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BIM maturity at scale: enabling digital transformation across the Canadian construction industry

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BIM Maturity at Scale

enabling digital transformation across the Canadian construction industry

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Executive Summary

The BIM Maturity at Scale Roadmap is a comprehensive strategy to advance digital transformation across the Canadian Construction Industry (CCI) by scaling Building Information Modelling (BIM) maturity assessment and improvement efforts nationwide. As the construction sector grapples with persistent challenges—including fragmented processes, low productivity, and mounting sustainability pressures—BIM is a cornerstone for digital transformation. It not only enables greater integration of the design, construction, and operation phases but also serves as a catalyst for digital innovation, decarbonization, and performance-based regulation.

This Roadmap is a strategic response to Canada's need for a unified and scalable approach to BIM adoption and maturity assessment. By addressing inconsistencies in adoption rates—especially among small and medium-sized enterprises, regions, and project types—it lays the groundwork for a cohesive national effort. The initiative aligns closely with the goals of the **National Research Council** (NRC)'s **Construction Sector Digitalization and Productivity Challenge Program** (CSDP), emphasizing productivity, sustainability, and innovation. This document is in nine sections:

Section 1 introduces the BIM Maturity Roadmap's purpose and alignment with the NRC's CSDP Challenge Program. It highlights BIM's role in advancing digital transformation, productivity, and sustainability in the Canadian Construction Industry. The section underscores the need for a standardized, scalable framework to address uneven BIM adoption and fragmented digital maturity across regions and sectors, fostering collaboration among stakeholders.

Section 2 covers **foundational concepts** and introduces key terms and principles underpinning the roadmap, including BIM maturity, capability, readiness, and compliance. It also discusses how these concepts connect to digital transformation metrics and processes, forming the theoretical basis for a scalable maturity framework.

Section 2 outlines the **tools, processes, and metrics** required to evaluate and enhance BIM maturity across various organizational scales and project types. It integrates benchmarking strategies and feedback mechanisms to ensure continuous improvement and alignment with industry needs.

Section 4 focuses on scaling **BIM maturity assessment** and discusses how the framework is designed to be adaptable to diverse regions, sectors, and project complexities. It addresses the challenges of scaling from individual organizations to industry-wide applications, providing a clear structure for data collection and analysis.

Section 5 clarifies how maturity assessments can translate into actionable **BIM maturity improvement** initiatives. It identifies key areas for growth, including digital competencies, interoperability, and client demand, while emphasizing collaboration among stakeholders.

Section 6 presents the **Roadmap in three stages**. The first stage establishes the foundational frameworks for BIM maturity assessment, integrating global standards like ISO 19650 and best practices from advanced national and international initiatives. The second stage focuses on activation, scaling, and benchmarking efforts, collecting data across provinces and sectors to inform targeted interventions. Finally, the third stage prioritizes the development of practical tools, collaboration protocols, and training programs to support stakeholders in improving their digital capabilities.

Section 7 details the insights from stakeholder consultations including the importance of coordinating efforts across the industry and the need to move forward without delay.

Section 8 provides a succinct summary of this document.

Section 9 includes two **annexes** that provide additional resources, including maturity models, assessment tools, and reference materials. These support the roadmap's practical application and scalability, ensuring alignment with international best practices and national objectives

In summary, the Roadmap addresses critical barriers for market-wide BIM adoption and digital transformation, including a lack of client demand, insufficient digital competencies, and limited interoperability. By encouraging collaboration among policymakers, industry leaders, and academic institutions, the BIM Maturity at Scale project aims to unlock the transformative potential of BIM. The ultimate objective is to create an adaptable, data-driven ecosystem that supports the entire lifecycle of built assets, enhances decision-making, and drives Canada's Construction Industry towards greater efficiency, innovation, and sustainability.

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List of Acronyms

This **Document** uses many acronyms that have specific connotations in the context of maturity assessment and improvement. The most frequently used acronyms are defined below:

1. **BIM**: Building Information Modeling
2. **BIMmas**: BIM maturity at scale
3. **BMG**: BIM Maturity Gap
4. **CCI**: Canadian Construction Industry
5. **CMP**: Current Maturity Profile
6. **CSDP**: Construction Sector Digitalization and Productivity challenge program
7. **DP**: Digital Performance
8. **DT**: Digital Transformation
9. **DTO**: Digital Transformation Objective
10. **OrgScale**: Organization Scale
11. **MATs**: Maturity Assessment Tools
12. **MITs**: Maturity Improvement Tools
13. **MP**: Maturity Profile
14. **NRC-CNRC**: National Research Council Canada - Conseil national de recherches Canada
15. **PLP**: Project Lifecycle Phases
16. **SEP**: Stakeholder Engagement Plan
17. **TMP**: Target Maturity Profile
18. **TPPs**: Technologies, Processes and Policies

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Acknowledgements

This document is produced as part of the deliverables of the National Research Council of Canada (NRC) - Construction Sector Digitalization and Productivity Challenge program (CSDP)/ Digitalization of Construction Processes theme and has been reviewed by many experts contributed their knowledge and time to the final version of this document from other government departments (OGD) steering committee.

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1 Introduction

The **BIM Maturity at Scale** (BIMas or Project) introduces the methodologies and provides the detailed roadmap for *conducting BIM maturity assessments and improvements activities at scale* across Canada. The Project is conducted in three stages detailed in Section 6 of this document. The first stage is completed upon the public release of the *strategic roadmap* (Roadmap) while the second and third stages are composed of a variety of BIM maturity assessment and improvement activities to be conducted collaboratively by industry stakeholders over an extended period. The Project complements other initiatives by the National Research Council of Canada (NRC) and aligns well with the goals of the Construction Sector Digitalization and Productivity Challenge Program (CSDP).

1.1 Project objectives

The **BIM Maturity at Scale** (BIMmas) project has three main objectives. The first is to clarify the central role that **Building Information Modeling** (BIM) plays in enabling and sustaining digital transformation, productivity and sustainability across the **Canadian Construction Industry** (CCI). Second, the Project will introduce the conceptual foundations for understanding BIM *maturity* and the methodologies necessary to assess and improve it. The third and final objective is to deliver BIMmas *assessments* across Canada's regions and provinces, followed by a variety of BIMmas *improvement tools* of benefit to all CCI stakeholders. The three objectives are coordinated with key Project participants and presented through a timeline subdivided into multiple stages, phases, activities and milestones.

In essence, the Project provides a guided path for engaging CCI stakeholders in the topics of digital performance, starting with BIM yet integrating associated topics such as Digital Twin, Integrated Project Delivery (IPD), Information Delivery Specification (IDS), and Common Data Environments (CDE)s. This approach complements the research released by the *Canadian Standards Association* (CSA, 2022) and several NRC publications (listed here) which underscore the importance of a national framework for BIM adoption and digital transformation. They also reference key challenges within a Canadian context especially the *lack of consistent demand* for BIM by clients, *inadequate digital competence* among stakeholders and the *intractable fragmentation* of the CCI supply and value chains.

To address these challenges, the BIMmas project will raise industry's awareness of BIM and digital transformation, generate market-wide BIM maturity benchmarks, and set in motion a process to deliver the many tools necessary to support industry's shift towards greater digital efficiency, sustainability and innovation.

1.2 Industry overview

The Canadian Construction Industry (CCI) is a vital component of the national economy, contributing *CAD 164.7 billion* to Canada's GDP in 2023 (Statista, 2023). CCI represents *7.5% of the country's GDP* and its many sectors encompasses a wide range of activities including residential, non-residential, engineering, and repair projects (Innovation, Science and Economic Development Canada, 2022). Despite its economic importance, the CCI has faced persistent challenges with low productivity growth causing it trail behind

other industries for decades (KPMG, 2023). These challenges are compounded by mounting pressures including housing shortages, climate change and the increasing complexity of projects which necessitates the adoption of equally complex digital tools to modernize operations and achieve sustainable outcomes. The industry's long-standing productivity issues, exacerbated by workforce shortages and the demand for sustainable practices, underscore the urgency of digital transformation to remain competitive and align with evolving global standards in information generation, management, and exchange.

Currently, the CCI is undergoing a significant transformation, driven by a concerted effort to decarbonize operations and improve productivity. *Digitalization is at the heart* of this transition and encompassing the adoption of BIM and openBIM standards. This shift aims to address two core challenges that are persistent even from before the advent of digital tools and process – that is enhancing sustainability and boosting productivity. The industry has traditionally lagged in these two areas with significant waste generation and suboptimal resource consumption.

1.2.1 A transitioning industry

Many large design firms and general contractors have started to contractually require BIM, interoperable data exchange - e.g. the use of Industry Foundation Classes (IFC) - and standardized information management protocols – e.g. BIM Execution Plans (BEP)s – which reflects the industry's progression towards tighter alignment with international best practices. The industry is also gradually transitioning towards performance-based construction codes and using BIM to automate code compliance checking and accelerate permitting processes.

While these developments represent important steps to modernize the CCI, major challenges persist. Legacy workflows, inconsistent standardization and incomplete implementations of openBIM and ISO 19650 standards hinder a faster transition and more fruitful progress. Furthermore, an ageing workforce and projected labour shortages loom large, highlighting the need to accelerate the digitalization and automation of industry flows, attract new talent and upskill current practitioners to sustain industry’s transformation.

1.2.2 Local initiatives

The challenges facing the Canadian Construction Industry are common across the various regions and provinces. This has prompted provincial policymakers and local champions to develop highly mature initiatives to facilitate digital transformation. For example, in Québec, the public sector has made significant digital transformation strides through a well-structured BIM Roadmap followed by BIM mandates developed by the *Société québécoise des infrastructures* (SQI, 2023), *Le Ministère des Transports et de la Mobilité Durable du Québec* (MTQ) which require the use of BIM for projects exceeding CAD 5 million while emphasizing a whole lifecycle management approach and alignment with sustainability goals (Canadian Construction Association & KPMG, 2021).

In addition to these public entities, the highly impactful Initiative Québécoise pour la Construction 4.0 (IQC, 2024) by Le Groupe BIM du Québec (GBQ, 2024) have managed to conduct in excess of 900+ detailed organizational assessments leading to the development of a world-leading database of BIM maturity data. On the other side of the country, in *British Columbia* (BC), multiple areas – e.g. City of Terrace, City of

Kelowna, and the District of Sparwood (NRC, 2024b) - have started experimenting with digital permitting (e-permitting) systems to streamline construction processes and improve their efficiency. Other initiatives, also in BC, focus on OpenBIM as the main approach to promote interoperability, collaboration and sustainable development among CCI stakeholders (buildingSMART Canada, 2023). Meanwhile in Ontario, organizations such as the Residential Construction Council of Ontario (RESCON) and the Toronto BIM Community (T-BIMc) have started providing support to industry practitioners through direct training and by actively promoting the adoption of BIM as a means to improve cost-efficiency and lifecycle management (Building Innovation Research Centre, 2023).

While these and similar local initiatives are well-worth celebrating, not all provinces and municipalities have managed to launch their own programs or digital transformation initiatives (CSA, 2022). This highlights the need for a wider and more inclusive national approach that complements existing local efforts and presents a national digital transformation approach that benefits all regions.

1.3 Role of NRC

To address all aforementioned challenges and present a nationally consistent effort, NRC has launched the ambitious and much needed *Platform to Decarbonize the Construction Sector at Scale* (PDCSS). This initiative seeks to integrate low-carbon requirements, develop innovative low-carbon solutions, and promote digital transformation across the industry. Central to the PDCSS are two key programs: the **Low Carbon Built Environment Challenge program** (LCBE) which focuses on promoting low-carbon construction materials, carbon accounting and lifecycle assessment; and the **Construction Sector Digitalization and Productivity Challenge program** (CSDP) which aims to accelerate digital transformation through performance-based codes, digitalizing construction processes, modular and advanced construction practices, modernized planning, information-rich asset management, web portals and innovative regulatory practices (NRC, 2024a) (Canadian Construction Association, 2024). One of the outputs of CSDP, as an example, is the **Digital Construction Platform** (DCP) (NRC, 2024d) which aims to streamline workflows, enable automated compliance checking and improve data management practices. All these and other efforts – including the BIM Maturity at Scale project - aim to ultimately advance the industry's digital efficiency and decarbonization goals.

As this Project is part of the CSDP challenge program. it is important to highlight its goals and delivers.

1.3.1 CSDP challenge program goals

This strategic NRC program aims to address decarbonization and productivity challenges across Canada's Construction Industry. The main objectives are to reduce construction time and costs, enhance innovation and accelerate the deployment of low-carbon solutions in both new and retrofit projects. The key ingredients to achieving these program goals include:

- Advancing BIM tools and processes and promoting their adoption across the value chain
- Empowering professionals by providing access to low-carbon building solutions and decision-support tools
- Driving modular construction and encouraging efficient, time-saving construction methods
- Supporting performance-based codes and green procurement practices

- Guiding digital transformation by developing clear roadmaps that lead to standardized interoperable practices
- Enhancing regulatory efficiency through digital portals that streamline planning process and automate compliance checking

The CSDP challenge program has many **Digital Transformation Objectives** (DTO)s. A core DTO is the development of *digital infrastructure* to modernize industry practices through the establishment of the Digital Construction Platform (DCP) which will consolidate many essential resources such as the National **Model Construction Codes** (NMCC) and the **National Master Specifications** (NMS) into a unified accessible system for managing standards, automating processes, and improving data management across the CCI. Another key DTO is *improving data interoperability* across the construction sectors by establishing a **National Common Data Framework** (CDF) and supporting *open standards* to facilitate information exchanges among stakeholders and enable more streamlined digital collaboration across both proprietary and non-proprietary software solutions. Another key DTO is the *widespread implementation of mature BIM practices* across the construction value chain. This would enhance collaboration during project delivery and improve process integration across all asset lifecycle phases - from inception, through design and construction, to operation, refurbishment and potential demolition or reuse. This BIM Maturity at Scale project is a representation of this key DTO.

These program goals and DTO are integrated into complementary frameworks, strategic roadmaps and tools. The preparation development and execution of these will not be attempted in one go but are spread over many years: starting from *near-term* adoption of digital tools to wider adoption of standardized processes in the *medium term*, and ultimately towards *longer-term* improvements in overall efficiency, costs and environmental performance. As this challenge program is part of the Platform to Decarbonize the Construction Sector at Scale (PDCSS), it will integrate with its overarching national aims to reduce the CCI's carbon impact and boost its productivity.

1.3.2 CSDP roadmaps, strategies and reports

For a more complete picture of the CSDP challenge program, and to set the scene for the BIM Maturity at Scale project, below is a summary of key CSDP publications released in the month preceding the publication of this document.

openBIM implementations for a Canadian roadmap
NRC-CNRC and buildingSMART Canada. Published January 2024
This document explores the implementation of open Building Information Modelling (openBIM) in Canada, focusing on the development of a roadmap for nationwide adoption. It emphasizes the need for interoperability, the use of open standards, and promoting collaboration across the industry. The document examines global openBIM environments and best practices, highlighting countries like Denmark, Finland, Singapore, and the United Kingdom. It analyses the key differences and similarities in their approaches, focusing on aspects like governmental role, standardization, technological innovation, education, and industry adoption. The document then provides a brief scan of BIM readiness in each Canadian province and territory, assessing their adoption levels and highlighting areas for improvement. It proposes a framework for openBIM implementation in Canada, emphasizing a collaborative approach involving stakeholders from various sectors. The document then highlights the importance of standardization, education, and a coordinated strategy to facilitate a successful transition to openBIM across the Canadian built asset industry.

Digitalization and productivity research and development roadmap
NRC-CNRC. Published March 2024:
This document outlines the research and development roadmap for the CSDP program in Canada. It analyses relevant international and national R&D initiatives, identifying common themes and patterns in digitalization strategies. The analysis reveals a focus on areas like BIM adoption, digital infrastructure development, interoperability, data management, and regulatory compliance. The document then proposes a structured roadmap for CSDP, including streams such as digital codes and specifications, information and data management, cybersecurity, cyber-physical coupling/digital twinning, and industrialized construction/advanced manufacturing. Each stream has defined actions, needs, and requirements, emphasizing the development, piloting, and scaling of solutions. The document advocates for a collaborative approach, involving stakeholders from across the built asset industry to guide Canada's digital transformation in construction.

Digital transformation of British Columbia's housing development sector
NRC-CNRC and *SCIUS Advisory*. Published August 2024.
This source examines the digital transformation of British Columbia's housing development sector, exploring opportunities to enhance efficiency, productivity, and sustainability. The source advocates for a modernized and harmonized approach to policies, codes, and standards, emphasizing the need for clear communication and streamlined approval processes. It identifies the benefits of a digital model serving as a "single source of truth" for project information, promoting the adoption of a Common Data Environment (CDE) for improved collaboration and data management. The source also explores the potential of affordable and user-friendly technologies and software to optimize the housing development process. This includes the implementation of collaborative platforms, e-submission systems, and integrated housing approval systems. The source concludes with a roadmap outlining key actions and strategies to guide the digital transformation of the housing development industry in British Columbia, emphasizing collaboration and innovation to achieve a more efficient and sustainable sector.

Towards a Digital Construction Platform at the National Research Council of Canada: Digitalization of National Construction Codes and Development of a National Common Data Framework
NRC-CNRC and *buildingSMART Canada*. Published November 2024.
This document focuses on establishing a Digital Construction Platform (DCP) at the National Research Council of Canada, with an emphasis on the digitalization of National Construction Codes and the development of a National Common Data Framework (CDF). It examines existing initiatives promoting digitalization in the built asset industry, highlighting international projects funded by the European Union and the efforts of the Center for Digital Built Britain in the UK. The source then proposes a tiered framework for the DCP, with the CDF as the foundation, emphasizing the integration of syntax, semantics, concepts, processes, and services. It stresses the importance of interoperability, benefiting from existing standards like IFC, and establishing information use libraries. The document outlines specific requirements for digitizing National Construction Codes and specifications, promoting automated compliance checks, and integrating data from different sources. It also proposes a roadmap with defined activities and milestones for the DCP's development and implementation.

1.4 Project rationale

Complementing the aforementioned NRC efforts, the **BIM Maturity at Scale** project addresses the Canadian Construction Industry's need for consistent and scalable BIM adoption across the industry. Currently, adoption of digital tools and workflows is uneven with higher uptake among *larger firms* and for *vertical assets* (e.g. residential buildings) while *infrastructure* (e.g. roads or bridges) and *smaller organizations* continue to fall behind. Such disparity limits the industry's digital potential and overall maturity – due to variations within supply chains - to harness the full benefits of integrated digital workflows across asset types and lifecycle phases.

There are many factors contributing to digital immaturity. One of these can be described as *effort fragmentation*, the *absence* of a uniform national approach to understanding, assessing and improving digital maturity. Even as some Canadian organizations, sectors and regions pull forward in their BIM adoption and general digitalization efforts, others face significant barriers due to the lack of *clarity* (to understand what needs to be done), *benchmarks* (to compare one's digital performance against recommended levels), *tools* (to bridge the performance gap) and *resources* (to activate performance improvement programs). This inconsistency hinders the industry's ability to uniformly deploy readily available technologies or to adopt innovative low-carbon solutions, which are essential to reaching Canada's decarbonization goals.

Another factor contributing to digital immaturity is the prevalence of *effort replication*, where BIM-adoption-acceleration efforts are implemented at local and provincial levels rather than through a nationally consistent initiative. This practice incurs financial costs from repeating the same steps in different regions and increases the risk of regional inconsistencies in a domain that benefits from national and international uniformity. The BIMmas project aims to address this fragmentation and replication by enabling a more consistent, flexible and scalable BIM maturity assessment and improvement effort. For the project to have the desired positive effect, it needs to provide a *common framework* to organize national, regional and local BIM/digital transformation efforts and *consistently apply* across organizational sizes, sectors, project types and geographical regions.

1.5 Document structure

In addition to Section1 (introduction), the remainder of this document is structured into 9 sections, each focusing on a different aspect of developing and delivering the BIM Maturity at Scale project:

Section 2: BIM Maturity - Foundational Concepts introduces the conceptual foundations underpinning BIM maturity including the terms and metrics necessary to develop the methodologies and tool for its accurate assessment and improvement.

Section 3: Assessment and Improvement Methodology introduces a methodological flow starting with Establishing Purposes, a 5-component Measuring and Improving Method, and ending with Evaluating Results by comparing them to established purposes.

Section 4: BIM Maturity Assessment at Scale introduces an Assessment to Improvement Flow and a Scaling Strategy to expand BIMmas assessment efforts to gradually cover different jurisdictions.

Section 5: BIM Maturity Improvement at Scale provides an insight into what BIM maturity means in the context of organizations and whole markets. This is followed by a list of potential tools and initiatives this Project may deliver during Roadmap Stage 3.

Section 6: Project Roadmap introduces a detailed roadmap to guide the delivery of this Project.

Section 7: Consultation Results provides insights from stakeholder consultations.

Section 8: Document Summary offers a succinct overview of topics covered in this document

Section 8: Annexes provide the list of resources that have informed the development of this strategy document and a compilation of all the references cited throughout the document.

2 BIM Maturity - Foundational Concepts

This section introduces the conceptual foundations underpinning BIM maturity including the terms and metrics necessary to develop the methodologies and tool for its accurate assessment and improvement.

2.1 The BIM term

BIM and other terms overlap in describing the tools and processes necessary for digital transformation across the construction industry. Whether different terms reflect real differences, competing commercial interests by software vendors or research funding pressures, the result is typically industry confusion. While distinctive terms – e.g. Virtual Design and Construction (VDC) or Digital Engineering (DE) - provide value in specific markets and contexts, there are more benefits when developing a national and unifying digital transforming strategy to focus on using a single term – Building Information Modeling (BIM) – as an *umbrella term* for assessing and improving digital maturity at scale. An umbrella term offers significant advantages including the reduction of semantic confusion, the elimination of conceptual redundancy due to topical overlaps, and – most critically - the opportunity to develop, deliver and maintain a set of unified maturity metrics[1].

For this Project, BIM will be defined as a "set of technologies, processes, and policies enabling multiple stakeholders to collaboratively design, construct, and operate a facility in virtual space (Succar, 2009; BIM Dictionary, 2024). This is complemented by an understanding that BIM provides a "*reliable basis for decisions*" due to its "use of a shared digital representation of a built asset [in a manner that clarifies, communicates and facilitates] design, construction, and operation processes" [emphasis added, based on ISO 19650]. These and other definitions[2] position the BIM term *at the core* of digital transformation within the construction industry. However, as will be demonstrated in through the Measuring and Improving Method in Section 3, it is practical to focus *less on terms* and *more on* the digital deliverables and requirements they represent.

2.2 Preparing to scale

Before discussing BIM maturity and how it can be measured and improved *at scale*, it is first important to introduce the *organizational hierarchy* used throughout this Project and then clarifying the different *digital performance metrics* (e.g. readiness and competence) and *digital performance processes* (e.g. adoption and diffusion). Each of these concepts will be briefly explained and then combined in an explanatory image and matrix (**Figure 1**) (**Table 1**).

[1] For an example of redundancy, imagine the need for a separate BIM, VDC, openBIM, Digital Twin and DE maturity roadmaps with their own metrics and measurement tools.
[2] One example is by NBIMS v4.0 which defines a Building Information *Model* (BIM) as a "shared digital representation of physical and functional characteristics of a built environment asset". https://www.nibs.org/nbims/v4/terms-definitions retrieved on December 4, 2024. Another example is the one provide by the EUBIM Task group where BIM is a "digital form of construction and asset operations [that] brings together technology, process improvements and digital information to radically improve client and project outcomes and asset operations […]". EU BIM Task Group. (2017). Handbook for the introduction of Building Information Modelling by the European Public Sector. Retrieved from https://www.eubim.eu/handbook/ . Retrieved on 4 December 2024.

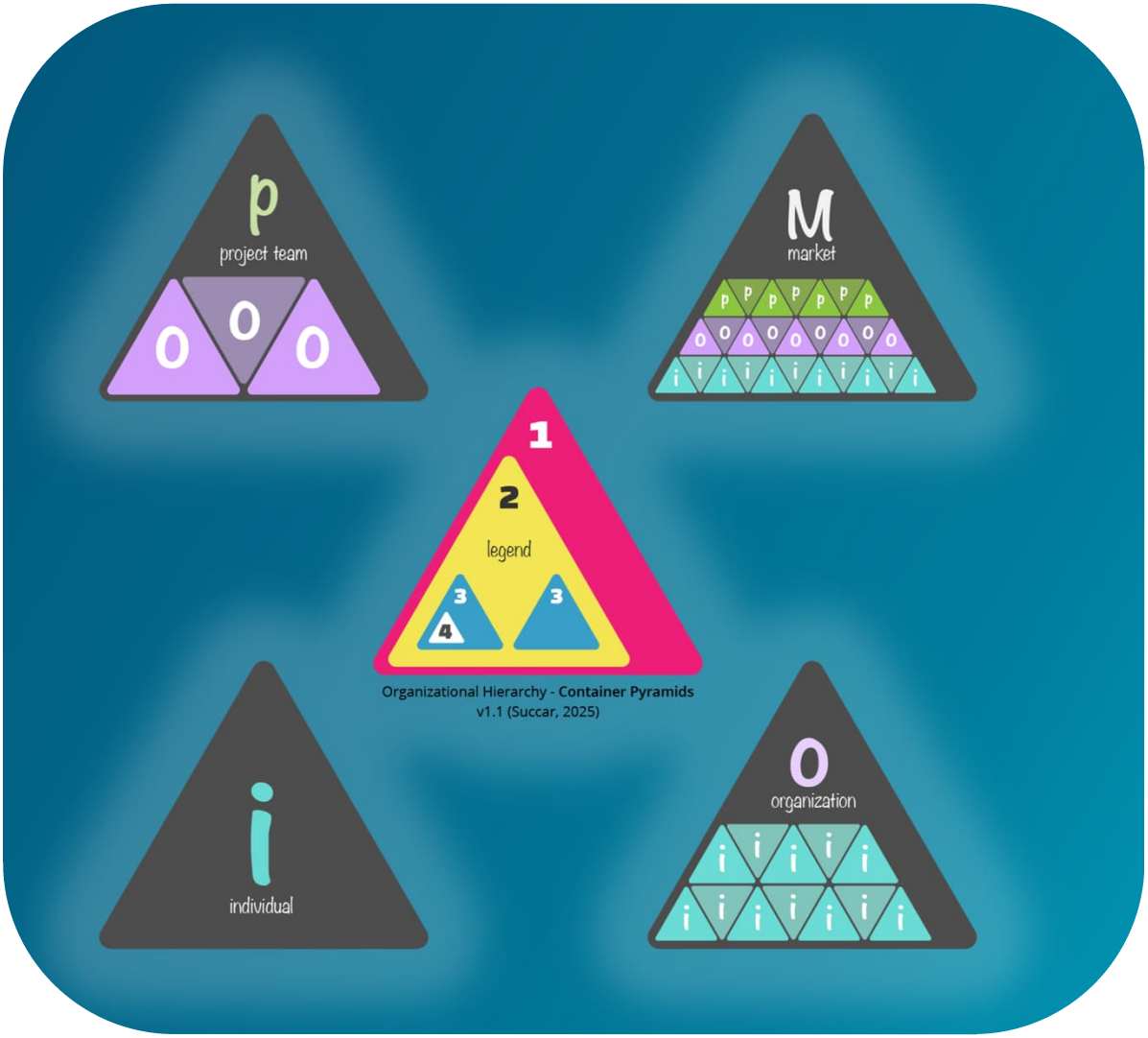
2.3 Organizational hierarchy

The Organisational Hierarchy is a *conceptual model* for understanding and measuring digital performance across different *entities*, from individuals to entire markets. This hierarchy include 12 *organizational scales* (OrgScales) grouped into 3 *organizational clusters* (micro, meso and macro) that provide the flexibility needed to focus on specific industry actors[3]. For this Project, the focus will be on a subset of OrgScales which are instrumental for explaining the concepts of BIM maturity assessment and improvement. The four scales to be used are "Individual (i)" (the smallest entity, also referred to as Organizational Member), "Organization" (o), "Project Team" (or supply chain) (p) and "Defined Market" (M) with each *larger entity* acting as a container for all smaller entities. That is, if we are to measure the BIM/digital abilities of an organization, we will need to assess organization-level criteria (e.g. organizational systems and outputs) *plus* the abilities of all operational staff, the assessable *smaller entities* within that organization. Similarly, if we are to assess a Project Team, we will need to assess the project-level criteria (e.g. contracts and information management frameworks) *plus* the compound abilities of member organizations within the team. Scaling this up to Defined Market, if we are to conduct a comprehensive BIM/digital assessment, this would require assessing the BIM/digital abilities of all – or more realistically, a representative sample of - projects, organizations and individuals.

