INDUSTRY INSIGHT

buildingSMART International

Guidance for Regulators on use of openBIM

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For ease of reading, please note that

This format is for content that normally refers to ISO and/or other national or international standards.

This format is for reporting text published in other publications.

Background

buildingSMART International[1] is an international not-for-profit organisation, active in the built environment for over 25 years, with a mission to bring together the global community to develop and implement open digital standards and services that improve automation and decision-making throughout the built environment lifecycle, increasing productivity, sustainability and profitability.

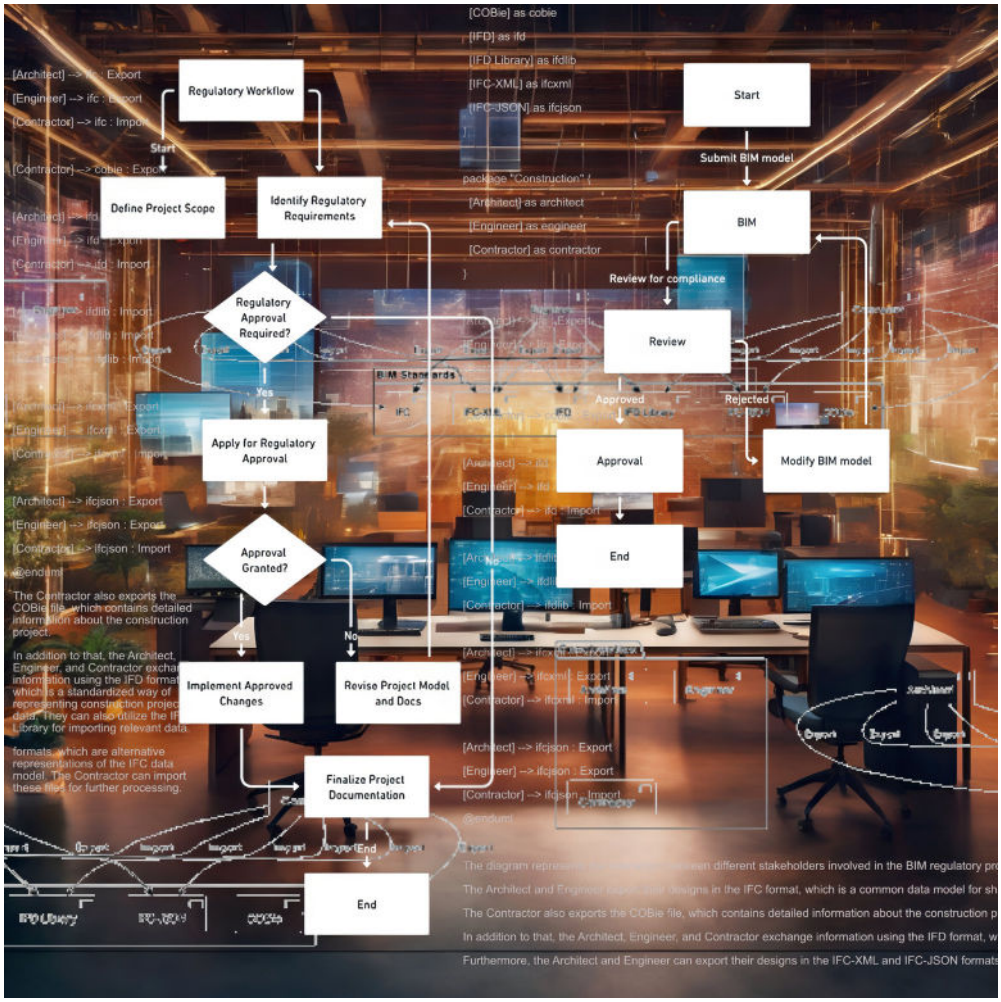
buildingSMART International's vision is the seamless exchange of trusted information across the built environment, achieved through the creation and maintenance of open and trusted digital standards and the promotion of their global adoption.

It works by channelling knowledge and concerns from a wide number of country 'chapters', while standards needs and evolutions are discussed in separate 'domain' groups, each focusing on one aspect of information flows.

Since 2014, the **buildingSMART International Regulatory Domain**[2], previously known as Regulatory Room is actively working at a global level to help project owners and regulators benefit from the use of openBIM®. The Regulatory Domain vision is an automated regulatory process, achieved by supporting a gradual change in workflow from manual to automated to ensure regulatory compliance.

The Regulatory Domain's mission is to make sure that the ability to represent facilities electronically – both buildings and infrastructure – on the supply side of the industry is complemented by the ability to represent the regulations, requirements and recommendations that comprise the demand side.

The outcomes from the projects and studies conducted by the Regulatory Domain have included reports on the business case for automated compliance checking, the technical challenge of obtaining regulations in machine-operable forms, the information required through the application forms and guidelines to support the transition of the building ecosystems to digitally regulated processes.



[1] https://www.buildingsmart.org/

[2] https://www.buildingsmart.org/standards/domains/regulatory/

1. Executive Summary

Currently, the construction industry contributes approximately 14% to global GDP, and its volume is expected to double by 2030 due to advancements in emerging markets and technological and sustainability demands.

However, the industry faces challenges in productivity and adapting to modernity, mainly due to fragmentation and slow digitalisation. The United Nations Sustainable Development Goal 11 "Make cities inclusive, safe, resilient and sustainable" highlights these issues and emphasises the urgent need for change, while some studies have shown that to date, construction remains one of the least digitised industries in the world.

It is a paradox that while virtually all built assets are digitally designed, more and more information and data are captured digitally in so-called Building Information Models [BIM] and home automation is driving the evolution of buildings, the industry lacks comprehensive digital data management systems. This hampers productivity and adaptability as critical information is often stored in isolated paper documents or in their dematerialised formats such as PDF files.

To address this, the industry has sought a standardised digital collaboration strategy, which has led to the development of openBIM, a set of open standards for building data interoperability, through buildingSMART International. These open standards enable interoperable digital communication and data exchange, overcoming barriers such as data general readability, long-term archiving of information and vendor lock-in.

Regulatory complexity poses a significant challenge to digital transformation in the construction sector, requiring an incremental approach to effective management and a legally compliant digital language. openBIM addresses these concerns by facilitating communication between regulators and industry stakeholders, ensuring compliance with international standards, and supporting the gradual evolution of processes involving rule change and digital platforms.

The global trend towards digitisation of regulatory processes, accelerated by the pandemic, shows that change is under way and inevitable, and effectively underlines the importance of openBIM standards, which we see forming the basis of automated compliance checks for buildings being rolled out in several countries, including Dubai and Singapore later this year and Finland and Estonia soon after.

While the path to digitisation is complex this guide aims to address key issues and advocate for a standardised approach to building e-permitting, including supporting legislators to recognise the transformative nature of digitisation and adapt regulations accordingly.

In summary, the main message we can report from the guidance is that collaboration within the international community of regulators can facilitate the realisation of a productive, transparent, reliable and fully digitised construction ecosystem that includes, or is somehow enhanced by, a digitised regulatory process.

This view is effectively corroborated by the lessons learned from the experience of the first regulators to successfully tackle the challenge of digital e-permitting, and by the trends of change in building regulation that we can see internationally thanks to the ongoing monitoring of building innovation championed by buildingSMART International.

2. Introduction

2.1 Scope of the guidance for regulators on using openBIM

The purpose of this guide is to explore, from a global perspective, why and how the adoption of Open Building Information Modelling (openBIM) standards in digital building permitting would accelerate all regulatory processes while improving their quality, veracity and accuracy.

The guide includes references to ISO standards to reinforce the legal requirements that are essential for the digitisation of building permits and explains how some of these requirements have been addressed. It also provides support for assessing the feasibility of e-permitting projects for buildings and outlines some key decisions needed to effectively address this challenge.

To achieve these goals, we draw on the successes and lessons learned from regulators around the world as they address their project challenges.

The document is aimed at those involved in the building permitting process, particularly those working and managing these processes in regulatory organisations.

2.2 Building Information Modelling (BIM)

Building Information Modelling (BIM) is a collaborative approach/methodology for the construction industry that leverages the digital representation of a building's physical and functional characteristics. It integrates all aspects of building design, construction and operation into a digital model.

BIM is defined in ISO 19650-1:2018 as follows:

"Building information modelling - BIM : use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions"

BIM is not only used in construction, but also support the entire lifecycle of the building, from design, construction, operation and maintenance to decommissioning, as all relevant information can be stored and managed in one place.

It is important to understand that BIM is different from CAD (Computer Aided Design), which is a drawing tool that allows the management of lines, curves, shapes and symbols that digitally just represent the design of the building. BIM, as a methodology is for collaboration and communication between all stakeholders of the AEC industry at any stage of the construction process, requires the computer model to contain not only the geometry of the building, but also the technical components and information related to each geometrical element, such as materials, properties, functions, costs, etc., as well as their relationships, represented in a scheme with a well standardised human readable and understandable language to avoid misinterpretations.

2.3 GIS[3] and BIM integration

Figure 1: Geographic Information System

[3] Chapter edited with the kind collaboration of the Open Geospatial Consortium (thanks to Francesca Noardo)

The Geographic Information System (GIS)[4] is a computer-based information system designed to capture, store, retrieve, manipulate, manage, model, share, analyse and present geographically referenced digital data, including raster and vector data[5]. The scope of GIS representation is typically the depiction of wide portions of land and cities, including themes such as buildings, roads and water networks, land cover and use, terrain, infrastructure, facilities and utilities, vegetation and any other information relevant for the specific application. GIS data (either 2D or 3D) accuracy and level of detail are comparable to traditional cartographic products.

