

Analysis of openBIM Adoptions and Implementations: Global Perspectives and Canadian Industry Adoption

Farzad Jalaei¹, Saman Davari², Yasir Sultan³, Claudia Cozzitorto⁴, Erik Poirier⁵, Arash Shahi⁶

¹National Research Council Canada, Construction Research Center, Ottawa, ON, Canada

Farzad.jalaei@nrc-cnrc.gc.ca, Saman.Davari@etsmtl.ca, Yasir.Sultan@nrc-cnrc.gc.ca, ccozzitorto@buildingSMARTcanada.ca, Erik.Poirier@etsmtl.ca, arash@accoinnovationlab.com

Abstract

The transition towards openBIM solutions has been receiving an increasing amount of attention in the built asset industry. This shift is principally driven by the adoption of open standards and services, aiming to promote a more collaborative, interoperable, and transparent digital workflow. This paper highlights openBIM adoption across various jurisdictions, with a focus on government involvement, standardization, technological innovation, environmental integration, national implementation, and knowledge resources. Drawing from international best practices, the paper presents a comprehensive analysis of openBIM opportunities and interoperability challenges, offering key takeaways and guidance for other nations such as Canadian construction industry to adopt and implement openBIM solutions efficiently.

Keywords –

openBIM; Built asset industry; Building Information Modeling; digitalization

1 Introduction

The past decade has seen a notable shift in the built asset industry regarding how projects are planned, designed, constructed, and operated. The traditional siloed approach to project delivery has given way to a more collaborative and integrated methodology, and at the forefront of this change is the concept of openBIM. According to buildingSMART International (bSI) [1], openBIM refers to: a universal approach to the collaborative design, realization and operation of buildings based on open standards and workflows. openBIM is an initiative of buildingSMART and several leading software vendors using the open buildingSMART Data Model. With the collaboration of international industry experts and stakeholders, bSI has developed specific standards and services to accelerate the implementation and adoption of openBIM. These open international standards and services – such as Industry Foundation Class (IFC) [2], BIM Collaboration

Format (BCF) [3], building Smart Data Dictionaries (bSDD) [4], etc. – are based on various types of Building Information Modeling (BIM) processes and information capabilities.

By utilizing open standards and services, openBIM enables the exchange of information across different software platforms and disciplines, facilitating a more efficient and transparent digital workflow [5]. At present, several leading jurisdictions have leveraged openBIM requirements into their building regulations and procurement processes, mandating its use in public projects. Professional organizations and industry alliances are actively promoting openBIM, developing guidelines, providing training, and advocating for its widespread adoption.

While the state of openBIM in the world today is promising, challenges still exist. Standardization efforts need to be strengthened further to ensure interoperable data exchange between different software platforms [6]. Education and training initiatives must be expanded to enhance the digital skills of professionals across the construction industry. Additionally, cultural barriers and resistance to change present ongoing obstacles that require continuous awareness campaigns and stakeholder engagement.

This paper aims to highlight the current state of openBIM at international level, with the primary goal of identifying and assessing the key trends, challenges, and potentials of openBIM within built asset industry. To do so, several leading jurisdictions, including the United Kingdom (UK), the United States (US), Norway, Finland, Denmark, France, Australia, Singapore, and Japan, were selected and analyzed. The selection of these primary countries was based on a diverse range of geographical locations, cultural contexts, and their contributions to advancing BIM workflow and processes. The key findings of reviewed international jurisdictions are outlined in the following sections.

2 Dimensions for Analysis

The adoption of openBIM across various jurisdictions is not a uniform process, owing to diverse regulatory

environments, technological capabilities, and strategic priorities. To critically evaluate the international state of openBIM, it is imperative to consider a multi-dimensional framework that reflects the complex interplay of factors influencing its adoption and implementation. To identify potential dimensions for this evaluation, the approach involved the deployment of surveys and direct engagements with international bSC chapters. These engagements were aimed at understanding the specific conditions and practices of openBIM implementation in their respective countries. The feedback received revealed commonalities in challenges and strategies across the board, enabling the research team to conduct a thorough analysis. The six dimensions identified for this analysis are as follows:

