Unlocking the Potential of Technologies and Digital Twins in British Columbia

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Executive Summary

As Canada embarks on an era of digital transformation, emerging digital twin technologies offer a vital opportunity for reskilling the workforce across key sectors such as smart cities, agriculture, mining, forestry, utilities and construction. Digital twins are virtual representations of physical environments that can enhance real-time decision-making and optimize operations across a range of applications. The rapid rise of digital twins in the workforce will drive a need for training in innovative technologies such as collecting and processing 3D data using aerial and ground-based autonomous vehicles, designing Internet of Things (IoT) networks, building and interpreting location-based AI analytics, and creating immersive virtual environments. These skills were previously accessible to only those with recent higher education, but technological advancement in the past decade is making the demand for these skills pervasive across sectors, which is driving a critical need to reskill the current workforce to be prepared to adopt digital twin technologies as they become commonplace.

The goal of the proposed research is to design an industry-defined reskilling framework aimed at digital twin technology adoption. In collaboration with partners from agriculture, mining, forestry, utilities, construction, and community emergency response, we aim to understand the core digital twin skills and competencies central to each sector and the barriers and opportunities for embedding skills training within the relevant workforce. We focus on these sectors because they are all being disrupted by the availability of accessible technologies that have the potential to enhance productivity and organizational intelligence through data-informed decision-making. Furthermore, these sectors are increasingly subject to external forces that are driving the need for greater efficiency and better real-time decision making.

For the proposed research, we take a two-stage approach: we first engage with key actors across sectors through targeted interviews to learn how digital twin technologies are being adopted within their organizations and industries, and what skills training would benefit organizational productivity. Second, we conduct a survey to a broader network of organizations

within these sectors to identify potential modes of training delivery that would benefit these organizations. Our findings lead to the development of a framework for meeting digital twin reskilling needs and recommendations on fostering partnerships between industry and educational institutions to ensure the sustainability of designed training programs.

The research revealed three key insights: First, there is a fragmented understanding of digital twin technologies across sectors, with many professionals familiar with individual tools but lacking systems-level integration knowledge. Second, employers prioritize practical skills and hands-on experience over formal credentials, indicating a need for flexible, skills-based training models. Third, traditional academic training formats are misaligned with industry needs, with respondents favoring self-paced, experiential learning over conventional approaches.

These findings suggest that policy makers and educators should support modular, community-driven training ecosystems that emphasize real-world application and cross-sector collaboration. We propose a five-stage framework offers a roadmap for building such systems, aligning workforce development with Future Skills Canada's strategic goals of inclusive, responsive, and future-ready training programs.

While this study was conducted in British Columbia, its findings and framework have strong potential for national scalability. The challenges addressed—climate change, population growth, and emergency management—are pervasive across Canada, and the enabling technologies such as GIS, IoT, and AI are already in use by governments, industries, and Indigenous communities nationwide. Moreover, the five-stage reskilling framework is inherently adaptable: it can be implemented in small, collaborative groups that invite industry partners to co-design education opportunities. These efforts can be replicated across regions and sectors, allowing outcomes, resources, and participants to scale beyond provincial boundaries. This positions the framework as a viable model for expanding digital twin workforce development across Canada.

This report was produced as part of a project funded by the Future Skills Centre (FSC), with financial support from the Government of Canada's Future Skills Program.

FSC is a forward-thinking centre for research and collaboration dedicated to preparing Canadians for employment success. We believe Canadians should feel confident about the skills they have to succeed in a changing workforce. As a pan-Canadian community, we are collaborating to rigorously identify, test, measure, and share innovative approaches to assessing and developing the skills Canadians need to thrive in the days and years ahead. The Future Skills Centre was founded by a consortium whose members are Toronto Metropolitan University, Blueprint ADE, and Signal49 Research.

Introduction

Canada is advancing into a new era of digital transformation, with digital twin technologies emerging as a powerful tool for enhancing decision-making, operational efficiency, and sustainability across sectors. These technologies—virtual representations of physical environments—are reshaping how organizations collect, analyze, and act on data in real time. Their relevance spans smart cities, agriculture, mining, forestry, utilities, and construction, where they enable integrated data systems that support more informed and agile responses to complex challenges.

Digital twins are particularly valuable in contexts where rapid decision-making and system optimization are critical. For example, in agriculture, digital twins can integrate sensor data, weather forecasts, and market information to guide planting and fertilization strategies. In urban planning, they can simulate traffic flows, energy consumption, and emergency response scenarios. These applications demonstrate the transformative potential of digital twins to improve productivity, reduce environmental impact, and enhance public safety.

Despite their promise, the adoption of digital twin technologies remains uneven across Canada. Many organizations are familiar with individual components—such as GIS platforms, sensors, autonomous vehicles or IoT devices—but lack the systems-level thinking required to integrate these tools into cohesive digital twin platforms. This gap is particularly evident in British Columbia, where sector leaders have expressed interest in digital twins but face barriers related to workforce capacity, training accessibility, and institutional support.

This research project, funded by Future Skills Canada, investigates the opportunities and challenges associated with adopting digital twin technologies in British Columbia. It aims to develop an industry-defined reskilling framework that supports sustainable training programs and fosters collaboration between industry and educational institutions. The project is guided by three core questions:

- What are the essential digital twin skills and competencies across sectors?
- What barriers exist to training and adoption?
- How can training programs be designed to be flexible, accessible, and aligned with industry needs?

This report anticipates their relevance to policy, practice, and behaviour. The project is expected to inform workforce development strategies by identifying the types of training and delivery models that best support digital twin adoption. These insights will contribute to Future Skills

Canada's strategic goals by helping to build inclusive, responsive, and future-ready training ecosystems. Specifically, the project will support the development of scalable, modular learning opportunities that reflect real-world needs and promote cross-sector collaboration.

