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Roadmap to Transform the Canadian Construction Industry

through Industrialized Construction, Research and Innovation

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Roadmap to Transform the Canadian Construction Industry through Industrialized Construction, Research and Innovation

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Executive Summary

Industrialized Construction (IC) has the potential to transform Canada's construction industry by increasing productivity, reducing waste, and addressing labour shortages through the integration of mechanization, automation, and advanced manufacturing technologies. However, widespread adoption is hindered by regulatory inconsistencies, financial constraints, procurement challenges, and a lack of industry-wide collaboration.

This project aimed to develop a roadmap for overcoming key barriers to IC adoption in Canada. The focus was on identifying challenges and barriers from industry and developing a framework to provide practical solutions that are industry-driven, to be supported by the National Research Council. The approach to the roadmap development included:

1. **Literature Review**: A review of international best practices and previous studies on IC in Canada shaped the structure for data collection.
2. **Regional Workshops**: Workshops were held in Western Canada and Eastern Canada, facilitated by teams from UNB OCRC, UofA, and Cast Consultancy, with input from NRC.
3. **Virtual Interviews**: Additional interviews were conducted to address gaps in stakeholder representation from the workshops.
4. **Public Survey**: A public survey was distributed via trade associations and industry contacts within the construction sector to prioritize strategies for advancing IC in the construction sector.

Recommendations are based on the input, insights, and opinions gathered through workshops, interviews, and surveys conducted during this project, and reflect the perspectives of participants, which may vary across the broader stakeholder community. The key roadmap focus areas and initiatives, at a high level, include:

- **Policy and regulatory frameworks:** Simplify and harmonize approval processes, review policies and fund projects through collaborative procurement with incentives, identify opportunities in codes and policies, align municipalities with government tiers, ensure continuity in government policy.
- **Procurement models and performance systems:** Develop collaborative procurement models and quantify IC value (e.g., pre-manufactured value), improve contract language and procurement (RFPs), work with CCDC to modify contracts for IC.
- **Financial and insurance services:** Government underwriting of IC lending, tax incentives to reduce risk and drive R&D, more flexible R&D funding for industry, structured financial solutions, create best practice IC proforma, conduct case studies to identify insurance gaps for IC.
- **Awareness, competency, and collaboration:** Launch awareness campaigns, address competency gaps for IC, drive design for manufacture and assembly through value chain collaboration.
- **Quantifying Capacity and Capability for IC:** Quantify labour benefits of IC specific to Canada's climate, provide a clear picture of off-site solutions and capabilities, incentivize IC demand aligned with capacity and capability.
- **Research and data sharing:** Focus R&D on industry data capture and sharing, develop a premanufactured value toolkit to demonstrate financial benefits to owners and lenders.

The roadmap further details these initiatives, and necessary steps to implementation, providing an informed foundation for strategic investment and action by the NRC, as well as guidance for industry leaders, government policymakers, and other stakeholders aiming to advance the construction industry in Canada.

Beyond the recommendations categorized above, two overarching key recommendations to highlight include, i) for NRC to be a hub for R&D in IC with regional research clusters scattered throughout the country to lead, support, or facilitate many initiatives identified in the roadmap and ii) for the federal government to adopt a common framework with IC categorizations, terminology and definitions to facilitate IC growth across the Canadian construction sector. **Without this common framework, categorization, and definition, many of the initiatives discussed will ultimately fail.**

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1.0 Introduction

1.1 Project overview

The roadmap to transform the Canadian construction industry through research and innovation aims to identify key challenges, barriers and gaps in the adoption of IC methodologies, technologies and processes within the Canadian construction sector. Led by the University of New Brunswick's (UNB) Off-site Construction Research Centre (OCRC) in collaboration with the University of Alberta (UofA) and Cast Consultancy, this initiative will inform future R&D activities required to increase adoption of such methods at scale, and leverage industry-driven insights to prioritize and guide such initiatives.

Through a combination of workshops, structured interviews and surveys, the project gathered key data to inform a strategic roadmap that accelerates IC adoption. While this roadmap was developed through an NRC-led initiative, its purpose is to support the broader construction industry by outlining key initiatives and implementation steps that can guide strategic action across the sector. It provides a foundation not only for NRC's future investments but also for industry stakeholders, public owners and operators, policymakers, and decision-makers working across the Canadian construction sector.

1.2 Context and relevance

As part of the NRC Platform to support the 'Decarbonization of the Construction Sector at Scale', the Construction Sector Digitalization and Productivity (CSDP) Challenge Program (CP) seeks to lower construction time and cost, while improving sector innovation potential and productivity to increase the pace at which low-carbon solutions can be deployed. Improving productivity in the Canadian construction sector is directly linked to the accelerated adoption of IC technologies and processes, which requires identifying and removing key barriers to enable broader industry uptake.

To better understand the gaps and challenges in the industry in the adoption of IC, and to identify potential collaboration opportunities for the overall Platform, detailed insights from industry on current challenges and potential solutions were gathered. The overarching goal being that a roadmap to transform the Canadian construction industry through research and innovation will spur impactful products for the entire NRC Platform and provide a roadmap for the industry on areas that do not necessarily fit within the NRC Platform and CSDP Program scope.

1.3 Scope and objectives

The project focuses on identifying and developing strategies to address key barriers to adoption of IC technologies, methodologies and processes in the Canadian construction sector. The primary focus on the project is to remain industry-driven, ensuring that insights and recommendations reflect real-world challenges and opportunities. The project scope includes:

- **Identify knowledge and implementation gaps** in IC across residential, institutional, and commercial construction.
- **Engage diverse stakeholders**, including contractors, manufacturers, policymakers, regulators, and industry associations.

- **Examine regulatory, financial, and technical barriers** limiting IC adoption, such as capital costs, procurement challenges, labour shortages, and compliance with building codes.
- **Leverage global expertise**, incorporating insights from international best practices to inform Canadian strategies.
- **Develop a strategic roadmap** with prioritized R&D focus areas and actionable recommendations to support the industry's transition to IC.

The objective of this project is to develop a comprehensive roadmap that supports the widespread adoption of IC technologies in Canada. Specific objectives include:

- **Understand industry challenges:** Identify and analyze the key barriers, including technical, financial, regulatory, and cultural, that may be hindering IC adoption.
- **Gather industry input:** Conduct two national workshops (Toronto and Edmonton) and targeted interviews and surveys to collect primary and secondary data from industry experts.
- **Provide actionable recommendations:** Develop clear strategies for overcoming IC adoption barriers-such as policy changes, financial incentives, and workforce training initiatives – targeted at industry leaders, policymakers, and other key stakeholders.
- **Enhance knowledge sharing:** Establish mechanisms to disseminate research findings effectively to industry stakeholders, ensuring maximum impact and adoption of IC technologies.
- **Deliver a roadmap for future R&D:** Produce a comprehensive, industry-informed document that guides future research, development, and policy efforts in IC.

2.0 Background

2.1 IC: Methodologies and Techniques

IC represents a transformative shift in the construction industry, aiming to significantly increase productivity through the integration of mechanization, automation, and advanced manufacturing technologies. Unlike traditional construction methods that are often labour-intensive and project-specific, IC focuses on creating more efficient, standardized, and scalable workflows that optimize resources, reduce waste, and improve overall quality. This approach can be divided into four key interconnected domains (**Figure 1**), each contributing to the modernization of the industry:

1. **Off-site construction (OSC)**: This method involves the production of building components in controlled factory environments, which are then transported and assembled at the construction site. OSC includes various systems such as volumetric (3D modular) and panelized (2D) structural components, as well as non-structural assemblies.
2. **Additive manufacturing (AM):** Often referred to as 3D printing, this innovative technique uses digital designs to fabricate building components layer by layer, either on site or remotely. It allows for unprecedented design flexibility and material efficiency while enabling the construction of complex structures that would be difficult to achieve using traditional methods.
3. **Product-led site labour reduction:** This approach focuses on improving on-site construction efficiency by utilizing prefabricated or specially designed products that simplify installation. Examples include larger or pre-cut materials, modular components, and easy-to-install systems that reduce manual labour requirements while maintaining build quality.
4. **Process-led site labour reduction:** In contrast to product-focused strategies, this approach seeks to optimize construction processes, both in the planning stages and on the construction site. It incorporates digital tools, automation, robotics, and lean methodologies to improve productivity, reduce waste, and enhance safety. Innovations such as AI-assisted scheduling, robotic bricklaying, and exoskeletons for workers are examples of elements in this process-driven approach.

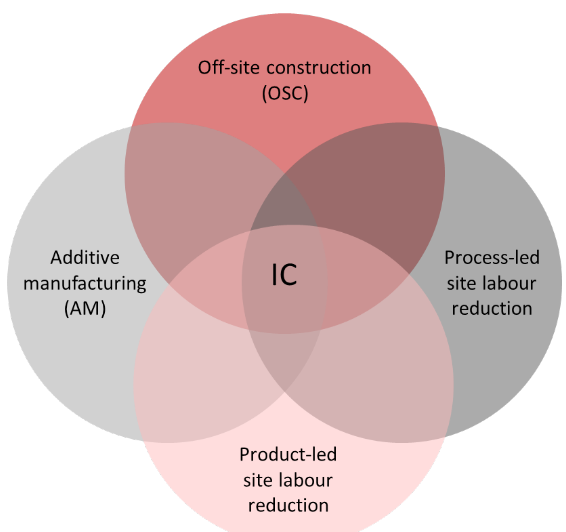


***Figure 1**. Interrelated domains of Industrialized Construction (IC)*

This section discusses various methods of IC focusing on OSC, AM, product-led site labour reduction, and process-led site labour reduction. It explores the benefits, challenges, and real-world applications of each method, highlighting their potential to improve construction efficiency, reduce labour requirements, and enhance sustainability. Additionally, the section examines barriers to adoption and showcase international case studies to demonstrate how these approaches are reshaping the construction industry.

2.1.1 Off-site Construction (OSC)

OSC or prefabrication is a construction approach in which building elements are produced in a controlled environment, transported to site, and assembled, rather than constructed on site. The OSC approach has offered several advantages both domestically and around the world, such as rapid construction, cost certainty, reduced labour requirement, and reduced embodied carbon and construction waste (Wang & Wang, 2020). In addition to this, OSC can facilitate a shift from a labour-intensive industry to a "knowledge-based" industry (Gan et al., 2018). Notwithstanding the associated benefits of OSC, though, there are several barriers to its widespread adoption. Some of these barriers include high investment costs, technical difficulties, logistics problems, and a lack of design standards (Mao et al., 2015). Despite these challenges, international case studies demonstrate the high potential of OSC when it is supported by government policies and industry collaboration. As an example, countries such as the United Kingdom, Sweden, China, New Zealand, Japan, USA have successfully integrated OSC into their construction sectors and have begun to realize the benefits of increased speed, cost savings, and enhanced quality control (Ribeirinho et al., 2020). Section 2.4 discusses the status of OSC adoption in select jurisdictions around the globe and highlights lessons learned. While global examples demonstrate the integration of OSC into mainstream construction, Canada—with a population of nearly 40 million spread across a vast land area of 9.9 million km^2—presents a unique construction context shaped by its expansive geography, challenging weather conditions, and varying provincial and regulatory jurisdictions.

Unlike more centralized governance structures in countries like the UK or China, Canada's building codes and regulations are largely administered at the provincial and municipal levels, resulting in inconsistent standards and slower adoption of innovative construction practices across regions. Furthermore, labour shortages, aging skilled workers, extreme weather conditions, and short building seasons also pose challenges to year-round on-site work, yet they simultaneously create an opportunity for OSC to address workforce and productivity issues. As Canada moves forward, a coordinated national effort—like strategies seen in Sweden or New Zealand—will be essential to overcome fragmentation and fully harness the potential of OSC.

2.1.2 Additive manufacturing (AM)

AM, commonly known as 3D printing, is an emerging technology in IC that enables the layer-by-layer fabrication of building components directly from digital models (Zhou et al., 2024). Initially developed as a prototyping tool in the 1980s, AM has since evolved into a viable manufacturing method, offering benefits such as design flexibility, reduced material waste, and automation of construction processes (Paolini et al., 2019; Zhou et al., 2024). In construction, AM allows for the creation of geometrically complex structures that would be difficult or impossible to achieve with traditional methods, while also improving productivity and workplace safety (Paolini et al., 2019). Some examples of its application in the industry include the 3D-printed bicycle bridge in the Netherlands and WinSun's development of fully 3D-printed homes in China (Ghaffar et al., 2018; Paolini et al., 2019)

Despite its advantages, AM faces challenges that limit its widespread adoption in construction. Material variety remains limited, printed parts often require significant post-processing, and large-scale 3D printing still struggles with precision and mechanical performance (Paolini et al., 2019; Zhou et al., 2024). High equipment costs and expensive raw materials can also offset labour savings, making AM economically unfeasible for some projects (Labonnote et al., 2016). Additionally, logistical concerns, such as transporting large-scale printers to construction sites and integrating AM within existing regulatory frameworks, present further barriers to implementation (Tuvayanond & Prasittisopin, 2023). However, as research continues to address these limitations, advancements in speed, material properties, and automation are expected to drive broader adoption of AM in IC (Ghaffar et al., 2018).

2.1.3 Product-led site labour reduction

Site product-led labour reduction focuses on improving construction efficiency by evolving traditional building materials to be quicker, easier, and safer to install (S.I. Sealy, 2025). This approach typically involves manufacturing building products in larger formats, pre-cut configurations, or with simplified jointing features, helping eliminate potential transportation constraints impacting OSC and reducing the reliance on manual labour during installation (Cast Consultancy, 2025). By adapting conventional materials to be more installation-friendly, construction teams can reduce on-site labour requirements while maintaining or improving build quality. Examples include large-format walling and roofing products, pre-sized and cut-to-measure traditional materials, and easy-to-install components such as brick slips, modular wiring, and flexible pipework (Cast Consultancy, 2019).

One of the key advantages of site product-led labour reduction is its ability to improve productivity without requiring significant changes to construction workflows (Cast Consultancy, 2019). Unlike digital-led automation or off-site manufacturing, this category of IC retains traditional materials but enhances their usability to streamline site work. Pre-made forming elements, for example, can significantly reduce the time required for formwork assembly compared to conventional methods. Since these components are often manufactured in controlled environments, they provide better quality and consistency, minimizing defects and rework on site (Mine et al., 2015).

By implementing these improved materials and methods, construction projects can see tangible benefits in reduced labour intensity, faster installation times, and enhanced site safety. While site product-led labour reduction does not entirely replace manual labour, it helps alleviate some of the industry's ongoing workforce challenges by making tasks more efficient and less physically demanding (Cast Consultancy, 2025; S.I. Sealy, 2025). As construction firms continue to seek productivity improvements, the adoption of larger, pre-configured materials and easy-install solutions (e.g., insulated concrete forms) will play an essential role in modernizing traditional building practices.

2.1.4 Process-led site labour reduction

Site-led process labour reduction is a critical sub-segment of IC that can be leveraged in focuses on improving on-site efficiency through innovative techniques, digital tools, automation, and robotics. Unlike pre-manufacturing approaches, site-led innovations aim to enhance productivity by optimizing labour utilization, reducing waste, and streamlining workflows directly at the construction site. This includes the use of factory-standard workface encapsulation for weather protection, lean construction techniques for process optimization, and new technology-led machinery to improve precision and consistency (Cast Consultancy, 2025). Additionally, digital tools such as BIM-connected workflow planning, augmented and virtual reality for worker assistance, and IoT-enabled site monitoring have been increasingly adopted to enhance coordination and real-time decision-making (Espina, 2025; Mischke et al., 2024).

Automation and robotics are playing a growing role in reducing labour demands on site. Technologies such as autonomous equipment, robotic bricklaying, automated rebar placement, and AI-assisted scheduling have demonstrated their ability to minimize manual tasks while improving accuracy and efficiency (Bleasby, 2025; Mischke et al., 2024). Exoskeletons and wearable technologies are also gaining traction, particularly for reducing worker fatigue and preventing musculoskeletal disorders caused by repetitive or physically demanding tasks (Pomerleau, 2022). These innovations help extend the careers of skilled tradespeople while increasing overall job site productivity. However, the high costs associated with implementing these technologies, along with the need for specialized training, present challenges to widespread adoption (Bleasby, 2025; Mischke et al., 2024).

Digital transformation is further driving productivity improvements in site-based construction activities. Smart sensors and predictive AI analytics are being used to optimize workflows, track equipment usage, and forecast supply chain disruptions, ultimately reducing costly downtime and delays (Espina, 2025). Wireless monitoring systems, real-time project tracking, and automated safety compliance tools are also becoming more common, enabling construction teams to proactively manage risks and improve quality control (Mischke et al., 2024). Additionally, the integration of lean construction principles such as just-in-time material delivery, daily huddle meetings, and value stream mapping, has proven to significantly enhance process efficiency while reducing excess labour, material waste, and rework (Ogunbiyi et al. 2014).

Despite these advancements, the construction industry remains slower than other sectors in adopting at-scale productivity innovations (McKinsey & Company, 2017). Many construction firms still rely on traditional labour-intensive methods, and the fragmented nature of the industry often hinders the large-scale deployment of new technologies (Bleasby, 2025; Mischke et al., 2024). However, as labour shortages persist and project demands continue to rise, the need for site-led process labour reduction, whether on a conventional stick-built construction project, or a project using OSC methods and technologies, will become increasingly urgent. By leveraging digital tools, automation, and lean construction methodologies, the industry can achieve significant improvements in productivity, cost efficiency, and worker safety while moving toward a more IC future (Cast Consultancy, 2025; McKinsey & Company, 2017; Espina, 2025).

2.2 Drivers of IC adoption in Canada

The current state of construction in Canada has led to a demand for IC. This is driven by the **housing deficit** affecting communities coast-to-coast, **productivity** problems causing risks to Canadian businesses, and pressure to build more **sustainably**, all compounded by an **increasing labour shortage**.

2.2.1 Productivity

Productivity in the Canadian construction sector has remained stagnant for decades (Statistics Canada, 2023), largely due to a reliance on traditional labour-intensive methods that are associated with inefficiencies and project delays (Kamali et al., 2019), an outdated construction training and education system that has not kept pace with modern methods, and a lack of direct financial incentives to improve productivity. The BuildForce Canada report (2024) on construction productivity emphasizes the critical need for the construction industry to enhance productivity to remain globally competitive. According to a

2024 TD Economics report (Caranci & Marple, 2024), over the past four decades, the construction sector has failed to achieve any meaningful productivity growth, making it a major drag on overall economic performance. This issue is not unique to Canada but reflects a global challenge, further exacerbated by the sector's increasing share of economic activity. The industry continues to struggle with outdated processes that contribute to rising costs, extended project timelines, and growing sustainability concerns. These challenges have been exacerbated by increased demand for housing, labour shortages, and inflationary pressures on materials and construction financing.

2.2.2 Sustainability

Another critical factor driving interest in OSC is its ability to meet national sustainability targets. Canada's 2030 Emissions Reduction Plan presents an ambitious and achievable roadmap that outlines a sector-by-sector approach for reducing emissions by 40% below 2005 levels by 2030 and achieving net-zero emissions by 2050 (Government of Canada, 2023). As illustrated in , the building sector contributes significantly to Canada's greenhouse gas emissions. Implementing OSC methods can help address this by enhancing energy efficiency, reducing waste, and lowering carbon emissions (Mah et al., 2011), thereby supporting national emissions reduction targets.

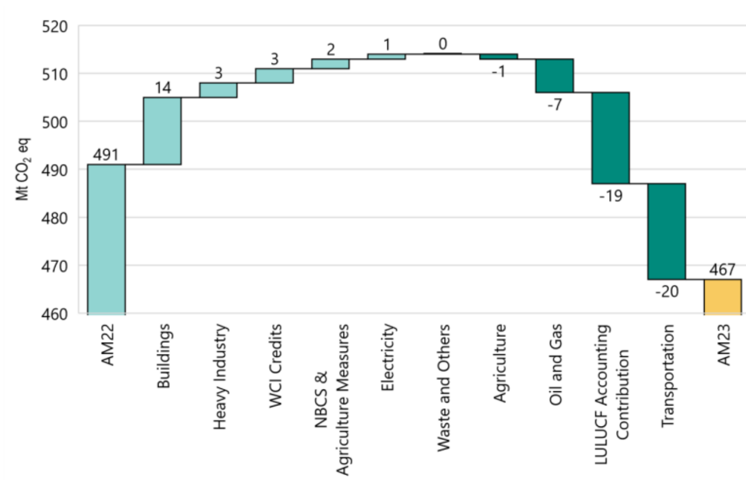


Figure 2: Sectoral contributions to emissions reduction in Canada by 2030 (Government of Canada, 2023)

2.2.3 Aging workforce

Another pressing issue is Canada's aging construction workforce. According to BuildForce Canada's 2023–2024 annual report, over a quarter-million workers, accounting for 21% of the industry's labour force, are expected to retire by 2033. Additionally, fewer young workers are entering the sector, exacerbating labour shortages. As shown in , the proportion of construction workers over the age of 55 has increased over the past two decades, highlighting the urgency of tackling long-term labour force stability. To keep pace with construction demands and retirements, employers will need to hire approximately 351,800 workers by 2033 (BuildForce Canada. 2023–2024 annual report). The adoption of OSC, particularly through automation and prefabrication, has the potential to alleviate these workforce constraints by reducing on-site labour dependency and streamlining production processes.

