (e.g., Microsoft Outlook, Gmail), Database software (e.g., Microsoft Access, data logging and entry)

Table A.5: Top 10 digital skills in each skill cluster (2020-2023)

Business and Management skills	Communication and Interaction skills	General Office-based skills	High-tech skills	Sales and Merchandising skills	Trades skills
Customer Relationship Management (CRM) software	Computer-aided three-dimensional interactive application (CATIA)	Microsoft Office	Technical Support[75]	Point of Sale (POS)[76] system/ software	Computerized maintenance management system (CMMS)
System Applications and Products (SAP)	Pascal[77]	Microsoft Excel	SQL	Computer Skills	Programmable logic controllers (PLC) software
Enterprise Resource Planning (ERP) software	WhatsApp	Microsoft Word	Information systems	Computer terminals	Autodesk combustion
Salesforce CRM	IRIS (graphics software)	Microsoft PowerPoint	Cloud computing	Closed Circuit TV (CCTV) systems	Maintenance software
Digital Marketing	Medical software	Microsoft Outlook	Agile software development	Global Positioning System (GPS) Software	Computer- aided design and drafting (CADD) software
Microsoft Project	CATIA V5	Microsoft Suite	Python	Inventory control software	Diameter[78]
Adobe system/ Adobe Photoshop	Audacity (sound editing software)	Microsoft Windows	Artificial Intelligence (AI)	Warehouse management system	Two-way radios
ERP system	Intuit TurboTax (tax filing)	Microsoft Access	Java	Inventory control system	Mastercam
Graphic Design	Eiffel[79]	Accounting software	Business Analysis	eQuest[80]	Transmitters
Google Analytics	Oracle Beehive	Intuit QuickBooks	Microsoft SharePoint[81]	POS bookstore software	LaTeX

Top 10 digital skills pairs

Table A.6: Top digital skills pairs[82]

Rank	Digital skill #1	Digital skill #2	Co-occurrences
1	Microsoft Suite (e.g., Excel, Word, PowerPoint, Outlook, Access)		4,998,813
2	Enterprise resource planning ERP software and systems (e.g., Oracle NetSuite, Sage Intacct, Microsoft Dynamics 365 Business Central)	Microsoft Excel/Office	116,792
3	SAP	Microsoft Excel/Office	93,181
4	Customer relationship management (CRM) software	Microsoft Office/Excel	76,258
5	Scrum	Agile software development	46,148
6	Cloud computing	Microsoft Azure	37,761
7	Python	Structured Query Language (SQL)	36,939
8	Cloud computing	Amazon Web Services (AWS)	33,257
9	Technical Support	Microsoft Office	30,988
10	Machine Learning	Artificial Intelligence (AI)	29,846

Digital sub-cluster

Workforce digital skills | Cybersecurity and system infrastructure skills | Software/product development and data skills