- **Governmental role:** the extent of governmental engagement in openBIM initiatives, examining how public policy, funding, and legislative frameworks shape the adoption landscape.
- **Standardization:** The adoption of universal standards is the cornerstone of openBIM's ethos. By evaluating the degree of standardization, this dimension pinpoints the efforts towards harmonizing procedures, data formats, and workflows, and the impact of these standards on cross-border and cross-industry collaborations.
- **Technological innovation:** the current state and evolution of technological advancements, spotlighting pioneering tools and platforms that enhance interoperability and facilitate openBIM implementation.
- **Environmental integration:** the integration of environmental considerations into openBIM reflects a commitment to sustainability. This analysis dimension gauges how openBIM interfaces with green building standards and eco-friendly practices, reinforcing its role in driving sustainable development within the built asset industry.
- **Implementations at national level:** the practical application of openBIM within national projects provides tangible evidence of its value and adaptability. This dimension scrutinizes the scope and scale at which openBIM is embedded into the public infrastructure, serving as a measure of its penetration and effectiveness in delivering complex projects.
- **Knowledge resources:** the generation and dissemination of openBIM knowledge through educational resources and training platforms are pivotal for its adoption. This

dimension evaluates the avenues through which expertise is improved and shared, reflecting the industry's capacity to nurture a proficient workforce well-versed in openBIM principles.

Figure 1 summarizes the analytical findings pertinent to the identified dimensions, emphasizing the most recent advancements in the adoption and implementation of openBIM across prominent jurisdictions. This depiction is current as of the date of this publication, acknowledging that these details may evolve over time.

3 openBIM implications and opportunities

Review of the selected jurisdictions through identified dimensions demonstrated potential implications and opportunities for other countries worldwide. The following sub-sections describe such findings.

3.1 Advocacy for open standards

Standardization serves as the foundation for the efficient and interoperable practice of digital construction [7]. The reviewed jurisdictions are currently advocating for openBIM standardization, recognizing the importance of standardized procedures in harnessing the true collaborative potential of the construction industry. In the UK, NIMA has been a front-runner in its support for openBIM through initiatives like the UK BIM Framework. Statsbygg, as a governmental body in Norway, has actively promoted openBIM, ensuring that projects adhere to these standards from the onset, ensuring quality and cost-efficiency. Singapore, a bustling hub of modern construction, is yet another shining example. Building Construction Authority (BCA) in Singapore has published different versions of BIM Guides, which provide detailed insights into the adoption of open standards and services in the city-state.

Moreover, advocating the standards is just one aspect; the true essence lies in ensuring their implementation and providing the community with access to guidelines and case studies, fostering an ecosystem where openBIM becomes ingrained in the industry's DNA. By prioritizing the generation and dissemination of openBIM knowledge through educational resources and training platforms, jurisdictions can effectively equip their workforce with the necessary skills and understanding to implement and adhere to these standards, thereby amplifying the impact of standardization efforts and fostering a more collaborative and efficient construction ecosystem.