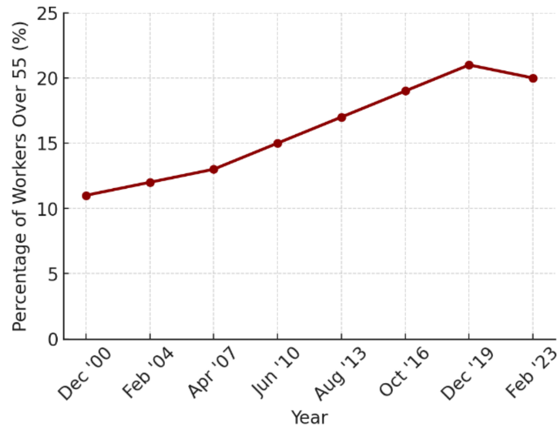


Figure 3: Share of construction workers over the age of 55 (2000–2023) (CIBC Capital Markets, 2023)

2.2.4 Housing shortage

Demand for housing in Canada has consistently outstripped supply, leading to a national housing crisis. The Canada Mortgage and Housing Corporation (CMHC) reports that Canada faces a housing shortfall, with approximately 3.5 million units needed by 2030 to restore affordability to 2004 levels. A report from the Office of the Federal Housing Advocate, similarly, projected that by the end of 2023, Canada would be confronting a 4.4 million housing deficit: 3 million homes in the range of low to very low-income households, and 1.4 million in moderate and median-income households (Government of Canada, 2023). This significant gap underscores the challenges faced in traditional construction and the lag in housing supply (CMHC, 2023). To address the principal challenges brought to bear by growing demand, the Canadian Government recently proposed a three-step housing plan that consists of (1) streamlining the construction of homes, (2) providing tools for easier home purchase and rental, and (3) pushing the industry to build more affordable housing (Government of Canada, 2024). Against this backdrop, IC, which involves shifting construction from traditional on-site methods to off-site, factory-controlled environments, has emerged as a promising solution to address these challenges. Through the transfer of construction activities to a controlled environment, OSC can minimize disruptions, reduce material waste, and improve overall project predictability as well as productivity (Alsakka et al., 2024).

2.3 Barriers to adoption in Canada

Despite the potential benefits of IC, its adoption in Canada remains limited. These barriers vary across the four categories of IC. For OSC, major obstacles include the high capital investment required for transitioning to factory-built construction or simply the construction sector culture. In AM, the barriers may be tied to the technologies, environmental conditions- such as Canada's cold climate that can affect material behaviour, equipment performance, and site accessibility- and the technology being viewed as futuristic whereas site-led building products and processes are seeing sporadic adoption depending on the maturity of the organization, and the willingness for the end customer (e.g., housing authority, infrastructure owner) to try a new process or product.

Research has demonstrated that up-front costs to open and run a factory require significant investment, which deter many home builders. In 2025, the CHBA reported that factory-built construction requires substantial upfront investment in advanced machinery, manufacturing facilities, and workforce training, making it less adaptable to the nature of the construction industry. Without certainties to home builders and sustainable demand, the financial burden may deter small and mid-sized builders from embracing OSC methods, despite the long-term cost savings they offer.

Across all of IC, regulatory challenges further complicate IC adoption. Canada's regulatory framework for building construction is fragmented ~~building code frameworks are inconsistent~~, with differing interpretations among jurisdictions leading to delays in approvals and added costs for factory-built projects (Gharbia et al., 2023). Additionally, the duplication of inspection, where both factory and on-site evaluations are required, undermines the efficiency benefits of OSC. The CHBA has called for the development of a unified National Building Code for Manufactured Homes, which would help streamline regulatory approvals and reduce barriers to IC adoption (CHBA, 2025).

A further limitation is the financial system's lack of support for IC projects, specifically OSC. Many financial institutions do not offer suitable financing products for OSC, creating additional investment challenges (Salama et al., 2020). Traditional financing structures are often geared toward incremental disbursements for on-site construction rather than large, upfront capital investments required for off-site manufacturing. As a result, developers seeking to adopt OSC often face higher financing costs and restricted lending options, limiting their ability to scale production.

On the other hand, there are signs of growing interest in OSC within the Canadian market. For instance, a recent report by the Canadian Home Builders' Association (CHBA) noted that 90% of builders are considering adopting some form of factory-built construction in the next one to three years, signaling a shift in market sentiment toward OSC solutions (CHBA, 2025). Additionally, infrastructure owners are exploring how to best leverage IC technologies, which has been proven through recent projects including the commissioning of a prefab database in Canada, several provinces and regions commissioning projects to create a strategy to leverage OSC for housing and infrastructure and through many political platforms at the national and provincial levels across Canada.

The current state of OSC in Canada reflects both significant potential and persistent challenges. While low productivity, labour shortages, sustainability goals, and market demand are pushing the industry toward OSC, financial, regulatory, and institutional barriers must be addressed to enable broader adoption. As industry stakeholders and government agencies work together to implement strategic policies and incentives, OSC has the potential to reshape the Canadian construction sector and contribute to meeting the country's growing housing and infrastructure demands. In this regard, the Canadian OSC sector is adapting to changing economic and technological landscapes. Challenges in this sector include managing evolving policy environments and economic fluctuations, both of which can, in turn, influence project financing and execution. Meanwhile, there are opportunities to leverage technological advancements to boost the efficiency of construction processes while addressing demand for sustainable building construction. In this context, Canada must develop a supportive regulatory framework, invest in financial incentives, and foster industry partnerships to drive OSC adoption.

2.4 Global context and best practices

Globally, governments and construction leaders are looking at IC as an opportunity to address major housing, building and infrastructure deficits. In the United Kingdom, the government adopted a Modern Methods of Construction (MMC) framework, creating common definitions and categories which provided clarity to the market. In New Zealand, Ireland and China, governments have accepted IC practices, particularly through OSC, modular or prefabrication, to increase housing supply. summarizes some programs in Ireland, United Kingdom, New Zealand, China, Sweden, United states, and Japan.

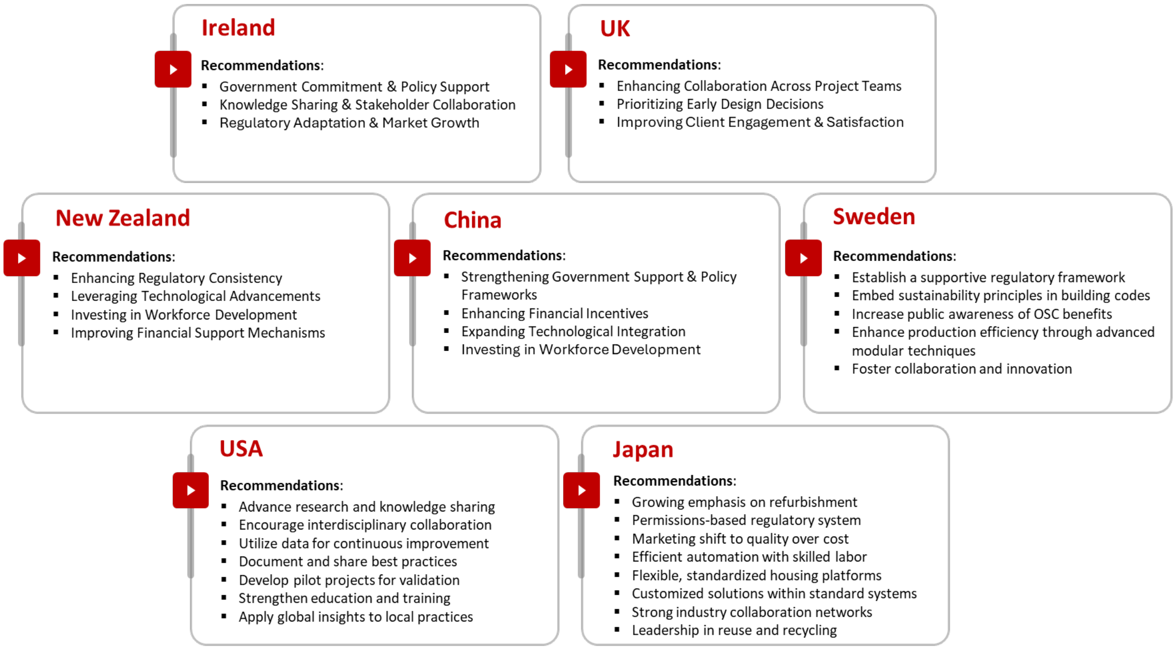


Figure 4: Summary of global context and best practices

2.4.1 Lessons learned from Ireland

With a population of approximately 5 million and a relatively small land area of 68,890 km², Ireland faces unique housing pressures that have made OSC a strategic necessity. The growing demand for housing in Ireland has drawn the industry's focus toward the adoption of OSC techniques (Property Industry Ireland, 2021). This shift has helped to increase the annual production of houses in Ireland from around 7,000 units per year in 2014 to close to 25,000 units per year in 2020. Meanwhile, the Irish government has indicated that, to keep pace with housing demand, approximately 440,000 must be delivered over the period 2023–2030 (Ireland Department of Housing, 2023). In this context, more than 100 companies in Ireland are implementing OSC techniques, representing an investment of over €1 billion (Searson, 2022).

Property Industry Ireland (2021), in their report on Ireland's OSC sector, presented several case studies of the effective application of OSC techniques. Their report also discussed several lessons learned and recommendations to foster the implementation of OSC. Similarly, the Ireland Department of Housing (2023), in its roadmap report for OSC, presented various recommendations that would promote the adoption of OSC in the coming years. The recommendations from these two reports are summarized as follows:

- **Commit to large-scale housing programs:** The government should implement a dedicated housing construction initiative that prioritizes OSC methods, encouraging investment in manufacturing facilities and workforce development.
- **Mandate OSC for affordable housing**: A required percentage of affordable housing projects should be built using OSC to incentivize industry adoption and improve delivery speed.

- **Facilitate knowledge-sharing:** Establishing a dedicated forum for stakeholders—including regulators, certifiers, and industry leaders—would promote best practices and innovation in OSC design and manufacturing.
- **Encourage design–build procurement:** Shifting procurement strategies toward design–build models can better accommodate the unique aspects of OSC and streamline project execution.
- **Strengthen workforce development:** Collaboration between the OSC sector, educational institutions, and Building Control Authorities is essential for upskilling workers and addressing knowledge gaps. Demonstration parks should be introduced to support reskilling efforts.
- **Modernize regulatory frameworks:** Building codes and policies should be revised to remove barriers to OSC adoption, such as restrictions on timber use in mid-rise buildings.
- **Enhance industry participation:** Expanding engagement in Ireland's Built to Innovate program will improve competitiveness and accelerate OSC sector growth.

2.4.2 Lessons learned from the United Kingdom

The UK, with a population nearing 68 million and a high population density (283 people/km²), has adopted OSC to address acute housing shortages, particularly in urban areas. The UK government has reinforced its commitment to OSC in recent years, as outlined in a report by the European Commission (2025). As part of this commitment, the Affordable Homes Programme allocated £11.5 billion for 2021–2026 to foster the adoption of OSC in the housing sector. Despite this support, the adoption of OSC in the UK is still relatively low. Scotland is a notable exception, as 80% of the new houses are reported to have been built using OSC solutions (compared to just 10% of the new homes in England).

Ofori-Kuragu et al. (2022) reviewed twelve UK housing projects built with OSC methods and extracted a number of relevant lessons learned. The Housing Forum (2015) also examined several similar UK case projects and their success factors. Notable lessons learned from these two studies are summarized as follows:

- **Foster cross-disciplinary collaboration:** Effective partnerships between contractors, manufacturers, structural engineers, and architects are essential for ensuring the structural integrity and efficiency of OSC projects.
- **Prioritize early design integration:** Engaging manufacturers early in the design phase enables seamless module production and reduces project delays.
- **Enhance client engagement:** While the benefits of OSC may not be immediately apparent, long-term satisfaction is driven by superior quality and consistency in construction outcomes.
- **Develop holistic project understanding:** Success in OSC depends on a comprehensive grasp of design processes, construction workflows, and long-term maintenance considerations.

2.4.3 Lessons learned from New Zealand

Despite its modest population of just over 5 million spread across a large land area (263,310 km²), New Zealand has turned to modular and prefabricated methods to address regional housing access and speed up approvals. In New Zealand, the government's MultiProof initiative, launched in 2010, streamlined the consenting process for prefabricated buildings, significantly accelerating the approval of standard modular designs. However, challenges such as inconsistent requirements across territorial authorities still play a factor, hindering the expansion of the modular construction industry. Although direct financial incentives are limited, the New Zealand government's efforts to reduce consenting time through MultiProof have indirectly lowered the costs of modular housing, making it more competitive with traditional building methods (Brown et al., 2020).

Meanwhile, technological advancements such as Building Information Modelling (BIM) have enhanced the accuracy and efficiency of modular construction projects. In New Zealand, BIM is seen as critical in improving design precision and facilitating the coordination of stakeholders, thereby streamlining the manufacturing process and aiding in project management (Brown et al., 2020). The growing awareness of the need for specialized skills in the modular construction sector remains a challenge, compounded by an aging workforce and a reliance on foreign labour. Workforce development is thus a key area for investment, and both the government and industry are focusing on the creation of training programs and apprenticeship schemes to build a skilled workforce (Brown et al., 2020).

In addition, New Zealand's experience offers valuable insights into the structural and seismic design challenges associated with different types of construction. Given that the country is located in a high seismic zone—similar to several regions in Canada—its approach to seismic resilience in modular systems is particularly relevant. Over the decades, New Zealand has developed a robust framework of seismic codes and standards, beginning with early foundational documents such as NZSS 95 (1955) and NZSS 1900 (1965), and evolving through several iterations to modern codes like NZS 1170.5:2004 for earthquake actions and NZS 3101:2006 for concrete structures. These standards emphasize performance-based design, ductility, and robust connection detailing to ensure safety in seismic events (Standards New Zealand, 2004; 2006). In addition, analytical work such as that by Fenwick et al. (1992) and Fenwick, Lau, and Davidson (2002) explored P-delta effects and compared seismic design practices internationally, reinforcing the significance of lateral load resistance and stability in seismic zones.

New Zealand's ongoing commitment to updating its National Seismic Hazard Model (NSHM) ensures that building codes remain aligned with the latest scientific understanding of seismic risks. These comprehensive models, combined with lessons from actual seismic events and regulatory insights (e.g., Stannard et al., 2007; Paulay, 1977), inform the design of modular and prefabricated systems to ensure resilience in high-risk areas. These practices and research outputs offer valuable guidance for Canadian efforts to extend modular construction into taller, urban developments in seismically active regions such as British Columbia.

2.4.4 Lessons learned from China

China, with over 1.4 billion people and vast geographic coverage, has implemented OSC at scale to meet enormous housing and infrastructure needs. In China, government initiatives have played a pivotal role in accelerating modular construction, especially with regard to high-rise buildings. Policies such as the 13th Five-Year Plan for the Development of Modern Construction emphasize the adoption of IC methods, including modular systems, to boost the sector's efficiency. China's modular construction practices are also guided by national standards developed by the Standardization Administration of China (SAC). These standards address key aspects of the modular construction process—including design, manufacturing, transportation, and installation. For example, the Technical Standard for Prefabricated Concrete Structures (JGJ1-2014) offers guidance on the structural performance of prefabricated concrete elements, which are foundational to modular systems. Additionally, the Code for Design of Modular Buildings (GB/T 51231-2016) sets out general principles and detailed requirements for modular building design, helping to ensure structural safety, quality, and scalability across various building types. Financial backing is substantial in China, with various government programs designed to support the adoption of modular systems. These programs offer financial incentives for projects incorporating advanced technologies, including modular construction, to reduce labour costs and improve overall efficiency (Pan et al., 2021). As a result, technological advancements, such as the integration of BIM and other smart construction tools, have been leveraged to enhance project management and ensure effective assembly processes. The government has also incentivized modular construction by providing various forms of assistance to suppliers and designers that adapt to Modular Integrated Construction (Pan et al., 2021).

Additionally, China's rapid shift towards IC has created a heightened demand for skilled workers, particularly in areas such as factory-based production and on-site assembly. Both the government and industry are focusing on workforce development through training programs, apprenticeship schemes, and partnerships with educational institutions to ensure a steady supply of skilled workers (Pan et al., 2021).

2.4.5 Lessons learned from Sweden

Sweden's relatively small population of 10 million and low density (25 people/km²) has not prevented it from becoming a global leader in OSC, especially for sustainable housing. Sweden's house-building industry has grown significantly over the past decade, particularly since the mid-2000s, introducing several innovative concepts in industrialized housebuilding (Jonsson & Rudberg, 2014). According to a report by Advance Building Construction (2021) "Sweden *is often recognized as a global pioneer in off-site modular construction, with prefabrication making up an impressive 84% of its residential construction market*". In the last ten years, Swedish companies have implemented industrialized house-building concepts, influenced by advancements in process innovation and the development of product platforms (Lidelöw et al., 2015). Their success stems from vertical integration, where they manage design, development, and fabrication while partnering with technology firms like Volvo to enhance efficiency (Modular Building Institute, 2018).

According to MBI (2018), Sweden's volumetric modular construction industry is characterized by its sustainability-focused approach, strategic partnerships, advanced automation, and long-term planning. The sector has successfully positioned itself as a viable alternative to traditional construction methods, with an emphasis on green building and timber-based solutions.

These key takeaways on Sweden's modular construction success are synthesized from Lessing's (2015) research and insights from Trullii (2024):

- **Establish a supportive framework:** A national performance-based building code can standardize regulations and enhance flexibility for OSC.
- **Emphasize sustainability:** Embedding sustainability in building codes promotes greener construction and meets rising eco-conscious demands.
- **Promote public awareness:** Educating the public on modular construction benefits can foster acceptance, as seen in Sweden.
- **Optimize production:** Using advanced modular techniques like pre-insulated and pre-wired panels enhances quality and efficiency.
- **Drive innovation through collaboration:** Promoting teamwork and innovation accelerates the adoption of advanced modular construction.

2.4.6 Lessons learned from the United States

The United States, with over 347 million people and a large land mass, faces regional disparities in housing which OSC aims to address through innovation and research. The United States is facing a housing crisis, with increasing prices making housing unattainable for many Americans (JCHS, 2024). OSC, which involves the design and delivery of housing through an industrialized and manufactured-style approach, has the potential to provide more affordable and accessible single-family and multifamily housing at scale. Despite the documented benefits of OSC—such as schedule improvements, quality control, worker safety, and environmental impact reduction—several challenges still hinder its widespread adoption.

To address these barriers, the *Offsite Construction for Housing Research Roadmap* (HUD, 2020) identifies key knowledge gaps and research needs. The roadmap aims to align HUD's programs and partnerships while also serving as a guide for governments, universities, and the OSC industry. The roadmap was developed through a structured process involving three phases: (1) forming a preliminary list of core research topics with the National Institute of Building Sciences (NIBS) Offsite Construction Council, (2) conducting a literature review and refining the topics with a Panel of Technical Experts (PTC), and (3) holding a workshop to validate and prioritize research questions.

The roadmap identifies six key research topics crucial for advancing OSC in the U.S.: Regulatory Frameworks, Standards and System Performance, Capital, Finance, and Insurance, Project Delivery and Contracts, Labor and Workforce Training and Management, and Business Models and Economic Performance.

The report also highlights several key takeaways:

- **Research culture:** More knowledge production and sharing are needed to promote OSC.
- **Interdisciplinary collaboration:** Breaking down silos and fostering cross-disciplinary research is essential.
- **Data-driven improvement:** Continuous data collection and analysis are crucial for OSC progress.
- **Best practices and lessons learned:** Documenting and disseminating successful OSC initiatives can aid adoption.
- **Pilot projects:** Demonstration projects are key to showcasing the feasibility and benefits of OSC.
- **Education and training:** Workforce development is necessary for the long-term success of OSC.
- **Global insights, local implementation:** Learning from international OSC models can inform U.S. practices.

As the U.S. continues to face growing housing demands, HUD and other stakeholders are working to address these challenges and integrate OSC into mainstream housing development strategies. The roadmap serves as a guiding document to advance the research, policy frameworks, and financial mechanisms necessary for scaling OSC across the country (HUD, 2020).

