Joint CSCE Construction Specialty & CRC Conference 2025
Conférence conjointe spécialisée en construction de la SCGC et CRC-2025

Montreal, Quebec
July 28-31, 2025 / *28-31 juillet 2025*

Scaling Off-site Construction: Identifying Opportunities to Address the Housing Crisis in Newfoundland and Labrador

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ABSTRACT: This research project explores the supply side of housing shortages and the potential to increase capacity through the adoption of off-site construction (OSC) in Newfoundland and Labrador (NL). By engaging stakeholders across government, industry, and academia, the Province's potential to scale factory-built housing as a sustainable, fast and affordable solution is assessed. The approach and results were enhanced by employing similar methods and comparing the detailed outputs of recent initiatives undertaken in the United Kingdom, Australia, New Zealand and most recently in Canada. Key activities included literature reviews, workshops, and focus groups to gather insights on market demand, barriers to adoption, and opportunities for growth. The project identified challenges related to regulatory frameworks, financing and insurance, skilled labour shortages, and logistics that currently hinder the widespread use of OSC that are specific to a region. A primary outcome of the project is to contribute to an OSC housing strategy for Atlantic Canada. The results align with national housing strategies and supports local efforts to increase housing supply, particularly through multi-unit and medium-density housing. Additionally, the project provides guidance on the creation of the Atlantic Offsite Housing Innovation Network—a collaboration to foster ongoing partnerships and knowledge-sharing among stakeholders to advance offsite construction and focus on promoting low-carbon and whole-life-cycle construction practices. Ultimately, the project will contribute to a framework for sustainable, resilient housing growth in Atlantic Canada, supporting regional strategic housing goals and contributing to national housing objectives and enable benchmarking against international efforts.

1. INTRODUCTION

Since the beginning of the national housing crisis in Canada, the demand side of the crisis (e.g., number of homes required), has been continuously examined and researched with estimates of an additional 3.5 million needed by 2030 to restore affordability (CMHC, 2022). Despite this continuous discussion around housing demand, researchers have rarely explored the supply side of the equation, and methods to rapidly increase housing supply. Off-site construction (OSC) methods, including volumetric modular, panelized or prefabricated elements are expected to boost productivity and shorten construction time (Zhang, 2024), in turn, increasing housing supply across the country.

In order to meet housing demands nationally, regionally and by province, methods for delivering housing must shift. These methods must focus on productivity gains, which can be found through the use of OSC (Zhang, 2024). OSC is often viewed as being of a higher quality, more environmentally friendly, and quicker to deliver, although this often comes at an increased cost (Broadhead et. al, 2023). This paper explores the opportunity for OSC to increase housing supply in Newfoundland and Labrador. It highlights a project completed with the Newfoundland and Labrador Housing Corporation (NLHC) wherein NLHC is working towards an OSC strategy that aligns with the Atlantic Offsite Housing Strategy and helps meet the increased

provincial housing demand: 60,000 homes in the next six years (Gear, 2024). The paper highlights key outputs found during the literature review and data collection exercises completed during the development of an OSC strategy for Newfoundland and Labrador.

1.1 Background

Atlantic Canada faces significant housing challenges driven by geographical constraints in certain provinces and regions, an aging housing stock and increasing demand for affordable and sustainable housing solutions (Gear, 2024). Traditional construction methods often struggle to meet productivity demands due to labour shortages, high costs associated with on-site construction in remote and rural communities, and uncertainties in project costs stemming from uncertain supply chains (Mischke et al., 2024). As a result, alternative project delivery methods, such as (OSC), have gained interest as a potential solution to increase housing supply in the region.

Volumetric modular, panelized, and prefabricated approaches, all part of the Modern Methods of Construction (MMC) framework in the United Kingdom, but also known as OSC, offers numerous advantages, including reduced construction timelines, improved quality control, and lower environmental impact (Zhang, 2024). However, the successful implementation of OSC requires a comprehensive understanding of the existing market conditions, supply chain capabilities and logistical constraints in addition to changes in procurement to create coordination within the supply chain (Wuni and Shen, 2023).