Governmental Role	Standardization	Technological Innovation	Environmental Integration	Implementation at National Level	Knowledge Sources
 <ul style="list-style-type: none"> Regulatory (very low) Mandate renews Leadership as client & owner 	<ul style="list-style-type: none"> ISO19650 series bSI standards 	<ul style="list-style-type: none"> Information Management Platform (IMP) GIIG platform 	<ul style="list-style-type: none"> GenZero for design of zero-carbon schools Guides and policies of UK Green Building Council (UKGBC) 	<ul style="list-style-type: none"> GIIG projects GenZero project Sellafield (CDE) Babcock Major Infrastructure Projects (MIP) 	<ul style="list-style-type: none"> NIMA guides and services UK BIM Framework
 <ul style="list-style-type: none"> Mandates through federal agencies (GSA). Moderate support for openBIM in infrastructures 	<ul style="list-style-type: none"> ISO19650 forwards & annex US-IDS CSI IBD (level of accuracy) bSI standards NBIMS-US 	<ul style="list-style-type: none"> Central facility repository (GOTS) platform 	<ul style="list-style-type: none"> NIBS-BETEC programs 	<ul style="list-style-type: none"> TPF-5(372) BIM roadmap Implementation of MALD for DoT in various US states 	<ul style="list-style-type: none"> bSI-US openBIM trainings GSA's BIM hub NIBS guides
 <ul style="list-style-type: none"> Strong support for standards, mandates, regulatory framework 	<ul style="list-style-type: none"> NS 8360-1 NS 8360-2 NS 8360-3 NS 8360-4 NS 8360-5 bSI standards NS/EN ISO19650 	<ul style="list-style-type: none"> Simplebim and Pillr platform BIMQ platform 	<ul style="list-style-type: none"> Handbook V770 & R760-model basis, to meet UN sustainability goals. 	<ul style="list-style-type: none"> Bane NOR: Project KIM National Digital building permit Statens vegvesen infra projects 	<ul style="list-style-type: none"> Statsbygg's online database Resource Bank (by bSN)
 <ul style="list-style-type: none"> Strong support for standards, mandates, roadmaps 	<ul style="list-style-type: none"> bSI standards ISO19650 series ISO 191XX (WMS, WFS, GML) ISO 16739 ISO 12006 	<ul style="list-style-type: none"> IFCtoolbox (by Eurostep) COVE (by YIT) Model Checkers (e.g.Solibri) 	<ul style="list-style-type: none"> RYTV program for sustainable use of resources 	<ul style="list-style-type: none"> RASTI projects RYTV projects Open InfraBIM Vera projects 	<ul style="list-style-type: none"> bSFinland's WIKI
 <ul style="list-style-type: none"> Strong support for standards, mandates, roadmaps 	<ul style="list-style-type: none"> bSI standards ISO19650 series IFC-SG 	<ul style="list-style-type: none"> Corenet X 	<ul style="list-style-type: none"> BCA-SkyLab sustainability program Singapore Green Building Masterplan (SGBMP) Super Low Energy Programme (SLE) 	<ul style="list-style-type: none"> BCA BIM implementation roadmap CORENET X for regulatory checks 	<ul style="list-style-type: none"> BCA community for education & knowledge sharing
 <ul style="list-style-type: none"> Moderate support for certifications Sustainability regulations 	<ul style="list-style-type: none"> bSI standards ISO19650 series 	<ul style="list-style-type: none"> Semantics4BIM 	<ul style="list-style-type: none"> Manifesto for openBIM at the service of ecological transition CSTB 2030 projects 	<ul style="list-style-type: none"> Projects of Digital Transition Plan (PTNB) BIM 2022 Plan 	<ul style="list-style-type: none"> bSFrance online database for guides and policies
 <ul style="list-style-type: none"> Moderate support for certifications Sustainability regulations 	<ul style="list-style-type: none"> bSI standards DS ISO19650 series DS/EN ISO 23386 DS/EN ISO 23387 DS/EN ISO 17412 	<ul style="list-style-type: none"> Molio's product series LeksiCON Molio Huset 	<ul style="list-style-type: none"> ConTech Lab's SME initiatives 	<ul style="list-style-type: none"> Molio House ICT program for openBIM 	<ul style="list-style-type: none"> Molio's BIM services and education
 <ul style="list-style-type: none"> Moderate support for national BIM guides and rules 	<ul style="list-style-type: none"> bSI standards AS ISO19650 series OBOS AS ISO 16739 BIM-MEPAUS 	<ul style="list-style-type: none"> NATSPEC BIM Properties Generator BIM Value tool BIM benchmarking tool 	<ul style="list-style-type: none"> Policies & guides of Green Building Council Australia (GBCA) AS sustainable built environment programs 	<ul style="list-style-type: none"> Sydney Opera House BIM implementation Brisbane's Queens Wharf Development 	<ul style="list-style-type: none"> NATSPEC BIM knowledge hub and trainings
 <ul style="list-style-type: none"> Moderate support for national BIM guides and rules 	<ul style="list-style-type: none"> bSI standards AS ISO19650 series OBOS AS ISO 16739 BIM-MEPAUS 	<ul style="list-style-type: none"> National automated regulatory check platform (by 2025) 	<ul style="list-style-type: none"> National BIM program to mitigate CO2 emissions. 	<ul style="list-style-type: none"> National DX for building and city planning 	<ul style="list-style-type: none"> bSJ online database for guides and regulations

Figure 1. Summary of openBIM adoption and implementation across the globe

3.2 Government-led initiatives and collaboration

The active involvement of a country's government can be an important force in the widespread adoption and success of openBIM. Governments possess the regulatory and financial clout to incentivize, mandate, and guide the direction of industry practices [8]. Considering the government role as one of the key dimensions of this study, Nordic countries and Singapore stand out in this regard due to the foresight of their government entities. Their push for openBIM isn't just about ticking a box; it's a larger vision for standardizing

practices, ensuring sustainability across projects, and ultimately uplifting the nation's entire construction ecosystem. Singapore's National BIM program is anchored in openBIM principles, and represent the nation's vision for disaster resilience, integration of openGIS and openBIM, and reduction of carbon footprint. This government-led integration of openBIM into broader developmental goals showcases how Singapore can use it as a tool to address larger challenges, ranging from urbanization to environmental conservation.