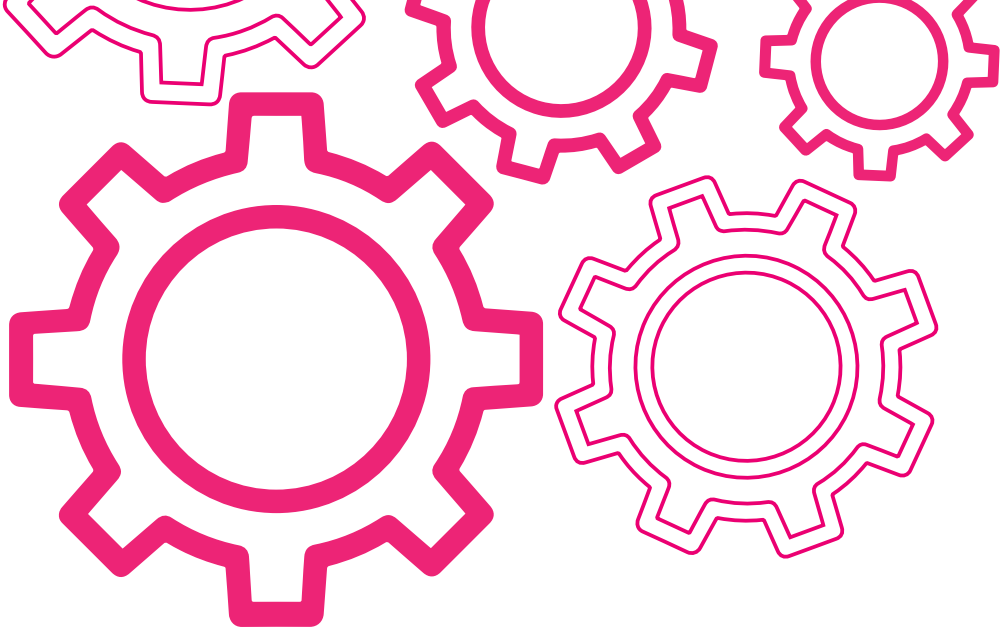
Top growing digital skills

Table A.7: Fastest-growing digital skills during the pandemic (2019-2021)

Skill[83]	Number of mentions in job postings in 2021	Growth (%)	Digital skill sub-cluster
Charting software	1,108	1,131%	Design and Marketing[84]
Computer terminals	8,057	521%	Workforce
Cisco WebEx	2,653	132%	Workforce
eQUEST	1,115	130%	Industrial Modelling and Geospatial
PayPal	1,467	129%	Design and Marketing
Google Sheets	2,497	106%	Workforce
C#	11,441	83%	Software/Product and Data
Microsoft Power BI	11,594	71%	Software/Product and Data
C++	10,109	65%	Software/Product and Data

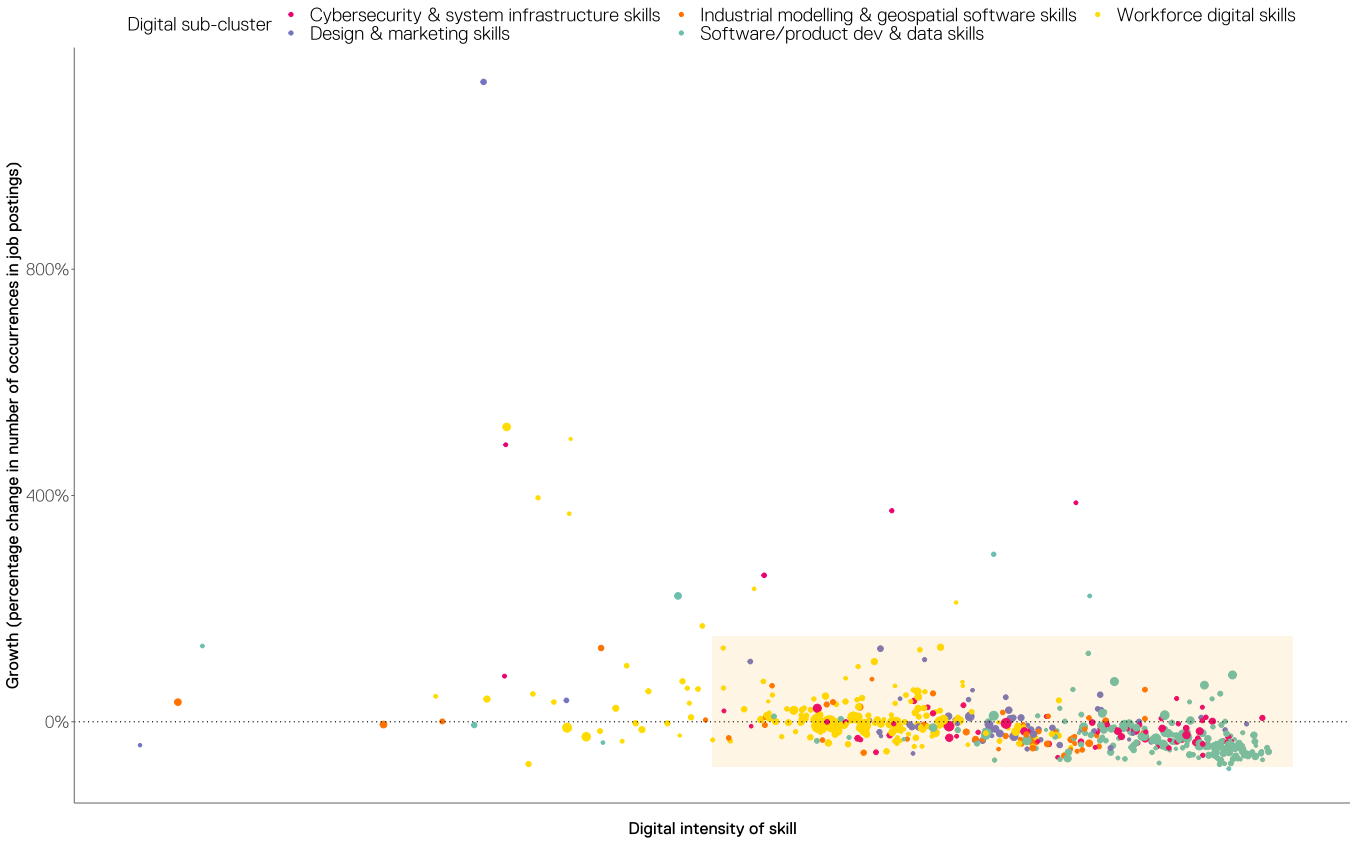
Table A.8: Growth of most in-demand digital skills[85] during the pandemic (2019-2021)