As a comprehensive assessment at Market scale that includes all projects, organizations and individuals is not feasible except for the smallest and most isolated Defined Markets (e.g. the first community of engineers on Mars), a more practical approach would be to apply a *Scaling Strategy* (refer to Section 4) to establish BIM/digital ability through selective sampling and progressive data capture.

[3] The Organizational Hierarchy and the 12 Organizational Scales were first published as part of the BIM Maturity Matrix (BIMei, 2015) and are available online on the BIM Framework blog: https://www.bimframework.info/2013/12/organizational-hierarchy.html (last checked Dec 15, 2024).

Figure 1. Organizational Hierarchy – Entity Containers



Legend – see first pyramid from the right: entity #1 is a *parent entity* of #2; entity #4 is a *child entity* of #3. entities #3 are *sibling entities*.

2.3.1 Digital performance metrics

There are numerous metrics that can be used in assessing and improving BIM/digital performance. Each is briefly introduced below, connected to BIM maturity and later combined with other materials in **Table 1**.

BIM readiness
BIM readiness is the *pre-implementation status* representing the propensity of an entity to adopt BIM tools, workflows and protocols. Readiness is expressed as the *level of preparation*, the *potential to participate*, or the c*apacity to innovate* (CID, 2014). Readiness can be measured using a variety of approaches – product-based, process-based, and through overall maturity (Saleh & Alshawi, 2005) and signifies *planning and preparation activities* preceding implementation.

Connection: *BIM readiness is a precursor for achieving BIM capability (see below) which is, in turn, the foundation for assessing and improving BIM maturity*.

BIM capability

BIM capability is the wilful *implementation* of BIM tools, workflows and protocols over a number of stages and steps (Succar, 2009). BIM capability covers numerous technology, process and policy topics and is expressed as the *minimum ability* of an entity to deliver a measurable outcome.

Connection: *BIM capability is the foundation for establishing and improving BIM maturity.*

BIM competence

BIM competence refers to the ability of smaller entities - individuals or groups - to complete BIM related activities, deliver expected outputs and achieve desired outcomes. More generally, competence has three overlapping *abilities* - Knowledge, Skill, and Experience – and two *enablers* for these abilities - intelligence and attitude. These abilities and enablers do not exist independently but can be measured using specialized tools.

Connection: *BIM competence of individuals within organizations and project teams is an enabler of these container entities to achieve and maintain BIM capability and maturity.*

BIM conformance

BIM conformance refers to the alignment of an entity's BIM/digital technologies, processes and policies (TPPs) with that of its *parent* container entity. For example, a department may not be aligned - and thus do not conform with – the TPPs of the whole organization; or an organization (e.g. a subcontractor) may not be aligned with the relevant TPPs of the main contractor.

Connection: *BIM conformance of child entities with the parent entity's internal guides and protocols is a sign of the parent entity's BIM maturity*.

BIM compliance

BIM *compliance* refers to the wilful adoption of standards and codes to organize BIM/digital processes and deliverables. For example, the adoption of ISO 19650 to organize and manage information exchange is a measure of BIM compliance with international standards.

Connection: *BIM compliance of child entity X with the external standards, codes and protocols of parent entity Y is a sign of the child entity's BIM maturity.*

BIM compatibility

BIM compatibility refers to the ability of two *temporarily grouped entities* to collaborate and integrate their BIM/digital tools, processes, and protocols. For example, Organization A and Organization B may have proven BIM capability but may not be compatible with each other within a project team or supply chain. Incompatibility can be due language, culture, or simply to misaligned technologies, processes, or policies.

Connection: *BIM compatibility between two temporarily grouped entities is a sign of their container entity's BIM maturity*.

BIM maturity

BIM maturity (or *post-implementation*) is the *gradual and continual improvement* in quality, repeatability and predictability within available capabilities. BIM maturity is expressed as *maturity levels* (or performance improvement milestones) that organizations, teams and whole markets aspire to.

Internal connection: *The BIM maturity of an entity reflects its child entities' BIM maturity*.

2.3.2 Digital performance processes

Digital transformation through the adoption of BIM is often referred to it as a *process of* adoption, implementation, diffusion or similar. While these terms conceptually overlap, it is beneficial to differentiate them and connect each to the BIM maturity metric.

BIM implementation

BIM implementation refers to the structured process of integrating BIM into organizational operations and project delivery workflows. Implementation relies on a deliberate effort, a structured step by step process, to integrate BIM into an entity's business operations. Typical BIM implementation activities include setting clear objectives and then developing Modelling, Collaboration and/or Integration (MCI) strategies covering the necessary Technologies, Processes and Policies (TPPs). These include deploying the requisite BIM software tools on projects in parallel with delivering the necessary training programs and information management protocols. In essence, BIM implementation is an *operational* set of activities focused on embedding relevant tools and workflows into daily operations, improved/new deliverable and decision-making processes.

Connection: *After achieving an adequate state of readiness, BIM implementation within an entity is the mechanism for acquiring BIM capability in distinct stages and then gradually improving BIM maturity [refer to the Point of Adoption Model (Succar and Kassem, 2016)]*

BIM adoption

BIM adoption encompasses the complete process of embracing and integrating BIM within an organisation or – when overarching cultural and technological shifts are considered - across the AECO industry. BIM adoption reflects a behavioural shift, often influenced by external drivers such as market demand, client requirements, or legislative mandates. Adoption within organizations starts with the initial decision to adopt BIM - referred to as the initial *Point of Adoption* (Succar and Kassem, 2016) - followed by BIM implementation (see above) and its ongoing use, adaptation and deeper integration.

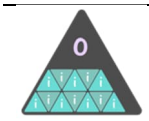
Connection: *BIM adoption is the mechanism that initiates BIM implementation. It activates an entity's journey to achieve progressively higher levels of BIM capability and maturity.*

BIM diffusion

BIM diffusion describes the process by which – or measures whether – BIM TPPs spread across organisations and markets *over time*. The term is rooted in innovation diffusion theory (Rogers, 2003) (Greenhalgh et al., 2004) and highlights the gradual spread from early adopters to a broader population due to multiple factors including *coercive*, *normative* and *mimetic* isomorphic pressures (Succar and Kassem, 2015) (DiMaggio & Powell, 1983) (Cao and Wang, 2014). Unlike BIM implementation and adoption, BIM diffusion focuses on the macro-level propagation of BIM practices within and across regions, sectors, and industries.

Connection: *BIM diffusion is the mechanism for describing or enabling the spread of BIM capability/maturity within an entity*.

Table 1. Digital Transformation Metrics and Processes

	Organizational Scales	**Metrics** *[excludes child/parent entity metrics]*	**Processes**	**DT Assessment Indices** (sample applies to Metrics & Processes)	**DT Assessment Models** (sample)	**DT Assessment Uses** *[allow the development of]*
	**Individual** (i)	Competence	Adoption (by learning)	Individual Competency Index	Competency Sets	Education curricula; Continual Professional Development programs; Role definition
	**Organisation** (o)	Readiness; Capability; Maturity	Adoption; Implementation ; Diffusion	Readiness Index; Capability Stages; Maturity Levels; Implementation Steps; Diffusion States	Capability Sets *(applicable to readiness, capability and maturity)*	Pre-qualification; Performance improvement strategies
	**Projects Team** (p)	Compliance; Conformance; Compatibility	Adoption	Comparative Index *(same index applies to all metrics and processes)*	Information Management Standards; Collaborative Contracts; Integrated Project Delivery	Capability matching; Project appointment
	**Defined Market** (M)	Maturity	Adoption; Diffusion	Maturity Index; Adoption Levels; Diffusion Dynamics	Macro Maturity Areas	Benchmarking; Adoption roadmaps; Diffusion policies

2.4 Why BIM maturity?

Compared to other digital transformation metrics, BIM maturity is the most beneficial to use for assessing and improving performance. The reason lies in the *clarity* and *flexibility* of staged maturity levels, which enable stakeholders to set clear targets and measure their digital performance accordingly.

To establish BIM maturity, one must first define explicit, achievable maturity targets, and then measure performance against these targets. In other words, assessing BIM maturity is not a competition among different players but rather an evaluation against pre-established requirements and deliverables. Because the BIM domain involves many interconnected tools, workflows, and policies, composite maturity targets must be subdivided into more focused sub-targets. This allows for more accurate assessments and the *independent* updating of each sub-target as new technologies, processes, and standards are adopted.

By clarifying maturity targets in advance and using a clear Maturity Index that distinguishes each performance level from the next (see Section 3), assessing BIM maturity becomes a straightforward exercise. This can be done with minimal effort using simple templates—for example, the BIM Maturity Matrix (BIMei, 2015). Defining these levels also helps stakeholders communicate and select appropriate BIM maturity targets during both assessment and improvement initiatives. This flexibility in defining maturity targets makes it possible to apply different BIM maturity assessment tools in different settings. A static template may be ideal for face-to-face workshops, while more sophisticated online tools can be used to evaluate thousands of participants spread across various regions. Likewise, the scores assigned to each

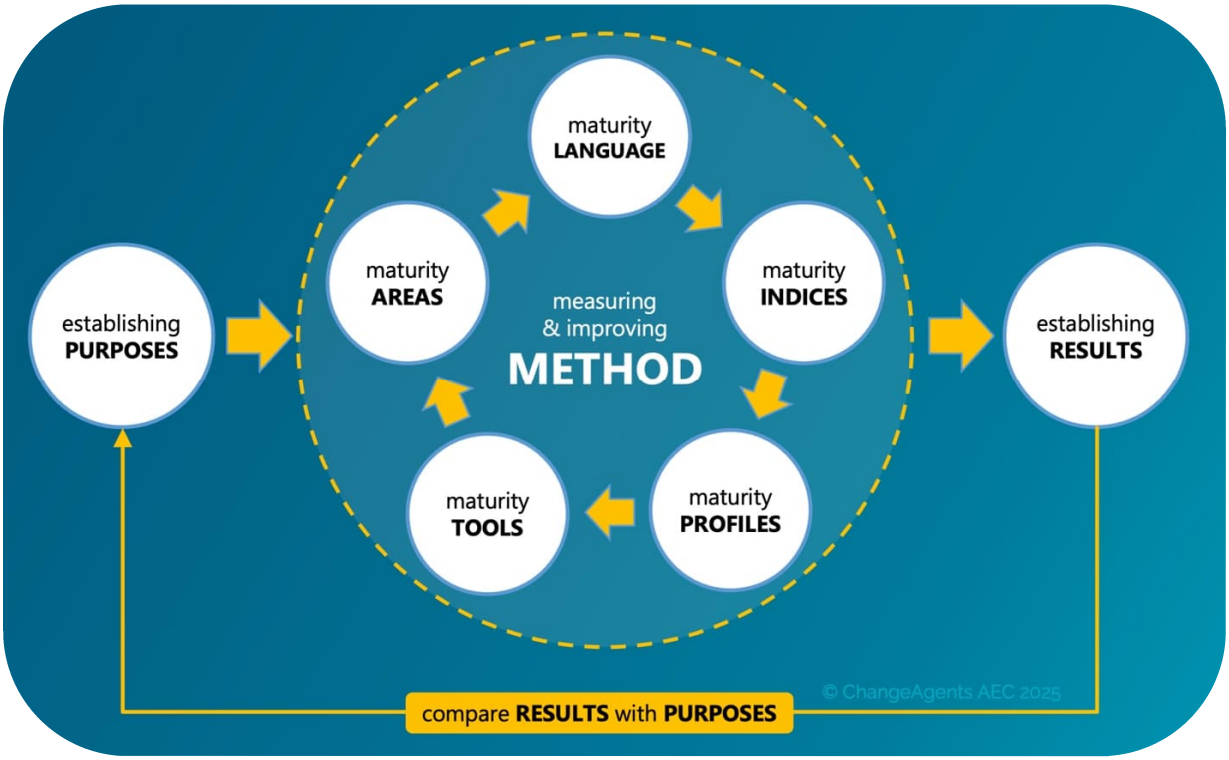
maturity level can vary to suit the assessment context: they may be qualitative, quantitative, or a blend of both, and follow either an arithmetic or algebraic progression. This offers the flexibility needed to design and deliver BIM maturity assessments on a large scale.

In summary, BIM maturity is a versatile digital transformation metric. It can be fine-tuned to any BIM maturity area and is applicable to individuals, organizations, projects and entire markets. This adaptability and the deployment of a robust *assessment and improvement methodology* ensures that the BIM maturity metric can effectively guide and facilitate digital transformation across the Canadian Construction Industry.

3 Assessment and Improvement Methodology

To enable accurate BIM maturity assessment and structured improvement efforts, a robust methodology grounded in research and practice is needed. Section 3 introduces a methodological flow *starting with* **Establishing Purposes**, a 5-component **Measuring and Improving Method,** and *ending with* **Evaluating Results** by comparing them to established purposes (**Figure 2**).

Figure 2. BIM Maturity Assessment and Improvement Methodology



3.1 Establishing the purposes

For BIM Maturity Assessment and Improvement efforts to be successful, the intent must be clearly defined and measurable by comparing the intended outcome (Purposes) with actual outcome (Results). These purposes overlap between the four Organizational Scales – individuals, organizations, project teams and markets - but are presented separately below:

3.1.1 Purpose of BIM maturity assessment and improvement efforts for individuals

Pi-01: Enhancing Professional Competence
BIM maturity assessments help individuals identify their strengths and weaknesses in BIM-related skills, enabling targeted skill development and professional growth.

Pi-02: Supporting Career Advancement
By achieving higher levels of BIM proficiency, individuals can position themselves as valuable assets within their organizations and increase their career opportunities in a competitive job market.

Pi-03: Improving Workflow Efficiency
Individuals can use BIM assessments to refine their personal workflows, adopt best practices, and improve their efficiency in delivering project tasks.

Pi-04: Aligning Skills with Industry Standards
BIM assessments provide a benchmark against industry standards, ensuring individuals' skills remain relevant and aligned with evolving practices and technologies.

Pi-05: Facilitating Collaboration
By understanding their role in a collaborative environment, individuals can enhance their ability to work effectively within multidisciplinary teams and contribute to project success.

Pi-06: Encouraging Lifelong Learning
BIM maturity assessments – if done in well communicated manner – would encourage a culture of continuous learning by highlighting areas for improvement and encouraging ongoing education and training.

Pi-07: Building Confidence in Tools and Processes
Through assessments, individuals gain confidence in their ability to use BIM tools and adhere to processes, improving their performance and reducing errors.

Pi-08: Preparing for Certification or Accreditation
Assessments help individuals prepare for BIM-related certifications and accreditations, validating their skills and expertise in the field.

Pi-09: Driving Innovation and Creativity
By identifying gaps and opportunities in their knowledge, individuals can explore innovative approaches and contribute creative solutions to project challenges.

Pi-1o: Strengthening Job Satisfaction and Motivation
As individuals achieve measurable improvements in their BIM capabilities, they gain a sense of accomplishment, leading to greater job satisfaction and motivation.

3.1.2 Purpose of BIM maturity assessment and improvement efforts within organizations

Po-01: Optimizing Processes and Operations
Organizations use BIM maturity assessments to identify inefficiencies in their processes, enabling them to streamline operations, reduce waste, and improve project delivery timelines.

Po-02: Enhancing Decision-Making
By evaluating BIM capabilities, organizations gain data-driven insights into their strengths and weaknesses. This informs strategic decisions about resource allocation, technology investments, and partnerships.

Po-03: Improving Collaboration Across Teams
BIM maturity assessments help organizations evaluate their ability to collaborate internally and externally. This is particularly important for multidisciplinary projects where seamless data exchange and integration are critical.

Po-04: Strengthening Competitive Advantage
Organizations assess their BIM maturity to identify areas where they can outperform competitors, such as adopting cutting-edge technologies or enhancing digital workflows, thereby gaining an edge in the market.

Po-05: Aligning with Industry Standards and Certifications
Many organizations seek to align their practices with national or international standards, such as ISO 19650, to ensure compliance, interoperability, and eligibility for high-value projects.

Po-06: Facilitating Change Management
Assessments enable organizations to measure their readiness for digital transformation, helping leaders manage cultural and structural changes necessary for BIM implementation.

Po-07: Enhancing Workforce Competencies
Organizations use BIM maturity evaluations to identify skills gaps and prioritize training and professional development. This ensures that staff competencies align with technological advancements and organizational goals.

Po-08: Minimizing Risk
By identifying areas where BIM practices are weak or underdeveloped, organizations can mitigate risks associated with poor project outcomes, such as cost overruns, delays, or rework.

Po-09: Supporting Sustainability Goals
BIM maturity assessments can identify opportunities for improving environmental outcomes, such as reducing material waste or improving energy efficiency in design and construction processes.

Po-1o: Building a Roadmap for Digital Advancement
Organizations deploy BIM maturity assessments to create structured plans for achieving higher levels of digital maturity, ensuring progress aligns with organizational strategies and market demands.

3.1.3 Purpose of BIM maturity assessment and improvement efforts for project teams

Pp-01: Enhancing Project Coordination and Collaboration
BIM maturity assessments help project teams identify barriers to effective collaboration and enhance data sharing, leading to better coordination among disciplines and stakeholders.

Pp-02: Improving Communication and Decision-Making in Projects
By providing a clear understanding of BIM capabilities and gaps, these assessments facilitate transparent communication and informed decision-making across all phases of a project.

Pp-03: Delivering High-Quality Project Outputs
Project teams use BIM maturity assessments to ensure they can meet client expectations and deliverables through improved accuracy, efficiency, and innovation.

Pp-04: Aligning with Project Goals and Standards
Assessments ensure that BIM workflows and tools are aligned with project-specific requirements, standards, and client goals, supporting compliance and achieving desired outcomes.

Pp-05: Reducing Errors and Rework in Projects
By identifying gaps in processes and competencies, project teams can mitigate risks associated with errors and rework, leading to cost savings and timely project delivery.

Pp-06: Supporting Multidisciplinary Integration in Projects
BIM maturity assessments facilitate integration across disciplines by highlighting discrepancies in tools, standards, and processes, enabling seamless collaboration.

Pp-07: Accelerating Adoption of Innovative Practices in Projects
Project teams use assessments to identify opportunities for integrating new technologies and methodologies, such as parametric design or digital fabrication, into their workflows.

Pp-08: Enhancing Team Competence
By pinpointing training needs, assessments help team members develop skills that align with project demands and emerging industry practices.

Pp-09: Enabling Continuous Improvement in Projects
Regular assessments provide benchmarks that allow project teams to monitor progress, measure improvement, and refine their workflows for future projects.

Pp-10: Strengthening Client Relationships
By demonstrating a commitment to quality and innovation through structured BIM practices, project teams can build trust and strengthen relationships with clients.

3.1.4 Purpose of BIM maturity assessment and improvement efforts in the industry

Pm-01: Enhancing Industry Efficiency and Sustainability
BIM maturity assessments aim to identify inefficiencies and gaps in adoption across stakeholders, ensuring the construction industry can use digital tools to improve sustainability and productivity. This aligns with broader national goals such as decarbonization and economic recovery.

Pm-02: Standardization and Consistency
These assessments support the establishment of standardized practices, reducing fragmentation in the industry. This includes harmonizing workflows, data exchange, and collaborative efforts to ensure smoother project execution and information management.

Pm-03: Guiding Policy and Investment Decisions
Assessments provide empirical data for stakeholders, including governments and industry leaders, to make informed decisions regarding investments in digital technologies and the development of supportive policies.

Pm-04: Improving Project Deliverables and Collaboration
Through structured maturity models, assessments identify and enhance the capabilities of organizations and project teams to deliver high-quality, collaborative, and innovative design, construction and operation solutions.

Pm-05: Benchmarking and Performance Improvement on Projects
Regular assessments establish benchmarks for performance across projects and help in identifying and developing initiatives for accelerating performance improvements.

Pm-06: Supporting Training and Upskilling at Scale
By identifying specific competency gaps, maturity assessments facilitate targeted education and training programs, equipping industry professionals with the necessary skills for advanced BIM practices.

Pm-07: Encouraging Adoption of Emerging Technologies at Scale
BIM maturity assessments serve as a foundation for integrating cutting-edge technologies such as Digital Twins and IoT into workflows, thus enabling a digitally advanced construction ecosystem.

3.2 Measuring and improving method

The BIM Maturity **Measuring and Improving Method** has five *interconnected* components: Maturity Areas, Maturity Language, Maturity Indices, Maturity Profiles and Maturity Tools. Together they translate the established purposes through assessment and improvement actions into measurable results. The five components are summarized below:

1. **Maturity Areas** are the topics and materials of relevance to BIM maturity assessment and improvement.
2. **Maturity Language** is the modular elements needed to simplify generating BIM maturity assessment profiles and BIM maturity improvement plans. The Maturity Language is consistent across Organizational Scales and is composed of reusable modules including:
   2.1. **Dictionary Items** (DI)s represent the common terms, and their descriptions and translations
   2.2. **Information Uses** (IU)s representing the expected digital deliverables - models, documents and data sets
   2.3. **Action Statements** (AS)s providing a common syntax to define activities, outputs and outcomes
   2.4. **Defined Roles** (DR)s clarifying the *individual*, *supply chain* and *market roles* being assessed or improved
3. **Maturity Indices** needed to conduct accurate assessments. These include:
   3.1. **Maturity Index** which defines five progressive BIM maturity levels
   3.2. **Granularity Index** which defines the five levels of detail applied when investigating BIM maturity
   3.3. **Evidence Index** which defines the five levels of evidence sought when establishing BIM maturity
4. **Maturity Profiles** combine the Maturity Areas expressed through the Maturity Language and Maturity Indices into well-defined profiles to be used in BIM maturity assessment and improvement
5. **Maturity Tools** are online and offline tools/templates used for BIM maturity assessment, analysis and/or improvement.

These components are further explained below:

3.2.1 BIM maturity areas

BIM maturity areas encompass the technologies, processes, and policies required to design, deliver, and operate facilities in a digital space. These areas are fundamental to conducting maturity assessments and driving improvements across the lifecycle of built assets. As they encompass a wide range of topics, BIM maturity areas must be filtered to align with the **organizational scale** being assessed or improved, whether at an individual, team, organization, or whole market.

At the core of BIM maturity areas are **technological systems**, which include digital modelling tools such as BIM software and platforms supporting a variety of model-based deliverables. These technologies are integral for generating and managing data-rich documents, models and data sets that enable deep collaboration and integration. Examples of these technological systems include Common Data Environments (CDEs) and cloud-based solutions forming the backbone of data storage and management and facilitating interoperable information exchange between stakeholders and across whole supply chains. Other examples include computer-assisted, automated and – increasingly - autonomous systems enabled

by robotics and artificial intelligence which are increasingly playing a key role in enhancing speed, efficiency and accuracy in design and construction workflows.

These technological systems require well-tuned **processes** which are equally critical in assessing and improving BIM maturity. These include information management practices derived from market experience and then aligned with international standards like ISO 19650 which clarify how information can be managed, shared and maintained through uniform information templates and workflows. Examples of processes that can be maturity-tested and improved are model-based workflows, such as clash detection, energy analysis, and other simulations (expanded upon in the Model Uses section) which encapsulate many sub-processes and activities needed to design, deliver and maintain a facility. Other examples include collaborative project delivery methods like Integrated Project Delivery (IPD), Concurrent Engineering (CE) and Lean Construction which optimize digital workflows, align organizational objectives and enhance project outcomes. Such assessable and improvable processes may cover a single lifecycle phase – Design, Construction or Operation - or span the whole asset lifecycle from cradle to grave, to cradle again in a continuous loop of information generation use and reuse (Succar and Poirier, 2020).

The third pillar of BIM maturity areas relates to well-defined **policies** that guide or dictate how BIM is adopted and applied within an entity and whether it complies with regulatory frameworks and international standards. Assessable and improvable policies include contractual arrangements that define the responsibilities for and expectations from digital deliverables in a manner that minimizes overlaps and allows clear accountability. These include governance structures addressing data ownership, security, and privacy which are essential to allow cloud-based collaboration, securing of model-based/digital permits, maintaining a digital thread connecting materials and actors to finished assets, and protecting the rights of all stakeholders. Other policies include social and environmental responsibility that connect BIM workflows to carbon-reduction and energy efficiency targets.

Given the broad coverage of these maturity areas, they must be filtered and tailored to suit specific organizational scales and contexts. For example, at the **individual level**, BIM maturity areas would focus on the BIM/digital competencies necessary for specific functional roles, ensuring practitioners are equipped to use tools and workflows effectively. At the **organizational level**, the emphasis shifts to broader governance structures, integration of BIM across projects, and alignment with corporate strategies. At the **project team level**, maturity areas expand to include collaborative platforms and model-based management systems tailored to domain-specific tasks, such as structural analysis or facilities management. Finally, at the **market level**, the focus widens to encompasses regional and national strategies for BIM adoption, standardization of processes, and benchmarking against industry best practices.

To maximize relevance, BIM maturity areas must also reflect specific **disciplines**, organizational **sizes**, and organizational **objectives**. For example, the BIM Maturity requirements for organizations working on small-scale residential projects differ significantly from those working on large-scale infrastructures which require highly synchronized information management capabilities. Similarly, BIM maturity areas can be filtered to reflect the Established Purposes similar to enhancing foundational capabilities, conformance with industry standards or pursuing cutting-edge competition-enhancing innovations.