The anticipated impact of this research extends beyond curriculum design. By identifying the skills and competencies needed for digital twin adoption, the project will help shape hiring practices, professional development strategies, and institutional partnerships. It will also support policy makers in understanding how digital transformation is affecting labour markets and where targeted investments in training infrastructure are most needed. The framework developed through this project is designed to be adaptable, allowing for implementation in diverse organizational contexts and geographic regions.

The report is structured as follows:

- **Methodology** outlines the qualitative and quantitative research design.
- **Key Findings** presents the major themes that emerged from interviews and survey data.
- **Solutions and Recommendations** introduces a five-stage framework for reskilling and training delivery.
- **Conclusion** reflects on the broader implications for workforce development and future research.

Together, these sections provide a roadmap for understanding and addressing the workforce challenges associated with digital twin technology adoption. By aligning training strategies with industry needs and national priorities, this project offers practical solutions for building a future-ready workforce in British Columbia and across Canada.

Literature Review

The world is increasingly saturated with data—from personal health and financial information to global-scale climate metrics. Making sense of this data to support informed decision-making is a growing challenge across sectors (Ali et al. 2024). Digital twin platforms offer a transformative solution: they integrate diverse data streams into dynamic, virtual representations of physical environments, enabling real-time monitoring, simulation, and optimization (Jeddoub et al. 2024, Ranatunga et al 2024). These technologies are not only reshaping how organizations operate, but also redefining the skills required to manage and interpret complex spatial systems (Metcalfe et al. 2024).

Digital twins are projected to grow from a $17.7 billion to a $259.3 billion global industry between 2024 and 2032 (Fortune Business Insights, 2025). This growth reflects a broader shift toward data-driven decision-making and the increasing demand for integrated systems that can simulate and optimize real-world processes. In agriculture, for example, digital twins can guide planting and fertilization strategies based on real-time soil analysis, weather forecasts, and market data (Zhang et al. 2025). In urban planning, they can simulate traffic flows, energy consumption, and emergency response scenarios, helping cities become more resilient and efficient (Hooli 2025). In mining, companies have reported a 20% reduction in unexpected work stoppages after implementing digital twins, while broader studies show up to a 15% reduction in carbon emissions across North American firms (Hexagon, 2024). These technologies are also increasingly relevant to community development, where they can help visualize and manage complex systems like energy grids, transportation networks, and emergency services (Ye et al. 2023).

Despite their potential, the adoption of digital twins remains uneven across sectors. Many professionals are familiar with individual components—such as GIS platforms, sensors, autonomous vehicles or IoT devices—but lack the systems-level thinking required to integrate these tools into cohesive digital twin platforms (van Beek et al. 2023). This fragmentation is evident in British Columbia's sectors such as construction where only 23% of firms currently leverage digital twins in their decision-making (Datta, 2024). Time constraints, budget limitations, and lack of training further restrict adoption, especially among small and medium-sized enterprises (Omowole et al. 2024).

Canada's position in global digital twin research also highlights a need for strategic investment. The country ranks 15th in the production of new knowledge in this field (Jansen, 2021), suggesting that while interest is growing, more coordinated efforts are needed to build capacity and expertise. This includes not only technical training but also the development of frameworks that support cross-sector collaboration and knowledge sharing. The literature points to the importance of creating environments where industry, academia, and government can work together to co-design solutions that are both scalable and contextually relevant.

However, a recurring theme in the literature is the misalignment between traditional academic models and the evolving needs of industry (Strain et al. 2023). Conventional training approaches—centered on lectures, assessments, and rigid curricula—are increasingly seen as inadequate for preparing workers to engage with emerging technologies (Hazrat et al. 2023). Employers consistently emphasize the value of hands-on experience, adaptability, and the ability to learn on the job. This has led to growing interest in alternative training models, such as micro-credentials, modular learning, and experiential education, which allow learners to acquire specific competencies in flexible and applied formats (Gamage and Dehideniya 2025) .

The literature also highlights the importance of equity and accessibility in training delivery. Many organizations face logistical barriers to professional development, including cost, time, and lack of awareness of available programs (Adegbite 2024). These barriers disproportionately affect smaller organizations and those operating in remote or underserved regions (Srivastava 2024). Addressing these challenges requires a shift toward community-driven training ecosystems that prioritize inclusivity and responsiveness. This includes designing programs that are self-paced, low-cost, and tailored to the specific needs of different sectors and regions.

In addition to technical skills, the literature emphasizes the need for systems thinking and interdisciplinary collaboration (Hazrat 2023). Digital twin technologies require professionals to understand how data flows across systems, how different technologies interact, and how decisions in one domain can affect outcomes in another (Nicoletti, B. & Appollon 2025). This calls for a workforce that is not only technically proficient but also capable of navigating complex, interconnected environments (Vasquez-Lopez 2025). Training programs must therefore go beyond tool-specific instruction to foster broader competencies in data literacy, spatial reasoning, and collaborative problem-solving.

In summary, the context for this research is shaped by a convergence of technological opportunity and workforce readiness. Digital twins offer a powerful tool for addressing complex challenges, but their adoption depends on the ability of the workforce to engage with integrated systems thinking and cross-disciplinary skills. The literature underscores the urgency of developing training models that are flexible, inclusive, and aligned with industry needs. This project contributes to that effort by evaluating the state of DT adoption in BC and proposing a scalable framework for reskilling the workforce, one that is grounded in real-world applications and designed to support Canada's transition to a digitally empowered economy.

Methodology

This research project employed a mixed-methods approach to explore the adoption of digital twin technologies across key sectors in British Columbia. The study was designed to be both **exploratory**—seeking to uncover emerging trends and perceptions—and **descriptive**, aiming to document current practices, barriers, and opportunities related to workforce training and technology integration.