Data are usually produced starting from the survey of what exists in the city and land, rather than coming from a design action, and a cartographic generalisation is applied to allow a suitable representation of objects to support effective analysis, relevant data retrieval as well as agile data management. It is the underlying technology for the familiar geographic services and tools we use in our mobile devices, and has many applications, supporting research and decision making.

For example, common use cases are the management of cadastral systems, of environmental information, including land cover and land use information, hydrographic information and other dynamic data (e.g. from sensors, such as pollution data, weather data, traffic data and so on). GIS support automating technical workflows such as cartographic production and image analysis; in other words, the capacity of GIS is currently being used to implement public policy decisions.

Similarly, digital building permits require GIS management to store and analyse data from the urban environment and the widest city context, while BIM does the same with data for buildings and urban infrastructure.

BIM-GIS integration is becoming increasingly important as the two kinds of data, as well as the related tools, address different needs and can provide complementary analysis and functionalities. For example, digital building regulations often refer to both kinds of information, which can equally serve a growing number of applications in the different phases of a built asset's life cycle, from design and construction to management, maintenance and demolition.

2.4 openBIM®

openBIM® [referred to as openBIM in this document] is the open version of BIM, which means it is openly accessible and usable by anyone and uses an open licence that allows for extensibility.

buildingSMART International is the not-for-profit global agency that manages the development and dissemination of openBIM standards.

openBIM[6] extends the benefits of BIM (Building Information Modelling) by improving the accessibility, usability, management and sustainability of digital data in the built asset industry.

At its core, openBIM is a collaborative process that is vendor neutral. openBIM models can be defined as digital sharable project information that supports seamless collaboration for all project participants and facilitates interoperability to benefit projects and assets throughout their lifecycle.

OPENBIM IS VALUABLE BECAUSE :

1. INTEROPERABILITY IS KEY TO THE DIGITAL TRANSFORMATION IN THE BUILT ASSET INDUSTRY

2. OPEN AND NEUTRAL STANDARDS SHOULD BE DEVELOPED TO FACILITATE INTEROPERABILITY

3. RELIABLE DATA EXCHANGES DEPEND ON INDEPENDENT QUALITY BENCHMARKS

4. COLLABORATION WORKFLOWS ARE ENHANCED BY OPEN AND AGILE DATA FORMATS

5. FLEXIBILITY OF CHOICE OF TECHNOLOGY CREATES MORE VALUE TO ALL STAKEHOLDERS

6. SUSTAINABILITY IS SAFEGUARDED BY LONG-TERM INTEROPERABLE DATA STANDARDS

[4] https://www.ogc.org/resources/ogc-glossary/
[5] Worboys M.F. & Duckham M (2004) GIS: a computing perspective GRC press
[6] https://www.buildingsmart.org/about/openbim/openbim-definition/ openBIM is a BuildingSMART trade mark

The adoption of openBIM is essentially linked to the sustainability of the building asset ecosystem, the strategic roadmap[7] for openBIM aligns with several of the United Nations' Sustainable Development Goals (SDGs).

Figure 2: Sustainable development goals affected by openBIM adoption

openBIM components are included in the official global suite of standards (ISO and other global standards[8]). Its use is highly boosted by global acceptance as a well-accepted semantic tool to communicate digitally using building consistent models in 3D, both in the digital industry and by regulatory bodies.

2.5 Regulatory bodies & building permitting

Numerous OECD reports provide detailed insights into specific aspects of the building regulatory challenge. For instance, they shed light on the prolonged duration necessary to obtain a building permit, a phenomenon observed in many countries, such as detailed for Slovenia[9]. Furthermore, more advanced analyses, such as the one conducted in Germany in 2023[10], delve into comparisons between permit productivity and sustainability objectives. Additionally, certain academic studies[11] have undertaken the task of estimating the overall economic benefits stemming from a significant improvement in building permitting performance.

All preceding reports highlight, as a prominent concern, the lack of homogeneity in regulatory regulations. This disparity often arises due to the structural complexity of the regulatory bodies themselves, stemming from both geographical variations and competency-related factors.

The regulatory bodies

The number and complexity of building regulatory bodies or building departments can vary considerably depending on country, location, the size of the jurisdiction and the specific regulations and standards in place.

Describing and comparing regulatory organisations in the deep is beyond the scope of this global guide but classifying them from a data flow perspective may be helpful.

[7] BuildingSMART International Annual Report 2022
[8] as detailed in the following "Data and standards" chapter in this guide
[9] https://www.oecd-ilibrary.org/economics/it-takes-long-time-to-get-a-construction-permit_59816a62-en
[10] https://www.oecd-ilibrary.org/economics/the-administrative-burden-is-high_c719749a-en
[11] https://www.worldbank.org/content/dam/doingBusiness/media/Miscellaneous/Conference2014/2014-GETE-permits-interest-rate---macro-dynamics.pdf

The data flow point of view

We could summarise that from a regulator point of view, his interactions could generally be seen as in the figure[12] here close, where two-way transactions are directed to asset owners and designers, especially in the permitting phases, and facility managers and supply chain for the public assets management.

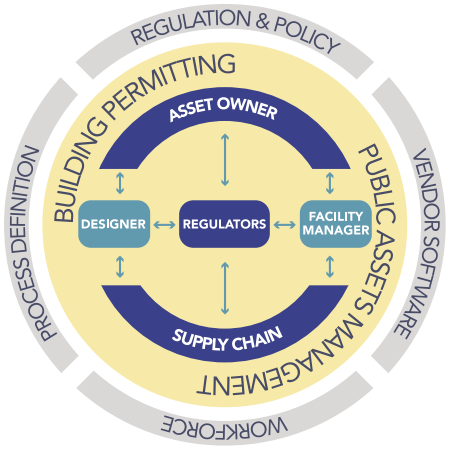
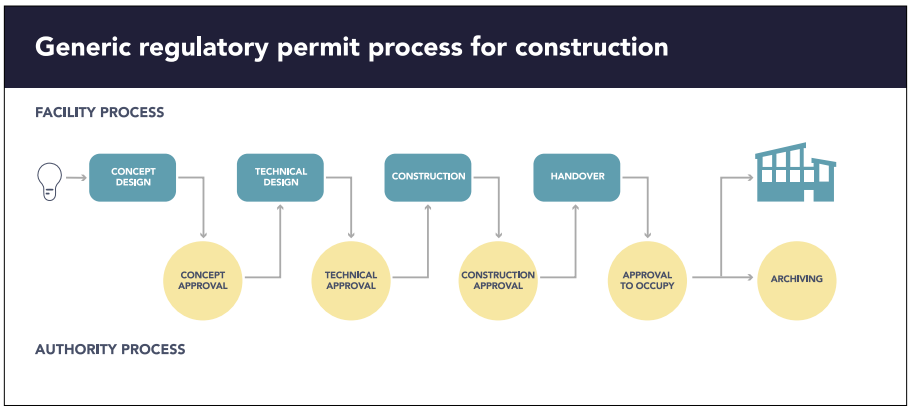


Figure 3: Regulators main data flows

Research conducted by buildingSMART International[13] reports that the generic global permit process can be summarised as follows



As there is no doubt about the authority's control over the whole permitting process' steps and the submitting role of the construction industry, there is evidence that there are two main organisational models to support the permitting process.

Two-tier model

The regulatory process is fully managed by public organisations and data exchange is directly between submitters and national and/or local authorities.

Three-tier model

There are agencies (private or semi-public) mandated by the authorities to partially and/or fully manage and optimise the exchange of data with industry or private submitters. The rules governing the activities of the agencies, the compliance of the agencies' activities and a final approval (sometimes only in case of exceptions) are maintained and controlled by the public authorities.

This classification is, of course, a simplified view of the state of the art, and in different jurisdictions, many other subjects, such as citizens' committees, perhaps better defined as permit issuing entities[14], may be involved and engaged in the processes through other or integrated mechanisms.

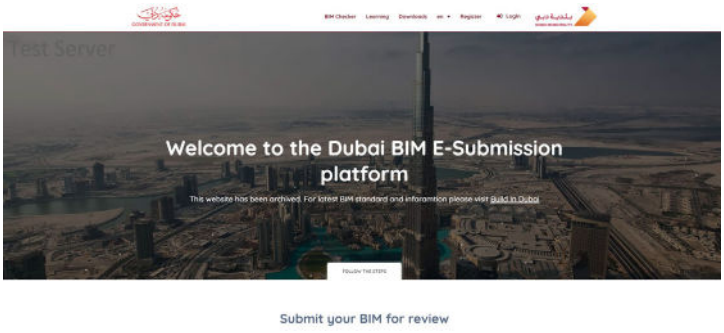
The interesting evidence is that examples in both models see a positive impact due to the adoption of open standards in the permitting process, because in both environments communication is simplified not only between the industry and the approval bodies, but also within the bodies themselves and/or other permitting issuing entities.

[12] T,Henttinen – BuildingSMART Int.l RIR project
[13] M.Muto : Aug.2020 e-submission common guidelines for introduce BIM to building process: https://www.buildingsmart.org/wp-content/uploads/2020/08/e-submission-guidelines-Published-Technical-Report-RR-2020-1015-TR-1.pdf

Two-tier model – Dubai

The digitalisation of the building permit process in Dubai is fully managed by the national (Government of Dubai) and local (Dubai Municipality) institutions.

They own and manage the BIM e-submission platform.[15].