3.2.2 BIM maturity language

Since the expanded BIM term covers overlapping concepts (jump back), the term needs to be replaced by a language that is more suitable for *defining* measurable digital deliverables and requirements. As a case in point, it is not useful to enquire "whether a design team *can use BIM* to deliver 5-story residential building?" as such an 'assessment question' is ambiguous and open to interpretation. To reduce this ambiguity, it is more useful to enquire "whether the design team (a) has the expertise in low-rise residential buildings, (b) can follow international standards to (c) collaboratively generate accurate 3D digital models of the building in an open non-proprietary format that can be (d) iteratively clash-tested and structurally analyzed throughout the design process and then, upon final submission, (e) yield an accurate bill of quantity and a visual skeleton for (f) an as-built functionally-connected digital twin for facility-management purposes". As another example, it wouldn't be clear enough if a senior manager declares "their intent to dedicate a sizable budget to *improve the BIM maturity* of the whole organization by the year 20XX" without also defining the (a) *maturity objectives* to be achieved from a broad spectrum of digital transformation possibilities, and identifying the (b) key technologies, processes, and policies to be adopted, (c) activities to be completed and (d) initiatives to be led by digital transformation agents over (e) well-defined milestones.

In essence, to assess and then improve BIM maturity, the purpose must be clear, and the language used need to be expressive, precise and well-suited for the task. To achieve such clarity, this section introduces four modular components – Dictionary Items, Information Uses, Action Statements, and Defined Roles[4] - that, when combined, allow granular control over what is assessed and how assessments results are used to improve performance.

3.2.3 Dictionary items

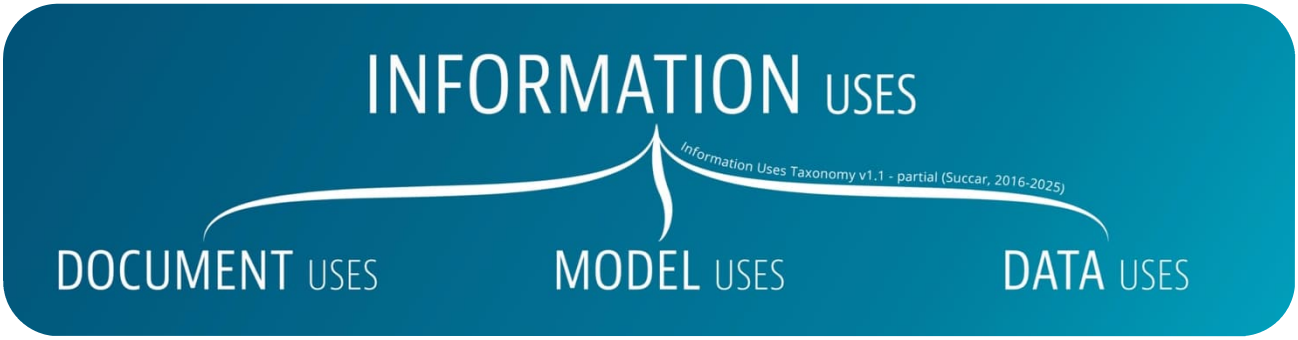
Dictionary Items (DI)s represent the common terms, and their descriptions and translations as needed to ensure accurate BIM maturity assessment. These are typically derived from the Online Browsing Platform (OBP) by the International Standards Organization or from formalized online glossaries similar to the International BIM Dictionary. Dictionary Items are typically embedded into the other modular components to ensure uniformity when conducting BIMmas activities at scale.

3.2.4 Information uses

Information Uses refer to the various applications of data generated, shared, and managed during the lifecycle of a project or asset to achieve specific objectives. These uses encompass tasks such as design visualization, construction planning, facility management, and performance analysis, translating project requirements into actionable outcomes. Information Uses are grouped into **Model Uses**, **Document Uses**, and **Data Uses**, each representing a branch of a broader taxonomy that structures information into purposeful and measurable deliverables. These will be introduced separately and later combined in the Maturity Profiles (jump forward).

[4] Based on the BIMe Initiative Knowledge Blocks. Please refer to 102in BIMe Initiative Knowledge Structures https://bimexcellence.org/102in

Figure 3. Information Uses - types



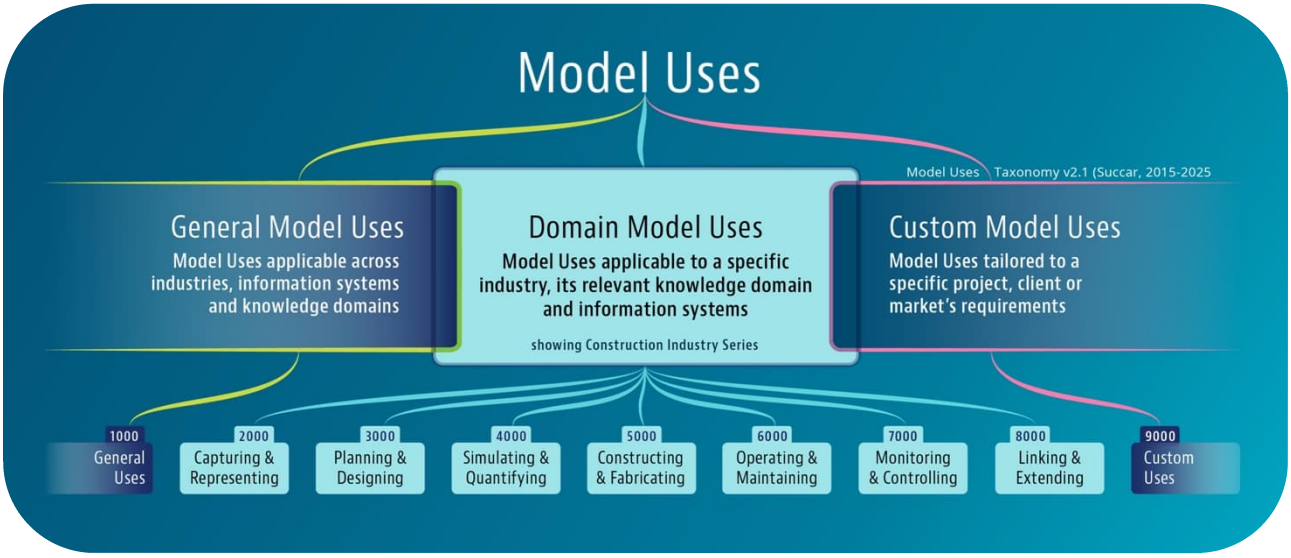
3.2.4.1 Model uses

Model Uses are the intended or expected project deliverables that result from **generating, collaborating on, and linking 3D models to external databases**. In essence, they represent the specific purposes for which a 3D digital model is created and utilized. When viewed from a performance management lens, Model Uses are **containers of activities** that, when successfully completed, result in an expected output or desired outcome. For instance, the Model Use "Clash Detection" would involve a series of activities such as establishing the responsibility for conducting clash detection, determining the software and methods to be used, and generating and communicating a clash detection report. Model Uses can **facilitate communication between project stakeholders**, enable efficient procurement, simplify performance assessment, and accelerate performance improvement. Model Uses can also **bridge semantic gaps** between different industries and information systems by providing a uniform language for describing model-based deliverables. When described in detail using, Model Uses can **identify information requirements, human competences, digital tools, and applicable methods** to deliver pre-defined outcomes.

There are three main types of Model Uses – general, domain specific and custom. **General Model Uses** (MU 1000s) are applicable across various industries and information systems. Examples include Forensic Modelling, Security Systems Modelling and Terrain Modelling. **Domain Model Uses** [5] (MU2000s - MU8000s) are industry-specific similar to Construction Planning, Clash Detection, and Construction Waste Management. Finally, **Custom Model Uses** (MU 9000s) are tailored to specific project requirements, combining general and domain Model Uses. Examples include modelling of a floating sculpture with a wave-powered signal beacon, or modelling ventilation systems for a space station.

[5] Model Uses are not limited to Building Information Modelling (BIM) and can be applied to other model-based information systems, similar to Geographic Information Systems (GIS) and Product Lifecycle Management (PLM).

Figure 4. Model Use Categories



3.2.4.2 Model uses table

Table 2. Model Uses Table

Series Description + MUs within Series
2000s Series: Capturing and Representing
2010 2D Documentation
2020 3D Detailing
2030 As-constructed Representation
2040 Generative Design
2050 Laser Scanning
2060 Photogrammetry
2070 Record Keeping
2080 Surveying
2090 Visual Communication
3000s Series: Planning and Designing
3010 Conceptualization
3020 Construction Planning
3030 Demolition Planning
3040 Design Authoring
3050 Disaster Planning
3060 Lean Process Analysis
3070 Lift Planning
3080 Operations Planning
3090 Selection and Specification
3100 Space Programming
3110 Urban Planning
3120 Value Analysis
4000s Series: Simulating and Quantifying
4010 Accessibility Analysis
4020 Acoustic Analysis
4030 Augmented Reality Simulation
4040 Clash Detection (and avoidance)
4050 Code Checking & Validation
4060 Constructability Analysis
4065 Construction Operation Analysis
4070 Cost Estimation
4080 Egress and Ingress
4090 Energy Utilisation (replaces Energy Use)
4100 Finite Element Analysis
4110 Fire and Smoke Simulation
4120 Lighting Analysis
4130 Quantity Take-off
4140 Reflectivity Analysis
4150 Risk and Hazard Assessment
4160 Safety Analysis
4170 Security Analysis
4180 Site Analysis
4190 Solar Analysis
4200 Spatial Analysis
4210 Structural Analysis
4220 Sustainability Analysis
4230 Thermal Analysis
4240 Virtual Reality Simulation
4250 Life Cycle Assessment
4260 Wind Studies
5000s Series: Constructing and Fabricating
5010 3D Printing
5020 Architectural Modules Prefabrication
5030 Casework Prefabrication
5040 Concrete Precasting
5050 Construction Logistics
5055 Construction Waste Management
5060 Mechanical Assemblies Prefabrication
5070 Sheet Metal Forming
5080 Site Set-outs
6000s Series: Operating and Maintaining
6010 Asset Maintenance
6020 Asset Procurement
6030 Asset Tracking
6040 Building Inspection

Series Description + MUs within Series
6050 Handover and Commissioning
6060 Relocation Management
6070 Space Management
7000s Series: Monitoring and Controlling
7010 Building Automation
7020 Field BIM
7030 Performance Monitoring
7040 Real-time Utilization
7050 Structural Health Monitoring

Series Description + MUs within Series
8000s Series: Linking and Extending
8010 BIM/Spec Linking
8020 BIM/ERP Linking
8030 BIM/FM Integration
8040 BIM/GIS Overlapping
8050 BIM/IOT Interfacing
8060 BIM/PLM Overlapping
8070 BIM/Web-services Extension
8080 BIM/ePermits Extension

3.2.4.2.1 Note on model use stacks

Model Use Stacks are combinations of interconnected Model Uses where the same 3D digital model can be used to deliver many uses. For example, even a simple 3D model developed to represent a single-story house can be used to derive 2D Documentation (MU2010), Cost Estimation (MU4070) and Solar Studies (MU4190). Another example of Model Use Stacks is a Digital Twin which may combine many Model Uses including Asset Maintenance (MU6010), Asset Tracking (MU6030), BIM/IOT Interfacing (MU8050).

3.2.4.3 Document uses

Document Uses refer to the intended or expected project deliverables from developing and exchanging information through digital or digitalized documents (e.g. Master Plan Drawing or Minutes of Meeting). Document Uses include a variety of categories and types, each intended to satisfy specific information representation or exchange needs.

Document Use Series (DU 100s - DU800s) cover general documentation (e.g. agendas, forms, matrices), visualizations (e.g., drawings, images, videos), guidance documents (e.g. manuals, policies, standards), legal documents (e.g. contracts, regulations), and investigative materials (e.g. surveys, assessments) – please refer to **Table 3**:

3.2.4.3.1 Document Uses Table

Table 3. Document Uses Table

Series Description + DUs within Series
100 General Document Use: Documents for basic administrative, informational, or functional purposes
101 Agenda
102 Memorandum
103 Bulletin
104 Note
105 Comment
106 Notice
107 Form
108 Template
109 Sheet
110 Table
111 Matrix
112 Chart
113 Sketch
114 Instruction
115 Invoice
116 Order
117 Requisition
118 Scope of Works
119 Estimate
120 Schedule/List
121 Ticket
200 Visualisations: Visual representations of data or concepts, including maps, drawings, and animations
201 Drawing
202 Map
203 Image
204 Illustration
205 Presentation
206 Board
207 Audio
208 Video
209 Animation
210 Game
300 Guidance: Documents providing instructions, frameworks, or standards for processes or systems
301 Guide
302 Manual
303 Strategy
304 Policy
305 Plan
306 Specification
307 Protocol
308 Programme
309 Framework
310 Standard
311 Code
400 Offerings: Documents related to proposals, bids, and offers for projects or services
401 Offer
402 Proposal
403 Submission
500 Legalities: Legally binding documents defining obligations, agreements, or regulations
501 Contract
502 Agreement
503 Ruling
504 Regulation
505 Legislation
600 Testaments: Official attestations, records, or assurances of quality or compliance
601 Certificate
602 Warranty
603 Bond
604 Permit
605 Guarantee
606 Statement
607 Report
608 Case Study
609 Record
610 Register
611 Log
612 Results
700 Communications: Documents facilitating interpersonal or inter-organizational communication
701 Message
702 Letter
703 Email
800 Investigations: Documents created for research, analysis, or testing purposes
801 Survey
802 Assessment
803 Test
804 Query
802 Assessment
803 Test
804 Query

The Document Uses list is derived from multiple sources including (Aðalsteinsson, 2014), (Adeline Zhu Teng, Atiq & Monty, 2018), (Cavka, Staub-French & Poirier, 2017), and (Fallon & Palmer, 2006).

3.2.5 Data uses

Data Use is "the intended or expected digital deliverable from using code to connect project tasks (e.g. a design task and a fabrication task). An example Data Use (dU) is Fabrication Scripting, the ability/desire to drive a cutting, milling or sintering equipment using scripts triggered from within the BIM Software Tool.

The Data Uses Series (dU10s – dU60s) organizes digital deliverables into 6 series: **Core Data Connections** (Series 10) covers fundamental scripting tasks like data extraction, conversion, and task automation. **Analytical Data Uses** (Series 20) covers advanced analysis, simulation, and optimization workflows. **Design and Visualization Integration** (Series 30) connects design outputs with visualization and AR/VR/MR applications. **Fabrication and Manufacturing Integration** (Series 40) connects design to fabrication processes, including robotic control and 3D printing. **Operational and Lifecycle Data Uses** (Series 50) covers maintenance, asset tracking, and lifecycle costing. Finally, **Specialized and Emerging Data Uses** (Series 60) covers innovative applications like digital twin integration, AI training, and custom workflows. The full Data Uses List is provided below:

3.2.5.1 Data uses table

Table 4. Data Uses Table

Series Description + dUs within Series
10 Core Data Connections: Fundamental uses that connect project tasks through basic scripting or automation
11 Fabrication Scripting
12 Data Extraction
13 Data Conversion
14 Task Automation
15 Data Mapping
20 Analytical Data Uses: Focused on using code to analyze, simulate, or optimize tasks
21 Structural Analysis Scripting
22 Energy Analysis Integration
23 Geospatial Data Linking
24 Optimization Scripting
25 Construction Sequencing Scripting
30 Design and Visualization Integration: Connecting design outputs to advanced visualization or AR/VR workflows.
31 Parametric Design Scripting
32 Visualization Integration
33 AR/VR Data Integration
34 Custom Visualization Scripting

Series Description + dUs within Series s (cont'd)
40 Fabrication and Manufacturing Integration: Connecting design to fabrication or manufacturing processes
41 Custom Fabrication Data Generation
42 Robotic Control Scripting
43 Material Quantity Scripting
44 3D Printing Integration
45 Off-Site Prefabrication Scripting
50 Operational and Lifecycle Data Uses: Focused on connecting tasks across the operational lifecycle of assets
51 Maintenance Scheduling Scripting
52 Asset Tracking Integration
53 Lifecycle Costing Scripting
54 Operational Performance Integration
55 Decommissioning Planning
60 Specialized and Emerging Data Uses: Advanced or niche applications of scripting to connect cutting-edge technologies or workflows
61 Digital Twin Integration
62 Blockchain Data Applications
63 AI Model Training
64 Autonomous System Integration
65 Custom Workflow Development

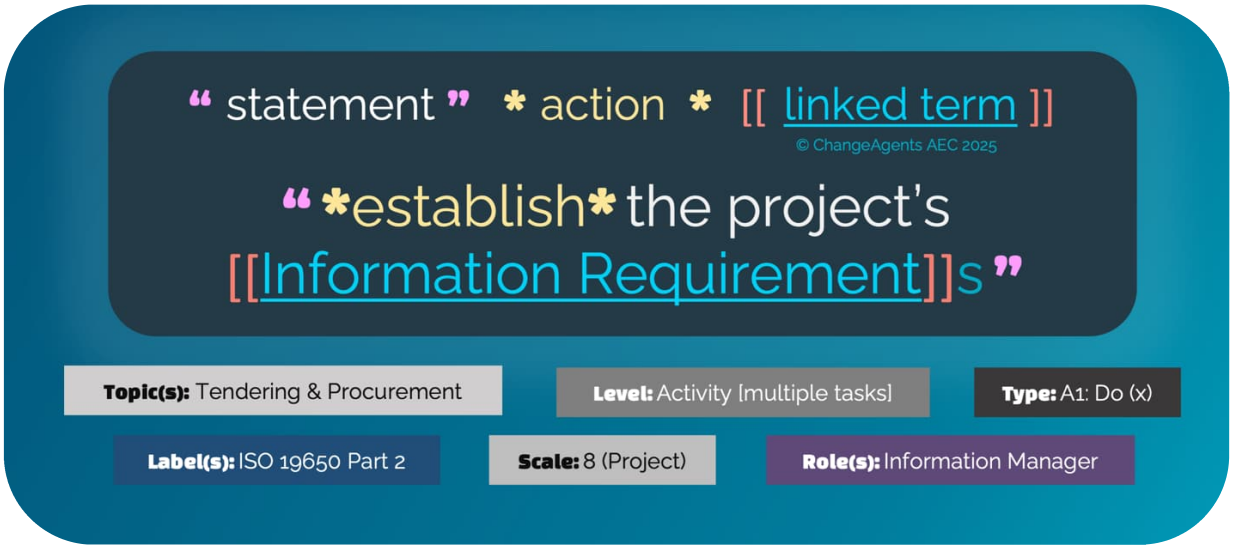
3.2.6 Action statements

Action Statements are structured sentences that *defines* an activity, output or outcome within a specific context. Action Statements have a formalized structure that starts with an **Action** (a *verb* from a *defined* list) and may include one or more *defined* terms derived from the International BIM Dictionary or similar online sources. Action Statements have a defined topology derived from an **Action Statements Taxonomy** with 17 types in 3 categories and can be further organized using label sets.

3.2.6.1 Understanding action statements

Action Statements are *structured sentences* that define activities, outputs, or outcomes within a specific context. They serve as reusable elements in structured assessments, workflows, and learning outcome lists. Each Action Statement begins with a verb selected from a predefined taxonomy, followed by terms derived from international standards (e.g. ISO 19650) and formalized sources such as the International BIM Dictionary.

Figure 5. Action Statement - configuration and labels



Action Statements are categorized into three main types: **Activity Statements** (AS) define actions or processes to be performed, such as "Establish the delivery team’s mobilization plan." **Enquiry Statements** focus on gathering or confirming information, for instance, "Identify the assets for which information shall be managed." **Capability Statements** evaluate abilities or competencies, such as "Determine if (x) is capable of doing (y)." When collated into a database, each Action Statement category can be enriched with metadata that specifies applicable Organizational Scales, Defined Roles, or Project Lifecycle Phases [see all Activity Statement types in **Table 5**].

Table 5. Activity Statement Types

Type Category	Type Code	Type Expression	Example Statement Type Use	Sample Action Statement
Enquiry (E)	E1	Establish if (x) is available	Verifying compliance with local building regulations	Establish if the BIM model meets regulatory compliance
	E2	Identify (x)	Mapping key stakeholders for collaboration and data sharing	Identify the primary stakeholders for project collaboration
	E3	Provide information about (x)	Communicating delivery timelines for BIM submissions	Provide information about model delivery milestones
	E4	Clarify (x)	Establishing required data points for operational and maintenance phases	Clarify the data requirements for asset lifecycle management
	E5	Confirm (x)	Ensuring that software and tools used by different teams can exchange data seamlessly	Confirm the interoperability of BIM tools within the project
	E6	Determine if (x) meets condition (y)	Assessing green building standards compliance	Determine if the proposed design supports sustainability goals

Type Category	Type Code	Type Expression	Example Statement Type Use	Sample Action Statement
Capability (C)	C1	Determine if (x) is capable of (y)	Evaluating the technical ability of a team to manage complex 3D BIM models	Determine if the project team is capable of managing federated models
	C2	Rate the capability of (x)	Measuring BIM maturity levels using standard metrics	Rate the organization's BIM adoption maturity
	C3	Test if (x) can adhere to (y)	Conducting assessments on compliance with established protocols	Test the team's ability to adhere to model management protocols
	C4	Establish the qualifications of (x)	Ensuring that the BIM Coordinator has necessary certifications and experience	Establish the qualifications of the BIM Coordinator
	C5	Benchmark (x) against (y)	Comparing project KPIs with benchmarks from industry or similar organizations	Benchmark project performance metrics against industry standards
Activity (A)	A1	Do (x)	Performing QA/QC processes on models prior to key project deadlines	Do a BIM quality check before project milestone delivery
	A2	Aggregate (x) into (y)	Combining architectural, structural, and MEP models for coordination purposes	Aggregate multiple models into a federated model
	A3	Learn (x)	Training team members to detect and resolve clashes in multi-disciplinary BIM models	Learn the use of specialized BIM tools for clash detection
	A4	Simulate (x)	Running thermal simulations to optimize energy efficiency in design	Simulate the thermal performance of the building model
	A5	Compare (x) to (y)	Using tools to identify updates or modifications in different iterations of the BIM model	Compare model versions to detect design changes
	A6	Define (x)	Drafting a comprehensive BEP to guide project workflows and ensure alignment with client and regulatory goals	Define the organization's BIM Execution Plan

The structure of Action Statements allows their easy generation, update and reuse as each AS begins with a verb (e.g. "Establish," "Verify," "Identify") that indicates the intended action, followed by an object that defines what is being addressed.

Table 6. Action Statements - Examples

Action Statement	Statement Type(s)	Defined Role(s)	ISO Reference [other]	Organizational Scale(s)	Maturity Topics - Labels*
Develop a national framework for BIM adoption	A6	Government Agencies, Policy Makers	N/A [National Guidelines]	Market	M03 Strategic Planning, M04 Organizational Management, M05 Business Development and Client Management
Establish cross-industry collaboration on BIM standards	A6	Standards Organizations, Industry Leaders	N/A [National Guidelines]	Market	F02 Collaboration, M06 Partnership and Alliancing, R07 Industry Engagement and Knowledge Sharing
Assess the BIM maturity of national infrastructure projects	C1	Research Organizations, Academic Institutions	N/A [National Guidelines]	Market	A03 Performance Management, F04 Project Management, R06 Research and Analysis
Establish the project's information requirements	A1	Information Manager	ISO 19650-2:2-1.2	Project	A06 Tendering and Procurement, F02 Collaboration, A09 Quality Management

Action Statement	Statement Type(s)	Defined Role(s)	ISO Reference [other]	Organizational Scale(s)	Maturity Topics - Labels*
Identify the assets for which information shall be managed	E2	Asset Manager	ISO 19650-3:3-1.3	Project	O06 Operating and Maintaining, A09 Quality Management, T09 Data Management
Rate the capability of the project delivery team	C2	Project Manager	ISO 19650-2:2-4.1	Project	A03 Performance Management, F05 Team and Workflow Management, A09 Quality Management
Define the project's shared information environment	A6	Information Manager	ISO 19650-3:3-1.5	Project	F02 Collaboration, T08 Document Management, T09 Data Management
Identify the foreseeable trigger events for which information shall be managed	E2	Risk Manager	ISO 19650-3:3-1.5	Project	A08 Risk Management, A09 Quality Management, T09 Data Management
Verify compliance of the information model	A1	Quality Assurance Lead	ISO 19650-2:2-5.1	Project, Organization	A09 Quality Management, T07 Model Management, T05 Documentation
Provide information about project information delivery milestones	E3	Scheduler	ISO 19650-2:2-1.4	Project, Organization	F04 Project Management, A06 Tendering and Procurement, F02 Collaboration
Clarify the roles and responsibilities of the project team	A6	Human Resources Lead	ISO 19650-2:2-1.6	Project, Organization	A04 Human Resource Management, F05 Team and Workflow Management, M02 Leadership
Develop a BIM implementation strategy for organizational projects	A6	BIM Manager	N/A [Typical Implementation Plans]	Organization	M03 Strategic Planning, I01 Implementation Fundamentals, A03 Performance Management
Conduct a BIM capability assessment for the organization	A1	BIM Consultant	N/A [Typical Performance Assessment Plans]	Organization	A03 Performance Management, F05 Team and Workflow Management, M04 Organizational Management
Define the organization's BIM training and development plan	A6	HR Manager, BIM Manager	N/A [Typical Implementation Plans]	Organization	A04 Human Resource Management, I05 Technical Training, M05 Business Development
Prepare a 3D model for construction scheduling	A1	3D Modeller	N/A [Typical Project Activity Sheet]	Individual	T04 Modelling, T09 Data Management, O03 Planning and Designing
Use a federated model to conduct egress and ingress simulations	A1	Simulation Specialist	N/A [Typical Project Activity Sheet]	Individual	O04 Simulating and Quantifying, T07 Model Management, O09 Custom Modelling
Maintain BIM models using the organization's protocols	A1	BIM Coordinator	N/A [Typical Project Activity Sheet]	Individual	T07 Model Management, A09 Quality Management, O06 Operating and Maintaining

*Maturity Topics are derived from the 201in Competency Table (BIMei, 2019) – https://BIMexcellence.org/201in (note: any purposeful and structured taxonomy can be used as Action Statement Labels)

3.2.6.2 Application in BIM maturity assessment and improvement

Action Statements enable generating of Maturity Profiles necessary for assessing and improving BIM maturity of Defined Roles (discussed in later **sections**).