Phase 1: Semi-Structured Interviews

The first phase of the research involved in-depth, semi-structured interviews with representatives from five organizations operating in sectors including mining, forestry,

environmental management, emergency response, construction, and data acquisition. These interviews were designed to capture qualitative insights into:

- Current use and perceptions of technologies
- Barriers to adoption and integration of digital twin platforms
- Roles and responsibilities best suited to engage with these technologies
- Specific tools in use (e.g., GIS, drones, IoT, AI analytics)
- Emerging skill trends and training practices
- Barriers to accessing training and ideas for improvement

Participants were selected based on their active involvement in technology use or workforce development within their organizations. The interviews were conducted virtually and recorded with consent, then transcribed and coded for thematic analysis.

Phase 2: Sector-Wide Survey

Insights from the interviews informed the development of a 30-question survey, which was distributed via email to a broader network of professionals across relevant sectors. The survey targeted both employers and employees and aimed to quantify:

- Organizational characteristics and respondent roles
- Level of digital twin-related technology use
- Familiarity and engagement with digital twin-related technologies
- Types of data and tools in use
- Perceptions of training needs and barriers to adopt digital-twin related technologies
- Opinions on the suitability of current academic models for delivering relevant training

The survey was distributed to 455 individuals and received 143 responses, resulting in a response rate of 31.43%. This sample included a diverse range of sectors and roles, allowing for comparative analysis across different levels of engagement with technologies.

Phase 3: Data Analysis

Survey responses were analyzed using descriptive statistics and cross-tabulations to identify patterns in technology use, training delivery, and perceived gaps. The data was segmented by:

- Sector (e.g., mining, forestry, construction)

- Role (employer vs. employee)
- Level of digital twin-related technology engagement

This segmentation enabled the research team to triangulate findings from the interviews and survey, identifying consistent themes and sector-specific nuances. The qualitative data from interviews was coded using a grounded theory approach, allowing themes to emerge organically from participant responses.

Limitations and Interpretation

While the study provides valuable insights into the current state of digital twin adoption and workforce readiness, several limitations should be noted:

- The sample size, while diverse, may not fully represent all sectors or geographic regions in British Columbia.
- Survey responses were self-reported and may reflect individual perceptions rather than organizational policy.
- The rapidly evolving nature of digital twin technologies means that findings represent a snapshot in time and may shift as adoption increases.

Despite these limitations, the mixed-methods approach provides a robust foundation for understanding the challenges and opportunities facing the workforce related to digital twin technologies. The triangulation of qualitative and quantitative data strengthens the validity of the findings and supports the development of actionable recommendations.

Equity, Inclusion, and Innovation

This project also incorporated equity and inclusion considerations into its design. Efforts were made to include organizations of varying sizes and capacities, including those operating in remote or underserved regions. The survey was designed to be accessible and inclusive, with language that avoided technical jargon and allowed respondents to self-identify their sector and role.

Innovatively, the project emphasized co-design principles by engaging stakeholders early in the research process. Interview participants were invited to reflect on training models and propose ideas for improvement, which directly informed the survey design and the development of the reskilling framework. This participatory approach ensures that the recommendations are

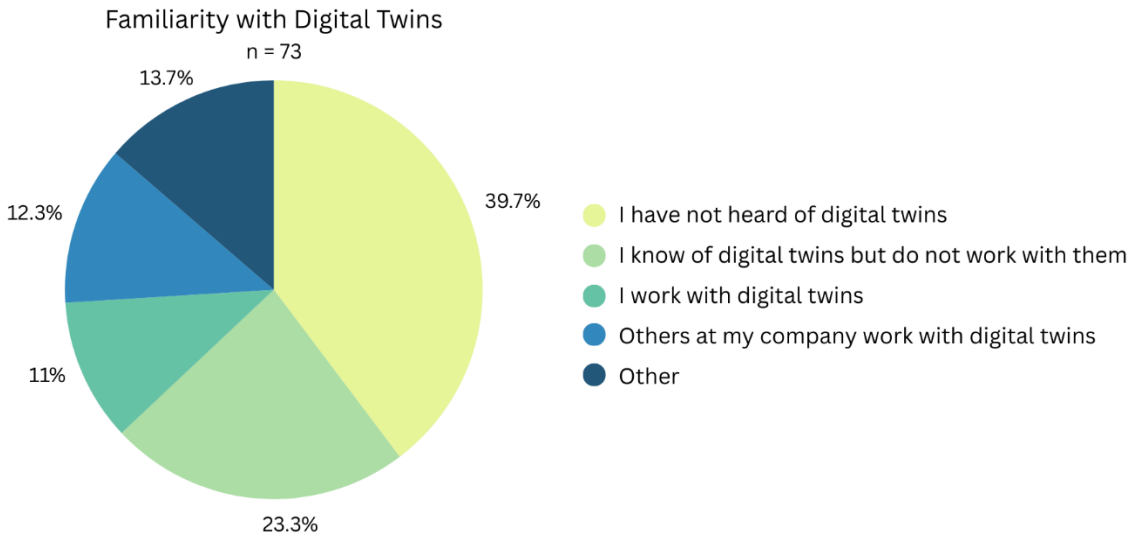
grounded in real-world experience and reflect the needs of those most affected by digital transformation.

Key Findings

This section presents the key themes that emerged from the interviews and survey responses. The findings have been triangulated across both qualitative and quantitative data sources and are organized around three major themes that are most relevant to workforce development, training design, and policy innovation.