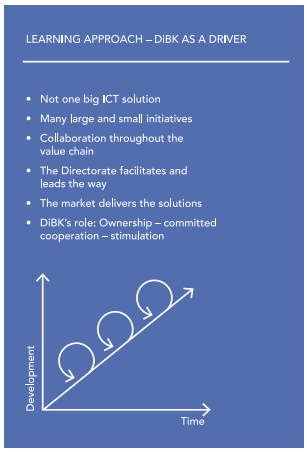


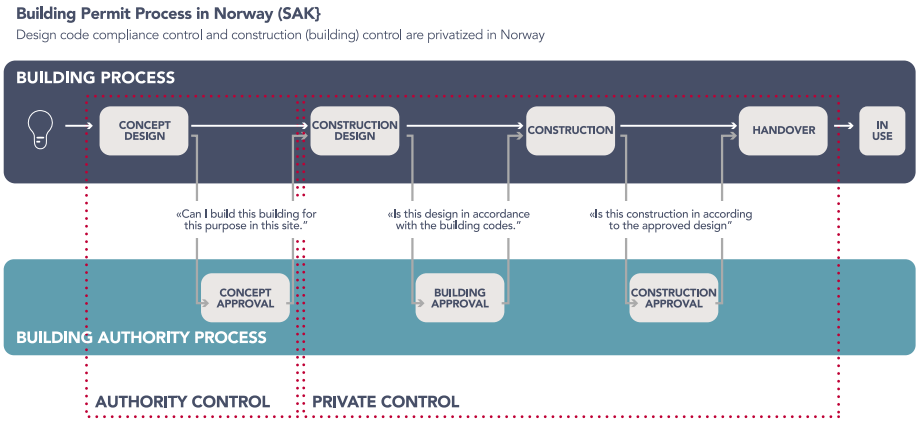
The platform aims to progressively automate all requirements specified in the Dubai Building Code (DBC), which incorporates, unifies and replaces the building design regulations issued by Dubai Municipality (DM), Dubai Development Authority (DDA), Department of Planning and Development - Ports Customs and Freezone Corporation (Trakhees) and Dubai Silicon Oasis Authority (DSOA). Many other regulations, such as those related to building design by the Dubai Electricity and Water Authority (DEWA) and the Islamic Affairs and Charitable Activities Department (IACAD), are incorporated or cross-referenced by the DBC.

Three-tier model – Norway

Norway is probably one of the first countries, along with Singapore and Korea, to embark on the project of developing a digital building permit on a national scale.

From the outset, their approach has been based on a three-tier model[16].





The vision of the Norwegian Building Authority [DiBK - Direktoraet for byggkvalitet] is digital self-service that makes the permit application process easier and more predictable. ByggNett, the Norwegian digital platform for building management, has been the strategy since 2014.

The authority's role is clearly to support the development of a system that makes the digital building permit system a citizen- and industry-led platform.

Of course, this approach has required detailed and well-defined data standardisation from the outset, which explains the driving role of national building authorities, industry and software vendors in the development of open standards for BIM.

[14] EU project - CHEK
[15] https://bim.geodubai.ae/
[16] Oivind Rooth – Digital Building Permit in Norway – 19/9/23 . buidingSMART Summit Lillestrom Norway

3. Why openBIM helps the regulatory process

We have already mentioned fragmentation as a reason for the slow adoption of digital transformation in the construction ecosystem with many small and medium-sized enterprises and municipalities that may lack the resources or expertise to implement digital technologies.

Add to this the fact that construction projects are often highly customised and built assets have been built and modified over centuries, and that their data model, while not digital, is in most cases unavailable, unreliable or lost, and you would have a common, silent scepticism in the construction industry that opening up this immanent ecosystem to a digital view is not feasible, or could only be possible in the distant future.

Notwithstanding the above, the need for a change is inevitable.

By example, in EU, over the past two decades, the labour productivity has grown at around a quarter of the rate in manufacturing (1.0% vs. 3.6% respectively) making the construction sector the poorest performer in terms of productivity.

in the post-pandemic period, there has been an important increase in awareness of the opportunities and needs to improve digitalisation in the construction industry, but the process seems to be moving slowly.

The latest RICS Digitalisation in Construction report[17] shows that despite increased interest in 2023 in the vital role of digital technologies in the construction industry, particularly in tackling climate change and driving economic progress, digital adoption in the sector is stagnating, particularly in areas such as carbon emissions calculations and whole-life assessments.

Fortunately, the increasing availability of simpler and cheaper technologies is changing attitudes too, and it is now widely accepted that an existing built asset can be captured[18] in a reliable three-dimensional digital model. This also helps to dispel scepticism about the ability to develop a digital twin[19] for entire cities[20] and that creating the City Information Model (CIM[21]) is not just a dream.

In Europe[22], within ten years, it is estimated that full-scale digitalisation in non-residential construction would lead to annual global cost savings of EUR 0.6 trillion to EUR 1.0 trillion (13% to 21%) in the engineering and construction phases and EUR 0.3 trillion to EUR 0.4 trillion (10% to 17%) in the operations phase.

3.1 Construction industry digitalisation standards requirements

As the digitisation of the construction sector is increasingly recognised as a potential game changer, there is a growing awareness of the need for a common digital 'language' or, more correctly, for a standardised open semantics.

Specifically, the need for a digital standard in the construction industry arose at the end of the last century in response to the following growing business needs which were:

1. Increased Complexity of Building Projects: Modern construction projects are totally digital and have become increasingly complex, involving multiple stakeholders, various software tools, and a vast amount of data.

2. Interoperability Issues: The construction industry has faced, and continues to face, the challenge of digital interoperability - the difficulty of sharing information and data between stakeholders. In fact, different software applications used in architecture, engineering and construction (AEC) have not been able to communicate effectively with each other, leading to data silos and inefficiencies.

[17] https://www.rics.org/news-insights/digitalisation-in-construction-report
[18] https://en.wikipedia.org/wiki/Point_cloud
[19] https://www.buildingsmart.org/the-role-of-digital-twins-in-driving-sustainability-a-three-horizon-approach/
[20] https://neuroject.com/city-information-modeling-cim-ultimate-guide-2023/
[21] https://neuroject.com/city-information-modeling-cim-ultimate-guide-2023/
[22] https://joinup.ec.europa.eu/collection/rolling-plan-ict-standardisation/construction-building-information-modelling

3. Emerging Digital Technologies: The rise of digital technologies and computer-aided design (CAD) in the construction industry necessitated a standardised approach to data exchange.

4. Globalisation of the Industry: As construction projects began to take place on a global scale, the need for a common, standardised approach to Building Information Modelling became apparent.

5. Efficiency and Cost Reduction: There has always been a great demand to improve efficiency and reduce costs in construction projects.

6. Sustainability and Safety compliance: The increasing global demand for building sustainability and safety is driving the need for highly detailed control documentation at both project and maintenance level, which can only be met by an interoperable, durable, yet easy to use, integrated database that follows the entire building lifecycle.

Most of the problems identified so far for the construction industry can also be applied to regulators, especially when several authorities are involved in the granting of a building permit, but a more specific analysis of the benefits for regulators is provided in chapter 3.2.

3.1.1 openBIM standards and the construction sector

The adoption of openBIM in the construction and infrastructure industry is reported to fulfil the requirements as in the following

1. Interoperability: openBIM allows interoperability among different software tools and platforms used in the construction and design processes. This allows different stakeholders, such as architects, engineers, contractors, controllers, regulators and facility managers, to work together seamlessly and exchange information in a standardised format.

2. Collaboration: openBIM encourages collaboration and information sharing among all parties involved in a construction project. It helps break down data silos and enables teams to work together more efficiently, reducing errors and misunderstandings.

3. Cost and Time Efficiency: openBIM can lead to cost savings and time efficiencies in construction projects. With standardised data exchange, project teams can streamline their workflows, leading to faster decision-making and reduced errors and project delays.

4. Data Continuity: openBIM ensures data continuity throughout the entire building lifecycle. Information can be used from the initial design phase through construction, operation, and maintenance, including building decommissioning. This continuity helps improve building performance and management.

5. Long-Term Sustainability: openBIM supports long-term sustainability efforts by providing access to valuable information for building operation and maintenance. This can lead to more efficient energy use, reduced maintenance costs, and improved building performance.

6. Standardisation: openBIM is based on open standards, such as Industry Foundation Classes (IFC) developed by buildingSMART, promotes a common language for data exchange. This standardisation helps ensure consistent and accurate information sharing.

7. Industry Trends: As the construction industry continues to evolve, digitalisation, automation, and information management have become more prominent. openBIM aligns with these trends by providing a framework for efficient digital collaboration and data management.

8. Global Adoption: openBIM has gained acceptance and adoption worldwide. Building professionals, software developers, and organisations recognise its benefits, making it a global standard for information modelling in the building industry.

Overall, openBIM has become an almost essential tool in the construction industry due to its capacity to enhance collaboration, data exchange, and the overall efficiency of building projects. It has the potential to transform the way buildings are designed, constructed, and managed, benefiting all stakeholders involved in the building lifecycle.

3.1.2 Historical overview

The specific timing of when openBIM was first used can be challenging to pinpoint, as it evolved gradually over time. openBIM principles and standards, such as the Industry Foundation Classes (IFC) developed by buildingSMART, have been in development since the late 20th century.

In the early 21st century, openBIM gained broader recognition and adoption as more stakeholders in the construction industry saw the benefits of open standards, interoperability, and improved collaboration. Since then, openBIM, continuously supported by buildingSMART activities and projects, has continued to evolve, and its adoption has expanded as technology and industry practices have advanced.