With 28% of the 2023 construction labour force in Newfoundland and Labrador expected to retire by 2033 (BuildForce Canada, 2023), and a continuous demand for increasing housing supply, the goal of this research is to evaluate the scalability of OSC to increase housing supply in the Province. This paper presents an overview of the research methodology, key findings, and implications of this study. It contributes to the broader discourse on OSC by highlighting the unique challenges and opportunities within the Province. Furthermore, it identifies areas for future research to advance the adoption and effectiveness of OSC strategies in similar regions facing comparable housing and infrastructure challenges. It is acknowledged by the project team that this is the first step of many to follow to enable OSC solutions in a specific geographical region.

2. METHODOLOGY

This research was carried out in six steps as shown in Figure 1: 1) review relevant reports related to housing for Newfoundland and Labrador, 2) review international strategies and roadmaps for leveraging industrialized or modern methods of construction to respond to housing, 3) complete three workshops with the construction industry in Newfoundland and Labrador to level set the industry on OSC, 4) identify barriers to OSC adoption, 5) identify market gaps and opportunities and prioritize actions to increase housing supply, AND 6) align the provincial actions with regional (Atlantic Canada) and national (Canada) actions, and create a timeline for executing the actions including stakeholder groups responsible for execution.

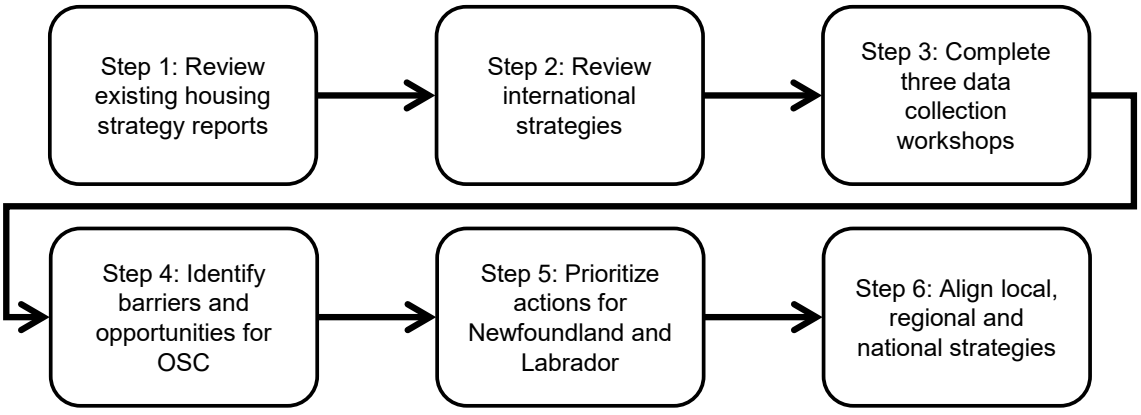

Figure 1: Methodology for OSC strategies on Newfoundland and Labrador

The first step considered historical reports and research in Atlantic Canada, with a specific focus on Newfoundland and Labrador. Following completion of the first step, the researchers reviewed existing international strategies for housing with an increased focus on relatively remote geographies (e.g., New Zealand, Ireland, etc.). Upon completion of the background literature, data collection was completed through a mix of in-person workshops and a virtual workshop (steps 3 to 5). The workshops were completed using physical documentation as well as online polling software. The three workshops divided groups of participants to discuss, brainstorm and prioritize ideas focused on three themes: i) current landscape of OSC on Newfoundland and Labrador, ii) barriers and opportunities for OSC adoption, and iii) market gaps and demand opportunities. The ideas discovered from these sessions were grouped and then prioritized by the participants. Lastly, the ideas and associated priorities were reviewed and compared to regional (Atlantic Canada) and national (Canada) priorities, helping with alignment and understanding the potential actions and solutions to execute the strategy.

2.1 Data Collection Process

The data collection processes included three workshops. Two in-person workshops were conducted, one in Corner Brook, NL (a western community) and a second in St. John's, NL (an eastern community), and a virtual workshop was completed following the two in-person workshops. There were 95 organizations invited to participate in the workshops including, provincial government, municipal and/or local government, Indigenous communities, trade associations, professional associations, general contractors, manufacturers, sub-contractors, non-profit housing groups, insurance and warranty providers, among others. Each workshop was completed over one full day according to the agenda provided in Table 1.