2.4.7 Lessons learned from Japan

Japan, home to over 123 million people and one of the most densely populated developed countries (338 people/km^2), has long embraced modular construction to address space constraints and urban housing demands. Japan's modular construction industry is well-established and widely adopted, with its origins tracing back to the early 1950s. As of 2018, off-site manufacturing accounted for 15% of all newly built homes and apartments in Japan (Advanced Building Construction Collaborative, 2021). Japan's modular construction industry initially emphasized the advantages of speed and cost-effectiveness but later transitioned to promoting quality enhancements made possible through standardization. At the same time, the industry recognized a growing demand for customization and adjusted its approach to meet these expectations.

The industry employs both volumetric modular and panelized systems, primarily using light gauge steel, although some light wood framing is also utilized.

Key takeaways from Japan's modular construction industry:

- **Shift toward refurbishment:** Recent trends show an increase in home refurbishment, driven by the high quality and longevity of modern IC.
- **Unique regulatory system (permissions-based):** The success of Japan's modular industry is largely attributed to a system of "permissions", where inspections follow company- or industry-specific standards rather than general building codes.
- **Initial marketing focus:** Like other countries, Japan's modular industry first emphasized speed and affordability, later shifting to highlight superior quality—despite being about 8% more expensive than conventional construction.
- **Smart use of automation and skilled labour:** Japanese factories are highly automated yet practical, using robots for tasks like painting (wood) and welding (steel), while still relying on a skilled workforce. Automation levels have remained consistent since the 1990s.
- **Universal product platform:** Companies offer a standardized yet flexible platform for both multi-unit and single-family housing.
- **High customization with standardization:** Proprietary software and architect-salespeople enable a high level of customization and client satisfaction without compromising standardization or delivery timelines.
- **Strong industry collaboration:** Firms collaborate through the Japan Prefabricated Construction Suppliers and Manufacturers Association (JPA) and Sumstock, which evaluates the remodelling potential of modular buildings.
- **Pioneering reuse and recycling:** Since 2004, Japan has been a global leader in promoting the reuse and recycling of volumetric modular components.

2.5 Development of a roadmap to transform the Canadian construction industry

The development of a Roadmap to transform the Canadian construction industry is essential for driving innovation and investment in Canada's construction sector. As seen in global case studies, counties that have successfully integrated IC have done so through strategic government support, regulatory modernization, workforce development and industry collaboration. These lessons highlight the need for a structured approach to identifying and prioritizing research initiatives that will address key challenges such as labour shortages, housing demand, sustainability goals and rising costs. This roadmap, developed through direct engagement with industry stakeholders—including workshops, one-on-one interviews, and a public survey—ensures that research priorities are aligned with real-world needs rather than theoretical advancements. By identifying knowledge and implementation gaps, the roadmap will:

- **Enable targeted R&D investments** to overcome barriers to IC adoption

- **Facilitate collaboration between industry, academia, and government** to align efforts and resources
- **Establish a foundation for knowledge-sharing and best practices** to ensure widespread adoption

By capturing insights from those actively working in the sector, the roadmap provides a strategic framework that outlines what initiatives should be pursued, when they should be implemented, and how they should be prioritized to maximize impact. Rather than a fragmented approach to research and innovation, this roadmap offers a cohesive, industry-informed strategy that will guide R&D efforts in the coming years, ensuring that investments are made in areas that will have the greatest effect on productivity, sustainability, and the adoption of IC practices. With Canada seeking to modernize its construction industry and scale up housing production to meet demand, this roadmap will serve as a critical tool for aligning government policies, industry efforts, and academic research to drive measurable advancements in the sector.

3.0 Methodology

To develop the roadmap, a multi-stage methodology was employed, integrating a comprehensive literature review, facilitated workshops, strategic stakeholder interviews and industry-wide surveys. The project collected and analyzed data to create a roadmap that prioritizes actionable steps for advancing IC in Canada based on the perspectives of the industry. presents the multi-stage methodological flowchart for this roadmap, illustrating the sequential approach taken to develop the framework. More details on the methodology are presented throughout Section 3.

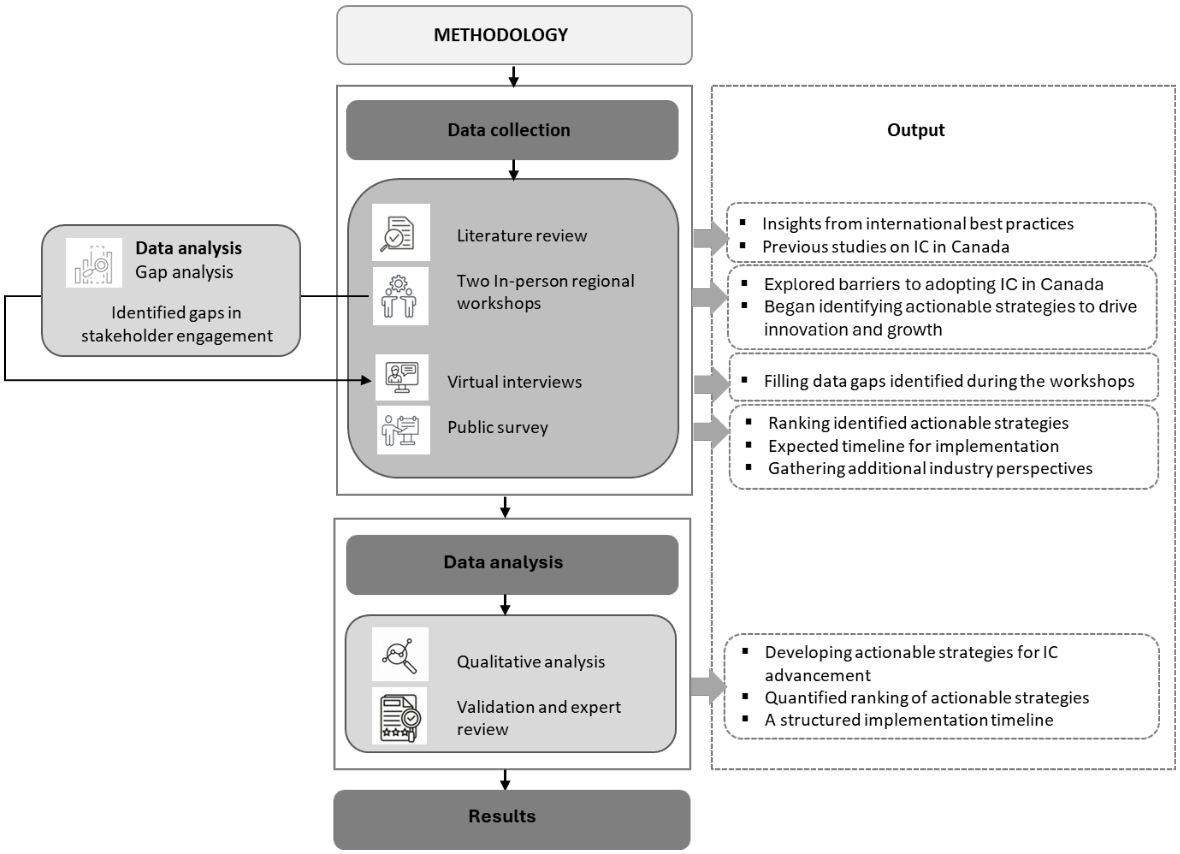


Figure 5: Multistage methodology flowchart

3.1 Data collection

Literature review: As a first step, a literature review was conducted to gather insights from international best practices and previous studies on IC in Canada. This review helped shape the structure of future data collection through the workshops and interviews.

In-person regional workshops: Two regional workshops were then conducted as the primary source of data collection. These sessions were held in-person in Western Canada (Edmonton) and Eastern Canada (Toronto). The workshops were designed and facilitated by teams from UNB OCRC, UofA, and Cast Consultancy, with input from NRC. To ensure a comprehensive and well-informed discussion, the process began with a keynote presentation by Mark Farmer from Cast Consultancy (

Appendix A: Workshops), followed by a moderated Q&A session to establish a shared understanding among participants. This helped level-set the room and create a common foundation for discussions.

Stakeholders were then guided through a structured ideation process to systematically identify key challenges and opportunities. Participants categorized ideas by themes such as policy development, procurement, and skills training, distinguishing between barriers and opportunities, and proposing initiatives. To refine and prioritize these initiatives, a digital ranking exercise using Mentimeter was conducted, allowing participants to evaluate and rank proposed initiatives within each focus area The most impactful ideas were further developed using structured idea development forms (

Appendix A: Workshops), ensuring a thorough exploration of their feasibility and implementation strategies.

Figure 6 illustrates the stakeholder categories that participated in these workshops and highlights gaps in stakeholder representation. To address these gaps, representatives from these groups were targeted in the second round of data collection through strategic interviews.

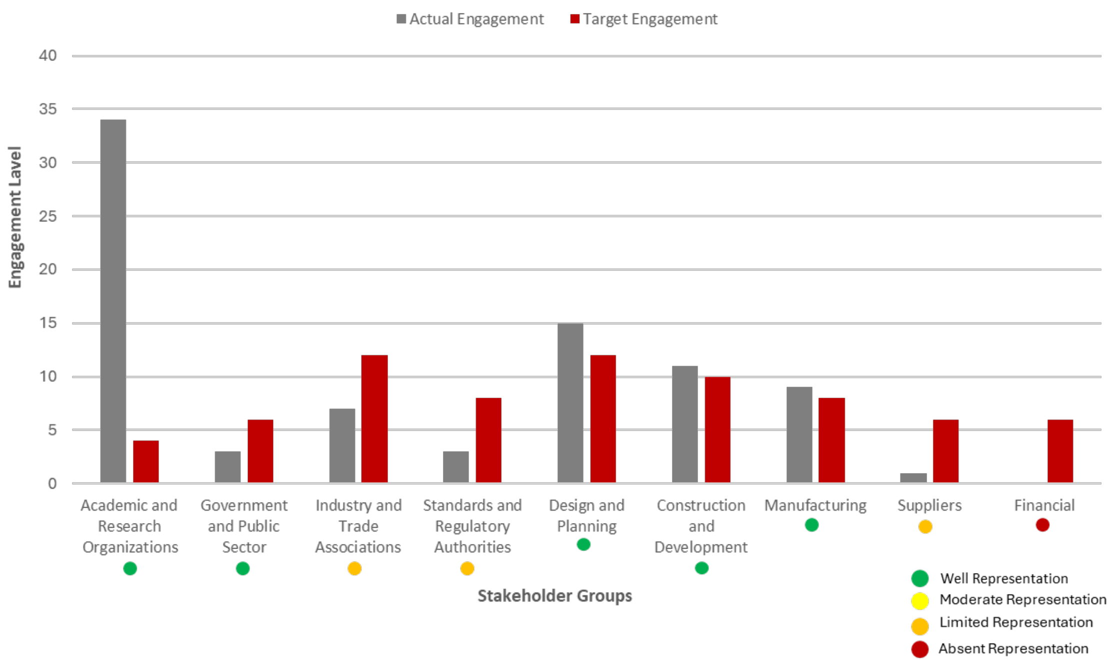


Figure 6: Summary of workshop participant stakeholder representation by category

Virtual interviews: Based on the initial assessment of the workshop data collection, considering factors such as stakeholder type, geography, and organization size, stakeholder groups with gaps in engagement were identified. To ensure balanced stakeholder representation and a data-driven approach, additional virtual interviews (

Appendix B: Interviews with key stakeholders were executed, as described by , to fill these perspective gaps. With an initial stakeholder engagement gap of 21, 18 additional interviews were successfully conducted, reducing this gap from 21 to 3 (Appendix C: Stakeholder Participation Analysis). Some gaps remain due to factors such as availability of representatives or scheduling constraints.

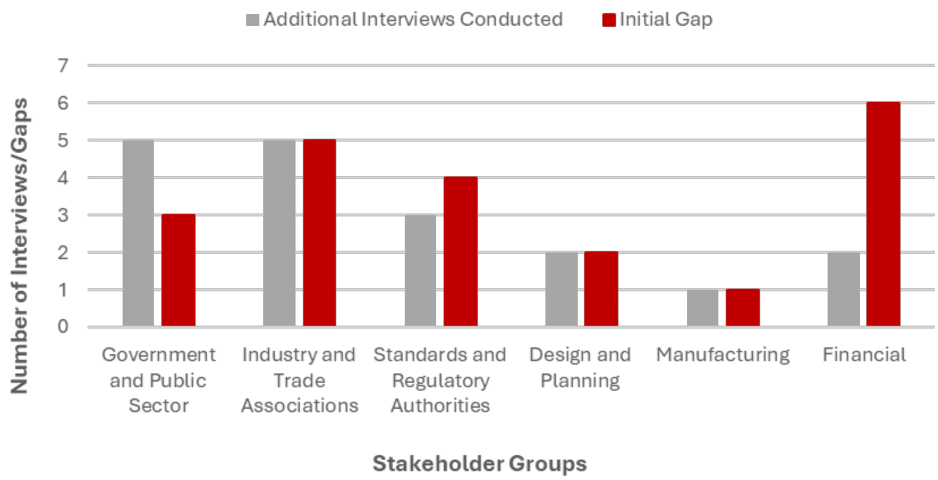


Figure 7: Summary of virtual interview participant stakeholder representation by category

Public survey: After completing the interviews, a public survey was distributed via trade associations, professional associations and industry contact lists within the construction sector (

Appendix D: Public Survey. The purpose of the survey was to gather industry perspectives on the most impactful ideas and strategies for advancing IC that were identified so far. The responses received, summarized by , helped prioritize initiatives that drive productivity improvements and innovation across the construction sector. This multi-channel approach ensured a comprehensive and well-balanced data collection phase, reflecting a full range of diverse industry perspectives.

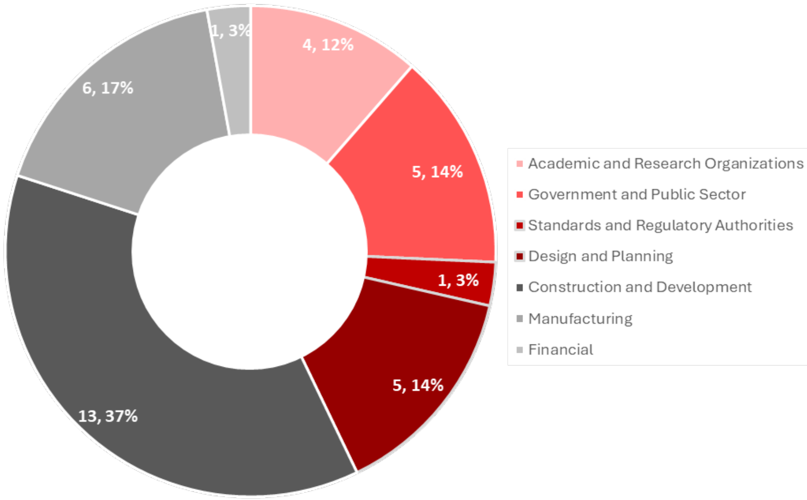


Figure 8: Summary of public survey stakeholder responses by category

3.2 Data analysis

After completing data collection, a multi-step analytical approach was employed to extract meaningful insights, identify themes, and prioritize recommendations for advancing IC in Canada. The analysis aimed to identify key barriers, enablers, and focus areas for policy and industry interventions.

3.2.1 Gap analysis

A structured gap analysis was conducted to identify missing data points and underrepresented stakeholder voices. This included:

- **Assessing stakeholder engagement gaps**: The degree of participation across various stakeholder groups from two regional workshop was assessed and addressed them in the secondary round of data collection through interviews to ensure broad representation.

3.2.2 Qualitative analysis

The qualitative data gathered from stakeholder workshops; interviews was analyzed using a thematic coding approach. This process involved:

- **Transcription and organization**: Workshop discussion notes and results, and interview transcripts were transcribed, categorized and digitized into Excel sheets.
- **Identification of key themes**: Recurring topics and ideas were manually reviewed and grouped into broad categories, such as regulatory alignment, procurement models and performance,

Financial and insurance systems, awareness and market education, skills development and workforce capacity, and research and innovation.

- **Pattern recognition**: Emerging patterns and insights were cross validated against literature findings and global best practices.
- **Stakeholder prioritization and timeline estimation**: Stakeholders were asked to rank the proposed ideas on a scale of 1 to 5 (with 5 being the highest) to indicate the perceived importance and impact of each initiative. Additionally, they were requested to specify the expected timeline for implementation, categorizing ideas into short-term, mid-term, and long-term actions. This helped establish a clear prioritization framework for roadmap development and informed the phased implementation strategy.

3.2.3 Validation and expert review

To ensure the validity of the findings, a third-party validation process was undertaken:

- **Expert peer review**: Findings were reviewed by a panel of experts in IC to provide feedback and insights that helped refine key themes and recommendations. To further validate the results, a public survey was distributed across industry networks, gathering broader perspectives to ensure the findings accurately represented diverse stakeholders and aligned with real-world challenges and priorities. Additionally, Cast Consultancy conducted a third-party review, identifying trends and refining recommendations for a more comprehensive analysis.
- **Cross-referencing with existing literature**: The findings were cross validated with global IC research and previous studies. The framework was aligned with successful national IC roadmaps from countries such as New Zealand, the United Kingdom, and Ireland, which were previously discussed in the literature review. These roadmaps were referenced again to ensure the proposed recommendations were not only contextually applicable but also aligned with proven strategies in more advanced IC ecosystems.

4.0 Results

Despite the growing recognition of IC's potential to enhance efficiency, sustainability, and affordability in construction, its widespread adoption remains constrained by financial, regulatory, cultural, and logistical barriers. Section 4.1 identifies these challenges, outlining the primary obstacles that must be addressed to achieve IC's adoption and potential.

Building on this foundation, Section 4.2 presents the focus areas for roadmap development, offering a strategic framework to guide policy, procurement, financing, skills development, and research efforts. These priorities reflect the most pressing industry needs, ensuring that future initiatives are both actionable and impactful.

Finally, Section 4.3 details the key actions and implementation strategies necessary to drive meaningful progress. A structured roadmap, supported by clear metrics, stakeholder roles, and phased timelines, ensures that research initiatives translate into real-world advancements. By fostering collaboration between government, industry, and academia, this roadmap serves as a critical tool for aligning efforts, scaling up housing production, and modernizing Canada's construction sector.

The following sections present detailed findings of the challenges, focus areas, as well as the comprehensive Roadmap for IC in Canada.

4.1 Challenges in adopting IC

Workshops and stakeholder engagements have identified several impediments that have hindered the widespread adoption of IC. **Figure 9** presents the percentage of workshop respondents who identified each barrier as a significant challenge to the adoption of IC. The size of each block represents the frequency of mention, indicating the most pressing barriers according to industry stakeholders.

The categorization of barriers to IC adoption, illustrated by **Figure 10**, are as follows:

- **Financing and insurance:** Lenders and insurers are often hesitant to support IC projects due to uncertainty and the lack of structured financial solutions. The higher upfront investment required for IC compared to traditional construction makes it challenging for developers to secure financing. Additionally, market fluctuations- such as tariff-induced material cost increases, supply chain disruptions, labor availability- create an unclear risk profile, leading to resistance from investors when it comes to funding innovation and automation in construction. Construction bonds—such as bid bonds, performance bonds, and payment bonds—play a vital role in mitigating financial risks by ensuring contractors fulfill their obligations and subcontractors and suppliers are compensated. However, the unique characteristics of IC projects, including novel technologies and off-site fabrication methods, can complicate the underwriting process for these bonds. Surety providers may be cautious in issuing bonds for IC projects due to unfamiliarity with the associated risks, potentially leading to higher premiums or difficulties in obtaining bonding capacity. This hesitancy can further impede the adoption of IC by increasing financial barriers for developers and contractors.
- **Government misalignment:** Government misalignment (i.e., lack of coordination among different levels of government leading to inconsistent policies and procedures) in policies creating inadequate procurement methods and contract structure to leverage IC, leads to delays in

permitting and regulatory approval. An example is the disconnect between housing and immigration policies: while there is a clear national push to build more housing to address affordability and supply shortages, recent immigration policies risk reducing the available labour force needed to support this construction demand. The introduction of new construction technologies often necessitates changes in government policies and codes, which can lead to additional delays. The federal government's efforts to align its codes and programs with innovative building practices are ongoing, but the lack of a centralized authority to standardize regulations continues to pose challenges for the widespread adoption of IC.