Why openBIM: some history[23]

BIM provides a source of federated and reusable information through 3D modelling. This can include geometry, spatial relations, geographical information, quantities and properties of construction elements, cost estimates, inventory material and project schedule. (Le & His ung,2014).

The model can be used throughout the project life cycle (Bazjanac, 2006; Eastman et al., 2011).

BIM provides not only virtual 3D models, but also visualizations (Azhar, Nadeem, Mok,& Leung, 2008; Bentley, 2018; BIMhub, 2018) and a better understanding of a project. It also facilitates communication between stakeholders (Le & Hsiung, 2014). Therefore, the sharing and exchange of information is more efficient, and information circulates in real time throughout project development.

BIM has a profound impact on construction project participants (Smith, 2014; Xiao & Noble, 2014) by reason of risk and knowledge sharing. It helps avoid serious financial losses and scheduling impacts.

3.2 openBIM advantages for regulators and authorities

While there is no doubt that openBIM was first adopted by the construction industry, its adoption in the regulatory sector has become increasingly important to both the industry and regulators as the compliance process has become more complex and collaborative.

3.2.1 Technological Neutrality

Most of the requirements laid out by government agencies or municipalities are software independent. It is frequent to see requests being done in open standards, such as PDF, with definitions made by the corresponding ISO Standard (ISO 32000).

In many countries, these global principles[24] are incorporated and detailed in national regulations and guidelines[25] on the general interoperability required for digital data for public use.

The use of open standards is very important to guarantee independence in the choice of technological alternatives for citizens and companies, to avoid discrimination in tendering procedures and to promote interoperability in the exchange of information between stakeholders along the life cycle of the built asset.

The opposite picture of requiring a specific proprietary format could have complex consequences, leaving governments and the whole building ecosystem in the hands of a software company that could at some point raise prices with no valid justification, or fail do develop an important feature for proper functioning of public processes, not to mention when the software company closes down, leaving digital processes in place, or worse, data blocked from further development.

[23] BIM for Municipalities White paper (CA)
[24] By example : new European Interoperability framework
[25] In Italy, Decreto legislativo 7marzo 2005, n.82

The well documented 'vendor lock-in' situation, as described above, can have catastrophic consequences, and should be avoided at the root of implementation of any process, especially in regulatory bodies and public offices.

The openBIM IFC [Industry Foundation Classes] data format, managed by buildingSMART and continuously updated in ISO 16739, underpins the above requirements for neutrality and openness, but the entire suite of related openBIM standards (see section 6) is designed and maintained to ensure neutrality in all aspects.

3.2.2 Data continuity and long-term sustainability of data and systems

While the concept of backward compatibility, ensuring software interoperability with older systems or versions, is prevalent in the software realm, it's noteworthy that several widely used Building Information Modelling tools offer limited backward compatibility, if any at all. This poses a potential challenge, as BIM models created in certain authoring tools may become inaccessible or unusable just a few years after their creation, especially considering the prevalent subscription-based sales model and automatic software updates that encourage users to adopt the latest versions.

In this context, the risk arises that BIM models, not updated within the backward compatibility window, could be lost indefinitely. Compounding this issue is the proprietary nature of file formats, preventing interpretation without public documentation and forbidding reverse engineering. On the contrary, open standards and model representation schemas, like Industry Foundation Classes (IFC), typically exhibit backward compatibility with older versions and offer a publicly available specification. This ensures interpretability and usability of the model files even decades after their creation.

Though backward compatibility may not be a concern during the brief delivery phase of a built asset, scenarios where projects are halted after the design phase and resumed years later due to financial or permitting difficulties underscore the importance of maintaining compatibility. A more common situation arises during building renovations, where project model files become obsolete, unable to be viewed or modified due to the lack of software support. Preserving an openBIM version of model files becomes crucial in these instances.

From a regulatory standpoint, the ability to recover and view model information is paramount in legal disputes, accidents, regulatory reviews, audits, etc., which may arise many years after the initial model submission during the permitting process. This underscores the need for an openBIM approach to ensure the longevity and accessibility of BIM models, that makes it legally compliant. The open legal 3D model is often called MALD[26] (Model As a Legal Document) in the US[27].

3.2.3 Collaboration with industry

The interoperability and communication values of openBIM have been widely recognised by authorities and regulators, and in several countries and jurisdictions, openBIM has been adopted as a part of regulatory and building permit requirements.

An open and globally accepted standard allows in fact different stakeholders to exchange data more effectively, regardless of the software or tools they use, and is clearly the preferred data language[28] for regulators as the approval process evolves to use 3D models of buildings and infrastructure.

The use of an open standard at the public level would also improve the competitiveness of the construction industry, as more companies would be able to access public tenders and/or permitting processes by breaking down the barriers of proprietary data formats.

This has a particularly positive impact on SMEs[29], which can avoid restrictions and continue to define their digital strategy and therefore the tools they will use to develop projects.

[26] https://www.enr.com/articles/58217-taking-steps-toward-model-as-the-legal-document-mald-through-data-standards
[27] https://www.fhwa.dot.gov/construction/econstruction/hif20027.pdf
[28] https://f3h3w7a5.rocketcdn.me/wp-content/uploads/2022/05/Regulatory_Process_Survey_bSI.pdf
[29] Small-Medium Enterprises

An EUBIM study[30] reports that competitiveness is essential for good economic policy and that the use of the open standard is a win-win approach that will increase productivity for both regulators and industry.

Other studies have gone as far as quantifying the benefit to regulatory bodies and the building industry of using a common, open data environment.

The value proposition for industry and government is estimated to increase significantly when both effectively collaborate digitally in a Common Data Environment [CDE], which is the foundation of openBIM-based regulatory platforms, as reported by more than 70% of the 250 organisations surveyed by buildingSMART International in 2022[31].

3.2.4 Regulatory internal harmonisation

Another aspect of increasing the adoption of openBIM in government is that the use of open standards and interoperable software in openBIM helps to foster collaboration within and between government and/or regulatory agencies, as architects, engineers, contractors and other stakeholders involved in the design and construction control process can be supported by sharing data in models rather than in 2D documents like PDFs or paper maps, as this collaboration leads to more efficient workflows and improved communication, reducing errors and rework.

openBIM also promotes the use of data management and analysis tools that enable stakeholders to better understand the impact of design decisions on the construction process and building performance. This includes tools for energy analysis, sustainability assessment and lifecycle management.

In addition, openBIM facilitates the exchange of information across the different stages of the building lifecycle, from design and construction to operation and maintenance. This helps to ensure that building information is accurate and up to date, which can improve building performance and reduce maintenance costs.

[30] https://www.eubim.eu/downloads/EU_BIM_Task_Group_Handbook_FINAL.PDF
[31] Understanding the role of BIM and Common Data Environments ("CDE") today and expectations for the future

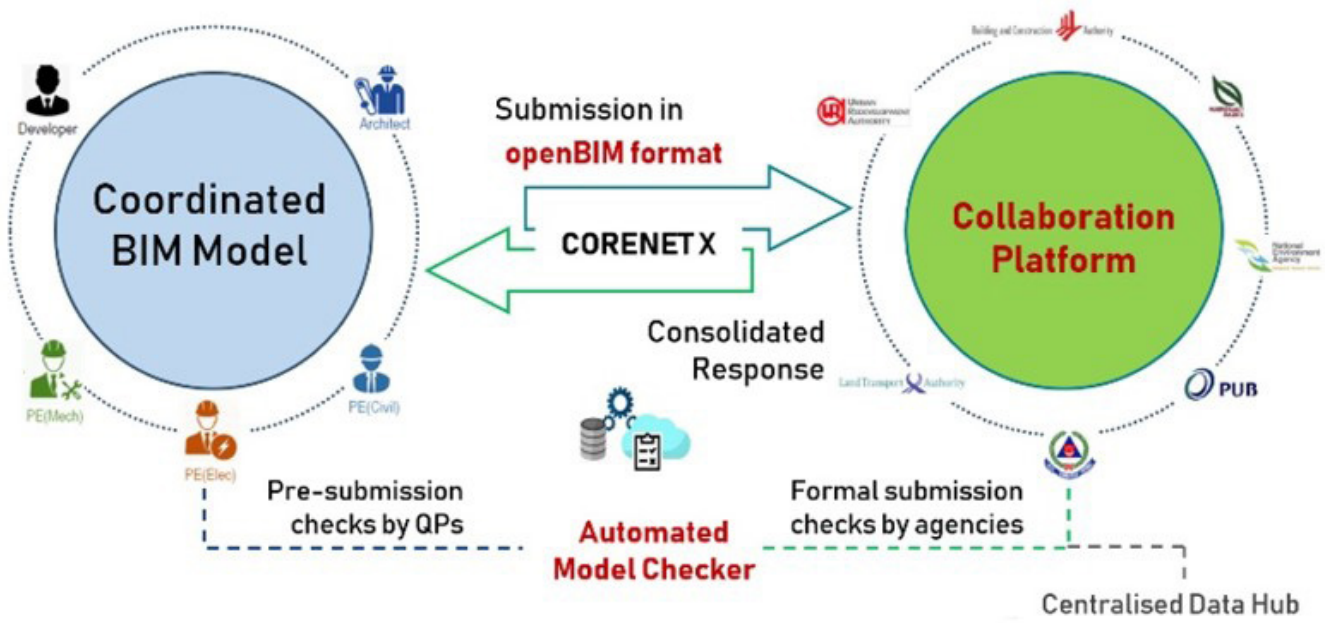
The Singapore case study

https://www1.bca.gov.sg/regulatory-info/building-control/corenet-x/corenet-x-faqs/general-information

Singapore is one of the countries that first experimented a digital process for approval in construction.