Table 1: In-person workshop agenda

Duration	Focus
0.5 hr	Registration and networking
0.5 hr	Welcome, opening remarks and workshop objectives
0.5 hr	Initial findings and literature review
0.5 hr	Break
1 hr	Session 1: Current landscape of OSC on NL (exercise)
1 hr	Session 2: Opportunities to increase OSC adoption and experiences to date (exercise)
1 hr	Lunch
0.25 hr	Review of the morning
1 hr	Session 3: Market gap and demand opportunities (exercise)
0.25 hr	Break
1 hr	Session 4: Prioritizing ideas from sessions 1 to 3 (exercise)
0.5 hr	Next steps, wrap up and end the day

During the "exercises", participants were encouraged to first brainstorm individually and then amongst their group of four to six individuals. Upon reaching consensus, participants were asked to discuss their ideas with the room where these were then displayed digitally in front of the room. Session 4 concluded the day by going through the actions and ideas identified through sessions 1-3 and asking the participants to prioritize the ideas by rating them on a scale of 1 to 5. The ideas which filtered to the top of the priority list were then documented, and participants ran through a final exercise to determine a timeline, an organization to lead the initiative or action, and stakeholders to engage in order to execute. Figure 2 demonstrates how feedback was collected during the "exercises" and Figure 3 shows how the outputs from the "exercises" were used to develop recommendations for input from NLHC.

