NGen
Next Generation
Manufacturing Canada

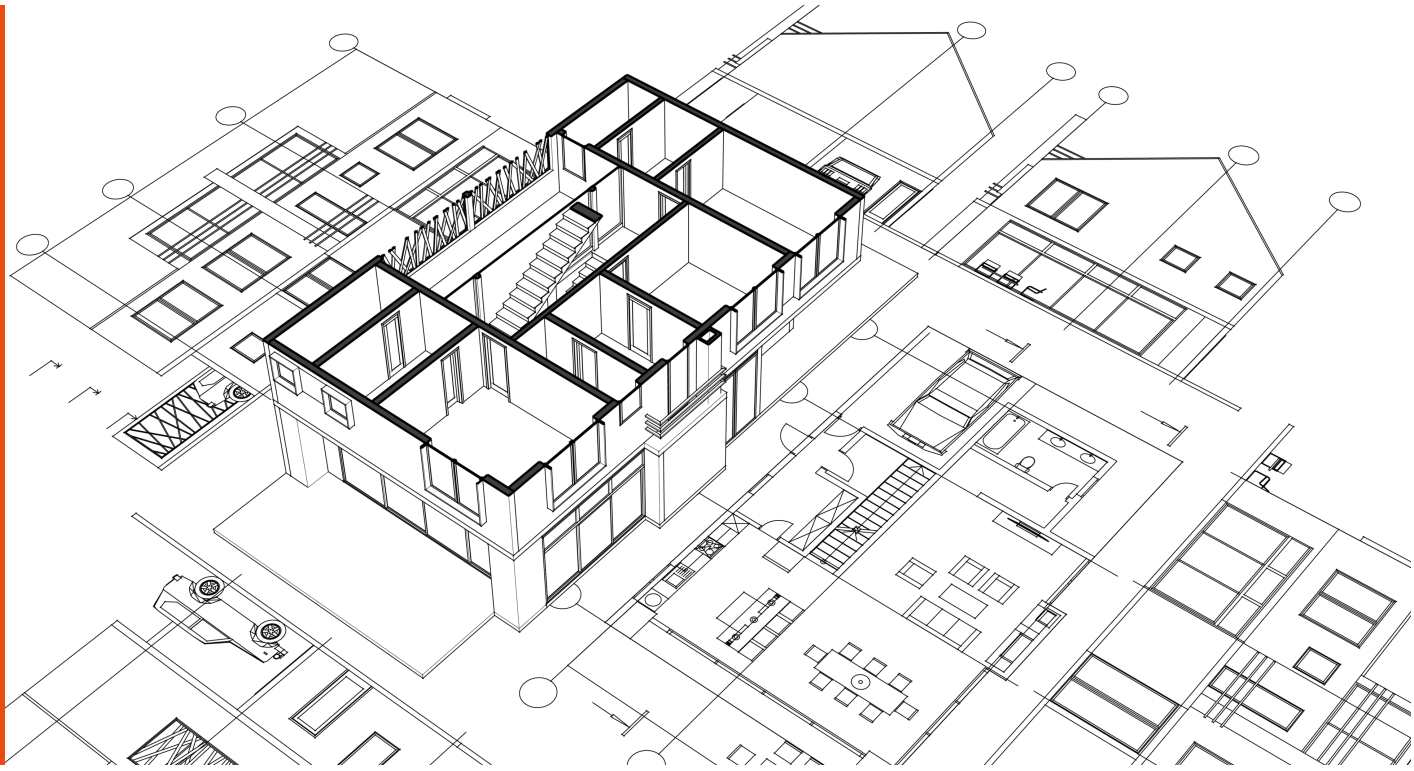
Modernizing Canada's Construction Workforce:

Mapping a Skills Development Path Forward

DEFINING OFF-SITE CONSTRUCTION (OSC)

Off-site construction (OSC) is a type of **Modern Method of Construction (MMC)**, which is defined as a range of building methods that are designed to be more efficient and effective than traditional construction techniques. OSC involves the manufacture of elements, components, or modules in a factory to be transported and assembled on a construction site; these components may include volumetric 3-D units such as bedrooms, bathrooms, and kitchens, or non-volumetric 2-D panels such as walls, floors, and roof trusses (OCRC, 2025).

OSC offers many benefits to the construction sector and to society at large. In traditional construction, tasks typically follow a linear, step-by-step sequential process wherein each phase must be completed before the next can begin. For instance, the foundation of a traditionally built home must be fully constructed before the floors can be installed, and wall framing cannot begin until both the foundation and flooring are in place. Off-site construction, by contrast, enables parallel workflows that significantly enhance efficiency. While the home's foundation is being poured on site, components such as floors, wall panels, and roof trusses can be fabricated simultaneously in a controlled off-site environment. Increased efficiency, waste-mitigation, and mass production collectively contribute to substantial cost-savings which may have the potential to support housing availability and affordability for Canadians (OCRC, 2024).



SKILLS FOR OSC

OSC draws on many of the same foundational skills found in traditional construction, but the application of those skills shifts significantly from hands-on labour toward predictable, automated, and technology-driven workflows.