Launched in November 2001, the Construction & Real Estate Network (or CORENET) is a Government to Business system that enables built environment professionals to make project-related electronic submissions to regulatory agencies for approval within a secured environment, from anywhere at any time.

At the moment Singapore is launching a new system to support the process, CORENET-X.



When CORENET was introduced in 2001, the system allows separate submissions to the various agencies for regulatory approval based on project progress. This supports expedience and is pro-business for the industry. Nonetheless, this is not without trade-offs. The practice of separate submissions based on project progress also meant that the plans are prepared and submitted at different stages of a project. Consequentially, the regulatory agencies would review the plans at different stages and convey their respective comments. Industry practitioners would have to address these comments and incorporate them into their design and re-submissions while ensuring that the changes will not affect what had been previously approved by the other agencies.

The advent of openBIM and emerging technologies presents the opportunity for the current modus operandi of the regulatory approval process to transform, becoming more integrated and smarter. CORENET X will change the current practice of requiring each consultant to deal separately with multiple agencies to one where the project team comes together to produce and submit a coordinated openBIM model for respective agencies to extract information for compliance review. Agencies will review the submission collectively and provide a consolidated response to the project team. The integrated submission process will improve regulatory governance and synergy among agencies, providing a One-Stop Integrated Digital Shopfront experience.

3.2.5 Automatise the permitting process

The automation of building permit controls is arguably the dream feature that has driven most the adoption of openBIM in the regulatory domain.

Back in 2014, the buildingSMART Regulatory Domain itself was established to research and provide a roadmap to achieve this iconic result. Since then, however, it has become clear to all that the goal can only be achieved incrementally, and that a long-term transition project is the only way to get there.

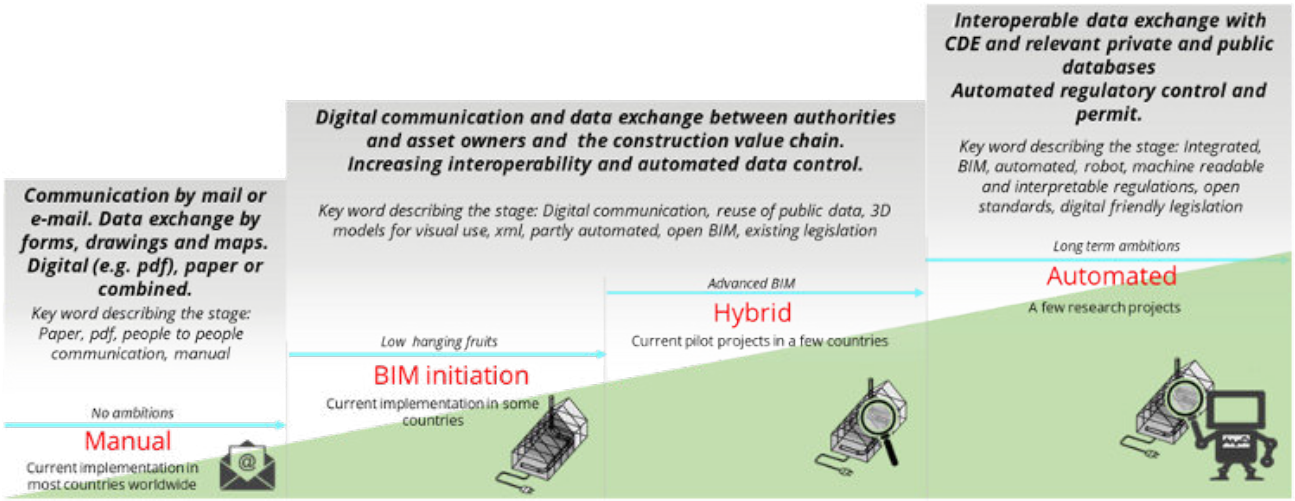


Figure 5: Maturity map construction permit process with openBIM[32]

It's now clear that this automation will be a game changer in the organisation and management of data in the regulatory structure, so much so that the Guide devotes another entire chapter (5.1.4) to this topic.

3.2.6 openBIM supports managing and maintaining public assets

In the public services sector, the efficient management and maintenance of assets is vital to the well-being and safety of communities. Public services encompass a wide range of assets, from schools and hospitals to transport infrastructure and government facilities, where the construction, management and maintenance issues can almost overlap with those of the construction industry previously reported.

openBIM could prove to be a powerful tool to address the unique challenges faced by public service organisations but is likely to add even more value to the proposition[33].

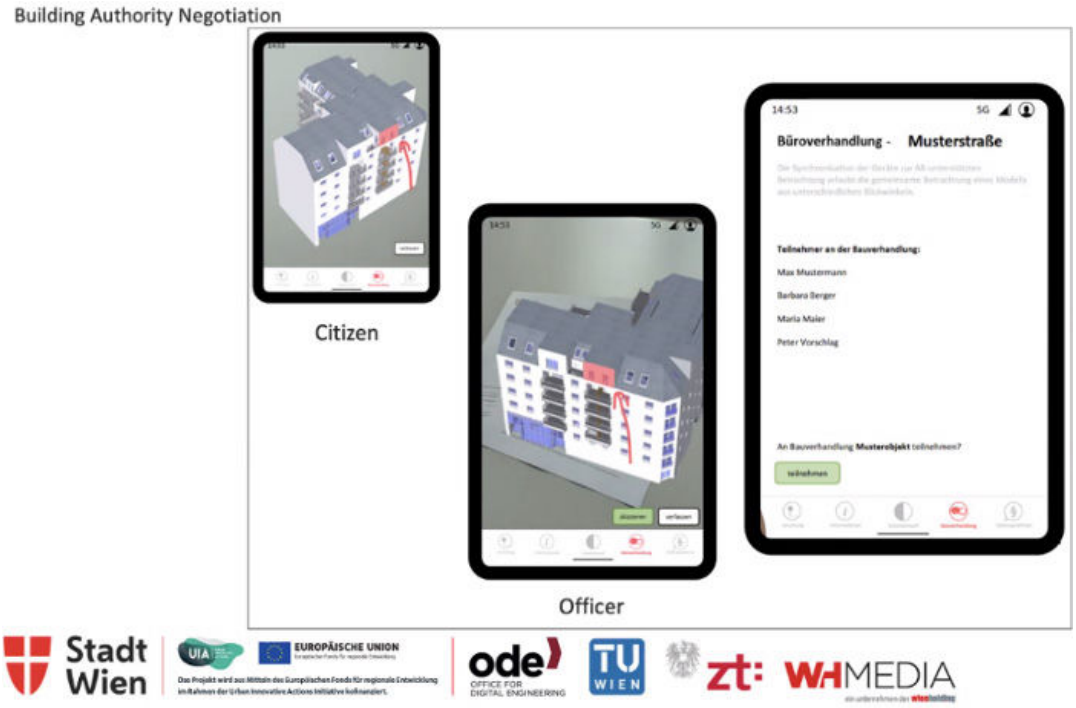
In fact, as an open digital standard, openBIM not only addresses the gaps in interoperability, cost-effectiveness, sustainability, and safety and compliance, but can also provide a foundation for:

- **Data unification:** Public service assets are diverse, often spanning multiple disciplines. openBIM unifies data across these different domains, ensuring that all assets, whether buildings, transport systems or utilities, are managed effectively.
- **Transparency:** Transparency is essential in public services. openBIM provides a transparent framework for data sharing and collaboration, enabling government agencies, contractors and the public to access accurate and up-to-date information.
- **Traceability:** As an open standard, the IFC format is designed to provide traceability and control at the lower data level, an essential feature for a long-term process such as asset maintenance.

[32] e-submission common guideline for introduce BIM to building process M.Muto – 2019
[33] https://www.buildingsmart.org/government-policy-makers/

3.2.7 openBIM supports to citizens engagement in urban evolutions

Effective citizen engagement in building permitting is often not only a matter of democracy, but also an important step in avoiding later legal or social disputes, and openBIM standards are the most suitable support for the tools to make the process transparent and more agile.