Skill	Number of mentions in job postings in 2021	Growth (%)	Digital skill sub-cluster
Microsoft Suite	1,180,812	-4.6%	Workforce
Customer relationship management (CRM) software	39,668	-10.1%	Workforce
Technical support	38,085	-2.9%	Cybersecurity and System Infrastructure
Structured Query Language (SQL)	37,753	-27.6%	Software/Product and Data
Agile software development	35,447	-30.1%	Software/product and data
Information systems	33,412	-7.7%	Cybersecurity and System Infrastructure
SAP	33,145	-15.6%	Workforce
Cloud computing	32,549	-15.8%	Software/Product and Data
Enterprise resource planning (ERP) software	29,883	-0.2%	Workforce
Python	27,165	-22.8%	Software/Product and Data



An overview of all digital skills growth is presented below in **Figure A.1**.

Figure A.1
All digital skills, shown by digital intensity and growth during the pandemic



Appendix C: Hybrid Skill Pairs

Table A.9: Top non-digital skill co-occurrences with Microsoft skills

Non-digital skill	Co-occurrences
Communication skills	2,823,205
Teamwork	2,225,292
Customer service	1,574,152
Attention to detail	1,459,718
Organizational skills	1,398,651
Interpersonal skills	1,345,052
Leadership	1,205,021
Planning	1,102,773
Time management	1,091,635
Fast-paced setting	1,073,489
Flexibility	1,030,657