Rather than performing sequential tasks on a jobsite, OSC leverages controlled factory settings where standardized and repeatable processes reduce the need for manual labour. This shift does not eliminate traditional competencies but instead reframes and contextualizes them within the manufacturing sector. As such, foundational trade knowledge used in traditional construction remains critical, yet its application leverages technology and automation; as the demand for these skills grows, traditional construction tradespersons, designers, labourers, and managers will require upskilling and reskilling to avoid lagging behind. Research highlights six areas for upskilling/reskilling for OSC in order to adapt traditional construction practices to manufacturing contexts:

1. Digital design,
2. Estimating,
3. Manufacturing,
4. Logistics,
5. Site management, as well as
6. On-site placement and assembly (Brennan et al., 2017).

Upskilling

In the shift to OSC, designers will still rely on core architectural and engineering principles but will require knowledge of how to integrate manufacturing and assembly considerations from the outset. Estimators will still evaluate materials and labour costs, yet OSC's repetitive production will require leveraging OSC's predictability to create supply-chain efficiencies. Logistical considerations made by project managers will shift from managing day-to-day operations on-site, to coordinating large, pre-assembled components across multiple production facilities. On-site construction traditionally conducted by labourers, framers, and other skilled trades will instead draw on the technical expertise of transportation specialists and assemblers who can deliver, hoist, and piece together large prefabricated OSC components, as manual trades that typically build a house from the ground-up on-site will move to assembly lines off-site. Finally, site management will evolve as managers will need unique skillsets to maintain safety protocols tailored to heavy machinery operation and rapid installation.

Reskilling

While these are just some of the nuanced differences in skills development for OSC adoption, the most significant transformation occurs in the manufacturing phase, where traditional trades remain essential but shift drastically with the adoption of manufacturing technologies. In off-site construction, traditional trades are supplemented with enhanced technology and automated machinery. Carpenters and framers, for instance, work alongside CNC machines, automated saws, and digital cutting tables that translate BIM models into manufactured components, improving accuracy and reducing material waste. While still often occurring on-site post-installation, OSC has the potential to see electricians pre-wire panels on assembly lines, and instead of traditional on-site rough- ins, plumbers can assemble fully integrated or pre-installed systems within wall panels and floors (National Electrical Contractors Association, n.d.). The evolution of skills for OSC reflects its hybrid nature, merging construction and manufacturing.

APPROACHES TO SKILLS DEVELOPMENT

Gaps in skill development have been widely recognized as a major barrier to OSC uptake globally, prompting governments to embed workforce training into broader sectoral strategies, in collaboration with educational institutions and industry partners (Solin et al., 2025). Among the countries leading this shift, the United Kingdom and Singapore stand out, not only for the scale of their modernization of the construction field, but for their intentional approach to tie workforce development upskilling and reskilling to long-term national goals in the construction sector and as part of a larger strategy to address housing insecurity.

The UK's *Construction 2025 Strategy* and Singapore's *Built Environment Industry Transformation Map* (ITM) both set explicit targets for 2025, leveraging these milestones to mobilize industry, education providers, and government agencies to adopt a shared vision. Their approaches offer two different models for skills development, pivotal to OSC adoption. In the UK, a "centralized approach" to OSC skills development has been undertaken, offering specific programs on MMC that follow a standardized curriculum across institutions. An alternative approach has been taken by Singapore, which concentrates on creating "specializations" in MMC through graduate certificates and micro-credentials, as well as incorporating OSC skills into existing programs, such as engineering and architecture (Solin et al., 2025).

The United Kingdom

The UK exemplifies a ***centralized approach*** to the development of off-site construction (OSC) skills, supported by a national vision for construction sector reform (Solin et al., 2025). The UK approach has been shaped by government strategy, close collaboration with industry, and technical education.

Government Strategy

For the UK, revolutionizing the construction workforce can be attributed to advocacy for construction efficiency that first began in 2013, when the UK Government released their *Construction 2025* strategy, setting out a series of ambitious targets for the sector to achieve by 2025, including a 33% reduction in initial construction costs and 50% reduction in overall project delivery time (Department for Business, Innovation & Skills, 2013). Their strategy explicitly identified Modern Methods of Construction (MMC) as a critical component to achieving these goals, arguing that smart construction, digital design, and manufacturing-led processes could improve productivity and reduce waste. To support implementation, the strategy proposed the establishment of a Construction Leadership Council (CLC), which in 2016 commissioned a review of the UK construction sector, and released the *Modernize or Die: Time to Decide the Industry's Future* report. This report identified ten "critical symptoms of failure" within the construction sector, many of which were heavily focused on labour gaps including low productivity relative to other industries, an ageing workforce, and insufficient investment in research, development, and innovation (Farmer, 2016). While acknowledging growing interest in off-site and modular construction, the report warned that without educational reform, MMC adoption could stall due to outdated perceptions, lack of capacity, and skills shortages. The report called for the development of new qualifications aligned with MMC, including higher-level technical education pathways capable of producing technicians, technologists, and managers prepared for Modern Methods and OSC practices (Farmer, 2016).