*The **City of Vienna (Austria)** and its Technical University (TUW) experienced a citizen engagement project during BRISE[34], an advanced project of the City Building Verification System based on openBIM. As shown in the picture, citizens were informed about the future building environment and asked to express their comments and issues directly on the building model. The use of these tools showed a clear gain in speed to result, as citizens were able to explore the impacts between neighbouring buildings before meeting with the authorities. In another pilot experience of using AR[35] to make it easier and more effective, the submitted BIM model is not embedded in the digital as-built model of the city, but is displayed on site, directly between the adjacent buildings, thus enabling higher forms of citizen participation.*

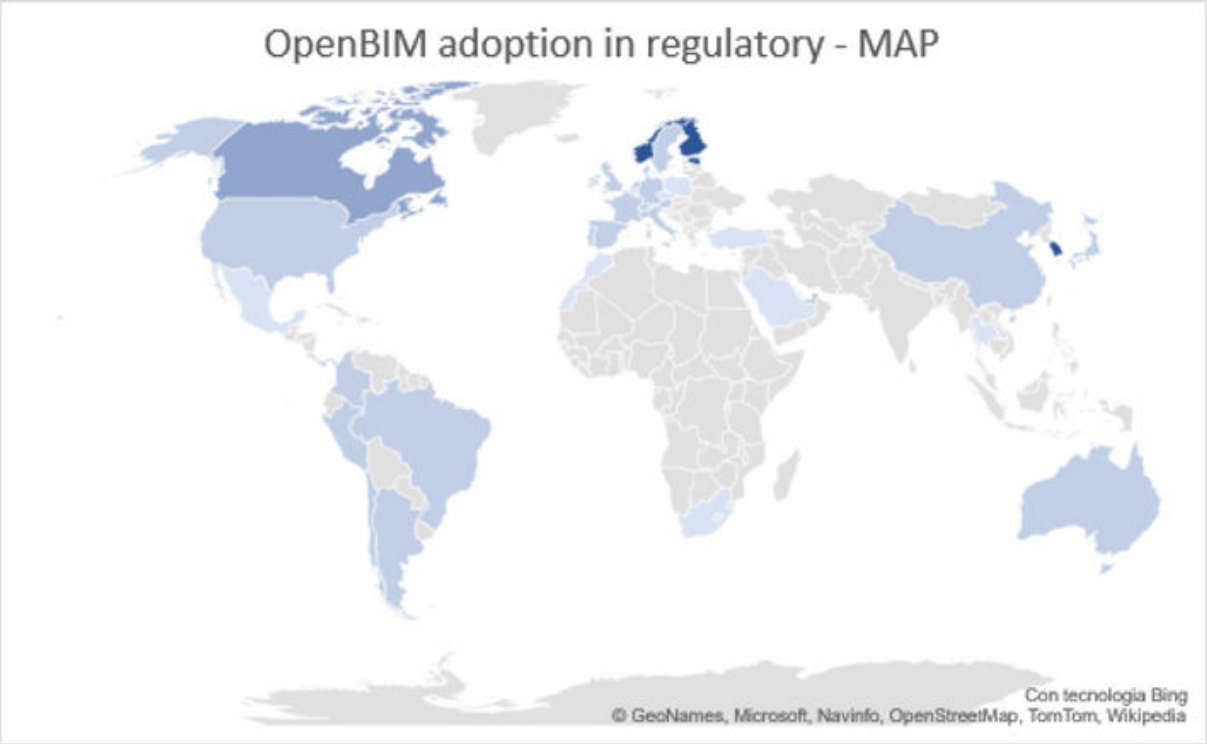
[34] https://www.uia-initiative.eu/en/news/zoom-piloting-brise-building-verification-system
[35] Augmented Reality for Building Authorities: A Use Case Study in Austria

4 The current state of use of openBIM in regulatory

4.1 An international perspective

As openBIM was increasingly used in the construction industry worldwide[36], many countries were adopting or working on it for their regulatory process, and a synthetic view is reported in the figure[37].

Today, Estonia, Singapore[38], Dubai[39], and Scandinavian countries are probably at the forefront of e-permitting using openBIM, and we sometimes refer to them in the guidance as the pioneer countries.



Finland, Norway and Sweden began to approach the use of the openBIM methodology in regulatory since the early 2000. Asian countries such as Singapore , Dubai , China and South Korea started about in the same years to use BIM first and openBIM in the following, so digital building permitting culture is in these areas developed and now improved through the development of standardisation and the publication of public mandates. More information can also be found in the "Global IFC Mandates" playbook, published by the buildingSMART chapters in 2024.

A global state of the art today is difficult to describe, both because of the difficulty of keeping all jurisdictions up to date, and because of the ever-changing regulations, often not specific to building regulations, that can impact on openBIM adoption strategy and projects. In the UK since 2016, the public sector has required the application of BIM methodology, with specific information requirements being defined in public works procurement. Switzerland use IFC as federal archiving digital format and approved a federal interface for digital building applications in 2024 to be reported in all regulations.

[36] Noardo https://www.eurosdr.net/sites/default/files/uploaded_files/eurosdr_eunet4dbp.pdf ; https://www.sciencedirect.com/science/article/pii/S0360132322001007
[37] DISCLAIMER : This is a tentative Map based on presence of buildingSMART directly involving projects and/or academic papers describing openBIM projects or activities at a national or local level
[38] See the case studies reported in this document.
[39] See the case studies reported in this document.

In EU[40] there is a common strategy[41] tending to promote digitalisation in the construction industry that involves the use of openBIM and regulator. In The Netherlands public procurement requires the use of openBIM standards. In Germany, the government has set up an initiative, consisting of several AEC organisations, to develop a national strategy for the implementation of BIM, aiming for implementation in all infrastructure projects. In 2015 the French government created the Plan de Transition Numérique dans le Bâtiment, which defined a national strategic plan for the implementation of BIM. Also in Spain, a mandate has been created for public sector projects to use BIM in 2023[42]. Additionally, there is an openBIM Mandate in Catalonia since 2019. Denmark have stated the use of IFC[43] since 2011. In Portugal there is a government mandate for BIM adoption for the issuing of digital building permits, with first results in some municipalities being expected in January 2027, whereas general country-wide adoption has been defined for January 2030, when a unique front-end platform for all building permits is expected (regarding of the municipality of concern) with automated checks being made based on IFC files. In Italy since 2017 there is a plan for a gradual mandatory use of openBIM models in public tenders, and the related national regulation[44] has been consequently updated and detailed in 2023, while the effective adoption starts in 2025.

Canada published guidance for municipalities[45] on the adoption[46] of openBIM to support some national projects in the country, and a growing interest on openBIM is also reported in Australia. In US institutions[47] like GSA (General Service Administration) and NIBS (National Institute of Building Science) are sponsoring its adoption and supporting pilots is some States.

In Japan institutions launched in 2023 a national BIM program related to a structural use of IFC standards and called DX for buildings and city.

In Latin America, Brazil, Argentina, Chile and some countries in Central America are developing their openBIM adoption in DBP strategies.

Finally, it is important to note that there are and have been initiatives focusing on the application of BIM at a local level, but with international relevance in terms of the result achieved. With varying degrees of depth, cities or regions such as Geneva in Switzerland, Hamburg in Germany, Järvenpää in Finland, Salvador in Brazil, Vienna in Austria, Gentofte in Denmark are placing particular emphasis on the digital building permit component, often acting as pioneers for their countries.

4.2 Data protection and privacy issues

Preventing data used for building regulation from being corrupted, protecting and restoring computers to ensure its availability, integrity, authentication, confidentiality and non-repudiation is an essential issue for the adoption of openBIM in building regulation, as reported in ISO 19650-5.

ISO19650-5: Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 5: Security-minded approach to information management. 2020

The ISO19650-5 is a standard concerned with the security risks involved in dealing with information management within the built environment, especially across multiple organizations as it usually is the case with collaborative BIM. It is directed to "not only appointing parties and appointed parties, as defined in ISO 19650-1, but also demand-side organizations who are not directly involved in an appointment", as are regulators. It establishes a "security-minded approach can be applied throughout the lifecycle of an initiative, project, asset, product or service, whether planned or existing, where sensitive information is obtained, created, processed and/or stored." This approach involves assessment of the need for further information security measures and, if so, the establishment of a security strategy and subsequent security management plan. It is recommended regulators apply it when dealing with information submitted to them in the permitting process as well as be aware that organizations using their services may have a security-minded approach in place.

[40] https://www.breakwithanarchitect.com/post/digitalisation-in-the-construction-sector-eu-analysis-report-2021
[41] https://public-buyers-community.ec.europa.eu/communities/bim-and-public-procurement
[42] June 2023 IFC, BCF and other open standards are included in this Mandate https://cibim.mitma.es/
[43] https://en.bygst.dk/construction/digital-construction/
[44] Codice degli appalti https://www.gazzettaufficiale.it/eli/gu/2023/03/31/77/so/12/sg/pdf
[45] https://www.researchgate.net/publication/365114691_BIM_4_Municipalities
[46] https://heyzine.com/flip-book/ca89bf13b2.html#page/1
[47] https://heyzine.com/flip-book/ca89bf13b2.html#page/1

Because digital building regulatory data are public and/or widely shared and always involve sensitive information, they are subject to the same security and privacy issues as many other digital public data, particularly given its legal and social importance[48]. Accordingly, this means that the protection of digital building data should be part of a wider system of public sensitive data, i.e. the inclusion of building data in national secure data infrastructures that provide the security and privacy solutions for all the data they contain.

This is the case in Estonia, where the e-permitting platform and all security and safety services are integrated into a larger nationwide platform, the e-construction platform.

In this way, every Estonian citizen actually has an e-estonia ID, which they regularly use for all kinds of government services, and which is officially recognised, making life much easier in terms of services. The security features implemented in the e-permission platform are continuously managed and improved, as reported in the national e-security activity[49].

4.3 Which built assets does openBIM focus on?

Historically, the BIM standards were born to model **BUILDINGS**, and supporting the data management of these extremely complex assets still requires a continuous activity to support the evolution of the standards to support the different aspects involved, including, of course, regulatory.

However, over the last 15 years, the use of openBIM has been extended to other built assets, mainly infrastructure such as railways, roads, bridges, tunnels, ports and waterways etc., and the features of infrastructure digital models are included in the latest versions of the data standard.

Due to the lower maturity in the adoption of openBIM in infrastructure, there is not yet an actual process example for infrastructure regulation and permitting. However, in many countries there is a strong will to adopt as soon as possible openBIM in infrastructure regulatory, especially because in this environment the benefits of a standardised digital process will be enormous, as recognised by the EU, which is proposing the use of openBIM as a support for public procurement[50].