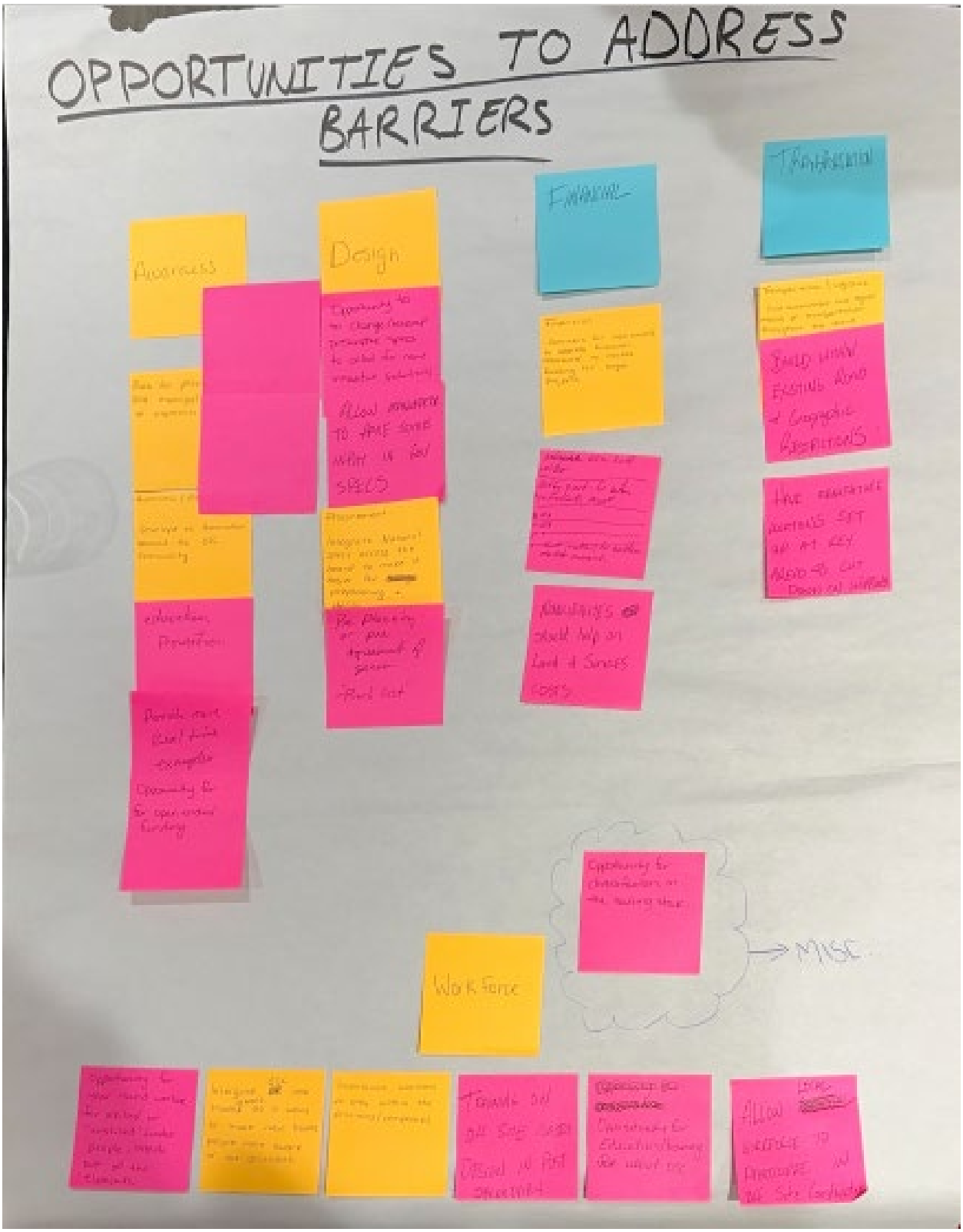

Figure 2: Example of information collected from workshop attendees

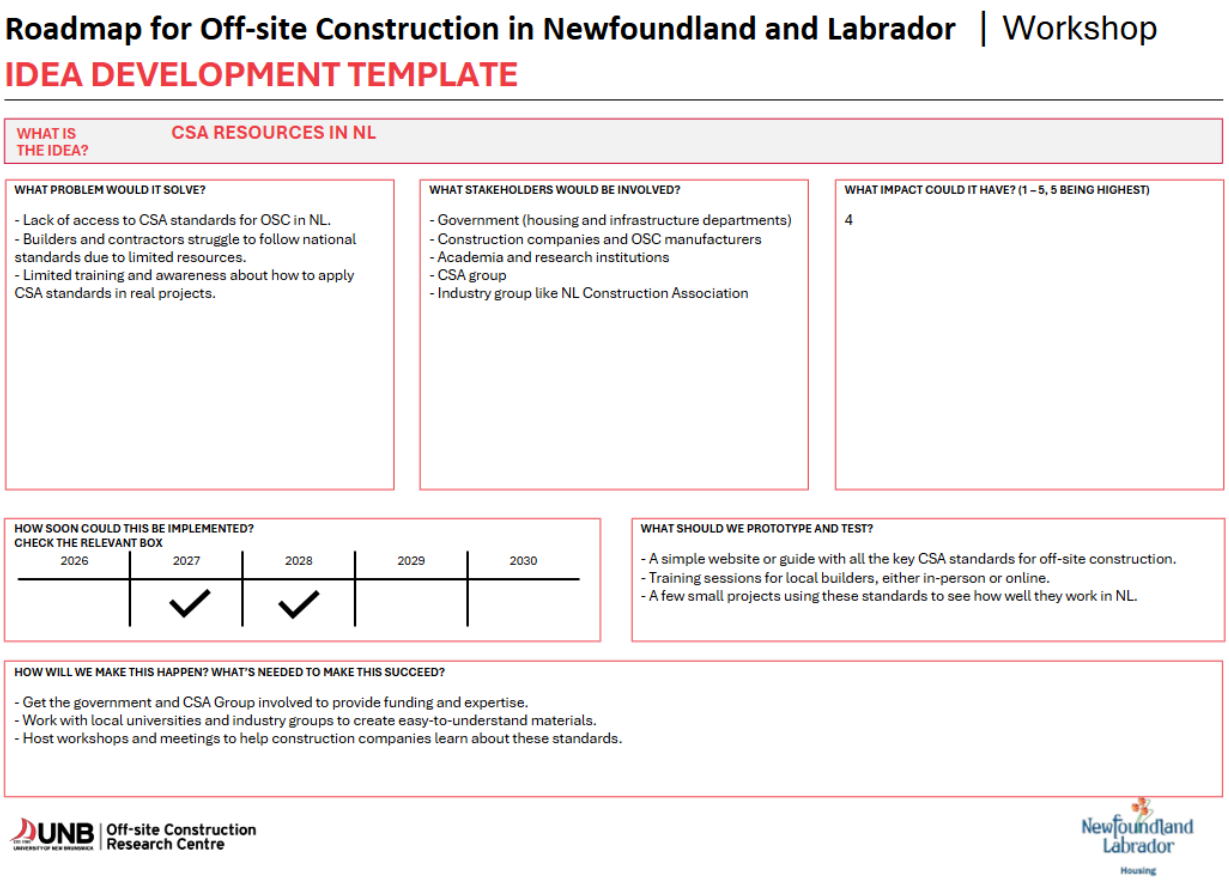

Figure 3: Draft implementation strategy for an initiative identified during the workshop