Skill cluster

Sales and merchandising skill cluster

Business and management skill cluster

Table A.10: Interaction of digital and non-digital skills between clusters

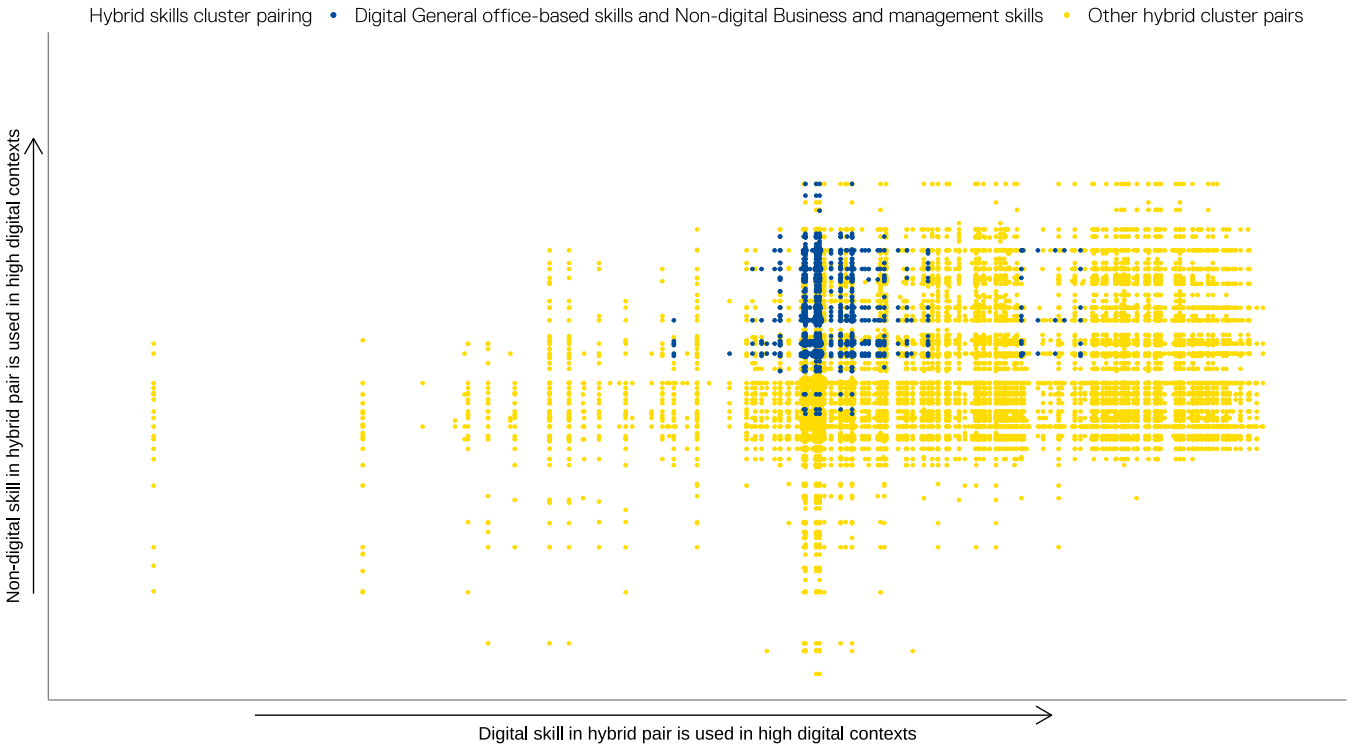
Digital skills from first cluster	Non-digital skills from second cluster	Co-occurrences (# of times they appear in the dataset)	Digital strength of cluster pair
General Office-based skills	Sales and Merchandising skills	20,936,603	Low
General Office-based skills	Business and Management skills	9,308,696	Medium
High-tech skills	Sales and Merchandising skills	9,301,357	Medium
High-tech skills	Business and Management skills	6,821,887	High

Examples of hybrid skills across clusters

General Office-based skills and Business and Management skills

The Business and Management skills cluster and the General Office-based skills cluster are the second most prevalent hybrid skills cluster combination, made up of complementary skills used in office, management, and corporate settings, and skills used to support tasks that are not primarily concentrated in the creation of digital products. In particular, there is a large co-occurrence of General Office-based digital skills with non-digital Business and Management skills. As seen in Figure A.2,[86] while general office digital skills are not inherently digitally intensive, non-digital skills in the Business and Management cluster have relatively higher digital intensities compared to other non-digital skills in many other clusters. Skills such as project management, quantitative and qualitative research, and financial risk management may not be inherently digital, yet they are often supplemented with some software skills to support their occupational tasks and supplement the output of their work.