Housing Insecurity: An Urgent Need for Action

IIn addition to modernizing the sector to address workforce development and innovation, the UK was also motivated by a dire need to address housing insecurity; Modern Methods of Construction, specifically OSC, became the solution to ensure housing supply could meet demand, following the UK Government's commitment to build 300,000 homes a year by the mid-2020s. This commitment resulted in the UK Prime Minister launching *Project Speed* to efficiently meet housing needs via Modern Methods of Construction (MMC): "It is well recognised that new technology and innovation have improved productivity, quality and choice across a range of sectors and we are keen to see the same happen in housing" (Ministry of Housing, Communities and Local Government, 2019, p. 4).

A Collaborative Approach to Skills Development

Prompted by the CLC's call for a trained workforce, and coupled with the demands of Project Speed, the Construction Industry Training Board (CITB), which is the statutory industry training board for construction in England, Scotland, and Wales, called for employers and education providers to address skills gaps via new technical qualifications (Construction Industry Training Board, 2023). In the UK, Pearson Training is the largest awarding organization for BTEC (Business and Technology Education Council) qualifications. These qualifications are career-focused, vocational, and work-related courses designed for practical learning across 16 sectors, including engineering and construction. Drawing on collaborations with the CITB and industry stakeholders, Pearson developed higher technical qualifications aligned with Modern Methods of Construction, resulting in the BTEC Level 4 Higher National Certificate and Level 5 Higher National Diploma in Modern Methods of Construction in 2023 (Pearson, 2023).

The BTEC Higher Nationals in MMC provide vocationally focused training in off-site and modular construction, Design for Manufacture and Assembly (DfMA), digital construction, and Building Information Modeling (BIM), as well as sustainable construction methods and low-carbon building techniques. In England, these qualifications are overseen by the UK Department of Education; as approved Higher Technical Qualifications (HTQs), they are formally recognized within the government's reformed technical education framework. As such, these qualifications are offered using Pearson's regulated standardized curriculum and delivered through several higher educational institutions in the UK.

Figure 1: *British Off-site manufacturing facility owned by Weston Group.*

Note. Image from Thomas-Alexander (2021), Construction News.

Singapore

Similar to the UK, significant housing insecurity motivated Singapore's adoption of OSC; in the 1960s and 1970s, Singapore faced a severe housing shortage.

Addressing Public Housing Needs

In Singapore, public housing construction was highly labour-intensive, dependent on outdated building methods, and reliant on foreign workers. Consequently, construction timelines were slow, and the government struggled to keep pace with rapidly rising demand. To overcome these challenges and deliver higher-quality homes, the government began implementing major reforms to modernize and streamline the public housing sector. Efforts were made to adopt prefabricated methods, resulting in the establishment of the Housing & Development Board (HDB), to adopt prefabrication technology universally by the 1980s (Sone, 2024). In order to keep up with the pace of industry and emerging technology in MMC, Singapore's Building and Construction Authority (BCA) released the *Built Environment Industry Transformation Map* (ITM) in 2017, in close partnership with industry, trade associations, institutes of higher learning, and unions (Department of Enterprise, Trade and Employment, 2020). This map set an ambitious target of 80,000 personnel trained in prefabricated construction technologies to enter the industry by 2025.