3. POINTS OF DEPARTURE

Over the last 35 years, Newfoundland and Labrador has had an average of 2,129 housing starts with a peak of just under 3,900 in 2012 (CMHC, 2024). As of 2024, the Canadian Mortgage Housing Corporation projected a need of 10,000 homes per year for the next six years, for a total of 60,000 net new homes across Newfoundland and Labrador.This need has led to increased interest in modular housing as a faster alternative to conventional construction methods. In Newfoundland and Labrador, modular housing presents a viable alternative to address affordability issues and aging housing stock. Despite having a strong modular home industry in Atlantic Canada, it's current manufacturing capacity is limited to 7,000 modular units over five years, a number that could increase to 19,500 units with capital infrastructure investments (Deloitte, 2024).

OSC refers to a new building approach that shifts the construction process from the physical jobsite to a controlled factory environment (Jiang et al., 2018). This approach offers significant advantages in achieving better project performance over traditional construction methods, including shorter project duration, cost certainty (Hong et al., 2018), improved quality, minimizing waste (Jin et al., 2018), energy performance (Hong et al., 2016), and sustainability benefits (Kamali & Hewage, 2017).

Despite its advantages, according to a recent study (Deloitte, 2024), the adoption of OSC in Atlantic Canada is challenging due to: regulatory processes, labour shortages, financial barriers, and infrastructure constraints. Delays due to municipal by-laws and permitting, along with a lack of familiarity with and understanding of modular housing, hinder efficient execution and funding opportunities. A shortage of skilled labour in critical trades further slows production, while consumers are reluctant to pay for energy efficiency and accessibility features that add to costs. High down payments (~30%) and transportation

restrictions present challenges to scalability. Additionally, delays in utility hook-ups and limited public infrastructure create further challenges.

Successful OSC housing programs in the United Kingdom, Australia, and New Zealand offer key insights for overcoming challenges in Atlantic Canada. The West Midlands Combined Authority (WMCA) in the UK has developed a Roadmap for Advanced Manufacturing in Construction (AMC) to boost productivity, address labour shortages, and expand sustainable housing production. AMC is an evolution of modern methods of construction (MMC) that integrates automation, high-performance materials, and digital construction technologies to improve efficiency. The West Midlands roadmap outlines a 10-year vision, emphasizing knowledge development, supply chain engagement, R&D partnerships, and government support to accelerate housing delivery, reduce construction waste, and promote net-zero goals (West Midlands Combined Authority 2020). New Zealand's adoption of Modern Methods of Construction (MMC), influenced by UK practices, highlights benefit such as faster construction (20-60% time reduction), lower labour requirements (up to 70%), reduced carbon emissions, and improved build quality. Lessons learned include the need for clear industry standards, gradual implementation strategies, government support, and cross-sector collaboration to ensure scalability (Cast & Construction Sector Accord, 2023). Australia integrates modular housing into disaster relief and rapid housing efforts, supported by government-backed innovation funds and industry collaboration (Deloitte, 2024). By drawing on these global best practices, Atlantic Canada can overcome existing barriers, ensures sustainable growth, modernization, and targeted interventions to meet the housing needs of Newfoundlanders and Labradorians.

Increasing application of OSC has the potential to address housing shortages in Atlantic Canada. However, regulatory, financial, and logistical challenges must be resolved to unlock its full scalability. Insights from global case studies demonstrate that policy alignment, industry investment, and public awareness campaigns are essential for widespread adoption. This paper builds upon these findings by assessing Newfoundland and Labrador's modular housing capacity, identifying regional barriers, and proposing a strategy for scaling modular construction across Atlantic Canada.