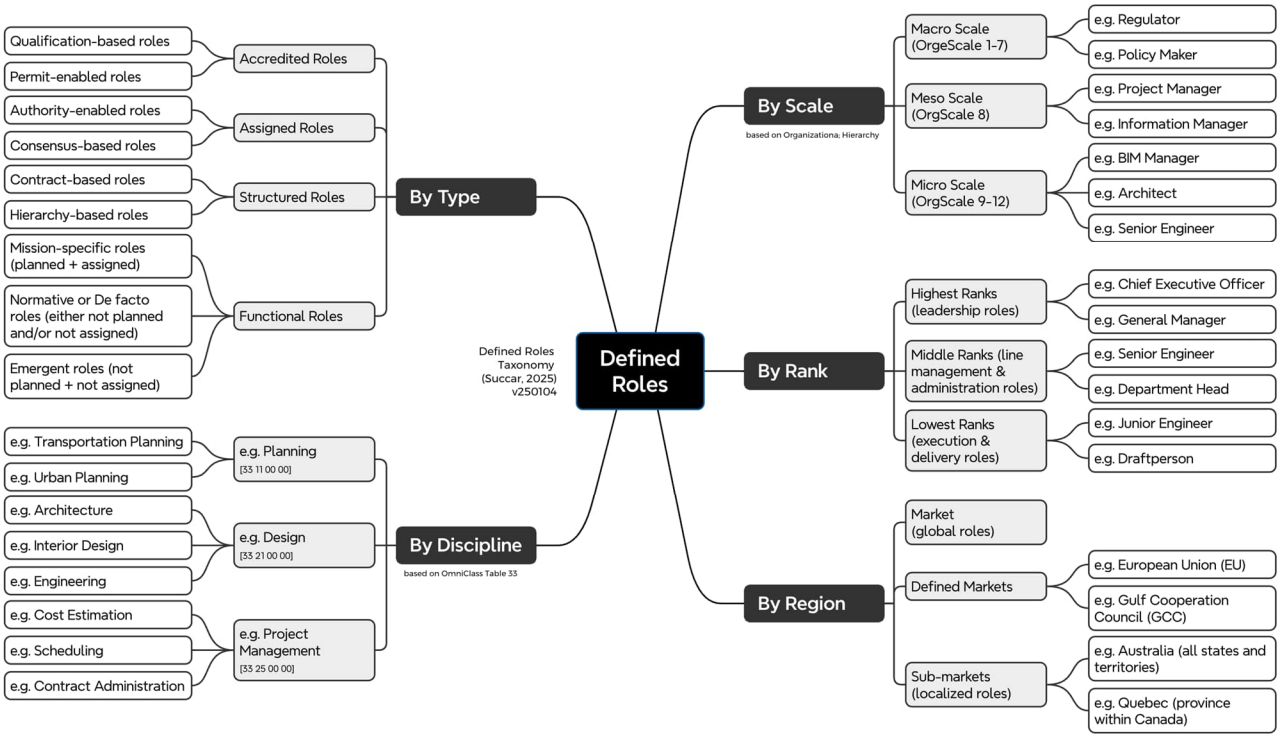
In *maturity assessment scenarios*, they provide a formalized language to describe desired or achieved abilities across organizational scales, from individuals and organizations to project teams and whole markets. For instance, an Enquiry Statement like "Determine if (x) meets condition (y)" can be used to assess whether a team or project complies with specified information management criteria.

In *maturity improvement efforts*, Action Statements support targeted interventions by identifying and directing actions required to address gaps. For example, "Establish the delivery team's mobilization plan" and "Establish the project's reference information and shared resources" can be part of an actions list for teams to effectively prepare for project initiation. Other Action Statements such as "Rate the competence of (x)" can provide insights that inform training and recruitment plans.

3.2.6.3 Defined roles

Defined Roles (DRs) are clearly delineated responsibilities or functions assigned to *individuals* or *organizations* operating within project environments or across whole markets. Defining the roles of these entities allow assigning them specific BIM maturity assessment targets and delivering tailored BIM maturity improvement efforts. Roles are defined according to a *taxonomy with five dimensions*: **Role Scale, Role Type, Role Scale, Role Rank, Role Discipline,** and **Role Region**.

Figure 6. Defined Roles Taxonomy



Role Scale

This dimension categorizes Defined Roles based on the Organizational Scale introduced in Section 2:
At the **market scale**, many institutions have Defined Roles - such as policymakers, regulators, research councils, and educators – which influence overall BIM maturity through the development of industry-wide standards, publishing national guides and facilitating collaboration across regions and sectors.
At the **project scale**, there are many Defined Roles – e.g. Information Manage and Project Manager – which play a critical role in integrated BIM/digital tools into project workflows and outcomes.
At an **organization scale**, commonly Defined Roles such as BIM Manager and BIM Trainer drive BIM implementation efforts and the gradual progression toward higher levels of BIM maturity.
At the **individual scale**, many Defined Roles such as Model Authors, Data Analysts, and Training Specialists contribute to the execution of digitalization tasks and the achievement of digitally enabled project objectives.

Role Type

This dimension classifies roles based on how they are defined and assigned.
Accredited roles require formal certification or qualifications, such as Licensed Engineers.
Assigned roles are defined by contractual or organizational mandates, such as Information Managers.
Structured roles are created to address planned tasks or hierarchical needs, like BIM Managers.
Functional roles are emergent or informal, evolving based on project or organizational requirements, such as Change Managers.
Permit-enabled roles are tied to specific authorizations, such as Compliance Officers.

Role Rank
This dimension organizes roles into three levels:
Highest Ranks include leadership roles such as CEOs or Taskforce Leaders who focus on strategic decision-making and governance.
Middle Ranks include line management roles, such as Department Heads and Senior Engineers, who oversee the implementation of strategies and manage teams.
Lower Ranks include delivery and execution roles similar to Model Authors and Draftspersons who are responsible for operational tasks and contributing directly to deliverables.

Role Discipline
This dimension aligns roles with specific areas of expertise or professional practice. Examples include **Policy and Regulation** (e.g., Standards Developers), **Design** (e.g., Architects), **Engineering** (e.g., Structural Engineers), **Planning** (e.g., Urban Planners), and **Project Management** (e.g., Cost Estimators). [Note: Role Discipline is based on OmniClass Table 33].

Role Region
This dimension identifies the geographic or jurisdictional scope of roles which include:
Global Roles similar to the International Standards Organizations and buildingSMART International who provide overall guidance leading to improved BIM maturity.
Defined market roles such as the National Research Centre in Canada which encourages BIM adoption and develops roadmaps for national BIM maturity assessment and improvement efforts.
Sub-market roles similar to Groupe BIM du Quebec, buildingSMART Canada and other key regional players who conduct targeted BIM maturity assessment and improvement activities.

3.2.6.4 Defined roles across dimensions

The below matrix (**Table 7**) clarifies how these dimensions are used in defining sample roles:

Table 7. Defined Roles Across Dimensions

Example Role	Scale	Type	Rank	Discipline	Region	Description
Regulator	Macro	Assigned	Leadership	Policy/Regulation	Global	Responsible for developing and enforcing BIM standards, policies, and compliance frameworks across industries
Policy Maker	Macro	Structured	Leadership	Policy/Regulation	Defined Markets (e.g., Canada)	Defines market-level BIM adoption strategies and develops national or regional BIM frameworks
Compliance Officer	Macro	Permit-Enabled	Middle	Regulation	Defined Markets	Ensures that BIM processes comply with local, national, or global legal and regulatory requirements
Standards Developer	Macro	Assigned	Leadership	Policy/Standards	Global	Contributes to the creation of global BIM standards (e.g., ISO, buildingSMART)
Information Manager	Meso	Assigned	Middle	Project Management	Defined Markets	Manages the Common Data Environment (CDE) and ensures adherence to project-specific BIM standards
Project Manager	Meso	Assigned	Middle	Project Management	Defined Markets	Oversees BIM deliverables and their integration into project workflows and schedules
Change Manager	Meso	Functional	Middle	Management	Defined Markets	Facilitates transitions in BIM adoption by addressing organizational or project-specific challenges

Example Role	Scale	Type	Rank	Discipline	Region	Description
Cost Estimator	Meso	Structured	Execution	Project Management	Defined Markets	Uses BIM tools to generate cost estimates and align them with project budgets
Scheduler	Meso	Structured	Execution	Project Management	Defined Markets	Develops and maintains project schedules by integrating BIM deliverables into timelines
Urban Planner	Meso	Structured	Middle	Planning	Defined Markets	Integrates BIM tools into urban planning projects, supporting long-term development strategies
BIM Manager	Micro	Structured	Middle	Organization-wide	Sub-Market (e.g., Quebec)	Develops and implements organizational BIM strategies, aligning them with national or regional frameworks
Senior Engineer	Micro	Structured	Middle	Engineering	Sub-Market	Supervises technical BIM-related work and ensures model accuracy and adherence to standards
Model Author	Micro	Functional	Execution	Design	Sub-Market	Creates and updates BIM models based on project requirements and organizational workflows
Draftsperson	Micro	Functional	Execution	Design	Sub-Market	Converts technical data and models into accurate drawings and documentation for construction teams
Architect	Micro	Accredited	Execution	Design	Sub-Market	Develops architectural designs within BIM environments, ensuring compliance with project standards
Data Analyst	Micro	Functional	Execution	Engineering/Data	Sub-Market	Analyzes BIM data to provide insights on performance, sustainability, or project metrics
Training Specialist	Micro	Functional	Middle	Education	Sub-Market	Designs and delivers BIM training programs to enhance organizational and individual competencies

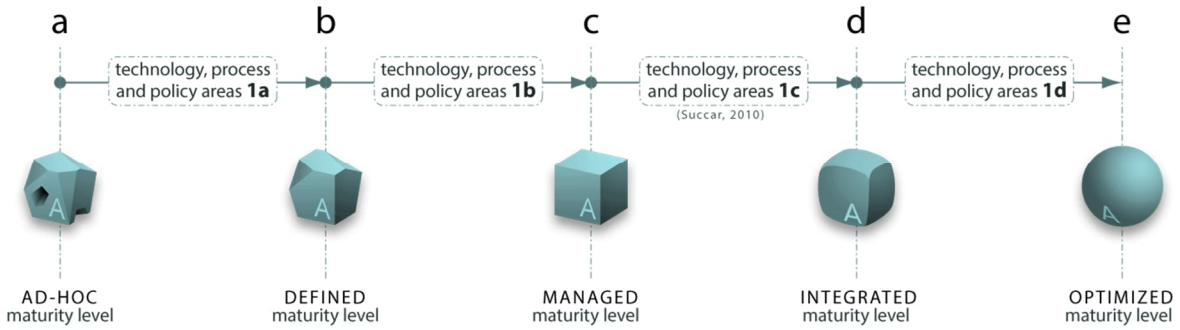
3.2.7 BIM maturity indices

This section introduces three key indices needed for developing and delivering BIM maturity assessment and improvement efforts at scale: the **BIM Maturity Index** measures progress from basic, unstructured practices to fully optimized implementations; the **Granularity Index** dictates the depth of assessment, from high-level reviews to comprehensive audits; and the **Evidence Index** defines how rigorously these maturity claims are verified, ranging from self-declared evidence to expert-led verification. Each index is clarified further below:

3.2.7.1 Maturity index

This report adapts previous research to deliver a unified **BIM Maturity Index** (BIMMI) capable of spanning market, project, and organizational levels (**Figure 7**) (Succar 2010).

Figure 7. BIM Maturity Index - shown at Capability Stage 1



The BIMMI includes 5 **Maturity Levels**:

Initial/Ad-hoc (Level a)
This level is characterized by sporadic, champion-driven BIM usage with little top-level support or overarching vision. Processes, data exchange protocols, and performance improvement efforts are typically uncoordinated.

Defined (Level b)
This level reflects basic documentation of BIM processes, formalized (but not always enforced) standards, and a growing recognition of BIM's business opportunities. Performance improvement efforts and workflow guides are available, though practice remains inconsistent.

Managed (Level c)
Maturity at this level includes structured plans, performance metrics, and clearly assigned functional roles. Through managed efforts - by a human manager, AI agent or a management system - BIM processes and protocols are institutionalized and integrated it into decision-making and enable more predictable project outcomes and competitive advantages.

Integrated (Level d)
At this level, BIM/digital ways of working become the core of strategic planning and is integrated into broader organizational and project governance systems. Efficiency gains come from well-synchronized systems and deliverables (that reached Maturity Level c), advanced collaboration approaches, and calibrated standards.

Optimized (Level e)
This level represents continuous innovation, real-time policy updates, cyclical process improvements, and the ability to embrace new technologies swiftly. BIM and its affiliated technologies, processes and policies become deeply embedded within organizational practices, resulting in repeatable, cutting-edge outcomes.

The progression from lower to higher levels of BIM Maturity indicates (i) better control through minimizing variations between targets and actual results, (ii) better predictability and forecasting by lowering variability in performance and costs and (iii) greater effectiveness in reaching defined goals and setting new more ambitious ones (Lockamy & McCormack, 2004) (McCormack, Ladeira, & Oliveira, 2008).

3.2.7.2 Granularity index

This report adapts previous research to deliver a simplified Granularity Index (Succar, 2014) that provides a simplified framework for assessing BIM maturity by categorizing the depth of detail into three **Granularity Levels** (GLevels):

GLevel 1: Discovery
This initial level focuses on exploring BIM adoption and readiness. It involves broad, high-level analysis to identify patterns, gaps, and opportunities in BIM implementation. Discovery is suitable for preliminary assessments where detail is minimal, enabling stakeholders to understand general trends without delving into specifics.

GLevel 2: Evaluation
At this intermediate level, structured assessments provide detailed insights into organizational or project maturity. Evaluation focuses on measurable criteria to gauge BIM capabilities and processes, identifying strengths and areas for improvement. This level is ideal for organizations seeking to benchmark their maturity against industry standards or to prepare for higher levels of conformance.

GLevel 3: Auditing
The highest level of granularity, auditing entails a comprehensive and formal analysis of BIM maturity. It requires extensive detail and evidentiary support to verify advanced practices, lifecycle integration, and adherence to established standards such as ISO 19650. Auditing is designed for organizations aiming to demonstrate high-level conformance and achieve certification or recognition for their BIM capabilities.

The three GLevels offer flexibility in assessing BIM maturity and developing BIM maturity improvement tools. They reflect progressively deeper insights and greater specificity as needed to allow more scalable and context-sensitive assessment and improvement efforts.

3.2.7.3 Evidence index

The **Level of Evidence** (LoE) index establishes the robustness and reliability of claims regarding BIM maturity. When an LoE level is decided at the start of BIM maturity assessment activities, it informs the process of requesting, inspecting and *validating* BIM maturity artefacts (e.g. BIM Execution Plan, Training Guide or similar). There are 5 Levels of Evidence that range from no substantiation required to the need to conduct a thorough expert-led audit:

LoE 0: No Claim of maturity
This baseline level involves no assertion of BIM maturity, indicating an absence of data or evidence to review.

LoE 1: Claimed Maturity without evidence
At this level, maturity is self-claimed by an entity without providing any corroborating artefacts or demonstrating claimed activities or outcomes. This level depends entirely on declarations made by the assessed party.

LoE 2: Exhibited Maturity with artefacts or demonstrated activities, outputs or outcomes
This level involves presenting artefacts such as 3D models as evidence of BIM maturity or demonstrating the successful completion of an activity (e.g. 3D modeling for a specific Model Use) or delivering the

expected outcome (e.g. a Case Study describing the process of modeling and delivering the 3D model according to Model Use). However, this evidence is not subjected to inspection, and their validity remains unverified.

LoE 3: Inspected Maturity without expert verification
This level entails a general review of artefacts, activities and outputs to ensure they are relevant and current. Inspection is typically conducted by the assessing party collecting the data and not necessarily by the relevant experts in each BIM maturity area and the validity of these activities, outputs or outcome remains unverified.

LoE 4: Audited Maturity with expert verification
This is the highest level of evidence that entails a comprehensive audit conducted by domain experts, specialists in each BIM maturity area being assessed. It involves a detailed *verification* of each artefact (output), the activities leading to the output and whether the desired outcome has been achieved.

The LoE index adds structure and differentiation between assessment efforts based on their rigour and ability to verify assessment results. If an LoE is set, it influences what assessment questions are posed, whether artefacts are demanded as part of submitting answers, and whether/how/by whom these artefacts are inspected and analyzed. This is important when developing BIM maturity assessments at scale where – typically – generalized organization- and market- scale assessments are conducted at LoE 1 or LoE 2, while more detailed project-scale assessments require LoE 3 or LoE 4 as a basis to make informed BIM maturity improvement efforts.

3.2.8 BIM maturity profiles

BIM Maturity Profiles (MP)s encapsulate current and desired states of BIM maturity for organizations, projects and whole markets. There are two types of MPs:

Current Maturity Profiles (CMP)s
CMPs are established through assessment and describe the current abilities of an entity by detailing maturity level for each assessed area. For example, a small Engineering Design Firm may have achieved a *Managed Level (level c)* of BIM maturity for maturity topics A, B and C but only an *Ad-hoc Level (level a)* for maturity topics X, Y and Z.

Target Maturity Profiles (TMP)s
TMPs are established by specialists to describe the aspiration levels of a BIM maturity for an entity. These TMPs are set at *minimum acceptable* Maturity Levels for key maturity areas by a specified point of time. For example, the TMP for a small Engineering Design Firm may be a *Managed Level (level c)* across BIM maturity topics A, B, X and Y.

By comparing TMPs to CMPs, the BIM Maturity Gaps (BMG)s can be discovered and well-defined. In this example of the Engineering Design Firm, the BMGs are for topics X and Y which - are currently at *maturity level a* but- need to be elevated through BIM maturity improvement efforts to *maturity level c* to meet the minimum requirements.

3.2.8.1 Sample BIM maturity profile

The section provides a simplified BIM maturity profile (MP) for a medium sized engineering firm. The profile can be represented through a document/template that clarifies the Defined Purpose and intended maturity targets, or as a matrix that highlights the maturity *targets* for each maturity area (**Table 8**).

Table 8. Sample Maturity Matrix with highlighted maturity targets

Sample Maturity Areas	Ad hoc level a	Defined level b	Managed level c	Integrated level d	Optimized level e
Governance and Strategy	No formal governance structures; inconsistent or absent BIM Execution Plans (BEPs)	BEPs established across major projects; governance structures formalized	Standardized governance frameworks implemented organization-wide	Governance outcomes monitored and adapted dynamically across projects	Automated governance systems ensure continuous improvement and scalability
Data and Information Management	Data management is limited to basic file storage with no standards or conventions	Common Data Environment (CDE) partially implemented; naming conventions applied	Fully operational CDE with standardized metadata and data validation processes	Data management processes measured and optimized; real-time audits conducted	Predictive analytics employed for real-time data management and error resolution
Technology Integration and Interoperability	Basic tools used in isolation; no integration with other systems	Adoption of interoperable tools with limited integration across systems	Interoperable systems integrated; workflows established for cross-system interaction	Advanced technology integration enabling seamless collaboration	Fully automated systems drive innovation and continuous integration
Competency and Training Development	No structured training or competency assessment programs in place	Initial training programs introduced; competencies evaluated sporadically	Structured training programs rolled out with periodic evaluations	Competency assessments conducted biannually with training refined accordingly	Real-time competency dashboards used for adaptive learning and performance tracking
Role definition	Roles for BIM processes are unclear; responsibilities are undefined	Roles are assigned based on project phases and BIM-specific tasks	Standardized documentation defines roles and responsibilities across projects	Role-specific workflows and accountability measures are integrated into BIM delivery	Performance optimization tools enhance role-based efficiency and accountability
Sustainability and Lifecycle Integration	Sustainability considerations are absent; no processes for lifecycle management	Sustainability goals outlined; early-stage energy modelling applied	Lifecycle efficiency embedded in BIM workflows; energy modelling and analysis expanded	Comprehensive lifecycle management integrated with Digital Twin workflows	Advanced Digital Twin capabilities enable ongoing optimization of asset performance
Model Uses	Model uses are not identified; stakeholders lack clarity on deliverables	Model uses are documented for specific project phases and client requirements	Workflows are standardized to deliver model uses with assigned responsibilities	Validation processes ensure consistency and alignment of model uses across projects	Advanced analytics and tools optimize model use delivery and integration into processes

These maturity targets – shown uniformly at levels c and d in **Table 8** - can then be isolated into a *Target Maturity Profile* (TMP) expressed using Action Statements:

Governance and Strategy

AS1c - Managed Level: *Standardize* governance frameworks across the organization to align BIM practices
AS1d - Integrated Level: *Monitor* governance outcomes across projects to adapt strategies dynamically based on performance data
AS2c - Managed Level: *Apply* and enforce BIM Execution Plans (BEPs) consistently across all projects
AS2d - Integrated Level: *Refine* governance structures using insights gained from project-level feedback

Data and Information Management

AS3c - Managed Level: *Operate* a fully functional Common Data Environment (CDE) with standardized metadata and validation protocols
AS3d - Integrated Level: *Measure* and improve data management processes through real-time audits and validation
AS4c - Managed Level: *Monitor* data processes regularly and improve accuracy through established validation procedures
AS4d - Integrated Level: *Establish* continuous improvement protocols to ensure data accuracy and quality throughout project lifecycles

Technology Integration and Interoperability

AS5c - Managed Level: *Integrate* interoperable systems and develop workflows to facilitate smooth interactions between platforms
AS5d - Integrated Level: *Apply* advanced integration technologies to support smooth collaboration across platforms and stakeholders
AS6c - Managed Level: *Maintain* systems to support collaboration between disciplines and teams in real-time
AS6d - Integrated Level: *Enhance* information sharing through tools that allow real-time updates and streamlined workflows

Competency and Training Development

AS7c - Managed Level: *Develop* and implement structured training programs for all relevant roles within the organization
AS7d - Integrated Level: *Conduct* biannual competency assessments to identify skill gaps & adjust training initiatives accordingly
AS8c - Managed Level: *Conduct* regular evaluations to measure competencies and adapt training programs as needed
AS8d - Integrated Level: *Refine* Continuously refine training programs based on performance metrics and evolving organizational needs

Role Definition

AS13c - Managed Level: *Document* and assign Defined Roles for BIM processes with clear responsibilities
AS13d - Integrated Level: *Integrate* Defined Roles with respective BIM delivery processes
AS14c - Managed Level: *Manage* the responsibilities for each Defined Role using a centralized system
AS14d - Integrated Level: *Connect* each Defined Roles with recruitment, induction and training programs

Note: “Defined Roles” can be expanded to be more specific to Information Managers, Senior Engineers and similar.

Sustainability and Lifecycle Integration

AS9c - Managed Level: *Incorporate* lifecycle efficiency measures into BIM workflows, including energy modelling and cost analysis
AS9d - Integrated Level: *Integrate* Fully integrate lifecycle management processes into BIM workflows to ensure seamless transitions from design to operations
AS10c - Managed Level: *Expand* the use of sustainability-focused practices during the design and construction phases
AS10d - Integrated Level: *Implement* Digital Twin workflows to support decision-making and monitor asset performance throughout its lifecycle

Model Uses

AS11c - Managed Level: *Identify* and document the required Model Uses for each project phase to meet client and stakeholder objectives
AS11d - Integrated Level: *Standardize* Model Uses across projects to align with organizational goals and enhance consistency
AS12c - Managed Level: *Develop* workflows for delivering Model Uses with clear responsibilities and data exchange protocols
AS12d - Integrated Level: *Implement* automated processes to validate and track the delivery of Model Uses throughout project phases

Note: “Model Uses” can be replaced with specific MUs from the MU List as to match the organization’s discipline and project types. A similar set of Action Statements can be generated for Document Uses and Data Uses.

These *sample* Action Statements can then be used to populate an online survey to conduct assessments - Action Statements can be easily transformed into questions (Succar et al., 2013), transformed into a simple checklist to communicate maturity targets, or expanded into BIM maturity improvement plans to organize and monitor performance improvement activities.

3.2.8.2 BIM maturity tools

BIM Maturity Tools are online and offline instruments used for assessment, analysis and/or improvement. There are two main types:

Maturity Assessment Tools (MATs)
BIM Maturity Assessment Tools include online or offline tools, static or interactive tools, self-directed or 3rd-party-administered tools that can be selected and set according to Established Purposes. These tools range from document-based matrices intended for workshops within organizations to assess their current BIM maturity through to highly specialised web platforms more suitable for large scale multi-cycle benchmarking efforts. Samples of these tools are provided in Section 6.

Maturity Improvement Tools (MITs)
BIM Maturity Improvement Tools include a variety of templates and guides intended to assist industry stakeholders to improve their digital abilities from ad-hoc/defined levels to more managed and integrated levels (refer back to the BIM Maturity Index) in a structured manner. For an exploration of such tools that can be developed as part of this project, please refer to Section 5.

MATs and MITs are complementary as MATs measure current BIM maturity while MITs guide the structured advancement of that maturity, enabling organizations, supply chains and whole markets to continuously assess and improve their digital capabilities.

3.3 Results

The **Establishing Results** part completes the methodological approach by comparing actual outcomes against intended outcomes (Purposes). This involves the mechanisms necessary to evaluate any discrepancy between the two and refining the Measuring and Improving Method (the five components) to ensure better alignment. These mechanisms include comparing the evolution of performance through iterative *benchmarks* and *feedback loops*.

3.3.1 Benchmarks

Benchmarks provide the data points to compare entity X's BIM Maturity to other entities or to a predefined maturity level. For this to be achieved, the benchmark must have an adequate level of data – in terms of quantity, relevance and recency - to enable meaningful comparisons. Once these comparisons are made, an entity can develop its own BIM Maturity Improvement Plans, execute these plans, and then – upon completing another wave of assessment - return to confirm any marked improvements. As opposed to comparative studies which are limited in scope and usefulness at scale, it is not enough to compare entity X's to entity Y based on common attributes but to a large number of relevant entities to reliably establish BIM Maturity Gaps. Once these gaps are identified, they can be closed through sustained BIM performance improvement efforts.

3.3.2 Feedback loops

Also, by continuously comparing **Established Results** with **Intended Purposes** through a cyclical process - e.g. comparing the *intent to improve standardization* with a*ctual levels of standardization* at the start and end of each BIM maturity assessment and improvement cycle - the project can self-correct and refine the **Measuring and Improving Method**. This is achieved by:

- Iteratively refining the maturity areas, language and tools based on stakeholder feedback (as highlighted in the "Roadmap" section).
- Ensuring the BIM **Target Maturity Profiles** remain adaptable to the evolving needs of varied industry stakeholders across the Canadian Construction Industry.
- Regularly updating what should be considered as **BIM Maturity Gaps** as to reflect innovative new tools, emerging best practices and industry standards.

By integrating cyclical benchmarking, comparative analysis, and iterative feedback loops, the Assessment and Improvement Methodology offers a robust and responsive foundation for conducting BIM maturity assessment and performance improvement at scale.