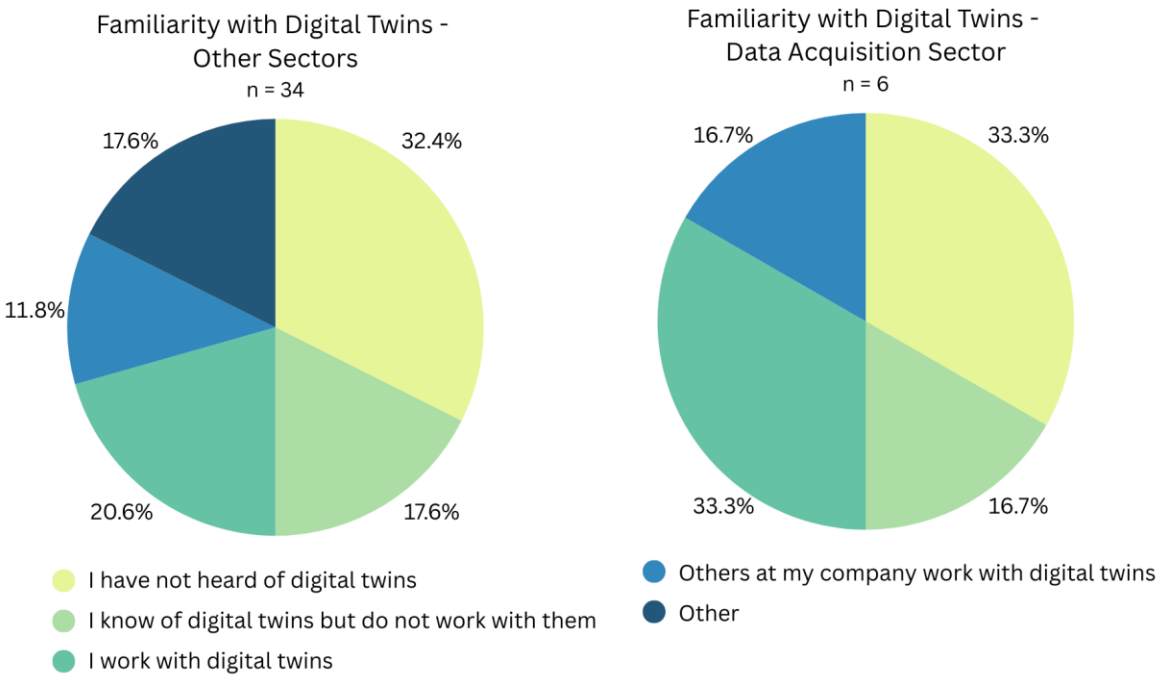
A. Fragmented Understanding of Digital Twins

Across sectors, there is growing awareness of technologies and digital twins, but understanding remains fragmented. From the survey, 40% of respondents were unfamiliar with the term 'digital twins'. Many organizations are familiar with individual components—such as GIS platforms, sensors, or drones—but struggle to see how these tools integrate into a cohesive digital twin system.

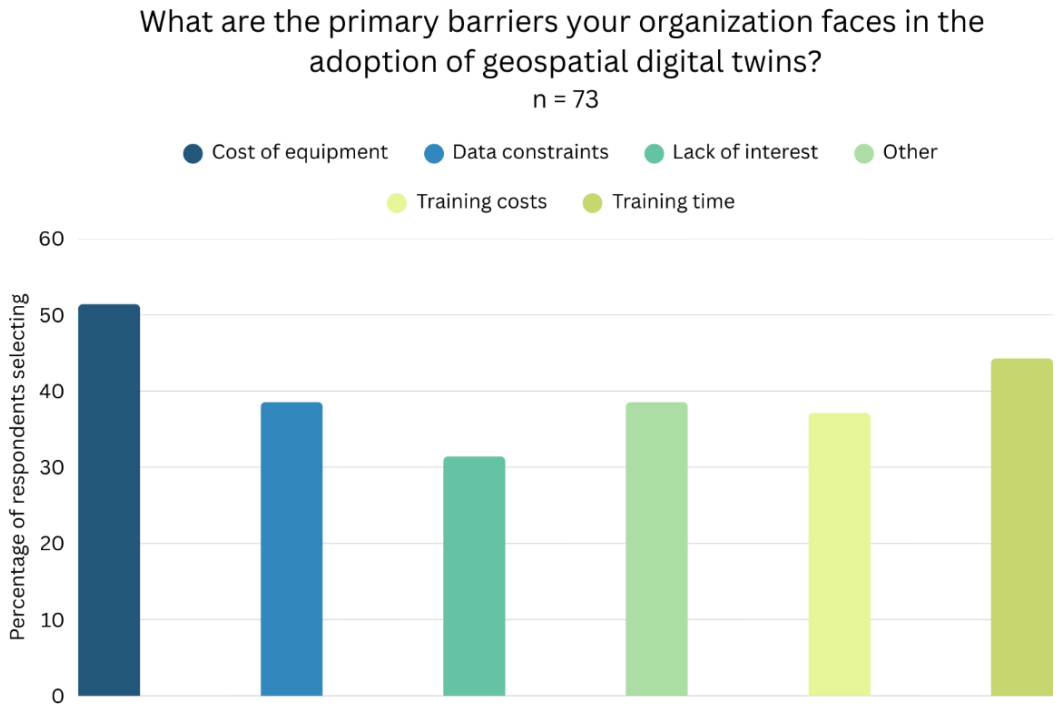


"[I] have not heard of [Digital Twins], but rely heavily on 3D models constructed using spatial data"

Two sectors stood out as being further along in the adoption of digital twins. Of the respondents that self-identified as working in the Data Acquisition sector, a third of these respondents reportedly already work with digital twins (much higher than the 11% of all respondents). The 'Other' sector is composed of respondents who felt their work lay outside of the given sector options and typed in their respective sectors. This group of people also had a much higher percentage of individuals that already work with digital twins (20.6%). Of the respondents that selected 'Other' as their sector and work with digital twins, most described their sector as land surveying/management, or consulting.