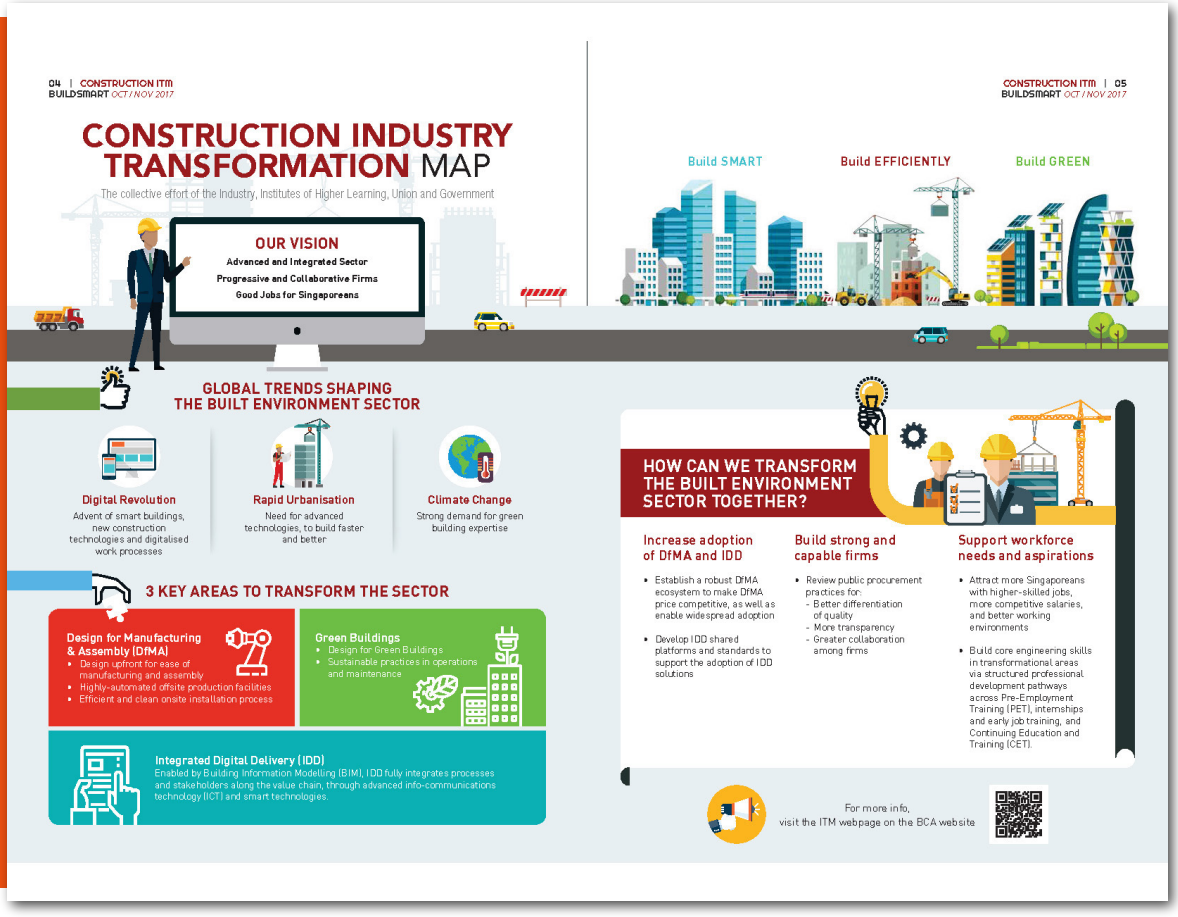
Figure 2: *Singapore's Avenue South Residence, the world's tallest Prefabricated Prefinished Volumetric Construction (PPVC) development.*

Note. Image from "Singapore's Avenue South Residence soars to new heights as world's tallest PPVC residential building," by Trade Link Media, 2022, Southeast Asia Construction. https://www.tradelinkmedia.biz/publications/7/news/3572

Developing Specialized Skills for OSC

In order to meet this goal, Singapore has taken a **specialist approach** to skills development; rather than having specific programs on off-site construction like the UK, a "Built Environment Skills Taskforce" was set up to establish niche specializations offered through structured professional development pathways across pre-employment training, internships, early job training, and continuing education (Department of Enterprise, Trade and Employment, 2020). Leveraging existing credential pathways, Singapore's Pre-Employment Training (PET), which is offered through Institutes of Technical Education, polytechnics, and universities, underwent curriculum adaptations to existing program curriculum wherein MMC proficiencies are embedded into related programs. These curriculum adaptations are informed by collaborations between trade associations and schools with representation on Academic Advisory Panels. An example of this specialization in PET is the development of Built Environment specialisations for Mechanical and Electrical engineering courses, to encourage students in broad-based courses to take up Built Environment electives related to OSC (Department of Enterprise, Trade and Employment, 2020). Furthermore, Singapore has taken a specialized approach by investing in continuing education and training for those who are in the field of construction but are looking to upskill traditional competencies to adopt MMC, in alignment with the ITM. Training opportunities in this area are offered primarily though the Building and Construction Authority Academy (BCAA), which is the leading institution for built environment training, targeting construction professionals, managers, executives, technicians, associate professionals, and construction personnel (Solin et al., 2025).

Figure 3. *Construction Industry Transformation Map.*



Note: Image from Singapore Institute of Architects (n.d.).

Canada

Similar to the UK and Singapore, Canada is facing a significant affordable housing shortage. According to Statistics Canada, in 2022, 22.0% of Canadian households reported spending 30% or more of their income on shelter costs, which is the threshold commonly used to define unaffordable housing, and in 2024, almost half of Canadians, 45%, indicated that they were "very concerned" about their ability to afford housing because of rising housing costs or rising rent (Statistics Canada 2024b; Statistics Canada 2024c). The current national housing crisis has resulted in growing rates of homelessness, with the country seeing a 20% increase in homelessness since 2018 (Statistics Canada 2024a); furthermore, nearly one in eight Canadian households report having experienced some form of homelessness in their lifetime.

Addressing the Housing Supply Gap through Skills Development

The Canadian Mortgage Housing Corporation attributes the current state of unaffordability in Canada to a "housing supply gap", defined as a significant housing shortage attributed largely to lagging housing construction (CMHC, 2023). Their report from 2023 states that "Materials have gotten more expensive, labour is in short supply, and it's hard to get financing for construction" (CMHC, 2023, p. 6). The housing supply gap has evolved into a social and economic crisis for Canadians as affordable housing supply has not adequately kept up with demand. To resolve the current crisis, CMHC estimates that 3.5 million housing units will be needed by 2030.