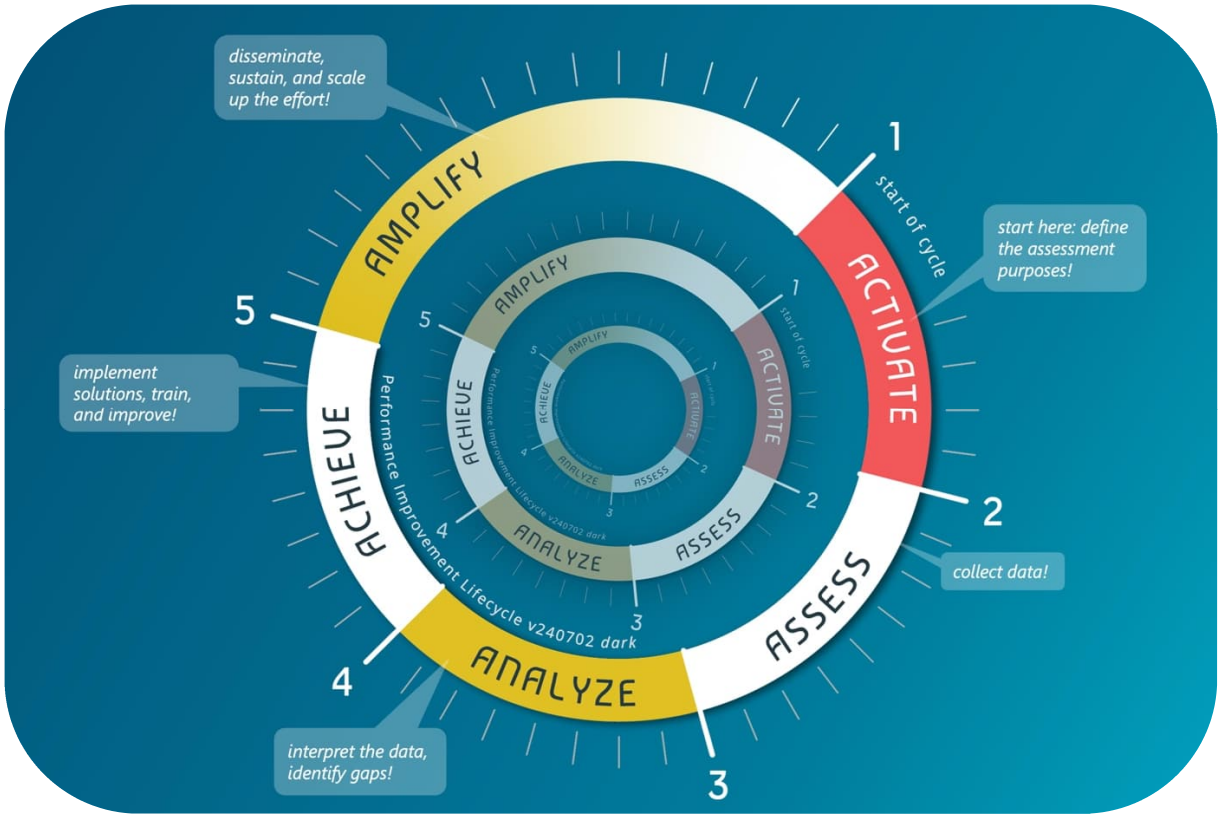
4 BIM Maturity Assessment at Scale

BIM maturity assessments and improvement efforts will be conducted over a long period and may include a variety of specialized players – assessors, researchers, educators and policy makers. To maintain uniformity, this report introduced a unified methodology to conduct these activities (refer back to Section 3) at different organizational scales, levels of detail and levels of evidence. To endure further uniformity without sacrificing flexibility, this section introduces a recommended **Assessment to Improvement Flow** and a **Scaling Strategy** to expand these efforts to gradually cover different jurisdictions.

4.1 Assessment to improvement flow

BIM maturity activities – from **assessment to improvement** - flow over *multiple cycles* according to CA's **Performance Improvement Lifecycle**[6] model. Each cycle has five phases - activate, assess, analyze, achieve and amplify (**Figure 8**):

Figure 8. Performance Improvement Lifecycle - model



[6] The Performance Assessment Lifecycle from assessor.io is provided by ChangeAgents AEC pty ltd (Australia) to NRC for their non-exclusive in this Project use under a *Creative Commons Attribution Non-commercial Share-alike 4.0 International* license (CC BY-NC-SA 4.0). Any use or reuse is allowed for education and research purposes and will be governed by this license.

These five stages detailed below are used in the BIM maturity assessment and improvement roadmap in Section 5:

4.1.1 Activate

The **Activate** phase initiates the BIM maturity assessment cycle by clearly aligning the **Purposes** of the assessment, which define the broader objectives and intended outcomes for BIM maturity assessment and improvement. These purposes may include advancing digital efficiency, achieving sustainability targets, or complying with national or industry standards (refer back to Section 3). This phase encompasses several critical activities, starting with the development of **Target Maturity Profile(s)** at the appropriate level of detail and deciding on the **Scaling Strategy** for subsequent cycles. These profiles reflect the relevant maturity topics and desired maturity levels and developed using the **maturity language** - composed of **Information Use**, **Action Statements** and **Defined** Roles - to suit the specific organizational scale(s), discipline(s), region(s), or project type(s) being targeted. Additionally, the phase establishes the privacy and confidentiality policies necessary to safeguard sensitive data and crafting a communication strategy to effectively engage stakeholders. Once these foundational elements are in place, the phase concludes by preparing the assessment materials, including the questions, answer sets, and scoring frameworks, while also developing or customizing the tool for capturing assessment data. The selected tool must align with the defined **Purposes**, **Target Maturity Profile(s)**, and the most effective engagement strategy for the targeted population.

4.1.2 Assess

The **Assess** phase focuses on collecting data from the targeted population to support the broader objectives of this cycle of the BIM maturity assessment and improvement effort. In this phase, one or more assessment campaigns are launched using the tool(s) identified in the previous phase. These tools may include surveys, structured interviews, interactive workshops, or a combination tailored to the desired **Granularity Level** and **Level of Evidence**. Follow-up activities are part of this phase to ensure reaching the desired participation levels, addressing any feedback received, and achieving completeness or reaching data saturation. Once the campaigns are concluded, the collected data is systematically compiled and organized, preparing it for the analytical efforts in the subsequent phase.

4.1.3 Analyze

The **Analyze** phase focuses on processing and interpreting the data collected during the Assessment phase to derive meaningful insights. It begins with data validation to ensure accuracy, consistency and reliability, addressing any gaps or anomalies identified during the review. Once validated, the data is analyzed in alignment with the **Established Purposes** (e.g., generating benchmarks and comparative metrics) to contextualize findings within the targeted region or across the broader Canadian industry. **BIM Maturity Gaps** are identified, and key insights are distilled to provide a data-rich foundation for actionable recommendations aimed at advancing BIM maturity. Typical outputs of this phase include comprehensive reports, presentations and interactive dashboards, tailored to meet the needs of industry stakeholders and facilitate informed decision-making.

4.1.4 Achieve

The **Achieve** phase transforms the actionable recommendations from the previous phase into concrete BIM maturity improvement initiatives. These efforts focus on addressing the identified **BIM Maturity Gaps** and advancing the maturity levels of the targeted entities. Key activities in this phase—aligned with the **Established Purposes**—include developing BIM implementation plans tailored to the specific needs of each stakeholder. These plans may involve updating workflows, adopting advanced technologies, and revising information management frameworks. Depending on the scale of the organizations or projects targeted, this phase may also incorporate collaborative mechanisms to improve alignment and shared accountability among supply chain participants and across the broader market. Such mechanisms often include developing and integrating industry best practices, standardizing processes (e.g., aligning with ISO 19650), and establishing continuous feedback loops to monitor progress against defined benchmarks. Typical outputs of the **Achieve** phase encompass a range of BIM maturity improvement activities. These are designed to enhance digital efficiency, elevate maturity levels from *ad-hoc* or *defined* tiers to higher levels, and strengthen overall digital competitiveness within the industry.

4.1.5 Amplify

The **Amplify** phase focuses on sustaining and scaling the improvements achieved in earlier phases, driving continuous advancement in BIM maturity across targeted entities and the broader industry. This phase transitions from isolated initiatives to systemic transformations, embedding lessons learned and successful practices into ongoing processes while promoting their widespread adoption among stakeholders. Key activities in this phase include documenting and disseminating best practices, employing feedback loops to refine strategies, and expanding the scope of maturity efforts—guided by the **Scaling Strategy** defined during the **Activate** phase—to encompass new regions, disciplines, or organizational scales. Stakeholders are encouraged to build on prior successes by identifying opportunities to further integrate enhanced workflows, technologies, and standards within their operations and across supply chains. To maximize the impact of these efforts, the **Amplify** phase often involves the development and deployment of knowledge-sharing mechanisms, such as **BIM maturity hubs**, industry workshops, self-assessment templates, and benchmarking tools. Typical outcomes of this phase include the broader adoption of standardized BIM practices and the establishment of a culture of continuous improvement, ultimately leading to stepwise industry-wide transformation and sustained digital competitiveness.

In summary, the five phases of the **Performance Improvement Lifecycle** offer a structured framework for assessing and enhancing BIM maturity across iterative cycles. This approach integrates feedback loops that refine processes and facilitate the effective execution of the **Scaling Strategy** in subsequent iterations and across the whole Project.

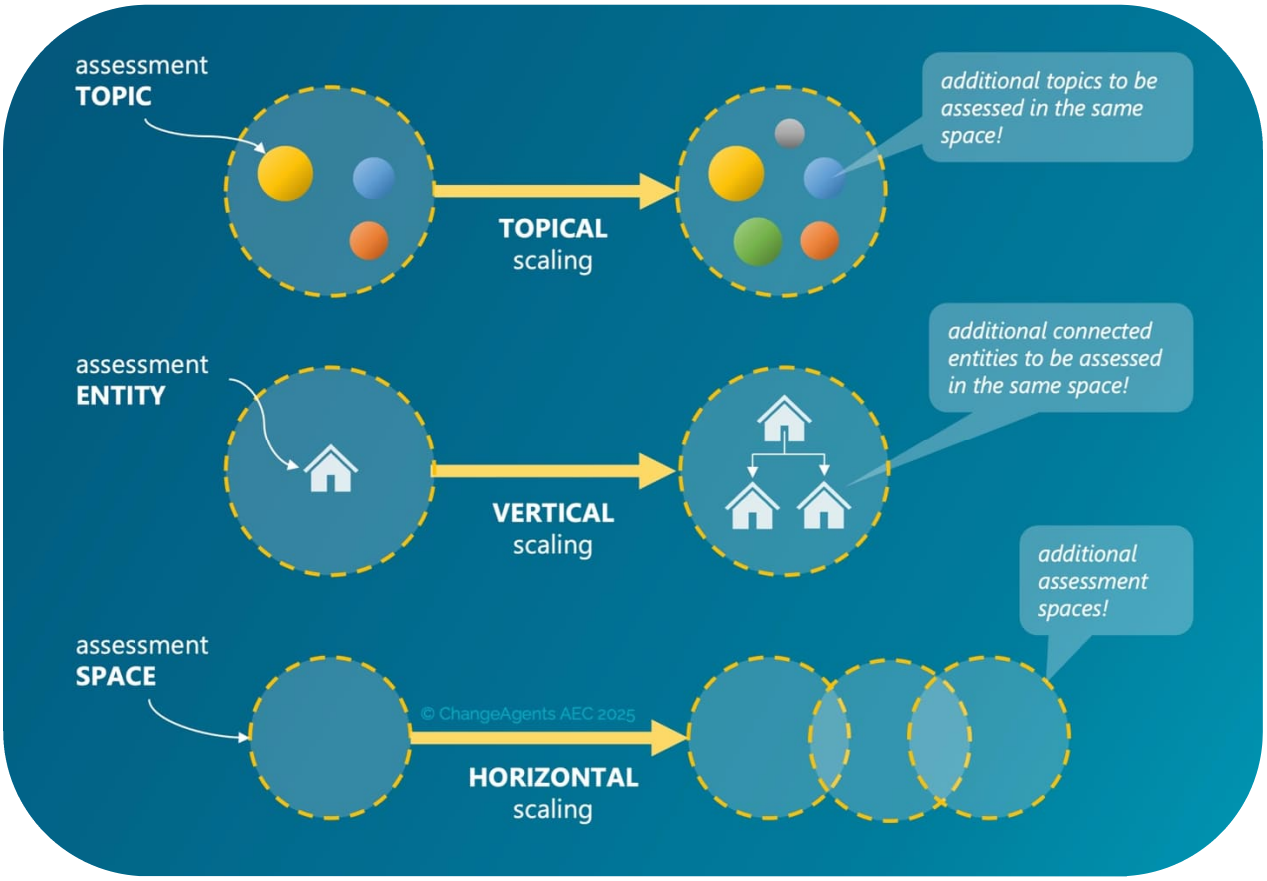
4.2 Scaling strategy

To positively impact the Canadian Construction Industry, BIM maturity assessment and improvement efforts must be holistic with a wide coverage of topics, organization sizes/types and geographical regions. Achieving measurable impacts requires a structured approach to *scale up* these efforts carefully and cost-effectively to include a representative group of industry stakeholders across organizational sizes and disciplines.

4.2.1 Scaling tactics

From an initial starting point [a completed assessment at any scale], assessments can be scaled using one or more scaling tactics (**Figure 9**):

Figure 9. Assessment Scaling Tactics



The scaling tactics are detailed below:

Horizontal scaling
Horizontal scaling refers to the increase in *coverage width* to include more disciplines, larger populations and additional geographical locations. For example, after conducting BIM maturity assessments in one region, or covering one discipline or one type/size of projects, the data collection efforts is expanded (scaled-up) to include multiple regions, disciplines, or project types/sizes.

Vertical scaling
Vertical scaling refers to the increase in *coverage depth* to include additional parts (parent or child concepts within a hierarchy) that were not initially covered. For example, a BIM maturity assessment of supply chains (each as a single unit) is later expanded to include BIM maturity assessments of all member organizations within the supply chain. This typically expands the focus of assessment from project performance to also include organizational systems and individual competences.

Topical scaling
Topical scaling refers to expansion in topic scopes from a wide coverage at low detail to narrow focus at high detail[7]. For example, the first BIM maturity assessment wave may focus on overall BIM adoption challenges across the whole market, the second wave on technology implementation challenges faced by design teams, and the third on openBIM information exchange challenges by mechanical subcontractors.

Adaptive scaling
Adaptive or responsive scaling refers to an *agile* method (Neto and Moura, 2023) (Gonzalez-Aleu et al., 2024) that responds to assessment results and feedback received from industry stakeholders to modify the features of a BIM maturity assessment and improvement program. As opposed to a fixed adaptive scaling strategy, adaptive scaling is flexible, iterative and collaborative and more capable of responding effectively to changing conditions or requirements. This is particularly important as the BIM maturity at scale project may span multiple years and will cover numerous regions with its own linguistic and legislative requirements.

4.2.2 Scaling considerations

When conducting BIM maturity assessments and improvements activities across different jurisdictions, the following need to be considered:

Policy actions
Mandates and other *policy actions* (Succar and Kassem, 2015) by federal, provincial and municipal bodies affect BIM diffusion and need to be considered in developing scalable BIM maturity assessment materials. When these policy actions are taken into consideration, BIM maturity assessments may need to be done separately for each province and municipality based on these actions (e.g. assess regions *with* mandates as one group, and those *without* as another group).

Diffusion dynamics
When developing BIM maturity assessment and improvement materials, the influence of larger organizations (e.g. General Contractors) on the BIM maturity of dependent entities (e.g. specialty contractors) need to be taken into consideration. That is, where *middle-out diffusion dynamics* (Succar and Kassem, 2015) are prevalent due to the presence of dominant players (e.g. the design and delivery of hydroelectric dams typically have one potential client within a region), then the sequence of assessments need to shift to conducting BIM maturity assessments of whole supply-chains rather than on assessing individual organizations within these chains.

Performance assurance models, standards, classifications and codes
When developing BIM maturity assessment and improvement materials, the applicability of specific accreditation regimes, standards and other BIM-related classifications and codes need to be taken into consideration. The effect of this consideration would be in the choice of BIM maturity topics to be included or excluded in BIM maturity assessment and improvement materials.

[7] Content Scaling corresponds to Scoping and Conceptual Lenses within the BIM Framework (Succar, 2009.

Public procurement models
When developing BIM assessment and improvement materials for use across provinces, the common /uncommon use of traditional or collaborative contracts, and the availability of e-permitting systems, need to be taken into consideration. When considered, BIM maturity assessment and performance improvement materials need to account for these procurement models due to their significant impact on BIM diffusion, model-based collaboration and both organization- and project- scale BIM/digital maturity.

4.2.3 Scaling challenges

Scaling up BIM maturity assessments presents a number of challenges that need to be carefully navigated. As the scope expands, the **volume of data** collected increases significantly causing potential delays in generating timely reports. This challenge can be addressed by dynamically reporting results through a dedicated hub rather than using a more manual approach to collect, analyze and report assessment results. Another key challenge is **data privacy and security** that must be safeguarded. This can be achieved by minimizing the collection of sensitive data and then adopting a robust **data governance framework** with adequate measures to protect private information. The framework needs to address compliance with federal data protection regulations and – as collected data may be released for publications through academic research, the framework must have provisions to comply with university ethics standards**.** This typically includes securing informed consent from participants and adhering to ethical guidelines for data collection, use and dissemination.

Scaling also adds a degree of **complexity** as assessments would target and attract diverse participants across asset scales and project types. To address this and manage data heterogeneity, assessment efforts need to be uniform with a degree of standardized data collection and analysis methods. This will be expressed through the use of a modular assessment language (jump back) and the adoption of a controlled number of complementary tools. Such uniformity would not only simplify the data collection efforts but would minimize data **inconsistency** that would hinder comparisons across different regions, disciplines and organizations.

Another challenge is managing **project cost**. Committing to assessing and improving BIM maturity at scale requires substantial human and financial resources. To mitigate some of these costs, it is important to adopt cost-effective data collection methods, automated data analysis flows and engaging industry stakeholders to actively contribute to this project, not as participants, but as active members of BIM maturity assessment and improvement efforts (discussed in Section 5).

5 BIM Maturity Improvement at Scale

In this section, BIM maturity improvement is discussed in the context of organizations and whole markets. This is followed by a list of potential tools and initiatives this Project may deliver during Roadmap Stage 3.

5.1 What does BIM maturity improvement look like?

Enhancing BIM maturity complements BIM maturity assessment and justifies the allocation of effort and resources to generate benchmarks and identify performance gaps. Upon determining how an organization's BIM maturity compares to best practices and receiving the corresponding evaluation, the subsequent logical step is to implement measures to improve or sustain performance, thereby ensuring a competitive advantage.

Before discussing potential actions and BIM maturity improvement projects, two examples are provided to illustrate how heightened BIM maturity can manifest within organizations and across markets.

5.1.1 Within organizations

Within organizations, improving BIM maturity translates to (a) introducing new technical capabilities, (b) adding structure to existing workflows, (b) strengthening management processes covering information exchange, training, etc., (c) integrating interdependent parts of the business, and (e) continuously refining the control mechanisms to improve consistency, quality and predictability.

In more detail, an organization with high BIM maturity demonstrates strong integration of digital technologies, processes and policies across relevant Project Lifecycle Phases. It has well-defined workflows and guidelines that ensure deep collaboration among team members and centralized management of project information through Common Information Environments (Succar and Poirier, 2020). Such an organization adopts applicable BIM standards and practices to improve data consistency, interoperability and quality. It emphasizes process optimization through data-rich models to reduce risks, improve communication and enrich information deliverables. Teams within this organization are proficient in the latest digital tools and methodologies and embrace a culture of open collaboration and process innovation. The organization continuously monitors and improves its own processes through feedback loops and acts as a change agent within the project teams it takes part in. In summary, an organization with high levels of BIM maturity is efficient, collaborative and maintain a competitive edge in the industry.

5.1.2 Across markets

Across market, improving BIM maturity translates to an increase in information-rich collaboration and more integrated systems across bridging all asset lifecycle phases. As a market reaches higher levels of BIM maturity, the construction industry starts operating as an efficient information ecosystem characterized by information-rich collaborative flows and integrated systems, enabled by reliable networks, interoperable and affordable technologies and uniform standards providing low-friction, AI-supported data generation, exchange and management. In BIM mature market, stakeholders across the supply and demand chains —

including architects, engineers, contractors, suppliers, owners, facility managers, insurers and regulators—contribute to and benefit from unified information flows that not only represent digital and physical assets in functional detail, but also accurately simulate the design, delivery, operations, refurbishment and the eventual demolition or adaptive reuse. Public frameworks – from prequalification to e-permits - and private contracts use open standards and integrated platforms that allow data fluidly across asset lifecycles. A BIM mature market has robust educational and training programs that integrate digital-by-default principles into their curricula and rely on modularized competency frameworks that allow professionals across disciplines to continually assess, improve and certify their abilities against well-established and dynamically updated benchmarks. Equally important, government-led policies and accreditation bodies harmonize with international best practices, facilitating a transparent, well-structured environment that encourages innovation, automation, integration, interoperability, sustainability, and risk reduction. As a result, and through a combination of mature digitalization efforts and the adoption of truly modern methods of construction, project timelines and costs become more predictable, and built assets are increasing better aligned with the wishes and needs of their users over increasingly extended lifespans.

While such scenarios are *optimistic*, they are definable, realizable, measurable and thus attemptable through well-organized, sustained and incentivized efforts based on tested performance improvement frameworks, methodologies and tools.

5.2 BIM maturity improvement projects

To improve BIM maturity at scale, a series of resources and activities are needed. These can be developed and delivered as a series of independent and interdependent projects including – not in order of priority:

1. Information Management Templates
2. Interactive Self-Assessment Tools
3. BIM Maturity Dashboard
4. BIM Improvement Guides
5. Common Information Environments
6. BIM Hub or portal
7. BIM e-permitting portals
8. Instructional Tools and Learning Materials
9. Legal and Contractual Resources
10. Cost and Benefit Analysis Tools
11. BIM Standards and Protocols
12. Continuous Professional Development (CPD) programs
13. BIM Maturity Assistance programs
14. Learning Outcome Frameworks
15. Functional Role Matrix
16. Model Uses Navigator
17. BIM Maturity Benchmarking Data
18. BIM Maturity Certification Regime
19. BIM Maturity Report

Project 1

Title: Information Management Templates
Description: Develop standardized templates to enhance uniformity and efficiency in information exchanges across the Canadian Construction Industry. This includes templates for Employer's Information Requirements (EIR), Asset Information Requirements (AIR), and Organisational Information Requirements (OIR).
Main Activities:
Develop and validate templates aligned with ISO 19650 standards.
Conduct workshops to adapt templates for diverse Canadian construction projects.
Pilot the templates across representative projects to gather feedback.
Dependencies:
Requires outputs from "BIM Standards and Protocols" (Project 11).
Benefits from "BIM Improvement Guides" (Project 4) to ensure usability.
Needed Resources:
Subject matter experts in ISO 19650 and Canadian construction standards.
Software tools for template design and testing.
Access to pilot projects for testing.
Alignment: Fully aligns with NRC's digitalization goals and ISO 19650 requirements for structured information management.
Labels: [Information Management / Standards]
Timeframe: Short-term

Project 2

Title: Interactive Self-Assessment Tools
Description: Create digital tools enabling organizations to self-assess their BIM maturity levels using frameworks like the BIM Maturity Matrix. These tools should provide actionable feedback and benchmarking capabilities.
Main Activities:
Develop a digital platform for self-assessment.
Integrate the BIM Maturity Matrix into the tool's framework.
Test usability and refine based on feedback from Canadian industry stakeholders.

Dependencies:
Requires data from "BIM Maturity Benchmarking Data" (Project 17).
Benefits from "BIM Maturity Dashboard" (Project 3) for integration.
Needed Resources:
Software development teams with expertise in UX/UI.
Access to BIM maturity datasets for benchmarking.
Experts to ensure alignment with Canadian-specific BIM requirements.
Alignment: Supports NRC's productivity improvement initiatives by nurturing self-driven BIM maturity improvements.
Labels: [Performance Assessment / Tools]
Timeframe: Medium-term

Project 3

Title: BIM Maturity Dashboard
Description: Develop an online dashboard that allows Canadian organizations to anonymously compare their BIM maturity against industry benchmarks and identify improvement opportunities.
Main Activities:
Design and implement a secure online platform.
Aggregate anonymized BIM maturity data from Canadian stakeholders.
Provide visualization and reporting tools for comparative analysis.
Dependencies:
Relies on data from "BIM Maturity Benchmarking Data" (Project 17).
Requires integration with "Interactive Self-Assessment Tools" (Project 2).
Needed Resources:
Data analysts to structure and manage benchmarking data.
Cloud infrastructure for secure data handling.
Visualization experts for user-friendly dashboards.
Alignment: Enhances transparency and competitiveness within the Canadian construction industry, aligning with NRC and ISO 19650.
Labels: [Performance Assessment / Visualization]
Timeframe: Medium-term

Project 4

Title: BIM Improvement Guides
Description: Publish guides that provide step-by-step instructions for Canadian organizations to improve their BIM maturity. These guides should be practical and tailored to varying organizational scales and capacities.

Main Activities:
Research common barriers to BIM maturity in Canada.
Develop improvement guides addressing these barriers.
Distribute guides widely and gather feedback for iterative updates.
Dependencies:
Draws insights from "BIM Maturity Reports" (Project 19).
Aligns with "Legal and Contractual Resources" (Project 9) to address compliance issues.
Needed Resources:
Industry experts to contribute best practices.
Designers for clear and engaging guide layouts.
Channels for distribution (digital and print).
Alignment: Directly supports NRC's digital transformation agenda by equipping organizations with actionable resources.
Labels: [Performance Improvement / Learning]
Timeframe: Short-term

Project 5

Title: Common Information Environments (CIEs)
Description: Develop and promote the adoption of Common Data Environments (CDEs) across Canada to enable collaborative information exchange and improve project outcomes.
Main Activities:
Identify barriers to CDE adoption in Canadian construction.
Develop a Canadian-specific implementation framework for CDEs.
Pilot CDEs in projects of varying scales.
Dependencies:
Informed by "Information Management Templates" (Project 1).
Benefits from insights in "BIM Standards and Protocols" (Project 11).
Needed Resources:
IT infrastructure and software for CDE deployment.
Collaboration with technology vendors.
Training materials for stakeholders.
Alignment: Facilitates collaborative workflows and aligns with NRC's productivity and decarbonization goals.
Labels: [Collaboration / Information Exchange]
Timeframe: Long-term

Project 6

Title: BIM Hub or Portal
Description: Establish an online hub to collate and share resources, tools, and case studies relevant to BIM maturity improvement within the Canadian Construction Industry.
Main Activities:
Design and deploy an interactive online portal.
Populate the portal with curated content, including best practices, standards, and success stories.
Promote the portal through industry events and partnerships.
Dependencies:
Requires content from "BIM Improvement Guides" (Project 4).
Benefits from "Instructional Tools and Learning Materials" (Project 8).
Needed Resources:
Web development team for portal creation.
Content management experts for maintaining resource quality.
Industry contributors for case studies and insights.
Alignment: Supports NRC's digital transformation goals by acting as a central repository for BIM resources.
Labels: [Collaboration / Knowledge Sharing]
Timeframe: Medium-term

Project 7

Title: BIM e-Permitting Portals
Description: Develop digital portals for municipalities to streamline permit applications and approvals through BIM-enabled submissions, improving efficiency and transparency.
Main Activities:
Research current permitting workflows and identify inefficiencies.
Design BIM-compatible submission frameworks.
Pilot e-permitting portals in selected municipalities.
Dependencies:
Informed by "Legal and Contractual Resources" (Project 10).
Benefits from "Common Information Environments" (Project 5).
Needed Resources:
Municipal partnerships for pilot testing.
Software developers specializing in e-permitting systems.
Training programs for municipal staff.