4. FINDINGS AND DISCUSSION

The research discovered opportunities to leverage OSC to respond and meet the demand requirements for housing in Newfoundland and Labrador. The results from the data collection allowed for the ideas to be grouped into five focus areas: i) policy and regulatory frameworks, ii) procurement models and contracts, iii) logistics, transportation and supply chain, iv) awareness and collaboration, and v) workforce training and skills development. This section highlights the ideas in each of the focus areas.

4.1 Policy and Regulatory Frameworks

To leverage OSC and deliver housing more effectively, policies and regulatory requirements on Newfoundland and Labrador cannot be restrictive. Unfortunately, policies and regulations vary across jurisdictions and may change between a city, town, village, or Indigenous community. The following four ideas were identified to the use of OSC and housing supply:

1) **Harmonize the policy and approval:** simplifying and harmonizing processes across the province allows industry to plan more effectively without needing to impact their design, manufacturing, inspection and construction process. This may include common processes for permitting and common design requirements across multiple jurisdictions.
2) **Harmonize procurement and incentives:** procurement is often viewed as a primary barrier to leveraging OSC as new procurement models and collaborative contract strategies need to be explored. Additionally, incentivizing the use of OSC (e.g. in British Columbia, developers can add 1-2 more storeys if using a mass timber solution) will lead to increased use of OSC which is proven to deliver housing quicker. Developing these strategies and then ensuring they are used across multiple jurisdictions allows the industry to respond more effectively and forms collaborations across the supply chain leading to increased housing supply.
3) **Ensure continuity in government policy:** aligning the municipal and provincial policies with the federal government policies avoids confusion and provides clarity for the industry.

4) **Adopt a common language and framework:** the countries who are leveraging OSC most effectively have a common language, framework and definition which guides requests for qualifications (RFQs), requests for proposals (RFPs), contract language, etc. The Province can begin by adopting a common language and framework for OSC, ultimately delivering housing more effectively and efficiently.

4.2 Procurement Models and Contracts

Policy and regulatory frameworks impact procurement and contracts. Historically, procurement and contract types impede the use of OSC as traditional design-bid-build (DBB) models do not effectively leverage OSC (NIBS, 2018). The following two recommendations related to procurement models and contracts were discussed:

1) **Develop procurement models focused on supply chain collaboration:** 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.
2) **Improve language in procurement and contracts:** Clearer language in contracts and requests for proposals (RFPs) specific to IC will mitigate misunderstandings and encourage participation.

4.3 Logistics, Transportation and Supply Chain

Logistics, transportation and supply chain constraints have been a significant factor in executing OSC projects. The logistical constraints with equipment, seasonal transportation load constraints, and transportation costs have made OSC less economical than conventional construction. Furthermore, an immature supply chain in this sector has led to OSC not being leveraged to deliver housing. The following ideas are being explored to remove logistics, transportation and supply chain constraints.

1) **Create a provincial database of companies working in OSC:** understanding the capabilities and capacity of organizations working in the residential sector is key to driving OSC adoption. Creating a database for companies within the supply chain will help developers, general contractors and public owners procure housing more effectively by understanding the capabilities within their local region.
2) **Work with manufacturers to identify logistics and transportation constraints:** work with manufacturers to understand the transportation or logistics constraints as it relates to accessing material, shipping and erecting OSC components (e.g., modules, panels, pods, etc.) and use these as inputs to drive procurement, scheduling and design considerations.
3) **Create a network of transportation companies who have experience with OSC:** work with the ports and shipping industries to understand their needs and requirements by region (e.g., urban Newfoundland, rural Newfoundland, Labrador, etc.) to ensure they are prepared to meet increased housing demand.

4.4 Awareness and Collaboration

Awareness and collaboration are central concepts to drive OSC adoption. The stigma associated with modular housing continues to exist, and creating awareness campaigns will support the use of OSC methods in the future.

1) **Document projects through case studies:** documenting OSC projects and marketing them will demonstrate the benefits to the public. Additionally, by identifying key performance indicators in advance, KPIs can be measured to compare OSC projects to traditional methods, allowing for postmortem project discussions, lessons learned, and implementing new findings into future projects.