To address housing shortages in the UK and Singapore, developing competencies for OSC was guided by a clear national vision; both countries positioned OSC within broader construction sector reforms and placed it at the forefront of government strategies. For the UK, this included *Construction 2025* and *Project Speed*; for Singapore, it was the *Built Environment Industry Transformation Map* (ITM). Each of these strategies set ambitious goals, with education and training playing a central role. Canada's recent initiative reflects similar national priorities: *Build Canada Homes* was established in 2025 as a new federal agency designed to speed up construction of affordable housing, with a focus on innovative techniques such as factory built and prefabricated construction, aiming to cut timelines by 50% (Housing, Infrastructure and Communities Canada, 2026). While its mandate signals a growing federal commitment to scaling innovation in housing as a strategy to support affordability and availability, similar to that seen in the UK and Singapore, it does not yet outline a coordinated strategy for skills development as part of this process. As such, these countries offer a potential roadmap for Canada. Recognizing the importance of governmental investment in workforce development highlights the need for Canada to do the same, by aligning OSC upskilling and reskilling with existing higher education frameworks and government oversight to achieve national goals, which in Canada is managed at the provincial level.

Provincial Approaches to Education and Training

In Ontario, the Ministry of Colleges, Universities, Research Excellence and Security (MCURES) is responsible for overseeing Ontario's higher education and publicly funded research system; following the Ministry's directives, Ontario colleges and universities play a pivotal role in cultivating a skilled workforce. Universities are primarily focused on academic learning, research, and the development of advanced theoretical knowledge; colleges complement universities by emphasizing applied learning, hands-on training, and alignment with labour market needs, ensuring graduates are able to transition quickly into the workforce.

Ontario Universities

Ontario's universities are fundamental to preparing the workforce while advancing innovation in the construction sector. At the university level, institutions offer undergraduate and graduate programs such as those in engineering (civil and manufacturing engineering to name a few), as well as architectural science. These programs emphasize theory, research, systems thinking, and advanced technical competencies, equipping graduates for roles in design, engineering, project planning, and senior management. Universities also contribute heavily through research, innovation centres and labs, as well as industry partnerships that have the capacity to advance the sector, such as through testing modular building materials, and advancing digital tools like Building Information Modeling (BIM) and Artificial Intelligence systems (University of New Brunswick, Off-site Construction Research Centre, n.d.). Implementation of OSC within the construction sector depends equally on an applied-skills workforce with advanced hands-on, technical, and trade-based competencies. In this context, colleges complement universities, playing a particularly critical role in delivering industry-aligned training and research that bridges innovation with practical applications.

Ontario Colleges

Colleges are specifically designed to respond to industry demand by delivering real-world, competency-based education that reflects current technologies and industry trends. Similar to models seen in the UK and Singapore, these institutions partner closely with employers, unions, and industry associations to identify and address skills shortages by offering a wide range of programs, including certificates, diplomas, advanced diplomas, apprenticeships, and applied degrees across fields such as health care, business, information technology, manufacturing, humanities, and skilled trades. For the purposes of this report, the focus of skills development will be examined through colleges, because colleges in Ontario offer a wide range of construction-related programs including but not limited to carpentry and renovation techniques, architectural and civil technician, as well as construction project management. These programs combine classroom instruction with labs and on-the-job training, ensuring graduates are equipped with the skills to meet industry standards and regulatory requirements. By supplying skilled tradespeople, technologists, and site supervisors, colleges directly support Ontario's infrastructure, economic development, and housing supply. When exploring the integration of off-site construction (OSC) competencies, construction-related programs offered at Ontario colleges are complemented by a wide range of manufacturing programs, including mechanical and manufacturing techniques, which have the potential to support education and training in the adaptation of traditional construction to modern methods. These programs offer training in manufacturing processes, automation, and quality control, as well as hands-on skills in factory workflows, fabrication, and assembly. Given their role in education and training, complementary and collaborative work with related university programs, close ties to industry, and Ministry oversight, Ontario colleges are well positioned to lead workforce development for OSC, leveraging expertise from both construction and manufacturing programs.

Ontario College Program Standards

As part of overseeing relevant, industry-informed programs, the Ministry of Colleges, Universities, Research Excellence and Security establishes standardized program frameworks that all public colleges must follow, ensuring consistency in skills and knowledge development across each vocation. This governance model offers the level of oversight that contributed to the UK's and Singapore's success in adopting Modern Methods of Construction. These standards, referred to in Ontario as Vocational Learning Outcomes (VLOs), define the integrated skills, knowledge, and attitudes graduates must demonstrate to meet industry expectations, while Elements of Performance further outline how each outcome is achieved. In order to ensure competencies and skill development, VLOs and Elements of Performance are used to shape curriculum; in Ontario, all College's must teach to the same VLOs as to ensure standardized proficiency. To remain responsive to labour market demands, technological change, and evolving industry practices, college programs undergo periodic, Ministry-led program reviews. Through this process, VLOs are updated and modernized, ensuring all graduates are equipped with the most up-to-date knowledge and skills (Ministry of Training, Colleges and Universities, n.d.).