- **Cultural issues:** The construction industry's traditional mindset in Canada often resists change, affecting the adoption of IC. In different regions some contractors and tradespeople are skeptical about OSC's quality and durability. This skepticism can result in reluctance to collaborate on IC projects, hindering their successful implementation.
- **Training and education:** The lack of training and education in labour force and design and management community, remains a major barrier. The shortage of skilled workers continues to slow the industry's transition to IC. A critical issue is that many skills required for IC are not immediately transferable from traditional construction practices and can be challenging to acquire. For instance, transitioning from conventional on-site construction to IC methods necessitates proficiency in digital tools, understanding of prefabrication processes, and familiarity with manufacturing principles. In particular, there is a growing need for specialized training—such as in Building Information Modelling (BIM), Design for Manufacturing and Assembly (DfMA), lean construction principles, and construction automation and robotics—especially among engineers, architects, and construction managers. These competencies are essential for coordinating modular projects, streamlining design-to-fabrication workflows, and improving integration across the supply chain. Despite their importance, specialized programs focusing on these areas remain limited across Canada. The lack of such education and training pathways hinders the development of a workforce equipped to support modern construction techniques, thereby impeding the industry's broader transition to IC.
- **Transportation and logistics:** Canada's vast geography poses logistical challenges for OSC. Transporting prefabricated modules to remote areas, such as the North, requires navigating limited infrastructure and harsh weather conditions. These factors can lead to increased transportation costs and complicate project timelines. Additionally, regulatory barriers impact the transportation of prefabricated modules across provincial boundaries. Interprovincial transportation falls under federal jurisdiction; however, each province and territory may have distinct regulations concerning the certification and approval of modular buildings. For instance, while some jurisdictions require CSA A277 certification to verify that factory-constructed buildings comply with local requirements, others may have different or additional standards. This lack of uniformity necessitates that manufacturers and developers navigate a complex landscape of varying codes and certifications, potentially leading to delays and increased costs.
- **Inconsistent regulations and policy gaps:** Outdated and traditional policies, regulations, and codes that differ across jurisdictions and contradict each other across 3 levels of government. For instance, while the National Building Code of Canada (NBC) serves as a model, its adoption and enforcement vary, with some provinces implementing additional requirements or modifications. This lack of harmonization complicates the approval process for IC products, as manufacturers must navigate differing standards and regulations in each jurisdiction. Moreover, there is an

absence of centralized leadership to standardize these regulations nationally. Although provincial and federal governments provide guidance, no overarching authority exists to unify the regulatory framework. Consequently, manufacturers and companies aiming to introduce IC technologies must invest substantial time and resources to gain approvals across multiple jurisdictions, escalating costs and delaying market entry.

- **Data gaps:** The adoption of IC is hindered by significant data limitations. A lack of comprehensive project data and benchmarking tools prevents stakeholders from fully understanding IC's benefits, making it challenging to build confidence in this approach. This uncertainty is intensified by the industry's limited past experience with IC methodologies.

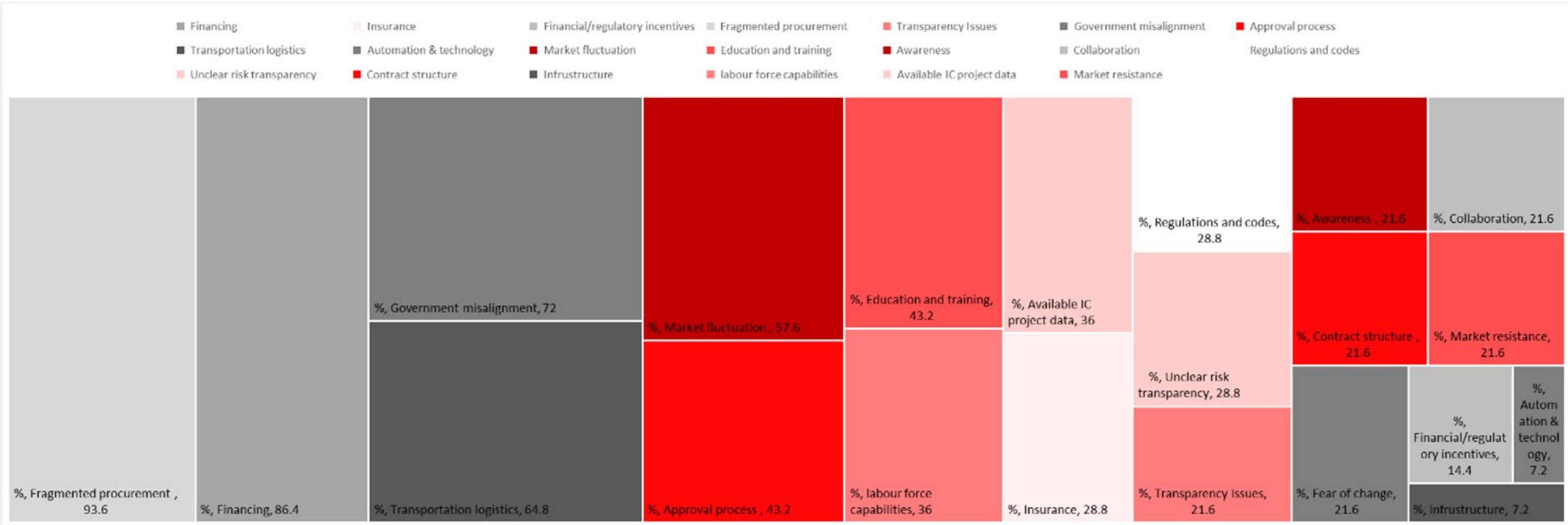


Figure 9. Keyword analysis of barriers to IC adoption

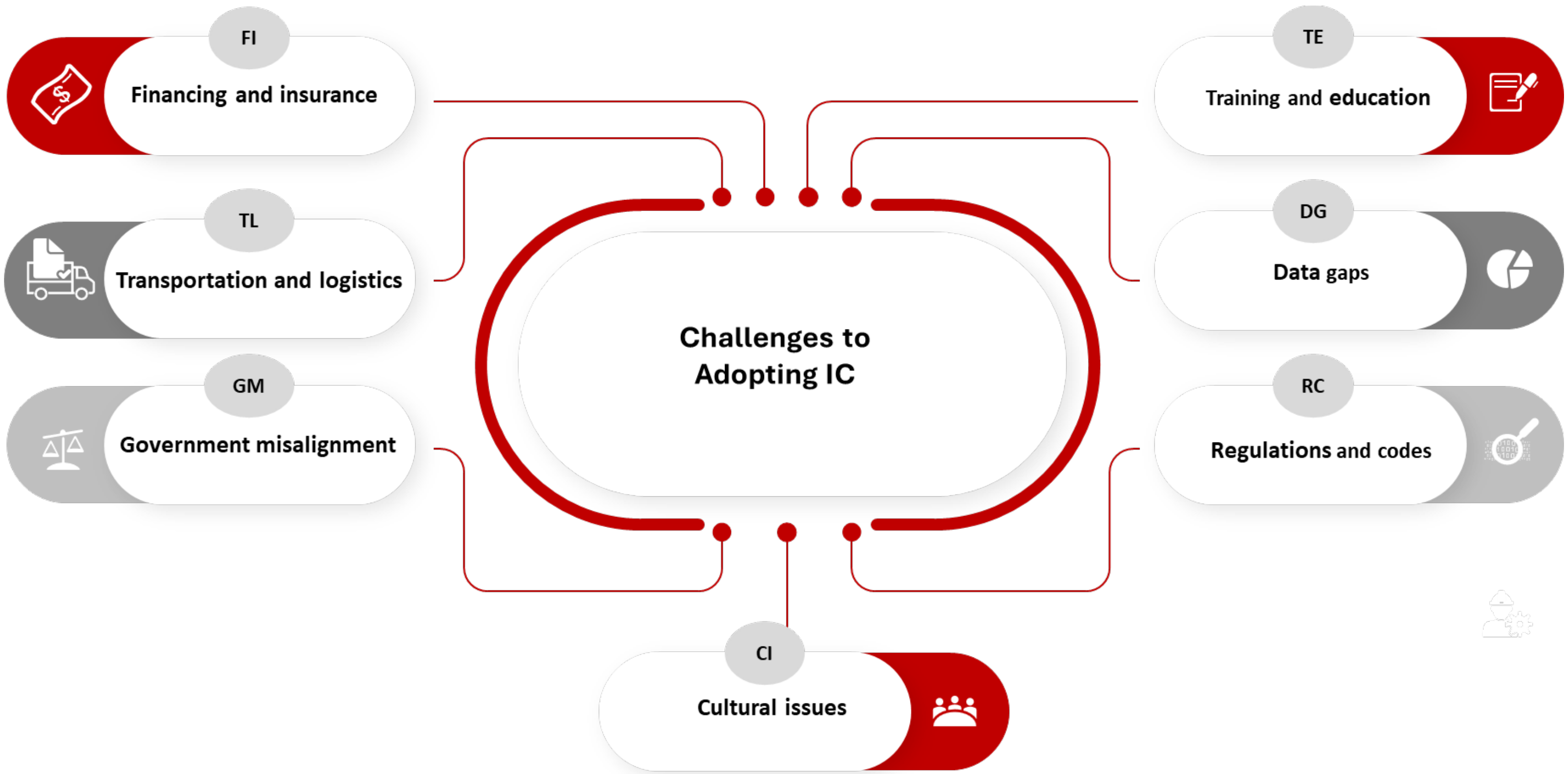


Figure 10. Challenges to IC adoption: insights from stakeholder engagements

4.2 Focus areas for roadmap development

The following focus areas for roadmap development, presented in ***Table 1***, have been identified based on extensive engagement with industry stakeholders in the data collection phase. The iterative and collaborative approach facilitated idea saturation, ensuring that the most relevant and actionable strategies were captured. This structured framework enables organizations such as the National Research Council and other government agencies to effectively support IC through policy implementation, financial incentives, procurement improvements, skills development, and research-driven decision-making tools.

Table 1: Key focus areas and strategic actions for advancing IC

N	Key focus area	Initiatives for advancing IC	Addressed IC Challenges
1	**Policy and regulatory frameworks**	**PR1** Simplify, improve, and harmonize the approval process	GM, RC
		PR2 Undertake a policy review and harmonize project funding through collaborative procurement tied to incentives	
		PR3 Identify opportunities to improve code and policies and develop supporting implementation guidelines	
		PR4 Alignment of municipalities and the three tiers of governments	
		PR5 Continuity in government policy	
2	**Procurement models and performance systems**	**PM1** Develop collaborative procurement models and methods to quantify value of IC (e.g., quantifying pre-manufactured value (PMV)) and incorporate in the procurement process.	TL, FI
		PM2 Improve language in contracts and procurement (RFPs)	
		PM3 Work with the Canadian Construction Documents Committee (CCDC) and key industry experts to develop or modify contracts for IC	
3	**Financial and insurance services**	**FI1** Government underwriting of lending against IC	FI
		FI2 Deleveraging risk by tax incentives that drive R&D	
		FI3 More flexible R&D funding	
		FI4 Structured financial solutions supported by financial institutions	
		FI5 Create a best practice template proforma document specific to IC for developers	
		FI6 Conduct key case studies to identify drawbacks and understand gaps in the insurance products for IC	
4	**Awareness, competency, and collaboration**	**AC1** Awareness campaign	CI, TE
		AC2 Focus on competency gaps and opportunities for IC to address	
		AC3 Standardization to drive design for manufacture and assembly through collaboration across the construction value chain (e.g., mass productization)	
5	**Quantifying capacity and capability for IC**	**CC1** Quantify and highlight the labour benefit of IC (specific to Canada's climate and geography)	TE, CI, DG
		CC2 Clear picture of off-site solutions available and quantify capability	
		CC3 Incentivize and support IC with a focus on driving IC demand that aligns with capacity and capability	
6	**Research and data sharing**	**RD1** R&D focus on methodologies and tools for industry data capture and sharing	DG, RC
		RD2 Develop a premanufactured value toolkit for Canada to demonstrate the commercial/financial benefits to owners and lenders	

4.2.1 Policy and regulatory frameworks

The following initiatives are recommended to address policy and regulatory barriers that hinder the adoption of IC. These recommendations aim to create a more streamlined, predictable and supportive regulatory environment for innovation in construction.

- **PR1 – Simplify, improve and harmonize the approval process**: The approval process for construction projects, encompassing building code compliance, zoning and land use approvals, product certification, and municipal permitting, varies across jurisdictions, creating delays and inconsistencies. While these challenges apply to all development projects, they are particularly significant for IC, where streamlined approvals can unlock the true industrial-scale benefits. Standardizing and simplifying these processes will not only enhance efficiency across the construction sector but also enable IC to realize its full potential by accelerating project timelines, reducing costs, and fostering innovation.
- **PR2 – Undertake a policy review and harmonize project funding through collaborative procurement tied to incentives**: A consistent approach to funding and incentivizing IC projects would encourage broader adoption and create a more predictable environment for stakeholders.
- **PR3 – Identify opportunities to improve code and policies and develop supporting implementation guidelines**: Outdated, inconsistent, or contradictory codes and regulatory policies can hinder IC adoption by creating unintentional barriers to approval and scalability. Working closely with willing jurisdictions to identify opportunities and collaboratively develop an agreed-upon set of 'acceptable solutions' that align with existing regulatory frameworks is key. This work should be supported by a clear implementation guideline to pilot and scale these solutions across participating jurisdictions, ensuring smoother integration of IC innovations while maintaining safety and compliance.
- **PR4 – Alignment of municipalities and the three tiers of governments**: Municipal, provincial, territorial and federal governments need to collaborate on policies, inspections, and approvals to avoid conflicting rules that delay IC projects. Provinces, territories and municipalities should coordinate consistent implementation of IC constructed buildings.
- **PR5 – Continuity in government policy**: Long-term, stable policies foster confidence in IC investments and reduce the risk of abrupt changes that disrupt projects.

4.2.2 Procurement models and performance systems

The following initiatives are recommended to address procurement challenges that affect the adoption of IC. These recommendations focus on creating fair, efficient, and innovation-driven procurement processes that align with the unique risks and benefits of IC.

- **PM1 – Develop collaborative procurement models and methods to quantify value of IC (e.g., quantifying pre-manufactured value (PMV)) and incorporate in the procurement process:** Tailored procurement models that recognize the unique risks and benefits of IC are essential for fair and efficient project execution. One key approach is outcome-based procurement, which prioritizes performance metrics and long-term value over traditional lowest-cost selection. Additionally, programmatic procurement through aligned collaborations, such as public bodies aggregating demand and standardizing technical specifications, can drive scale, improve consistency, and enhance the impact of IC adoption. By integrating these strategies, procurement can better support innovation, efficiency, and risk-sharing in IC projects.

- **PM2 – Improve language in procurement (RFPs) and develop a guide for leveraging IC:** Clearer language in requests for proposals (RFPs) specific to IC will mitigate misunderstandings and encourage participation. A common procurement guide template used by public owners should be developed (by region).
- **PM3 – Work with the Canadian Construction Documents Committee (CCDC) and key industry experts to develop or modify contracts for IC:** Through a collaborative project, bring the CCDC and industry experts together to add, edit or modify existing CCDC contracts, making them more IC friendly (specifically categories 1 to 4). These may begin with CCDC-5B and CCDC-14.

4.2.3 Financial and insurance services

The following initiatives are recommended to address financial and insurance barriers that hinder the adoption of IC.

- **FI1 – Government underwriting of lending against IC**: When governments underwrite loans for IC projects, they reduce financial risks for developers and investors, making IC more viable.
- **FI2 – Deleveraging risk through tax incentives that drive R&D:** Offering tax incentives specific to SMEs (beyond the NRC IRAP programs) for IC-related R&D reduces financial burden and stimulates innovation in the sector.
- **FI3 – More flexible R&D funding for industry to easily participate:** Streamlined access to R&D funds with less administrative burden and quicker approval times ensures more companies, especially SMEs, can contribute to IC advancements.
- **FI4 – Structured financial solutions supported by financial institutions:** Provide long-term, low-interest loans, loan guarantees, and public-private partnerships to reduce financial risks and improve capital access for IC projects. The financial sector facilitates investment in modular construction, supply chains, and advanced manufacturing by offering tailored financing options, ensuring industry scalability and innovation. By mitigating risks and enhancing funding accessibility, financial institutions help drive the widespread adoption and financial sustainability of IC.
- **FI5 – Create a best practice template proforma document specific to IC for developers**: Developers, cost consultants and estimators are often unsure of the differences in traditional stick-built construction compared to IC methods, particularly with OSC and AM. Developing a proforma template that highlights the differences of using IC provided developers with more certainty in their investments (this may come with a data trust and common unit rates will need to be updated regularly).
- **FI6 – Conduct key case studies to identify drawbacks and understand gaps in the insurance products for IC**: Insurance is often viewed as a major barrier to IC as insurers have less data on projects leveraging IC (particularly categories 1 to 5) thus increasing premiums due to more unknowns. By understanding the data needed, case studies can be shaped to help insurers learn of the benefits to IC and develop products for IC projects. Additional case studies could consider the benefits of categories 6 and 7 in executing projects, whether off site or on site, and understand how digital technologies or site-based productivity improvements influence key project outcomes (e.g., schedule, budget, safety, etc.).

4.2.4 Awareness, competency, and collaboration

The following initiatives are recommended to enhance awareness, competency, and collaboration in the adoption of IC.

- **AC1 – Awareness campaign**: Educating the public and general construction industry with successful case studies builds confidence in IC's reliability and potential benefits.
- **AC2 – Focus on competency gaps and opportunities for IC to address**: Identifying and addressing skill gaps ensures a workforce capable of meeting IC demands, boosting productivity and project quality.
- **AC3 – Standardization of terminology, product types, and definitions to drive design for manufacture and assembly through collaboration across the construction value chain (e.g., mass productization)**: Establishing standards for processes and outcomes improves collaboration and allows for measurable performance comparisons.

4.2.5 Quantifying capacity and capability for IC

The following initiatives are recommended to quantify capacity and competency gap through the lens of labour and skills development. The initiatives will enhance workforce readiness, inform training programs, and align IC growth with industry capacity. While some initiatives focus directly on skill-building, others support the broader ecosystem by providing the data, tools, and incentives necessary to guide workforce planning and ensure that capacity development keeps pace with demand.

- **CC1 – Quantify and highlight the labour benefit of IC (specific to Canada's climate and geography)**: Demonstrating how IC suits Canada's unique challenges, such as remote locations and harsh climates.
- **CC2 – Clear picture of off-site solutions available and quantify capability and capacity**: Mapping available OSC solutions and capacities is essential for effective planning and alignment with market demand. This process should include a maturity assessment framework to classify the supply chain based on key factors such as capability, readiness, and maturity. By identifying strengths and gaps, stakeholders can target areas for improvement, enhance collaboration, and ensure a more robust and resilient OSC ecosystem.
- **CC3 – Incentivize and support IC with a focus on driving IC demand that aligns with capacity and capability**: Incentives should align with the current capacity and capability of the IC industry to ensure sustainable growth and prevent overextension.

4.2.6 Research and data sharing

The following initiatives are recommended to enhance data sharing and drive IC industry adoption through data-driven decision-making.

- **RD1 – R&D focus on methodologies and tools for industry data capture and sharing:** Adopt a productivity framework and standardize data collection methods to capture data and drive industry adoption of IC.
- **RD2 – Develop a premanufactured value toolkit for Canada to demonstrate the commercial/financial benefits to owners and lenders:** Create a toolkit to objectively quantify the pre-manufactured value on projects.

4.3 Key actions and implementation strategies

This section outlines the key actions and strategies necessary for the successful implementation of the initiatives identified in this report. A series of one-page dashboards has been developed to provide a structured and visual framework for execution. Each dashboard highlights specific initiatives, timelines, engaged stakeholders, and implementation priorities. ***Table 2*** provides an overview of each component's significance in the dashboards and how they were derived from the report's findings.

Table 2: Framework elements and descriptions

Table Column	Description
Unique identifier	Lists the unique identifier corresponding to the initiative listed in the table.
Initiative	Lists the key actions or strategic initiatives identified in the report to achieve the intended goals. For more details, refer to Section 4.2.
Metric	Specifies relevant metrics that help track progress, such as cost reduction, time savings, efficiency improvements, or stakeholder satisfaction. The metrics were identified through discussions with stakeholders during workshops and interviews. These discussions helped define key metrics that reflect the effectiveness of each initiative in overcoming challenges such as high capital costs, regulatory hurdles, fragmented procurement, and workforce shortages. By using these metrics, stakeholders can evaluate progress, measure impact, and adjust strategies to enhance implementation success.
Key stakeholder	The primary entity responsible for leading and driving the implementation of the initiative. Based on the stakeholder analysis in the report, the key stakeholder was identified through workshop discussions and interviews.
Other stakeholders	Additional parties who play a supporting or influencing role in the implementation of the initiative. Based on the stakeholder analysis in the report, other stakeholders were identified through workshop discussions and interviews.
Expected timeline for implementation	Indicates the anticipated timeframe required to execute the initiative. The expected timeline for implementation is based on the roadmap timeline and stakeholder inputs gathered through workshops, interviews, and public survey. During the data collection, respondents were asked to select short- (Q32025–Q42025), mid- (2026–2028) or long-term (2029—beyond 2030). However, the recommended year has been included.
Ease of implementation	The ease of implementation is determined by analyzing key challenges identified through stakeholder discussions. The initiatives are classified into five levels based on their feasibility and the extent of challenges they face: • **Very easy**: The initiative faces minimal challenges, with strong market readiness, clear regulatory support, and available funding. No major infrastructure or workforce barriers exist. • **Easy**: The initiative requires moderate effort, with minor financial, regulatory, or logistical challenges. Existing infrastructure and workforce capabilities support implementation with minimal adjustments.