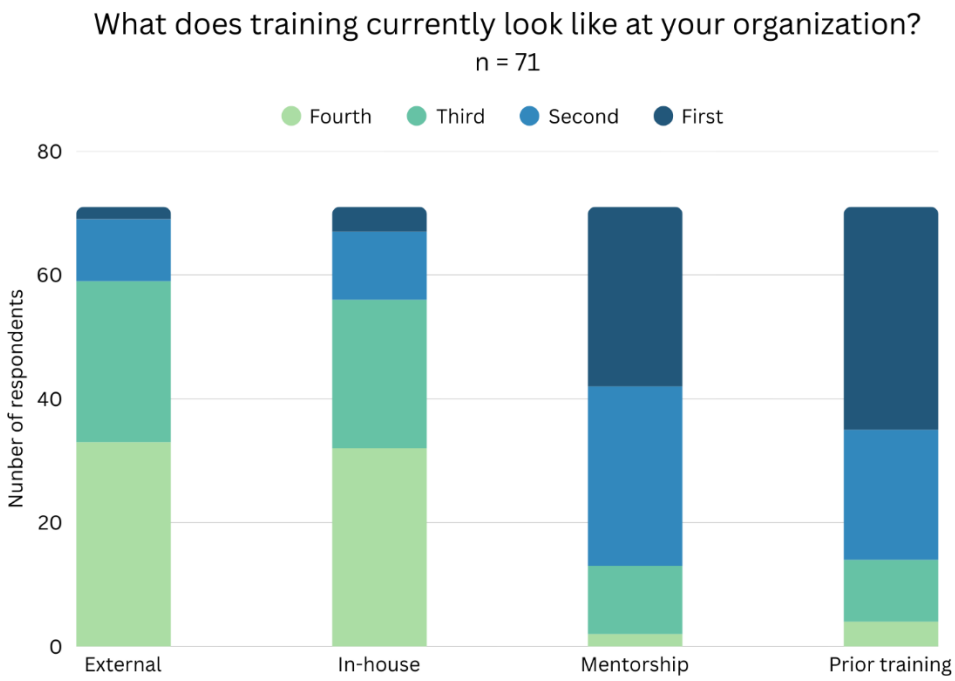
Organizations expressed interest in technologies that support real-time decision-making and operational efficiency, but adoption is often constrained by limited internal expertise and a lack of accessible training. This signals a need for educational resources that demystify digital twins and show how they can be practically applied across different contexts—from farms and forests to cities and industrial operations.



"This [Digital Twins] sounds like an amazing technology with lots of applications, but our lack of capacity and understanding would hamper the uptake"

B. Skills Over Credentials: How Employers Approach Training and Hiring

Employers consistently emphasized the importance of hiring individuals who are both skilled and trainable. When asked to rank the types of training that are utilized by organizations, 35% of respondents said that their primary approach is to rely on the existing training of employees, with less than 10% utilizing formal in-house or external training for their employees.



Rather than focusing solely on formal credentials, employers value hands-on experience, adaptability, and the ability to learn on the job. Co-op experience and practical training were seen as more valuable than advanced degrees in many cases with 37% of survey respondents indicating that work experience was the most valuable asset when hiring, followed closely by a bachelor's degree in a relevant field. Obtaining a Bachelor's or Master's degree in any field was by far the least appealing, demonstrating that employers prioritize domain-specific experience and practical skills over generalized academic qualifications when hiring. The survey also revealed a lack of interest in microcredential certification when hiring, as only 7% chose this as their preferred option (primarily from the Data Acquisition sector), while almost 40% ranked this fourth out of the six choices.

This finding suggests that training programs should prioritize experiential learning and task-based instruction over traditional academic formats. Employers are looking for candidates who can immediately contribute to operations and adapt to evolving technologies. This has implications for how post-secondary institutions design and deliver training, particularly in emerging fields like digital twins.

One interviewee noted:

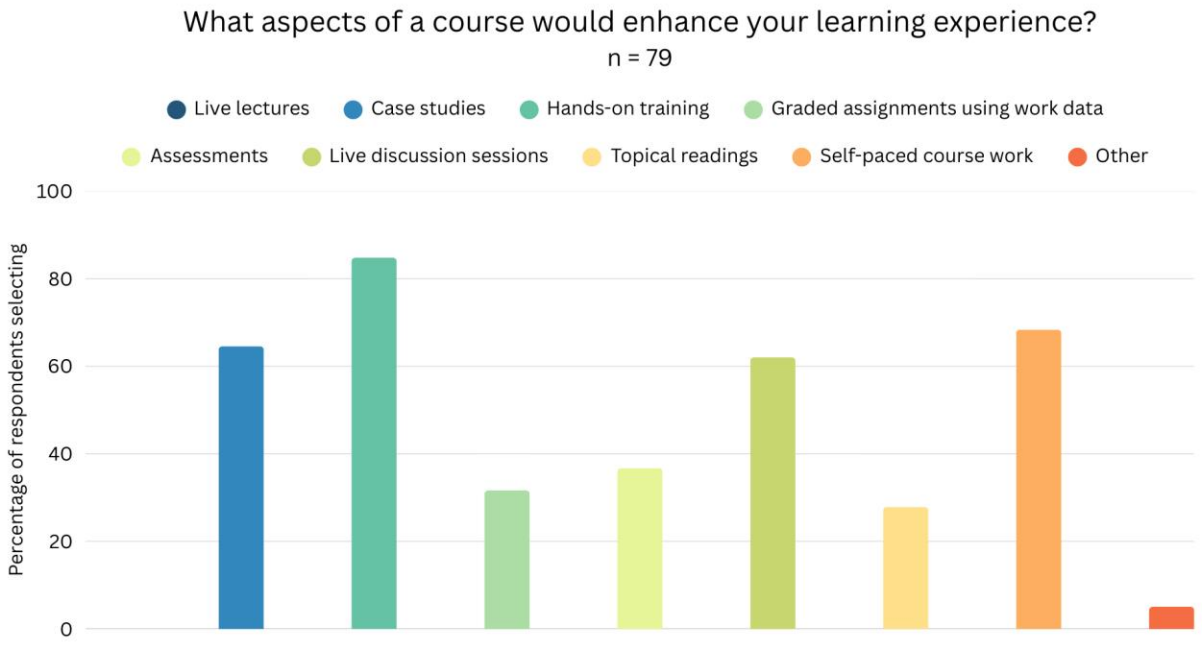
"Training is mostly done through hiring and mentorship. Although management is very supportive of professional development courses. I would say the lack of professional development opportunities is the biggest barrier to training."