4.4 The building digital permitting today

Simply put, from an information management perspective, the main difference between a digital and non-digital approval process seems that the former requires the creation of a highly detailed framework of data definitions and rule checks prior to the approval process to make it highly productive and simple.

Because the rules change less frequently than the applications, and because the software and parameters can be created once and generally shared between offices in different jurisdictions, the digital process is logically seen as more productive.

[48] An example is the security adopted in the digital regulation of pharmaceuticals, where huge amounts of data have to be shared by a large number of participants over a long period of time, with a high requirement to maintain traceability of data changes.
[49] See https://e-estonia.com/enter-e-estonia-security-and-safety/
[50] https://public-buyers-community.ec.europa.eu/communities/bim-and-public-procurement

The Estonian Use case

A pilot-live example of how the permitting process could work using an openBIM data based digital platform is well reported in the Estonia presentation[51] of their National e-permitting project.

Figure 6: e-permitting Estonia : do all stairs have handrails?

The Estonian project overview reported in the linked video[52] explore themes which are common to most other experiences so far.

Synthetically, the reported advantages can be summarised as follows:

- *You can have a complete, manageable and geometrically referenced dataset that can be intuitively explored and analysed.*
- *Pre-defined control rules to support building compliance checks and the ability to manage rule exceptions and clashes in the same system will definitely improve process productivity and quality.*
- *You get a common data requirement to support the dialogue with the building project submitter; this might look like a problem (and it definitely is at the beginning), but then you have a known, shared, reliable and complete data frame for all permit submissions that can be used at all stages of the permitting process (and, fortunately, beyond).*

In terms of disadvantages, we can highlight:

- *Building regulations are not (yet) written to support digital permitting, and sometimes it is not easy to translate them into machine-readable instructions for both technical and logical reasons.*
- *BIM requirements are affected by the need for new data sets strictly related to regulatory requirements, and the standard needs to be adapted to the permitting process.*
- *Software sometimes does not fit the regulatory process and needs to be written and/or modified to meet the requirements.*

However, the main challenge is the implementation path that needs to be taken to prepare the construction industry people and all regulatory users to use and manage a digital building permit system.

For example, the meaning of "intuitive procedure", once applied to computer platforms, should be related to the level of computer literacy of the operators, which is by design very uneven; therefore, a specific chapter on training and digital literacy will be devoted to this.

[51] https://www.youtube.com/watch?v=jp9JeKYJSwU&list=PL3ltG6f5UHC4p3TZSFAKKwHM03IHBr8nv&index=20 . (1 minute video).
[52] https://www.youtube.com/watch?v=XLLI2Av6930 (30 minutes video presentation) : the presented platform is in general use since 2024.

4.4.1 Expectations survey

A 2021 survey with 160 participants from 38 countries on The Role of openBIM in the Regulatory Process[53] showed that for this audience openBIM in regulatory is an established topic for the building ecosystem, and this is enforced by considering that almost one half of the attendance was not directly involved in the matter.

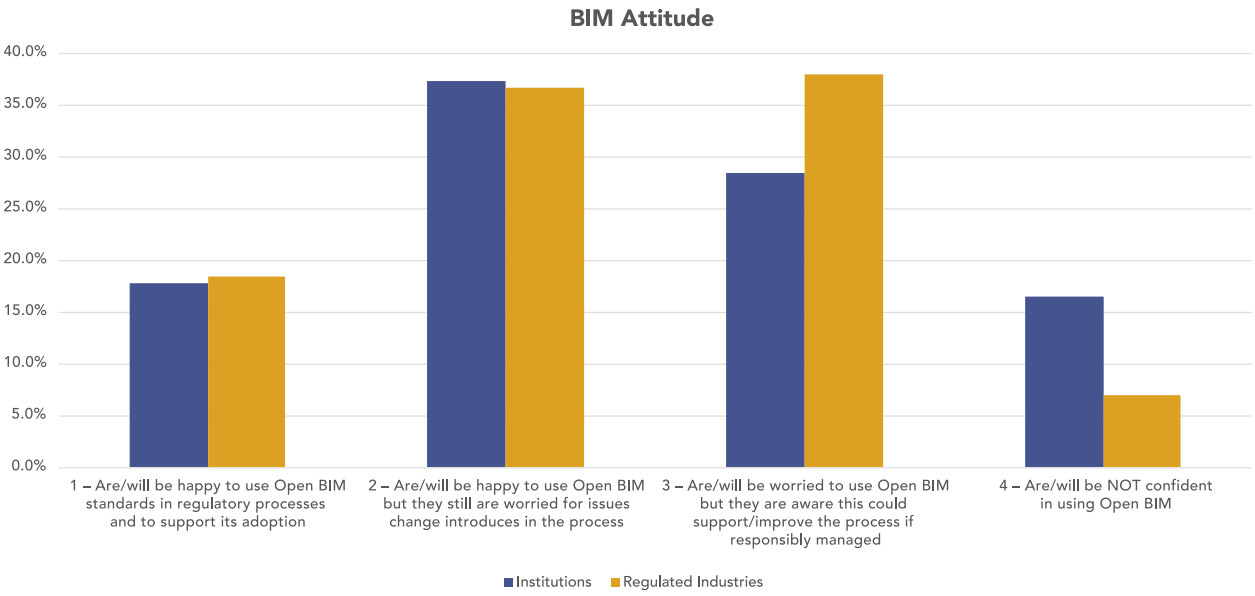


Figure 7: BIM attitude

The awareness about the advantages of using open digital standards for compliance is growing fast around the world.

Involved regulators showed a good awareness combined with the moderate positive attitude to adopt openBIM, and the ecosystem looks generally ready to start the transformation.

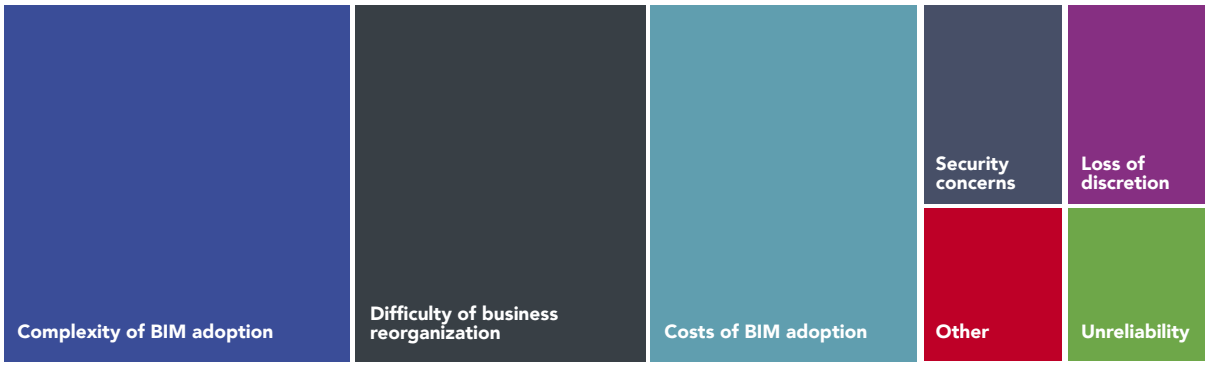


Figure 8: BIM worries

They look however conscious about the gaps in knowledge and training to fulfil, but the global audience declared the main worries are about openBIM adoption complexity.

[53] https://buildingsmart.org/wp-content/uploads/2022/05/Regulatory_Process_Survey_bSI.pdf

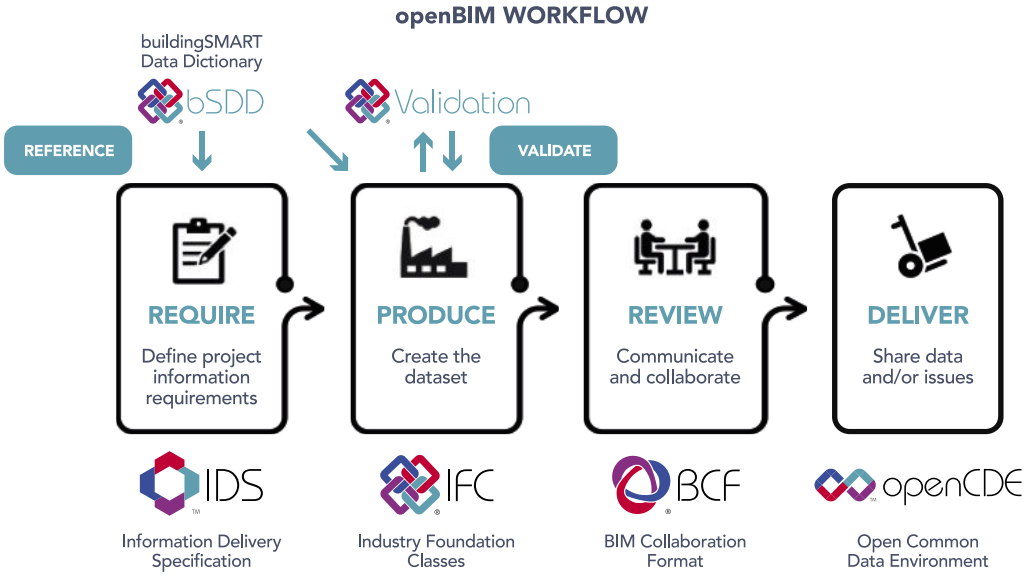
5 Data and standards

The aim of this chapter is to provide readers with some very early basics of the openBIM standard.