Figure A.2
Digital intensity of hybrid skills pairs



These hybrid skill pairings are frequently seen in a wide range of jobs, from accountants, architects, and engineers, to individuals working in the financial, sustainability, and business management sector more broadly. Pairing Microsoft Excel or other Microsoft Suite software with non-digital soft skills such as and leadership, or other Microsoft Office Suite software paired with a variety of non-digital skills such as leadership, supervisory skills, problem solving, project management, and analytical skills appear together frequently. These skill combinations could be useful in roles that require the organization and presentation of information using Microsoft Office Suite tools, with a knack to manage business operations using skills like indicating/tracking key performance indicators, being able to negotiate, and multi-task.

The wide applicability of skills within these clusters could equate to its prevalence and demand across a number of industries, all of which might require some sort of occupation-specific training in operating some role-specific software and tools, while also having the ability to perform as a leader, perhaps in a managerial capacity.

The top co-occurrences of skills, (with the exclusion of Microsoft Suite skills such as Excel, Word and Office), which make up the top 47 co-occurring hybrid pairs, which appear over eight million times) are presented in Table A.11.

Table A.11: Top hybrid skills pairings between, digital General Office-based skills and non-digital Business and Management skills[87]

Digital skill	Non-digital skill	Co-occurrences
Autodesk AutoCAD	Project Management	11,194
Human Resource Information System (HRIS)	Leadership	10,334
Oracle HRIS	Leadership	10,223
Autodesk AutoCAD	Planning	9,444
Accounting software	Budgeting	9,029
Human Resource Information System (HRIS)	Planning	8,708
Oracle HRIS	Planning	8,569
Accounting software	Problem Solving	8,320
Autodesk AutoCAD	Leadership	7,784
Accounting software	Planning	7,641

High-tech skills and Sales and Merchandising skills:

We also observe a large number of co-occurrences of digital skills in the High-tech skills cluster and non-digital skills in the Sales and Merchandising skills cluster. Pictured in Figure A.3, the link between the most digitally intensive cluster (High-tech) and the least digitally intensive cluster (Sales and Merchandising) demonstrates that digital skills do not supplant the need for soft skills.

Figure A.3
Digital intensity of hybrid skills pairs

With a digital skill such as technical support, the ability to advise and assist would require skills in customer service and troubleshooting to support users with issues concerning their technical products. For example, if an Apple Mac computer user faces trouble in their iOS system, the user could set up an appointment at the Genius Bar for problem resolution. Technical support could be provided through various modes of communication, including email, live chat, telephone, or in-person, which all require customer interaction. In addition, workers in many high-tech roles such as data scientists, data analysts, and data engineers would have to collaborate with colleagues ranging in different levels of technical expertise. This requires effective communication of any system issues arising while creating digital platforms/products, as well as liaising with technical writers and designers. Across many examples of high-tech workers, having interpersonal and communication to supplement digital skills are highly valuable to the success of their role.

Outside of Microsoft Suite digital skills in the High-tech cluster (which includes Microsoft Azure, SharePoint and Power BI, making up 1.4 million of co-occurrences), the top hybrid pairs in these clusters are shown in Table A.12.

Table A.12: Top hybrid skills pairings between, digital High-tech skills and non-digital Sales and Merchandising skills

Digital skill	Non-digital skill	Co-occurrences
Technical support	Communication skills	73,449
Information systems	Communication skills	67,075
Structured Query Language (SQL)	Communication skills	66,501
Structured Query Language (SQL)	Teamwork	62,541
Technical support	Teamwork	62,137
Agile software development	Teamwork	59,922
Technical support	Customer service	59,718
Cloud computing	Communication skills	57,200
Agile software development	Communication skills	57,082
Cloud computing	Teamwork	56,764

Top hybrid skills across digital sub-clusters

A key finding of *I, Human* (2019), that is reinforced by this study, is the complementarity of digital and non-digital skills, reflected in employer demand as expressed in job postings. Table A.13 presents the top non-digital skills as reported with digital skills in each of the five sub-clusters. A number of these hybrid soft skills—teamwork, communication, interpersonal and leadership skills—are transversal, commonly in demand across all or most of the sub-clusters (and subsequently, the occupations that require them). Non-digital skills interact differently depending on digital intensity and the purpose of different digital skills. Within each digital sub-cluster, there are variations in the types of non-digital skills that would enhance the work that is conducted.