<table>
<tr><th>Table Column</th><th>Description</th></tr>
<tr><td></td><td>Moderate: The initiative encounters notable challenges, such as fragmented procurement, decision-making complexities, and cultural resistance. It may require stakeholder coordination, funding support, or regulatory adjustments.
Difficult: The initiative faces significant barriers, including high capital costs, unclear risk, long-term strategy concerns, and workforce shortages. Successful execution depends on policy alignment, strong industry collaboration, and phased implementation.
Very difficult: The initiative presents substantial obstacles, including financing difficulties, market resistance, fear of change, and misalignment between government policies and industry needs. Implementation is only feasible with long-term investment, regulatory reforms, and significant stakeholder engagement.</td></tr>
<tr><td rowspan="2">Scope of implementation</td><td>IC focus area
Specifies how each initiative relates to a specific IC sub-section, ensuring clear alignment with the distinct areas of IC, which is divided into four sub-sections, refer to Section 2.1. Each initiative is assessed to determine whether it applies to one or more of these IC sub-sections or has a broader impact across the entire IC framework. This categorization ensures that implementation strategies are aligned with the specific needs and characteristics of each segment.</td></tr>
<tr><td>Location (national, regional or local)
Specifies whether the initiative should be targeted at a national level (country-wide) or tailored to a specific region or local jurisdiction. In some cases, projects are best tested and validated at a local or provincial level before carried out regionally or nationally.</td></tr>
<tr><td>Role of Federal Government (NRC)</td><td>Describes the involvement of the NRC Construction Research Centre (CRC) in supporting or facilitating the implementation of the initiative. NRC's role is determined based on workshops, interviews, and survey responses, ensuring alignment with industry needs and stakeholder expectations. It is recommended that a Centre of Excellence (CoE) be established to serve as the fulcrum and broker in the triple-helix model of innovation—connecting industry with government and university leaders—thereby reinforcing NRC CRC's central role in fostering collaboration and innovation.</td></tr>
<tr><td>Impact (out of 10)</td><td>The expected impact of the initiative on a scale of 1 (lowest) to 10 (highest) based on potential benefits. This assessment was derived from workshops, interviews, and survey responses, ensuring a comprehensive evaluation of the initiative's potential influence on industry advancement, economic growth, and sustainability.</td></tr>
<tr><td>Steps for implementation</td><td>Details the specific actions required to execute the initiative successfully. The steps for implementation were developed based on stakeholder discussions during workshops, ensuring alignment with industry needs and practical feasibility.</td></tr>
</table>

Throughout and after completing the initiatives, the NRC through the CoE should take the lead in documenting all initiatives identified in the form of a **case study**. Data collected through the case studies should be housed with Statistics Canada and NRC should facilitate, collect, clean, and maintain the data for both industry and academic use. Prior to this beginning, the Federal Government, with support from the NRC, must develop and adopt a national framework for IC, including definitions of the categories and high-level categorization of building products. It is recommended that the Modern Methods of Construction (MMC) Framework from the UK is adopted, a working group is established to make the framework Canadian specific, and the categories and definitions are finalized by the end of December 2025. Without this common framework, categorization and definition, many of the initiatives presented in the series of one-page dashboards will ultimately fail.

*Throughout and after completing the initiatives, the **NRC through the CoE** should take the lead in **documenting all initiatives** identified in the form of a **case study***

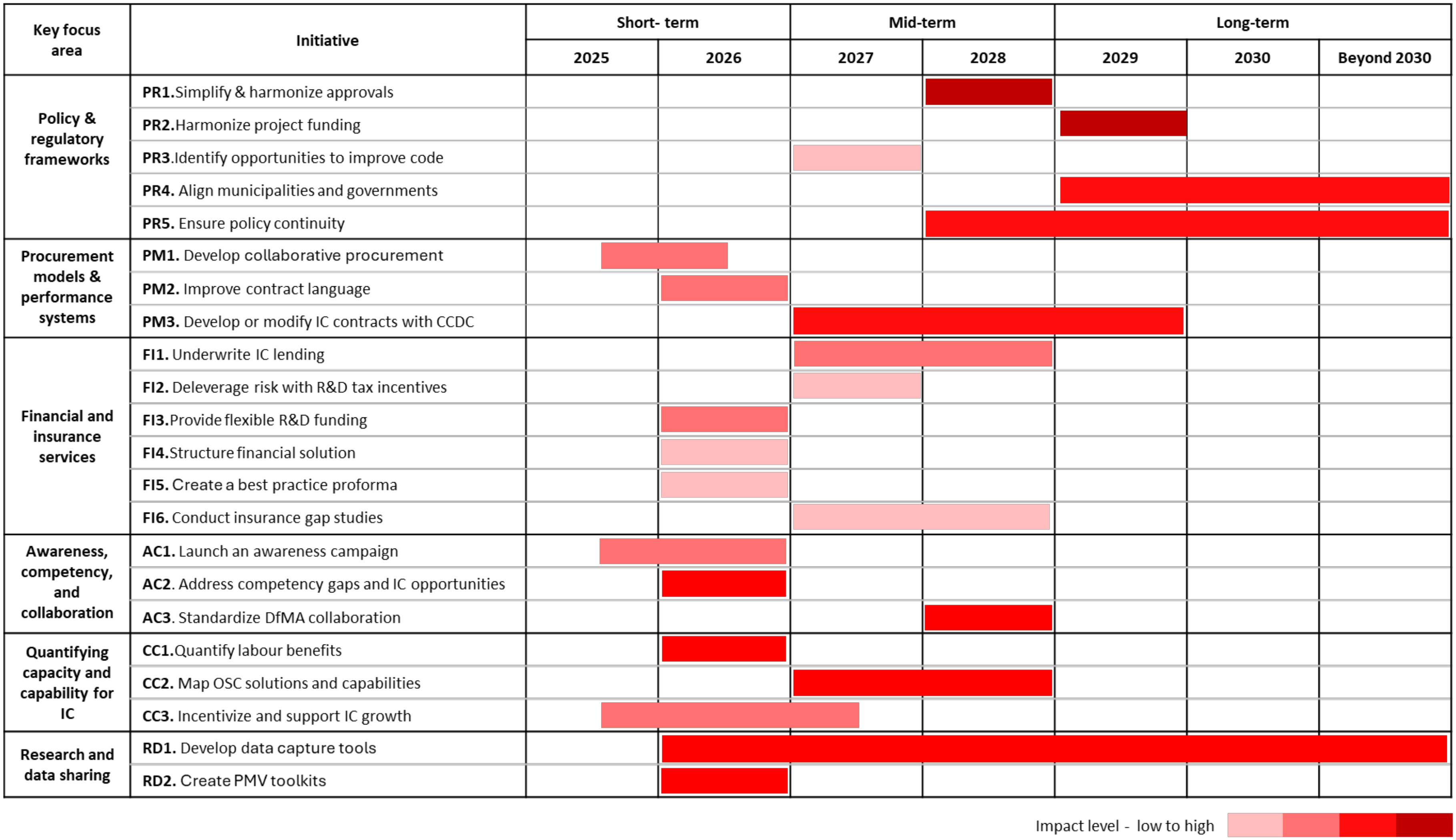


Figure 11. Timeline and impact level of strategic initiatives to advance industrialized construction (IC) in Canada across key focus areas

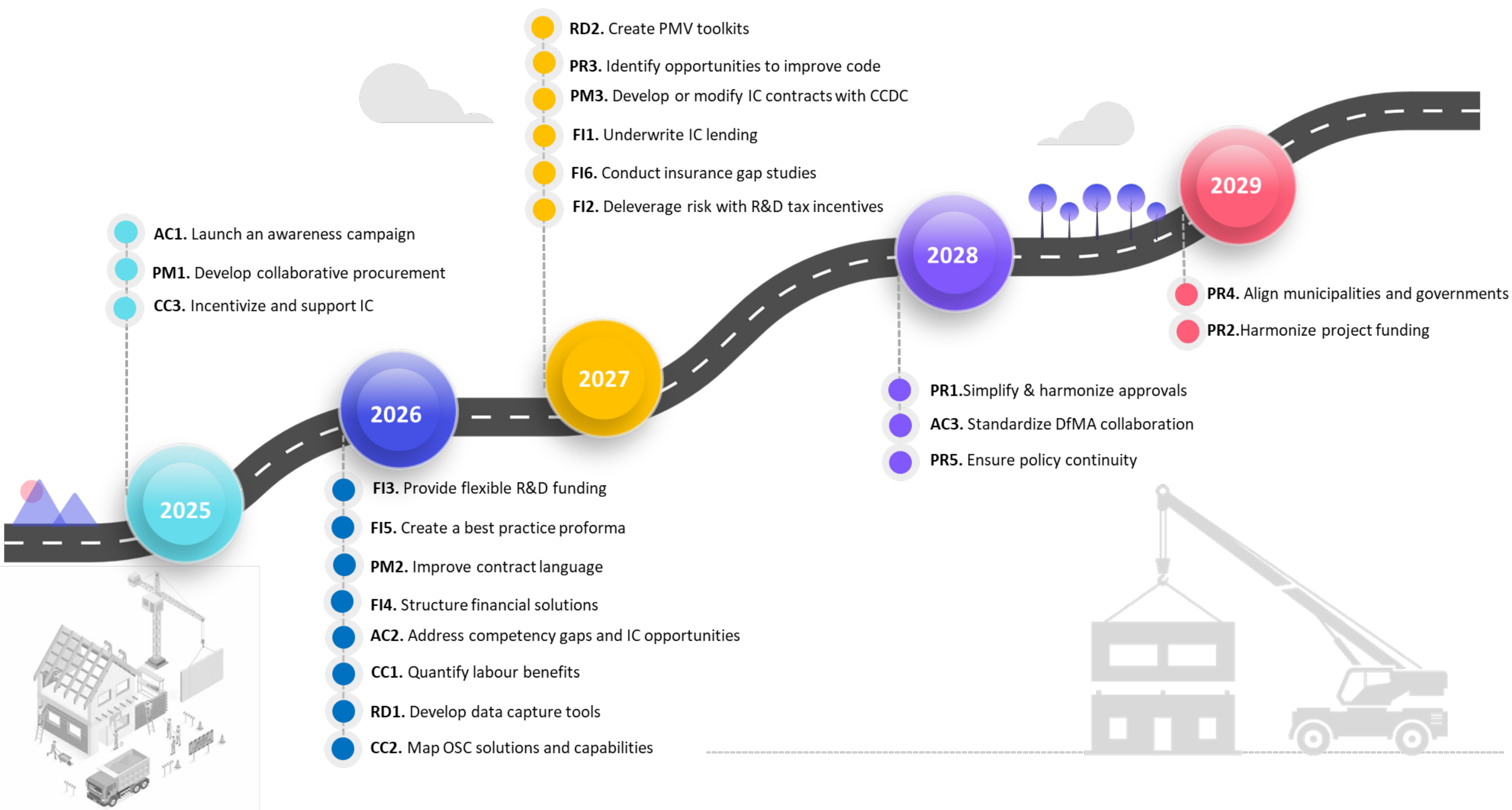


Figure 12. Visual roadmap illustrating the phased implementation of Industrialized Construction (IC) initiatives

Policy and regulatory frameworks

PR1 Initiative

Simplify, Improve, and Harmonize the Approval Process

Timeline and implementation

Expected timeline	Ease of implementation
2028	Difficult

Impact 9/10

Stakeholders

Key Stakeholder(s)
Regulatory and code authorities

Other Stakeholders
Government and public sector
Construction and development sectors
Design and planning departments
Royal Architectural Institute of Canada
Canada Mortgage and Housing Corporation (CMHC)

Metrics

- % Reduction in approval time from permit application to building occupancy
- # No. of jurisdictions adopting streamlined approvals

Scope of implementation

IC Focus Area	Location
All levels of IC	Local & regional

Prerequisite initiative (s)

PR3 – PM3 – RD1

Steps for implementation

1. Conduct regulatory comparisons through regional pilots.
2. Develop standardized approval process model framework.
3. Pilot testing implementation.
4. Develop IC certification program.

Role of Federal Government **(NRC)**

Work with innovative jurisdictions to create a pilot R&D study and streamline codes implementation for IC/prefab adoption.

Policy and regulatory frameworks

PR2 Initiative

Undertake a policy review and harmonize project funding through collaborative procurement tied to incentives

Timeline and implementation

Expected timeline	Ease of implementation
2030	Difficult

Impact 9/10

Stakeholders

Key Stakeholder(s)

Canada Infrastructure Bank
Insurance Bureau of Canada (IBC)
Infrastructure owners in the federal government

Other Stakeholders

Provincial government
Federal government
Private investors
Banks
Developers
General contractors
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)

Metrics

- # No of IC projects receiving incentives
- % increase in IC companies adopting IC processes

Scope of implementation

IC Focus Area	Location
OSC	Regional

Role of Federal Government **(NRC)**

Facilitate collaboration between government and financial institutions.

Steps for implementation

Prerequisite initiative (s)

FI1 – FI2 – FI3 – PM1

1. With the lead of CMHC, identify an innovative private developer, funder (private bank and CIB), insurance company (insurance company and IBC), and construction consortium to pilot three projects using similar OSC technology (e.g., mass timber, volumetric construction, precast concrete, etc.) in western, central and Atlantic Canada.
2. Assess gaps and inefficiencies in current procurement and lending structures.
3. Develop clear and measurable funding criteria that incentivize IC adoption.
4. Execute projects as case studies and document the lessons learned from a procurement, lending, and insurance lens.
5. Share findings with financial institutions on incentive-based loan structures in each of the three regions.
6. Develop national procurement guidelines and support the roll out through training (completed by the new Centre of Excellence).

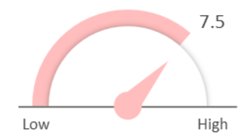
Policy and regulatory frameworks

PR3 Initiative

Identify opportunities to improve code and policies and develop supporting implementation guidelines

Timeline and implementation

Expected timeline	Ease of implementation
2027	Difficult



Impact 7.5/10

Stakeholders

Key Stakeholder(s)
Standards association

Other Stakeholders
Regulatory and code authorities
Municipal and provincial government
Engineering firms
Industry associations
Trade associations
Royal Architectural Institute of Canada (RAIC)
Developers
Manufacturers
Canada Mortgage Housing Association (CMHC)

Metrics

- No. of outdated codes revised
- % Reduction in project delays due to regulatory issues
- % Increase in IC adoption rates

Scope of implementation

IC Focus Area	Location
All levels of IC	Regional

Role of Federal Government **(NRC)**

Research and advisory role for new standards and best practices.

Steps for implementation

Prerequisite initiative (s)
SD1 – SD2

1. Identify the innovators doing this (e.g., Digitally Accelerated Standard Housing project team in BC funded by CMHC) and roll out in other jurisdictions in Canada.
2. Repeat the work in British Columbia but specific to the supply chain and needs in other provinces.
3. Conduct regulatory gap analysis.
4. Develop amendment proposals for key regulatory gaps identified in Step 1.
5. Gaining regulatory acceptance, aligning with provincial governments, and ensuring industry adoption.
6. Pilot implementation strategies in selected jurisdictions to test proposed amendments and guidelines.
7. Develop and publish implementation guidelines.

Policy and regulatory frameworks

PR4 Initiative

Alignment of municipalities and the three tiers of governments

Timeline and implementation

Expected timeline	Ease of implementation
2029	Very difficult

Impact 8.5/10

Stakeholders

Key Stakeholder(s)
Local governments

Other Stakeholders
Federal and provincial government
Industry Associations
Trade and Professional Associations
Canadian Standards Association (CSA)
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)

Metrics

- # No of projects in collaboration with local governments, the provincial government and federal government

Scope of implementation

IC Focus Area	Location
OSC Site-led processes	Regional & local

Role of Federal Government **(NRC)**

Facilitate collaboration between governments, academic and industry leaders as necessary.

Steps for implementation

Prerequisite initiative (s)
PR5 – PR1

1. Identify the innovators doing this and roll out regionally across Canada.
2. Repeat the work in British Columbia but specific to the supply chain and needs in other provinces.
3. Conduct regulatory gap analysis.
4. Develop amendment proposals for key regulatory gaps identified in Step 1.
5. Gaining regulatory acceptance, aligning with provincial governments, and ensuring industry adoption.
6. Pilot implementation strategies in selected jurisdictions to test proposed amendments and guidelines.
7. Develop and publish implementation guidelines.

Policy and regulatory frameworks

PR5 Initiative

Continuity in government policy

Timeline and implementation

Expected timeline	Ease of implementation
2028	Very difficult

Impact 8.5/10

Stakeholders

Key Stakeholder(s)
Federal government

Other Stakeholders
Provincial government
Industry Associations
Private Investors
Banks
Developers
General Contractors

Metrics

- # No of IC policies sustained across multiple governments

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government **(NRC)**

Facilitate collaboration between governments, academic and industry leaders as necessary.

Steps for implementation

Prerequisite initiative (s)
FI3 – PM1 – PM3

1. Advocate long-term commitments and policies that live beyond election cycles.
2. Implement a multi-decade policy strategy.
3. Secure cross-party endorsements.
4. Develop KPIs and track policy impacts.
5. Industry consultation for continuity.

Procurement models and performance systems

PM1 Initiative

Develop collaborative procurement models and methods to quantify value of IC (e.g., quantifying pre-manufactured value (PMV)) and incorporate in the procurement process

Timeline and implementation

Expected timeline	Ease of implementation
Q4 2025	Moderate

Impact 8/10

Stakeholders

Key Stakeholder(s)
Private and public infrastructure owners

Other Stakeholders
Provincial government
Trade and professional Associations
Developers
General Contractors
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)
Cost consultants

Metrics

- # No of jurisdictions quantifying value of IC in procurement

Scope of implementation

IC Focus Area	Location
OSC	National

Steps for implementation

1. Identify an innovative private developer, funder (private bank and CIB), insurance company (insurance company and IBC), and construction consortium to pilot three projects similar OSC projects (e.g., volumetric modular, mass timber, precast concrete or panelized) in western, central and Atlantic Canada.
2. Assess gaps and inefficiencies in current procurement and lending structures.
3. Develop clear and measurable funding criteria that incentivize IC adoption.
4. Execute projects as case studies using a common framework and document the lessons learned from a procurement, lending, and insurance lens.
5. Share findings with financial institutions on incentive-based loan structures in each of the three regions.
6. Develop national procurement guidelines and support the roll out through training (completed by the new Centre of Excellence).

Role of Federal Government **(NRC)**

Lead and/or support the creation of a database for proper PMV calculations, maintained annually. **Facilitate and provide researchers to best quantify PMV.**

Procurement models and performance systems

PM2 Initiative

Improve language in contracts and procurement (RFPs) and develop a guide for leveraging IC

Timeline and implementation

Expected timeline	Ease of implementation
2026	Moderate

Impact 8/10

Stakeholders

Key Stakeholder(s)
Industry Association

Other Stakeholders
Trade associations
Regulatory and code authorities
Infrastructure owners
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)
Consultants
Engineering firms Developers
General Contractors

Metrics

- # No of revised RFP documents for IC adoption

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government (NRC)

Lead and/or support the creation of a database for best practice documents.
Facilitate and provide researchers to develop best practice procurement guides for both ICI and residential.

Steps for implementation

1. Begin a review of selected CCDC documents (e.g., CCDC 5B, CCDC 14, etc.) compare them against the new AIA contract documents and update or create an annex for each of the four IC categories.
2. Support implementation with innovative infrastructure owners and innovators within the supply chain
3. Document the project through a case study where results are shared publicly – case study funded and owned by the NRC.

Procurement models and performance systems

PM3 Initiative

Work with the Canadian Construction Documents Committee (CCDC) and key industry experts to develop or modify contracts for IC

Timeline and implementation

Expected timeline	Ease of implementation
2027	Difficult

Impact 8.5/10

Stakeholders

Key Stakeholder(s)
Standards associations

Other Stakeholders
Regulatory and code authorities
Developers
General contractors

Metrics

- # No of new or revised contracts amended for IC

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Steps for implementation

1. Begin a review of selected CCDC documents (e.g., CCDC 5B, CCDC 14, etc.) compare them against the new AIA contract documents and update or create an annex for each of the four IC categories.
2. Support implementation with innovative infrastructure owners and innovators within the supply chain
3. Document the project through a case study where results are shared publicly – case study funded and owned by the NRC.