Despite advancements made in the construction sector globally, off-site construction and broader competencies in Modern Methods of Construction are not currently embedded in Ontario construction or manufacturing curriculum, with current outcomes favouring traditional and labour-intensive practices. This presents a significant barrier to the adoption of OSC. That said, Ontario's provincial standards, VLOs, and the existing program review framework provides a clear and structured pathway for modernization and innovation. The Ministry's directive for colleges to deliver practical, career-focused education, aligned with in-demand skills, positions the Ontario college system as an ideal platform for embedding OSC across construction and manufacturing programs. Due to the diversity of programs, courses, apprenticeships, and micro-credentials offered at Ontario College's, opportunities also exist for both a centralized and/or specialist approach. For OSC integration to take a centralized approach, as seen in the UK, entirely new programs in OSC may be developed and offered provincially. Alternatively, Singapore's specialist approach may offer a timelier solution wherein OSC is embedded into existing relevant program curriculum and further supported by continuing education courses or post-graduate certificates for those already in the workforce.

ONTARIO COLLEGE PROGRAM REVIEW

Programs currently offered in Ontario typically include 1- to 3-year diplomas, certificates, and apprenticeships, focusing on hands-on skills. In addition to these full- and part-time programs, Ontario colleges also offer continuing education opportunities, such as micro-credentials, post-graduate certificates, and standalone courses.

To identify opportunities for integrating off-site construction (OSC) skills, a review of existing construction-related programs at the Ontario college level was conducted.

- Vocational Learning Outcomes (VLOs) across construction programs were analyzed and reviewed for indicators of each OSC skill area: design, estimating, logistics, manufacturing, on-site assembly and placement, and site management.
- Recognizing OSC as a hybrid of construction and manufacturing, the analysis was expanded to include manufacturing programs.
- Through this review, strengths and gaps within current construction and manufacturing programs' learning outcomes were identified.

The Ontario college programs relevant to the construction sector reviewed for this report focused on disciplines that contribute directly to skills in design, construction practices, and material knowledge. Civil Engineering programs were examined, given their emphasis on planning and design; these programs were assessed for their integration of digital tools and BIM competencies. Architecture programs were also included due to their central role in architectural design, building technology, and theoretical foundations that shape the built environment. Building and Construction programs were reviewed for their applied focus on skilled trades, cost estimation, material sourcing, project coordination, and site management. Finally, Carpentry programs were evaluated to understand how colleges have embedded hands-on elements of the building process, including applied construction techniques.

In addition to construction programs, this analysis was expanded to include Ontario college programs in the manufacturing sector as a way to identify opportunities for modernizing construction-related curriculum and embedding cross-curricular knowledge. These programs cover a range of competencies relevant to off-site construction, including the production of mechanical components and assemblies, and the integration of automation and emerging technologies in the design and fabrication process. Programs reviewed included Mechanical and Manufacturing Engineering, both of which offer valuable insights into advanced production methods, automation, and factory workflows.

Construction Programs

Ontario construction programs focus heavily on traditional construction practices, which offer foundational knowledge applicable to off-site construction (OSC). In reviewing OSC-related skills, design competencies emerge as a notable strength, particularly in Architecture and Civil Engineering programs; however, few program Vocational Learning Outcomes explicitly reference BIM. While digital design skills are present, they are generally framed around permitting and visualization, mentioning the use of digital tools in broad terms. In contrast, OSC specifically places BIM at the forefront of design, due to its critical role in the manufacturing process (Widanage, 2024). BIM designs for OSC account for prefabrication and assembly specifications, which is a methodology referred to as Design for Manufacture and Assembly (DfMA), an essential component of Modern Methods of Construction that is not currently mentioned in any construction program outcomes. As such, while digital design is mentioned in several program VLOs, greater specialization in BIM and DfMA should be explicitly outlined.

In addition to design, sustainability is a recurring theme across VLOs, appearing in the majority of construction programs and aligning closely with one of the core benefits of OSC: waste mitigation. This consistent focus on sustainable design and material selection positions construction graduates well to prioritize efficiency and reduce waste during the various phases of an OSC project. That said, it is important to note that these concepts are largely framed as factors for consideration rather than as inherent to the construction process itself, as they are in OSC. Additional transferable skills from traditional to off-site construction that are addressed in existing programs include logistical skills of material ordering, labour coordination, and scheduling, which are consistently mentioned, particularly in programs such as Construction Project Management, Building Renovation Technology, and Carpentry and Renovation Techniques. Despite their presence however, these logistical skills are tailored to traditional construction contexts. OSC has a unique supply chain, order of sequence, and material sourcing demands, fueled by the pace of mass production. As such, current VLO's offer a relevant starting point, but would require modification to tailor these competencies to OSC contexts. Similarly, health and safety competencies are thoroughly integrated in existing programs; however, further training is needed as current health and safety instruction does not fully reflect the hybrid nature of OSC wherein risks span both construction sites and factories. These are governed by different regulatory guidelines within the Occupational Health and Safety Act (OHSA) and therefore need to be independently addressed in curriculum.