This raises a critical question: can skills-based learning replace the perceived need for advanced degrees? The findings suggest that many employers would prefer candidates with the right skills and practical experience over those with general higher academic qualifications but less hands-on exposure.

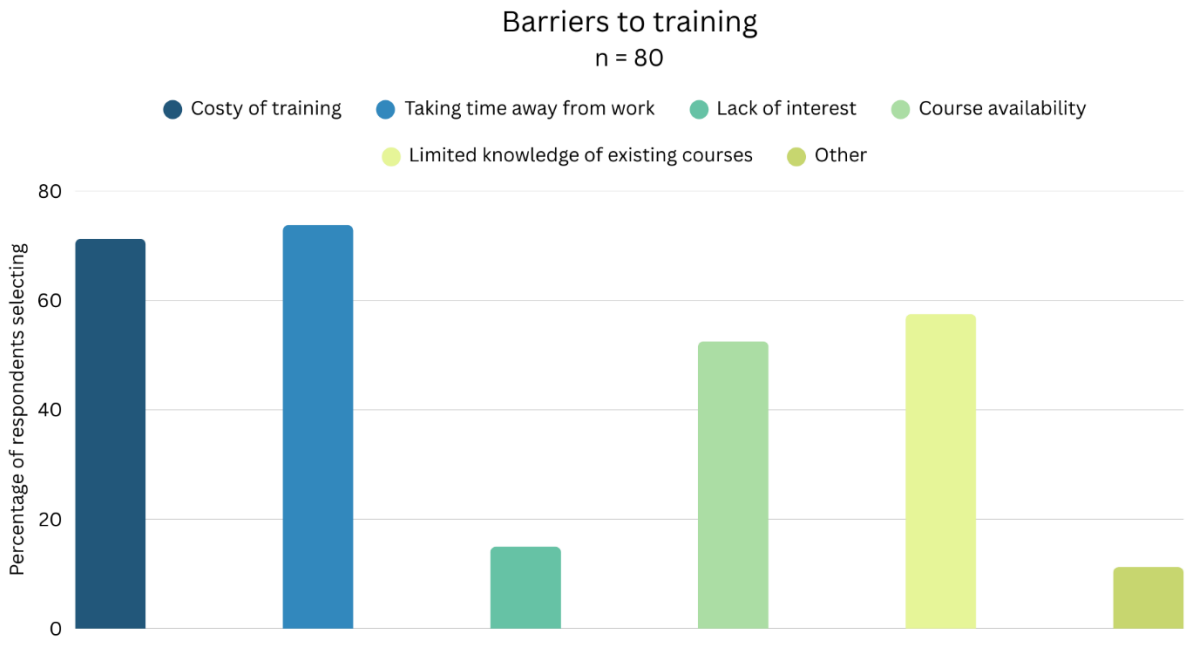
C. Academic Models Misaligned with Industry Training Needs

The survey results emphasize a growing concern that the traditional academic model—centered around lectures, grades, and rigid curricula—is seen as misaligned with industry needs. While there is a desire to engage in training, respondents overwhelmingly expressed an improved ability to complete tasks and an interest in the content as their main drivers for taking a course. Furthermore, only 29% selected obtaining a certificate such as a microcredential from a university as a motivation.

Respondents expressed a strong preference for hands-on, real-world learning and implementation-based assessment over conventional delivery. As an example, no participants stating an interest in live lectures, and a small number stated that training should include assessments such as quizzes, graded assignments, or topical readings. Instead, respondents were more interested in a self-paced delivery, hands-on training and live interactions with instructors and other students



Regardless of the training format, it is clear from the survey results that the most significant barrier to training is logistical, with cost of training and taking employees away from their work tasks for training being a concern for over half the respondents. Respondents also mentioned that awareness (58%) and availability (53%) of courses being significant hindrances to training.