Table A.13: Top 10 non-digital skills in each digital sub-cluster

Skill	Software/ Product Development and Data skills	Cybersecurity and System Infrastructure	Industrial Modelling and Geospatial Software	Design and Marketing	Workforce Digital Skills
Teamwork	✓	✓	✓	✓	✓
Communication skills	✓	✓	✓	✓	✓
Planning	✓	✓	✓	✓	✓
Interpersonal skills	✓	✓	✓	✓	✓
Leadership	✓	✓	✓		✓
Flexibility	✓	✓	✓	✓	
Project management	✓	✓	✓	✓	
Customer service		✓	✓		✓
Attention to detail			✓	✓	✓
Organizational skills			✓	✓	✓
Fast-paced setting				✓	✓
Problem solving	✓	✓			
Troubleshooting	✓	✓			
Analytical skills	✓				
Writing				✓	
Time management					✓

Endnotes

[1] The original I, Human report was produced by the Brookfield Institute for Innovation + Entrepreneurship (BII+E), which has since been merged with the Leadership Lab to form the Dais at Toronto Metropolitan University.

[2] Future of Jobs Report 2023, (Switzerland: World Economic Forum, 2023), https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf.

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[14] *Canadian Survey on Business Conditions Report*, Q3 2022, Canadian Chamber of Commerce, 2022, https://chamber.ca/wp-content/uploads/2022/09/2022Q3_BDL_CSBC_Report_EN.pdf.

[15] *Future of Jobs Report 2023*, World Economic Forum, 2023, https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf.

[16] Ibid.

[17] *Empowering People for Recovery and Growth: 2022 Skills Survey Report*, Business Council of Canada: Business + Higher Education Roundtable March 2022, https://thebusinesscouncil.ca/app/uploads/2022/03/Empowering-People-for-Recovery-and-Growth_2022-Skills-Survey-Report-Final.pdf.

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[27] Employment and Social Development Canada, "Programs and Policy Development," https://www.canada.ca/en/employment-social-development/programs.html.

[28] Government of Canada, "Sustainable Jobs Plan," https://www.canada.ca/en/services/jobs/training/initiatives/sustainable-jobs/plan.html.

[29] Not every job posting contains all of the information listed, with date of posting and job posting being the only consistent information across all postings.

[30] This list is not exhaustive; a full outline of all the dimensions of job postings data can be found in Appendix A.

[31] National Occupational Classification (NOC) is Canada's national system for describing occupations, as per Employment and Social Development Canada (ESDC)'s definition. The 2021 version of the NOC system has 516 unique 5-digit occupations.

[32] North American Industry Classification System (NAICS) is Canada's national system used to classify businesses and industries, as per Statistics Canada. As of 2022, there are 20 high-level NAICS sectors, with many more sub-sectors within each sector.

[33] Individual skills manually assigned as digital include "Business Systems Analyst," "Bit error rate testers (or BERT)", and "Backup drives," while keywords chosen include digital, tech, software, computer, network, cyber, server, and automation.

[34] Viet Vu, Creig Lamb, and Asher Zafar. *Who Are Canada's Tech Workers?* (Toronto: Brookfield Institute, 2019), https://brookfieldinstitute.ca/wp-content/uploads/FINAL-Tech-Workers-ONLINE.pdf.

[35] Validation to determine the optimal threshold to identify digital skills was conducted. More information is available in Appendix B to outline this process.

[36] A brief overview of these two methods is described in Günce Keziban Orman et al J. Stat. Mech. (2012), Comparative evaluation of community detection algorithms: a topological approach, https://arxiv.org/ftp/arxiv/papers/1206/1206.4987.pdf.

[37] 270 skills could not be displayed, based on the unavailability of digital intensity scores using our methodology. However, these skills were able to be manually categorized as non-digital or digital in our skills cluster assessment.