2) **Create an awareness campaign in collaboration with practitioners:** the OSC supply chain is driven to increase their market share and Newfoundland and Labrador is eager to build more housing. Creating an awareness campaign will help remove stigmas and educate the private sector of the opportunities that exist when using OSC methods.

4.5 Workforce Training and Skills Development

Training the workforce, both professionals (architects, engineers, inspectors, etc.) and trades (carpenters, HVAC technicians, plumbers, etc.) is a major opportunity to increase OSC adoption in Newfoundland and Labrador. The following ideas were identified in the research.

1) **Focus on competency gaps and opportunities that OSC can help address:** identify and address skill gaps ensures a workforce capable of meeting OSC demands, boosting productivity and project quality.
2) **Quantify and highlight the labour benefit of OSC:** demonstrating how OSC suits Newfoundland and Labrador's unique challenges, such as remote locations and harsh climates to combat labour shortages will help drive workforce development.
3) **Collaborate with educational institutions and associations to support training to the Newfoundland and Labrador residential construction sector:** working with Memorial University, College of the North Atlantic as well as the Canada Standards Group (CSA) and other groups who have already begun delivering training on OSC will ensure the Newfoundland and Labrador residential construction sector is prepared to respond to increased housing demand.

While financing and insurance are not discussed in the 14 ideas listed above, for Newfoundland and Labrador, previous and current efforts are clear on the importance of these aspects. Financing and insurance continue to be a barrier to OSC adoption due to the nature of lending policies and practices and liability tools and mechanisms employed within the insurance industry. Similar to other provinces and jurisdictions in Canada, Newfoundland and Labrador should be involved in discussions related to financing housing projects and with the insurance community. This will help drive adoption of OSC through awareness with lenders, sureties, insurers and underwriters.

5. CONCLUSIONS

Similar to all jurisdictions in Canada, Newfoundland and Labrador are facing a housing crisis. While Newfoundland and Labrador is experiencing similar issues to all of Canada (e.g., productivity stagnation, labour shortages, etc.), the opportunity for Newfoundland and Labrador to leverage offsite construction is significant. Despite this opportunity for OSC, there are several challenges and barriers impeding the province from leveraging OSC methods and technologies.

This research brought together desktop analysis and industry stakeholders to identify ideas to overcome the housing crisis by leveraging OSC. These actions included policy and regulatory changes, innovations in procurement models and contracts, changes required to address transportation, logistics and supply chain maturity, ideas to increase awareness and collaboration in the residential construction sector and opportunities to upskill the workforce through training and skills development. While OSC methods and technologies could be leveraged as is on Newfoundland and Labrador, executing the ideas identified will help increase housing supply and aid in optimizing the use of the residential construction sector in the province.

6. FUTURE RESEARCH

The research conducted to date focused on a literature review with reports easily accessible online or funded by Newfoundland and Labrador Housing Corporation (NLHC) as well as data collection through in-person and virtual workshops with the local residential construction community. While the ideas have been listed, prioritization, scheduling, stakeholders involved and methods to measure the ideas' success have not been identified. The following items are actions that NLHC can consider in partnership with the research community as a form of action research.

- Engage the construction industry and local governments to prioritize and schedule the 14 ideas from the workshops.
- Identify the key stakeholders who should be involved in executing each of the ideas and create performance measures for how these ideas will be measured (e.g., increased housing starts).
- Further investigate the development of a provincial framework and common definitions for NLHC to adopt
- Conduct a case study comparing two similar housing projects – one delivered through OSC and another through traditional – to quantify the benefits. This should ideally be done in various regions to understand how geography, transportation and the local supply chain impact project execution.
- Conduct further research into procurement and contract best practices that can be incorporated into the existing processes at NLHC.

While the above future research ideas are a next step to executing the ideas, it is anticipated that additional future research ideas will be stimulated upon completion of the ideas. Some of these items may be more specific to design for manufacturing and assembly for universal design and creating a networking for OSC best practices on Newfoundland and Labrador.

ACKNOWLEDGMENTS

The authors acknowledge the project team from the UNB Off-site Construction Research Centre, Newfoundland and Labrador Housing Corporation and the participants in the workshop including many stakeholders from the Newfoundland and Labrador construction community.

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