Role of Federal Government **(NRC)**

Lead and/or support the creation of a database for proper PMV calculations, maintained annually. **Facilitate and provide researchers to best quantify PMV.**

Financial and insurance services

FI1 Initiative

Government underwriting of lending against IC

Timeline and implementation

Expected timeline	Ease of implementation
2027	Difficult

Impact 8/10

Stakeholders

Key Stakeholder(s)

Federal Government
Canada Mortgage Housing Association (CMHC)

Other Stakeholders

Provincial government
Trade and Professional Associations
Developers
General Contractors
Canadian Construction Documents Committee (CCDC)
Cost consultants
Alliance of Canadian Building Officials' Association (ACBOA)
Insurance Bureau of Canada (IBC)

Metrics

- A lending program backed by CIB and CMHC for housing

Scope of implementation

IC Focus Area	Location
OSC	Regional

Role of Federal Government **(NRC)**

Support efforts of this development by providing case studies to justify the benefits of IC to deliver housing at scale.

Steps for implementation

1. Create a committee of trade and professional associations to work with CMHC, private banks, IBC, infrastructure owners, private developers and cost consultants by region.
2. Identify key data points and pain points experienced when executing IC related projects, with focus on the category with most barrier to entry: OSC.
3. Develop guide document for how the Canada Infrastructure Bank should offer preferred lending rates for OSC.
4. Implement in parallel to campaign targeting private developers.

Financial and insurance services

FI2 Initiative

Deleveraging risk through tax incentives that drive R&D

Timeline and implementation

Expected timeline	Ease of implementation
2027	Moderate

Impact 7.5/10

Stakeholders

Key Stakeholder(s)
Federal Government

Other Stakeholders
Provincial government
Academic institutions
Developers
General Contractors
Start-up and Venture community

Metrics

- # No. No. of construction projects that require R&D investment as part of the selection process

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government **(NRC)**

Support the development of the criteria and then help with execution of R&D projects.

Steps for implementation

1. Review R&D requirements for successful proponents who were part of past mega-projects funded by the federal government (e.g., National Shipbuilding Strategy, Strategic Aerospace and Defence Initiative, etc.)
2. Adopt the R&D requirements for successful proponents in these projects through national superclusters.
3. Identify mega infrastructure initiatives where this requirement can be adopted.
4. Create a systematic method to measure success of the R&D being developed through these projects (e.g., no.# of start ups in construction, # no. of exports (goods and services) from a region, etc.)

Financial and insurance services

FI3 Initiative

More flexible R&D funding for industry to easily participate

Timeline and implementation

Expected timeline	Ease of implementation
2026	Easy

Impact 8/10

Stakeholders

Key Stakeholder(s)
Industry Association

Other Stakeholders
Provincial government
Trade and Professional Association
Developers
General Contractors
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)

Metrics

- # No. of projects completed by the NRC CoE direct with industry practitioners

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government **(NRC)**

Lead the development of R&D funding programs for SMEs in the construction with less barriers to access funding.

Steps for implementation

1. In partnership with IRAP and other federal departments, develop a performance-based R&D initiative with less administrative burden.
2. Create a group within the CoE, in collaboration with IRAP, who provides "white glove service" to SMEs looking to access the funding.
3. Connect Canadian SMEs with Canadian researchers, including internal NRC researchers, to execute the projects.
4. Allow the SMEs to own all IP for commercial rights.

Financial and insurance services

FI4 Initiative

Structured financial solutions supported by financial institutions

Timeline and implementation

Expected timeline	Ease of implementation
2026	Moderate

Impact 7.5/10

Stakeholders

Key Stakeholder(s)
Banks

Other Stakeholders
Professional Associations
Developers
General Contractors
Canada Mortgage Housing Association (CMHC)
Cost consultants

Metrics

- # No. of banks offering incentives for using IC to deliver projects

Scope of implementation

IC Focus Area	Location
OSC	National

Role of Federal Government **(NRC)**

Support the creation of the consortium focused on developing financial products for IC.

Steps for implementation

1. Similar and can be combined with FI1.

Financial and insurance services

FI5 Initiative

Create a best practice template proforma document specific to IC for developers

Timeline and implementation

Expected timeline	Ease of implementation
2026	Easy

Impact 7.5/10

Stakeholders

Key Stakeholder(s)
Industry Association

Other Stakeholders
Professional Associations
Developers
General Contractors
Canada Mortgage Housing Association (CMHC)
Cost consultants

Metrics

- Development of proforma template guide for developers
- # No. of developers implementing the guide

Scope of implementation

IC Focus Area	Location
OSC	National

Steps for implementation

1. Create a committee including developers, lenders, and cost consultants.
2. Identify best practices for pro forma and develop a template.
3. Ensure committee input and collaboration throughout the project.
4. Pilot the pro forma template across all methods of IC in multiple jurisdictions. Begin with one region and repeat across other regions in Canada.

Role of Federal Government **(NRC)**

Create and support execution of a research projects.

Financial and insurance services

FI6 Initiative

Conduct key case studies to identify drawbacks and understand gaps in the insurance products for IC.

Timeline and implementation

Expected timeline	Ease of implementation
2027	Difficult

Impact 7.5/10

Stakeholders

Key Stakeholder(s)
Insurance

Other Stakeholders
Provincial government
Trade and Professional Associations
Developers
General Contractors
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)
Cost consultants
Alliance of Canadian Building Officials' Association (ACBOA)
Insurance Bureau of Canada (IBC)

Metrics

- # No. of insurance products offered for IC
- Database of case studies for insurance companies to review

Scope of implementation

IC Focus Area	Location
OSC, AM site-based products	National

Role of Federal Government (NRC)

Act as broker to bring insurance providers, industry and researchers together to conduct case studies.

Steps for implementation

1. Create a committee of innovative developers, CMHC, cost consultants, and insurance companies through IBC.
2. Identify key issues faced with receiving insurance across all phases of the projects from construction professionals when doing IC projects.
3. Document the projects through case studies to demonstrate lessons learned and best practices for industry.
4. Share as widely as possible through conferences, webinars, and other forms of communication.

Awareness, competency, and collaboration

AC1 Initiative

Awareness campaign

Timeline and implementation

Expected timeline	Ease of implementation
Q4 2025	Easy

Impact 8/10

Stakeholders

Key Stakeholder(s)
Industry Association

Other Stakeholders
Academic institutions
Trade and Professional associations
Royal Architectural Institute of Canada (RAIC)
Engineers Canada

Metrics

- # No. of webinars, conferences, and other engagement events where the CoE played a vital role in creation and execution

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Steps for implementation

1. Collaboration of an outreach committee led by NRC in collaboration with other government departments, academia, and industry communications teams.
2. Execute a webinar series in collaboration with other groups in the triple- helix model.
3. Host an annual event in Ottawa.
4. Create a commercial or other forms of media content to promote IC practices and the benefits to create a more productive, sustainable and innovative construction sector.

Role of Federal Government **(NRC)**

Lead development of programs, participate in webinars, conferences and podcasts.

Awareness, competency, and collaboration

AC2 Initiative

Focus on competency gaps and opportunities for IC to address

Timeline and implementation

Expected timeline	Ease of implementation
2026	Moderate

Impact 8.5/10

Stakeholders

Key Stakeholder(s)
Academic and research organizations

Other Stakeholders
Industry associations
Trade and Professional Associations
Canadian Standards Association (CSA)
Royal Architectural Institute of Canada (RAIC)
Engineers Canada
National and provincial trade unions

Metrics

- # No. of programs offered at universities focused on IC, OSC, MMC, AMC.
- # No. of training programs offered by trade schools (public or private) focused on IC, OSC, MMC, AMC.

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government **(NRC)**

The NRC CoE can support through committees that contribute to curriculum development.

Steps for implementation

1. Collaboration of an outreach committee with NRC, construction associations (through CCA), union representatives, universities and colleges.
2. Beginning in a province or region, identify key competencies and learning outcomes for engineers, architects, and trades of the future.
3. Support the institutions in executing the launch of these programs.

Awareness, competency, and collaboration

AC3 Initiative

Standardization to drive design for manufacture and assembly through collaboration across the construction value chain (e.g., mass productization)

Stakeholders

Key Stakeholder(s)
Standards Association

Other Stakeholders
Standards associations including ICC, ANSI, UL, CSA
Product suppliers
Manufacturers
BIM and VDC consultants
BIM and VDC teams within the GCs
Sub-trades
Database and website developers
Royal Architectural Institute of Canada (RAIC)
Engineers Canada
National and provincial trade unions

Role of Federal Government **(NRC)**

Act as a broker bringing the right stakeholders together to create a database for IC products.

Timeline and implementation

Expected timeline	Ease of implementation
2028	Difficult

Impact 8.5/10

Metrics

- # No. of standard products and components

Scope of implementation

IC Focus Area	Location
All levels of IC	National/International

Steps for implementation

1. Create a working committee backed with funding to create the database and maintaining the database long-term.
2. Work with suppliers, manufacturers, product certification bodies, BIM experts, etc. to create a marketplace for IC products.
3. Launch a pilot by 2028, demonstrating value to the market.
4. Create a simplified process for suppliers to add new and certified products to their marketplace.

Quantifying capacity and capability for IC

CC1 Initiative

Quantify and highlight the labour benefit of IC (specific to Canada's climate and geography)

Timeline and implementation

Expected timeline	Ease of implementation
2026	Moderate

Impact 8.5/10

Stakeholders

Key Stakeholder(s)
Academic and Research Organizations

Other Stakeholders
Provincial government
Trade and Professional Associations
Developers
General Contractors
Manufacturers

Metrics

- # No. of output vs. input for different IC methods and products by region and project type

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government (NRC)

Research case studies to document the productivity gains and required skillsets for IC projects.

Steps for implementation

1. Create a committee in each region (Atlantic, Central, Prairie, West, and North) to develop productivity framework.
2. Conduct case studies (preferably on projects using similar procurement models and contract types) to quantify productivity improvements comparing IC technologies (OSC- volumetric modular, panelized, etc., AM, and product led on-site components) to traditional stick-built methods.
3. Present findings in a comparable way across all forms of IC by geography, climate, and region.

Quantifying capacity and capability for IC

CC2 Initiative

Clear picture of off-site solutions available and quantify capability

Timeline and implementation

Expected timeline	Ease of implementation
2027	Moderate

Impact 8.5/10

Stakeholders

Key Stakeholder(s)
Academic and Research Organizations

Other Stakeholders
General Contractors
Manufacturers
Trades and sub-contractors
Suppliers
Professional services

Metrics

- # No. of users using an IC database.

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Steps for implementation

1. Beginning with OSC based systems, build on the Prefab database to create a Canadian marketplace for IC.
2. Engage general contractors, manufacturers, and suppliers to understand their capacity and document their solutions in a database.
3. Launch database by 2026 with continuous improvement and additions to the database ongoing.

Role of Federal Government **(NRC)**

Building from the Prefab database from NRCan, develop a more robust database (in alignment with AC3)

Quantifying capacity and capability for IC

CC3 Initiative

Incentivize and support IC with a focus on driving IC demand that aligns with capacity and capability

Timeline and implementation

Expected timeline	Ease of implementation
2027	Easy

Impact 8/10

Stakeholders

Key Stakeholder(s)
Federal Government

Other Stakeholders
Provincial government
Trade and Professional Association
Developers
General Contractors
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)
Cost consultants
Alliance of Canadian Building Officials' Association (ACBOA)
Insurance Bureau of Canada (IBC)

Metrics

- # No. of knowledge mobilization initiatives supported annually (e.g., conferences, webinars, podcasts, etc.)

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government (NRC)

Promote findings of projects funded by the NRC CoE and host an annual symposium in Ottawa.

Steps for implementation

1. Collaborating with the whole construction value chain, host an annual symposium on CSDP with a focus on presenting findings from the projects completed over the previous 12 months.
2. Host the first conference in fall 2025 and continue annually with a recurring date, time, and agenda.
3. Ensure that all researchers receiving funding through the program are aware that findings will need to be shared at the knowledge mobilization event hosted by the NRC Construction CoE.
4. Ensure collaboration with key industry (e.g., partnerships through Canadian Construction Association and all their members, Building Transformations, BuildingSMART Canada, Modular Building Institute, Canada Home Builders Association, SitePartners, etc.) focused organizations to foster the triple- helix model of innovation (government-academia-industry collaboration).

Research and data sharing

RD1 Initiative

R&D focus on methodologies and tools for industry data capture and sharing

Timeline and implementation

Expected timeline	Ease of implementation
2026- Ongoing	Difficult

Impact 8.5/10

Stakeholders

Key Stakeholder(s)

Federal Government (Statistics Canada)

Other Stakeholders

Provincial government
Trade and Professional Associations
Developers
General Contractors
Manufacturers
Trades and sub-contractors
Suppliers
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)
Cost consultants
Alliance of Canadian Building Officials' Association (ACBOA)
Insurance Bureau of Canada (IBC)

Metrics

- # No. of databases created and maintained by the federal government

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Role of Federal Government **(NRC)**

Support adoption of a productivity framework and creation and ongoing maintenance of a key data collected for the construction sector.

Steps for implementation

1. Begin working with Statistics Canada to understand steps to collect and host datasets required to grow the IC market.
2. Using initiatives listed in Table 2, package the datasets in a way that can be shared publicly and continually updated to measure productivity and innovation across the construction sector.

Research and data sharing

RD2 Initiative

Develop a premanufactured value toolkit for Canada to demonstrate the commercial/financial benefits to owners and lenders

Stakeholders

Key Stakeholder(s)

Industry Association

Other Stakeholders

Provincial government
Trade and Professional Association
Developers
General Contractors
Manufacturers
Trades and sub-contractors
Suppliers
Canadian Construction Documents Committee (CCDC)
Canada Mortgage Housing Association (CMHC)
Cost consultants
Alliance of Canadian Building Officials' Association (ACBOA)
Insurance Bureau of Canada (IBC)

Role of Federal Government (NRC)

In collaboration with academia and industry, lead the development of a premanufactured value toolkit for construction projects in Canada. Example measures to quantify include, lifecycle costs, GHG emissions, GHG emission costs, health and safety costs, waste produced, labour required and job creation.

Timeline and implementation

Expected timeline	Ease of implementation
2026	Difficult

Impact 8.5/10

Metrics

- # No. of case studies highlighting all IC benefits

Scope of implementation

IC Focus Area	Location
All levels of IC	National

Steps for implementation

1. Identify key research partners in Canada and abroad and form a project advisory committee from industry.
2. Complete a review of methods to quantify the measures identified.
3. Develop an online cloud-based PMV toolkit hosted by the CoE for industry to use.
4. In partnership with public infrastructure owners, implement the toolkit through procurement processes (e.g., all proponents looking to access public funding must use the toolkit and demonstrate their project has a PMV of X % - % may vary by region, province or project type).
5. Through iterative feedback from industry, update the toolkit as needed.
6. Continually update the toolkit as more information and data becomes available.

5.0 Conclusion and Next Steps

The Industrialized Construction Research and Development Roadmap provides a structured, industry-driven approach to achieving improving Canadian construction sector productivity through increased adoption, of IC. Through in-person, virtual interviews, and public survey, industry practitioners across the entire construction value chain provided input into the key barriers and opportunities to drive IC adoption. Policy, regulation, procurement, financial, industry awareness, education and skills development, and research were all areas where initiatives were identified to overcome the barriers.

Through a phased roadmap, the framework develops research priorities based on needs from industry practitioners. The identification of knowledge and implementation gaps were collected from a wide array of perspectives across the construction industry, as described in Section 3, and the scope was all encompassing to include residential, institutional, and commercial construction sectors.

*The **Federal Government**, with support from the **NRC**, must **develop and adopt a national framework** for industrialized construction – this is the **top priority.***

Prior to executing the initiatives detailed in Table 3 to Table 8, the Federal Government, with support from the NRC, must **develop and adopt a national framework for industrialized construction – this is the top priority.** The framework should include definitions of the categories and high-level categorization of building products. This should be completed by the end of December 2025 where the Modern Methods of Construction (MMC) Framework from the United Kingdom is adopted, a working group is established to make the framework Canadian specific, and the categories and definitions are finalized. **Without this common framework, categorization and definitions, many of the initiatives discussed in this roadmap will ultimately fail.**

*Without this **common framework, categorization and definitions,** many of the initiatives discussed in this roadmap will **ultimately fail.***

In almost all initiatives, the NRC, through the new CoE, is challenged to take a lead or supporting role, highlighting the impact of being a *broker* to achieving the triple helix innovation model in the construction sector. To do this, a hub and spoke system has been proposed wherein the NRC CoE acts as the primary hub for R&D activity, and regional clusters are created in partnership with institutions across Canada. As a staring point, the NRC should reference the *Environmental Scan of Construction Research at Canadian Institutions* completed for the NRC in 2023. This will help identify the resources required and expertise at each institution, ensuring collaboration across the regional clusters. All national initiatives would be led by the NRC, and supported by the regional clusters, while regional, provincial, and local initiatives should be led by the regional clusters, with a requirement for the clusters to collaborate across the country and report up to the CoE. **Figure 13** demonstrates this at a high level.

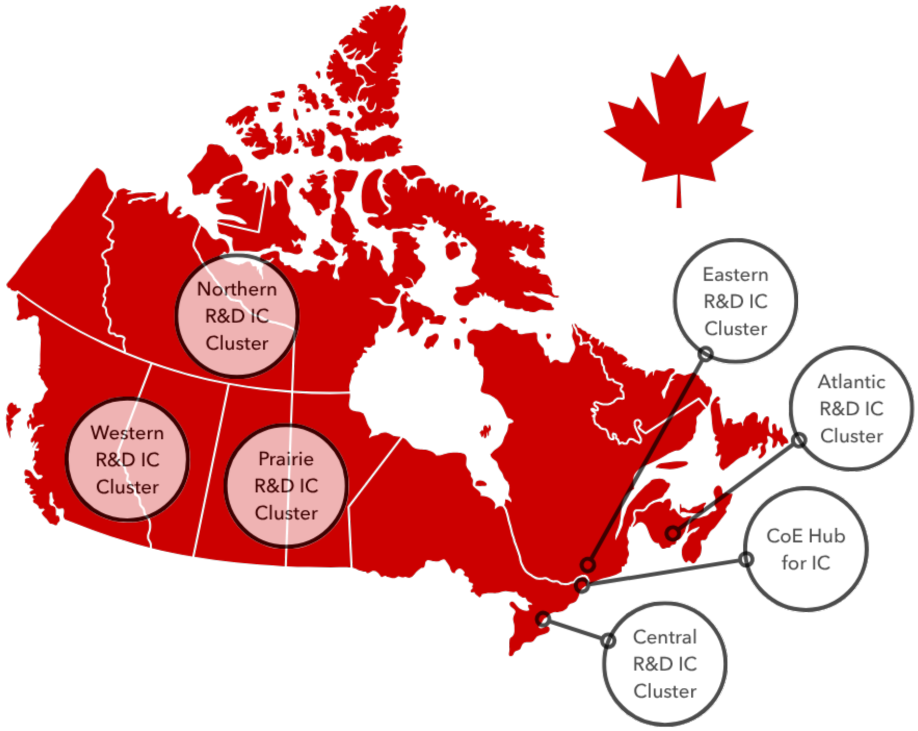


Figure 13: *Map of hub and spoke system for executing initiatives*

Throughout and after completing the initiatives, the NRC should document all initiatives in the form of a case study. The data collected through the case studies should be housed with Statistics Canada and NRC should facilitate, collect, clean, and maintain the data for both industry and academic use.

To summarize, the **immediate next steps** prior to executing the initiatives detailed in the series of one-page dashboards include:

- Adopt and Canadianize an IC framework with categories, definitions, and common terminology.
- Establishing and beginning the data collection of a national construction productivity framework.
- Creating the Centre of Excellence, including establishing by-laws and terms of reference.
- Creating the regional clusters to support the Centre of Excellence.
  - Establishing and secure funding for a minimum 4-year budget to support the Centre of Excellence and regional hubs.
- Executing the initiatives described in Section 4.3 of this Roadmap.