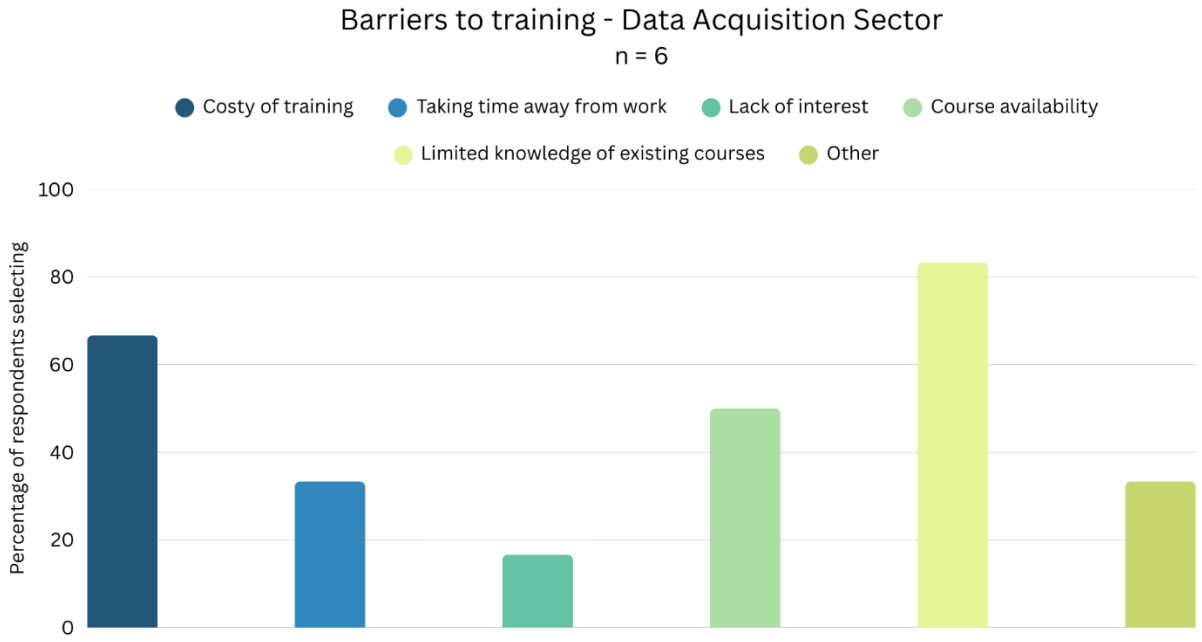


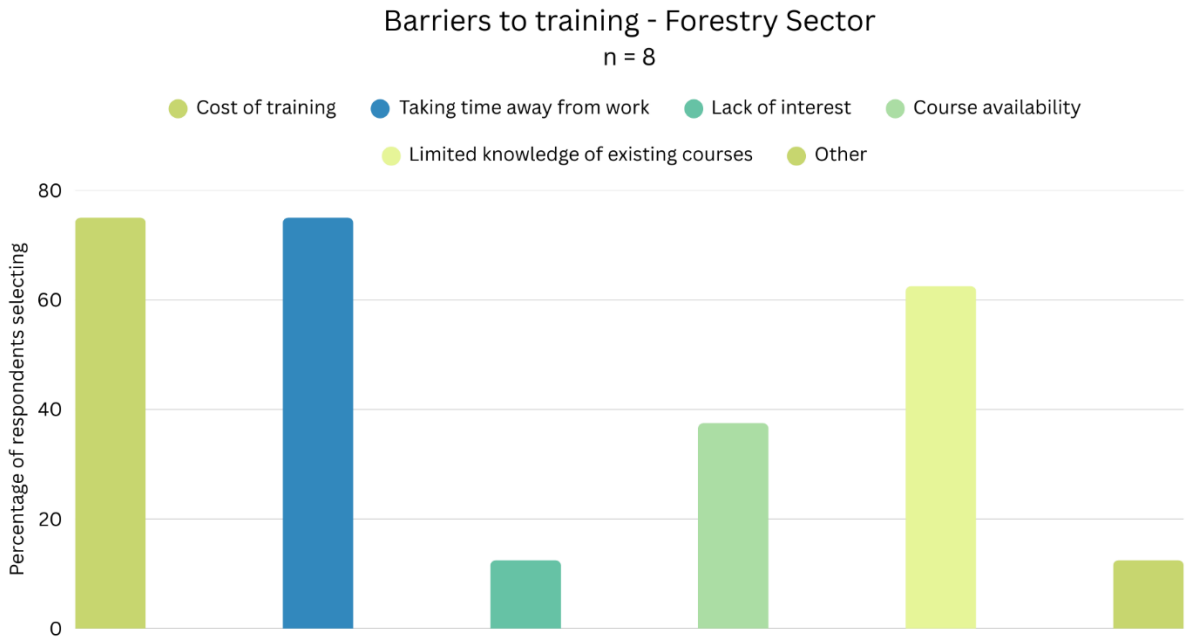
These findings suggest a need to "flip the script" on higher education—moving from a top-down curriculum design to collaborative, flexible, and experiential learning environments that better reflect the realities of today's workforce.

"The ability for applicable courses to be taken remotely while employee still works." - Response to survey question about barriers to training.

Interestingly, looking at these responses by sector, the Data Acquisition sector indicated that lack of knowledge of existing courses was a higher barrier to training than cost or time. Over 80% of the respondents who identified as working in the Data Acquisition sector selected this barrier in comparison to 67% for cost of training and 33% for the loss of time. Forestry similarly ranked this lack of knowledge quite high (62%) although not as highly as cost of training or time

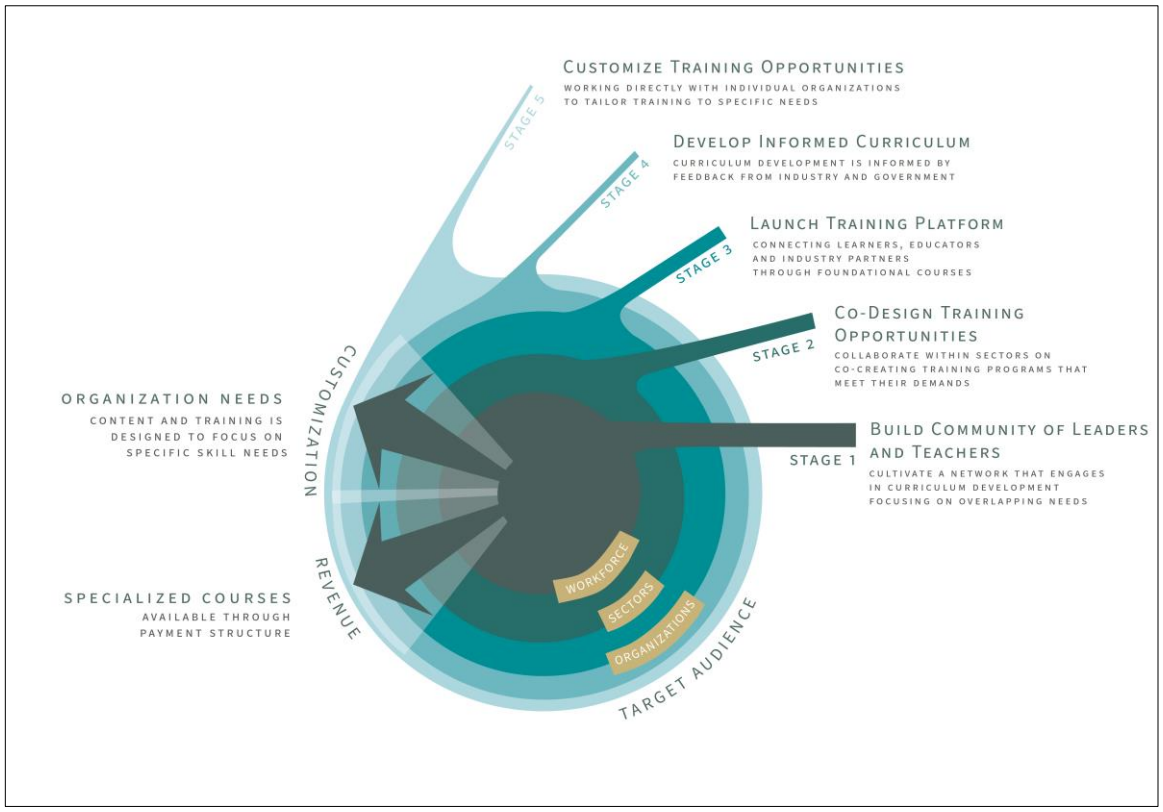
(both 75%).