[38] Each dot in subsequent dot plots also represents one skill.

[39] Murtaza Hussain, "The Future of Data and AI in the Financial Services Industry," *Forbes*, February 27, 2023, https://www.forbes.com/sites/forbestechcouncil/2023/02/27/the-future-of-data-and-ai-in-the-financial-services-industry/?sh=78aa062c3a00.

[40] More examples of digital green skills and how they are used can be found here: Andy Leidof, "The Power of Environmental Data Visualized Through CAD Drawings," Environmental Management Consultants, May 6, 2020, https://www.emcevv.com/blog/the-power-of-environmental-data-visualized-through-cad-drawings.

[41] Environmental Intelligence (EI) is instrumental in integrating environmental data with AI to provide meaningful insight to make informed decision making and enable a sustainable interaction with the natural environment; "Innovating Environmental intelligence," *Green Futures*, University of Exeter, https://greenfutures.exeter.ac.uk/environmental-intelligence/.

[42] *Digital Technology and the Environment: Sustainability at the Speed of Open Innovation*, IBM, 2021, https://www.ibm.com/downloads/cas/BPRYZAOY.

[43] Job postings were compared between these two years given the similar number of job postings and skills data availability; Given the initial impact on the labour market in 2020 (resulting in fewer job postings) and the subsequent labour market tightness in 2022 (resulting in more job postings), it was most appropriate to examine these two years to get an accurate representation of skills growth.

[44] Employment and Social Development Canada, "Discover the Skilled Trades," January 27, 2023. https://www.canada.ca/en/employment-social-development/campaigns/skilled-trades.html; Some of the top in-demand skilled trades across Canada_ include cooks/chefs, industrial electricians, industrial mechanics, painters and decorators, and welders.

[45] Ibid.

[46] Christopher Elliott, "This is How the Pandemic Improved Customer Service," *Forbes*, January 28, 2021, https://www.forbes.com/sites/christopherelliott/2021/01/28/this-is-how-the-pandemic-improved-customer-service/?sh=4f7bc80548dd.-

[47] For hybrid skills with over 1,000 co-occurrences. The size of the bubble is exponentially scaled to the number of co-occurrences.

[48] This excludes Microsoft Suite skills.

[49] Burning Glass Technologies was a data provider for job postings. The company merged with Emsi to form Lightcast in 2021; Ethan Oldham, "Emsi and Burning Glass Merger," Lightcast, June 13, 2021, https://lightcast.io/resources/blog/emsi-and-burning-glass-merger.

[50] For job postings with skills data only.

[51] Includes all Microsoft products under the Microsoft Office Suite; some of the top products (in order of number of appearances in job postings) include spreadsheet software such as Excel, word processing software such as Word, presentation software such as PowerPoint, e-mail software such as Outlook, database software such as Access, project management software such as SharePoint, cloud computing software such as Azure, data analysis software such as Power BI, etc.

[52] This number is for any job posting that mentions at least one Microsoft skill.

[53] Three software skills in a sixth sub-cluster were omitted, which have a primary concentration in DNA sequencing and analysis; these skills do not have overlap with other digital skills. In addition, 35 digital skills were not able to be categorized into a digital sub-cluster given the lack of interaction with other digital skills.

[54] The skill "excavator" was removed due to imperfect skills categorization.

[55] Groups together all Microsoft software in the database, including Access, Excel, Word, PowerPoint, etc.

[56] Author's calculations are based on employment statistics in the 2016 and 2021 censuses.

[57] Similar to caveats outlined by the Labour Market Information Council in *How representative are Online Job Postings?* https://lmic-cimt.ca/publications-all/lmi-insight-report-no-36/.

[58] For skills with at least 100 observances in job postings only.