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Appendix A: Workshops

Workshop participant invitation

Figure A-1: Workshop participant invitation

Workshop schedule

- **Workshop 1**: Tuesday, November 12, 2024, Toronto Metropolitan University, Toronto
- **Workshop 2**: Thursday, November 14, 2024, University of Alberta, Edmonton

START *(Eastern Time)*	END *(Eastern Time)*	EVENT
8:30 AM	8:45 AM	Overview of project and NRC program
8:45 AM	10:00 AM	Keynote (45 minutes) and Q&A (45 minutes)
10:00 AM	10:30 AM	Break
10:30 AM	12:00 PM	Workshop 1 - Industry, developer and funder perspectives on Industrialized Construction
12:00 PM	12:30 PM	Lunch
12:30 PM	2:00 PM	Workshop 2 - Government and regulatory perspectives on Industrialized Construction
2:00 PM	2:30 PM	Break
2:30 PM	4:15 PM	Workshop 3 - Developing ideas into an outline R&D roadmap
4:15 PM	4:30 PM	Wrap up, final remarks, next steps

***Figure A-2**: Workshop schedule*

Workshop keynote speaker and facilitator

Figure A-3: Keynote speaker and facilitator

Keynote speaker presentation

https://youtu.be/ErcY47MntRQ

Workshop structure

Advance Preparation:

- Attendees receive pre-event questions.
- Keynote from Mark Farmer, CEO and Founding Director of Cast Consultancy – sets context with a global perspective.

Table Discussions:

- Organized into roundtables of approximately six people with a champion at each table.
- Focus on interactive dialogue rather than formal presentations.

Interactive Tools:

- Paper, post-its, and Mentimeter for idea sharing, voting, and feedback.

Workshop Focus:

- Workshops 1 and 2: Identify key IC themes, challenges, and prioritize initiatives.
- Workshop 3: Prioritize ideas from a shortlist.

Pre-workshop questions

Workshop 1 - Industry, developer and funder perspectives on Industrialized Construction

Commercial advantages:

1. In what ways can industrialized construction (IC) help developers overcome challenges related to labour shortages, project delays, and cost overruns that are prevalent in traditional construction?
2. What commercial advantages does IC offer in terms of speed to market, cost savings, and quality consistency?

Fundability:

1. How can financial institutions adapt their lending criteria to support IC projects?
2. What role should venture capital or innovation-driven funding play in the growth of IC startups and technology companies?

Insurability:

1. What changes in insurance policy structures or underwriting criteria are needed to accommodate the unique aspects of IC?
2. How can the industry collaborate with insurance providers to create more flexible and affordable insurance products tailored to IC?

Delivery and business models:

1. How can risk-sharing models, such as joint ventures or integrated project delivery, help address some of the financial and insurance challenges of IC?
2. How can construction companies move from a project-based business model to a more productized, repeatable business model in IC?
3. What challenges will companies face when transitioning from traditional construction models to business models that fully embrace IC?

Workshop 2 – Government and regulatory perspectives on Industrialized Construction

Government Support for IC:

1. What types of government incentives—such as grants, tax breaks, subsidies—would be most effective in accelerating the adoption of industrialized construction (IC) in Canada?
2. What is the role of government procurement policies in driving the adoption of IC, and how can public sector demand stimulate private sector growth?
3. How can the federal and provincial governments align their policies to promote a unified approach to IC?

Regulatory Environment:

1. How can Canada's existing building codes and regulations be adapted to better support the growth of IC?
2. What specific regulatory barriers currently hinder the adoption of IC methods in Canada?
3. How can municipalities and provincial governments streamline permitting processes to facilitate faster deployment of IC projects?

Workforce and Skills:

1. How can Canada address the current skills gap in the construction industry to ensure a workforce is ready for the adoption of IC techniques?
2. What specific skills and training programs should be prioritized to ensure workers can effectively use IC
3. technologies like robotics, automation, and modular construction?

Workshop Idea Development Sheet Template

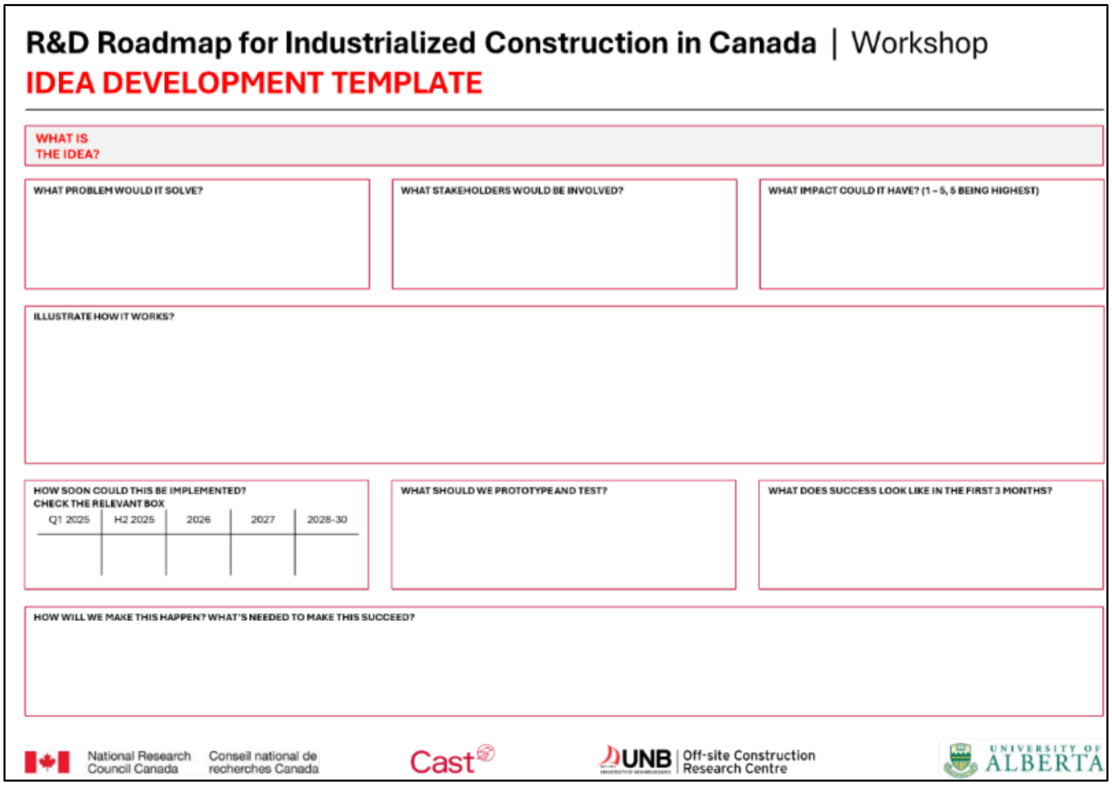
R&D Roadmap for Industrialized Construction in Canada | Workshop
IDEA DEVELOPMENT TEMPLATE
WHAT IS THE IDEA?
WHAT PROBLEM WOULD IT SOLVE?
WHAT STAKEHOLDERS WOULD BE INVOLVED?
WHAT IMPACT COULD IT HAVE? (1 – 5, 5 BEING HIGHEST)
ILLUSTRATE HOW IT WORKS?
HOW SOON COULD THIS BE IMPLEMENTED? CHECK THE RELEVANT BOX
Q1 2025 | H2 2025 | 2026 | 2027 | 2028-30
WHAT SHOULD WE PROTOTYPE AND TEST?
WHAT DOES SUCCESS LOOK LIKE IN THE FIRST 3 MONTHS?
HOW WILL WE MAKE THIS HAPPEN? WHAT'S NEEDED TO MAKE THIS SUCCEED?
National Research Council Canada | Conseil national de recherches Canada
Cast
UNB | Off-site Construction Research Centre
UNIVERSITY OF ALBERTA

Figure A-4: Workshop Idea development sheet template

Appendix B: Interviews

Pre-Interview Document

Purpose of the Document

This document provides an overview of the project, the purpose of your participation, and the structure of the pre-interview and interview process. It is intended to ensure transparency and help you prepare effectively.

Overview of the Research Study

The purpose of this study is to develop a comprehensive roadmap to transform the Canadian construction industry through research and innovation. As a participant, your insights will contribute to identifying key challenges, gaps, and opportunities within the IC landscape.
This project has been reviewed by the University of New Brunswick Research Ethics Board and is on file as REB 2024-211.

Tasks completed to date

Hosted two full-day workshops in Toronto and Edmonton with key stakeholders, including:

- Developers, architects, and contractors
- Prefab, panelized, and modular builders
- Representatives from all levels of government

Explored barriers to adopting IC in Canada
Began identifying actionable strategies to drive innovation and growth
The preliminary results of the two workshops are listed below

***Table B-1**: Summary of key ideas discussed in workshops*

1	**Policy and Regulatory Frameworks**	Simplify, improve and harmonize the approval process Harmonize procurement through funding and incentives Identify inefficiencies in codes and policies Standardization of codes/regulations (with IC in mind) Alignment of municipalities with all levels of government (e.g., policy, inspection, etc.) Improve language in contracts and procurement (i.e., RFPs) Continuity in government policy
2	**Procurement and Financial Support**	Develop procurement models aligned to incentives and risks of IC Performance/ outcome-based procurement Government underwriting of lending against IC De-leveraging risk through tax incentives that drive R&D More flexible R&D funding for industry to easily participate
3	**Awareness, Competency, and Collaboration**	Awareness campaign (data trust, case studies) Focus on competency gaps and opportunities for IC to address

		Standardization to drive efficiency, collaboration, innovation, policy and benchmarking performance
4	**Labour and Capability Development**	Quantify and highlight the labour benefit of IC (specific to Canada's climate and geography) Clear picture of off-site solutions available and quantify capability Incentivize and support IC with a focus on driving IC demand that aligns with capacity and capability
5	**Research and Data Sharing**	R&D focus on methodology for data capture and sharing Link IC outcomes to commercial/financial benefits to clients and funders

Note: The key ideas summarized in this table are based on workshop discussions. Slight modifications have occurred in the final roadmap to reflect ongoing feedback, further analysis, and alignment with evolving project priorities.

Instructions for participation

Pre-Interview Questions: The pre-interview questions document has been sent to you to gain a general understanding of your experiences and perspectives related to IC. This will help us prepare for a more targeted discussion during the interview. You are not required to return the pre-interview questions document, but your responses will help shape the focus of the conversation.

Interview Questions: During the interview, we will ask questions tailored to your insights from the pre-interview document, as well as additional inquiries to explore specific aspects of IC technologies and their adoption.

Your Rights as a Participant

Participation in this study is entirely voluntary. You are under no obligation to take part, and you may choose to withdraw from the interview at any time, for any reason, without facing any consequences.

Confidentiality and Data Use

All information shared during the pre-interview and interview will be treated with strict confidentiality. Your responses will be anonymized and used solely for the purposes of this research.

Pre-interview questions

Industry, developer and funder perspectives on Industrialized Construction

Commercial Advantages:

1. In what ways can industrialized construction (IC) help developers overcome challenges related to labour shortages, project delays, and cost overruns that are prevalent in traditional construction?
2. What commercial advantages does IC offer in terms of speed to market, cost savings, and quality consistency?

Fundability:

3. How can financial institutions adapt their lending criteria to support IC projects?
4. What role should venture capital or innovation-driven funding play in the growth of IC startups and technology companies?

Insurability:

5. What changes in insurance policy structures or underwriting criteria are needed to accommodate the unique aspects of IC?
6. How can the industry collaborate with insurance providers to create more flexible and affordable insurance products tailored to IC?

Delivery and Business Models:

7. How can risk-sharing models, such as joint ventures or integrated project delivery, help address some of the financial and insurance challenges of IC?
8. How can construction companies move from a project-based business model to a more productized, repeatable business model in IC?
9. What challenges will companies face when transitioning from traditional construction models to business models that fully embrace IC?

Government and regulatory perspectives on Industrialized Construction

Government Support for IC:

1. What types of government incentives—such as grants, tax breaks, subsidies—would be most effective in accelerating the adoption of IC in Canada?
2. What is the role of government procurement policies in driving the adoption of IC, and how can public sector demand stimulate private sector growth?
3. How can the federal and provincial governments align their policies to promote a unified approach to IC?

Regulatory Environment:

4. How can Canada's existing building codes and regulations be adapted to better support the growth of IC?
5. What specific regulatory barriers currently hinder the adoption of IC methods in Canada?
6. How can municipalities and provincial governments streamline permitting processes to facilitate faster deployment of IC projects?

Workforce and Skills:

7. How can Canada address the current skills gap in the construction industry to ensure a workforce is ready for the adoption of IC techniques?
8. What specific skills and training programs should be prioritized to ensure workers can effectively use IC technologies like robotics, automation, and modular construction?

Interview Questions

Section 1: Demographic and Organizational Information

Personal and Organizational Details

1. What is your full name? (Optional)
2. What is your job title?
3. What is the name of your company/organization?
4. What is the primary industry of your company (e.g., construction, manufacturing, consulting)?

Geographic Information

5. Where is your company headquartered?
6. In which regions do your company operate?

Company Size and Structure

7. How many employees does your company have?
   Fewer than 50
   51–200
   201–500
   More than 500
8. Is your company
   privately owned
   Publicly traded
   Government entity
   A membership-based organization
9. *(For membership-based organizations only)* How many members does your organization have?
   Fewer than 100
   101–500
   501–1,000
   More than 1,000

Company Focus

10. What type of projects does your company typically undertake? (e.g., residential, commercial, industrial)
11. What percentage of your projects involve IC methods?
    - Volumetric modular
    - Structural panels
    - Non-structural components (floor slabs, staircases, etc.)
    - Additive manufacturing
    - Non-structural assemblies and sub-assemblies (M&E sub-assemblies, kitchen pods, floor pods, etc.)
    - Traditional building product led productivity improvements (think ICF)
    - Site process led productivity improvements (on-site robotics, AR/VR, etc.)

Section 2: Understanding challenges, barriers, and gaps in IC

Opportunities:

- What opportunities do you see for improving the adoption of IC technologies in Canada?

Challenges:

- What are the main challenges faced in adopting IC technologies and processes in Canada (with a focus on pre-manufactured components)?

Potential Solutions:

- What solutions or initiatives do you think could help overcome the challenges you mentioned earlier in adopting IC technologies in Canada?
- Can you identify a few solutions or initiatives to prioritize as the most impactful or urgent to implement in the construction sector?

Appendix C: Stakeholder Participation Analysis

Table C-1: Stakeholder categories represented among workshop participants and gaps in stakeholder representation

Stakeholder Group	Actual Engagement	Target Engagement	Difference	Representation Status			
				Well	Moderate	Limited	Absent
Academic and Research Organizations	**34**	**4**	**30**	✓			
Academic Institution	22	2	20	✓			
Research Institution	12	2	10	✓			
Government and Public Sector	**3**	**6**	**−3**			✓	
Municipal government	1	2	−1			✓	
Provincial government	1	2	−1			✓	
Federal government	1	2	−1			✓	
Industry and Trade Associations	**7**	**12**	**−5**			✓	
Industry association	4	6	−2			✓	
Design association	0	2	−2				✓
Trade association	3	2	1		✓		
Labour unions	0	2	−2				✓
Standards and Regulatory Authorities	**3**	**8**	**−5**			✓	
Standards association	3	2	−1			✓	
Regulatory and code authorities	0	2	−2				✓
Building inspectors	0	2	−2				✓
Authorities having jurisdiction (AHJs)	0	2	−2				✓
Design and Planning	**15**	**12**	**3**		✓		
Architecture firm	4	2	2	✓			
Engineering firm	0	2	−2				✓
Design software	4	2	2	✓			
Planning software	2	2	0		✓		
Enterprise software	2	2	0		✓		
Consultant	3	2	1		✓		
Construction and Development	**11**	**10**	**1**		✓		
General contractor	7	2	5	✓			
Developer	1	2	−1			✓	
Integrator	2	2	0		✓		
Specialized sub-contractor	1	2	−1			✓	
MEP sub-contractor	2	2	−2				✓
Manufacturing	**9**	**8**	**1**		✓		
Manufacturer—volumetric modular	5	2	3	✓			

Manufacturer—panels	2	2	0		√		
Manufacturer—precast concrete	1	2	−1			√	
Manufacturer—mass timber	1	2	−1			√	
Suppliers	**1**	**6**	**−5**			√	
Equipment supplier	1	2	−1			√	
Equipment manufacturers	0	2	−2				√
Logistics providers	0	2	−2				√
Financial	**0**	**6**	**−6**				√
Banks	0	2	−2				√
Private investors	0	2	−2				√
Insurance	0	2	−2				√

Table C-2: Summary of interviews conducted to address stakeholder engagement gaps

Stakeholder Group	**Initial Gap**	**Actual Additional Interviews Conducted**	**Remaining Gap**
Government and Public Sector	3	5	+2
Municipal government	1	1	0
Provincial government	1	2	+1
Federal government	1	2	+1
Industry and Trade Associations	5	5	0
Industry association	5	5	0
Standards and Regulatory Authorities	4	3	−1
Regulatory and code authorities	2	2	0
Building inspectors	2	1	−1
Design and Planning	2	2	0
Developer	1	1	0
Specialized sub-contractor	1	1	0
Manufacturing	1	1	0
Manufacturer—mass timber	1	1	0
Financial	6	2	−4
Banks	2	1	−1
Insurance	2	1	−1

Appendix D: Public Survey

Public Survey Questions

Development of a roadmap to transform the Canadian construction industry through research and innovation

Thank you for participating in this survey. Your input will help shape a roadmap for the future of industrialized construction (IC) in Canada.

Purpose of the Survey
This survey is designed to gather industry perspectives on the most impactful ideas and strategies for advancing IC. The results will help prioritize initiatives that drive productivity improvements and innovation across the construction sector.

How the Data Will Be Used
The insights you share will contribute to a comprehensive roadmap for IC. This roadmap will serve as a guide for all industry participants—including industry leaders, researchers, and policymakers—on where to focus efforts for maximum benefit. Individual responses will remain confidential, and results will be reported in an aggregated format.

What is Industrialized Construction?
IC refers to a broad range of strategies and processes aimed at improving productivity in construction. While IC includes OSC methods, such as volumetric modular construction, it is not limited to these. To provide clarity, this survey adopts the Modern Methods of Construction (MMC) categories to define IC practices.

The MMC Framework for IC
IC encompasses seven categories aimed at enhancing construction productivity:

1. Category 1: Pre-manufacturing (3D primary structural systems – volumetric modular)
2. Category 2: Pre-manufacturing (2D primary structural systems – panelized systems)
3. Category 3: Pre-manufacturing components (non-systemized primary structure)
4. Category 4: Additive manufacturing (structural and non-structural – 3D printing)
5. Category 5: Pre-manufacturing (non structural assemblies and sub-assemblies – MEP sub-assemblies, kitchen or bathroom pods, etc.)
6. Category 6: Traditional building product led site labour reduction / productivity improvements (e.g., insulated concrete forms)
7. Category 7: Site process led site labour reduction / productivity / assurance improvements (e.g., on-site drone, robotics, augmented reality, etc.)

By focusing on these categories, IC aims to address challenges such as labour shortages, rising costs, and environmental impacts, while also improving quality, safety, and project timelines.

Next Steps
In this survey, you will be asked to rank ideas and initiatives generated during prior consultations and specify the expected timeline for the implementation as well as the opportunity to generate your own ideas to enable IC adoption. Your rankings will help identify the areas of IC with the highest potential impact.

Thank you for your time and valuable insights.

Section 1: Demographic and Organizational Information

Personal and Organizational Details

12. What is your full name? (Optional)
13. What is your job title? (Optional)
14. What is the name of your company/organization? (Optional)
15. What is the primary industry of your company (e.g., construction, manufacturing, consulting)?

Geographic Information

16. Where is your company headquartered?
17. In which regions does your company operate? (select all that apply)
    Atlantic
    Central
    Prairie
    Western
    North
    International

Company Size and Structure

18. How many employees does your company have?
    Fewer than 50
    51–200
    201–500
    More than 500
19. Is your company
    privately owned
    Publicly traded
    Government entity
    A membership-based organization
20. *(For membership-based organizations only)* How many members does your organization have?
    Fewer than 100
    101–500
    501–1,000
    More than 1,000

Company Focus

21. What type of projects does your company typically undertake? (e.g., residential, commercial, institutional, etc.)
22. What percentage of your projects involve IC methods?
    - Volumetric modular
    - Structural panels
    - Non-structural components (floor slabs, staircases, etc.)
    - Additive manufacturing
    - Non-structural assemblies and sub-assemblies (M&E sub-assemblies, kitchen pods, floor pods, etc.)
    - Traditional building product led productivity improvements (think ICF)
    - Site process led productivity improvements (on-site robotics, AR/VR, etc.)

Section 2: Understanding challenges, barriers, and gaps in IC

The following ideas were identified through consultation with two in-person workshops and structured interviews that included over 100 industry professionals across the country. A full description of each idea can be found here. Upon reviewing the ideas, please answer the followings:

1. What amount of impact could it have? (1–5, with 5 being the greatest impact)
2. What is the expected timeline for implementation?

If you have additional ideas, you will have an opportunity to provide those in section 3 of the survey.