Despite existing program strengths, construction programs frame their content within traditional, on-site construction models, with limited to no recognition of factory-based production or Modern Methods of Construction; in fact, no programs explicitly mention MMC or OSC. Overall, construction programs offer a starting point for OSC skills development but lack emphasis on modernized approaches.

Manufacturing Programs

To explore opportunities for innovation, manufacturing programs were reviewed to explore opportunities for integration. Construction VLOs focus primarily on site-based practices, trade skills, and labour-intensive methods, with little to no reference to fabrication or factory-based production. In contrast, programs such as Mechanical and Manufacturing Engineering introduce production planning, process optimization, and quality control which are competencies required when building OSC components in controlled factory environments, leveraging technology and advanced automation. For design, traditional construction programs emphasize 3-D modeling for permitting, code compliance, and site layout. Manufacturing programs however focus on designing for fabrication, installation, and assembly, which directly aligns with OSC's Design for Manufacturing and Assembly (DfMA) principles. Manufacturing programs introduce mechanical and automation competencies essential for reskilling the construction workforce; as labour-intensive tasks such as framing and insulating shift to automated processes, workers must understand production workflows and equipment handling. With potential to address this need, manufacturing and engineering VLOs include operating machinery to manufacture, assemble, install, and repair components and systems, which are skills that directly support the transition from site-based construction to factory-based OSC.

While construction program VLOs mention sustainability in principle, OSC positions sustainability as essential. Enhanced competencies in this area are found in manufacturing programs, such as Mechanical Engineering Technology, wherein graduates are not only expected to *consider* sustainability, but also expected to *implement*, and *monitor* it. Furthermore, engineering programs mention the interrelationship of technology, society, the environment, politics, and the economy, in engineering projects. These social, political, and economic considerations are particularly relevant to OSC in the context of housing affordability; however, these themes are not currently present in construction program VLOs. Although estimation and cost are addressed, they are primarily treated as technical or managerial tasks, with limited discussion of broader social implications of affordability and its role in shaping industry practices and long-standing sector attitudes; this is a notable strength of manufacturing programs that should be extended to construction programs as well.

While manufacturing programs address several gaps in construction, it is important to note that none of these programs frame these competencies within the context of housing or provide fundamental knowledge of construction techniques. Although these programs offer competencies to bridge gaps in existing construction program curricula, a comprehensive program that addresses the hybrid nature of OSC, combining skills in manufacturing and construction, does not currently exist.

RECOMMENDATIONS

In response to housing shortages, productivity challenges, and affordability pressures, Canada must take deliberate steps to formalize the development of OSC-related skills within postsecondary education. The findings of this analysis demonstrate that while Ontario college construction programs provide strong foundational skills in construction, significant gaps remain in areas critical to OSC, as a comprehensive program that bridges construction and manufacturing competencies for OSC does not exist. Within the structure of Ontario's college system, three approaches exist for next steps: (1) the development of new OSC-specific programs; (2) targeted updates to individual construction program standards to include OSC competencies; or (3) the creation of OSC specializations through micro-credentials and graduate certificates.

1. Centralized Development of Dedicated OSC Programs

At a national or provincial level, Canada would benefit from adopting a centralized approach similar to that of the United Kingdom by establishing dedicated OSC-specific programs. New OSC-specific diploma or advanced diploma programs would allow for comprehensive coverage of the full OSC lifecycle. Dedicated program standards would ensure consistency across institutions, support industry alignment, and create a clear and recognizable pathway for graduates. Such programs could draw heavily from existing manufacturing and technologies curricula while contextualizing these competencies and merging them with existing construction program knowledge.

While countries such as the United Kingdom have demonstrated success with this model, developing new, standardized programs requires substantial time, funding, faculty expertise, and institutional commitment. Designing and launching an entirely new program dedicated to OSC would also require unique expertise that has not yet been fully developed within Canada. In addition, such programs would depend heavily on access to dedicated lab space, equipment, and relevant work-integrated learning opportunities. Given the relative newness of OSC in Canada, securing these human and physical resources and establishing strong industry partnerships will likely present significant logistical and financial barriers that may not be resolved quickly enough to address the country's dire housing supply needs. That being said, this option may serve as a long-term objective for Canada and a goal for future sector maturation, particularly as industry capacity expands, institutional expertise deepens, and demand for OSC-specific competencies becomes more firmly established across construction and manufacturing sectors.

2. Targeted Updates to Individual Construction Program Standards

A second approach to skills development could be through targeted revisions to existing construction program VLOs. This approach is particularly well suited to OSC competencies that are extensions of traditional construction skills, rather than entirely new skills to the field. The program analysis identified multiple opportunities to modernize current VLOs in areas such as design, estimating, logistics, and site management by explicitly distinguishing between traditional and off-site construction as to ensure all graduates, regardless of construction program, are prepared for the future without sacrificing current industry knowledge. Revisions would allow existing programs to produce graduates who are OSC-literate, even if not exclusively in off-site construction.