Collaboration at both national and international levels has proven beneficial. The US and Nordic countries, for instance, have initiated joint ventures to bolster openBIM's potential. Such collaborations not only pool resources but also bring together diverse expertise,

leading to refined solutions and strategies. Moreover, challenges faced in one region can be addressed by solutions tried and tested in another. This reciprocal sharing of experiences and resolutions fast-tracks problem-solving and fosters an environment of continuous improvement. The results are refined strategies, enhanced openBIM standards, and improved tools and methodologies that are the by-products of shared expertise.

3.3 Standardized terminology and semantic consistency

In a fragmented and complex domain like the built asset industry, the use of common semantics, definitions, and terminologies allow for effective implementation and collaboration across various stakeholders. Drawing inspiration from countries that have successfully implemented openBIM workflows, establishing common semantics and terminologies are the initial steps towards the effective exchange of digital assets across lifecycle stages. Denmark provides a stellar example in this regard, through the development of the LeksiCON, Molio has focused on achieving consistency in the way construction-related information is shared and understood. The primary goal is to reduce misinterpretations, which could lead to costly errors. By making LeksiCON available openly, they ensure that every participant in the construction process is on the same page, figuratively and literally. In France, buildingSMART France is promoting Semantic4BIM to ensure that when a project transitions from one phase to another, or one discipline to another, the terminology remains consistent, avoiding potential misunderstandings or errors. Such a resource wouldn't just be a repository but a reflection of the country's commitment to ushering its construction sector into a new digital age while maintaining clarity, consistency, and cohesion.

3.4 openBIM and sustainability

Beyond the immediate benefits of open standards in the built asset industry, openBIM offers avenues to address larger sustainability challenges. The move towards sustainable and smart cities necessitates a departure from siloed decision-making. Urban planners, environmentalists, transportation experts, and technologists must collectively envision urban spaces. openBIM can serve as the unifying ecosystem where diverse stakeholders converge to share insights, analyze data, and measure sustainability of asset and products. This collective approach can lead to more informed decisions, ensuring that urban infrastructures are functional, sustainable, adaptable, and in tune with the environmental condition, as well as needs and aspirations of their residents. Having a centralized and open

ecosystem provides numerous opportunities to integrate openBIM and openGIS digital assets. This enhances the integration of environmental data with as-built assets and enables users to trace the circularity of information across multiple resources. It also increases the longevity and efficiency of the materials, systems, and strategies implemented.

4 Conclusion

The research presented openBIM's transformative impact on the built asset industry, marking a shift toward collaborative, efficient, and sustainable practices. Despite momentum in adoption propelled by government initiatives and technological advancements, challenges persist demanding greater standardization, enhanced digital competency, and the navigation of cultural resistance. Notably, openBIM's role in fostering sustainability and its integration into smarter, sustainable cities is gaining recognition. Canada stands on the cusp of a transformative era, leveraging global best practices and openBIM as a blueprint for a sustainable digital future. Embracing open standards fosters collaboration and consistency across projects, while proactive governmental roles, as seen in Norway, Japan, UK, and Singapore, illustrate the impact of regulatory mandates. The potential for openBIM in enhancing sustainability is pivotal, offering opportunities for circular information flow and efficiency in materials and systems. A comprehensive roadmap, blending technology, collaboration, and sustainability, positions Canada for a promising future in the built environment. Collaboration, both domestically and internationally, can accelerate Canada's digital journey, promoting shared expertise and mutual growth. Aligning with a global data dictionary enables harmonization of classifications, definitions, and terminologies, fostering enhanced collaboration and understanding among diverse professionals. Initiatives to enhance awareness, conduct cost benefit analyses, and ensure access to standardized documentation are vital for owners and government bodies. Implementation should be guided by a culture of accountability and a recognition that BIM's utility extends well beyond the design and construction phases.

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