[59] Job postings demanding these skills are relatively small. Many jobs do not explicitly ask for these skills, possibly due to their low digital intensities, which makes learning these skills relatively accessible. Furthermore, much of the increase from the use of these technologies during the pandemic would occur in jobs that were already occupied. In 2021, around 3,000 job postings required the ability to use video conferencing software as a skill, and around 400 job postings required the use of instant messaging. The analysis is indicative of overall trends in the labour market, even these numbers do not exactly represent the overall size of the increase.

[60] DataCamp, "How to Use ChatGPT Code Interpreter". https://www.datacamp.com/tutorial/how-to-use-chat-gpt-code-interpreter.
[61] OpenAI, ChatGPT Plug-ins. https://openai.com/blog/chatgpt-plugins.

[62] A weighted least squares regression was conducted, with the significance of the correlation at a 99 percent confidence level.

[63] For skill sub-groups with over 100 occurrences in job postings in 2021. Some sub-groups were removed due to data quality (see Appendix A for more details).

[64] For job postings with skills data only.
[65] At the time of retrieval, data was only partially available up until June 14, 2023; therefore, data will only reflect job postings up until this date.

[66] Labour Market Information Council, "Canadian Job Trends Dashboard Overview," https://lmic-cimt.ca/data-dashboards/canadian-job-trends-dashboard/overview/#topic5.

[67] *How Representative Are Online Job Postings?* LMI Insights Report no. 36, Labour Market Information Council, October 2020, https://lmic-cimt.ca/publications-all/lmi-insight-report-no-36/.

[68] As defined by Employment and Social Development Canada's National Occupational Classification system: https://noc.esdc.gc.ca/.

[69] Anthony P. Carnevale, Tamara Jayasundera and Dmitri Repnikov, *Understanding Online Job Ads Data: A Technical Report*, Georgetown University Centre on Education and the Workforce, April 2014, https://cew.georgetown.edu/wp-content/uploads/2014/11/OCLM.Tech_.Web_.pdf.

[70] *How Representative Are Online Job Postings? LMI Insights Report no. 36.*

[71] The Government of Canada's Occupational and Skills Information System (OaSIS) expands on the 516 5-digit NOC codes, with over 900 occupations provided. A framework of skills, abilities, knowledge and interests are also associated with each OaSIS occupation.

[72] A full list of TEER categories are available here: https://www.canada.ca/en/immigration-refugees-citizenship/services/immigrate-canada/express-entry/eligibility/find-national-occupation-code.html.

[73] A full list of CIP programs as defined by Statistics Canada is available here: https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1420413.

[74] At the time of the production of the analysis, data was available up until June 14, 2023.

[75] Technical support is defined as having IT support skills, and these skills are used by computer scientists to troubleshoot any technical equipment and software. It requires the use of technical products like software applications, mobile apps, computer hardware and also requires advanced knowledge of information technology; "What are IT Support Skills?" Indeed Career Guide, https://www.indeed.com/career-advice/resumes-cover-letters/it-support-skills.

[76] Point of Sale (POS) software is the operating system used to manage physical stores; it also helps in reporting sales, inventory management, and reporting on transactions.

[77] Pascal is a programming language.

[78] Diameter is an authentication, authorization, and accounting protocol for applications such as network access or IP mobility, see https://www.synopsys.com/software-integrity/security-testing/fuzz-testing/defensics/protocols/diameter-server.html.

[79] Eiffel is a programming language.

[80] eQuest is a human resources software.

[81] Microsoft SharePoint is used by organizations to create websites.

[82] The pairs Point of Sale (POS) systems/POS software, and Microsoft SQL/SQL were removed because of the similarity between these skills, but were categorized separately.

[83] For skills with at least 1,000 appearances in the job postings data. Some skills were removed due to the possibility of mis-categorization (see Appendix A).

[84] While charting software mainly refers to e-charting software used in the health care industry to document and store patient information, some skills within graphic design or cartography are also categorized as charting software.

[85] These digital skills had the most appearances in job postings between 2020 and 2023.

[86] For hybrid skills with over 1,000 co-occurrences. The size of the bubble is exponentially scaled to the number of co-occurrences.

[87] This excludes Microsoft Suite skills.