Table D-1: Strategic actions for advancing IC in Canada: Impact assessment and implementation timeline

Strategic actions	**Impact**					**Expected Timeline**		
Policy and Regulatory Frameworks	**1**	**2**	**3**	**4**	**5**	**Short Term**	**Mid Term**	**Long Term**
Simplify, improve, and harmonize the approval process								
Harmonize Procurement Funding combined with Incentives								
Looking for Inefficiencies in Codes and Policies and develop implementation guidelines								
Standardization of Codes/Regulations (IC Friendly)								
Alignment of Municipalities and the Three Tiers of Governments								
Improve Language in Contracts and Procurement (i.e., RFPs)								
Continuity in Government Policy								
Procurement Models and Performance Systems	**1**	**2**	**3**	**4**	**5**	**Short Term**	**Mid Term**	**Long Term**
Develop Procurement Models More Aligned to Incentives and Risks of IC								

Performance/Outcome-Based Procurement								
Financial and Insurance Services	**1**	**2**	**3**	**4**	**5**	**Short Term**	**Mid Term**	**Long Term**
Government Underwriting of Lending Against IC								
Deleveraging Risk by Tax Incentives That Drive R&D								
More Flexible R&D Funding								
Structured Financial Solutions Supported by Infrastructure Banks.								
Awareness, Competency, and Collaboration	**1**	**2**	**3**	**4**	**5**	**Short Term**	**Mid Term**	**Long Term**
Awareness Campaign (Data Trust, Case Studies, Pilot Projects)								
Focus on Competency Gaps and Opportunities for IC to Address								
Standardization to Drive Efficiency, Collaboration, Innovation, Policy and Benchmarking Performance								
Quantifying Capacity and Capability for IC	**1**	**2**	**3**	**4**	**5**	**Short Term**	**Mid Term**	**Long Term**
Quantify and Highlight the Labour Benefit of IC (Specific to Canada's Climate and Geography)								
Clear Picture of Off-site Solutions Available and Quantify Capability								
Incentivize and Support IC with a Focus on Driving IC Demand That Aligns with Capacity and Capability								
Research and Data Sharing	**1**	**2**	**3**	**4**	**5**	**Short Term**	**Mid Term**	**Long Term**
R&D Focus on Methodologies and tools for Industry Data Capture and Sharing								
Link IC Outcomes to Commercial/Financial Benefits to Clients and Funders								

Public Survey Analysis

Table D-2: Public survey respondents and overall stakeholder participation

Stakeholder Groups	Responses from Additional Public Survey
Academic and Research Organizations	4
Government and Public Sector	5
Standards and Regulatory Authorities	1
Design and Planning	5
Construction and Development	13
Manufacturing	6
Financial	1
Total	35

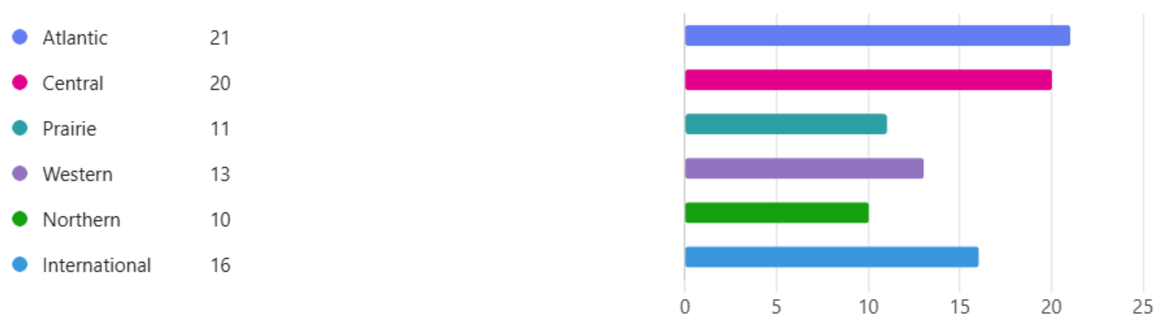

Figure D-1: Geographic distribution of survey respondents' company operations

Figure D-2: Company size distribution among public survey respondents

Figure D-3: Public survey respondents by company ownership type

Figure D-4: Distribution of project types typically undertaken by companies that participated in the public survey

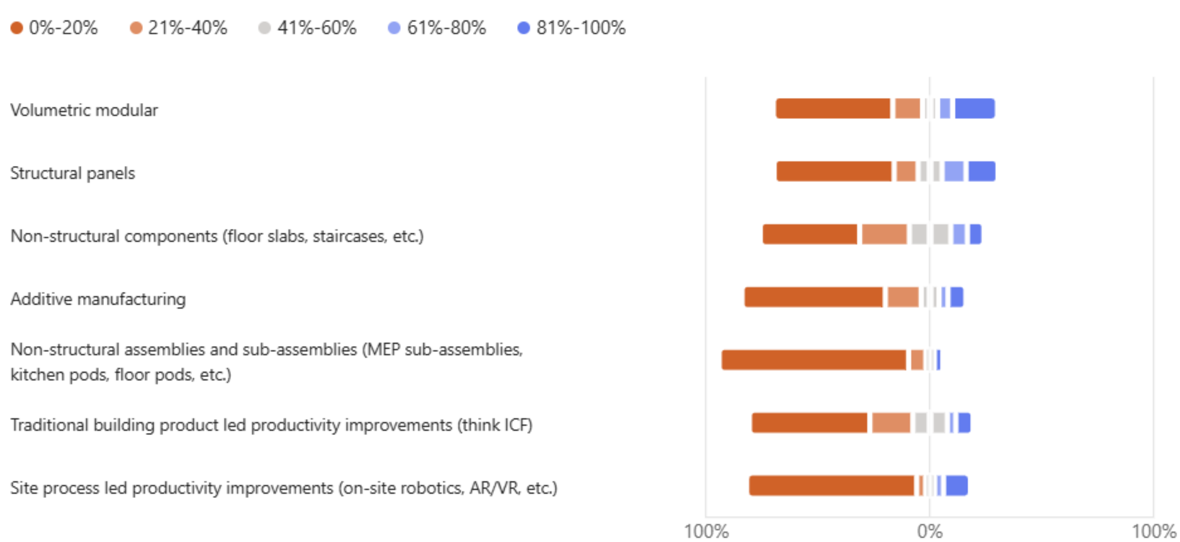

Figure D-5: Adoption levels of industrialized construction methods among public survey respondents

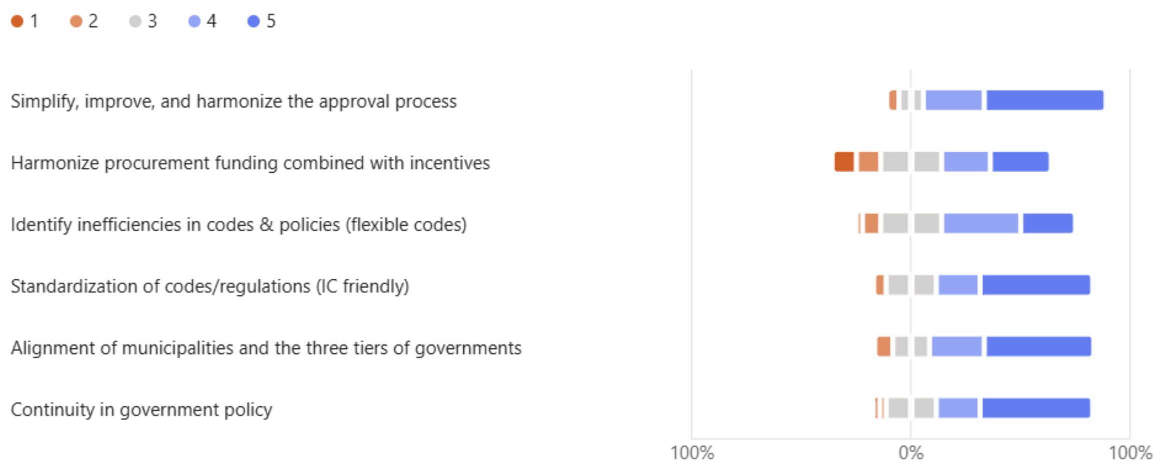

Figure D-6: Public survey responses on the impact of policy and regulatory frameworks ideas for IC

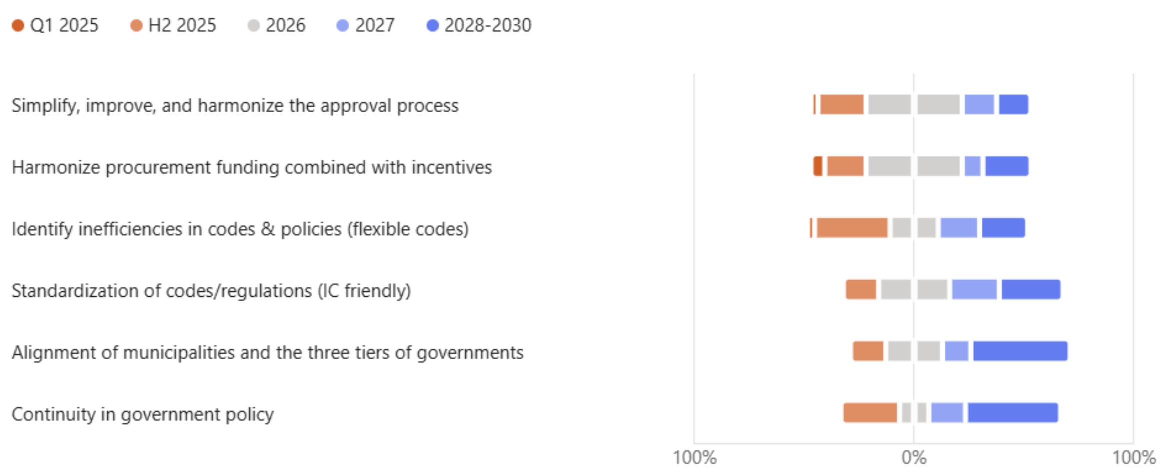

Figure D-7: Public survey responses on the expected timeline for the implementation of policy and regulatory framework-related ideas for IC

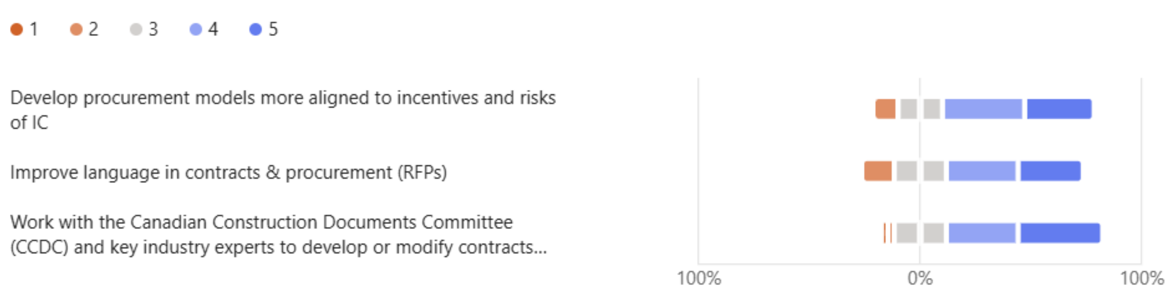

Figure D-8: Public survey responses on the impact of procurement models and performance system-related ideas for IC

Figure D-9: Public survey responses on the expected timeline for the implementation of procurement models and performance system-related ideas for IC

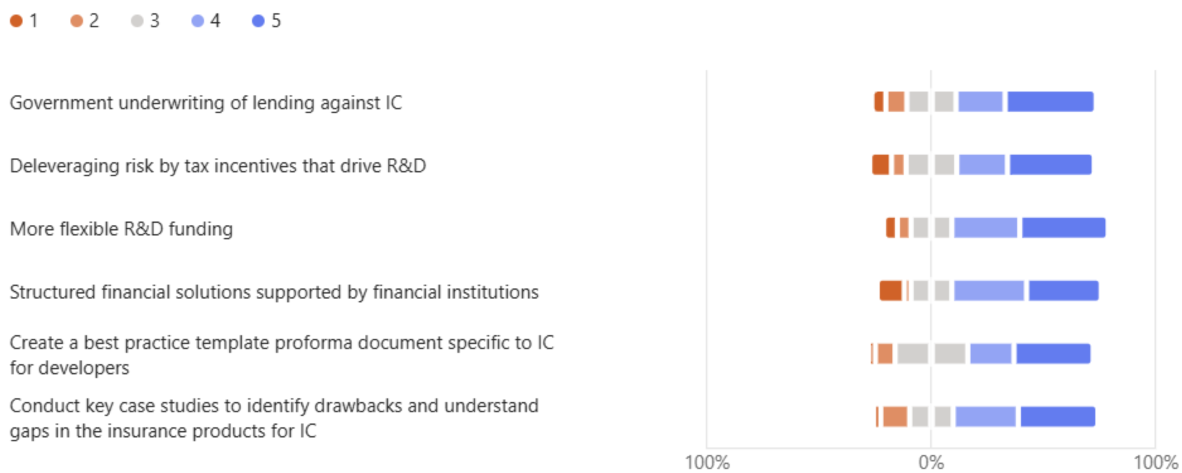

Figure D-10: Public survey responses on the impact of financial and insurance services-related ideas for IC

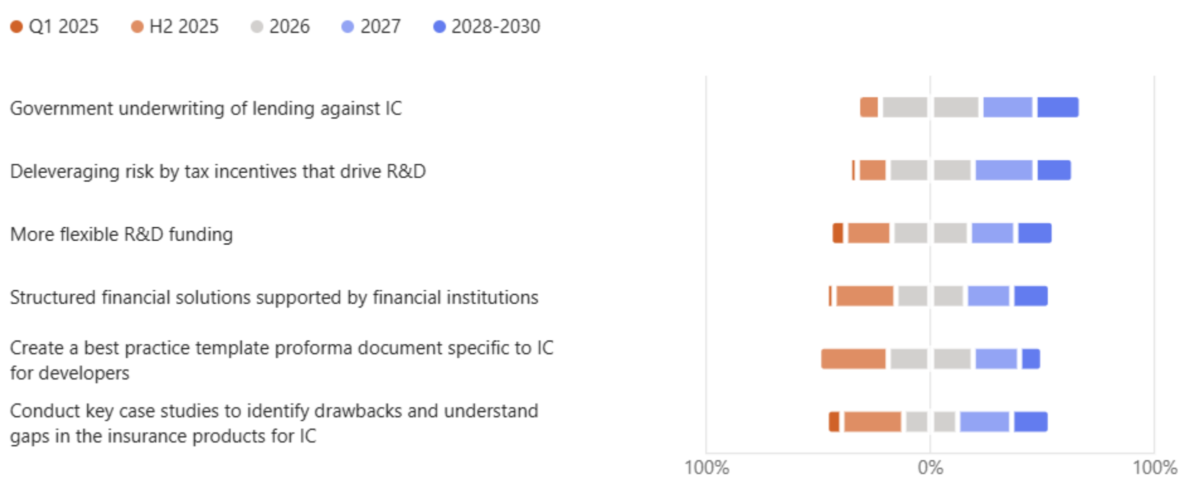

Figure D-11: Public survey responses on the expected timeline for the implementation of financial and insurance services-related ideas for IC

Figure D-12: Public survey responses on the impact of awareness, competency, and collaboration-related ideas for IC

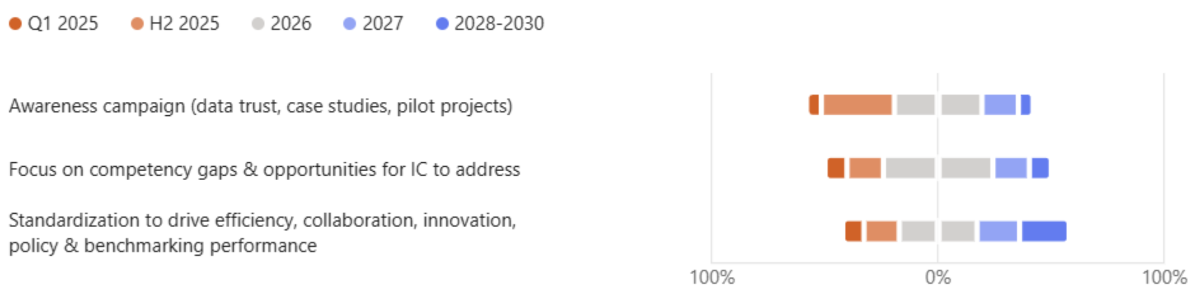

Figure D-13: Public survey responses on the expected timeline for the implementation of awareness, competency, and collaboration-related ideas for IC

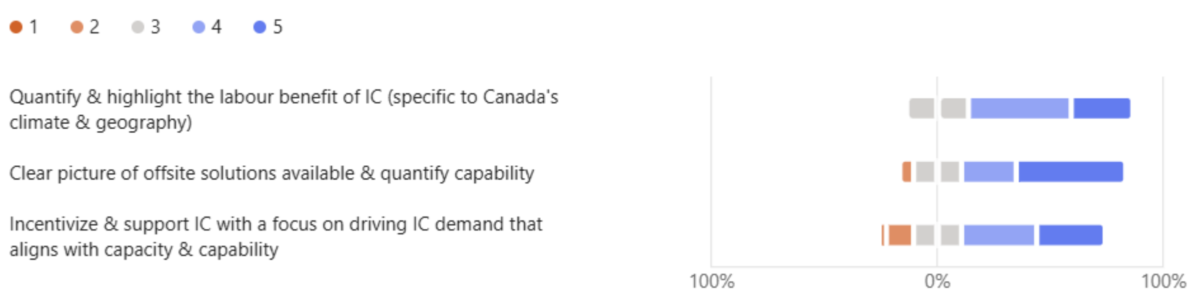

Figure D-14: Public survey responses on the impact of Quantifying Capacity and Capability for IC -related ideas for IC

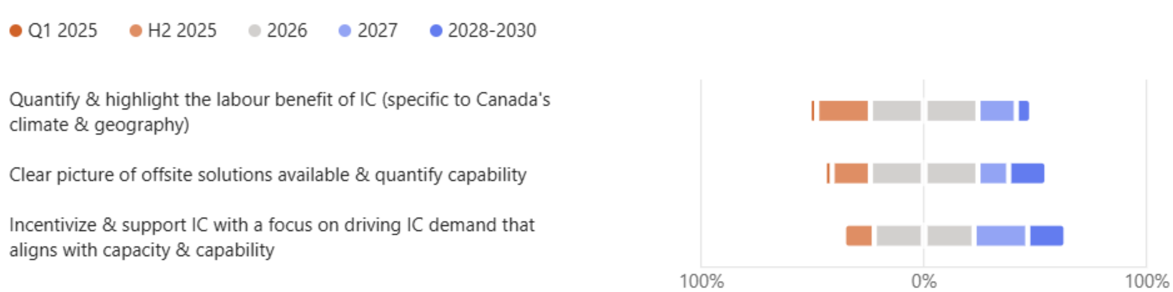

Figure D-15: Public survey responses on the expected timeline for the implementation of Quantifying Capacity and Capability for IC -related ideas for IC

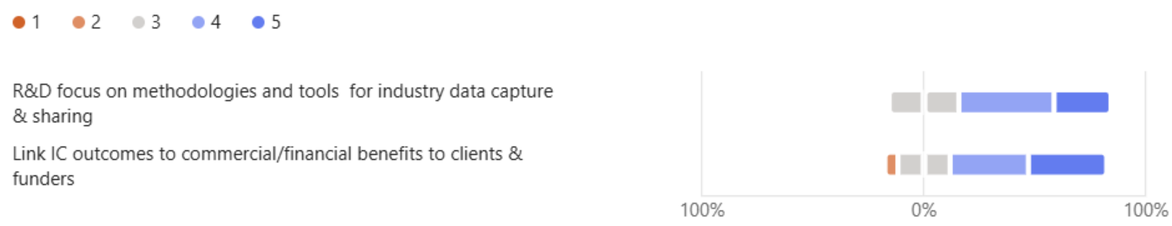

Figure D-16: Public survey responses on the impact of research and data sharing-related ideas for IC

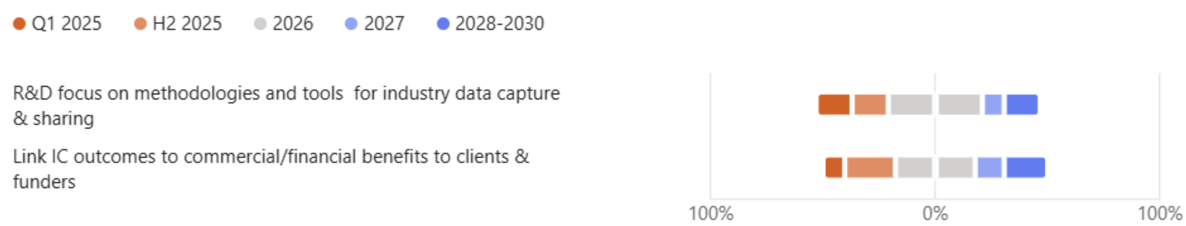

Figure D-17: Public survey responses on the expected timeline for the implementation of research and data sharing-related ideas for IC