Alignment: Aligns with NRC's productivity improvement agenda by digitizing a critical regulatory process.
Labels: [Collaboration / Digital Processes]
Timeframe: Long-term

Project 8

Title: Instructional Tools and Learning Materials
Description: Develop standardized teaching materials and tools to promote uniform BIM education across Canadian academic and professional training programs.
Main Activities:
Collaborate with academic institutions and industry bodies to design curricula.
Develop online and offline training resources.
Host workshops to train educators and trainers.
Dependencies:
Aligns with "Learning Outcome Frameworks" (Project 14).
Benefits from "BIM Improvement Guides" (Project 4).
Needed Resources:
Academic experts to design curricula.
Multimedia designers for engaging content creation.
Training platforms for material distribution.
Alignment: Contributes to NRC's goal of building digital capacity within the industry.
Labels: [Learning / Capacity Building]
Timeframe: Medium-term

Project 9

Title: Legal and Contractual Resources
Description: Develop resources to address legal and contractual challenges related to BIM implementation, focusing on enabling seamless information exchange and reducing disputes.
Main Activities:
Analyse common legal barriers and contract issues in Canadian BIM projects.
Develop standard contract clauses for BIM-enabled projects.
Provide guidance on dispute resolution mechanisms.
Dependencies:
Informed by "Information Management Templates" (Project 1).
Benefits from "BIM Improvement Guides" (Project 4).
Needed Resources:
Legal experts with BIM knowledge.
Collaboration with industry associations and legal institutions.
Reference cases from Canadian BIM projects.
Alignment: Aligns with NRC's goals of encouraging collaboration and reducing legal risks in the construction industry.
Labels: [Collaboration / Legal Frameworks]
Timeframe: Medium-term

Project 10

Title: Cost and Benefit Analysis Tools
Description: Create tools to evaluate the financial and operational impacts of BIM implementation, helping organizations to understand and justify investments in BIM.
Main Activities:
Develop a framework for cost-benefit analysis tailored to Canadian projects.
Design an interactive tool for financial modelling.
Validate the tool through pilot projects and industry feedback.
Dependencies:
Requires data from "BIM Maturity Benchmarking Data" (Project 17).
Benefits from "BIM Improvement Guides" (Project 4).
Needed Resources:
Economists and data analysts.
Software developers for tool creation.
Pilot projects for validation.
Alignment: Supports NRC's initiatives by providing evidence-based insights for BIM adoption.
Labels: [Performance Assessment / Financial Modelling]
Timeframe: Medium-term

Project 11

Title: BIM Standards and Protocols
Description: Develop and disseminate national standards and protocols for BIM adoption, ensuring consistency and interoperability across Canadian projects.
Main Activities:
Review international standards and adapt them to Canadian needs.
Collaborate with industry stakeholders to ensure buy-in.
Publish and promote standards and protocols.

Dependencies:
Directly informs "Information Management Templates" (Project 1).
Benefits from insights in "Legal and Contractual Resources" (Project 9).
Needed Resources:
Standards development committees.
Collaboration with buildingSMART Canada.
Funding for stakeholder engagement.
Alignment: Aligns with ISO 19650 and NRC's goals of standardizing BIM practices.
Labels: [Information Management / Standards]
Timeframe: Long-term

Project 12

Title: Continuous Professional Development (CPD) Programs
Description: Establish CPD programs to help industry professionals stay updated on BIM technologies, standards, and practices.
Main Activities:
Develop CPD curricula in collaboration with industry bodies.
Launch online and in-person CPD courses.
Provide certifications for completed CPD modules.
Dependencies:
Informed by "Instructional Tools and Learning Materials" (Project 8).
Benefits from "Learning Outcome Frameworks" (Project 14).
Needed Resources:
Academic and industry experts.
Training platforms and venues.
Certification frameworks.
Alignment: Builds digital capacity within the Canadian construction sector, supporting NRC's transformation objectives.
Labels: [Learning / Professional Development]
Timeframe: Medium-term

Project 13

Title: BIM Maturity Assistance Programs
Description: Provide direct support to organizations aiming to improve their BIM maturity through workshops, training, and consultancy.
Main Activities:
Organize workshops tailored to organizational needs.
Offer consultancy services for BIM implementation.
Develop toolkits to facilitate self-improvement.
Dependencies:
Informed by "BIM Improvement Guides" (Project 4).
Benefits from "Instructional Tools and Learning Materials" (Project 8).
Needed Resources:
BIM consultants and trainers.
Toolkits and training materials.
Collaboration with industry associations.
Alignment: Supports NRC's goal of widespread BIM adoption by reducing entry barriers for organizations.
Labels: [Performance Improvement / Support]
Timeframe: Medium-term

Project 14

Title: Learning Outcome Frameworks
Description: Create frameworks to bridge the gap between academic BIM education and industry requirements, ensuring graduates are job ready.
Main Activities:
Map industry needs against current academic curricula.
Develop standardized learning outcomes.
Collaborate with universities to implement frameworks.
Dependencies:
Aligns with "Instructional Tools and Learning Materials" (Project 8).
Benefits from "CPD Programs" (Project 12).
Needed Resources:
Academic and industry collaboration.
Benchmarking studies.
Pilot programs in selected universities.
Alignment: Ensures alignment between education and industry needs, advancing NRC's workforce readiness goals.
Labels: [Learning / Education]
Timeframe: Medium-term

Project 15

Title: Functional Role Matrix
Description: Develop a matrix to define BIM-related roles and responsibilities, assisting organizations in improving staff competencies and aligning roles with project needs.
Main Activities:
Identify key BIM roles across project stages.

Define responsibilities and required competencies for each role.
Develop a user-friendly matrix tool.
Dependencies:
Informed by "BIM Maturity Assistance Programs" (Project 13).
Benefits from "Instructional Tools and Learning Materials" (Project 8).
Needed Resources:
HR and BIM experts.
Industry feedback for refinement.
Software for interactive matrix development.
Alignment: Supports NRC's objective of improving organizational competence in BIM.
Labels: [Learning / Competency Frameworks]
Timeframe: Medium-term

Project 16

Title: Model Uses Navigator
Description: Develop a tool to help clients and project teams define and prioritize the digital information they need for specific project outcomes.
Main Activities:
Identify common model uses in Canadian projects.
Develop a structured, interactive navigator tool.
Pilot the tool in real-world projects.
Dependencies:
Informed by "BIM Standards and Protocols" (Project 11).
Benefits from "Instructional Tools and Learning Materials" (Project 8).
Needed Resources:
Subject matter experts on model uses.
Software developers for tool creation.
Pilot project partnerships.
Alignment: Enhances project outcomes by aligning information requirements with delivery processes, supporting NRC's digital transformation efforts.
Labels: [Information Management / Tools]
Timeframe: Medium-term

Project 17

Title: BIM Maturity Benchmarking Data
Description: Establish a comprehensive and anonymized data pool to enable researchers to conduct in-depth studies and continuously expand the knowledge base of BIM maturity trends across the Canadian construction sector.
Main Activities:
Develop secure systems for data collection and anonymization.
Partner with industry organizations to encourage data sharing.
Analyze collected data to identify patterns and inform future projects.
Dependencies:
Directly supports "BIM Maturity Dashboard" (Project 3).
Provides input for "BIM Maturity Reports" (Project 19).
Needed Resources:
Data analysts and software developers.
Collaboration with industry associations for data acquisition.
Secure data storage and processing infrastructure.
Alignment: Supports NRC's goal of data-driven decision-making and continuous improvement in BIM maturity.
Labels: [Performance Assessment / Data]
Timeframe: Medium-term

Project 18

Title: BIM Maturity Certification Regime
Description: Establish a certification regime to formally recognize organizations and individuals achieving specified levels of BIM maturity. This initiative aims to standardize assessment criteria and provide assurance to clients and stakeholders.
Main Activities:
Develop certification criteria based on the BIM Maturity Matrix and related standards.
Collaborate with accreditation bodies to ensure credibility.
Launch pilot programs for certification processes.
Promote the certification regime through industry events and associations.
Dependencies:
Builds on outputs from "Interactive Self-Assessment Tools" (Project 2).
Benefits from insights in "BIM Maturity Dashboard" (Project 3).
Needed Resources:
Certification development specialists.
Collaboration with accreditation and standards organizations.
Tools and platforms for assessment and tracking.
Alignment: Supports NRC's goal of accelerating BIM maturity and standardization in the Canadian construction industry.
Labels: [Performance Assessment / Certification]
Timeframe: Long-term

Project 19

Title: BIM Maturity Reports
Description: Develop periodic reports to inform policymakers on the state of the Canadian Construction Industry's BIM maturity. These reports will guide funding decisions and the strategic direction of digital transformation initiatives.
Main Activities:
Design a reporting framework aligned with industry benchmarks.
Collect and analyze data from BIM maturity assessments and market trends.
Publish reports on a regular basis to highlight progress and identify gaps.
Dependencies:
Informed by "BIM Maturity Benchmarking Data" (Project 17).
Benefits from insights in "BIM Standards and Protocols" (Project 11).
Needed Resources:
Data analysts and market researchers.
Collaboration with industry associations for data collection.
Design and publication teams for report creation.
Alignment: Provides a strategic tool for policymakers to support the Canadian construction sector’s digital transformation, aligning with NRC’s vision
Labels: [Performance Assessment / Certification]
Timeframe: Long-term

The determination and implementation of these projects is contingent upon market insights, which are derived from the collection and analysis of BIM maturity data on a large scale. Only then, the availability of suitable resources from industry stakeholders and the unique requirements of each Canadian region must also be considered. The next section introduces a tailored Roadmap with key activities, milestones and deliverables aimed at assessing and improving the BIM maturity of various Canadian Industry Stakeholders, over time, and at scale.

6 Project Roadmap

After introducing BIMmas concepts and methodologies, Section 6 introduces a detailed roadmap to guide the delivery of this Project. Section 6 has three sections:

1. **Roadmap Stages** including Phases and Activities to be completed)
2. **Roadmap Stakeholders** detailing the potential beneficiaries and participants
3. **Roadmap Controls** briefly explaining the project governance model and the applicable data, risk, quality, cost and similar controls.

6.1 Roadmap stages

The roadmap to deliver this Project has three stages, starting with setting the foundational concepts for BIM maturity assessment and improvement (completed upon the publication of this report) followed by BIM maturity assessment and benchmarking activities, and ending with the delivery of a complementary set of BIM maturity improvement initiatives, tools and supporting materials. Engagement with stakeholders is a feature of all stages and is most explicit in the final stage where collaborative efforts would be needed to achieve Project objectives under the CSDP challenge program.

6.1.1 Roadmap Stage 1: Foundations

The first stage establishes the conceptual foundation for the BIM Maturity at Scale (BIMmas) project. It involves rigorous research, stakeholder engagement, and the consolidation of methodologies to deliver an actionable roadmap. Stage 1 has three phases:

6.1.1.1 Phase 1A: concepts, methodologies and milestones

This phase focuses on synthesizing foundational concepts, methodologies, and international best practices tailored to the Canadian construction industry. Drawing on other NRC reports and frameworks, this phase delivered:

> **BIMmas Concepts**: A set of complementary concepts that explain the possibilities and challenges of BIM maturity and the metrics needed to support reaching higher levels of BIM/digital efficiency.
>
> **BIMmas Methodologies**: A BIM maturity assessment and improvement methodology including multiple components to support a structured assessment flow and stepwise scaling strategy.
>
> **BIMmas Roadmap**: A strategic guide detailing phases and timelines for BIM maturity assessment and improvement across the Canadian Construction Industry.

6.1.1.2 Phase 1B: Stakeholder Consultations and Refinement

This phase focuses on engaging stakeholders to ensure that the methodology and roadmap are grounded in practical realities and aligned with national goals. This phase includes:

> **Focus Group Discussions**: Facilitating structured dialogue with BIM experts from public and private sectors, and academia. The discussions will identify the regions to be included in the scaling strategy and identify the sequence of BIM maturity assessment and improvement efforts.
>
> **Feedback Integration**: Refining the roadmap and framework to incorporate stakeholder perspectives and address identified gaps.

6.1.1.3 Phase 1C: Finalization and Public Release

The culmination of Stage 1 involves delivering the framework and roadmap in their final forms, signifying a national commitment to BIM maturity:

> **Publication**: A detailed NRC report articulating the strategy, methodologies, and objectives for BIM maturity at scale.
>
> **Presentation**: A public launch event aimed at raising awareness, building momentum, and encouraging industry collaboration.

6.1.2 Roadmap Stage 2: Activation, Assessment, and Analysis

Building on the foundations established in Stage 1, Stage 2 operationalizes the conceptual foundations through pilot assessments, data collection and analysis to inform scalable implementation. Stage 2 has 4 phases:

6.1.2.1 Phase 2A: Activation

> **Preparation**: This phase prepares the materials, tools and teams required for BIM maturity assessment at scale. These include Target Maturity Profiles, the selection/deployment of suitable assessment tools and templates, and setting the scoring methodologies according to Project objectives.
>
> **Stakeholder Engagement**: Identifying and onboarding collaborating partners, including public agencies, private firms, and academic institutions. During this phase the **Stakeholder Engagement Plan** (SEP) will be activated (please refer to next section)

6.1.2.2 Phase 2B: Pilot Assessment

This phase involves conducting the initial assessments to validate the methodology, refine the materials and then prepare to conduct assessment activities at scale:

> **Pilot Campaigns**: Deploying trial assessments to refine the tools and methodologies.
>
> **Initial Report**: Delivering an initial report and recommendations prior to scaling up the BIM maturity assessment efforts.

6.1.2.3 Phase 2C: Scaled Assessments

This phase involves expanding the BIM maturity assessments activities to cover new regions:

> **Scaling Efforts**: Gradually expanding the scope of assessments based on insights from pilot projects and the scaling strategy.
>
> **Scaling Report**: Delivering running reports to cover new regions and providing insights into how to improve the target maturity profiles and the scaling strategy.

6.1.2.4 Phase 2D: Analysis

Comprehensive analysis of the assessment data to deliver actionable insights:

> **Interactive Dashboard**: A dynamic platform for visualizing BIM maturity metrics, identifying trends, and benchmarking performance.
>
> **National Reports**: Detailed analyses providing stakeholders with granular insights into BIM maturity levels and gaps at regional and national levels.

6.1.3 Roadmap Stage 3: Implementation and Monitoring

Stage 3 focuses on applying the insights gained from the earlier stage to design, deliver and monitor BIM maturity improvement projects of various stakeholders across the Canadian Construction Industry. (Note: Roadmap Stages 2 and 3 may overlap as some Stage 3 activities can be started during the scaling phase of Stage 2)

6.1.3.1 Phase 3A: Collaboration Protocols

This phase formalizes collaboration frameworks and funding mechanisms to ensure robust project delivery. These may include:

> **Collaborative Partnerships**: Initiatives co-funded by NRC and partner organizations, targeting innovation and capacity building.
>
> **Collaborative Affiliations**: Broader participation through public-private partnerships, supported by government grants and industry sponsorship.

6.1.3.2 Phases 3B, 3C, 3D: Iterative Delivery and Monitoring

These phases represent the iterative delivery of BIM maturity improvement projects in a manner that adapts to new standards and emerging possibilities or challenges:

> **Delivery of BIMmas Projects**: Projects that addressing the critical gaps identified in earlier stages, including the typical need to improve interoperability, adopt international digital standards, and continuous professional development.
>
> **Monitoring and Adjustment**: Continuous evaluation of Project outcomes against Project objectives and ensure alignment with CSDP challenge program goals.

6.1.3.3 Phase 3E: Project Closeout

The completion of Roadmap Stage 3 concludes this Project with the delivery of:

Roadmap Update: Preparing for subsequent iterations of the BIMmas roadmap based on the outcomes and findings of all stages**.**

Final Report: Documenting the activities, achievements, lessons learned and recommendations for sustaining BIM maturity improvement momentum.

6.1.4 Roadmap stakeholders

This section clarifies who are the stakeholders that will be targeted for involvement in this project, either as *participants* or general *beneficiaries* of BIM maturity at scale deliverables. The exact list of stakeholders and the roles they wish to play will be clarified upon the completion of Phase 1B.

6.1.4.1 Stakeholders:

The **BIM Maturity at Scale Roadmap** relies heavily on the active participation and alignment of diverse stakeholder from across the Canadian Construction Industry. Representing various sectors and interests, each stakeholder contributing both complementary and unique perspectives that need to be incorporated into BIM maturity assessment and improvement efforts. Many stakeholders will need be engaged throughout the Project and it is thus beneficial to clarify the main groups[8] that will either participate in the assessment efforts or actively contribute to the development of BIM maturity improvement materials:

Government and regulatory bodies
Federal, provincial, and municipal governments are *key drivers* of digital transformation through policy, funding, and enforcement mechanisms. Agencies like Infrastructure Canada and Public Services and Procurement Canada are well-positioned to embed BIM maturity objectives within public procurement frameworks, ensuring that government-funded projects act as exemplars for wider BIM adoption. An example of impactful government involvement is Alberta Infrastructure's initiative that have incorporated BIM into its project delivery, demonstrating how public agencies can lead by example in adopting advanced digital processes.

Industry associations
Industry associations, such as the *Royal Architectural Institute of Canada* (RAIC), *Canadian Construction Association* (CCA), and *Engineers Canada,* play a vital role in championing BIM adoption and encouraging collaboration across different sectors. These associations provide critical guidance to their members and have a unique capacity to promote and improve BIM maturity across their networks. As potential partners in this Project, they can spearhead the development of tailored BIM maturity programs and specialized training materials of direct benefit to the practitioners they represent. They are also well-positioned to advocate for policy changes that promote consistency in digital information exchanges across regions and sectors, thereby supporting a unified, standards-enabled approach to digital transformation. By encouraging their members to participate in BIM maturity assessment and improvement efforts, Industry Associations serve as catalysts for improving digital competence and advancing digital productivity across the Canadian Construction Industry.

[8] Stakeholder groups and examples of digitalization initiatives are derived from “Table 1 - digitalization initiatives in the Canadian built asset industry” in the *Digitalization and Productivity Research and Development Roadmap* (NRC, 2024b, Table 1).

Communities of practice
National and regional Communities of Practice (CoP) are key players in translating BIM maturity assessment and improvement strategies into well-subscribed efforts that address practitioner needs. For example, *Groupe BIM du Québec* (GBQ) has developed a structured model for BIM maturity assessment and improvement efforts, which is influencing the digital transformation across the province. Another CoP, *Building Transformations* (previously CanBIM), provides communal meetings, materials, and certification programs beneficial to various stakeholders across Canada. These and similar initiatives will benefit from this Project and are likely key partners to BIM maturity scaling efforts.

Industry practitioners
The architectural, engineering, and construction (AEC) sectors are *the implementers* of BIM technologies, processes and policies. AEC practitioners would benefit directly from BIM maturity benchmarks and improvement tools to align their workflows with digital best practices and international standards. Other organizations which have already implemented pilot BIM programs, may provide valuable case studies to help others and provide practical insights into the effectiveness of BIM maturity improvement tools to be generated by this project.

Educational and research institutions
Universities, colleges, and research bodies play an important role in *fostering a BIM-ready workforce*. Educational institutions such as École de technologie supérieure (ÉTS) and the University of British Columbia (UBC) already contribute valuable research that informs both BIM adoption and standardization efforts. Their work underscores the critical role of academia in addressing the evolving needs of the construction industry, preparing students for a digital-by default working environments and encouraging other institutions to align their curricula with emerging industry demands. In addition to these educational institutions, research bodies play a pivotal role in leading and supporting BIM maturity assessment and improvement activities (as exemplified in this NRC Project). They provide the materials, benchmarks and tools necessary to accelerate industry's adoption of BIM and other digital ways of working. Collectively, these institutions bridge the gap between education, research and to support sustainable innovation across the Canadian Construction Industry.

Standards organizations and technology advocates
Standards organizations, such as the *Canadian Standards Association*, and technology advocates, such as *buildingSMART Canada* (and its international counterpart), play a crucial role in driving market-wide BIM maturity improvements. By championing interoperability, openBIM principles and alignment with local and international standards, they offer essential frameworks and resources to guide BIM maturity assessment and generating standards-aligned benchmarks. Also, the active participation of this stakeholder group in BIM maturity improvement efforts - through their national advocacy for standardization and the promotion of best digital practices - would play a pivotal role in this Project and help to accelerate the digital transformation of the Canadian Construction industry.

Clients and asset owners
Asset owners, both public and private, play a dual role as *drivers* of BIM adoption and *beneficiaries* of its outcomes. Public sector clients, such as the City of Calgary, exemplify leadership by integrating BIM into asset management and project delivery, showcasing how municipalities can influence broader industry practices. Private asset owners, including developers and facility managers are key beneficiaries of improved BIM maturity and may thus contribute to this Project's activities and deliverables.

Technology providers
Technology providers are instrumental in delivering the tools and platforms required for BIM maturity improvement. Both local and international companies that have solutions tailored to Canadian market needs, can be invited to contribute to this Project as heightened BIM maturity would translate to improved commercial prospects. These providers may engage in partnerships with other stakeholders – e.g. public agencies and educational institutions - to sponsor the needed knowledge hubs and provide the necessary training to close the BIM Maturity Gaps as they get discovered and mapped to BIM maturity improvement efforts.

6.1.4.2 Stakeholder engagement plan

The **Stakeholder Engagement Plan** (SEP) is intended to encourage collaboration, build consensus, and maintain sustained commitment among diverse groups across the Canadian Construction Industry. The plan focuses on clear communication, regular interaction, and feedback collection mechanisms to keep all stakeholders informed, well-aligned and actively contributing to the Project's objectives. The SEP need to be reviewed and activated starting from Roadmap Stage 2, Phase 2A and will continue to evolve until the practical completion of Roadmap Stage 3. The SEP includes several steps, channels and metrics:

6.1.4.2.1 SEP steps

The initial SEP step is to *raise awareness* and inform stakeholders about the Project and its roadmap. This step includes the *development of briefing materials* including a short presentation and explanations of the Project's objectives and overall timeline. The second SEP step includes setting up a simple *project webpage* that explains the project and provides answers to frequently asked questions. This project webpage will later be transformed into a *knowledge hub* to share BIM maturity benchmarks, self-improvement tools and other Project deliverables. Following the completion of the Pilot Assessment, and in preparation of a scaling up the BIM maturity assessment efforts, the third SEP step includes inviting a representative group of key stakeholders - such as government bodies, private firms and academia - to participate in a *focus group* to present the Initial Report from the pilot assessment, address any of their concerns and jointly define the best strategy – a combination of scaling tactics presented in Section 4 – to scale up the BIM maturity assessment efforts. The discussions will allow in-depth discussions and – more importantly – the identification of organizations interested in either funding, leading and/or supporting any of the BIM maturity improvement projects identified in Section 5). When Roadmap Stage 3 has started and BIM maturity improvement projects are being gradually delivered, the fourth SEP step is to develop and deliver a *recognition program* to celebrate stakeholder contributions which will assist in encouraging their continued engagement and encouraging others to join the Project.

6.1.4.2.2 Engagement channels

The Stakeholders Engagement Plan will employ **diverse channels** to connect with different stakeholder groups. While interactive workshops and webinars offer opportunities for direct dialogue, the online platform will serve as a hub for updated resources, use cases and useful BIM maturity tools. It is also recommended to prepare short newsletters and targeted social media posts covering Project activities to keep the general public informed about the progress of BIM maturity assessment and improvement efforts.

6.1.4.2.3 Engagement metrics

To measure success, the SEP will track **several engagement metrics** such as the *diversity* and *number* of stakeholders engaged, *levels of participation* in activities, and stakeholder satisfaction throughout the process. Inclusivity and equity are central to this engagement strategy and efforts will be made to involve stakeholders from all regions and sectors, including underrepresented groups and smaller firms. Key materials will be available in English and French with further translations of detailed reports provided if requested.

In summary, the SEP is a foundational deliverable of this Project. It needs to be regularly reviewed so it remains responsive to stakeholder needs and feedback. This is especially important upon starting Phase 2B as BIM maturity assessment and improvement efforts scale up to cover diverse stakeholders and regions across the Canadian Construction Industry.

6.1.5 Roadmap controls

To achieve the Project's objectives, the BIMmas Roadmap need to incorporate a simplified governance model and a set of project controls to manage risk, quality and cost. These controls would ensure the Roadmap remains adaptable, transparent and effective throughout its execution stages.

6.1.5.1 Governance model

Project governance will be handled by NRC according to their internal protocols. Alternatively, a separate governance framework can be developed that includes key stakeholder groups. Such a model can be developed at the start of Roadmap Stage 3 and will need to define the roles and responsibilities of participating stakeholders. A typical governance structure may include a steering committee, working groups, or an advisory boards to oversee roadmap execution to meet initial and evolving Project objectives.

6.1.5.2 Project controls

To ensure the Project meets its set objectives and deliver high-quality outcomes within set budgets, several controls need to be implemented and maintained, starting from Roadmap Stage 2. These include:

Risk management
A dynamic risk management plan is essential for addressing the challenges that may impact the implementation of this Project and effectiveness of the BIMmas Roadmap. Key risks include *stakeholder disengagement*, where key contributors may lose interest or fail to align with Roadmap objectives; *regional disparities* in BIM readiness, which could hinder uniform adoption of BIM/digital practices across provinces and territories; and the *rapid pace of technological advancement*, which risks rendering digital tools and frameworks obsolete. To address these challenges, a proactive approach will need to be adopted by carefully identifying and evaluating risks at the outset of each Roadmap Stage and Phase and implementing mitigation strategies. For instance, tailored engagement campaigns can keep stakeholders invested, while adaptive regional strategies can address localized BIM readiness challenges. Regular risk reviews are also needed to ensure the Scaling Strategy is adjusted as needed to improve Roadmap resilience by keeping it both relevant and actionable.

Quality management
Quality control mechanisms are necessary to ensure that the Roadmap's deliverables meet industry expectations. These mechanisms need to include rigorous monitoring of metrics such rates of stakeholder engagement and improvement of (or lack of) BIM maturity benchmarks across regions and sectors. By employing best practices in project management, the Roadmap will need to include quality checkpoints

at key milestones to allow for early detection of any deviations from Project objectives followed by immediate course corrections. These quality monitoring, control and assurance mechanisms should align with national and international frameworks, such as ISO 9001 standards for quality management, to ensure the Roadmap's outputs remain credible and impactful.