Ontario's Ministry-led system of reviewing and modernizing Vocational Learning Outcomes provides an existing framework that is well suited for this approach to support adoption; however, the program analysis indicates that the depth and breadth of manufacturing competencies required for OSC, specifically automation; factory-based machinery operation; advanced BIM knowledge; and code-compliant safe assembly, cannot be fully realized within existing construction program structures without risking overextending curricula. Reviewing all program VLOs and making incremental adjustments may rely on adding additional courses to already-demanding programs; furthermore, while the process of updating VLOs at the Ministry level may appear feasible, these changes need to be reflected in college-level curriculum which is done on an institutional basis. The expectation that individual institutions will have the capacity and faculty expertise to make these changes promptly is unlikely and will therefore significantly stall adoption; however, this approach should remain a strategic objective for the medium- to long-term future as institutional capacity and sector demand continue to evolve.

3. OSC Specializations Through Micro-Credentials and Graduate Certificates

Creating OSC specializations through micro-credentials and graduate certificates represents the most strategic and practical pathway for Ontario to advance off-site construction (OSC) quickly and effectively. Compared to launching entirely new programs or revising existing program Vocational Learning Outcomes, these credentials can be developed, approved, and delivered far more efficiently, allowing institutions to respond to industry needs in real time. Micro-credentials and graduate certificates also serve both post-graduate students and workers, allowing individuals already employed in the sector to upskill without leaving the workforce. Learners can build on traditional foundations in areas such as digital fabrication, modular design, and advanced manufacturing processes, with expertise leveraged from identified champions such as experts and OSC startups within the field, concentrated solely on curriculum development that is a far leaner process for post-graduate offerings. These programs are also typically offered during off-schedule times such as evenings and weekends, which would free up space in existing construction and engineering lab spaces and equipment.

Along with providing new opportunities for both upskilling and reskilling, this approach reflects the nature and current state of the construction sector nationally; while innovation in OSC has accelerated globally, Canada has not maintained the same pace. Traditional construction programs must continue to serve the existing labour market, which still demands conventional building practices and competencies. Attempting to significantly modify or replace these programs prematurely could create misalignment with employers who are still operating within traditional models.

Despite significant benefits, this option does still carry limitations that must be addressed. Micro-credentials and graduate certificates are narrower in scope than full diploma or degree programs, and on their own they may not provide the same depth of theoretical or technical knowledge. Furthermore, their success depends on strong coordination with employers to ensure recognition. Because unions are likely to play a central role in sponsoring or directing employees toward training, ensuring that these credentials are formally recognized and valued by unions will be critical, as seen in Singapore. Even with these considerations, however, micro-credentials and graduate certificates remain the most effective immediate mechanism for building OSC capacity in Ontario, overcoming existing program limitations, and accelerating sector-wide modernization through education and training.

CONCLUSION

As seen in the United Kingdom and Singapore, Canada is facing a significant affordable housing supply crisis, one that cannot be resolved through traditional construction methods. Off-site construction (OSC), as a form of Modern Methods of Construction (MMC), offers a viable pathway to increase productivity, reduce waste, improve affordability, and accelerate housing availability. However, as this analysis suggests, the successful adoption of OSC depends not only on technological innovation, but on deliberate and coordinated workforce development.

The review of Ontario college program Vocational Learning Outcomes (VLOs) reveals that while existing construction programs provide strong foundations in design, sustainability, estimating, logistics, and site management, they remain contextualized within traditional, site-based construction models. Critical OSC competencies such as advanced BIM integration, Design for Manufacturing and Assembly (DfMA), and factory-based production workflows, are not currently embedded in program standards. To address these gaps, manufacturing programs offer many of the technical capabilities required, highlighting a significant opportunity for cross-curricular integration. The challenge, therefore, is not a lack of existing skills, but rather the absence of a coordinated strategy to merge these two sectors. To do so, international examples demonstrate that workforce transformation of this kind must be intentional and government supported. The UK's centralized qualification model and Singapore's specialized approach each emphasize the importance of aligning education and industry with national housing goals. Ontario's Ministry-led governance framework, standardized VLO system, and strong college-industry partnerships position the province well to pursue a similarly strategic pathway to OSC, as achieved globally.

Potential options for OSC skills development include (1) the development of new OSC-specific programs; (2) targeted updates to individual construction program standards to include OSC competencies; or (3) the creation of OSC specializations through micro-credentials and graduate certificates. Of which, the latter option appears to be the most immediate and practical path forward. Creating micro-credentials and graduate certificates enables rapid upskilling and reskilling without disrupting existing construction programs that continue to serve the current labour market. It also acknowledges that while global innovation in OSC is advancing quickly, Canada's construction industry has not yet modernized. Rather than prematurely replacing established training pathways, specialized credentials allow Ontario to modernize traditional competencies and develop expertise in targeted areas while maintaining alignment with present-day industry needs. By leveraging its existing programs and expanding specialized learning pathways, Ontario can build a workforce capable of bridging traditional construction and advanced manufacturing; in doing so, the province can accelerate the adoption of OSC, strengthen productivity in the construction sector, and collaboratively address Canada's housing supply crisis.

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