Barriers to training - Data Acquisition Sector
n = 6
Costy of training
Taking time away from work
Lack of interest
Course availability
Limited knowledge of existing courses
Other
Percentage of respondents selecting
100
80
60
40
20
0


Barriers to training - Forestry Sector
n = 8
Cost of training
Taking time away from work
Lack of interest
Course availability
Limited knowledge of existing courses
Other
Percentage of respondents selecting
80
60
40
20
0

5. Solutions and Recommendations

To address the skills gap and support sustainable training for technologies and digital twins, this research proposes five key stages of action. These stages are designed for post-secondary institutions and training organizations to better align with industry needs and foster long-term workforce development across sectors. As shown in the figure below, these stages are focused on building a community of teachers and learners as the very first and most important step, followed by co-developing training opportunities with this community, launching a community platform for engagement, integrating feedback into improving training content and delivery, and customizing training for individual organization or sector needs.



The design of this framework places community building at the centre, and involves as many individuals and organizations in the workforce as possible. As we progress through the stages, courses and content become more specific and customized for certain sectors and audiences, utilizing relationships built and lessons learned from the initial stages. The final stage targets organizational needs with more specified content and skills development. Costs for training at the initial stages should be minimal or non-existent and increase as content becomes more

targeted. This cost model facilitates relationship building at its core, and the potential for revenue generation once the foundations of the community have been built and more sophisticated training opportunities become available.

Stage 1: Build Your Digital Twin Community

A thriving digital twin training ecosystem begins with a strong, engaged community of learners, educators, and industry partners. Institutions should foster networks that support peer learning, mentorship, and collaborative curriculum design—especially around spatial data, systems integration, and real-time analytics.

- Create a network of learners, educators, and technical experts
- Focus on overlapping needs across sectors using digital twin tools
- Engage the community in co-developing curriculum aligned with digital twin workflows

Stage 2: Co-Design Digital Twin Training Opportunities

Training programs are most effective when co-created with industry partners who understand the real-world demands of digital twin implementation. With 68% of survey respondents emphasizing the importance of self-paced learning, programs should be modular, task-based, and grounded and systems thinking.

- Collaborate with a small number of organizations using digital twin platforms
- Emphasize self-paced, task-based learning focused on spatial reasoning and data integration
- Ensure curriculum is modular and adaptable across sectors
- Target transferable skills such as data literacy, simulation, and collaborative problem-solving

Stage 3: Launch the Digital Twin Training Platform

Once training content is co-designed and tested, institutions should build a platform that connects learners, educators, and industry partners. This platform should reflect the dynamic, layered nature of digital twin systems and support continuous feedback and iteration.

- Use partner networks for outreach across sectors using digital twins
- Offer foundational courses at low or no cost (71% cited cost as a major barrier)
- Feature industry voices from digital twin implementation projects
- Create short, focused content (73% cited time as a major barrier)
- Encourage feedback and iteration to reflect evolving technologies

Stage 4: Expand Digital Twin Curriculum

Curriculum development should be a continuous process, informed by feedback from industry, government, and technology providers. As digital twin technologies evolve, training must remain responsive to new tools, standards, and use cases.

- Work in a feedback loop with digital twin adopters
- Build new training opportunities based on emerging technologies
- Maintain flexibility in curriculum design to accommodate diverse platforms and data types

Stage 5: Customize Digital Twin Training

At this stage, institutions work directly with individual organizations to tailor training to their specific digital twin use cases—whether in infrastructure, agriculture, urban planning, or environmental monitoring.

- Adapt existing flexible curriculum to specific digital twin applications
- Deliver training to smaller audiences with targeted needs
- Position universities as facilitators of digital twin innovation and workforce development

5. Conclusion

As British Columbia and Canada more broadly navigate the accelerating pace of digital transformation, technologies and digital twins are emerging as critical tools for enhancing decision-making, operational efficiency, and sustainability across sectors. This research has

revealed both the promise and the complexity of adopting these technologies, particularly in relation to workforce readiness and training.

Through interviews and a sector-wide survey, we identified key barriers to adoption—including limited understanding of digital twin systems, constrained training resources, and a disconnect between traditional academic models and industry needs. At the same time, we uncovered strong interest in hands-on, skills-based learning and a desire for training that is flexible, relevant, and co-created with industry.

The five-stage solution presented in this report offers a roadmap for post-secondary institutions and training organizations to respond to these needs. By building communities of learners and educators, co-designing training with industry, launching accessible platforms, continuously updating curriculum, and providing custom training, institutions can reposition themselves as facilitators of workforce development rather than traditional content providers.

This approach not only supports the adoption of digital twins but also lays the foundation for a more agile, responsive, and inclusive training ecosystem—one that can evolve alongside technological change and meet the diverse needs of sectors across British Columbia and beyond.

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