Data protection and privacy

Compliance with Canadian privacy laws, including the *Personal Information Protection and Electronic Documents Act* (PIPEDA), will be at the core of data protection and privacy measures within the Roadmap. Data collected during BIM maturity assessments, such as personal details, organizational capabilities and project-level details, will follow detailed publicly available protocols to protect or anonymize any sensitive information. This includes encryption of data transfers, restricted access based on stakeholder roles and adherence to clear data retention policies. Privacy impact assessments will be conducted regularly to identify potential vulnerabilities, and informed consent will be obtained from all participating stakeholders. All data collection from people will follow NRC's ethics approval processes for data collection and will include obtaining other required ethics approvals from relevant organizations prior the data collection. By prioritizing data privacy and security, the Project aims to build and maintain trust among stakeholders and ensure that ethical considerations are embedded in every aspect of Roadmap execution.

Performance monitoring

Continuous performance monitoring will provide actionable insights into the Roadmap's impact and effectiveness. Key tools, such as interactive dashboards and BIM maturity indices, will track progress against defined goals. For example, regional maturity benchmarks can identify areas requiring additional support, while sector-specific analyses will inform targeted interventions. Annual reviews will serve as an opportunity to assess Project achievements, identify gaps, and recalibrate objectives as needed. This iterative process will ensure that the Project and its Roadmap remain aligned with industry expectations and can adapt to evolving priorities. Transparent reporting mechanisms will keep stakeholders informed, improving accountability and encouraging sustained engagement throughout all Roadmap Stages.

Alignment with national initiatives

As this Project is among many conducted by the NRC, synchronized alignment with the Construction Sector Digitalization and Productivity (CSDP) challenge program – and more widely with national initiatives like Canada's Digital Charter - are vital. This alignment will ensure the Roadmap reinforces broader NRC goals, such as advancing sustainability, enhancing productivity, and enabling the digital transformation of Canada's Construction Industry. Benefiting from synergies with existing programs and funding streams will generate efficiencies and reduce duplications. The Project's objectives need to complement CSDP's focus on decarbonization and productivity improvements, generating BIM maturity benchmarks and performance improvement tools that resonate with stakeholders. Regular communication between the Project team and relevant federal and provincial bodies will ensure consistent messaging and amplify the Project's reach.

Cost monitoring

Effective cost monitoring is crucial to ensure the Project's *financial sustainability* with optimized resource allocation and use. This is especially true for Stage 2, Phase B (BIM maturity assessment at scale) and the plethora of Stage 3 deliverables. A robust cost management plan will need to be established (through the Governance Framework) to track expenses against predefined budgets, ensuring transparency and accountability throughout the Roadmap many stages and phases. Irrespective of the financial model to be adopted to fund different Roadmap activities, regular financial reviews will be needed to identify any potential overspending or underspending and allow for timely adjustment/reallocation of funds to assigned activities. Tools such as cost allocation spreadsheets or more detailed cost management dashboards are needed to enable all involved stakeholders to monitor expenditures in real-time. Furthermore, cost-efficiency measures, such as using shared resources and allowing for in-kind contributions by interested stakeholders would minimize costs and financial risks. This and other costs controls will be introduced to ensure that any investments in BIM maturity assessment activities and BIM maturity improvement efforts would deliver cost-effective outcomes and contribute to the long-term viability and impact of the Project.

6.2 Stages, Phases and Activities

The below simplified Gantt chart and Table 9 clarify the Roadmap's activities, deliverables and milestones [Note: this needs to be updated upon conclusion of Phase 1B which includes consultations with NRC and key stakeholders].

Figure 10. Summary Roadmap - Simplified Gantt Chart

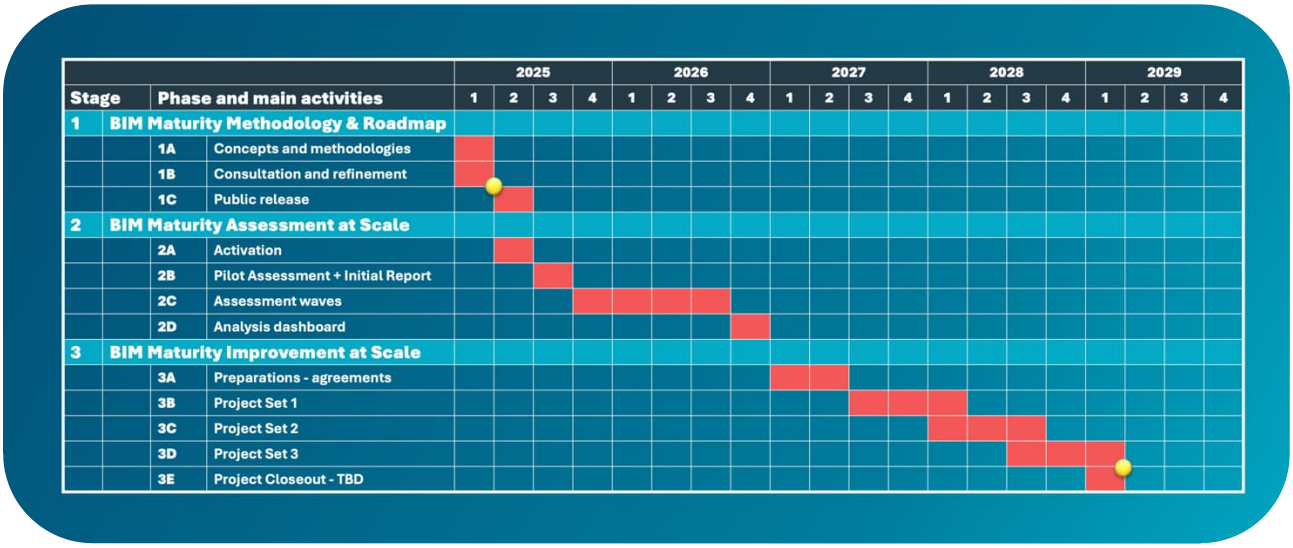


Table 9. Roadmap - Stages, Phases and Activities Table

Stage	Phase	Timeline	Key Activities	Deliverables	Milestones
Stage 1: Foundations	1A: Concepts, Methodologies & Milestones	Jan – Feb 2025	- Conduct literature review of BIM best practices - Consolidate NRC reports & frameworks - Develop BIMmas Concepts & Methodologies - Draft BIMmas Roadmap structure	- Draft BIMmas Concepts & Methodologies - Initial BIMmas Roadmap Draft	- Draft Submission (Jan 10) - Final sign-off on conceptual approach (Feb 28, 2025)
	1B: Stakeholder Consultations & Refinement	Mar 2025	- Engage NRC Codes, buildingSMART Canada, academic experts - Host focus group discussions - Gather and integrate feedback into methodology & roadmap	- Revised Roadmap and Framework - Focus Group Summary Report	- Stakeholder approval to proceed (Apr 2, 2025)
	1C: Finalization & Public Release	Mar 2025	- Finalize BIMmas framework & roadmap - Coordinate final editing & design - Public release event & communications	- Published NRC Report - Public Launch Presentation	- Official national Release (Apr 30, 2025)

Stage	Phase	Timeline	Key Activities	Deliverables	Milestones
Stage 2: Activation, Assessment & Analysis	2A: Activation	May 2025	- Prepare materials, tools & teams for BIM maturity assessment - Define scoring methodologies & target maturity profiles - Onboard collaborating partners (public agencies, etc.)	- Assessment Tools & Templates - Stakeholder Engagement Plan (SEP)	- Kickoff (May 12, 2025)
	2B: Pilot Assessment	Jun – Dec 2025	- Run trial assessments with selected pilot organizations - Refine tools & methodologies based on pilot feedback - Share initial findings	- Pilot Campaign Results - Initial Recommendations Report	- Pilot completion & preparedness check (Dec 31, 2025)
	2C: Scaled Assessments	Jan – Dec 2026	- Gradually expand assessments to multiple regions & project types - Ongoing data collection and analysis - Issue incremental scaling reports	- Running Assessment Reports - Improved Target Maturity Profiles	- Multiple national coverage milestones (Ending Dec 31, 2026)
	2D: Analysis	Jan – Mar 2027	- Comprehensive data analysis Develop interactive dashboard for performance visualization - Draft national reports on regional & national BIM maturity levels	- Interactive Analysis Dashboard - National BIM Maturity Reports	- Release of national analytics portal (Mar 2027)
Stage 3: Implementation & Monitoring	3A: Collaboration Protocols	Jan – Jun 2027	- Formalize collaboration frameworks & co-funding mechanisms - Establish guidelines for partner project involvement - Launch Collaborative Partnerships & Affiliations	- Collaboration Framework Document - Signed Funding Agreements	- First partnership MOU signed (Mar 2027)
	3B, 3C, 3D: Iterative Delivery & Monitoring	Jun 2027 – Mar 2029	- Initiate BIMmas improvement projects based on assessment findings - Monitor ongoing digital transformation initiatives - Adapt strategies to emerging standards & challenges	- Quarterly Progress Reports - Updated Tools & Templates	- Improvement Projects across 3 phases-completion (Mar 2029)
	3E: Project Closeout	Jan – Mar 2029	- Final evaluation of outcomes vs. objectives - Prepare next iteration of BIMmas roadmap - Publish Final Report documenting lessons learned & recommendations	- Roadmap Update - Final Project Report	- Official Project Closeout Event (Mar 2029)

7 Consultation results

A draft version of this document was sent to representatives of other Other Government Departments (OGD) steering committee (refer to acknowledgements section). After written feedback was received containing pertinent comments and recommendations, an online meeting was held including an overview presentation and content discussions. This section presents the primary insights and suggestions gathered from these consultations, aligning them with the objectives of the BIM Maturity at Scale project. The findings reinforce the importance of coordinated BIM initiatives at the federal and provincial levels, highlight opportunities to integrate existing provincial efforts, underscore the need for inclusive stakeholder engagement, and call attention to benefits, barriers, and the importance of standardization. Participants also underscored the significance of NRC's role in advancing pan-Canadian BIM maturity and emphasized that time should not be lost in moving forward.

7.1 Federal and provincial roles

A consistent theme emerging from consultations is the need to clarify how federal and provincial authorities can work together to accelerate BIM adoption. Participants underscored the distinctive responsibilities of each jurisdiction and emphasized that clarity on complementary roles would reduce duplication and stimulate shared efforts. Participants expressed how federal entities could provide guidance on national standards, supporting interjurisdictional knowledge exchange, and pan-Canadian BIM initiatives. Meanwhile, provinces would focus on regional BIM practices and ensuring alignment with any unique industry conditions.

Participants highlighted how several provinces - such as those in Quebec, British Columbia and Alberta - have advanced BIM guidelines tailored to local contexts. Harmonizing these strategies into a cohesive national BIM maturity framework would minimize overlaps, provide consistent benchmarks across jurisdictions, and support incremental improvements.

7.2 Stakeholder engagement and ongoing feedback

Participants noted that meaningful and ongoing engagement across all stakeholder groups is central to the BIMmas Roadmap's success. Involving government agencies, private-sector firms, industry associations, and educational institutions would deepen adoption and yield actionable insights. Emphasizing support mechanisms, inclusive decision-making processes and the creation of open feedback channels would enable continuous refinement of the BIMmas Roadmap and aligning it with evolving stakeholder requirements.

7.3 Benefits and barriers

The consultations acknowledged the role of BIM – as a broad term representing digital innovation across the built environment – in improving productivity through enhanced collaboration and higher-quality project deliverables. Participants agreed that BIM maturity, when robustly measured and consistently improved, has a positive correlation with sustainability targets and overall industry performance. However, numerous

barriers persist, including (a) the inability of some public entities to enforce specific digital requirements on the supply chain due to the absence of clear mandates; and/or (b) the inability to benefit from the rich digital deliverables of the supply chain due to the lack of funding to invest in suitable technical infrastructure or required training. These notable challenges need to be addressed for the benefits of BIM adoption to spread more widely.

7.4 Standardization

Feedback affirmed that standardizing BIM best practices while allowing for flexibility across different sectors is vital. Participants observed that productivity gains can be achieved when key stakeholders are working with shared definitions and protocols aligned with existing international standards such as ISO 19650. By conducting BIM maturity assessments at scale, additional clarity can be brought to this area, and targeted initiatives can be launched to encourage more structured and uniform adoption.

7.5 General consultation outcomes

Overall, participants commended the document's well-structured format, its logical flow, and its ability to explain BIM maturity concepts with clarity. This positive feedback positions the BIMmas project – along other NRC projects - as a guiding effort for the sector's digital evolution. The consultations confirmed broad support for a national BIM maturity assessment and improvement strategy that respects provincial mandates, includes all industry stakeholders in an evolving discussion, highlights both benefits and barriers, and integrates local experiences into a coherent framework.

Additionally, participants indicated that the NRC is well-positioned to serve as a catalyst for digital transformation and shared learning across Canada's diverse construction environment. By providing guidance and continuity, the NRC can accelerate the convergence of provincial BIM maturity improvement efforts to assist a widest array of stakeholders. In summary, the consultations highlighted that - while many of the requirements for digital transformation and BIM maturity in the construction sector are already understood - the most important next step is to move forward decisively so that opportunities for innovation, cost savings, and sustainability can be achieved without delay.

8 Document summary

This BIM Maturity at Scale project presented in this *strategy document* is poised to play a foundational role in accelerating the digital transformation of Canada's Construction Industry. Focusing on an expanded definition BIM and through a *structured* BIM maturity assessment and improvement methodology, the document presented detailed conceptual foundations, a BIM maturity assessment and improvement methodology and staged roadmap for executing a series of complementary activities over multiple years.

The document communicates NRC's intent to improve the CCI and clarifies how this Project will engage closely with key industry stakeholders through a series of activities – focus groups, assessments and collaborative generation of knowledge tools. This close and transparent collaboration - detailed in the *Stakeholder Engagement Plan* (SEP) and Project Controls - will not only improve Project deliverable but will raise trust in the *Digital Transformation Objectives* (DTO)s outlined in the CSDP challenge program.

This document also complements the many key NRC publications introduced in Section1 and aligns closely with the Program's short-, medium-, and long-term objectives:

- In the **short term** (years 1–2), the BIMmas project will establish the foundational concepts for large-scale BIM maturity assessments. This includes the publication of this document as a clear *strategic intent communication tool* to demonstrates the importance of BIM maturity across sectors. The Project will also provide a *methodology* for structuring and conducting *unified* BIM maturity assessment and improvement activities. Finally, the Project will deliver a *roadmap* that clarifies the stages, phases, milestones and resources necessary for continuously improving BIM/digital maturity across various sectors and regions and addressing the current limitations of fragmented digital practices. By focusing on early-stage engagement, uniformity and communication, the project aligns with the CSDP's immediate goal of enhancing the digital competitiveness of the Canadian Construction Industry.
- In the **medium term** (years 3–6), the project will facilitate the g*radual scaling up of BIM maturity assessment and improvement activities*. This includes supporting the development of a nationally consistent BIM/digital maturity certification framework and progressively delivering interactive resources and tools for industry stakeholders to self-assess, learn and continuously improve. As BIM maturity levels improve across the wider CCI, this will provide the opportunity for the gradual integration of BIM workflows with other CSDP initiatives (e.g. e-permitting and performance-based codes) as well as tighter digitally enabled adherence with evolving decarbonization goals.
- Finally, in the **longer term** (years 7–10+)**,** the project will support the CSDP's overarching goal of lowering construction times and costs while improving innovation and productivity. The longer-term outcomes include industry-wide adoption of performance assurance regulations and the widespread deployment of low-carbon solutions across new and retrofit projects. By delivering a unified and progressively scalable BIM maturity assessment and improvement initiatives, this Project will help to position Canada's Construction Industry as a leader in both digital transformation and decarbonization and thus contributing to a more sustainable future.

Upon the successful delivery of this Project over its multiple stages and phases, its outcomes will play a pivotal role in elevating the BIM maturity of various stakeholder groups and thus accelerating the digital transformation of the Canadian Construction Industry. Complementing other NRC initiatives, the BIM Maturity at Scale project would thus contribute to Canada's overarching goals of digital innovation, productivity and sustainability.

In summary, as detailed in Section 2, to fully realize the benefits of digital transformation, Canada's Construction Industry needs to adopt a *unified* approach to evaluating and improving BIM maturity. Only a unified and national approach would enable *deep collaboration*[9] among industry stakeholders, align with international standards and promote best digital practices. There are however challenges - not barriers - for this unified national approach to accommodate divergent requirements. These challenges include financial constraints experienced by small and medium enterprises (SMEs), and 'common' resistance to continuous change within the workforce. Also, *fragmented regulatory frameworks* across provinces would further complicate a *cohesive and consistent adoption* of digital transformation and collaborative solutions. As mentioned in a 2023 report by KPMG, national policies and targeted workforce upskilling programs are critically important to overcome such challenges (KPMG, 2023). Furthermore, the continued reliance on manual processes further underscores the urgency for well-structured and broadly applicable modernization efforts (McKinsey & Company, 2024). These and other challenges can be addressed through a nationally consistent approach to digital transformation and by adopting the key lessons learned by similar international efforts. Through a unified national approach and alignment with international best practice, the Canadian Construction Industry will be well-positioned to address productivity challenges, enhance its sustainable practices and enable a vibrant environment for construction innovation.

…

[9] BIM enables *deep collaboration* – as opposed to typical or shallow collaboration – through information-rich mediums. For example, by *interchanging* (interoperable exchange) information through semantically rich 3D digital models would allow for an expanded quality of *collaboration* – exemplified as open information exchange between actors leading to their coordinated activities towards a common goal - beyond what a 2D drawing can typically achieve.

9 Annexes

This document includes two annexes: *Annex A* provides an extended list of resources – multiple tables covering taxonomies and initiatives that have informed the development of this strategy document; while Annex B compiles all the references cited throughout the document.

9.1 Annex A – Resources

This Annex includes lists and other resources of potential benefits to researchers and document reviewers.

9.1.1 BIM maturity assessment and improvement initiatives

There are numerous not-for-profit, government-led or government-supported efforts to assess and improve BIM/Digital maturity. Excluding academic studies and publications, the below list includes a few of the well-noted ones:

Macro BIM Adoption (BIMe Initiative)

Date: 2020–Ongoing

Description & Purpose:
A global, not-for-profit effort to assess and improve BIM/digital competencies in organizations and individuals through open-access frameworks, tools (e.g., BIM Dictionary), and structured competency benchmarks. Supports macro-adoption by developing standards, guidelines, and free industry resources.

Leading Entity:
BIMe Initiative (international volunteer network)

Type of Entity:
Non-profit / International research community

Metrics Used:
Maturity Index, Maturity Indicators and Qualifiers

Tool / Application:
Web-based platform (https://assessor.io)

Impact Measurement:
Widely referenced by national BIM programs (e.g., Scotland, Chile). Its frameworks and dictionaries have been adopted/translated globally. Qualitative case studies show significant impact on guiding policy and educational programs.

Reference:
Macro Adoption Project. (2020). Part of the BIM Excellence Initiative. Retrieved from https://bimexcellence.org

Quebec Initiative for Construction 4.0 (Initiative Québécoise pour la Construction 4.0, IQC 4.0)

Date: 2018–2024 (phased)

Description & Purpose:
Province-wide (Québec, Canada) program to diagnose construction firms' digital (BIM/VDC) maturity and deliver tailored action plans. Seeks to accelerate industry productivity, with each participant receiving a customized roadmap.

Leading Entity:
Groupe BIM du Québec (GBQ), supported by the Québec Ministry of Economy and Innovation

Type of Entity:
Non-profit / Government-funded

Metrics Used:
Structured digital maturity levels (technology, processes, skills). Tracks readiness and

integration in participating firms.

Tool / Application:
Web-based platform (https://assessor.io). Other surveys and on-site evaluations.

BIM Maturity Improvement Projects:
Customized digital transformation plans and funded pilot projects to address skill gaps. Ongoing coaching.

Impact Measurement:
Over 250 firms assessed by 2021. Internal surveys report 10–20% efficiency gains in project coordination post-adoption. The initiative is credited with spurring wide interest in BIM across Québec.

Reference:
IQC. (2024). Initiative Québécoise pour la Construction 4.0. Groupe BIM du Québec. Retrieved from https://www.constructionnumerique.ca. Last accessed 10 February 2025.

National BIM Survey (BuildDigital, Ireland)

Date: 2023–Ongoing (annual)

Description & Purpose:
Conducted annually to measure BIM and digital construction adoption in Ireland. Informs government policy, highlights barriers (skills, cost), and supports the Build Digital Project under Project Ireland 2040.

Leading Entity:
Build Digital Project (funded by Dept. of Public Expenditure & Reform)

Type of Entity:
Gov't-funded consortium (academia + industry)

Metrics Used:
BIM Maturity Index. BIM/digital adoption indicators (e.g., % of orgs using BIM, involvement of leadership, standards compliance).

Tool / Application:
Web-based platform (https://assessor.io)

BIM Maturity Improvement Projects:
Informs targeted training and knowledge hubs. Gaps identified lead to best-practice guides and educational resources.

Reference:
BuildDigital. (2023). National BIM Survey – Results Overview. Retrieved from https://www.builddigitalproject.ie.

Malaysia National BIM Report

Date: 2019 (2nd edition)

Description & Purpose:
A national survey and report published by CIDB to track BIM adoption and readiness in Malaysia's AEC sector. The 2019 edition updates progress since 2016, informing policy and training initiatives under Malaysia's Construction 4.0 strategic roadmap.

Leading Entity:
CIDB Malaysia (Construction Industry Development Board)

Type of Entity:
Government agency (statutory board)

Metrics Used:
BIM Adoption Rate (% of firms/projects using BIM), future adoption forecasts, readiness metrics.

Tool / Application:
Industry-wide questionnaire (online & in-person).

BIM Maturity Improvement Projects:
Findings led CIDB to expand the myBIM Centre, mandate BIM for certain projects, and organize training for professionals.

Impact Measurement:
Between 2016 and 2019, adoption jumped from 17% to 49%. The report potentially spurred further interventions in the Construction 4.0 Strategy (2021–2025).

Reference:
CIDB Malaysia. (2019). Malaysia Building Information Modelling Report 2019. Retrieved from http://www.cidb.gov.my.

Plan BIM (Chile)

Date:
2016–2020 (ongoing)

Description & Purpose:
A public program to boost BIM adoption in Chile's AEC sector, mandating BIM for government projects to increase productivity and cost-effectiveness. Implements national BIM standards, fosters capacity-building, and tracks usage.

Leading Entity:
CORFO (Chilean Economic Development Agency) + multiple ministries

Type of Entity:
Government agency program

Metrics Used:
Key adoption milestones in public projects (use of BIM in design by 2020, etc.), monitored through surveys and pilot projects.

Tool / Application:
MiBIM web platform for self-assessments; also uses national BIM surveys (2013, 2019, 2022).

BIM Maturity Improvement Projects:
Developed a BIM standard for public projects, pilot projects, and training. Continues to refine strategies based on adoption data.

Impact Measurement:
By 2019, industry surveys showed significant adoption growth, with many public agencies implementing BIM workflows. Program extended beyond 2020 to maintain momentum.

Reference:
Global BIM Network. (2021). Chile – Planbim National BIM Program.
https://www.globalbim.org/

es.BIM Commission (Spain)

Date:
2016–2018 (survey)

Description & Purpose:
A multi-agency body coordinating Spain's BIM strategy and conducting nationwide surveys to gauge BIM awareness and use. Results shape Spain's BIM Roadmap and phased public procurement mandate.

Leading Entity:
es.BIM Commission (Spanish Ministry of Transport, Mobility, and Urban Agenda)

Type of Entity:
Government committee

Metrics Used:
BIM awareness, usage levels among AEC professionals, classification by project phases.

Tool / Application:
Online questionnaires distributed via professional associations.

BIM Maturity Improvement Projects:
Data informed the 2018–2020 National BIM Roadmap, leading to new guidelines and pilot projects for public tenders.

Impact Measurement:
Survey revealed that only ~15% of contractors actively used BIM in 2018, prompting targeted measures. By 2020, public tenders increasingly required BIM deliverables.

Reference:
BuildingSMART Spain. (2017). Encuesta de situación BIM de la Comisión es.BIM. Retrieved from https://www.buildingsmart.es.

New Zealand BIM Benchmark Surveys (BIM Acceleration Committee)

Date:
2016–2021 (series)

Description & Purpose:
Annual surveys to track BIM adoption in NZ's construction sector, guide policy, and highlight areas for improvement. The BIM Acceleration Committee, partly government-funded, publishes these reports to accelerate digital transformation.

Leading Entity:
BIM Acceleration Committee (backed by MBIE & industry)

Type of Entity:
Public–private partnership

Metrics Used:
Percentage of projects using BIM, organizational BIM maturity, and adoption barriers tracked year over year.

Tool / Application:
Online surveys of a consistent sample (EBOSS platform) plus industry-wide outreach.

BIM Maturity Improvement Projects:
Findings led to national BIM Handbook, client guides, and training programs to address identified skill gaps.

Reference:
BIM Acceleration Committee. (2021). BIM in New Zealand – Survey Report 2021. Retrieved from https://www.eboss.co.nz.

Germany "Road Map for Digital Design and Construction"

Date:
2015–2020

Description & Purpose:
A federal initiative to require BIM on all public transport infrastructure projects by 2020. Implemented a 3-phase approach: prepare (till 2017), pilot (2017–2020), then mandate for all new federal projects.

Leading Entity:
Federal Ministry of Transport and Digital Infrastructure (BMVI)

Type of Entity:
Government ministry

Metrics Used:
Milestone-based (100% new federal projects with BIM by 2020). Pilots tracked cost/time savings versus traditional processes.

Tool / Application:
Pilot project data and compliance checks in procurement. Additional research under "BIM4INFRA2020."

BIM Maturity Improvement Projects:
Implemented 4 large pilot projects (bridges, highways), developed guidelines (VDI 2552), and mandated BIM for all new projects by 2020.

Reference:
BMVI. (2015). Road Map for Digital Design and Construction. Federal Ministry of Transport, Germany.

National BIM Mandate (Russia)

Date:
2019

Description & Purpose:
Inspired by the UK's BIM Level 2 approach, Russia's Ministry of Construction introduced a nationwide BIM requirement for public projects from 2019 onward. Seeks to reduce costs (targeting ~30% savings) and improve quality.

Leading Entity:
Ministry of Construction, Housing, and Utilities (Russian Federation)

Type of Entity:
Government ministry

Metrics Used:
Compliance with a "BIM Level 2" standard for design and collaboration. Also tracks potential cost/time reductions in public works.

Tool / Application:
Project approval system includes BIM deliverables; national standard "GST BIM" is used.

BIM Maturity Improvement Projects:
Funded pilot projects pre-2019, developed a national standard, and mandated training for contractors.

Reference:
Slowey, K. (2016). Russia following UK's lead with plans for BIM mandate. *Construction Dive*. https://www.constructiondive.com.

Bahrain BIM Guidelines

Date:
2020

Description & Purpose:
Under a government e-Government initiative, Bahrain launched its first BIM guidelines to standardize BIM usage in public projects,

improve collaboration, and raise digital maturity. Provides protocols for design and construction.

Leading Entity:
Bahrain Information & eGovernment Authority (with Ministry of Works)

Type of Entity:
Government agency

Metrics Used:
Early baseline adoption rate (~39% in 2020). Aims to raise that percentage through official guidelines and mandatory BIM in certain tenders.

Tool / Application:
Guideline documents; government approval processes. Potential future digital submission platform.

BIM Maturity Improvement Projects:
Government agencies began pilot implementations and training programs. A national roadmap is being developed to expand the guidelines' use.

Reference:
Ahmed, R., & Suliman, S. (2020). Exploring BIM adoption in Bahrain. *Jesbim White Papers*. (39% figure).

Plan BIM Perú

Date:
2019–ongoing

Description & Purpose:
A national policy forming part of Peru's Competitiveness Plan (Measure 1.2). Aims to gradually implement BIM in public infrastructure projects to enhance efficiency, transparency, and quality of public investments.

Leading Entity:
Ministry of Economy and Finance (MEF), Peru

Type of Entity:
Government ministry

Metrics Used:
Sets staged goals (short, medium, long term) for % of public projects using BIM. Tracks pilot projects and training.

Tool / Application:
Government dashboards and Invierte.pe (public investment platform). An inter-ministerial working group monitors progress.

BIM Maturity Improvement Projects:
Developed a national BIM guideline, launched pilot projects with select public agencies, established a BIM Forum for knowledge-sharing.

Impact Measurement:
Early pilots show improved project delivery times. Full impact to be documented as adoption scales.

Reference:
Ministerio de Economía y Finanzas. (2019). Plan BIM Perú. https://www.mef.gob.pe.

Costa Rica National BIM Strategy

Date:
2020–ongoing

Description & Purpose:
Costa Rica's Ministry of Planning (MIDEPLAN) published a BIM strategy and subsequent Roadmap (2022) to adopt BIM in government processes. Seeks to leverage public procurement for digital transformation and sets phased targets.

Leading Entity:
Ministry of National Planning and Economic Policy (MIDEPLAN)

Type of Entity:
Government ministry with inter-institutional BIM Commission

Metrics Used:
Milestones for % of public tenders including BIM. Tracks trained personnel, pilot projects, and compliance with newly issued BIM guidelines.

Tool / Application:
Inter-institutional BIM Commission collects data from agencies. Procurement systems begin tracking digital deliverables.

BIM Maturity Improvement Projects:
Created a multi-agency BIM Commission, introduced standards, and launched pilot projects. Collaboration with academia and private sector for training.

Reference:
Red Internacional de Ciudades Inteligentes. (2023). Costa Rica – BIM Strategies. https://www.ciudadesinteligentes.com.

Vietnam BIM Program (Decision 2500/QĐ-TTg)

Date:
2016–2021 (phased)

Description & Purpose:
Prime Minister-approved program to apply BIM nationwide, reduce project costs by 10%, and pilot BIM on at least 20 projects by 2020 before mandating BIM for large projects from 2021.

Leading Entity:
Ministry of Construction (Vietnam)

Type of Entity:
Government ministry (Prime Minister's Office)

Metrics Used:
Performance metrics: 10% cost/time reduction, 20+ pilot projects using BIM, full mandate by 2021.

Tool / Application:
Government pilot project evaluations; official progress reports.

BIM Maturity Improvement Projects:
Launched pilot projects (design, construction, operations), established national guidelines, and from 2021 required BIM on new public construction.

Reference:
Government of Vietnam. (2016). Decision 2500/QĐ-TTg: Approving the BIM application program in construction. https://www.xaydung.gov.vn.

National BIM Strategy of Brazil (Estratégia BIM BR)

Date:
2018–2028 roadmap

Description & Purpose:
A federal decree-based strategy for nationwide BIM adoption. Sets phased targets for government projects (design by 2021, construction by 2024) and invests in training, standardization, and pilot projects to boost industry readiness.

Leading Entity:
Inter-ministerial Committee for BIM Strategy, Ministry of Economy (Brazil)

Type of Entity:
Government committee

Metrics Used:
Monitors # of BIM-based public projects, cost/time savings, # of trained professionals, and standard adoption levels.

Tool / Application:
Progress updates and pilot data are published by the official BIM Strategy site. Federal decree mandates periodic reviews.

BIM Maturity Improvement Projects:
Phased introduction of BIM in federal procurements. Supports capacity-building in technical schools and offers tax incentives for adopting digital methods.

Reference:
Ministério da Economia, Brasil. (2018). Estratégia Nacional de Disseminação do BIM (BIM BR). https://www.gov.br/economia.

Saudi Arabia BIM Initiative (Vision 2030)

Date:
2018

Description & Purpose:
MOMRA mandated BIM for all public construction under Vision 2030, aiming to modernize the sector, reduce project overruns, and improve asset management. Focus on open standards and training.

Leading Entity:
Ministry of Municipal and Rural Affairs (MOMRA), Saudi Arabia

Type of Entity:
Government ministry

Metrics Used:
Tracks compliance with the mandate in public tenders and measures project efficiency (cost,

schedule) improvements.

Tool / Application:
Government project approval processes, with buildingSMART KSA for open BIM guidelines.

BIM Maturity Improvement Projects:
Introduced pilot BIM projects for key public works, developed guidelines, and provided training for government staff and contractors.

Reference:
buildingSMART International. (2019). Kingdom of Saudi Arabia joins bSI. https://www.buildingsmart.org.

New Zealand BIM Benchmark Programme (extension of previous BAC Surveys)

Date:
2016–present

Description & Purpose:
Continuation of annual/biannual surveys by the BIM Acceleration Committee (BAC) to gauge market maturity. Published "BIM in NZ" reports, guiding policy and resource allocation.

Leading Entity:
BIM Acceleration Committee (supported by MBIE)

Type of Entity:
Public–private partnership

Metrics Used:
Year-over-year tracking of % projects using BIM, organizational BIM maturity level, knowledge barriers.

Tool / Application:
Online surveys, focus groups for deeper insights. Results compiled in "BIM in NZ" reports.

BIM Maturity Improvement Projects:
The data supports targeted outreach, training, and the creation of a national BIM Handbook. Identifies new gaps (e.g., asset owners' slow uptake).

Reference:
BIM Acceleration Committee. (2021). BIM in New Zealand: Industry-wide View 2021. https://www.building.govt.nz.

Russia's National BIM Mandate (roll-out continuation)

Date:
2019–present

Description & Purpose:
Extension of the initial 2016 announcement. By 2019, mandatory BIM was in effect for all federally funded projects, with subsequent expansions to regional projects. Emphasizes open standards (IFC) and a "Level 2" approach.

Leading Entity:
Ministry of Construction (Russian Federation)

Type of Entity:
Government ministry

Metrics Used:
Tracks # of public projects employing BIM, compares cost/time performance to pre-BIM baselines.

Tool / Application:
Federal procurement system enforces BIM deliverables; data aggregated by the ministry.

BIM Maturity Improvement Projects:
Standardization (GST BIM), training initiatives for government staff, expansions to non-federal projects after 2020.

Reference:
Global Construction Review. (2020). Russia expands mandatory BIM to regional projects. https://www.globalconstructionreview.com.

Singapore's CORENET X and IDD Initiatives

Date:
2018–ongoing

Description & Purpose:
Building on Singapore's earlier BIM roadmap (started 2010), the government launched the "Integrated Digital Delivery" (IDD) initiative and upgraded e-submission platform (CORENET X) to push for higher BIM maturity in design, approvals, and facility management. Aims for end-to-end digitalization.

Leading Entity:
Building and Construction Authority (BCA Singapore)

Type of Entity:
Government statutory board

Metrics Used:
Tracks digital adoption across the supply chain, e-submission usage rates, and IDD pilot performance.

Tool / Application:
CORENET X (electronic submission platform), IDD pilot data on cost/time savings.

BIM Maturity Improvement Projects:
BCA runs IDD pilot projects (4D/5D integration, digital handovers), invests in workforce upskilling, and sets progressive e-submission requirements for plan approvals.

Reference:
Building and Construction Authority. (2018). BIM & IDD Transformation Roadmap. https://www1.bca.gov.sg.

Australia's National Digital Engineering Policy (transport focus)

Date:
2016–2021 (ongoing updates)

Description & Purpose:
Initiated by Transport for NSW, VicRoads, and other state agencies to align Digital Engineering (DE)/BIM practices in infrastructure. Aims to set consistent DE standards, maturity models, and mandates for large transport projects across states.

Leading Entity:
Various state transport agencies (supported by Infrastructure Australia)

Type of Entity:
Government agencies consortium

Metrics Used:
Each state sets DE maturity benchmarks, typically referencing "BIM maturity levels" in alignment with the UK approach. Measures compliance, cost/time improvements on pilot infrastructure projects.

Tool / Application:
Mixed. Each agency runs internal DE/BIM pilot evaluations. Some states use online portals for data. National alignment efforts attempt consistent data definitions (ANZLIC).

BIM Maturity Improvement Projects:
Governments require DE deliverables in major transport projects; trialed cross-state data standards (e.g. IFC for infrastructure). Surveys of industry readiness shape updated guidelines.

Reference:
Transport for NSW. (2019). Digital Engineering Framework. https://roads-waterways.transport.nsw.gov.au. Infrastructure Australia. (2020). Australian Infrastructure Audit.

UAE BIM Roadmap (Dubai Municipality & Federal Public Projects)

Date:
2016–present

Description & Purpose:
Dubai Municipality mandated BIM for certain large projects as early as 2013. From 2016 onward, expansions of this approach at the federal level (Ministry of Infrastructure Development) set out a BIM roadmap for government buildings and infrastructure. Seeks to unify standards, ensuring that new government projects harness 3D/4D modelling.

Leading Entity:
Dubai Municipality, UAE Ministry of Infrastructure Development

Type of Entity:
Government agencies

Metrics Used:
Compliance with BIM mandates in building permits (Dubai) and federal public works. Some agencies measure time/cost savings on digitized projects.

Tool / Application:
Dubai's online building permitting system, plus each ministry's project data.

BIM Maturity Improvement Projects:
Provided guidelines for design consultants and contractors, offered BIM training, and mandated digital submission of building plans beyond certain project sizes.

Reference:
Dubai Municipality. (2016). Dubai BIM Mandate Extension Notice. https://www.dm.gov.ae. UAE Ministry of Infrastructure Development. (2018). Federal BIM Adoption Strategy.

Other BIM maturity efforts

In addition to the above detailed descriptions, please find below a list of other notable International BIM Maturity Assessment and Improvement efforts (**Table 10**):

Table 10. Other International BIM maturity assessment and improvement efforts

Initiative/Project Title	Date	Description of Initiative/Purpose	Leading Entity	Type of Entity	Reference
Australian BIM Collaborative Forum (ABCF) Maturity Assessment	2022	Evaluates BIM maturity across Australia's construction industry. Focuses on improving collaboration and data exchange.	Australian Construction Industry Forum (ACIF)	Government-supported initiative	(ACIF, 2022)
Netherlands BIM Loket Maturity Model	2021	Develops a national BIM maturity model to guide organizations in assessing and improving their BIM capabilities.	BIM Loket	Government-supported initiative	(BIM Loket, 2021)
Germany's Planen-Bauen 4.0 Maturity Assessment	2020	Assesses digital maturity in Germany's construction sector, focusing on BIM and digital engineering. Supports the national digital strategy.	Federal Ministry of Transport and Digital Infrastructure	Government agency	(BMVI, 2020)
New Zealand BIM Acceleration Committee (BAC) Maturity Assessment	2020	Evaluates BIM adoption across New Zealand's construction industry. Focuses on improving productivity and sustainability.	MBIE	Government agency	(MBIE, 2020)
France's Plan Transition Numérique dans le Bâtiment (PTNB)	2019	Assesses BIM maturity in France's building sector. Supports the transition to digital processes.	Ministère de la Transition Écologique et Solidaire	Government agency	(MTES, 2019)
Norway's Statsbygg BIM Maturity Model	2019	Assesses BIM maturity for public infrastructure projects. Focuses on improving efficiency and quality.	Statsbygg	Government agency	(Statsbygg, 2019)
Sweden's ByggaF Maturity Assessment	2018	Assesses BIM maturity in Sweden's construction sector. Focuses on improving collaboration and data exchange.	Swedish Construction Federation	Government-supported initiative	(ByggaF, 2018)
Denmark's Digital Construction Strategy	2018	Assesses BIM maturity and develops a roadmap for digital transformation in Denmark's construction sector.	Danish Enterprise and Construction Authority	Government agency	(DECA, 2018)
Spain's BIM Commission Maturity Assessment	2018	Assesses BIM maturity in Spain's construction sector. Focuses on improving public procurement practices.	Ministry of Public Works	Government agency	(Ministry of Public Works, 2018)
Italy's Piano Casa Italia Maturity Assessment	2017	Assesses BIM maturity in Italy's construction sector. Focuses on improving resilience and sustainability.	Ministry of Infrastructure and Transport	Government agency	(MIT, 2017)

Initiative/Project Title	Date	Description of Initiative/Purpose	Leading Entity	Type of Entity	Reference
Brazil's BIM BR Maturity Assessment	2017	Assesses BIM maturity in Brazil's construction sector. Focuses on improving public procurement practices.	Ministry of Regional Development	Government agency	(MRD, 2017)
South Africa's BIM Institute Maturity Assessment	2017	Assesses BIM maturity in South Africa's construction sector. Focuses on improving collaboration and data exchange.	BIM Institute	National not-for-profit	(BIM Institute, 2017)
India's BIM Adoption Framework	2017	Assesses BIM maturity in India's construction sector. Focuses on improving public procurement practices.	Ministry of Housing and Urban Affairs	Government agency	(MoHUA, 2017)
Finland's BIM Alliance Maturity Assessment	2021	Assesses BIM maturity in Finland's construction sector. Focuses on improving collaboration and data exchange.	Finnish BIM Alliance	National not-for-profit	(Finnish BIM Alliance, 2021)
Portugal's BIM Maturity Assessment	2020	Assesses BIM maturity in Portugal's construction sector. Focuses on improving public procurement practices.	Ministry of Infrastructure	Government agency	(Ministry of Infrastructure, 2020)
Colombia's BIM Adoption Strategy Maturity Assessment	2018	Assesses BIM maturity in Colombia's construction sector. Focuses on improving public procurement practices.	Ministry of Transport	Government agency	(Ministry of Transport, 2018)
Argentina's BIM Implementation Plan Maturity Assessment	2017	Assesses BIM maturity in Argentina's construction sector. Focuses on improving public procurement practices.	Ministry of Public Works	Government agency	(Ministry of Public Works, 2017)
Mexico's BIM Adoption Framework Maturity Assessment	2016	Assesses BIM maturity in Mexico's construction sector. Focuses on improving public procurement practices.	Ministry of Infrastructure	Government agency	(Ministry of Infrastructure, 2016)
Japan's i-Construction Maturity Assessment	2021	Assesses BIM maturity in Japan's construction sector. Focuses on improving productivity and sustainability.	Ministry of Land, Infrastructure, and Transport	Government agency	(MLIT, 2021)
South Korea's BIM Roadmap Maturity Assessment	2020	Assesses BIM maturity in South Korea's construction sector. Focuses on improving public procurement practices.	Ministry of Land, Infrastructure, and Transport	Government agency	(MLIT, 2020)
China's BIM Standardization Maturity Assessment	2019	Assesses BIM maturity in China's construction sector. Focuses on improving standardization and interoperability.	Ministry of Housing and Urban-Rural Development	Government agency	(MOHURD, 2019)

9.1.2 Maturity models

The table below provides a *partial* list of Maturity Models that have influenced the conceptual foundations of this project.

Table 11. Maturity Models

Title	Description	Date	SCALE	Citation
An Integrated Building Information Modelling, Integrated Project Delivery and Lean Construction Maturity Model	This thesis presents a framework that integrates Building Information Modelling (BIM), Integrated Project Delivery (IPD), and Lean Construction (LC) to assess and enhance organizational maturity in construction projects.	2024	Project	(Rashidian, 2024)
Digital twin — Maturity model and guidance for a maturity assessment	This standard aims to provide a generic digital twin maturity model, define assessment indicators, and offer guidance for conducting maturity assessments.	2024	Project [Product]	(ISO, 2024) (bsi, 2022)
Digital Twin Maturity Framework	Links BIM maturity to Digital Twin readiness, focusing on data connectivity, lifecycle integration, and digital infrastructure maturity to enable enhanced decision-making capabilities.	2020	Organization; Project [Product]	(CDBB, 2020)
BIM Macro Adoption Model	Explores BIM adoption on a national scale, focusing on government mandates, education, industry capability, and market readiness as key maturity factors.	2017	Market	(Kassem & Succar, 2017)
Macro Maturity Components Model	This model identifies eight components—such as objectives, champions, regulatory frameworks, and technology infrastructure—to measure and establish BIM maturity at macro levels.	2015	Market; Organization	(Succar & Kassem, 2015)
BIM Maturity Index (BIMMI)	Part of the BIM Framework, this model defines five maturity levels (Initial, Defined, Managed, Integrated, Optimized) to guide the progression of BIM adoption with increasing control and predictability.	2015	Organization	(BIMThinkSpace, 2015)
UK BIM Maturity Model (originally B/555 Roadmap)	Also known as the BIM Wedge by Bew and Richards, this model illustrates maturity levels from Level 0 (Unmanaged CAD) to Level 3 (Integrated BIM), emphasizing collaboration and data sharing.	2015	Organization	(bsi, 2015) (Thomson, 2016)
VDC Maturity Model	Part of Stanford University's research, this model evaluates the maturity of Virtual Design and Construction (VDC) processes and technologies within projects, emphasizing collaboration and integrated workflows.	2013	Project	(Kam et al., 2013)
BIM Capability Stages	Part of the BIM Framework, this conceptual model delineates three stages—Modelling, Collaboration, and Integration—representing marked changes in BIM adoption.	201o	Organization	(Succar, 2010)

9.1.3 Maturity assessment tools

The table below provides a partial list of Maturity Assessment Tools that were reviewed when developing the list BIM maturity improvement projects in Section 5:

Table 12. Maturity Assessment Tools

Title	Description	Date	SCALE	Reference
Assessor Platform	Developed by ChangeAgents AEC, this platform assesses BIM maturity at organizational and project levels, focusing on compliance, readiness, and capability. The tool was first developed in 2020 as BIM Excellence Online and then replaced in 2022 by the assessor.io platform.	2024	Individual, Organization; Project, Market	(ChangeAgents, 2020)
MiBIM Organisational BIM Assessment	A self-assessment web platform to measure the BIM maturity level of an organization, considering strategy, processes, people, and technology.	2024	Organization	(Global BIM Network, 2024)
Organizational BIM Assessment Profile	Developed by Pennsylvania State University, this profile assesses BIM project execution planning, tools, and collaboration experience.	2020	Organization	(PennState, 2020)
BIM Maturity Assessment Tool (BMAT)	Developed by the University of Cambridge, this tool uses established performance measurement practices to assess BIM development maturity and supporting processes, building on existing BIM assessment tools.	2020	Project	(Cambridge University, 2020)
SFT's BIM Compass	Hosted by the Scottish Futures Trust, this tool assesses BIM capabilities and compliance against UK standards for suppliers and procurers.	2019	Organization	(SFT, 2019)
Maturity Matrix: Self-Assessment Questionnaire	Provided by Project 13 under the Institution of Civil Engineers, this self-assessment questionnaire evaluates collaborative and digital maturity across five core areas.	2019	Organization	(Project13, 2019)
MiBIM (Matriz de Implementación BIM)	Developed by PlanBim in 2018, this free methodological support tool allows organizations to objectively self-assess the current state of BIM incorporation in their processes, focusing on planning, implementation, and maintenance actions across strategy, people, processes, and technology.	2018	Organization	(PlanBIM, 2018)
NBIMS Capability Maturity Model	Offered by the National Institute of Building Sciences, this tool evaluates organizational BIM maturity against a minimum BIM standard across 11 areas of interest.	2015	Organization	(NBIMS, 2015)
BIMetric	Developed by the Luxembourg Institute of Science and Technology (LIST), this method evaluates the degree of BIM integration in a project, focusing on practices and stakeholder maturity.	2015	Project	(LIST, 2015)
BIM Maturity Measurement Tool	An Excel-based tool designed by Arup and the Institution of Civil Engineers to measure understanding of BIM and guide organizations towards BIM Level 2, highlighting areas for improvement.	2015	Organization; Project	(ICE, 2015)
BIM Maturity Matrix	A knowledge tool by the BIMe Initiative for identifying the current BIM maturity of an organization or project team, structured around BIM Capability Sets and the BIM Maturity Index.	2015	Organization; Project	(BIMei, 2015)
BIM QuickScan	Developed by TNO, this tool provides a quick assessment of an organization's BIM maturity	2015	Organization	(TNO, 2015)

Title	Description	Date	SCALE	Reference
	across various dimensions, offering insights into strengths and areas for improvement. The tool is now offered by https://bimsupporters.com/			
IU BIM Proficiency Index	Developed by Indiana University, this index assesses the proficiency of BIM implementation within organizations, focusing on processes, technology, and policies.	2015	Organization	(IU, 2015)
VDC Scorecard	Developed by Stanford University's Center for Integrated Facility Engineering (CIFE), this benchmarking tool evaluates Virtual Design and Construction (VDC) maturity in projects based on planning, adoption, technology, and performance.	2014	Project	(CIFE, 2014)

9.1.4 BIM benefit calculation tools

The table below provides a partial list of BIM Benefit Calculation Tools that were reviewed when developing the list BIM maturity improvement projects in Section 5:

Table 13. BIM Benefit Calculation Tools

Tool Name	Provider	Summary	Reference
BIM Return on Investment Tool	Scottish Futures Trust	Estimates the benefits and level of return that adopting BIM Level 2 will bring to a project.	Scottish Futures Trust. (2024). **BIM Return on Investment Tool**. Retrieved from https://bimroi.scottishfuturestrust.org.uk/ on Dec 22, 2024
BIM Value Tool	NATSPEC	A decision-support tool that helps develop value realization strategies to identify and maximize benefits from implementing BIM.	NATSPEC & SBEnrc. (2024). **BIM Value Tool**. Retrieved from https://bimvaluetool.natspec.org/ on Dec 22, 2024
BIM Benefits Tool	University of Cambridge	Assesses benefits across time, cost, materials savings, health and safety, and risk reduction using impact ratings and monetary conversion.	University of Cambridge. (2024). **BIM Benefits Tool**. Available from https://www.cdbb.cam.ac.uk/ on Dec 22, 2024
BIM Maturity Matrix	BIM Excellence Initiative (BIMei)	Provides the BIM Maturity Matrix for assessing BIM capability and maturity across various dimensions.	BIM Excellence Initiative. (2015). **301in BIM Maturity Matrix**. Retrieved from https://bimexcellence.org/301in on Dec 24, 2024
Calculating Costs and Benefits of BIM in Public Tenders Methodology Handbook	EUBIM	Introduces a cost-benefit analysis (CBA) tool to assess BIM adoption in public tenders. The tool is intended to help public entities align with EU goals for digitalisation and sustainability.	EUBIM, (2021). **Calculating Costs and Benefits for the use of Building Information Modelling in Public Tenders.** Methodology Handbook. Retrieved from https://www.eubim.eu/wp-content/uploads/2021/10/Handbook-BIM_WEB_oct21_compressed.pdf on Dec 24, 2024.

9.1.5 BIM uses and use cases

The table below provides a partial list of *BIM Use* and *Use Case* taxonomies that were reviewed when developing the *Information Use* taxonomies in Section 3:

Table 14. BIM Uses and Use Cases

Title	Description	Number of Uses	Last Updated	Source
VA BIM Guide (2010)	Provides 19 requirements for using BIM, with 10 explicitly defined. The guide was updated to Version 2.2 on November 1, 2023, to align with current BIM practices and technologies.	9 Categories	Nov 1, 2023	https://www.cfm.va.gov/til/bim/BIM-Manual.pdf
New York City BIM Guide (2012)	Offers 15 well-defined BIM Uses to ensure consistent use of BIM across a wide range of building types and municipal agencies.	15	2024	https://www.united-bim.com/bim-uses-guidelines-ddc-ny/
Finland COBIM Standards (2012)	Presents 12 common BIM requirements across project phases to ensure consistent BIM practices in Finland. No publicly available updates since its initial release.	12	2012	https://wiki.buildingsmart.fi/en/04_Guidelines_and_Standards/COBIM_Requirements
Massport Authority BIM Guide (2014)	Details 51 well-defined BIM Uses to enhance project delivery and facility management for the Massachusetts Port Authority.	51	2021	https://www.massport.com/media/3243/massport-bim-guide.pdf https://www.massport.com/sites/

Title	Description	Number of Uses	Last Updated	Source
				default/files/2024-05/Massport-BIM-Guide-Appendix.pdf
The Port Authority of NY & NJ BIM Standards (2015)	Lists 38 BIM Uses without detailed definitions, aiming to standardize BIM processes across the Port Authority's projects.	38	2021	https://www.panynj.gov/content/dam/port-authority/pdfs/-available-engineering-documents/BIM-Standard.pdf
National Institute of Building Sciences (NIBS) – BIM Use Definitions (BUD)	Provides a standardized framework detailing 16 widely adopted BIM Uses across the construction industry, each defined with attributes such as prerequisites, inputs, and outputs. This list is based on the Penn State BIM Project Execution Planning Guide (2010), which had 25 BIM Uses mapped to four phases. This classification was partially adopted by the US National BIM Standards v3 (2015) and updated by Kreider and Messner as a Model Use Ontology (2015).	16	Dec 5, 2024	https://www.nibs.org/nbims-v3/bim-use-definitions
buildingSMART International – Use Case Management	Offers a repository of 41 BIM Use Cases, each documenting specific processes or tasks where BIM adds value, covering various lifecycle stages and disciplines. The Use Cases are in various stages of development and are available in English.	41	Dec 5, 2024	https://ucm.buildingsmart.org/use-case-management

9.2 Annex B – References

Annex B compiles all the references cited throughout the document. Where possible, these references include direct links to allow further inspection by industry researchers.

9.2.1 NRC publications

(NRC, 2024a)
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(NRC, 2024b)
Jalaei, Farzad; Sultan, Yasir; Poirier, Erik A.; Staub-French, Sheryl; Bhonde, Devarsh; Davari, Saman. (2024), **Digitalization and Productivity Research and Development Roadmap**, *NRC-CNRC*. Published March 2024.

(NRC, 2024c)
Goodland, Helen; Walsh, Kelly; Refour, Julien; Lam, Albert; Chatterton, Scott; Devereux, Mark. (2024), **Digital transformation of British Columbia's housing development sector**, *NRC-CNRC* and *SCIUS Advisory*. Published August 2024.

(NRC, 2024d)
Poirier, Erik; Cozzitorto, Claudia; Davari, Saman; Rezaei, Neda; Naderi, Esmaeil; Naghshzan, Zahra; Grenier, Mederick; Minicola, David; Jalaei, Farzad. (2024), **Towards a Digital Construction Platform at the National Research Council of Canada: Digitalization of National Construction Codes and Development of a National Common Data Framework**, buildingSMART Canada. Published November 2024.

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