In case detailed information is required, we invite readers to explore the buildingSMART website and its technical chapters and forums[54] , to attend to buildingSMART events and/or directly contact the Regulatory Domain at regulatory@buildingsmart.org.

The creation of a building model, like a building itself, requires several tasks to be managed sequentially and/or in parallel throughout the model's lifecycle. In order to manage all the steps in a fully open environment, it is necessary to define appropriate methodologies, semantics and logical structures for each of the activities to be performed; therefore, openBIM is made up of several components, some of which are also expressed as technologies[55], which can be used as a basis for new ones and are part of the digital process of building model definition.

To introduce the elements that constitute the openBIM, we can help ourselves to a simple workflow as in the following



The requirements for the data to be exchanged are captured in a specification (IDS). Design tools and human input generate a corresponding amount of information about the building, which is stored in a dataset (the IFC file). Both the requirements and the dataset are easily and formally interpretable thanks to references (bsDD), and the IFC file can be checked for conformity (validation).

During the data exchange, which can be repeated, changes and additions are made by a tool that updates the dataset in a controlled way (BCF) and is managed in a secure and controlled digital environment (CDE).

A deep understanding of these technical aspects is beyond the scope of this guide, and a complete documentation is available in the buildingSMART documentation as reported above, but the knowledge of the presence of different elements in the standard is useful in the following when we talk about them.

5.1 Which regulatory information are exchanged with the openBIM Model?

When a building project is managed with openBIM, the model becomes, day by day, the repository of all information used and/or processed in the construction, renovation and management of a building asset. All project stakeholders work together to add, comment on, validate and refine the asset data in the same open and fully traceable model. For this reason, the inclusion of the approval process in the workflow has been a natural evolution of the use of these digital tools from the outset.

It seems clear that the availability of geographic, architectural, structural, mechanical, electrical, plumbing, HVAC and other type of data used for the construction and maintenance of the asset in a single open and standardised model provides most of the regulatory data required for a building regulatory process.

[54] https://forums.buildingsmart.org/
[55] https://technical.buildingsmart.org/standards/

However, the need for full regulatory data compliance in the real world demonstrates that some additional information may be required by regulatory requirements.

This has not been a problem for the pioneers of digital regulation projects, who have created bespoke libraries of datasets to meet national and/or jurisdictional regulation requirements, as openBIM, and in particular the data repository file, called the IFC[56] file, can be extended in a standardised way while retaining all structural features.

Experience has shown that there are several data sets that are common across different jurisdictions, so buildingSMART has launched a Regulatory Information Requirements [RIR] initiative to collect, streamline and add to the global openBIM recommendations for these common additional data sets required for regulatory purposes.

The requirements areas that have been initially explored are Project Identification, Structural General Data, Fire Safety, Energy and Accessibility.

The RIR project evidence is that the added data is mostly related to some regulatory requirements related to validation of formally accepted data, and that automated verification processes enhance these requirements by providing methods of demonstrating compliance final proof of positive algorithm execution and verification.

As an example, here are some of the data sets that have been added to meet regulatory requirements in Estonia.

Annex 1: Minimal BIM requirements current checks

General				
One BIM file should only contain one ifcBuilding				
The BIM file should be geo-located according to the Estonian L-EST97, epsg:3301 coordinate system				
Also an elevator shaft should be modelled as a (one) space (AR_Ruum) with the correct 115_Kategooria property				
AR_Hoone/ifcBuilding				
Attribute	ifcReference	Data Type	Content	Example
040_Kõrgus	TotalHeight	ifcLenghtMeasure	Height	25,1
045_Hoonealune_pindala	SiteCoverage	IfcAreaMeasure	Underground surface (above ground) ACTUAL UNDER CONSTRUCTION	8000,1
056_Kasutajate arv	OccupancyNumber	ifcInteger	Max number of people	55

Figure 9: An example of the regulatory required data in Estonia e-permitting system structure[57]

It also seems clear that the actual regulations are not at all written to support digital authorisation, and that the full burden of regulatory compliance is supported by digital platform customisation, which enhance the need for data sets to support specific practices.[58]

Fortunately, the evidence from the most advanced projects is that regulations adaptations to digital authorisation seem to be happening, and this can reduce the demand for regulatory specific data and simplify the model.

[56] The IFC (Industry Foundation Classes) schema is the openBIM standardised digital description of the built environment, including buildings and civil infrastructure. It is an open, international standard (ISO 16739:2024) https://www.iso.org/standard/84123.html

[57] https://eehitus.ee/wp-content/uploads/2022/02/Final-work-report-second-phase-BIM-based-permit-procedure.pdf

[58] https://eehitus.ee/wp-content/uploads/2022/02/Final-work-report-second-phase-BIM-based-permit-procedure.pdf page 36

5.1.1 Steps and Standards

We have often reported that the use of openBIM in regulation requires a set of REQUIREMENTS DEFINITIONS, usually set out in regulations on the data and tools to be used, and that they are strictly related to the process flow.

To help understand this, the following diagram shows a possible example of a regulatory process for a project submitted for approval using openBIM features, also known as a USE CASE in BIM terminology.

5.1.1.1 Building e-permitting: a process map

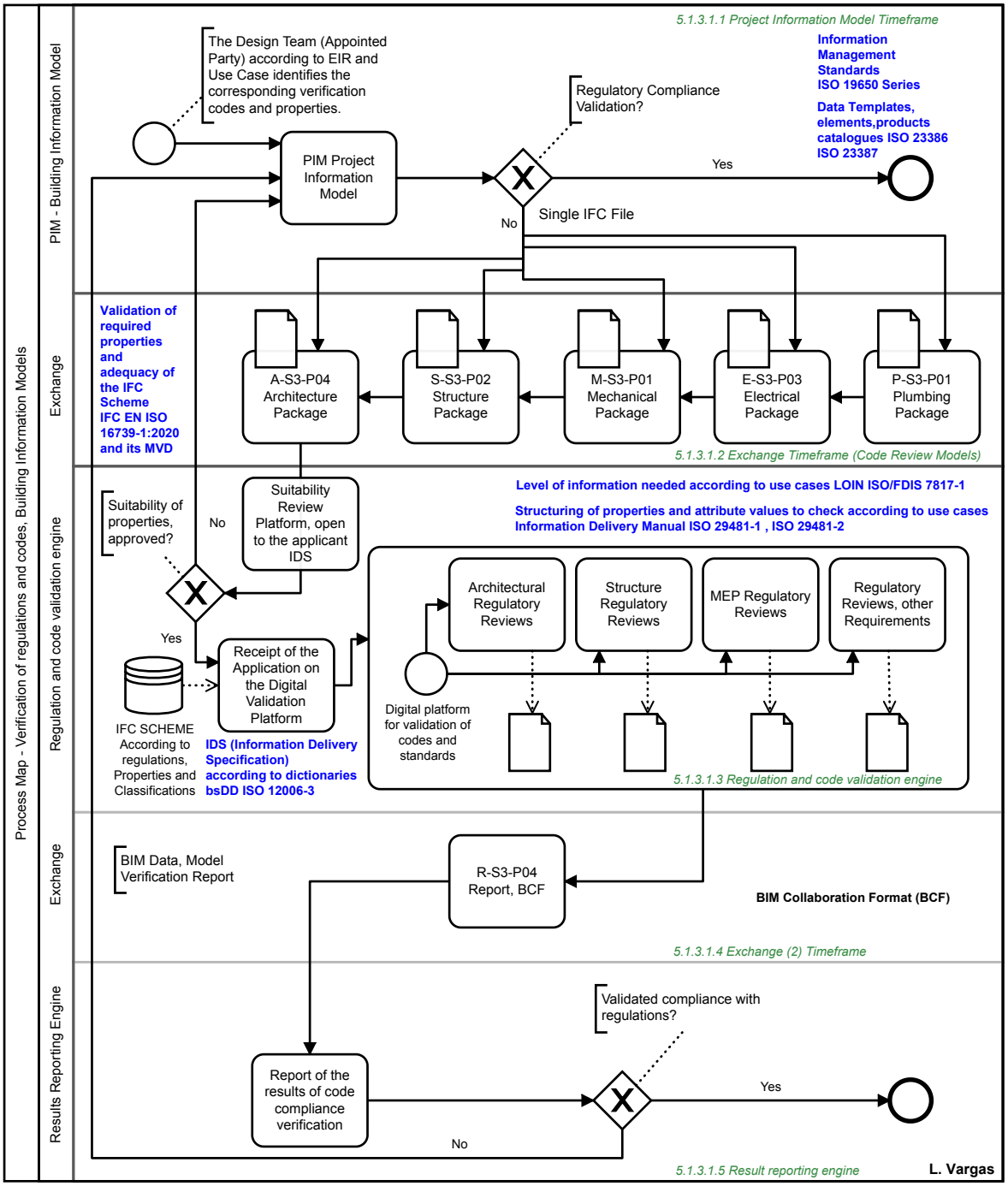


Figure 10: Building e-permitting: a process map -in blue some of the international ISO standards that support from a regulation point of view both proposed methodology and technicalities

The map shows the process flow from the submission of a building project (top left) to the final approval (bottom right) managed with a hypothetic e-permitting digital platform.

5.1.1.1.1 Project Information Model timeframe

The digital regulatory platform receives from submitters the Project openBIM Information Model [PIM], i.e. the specific project 3D model into a single IFC file. The data included in the model and the level of detail should comply with a use case published by the regulators for this type of submission (see IDM and IDS), that are specific attributes and properties of Architecture, Structure, Mechanical Systems, Electrical or Plumbing Systems (see ISO19650 for requirements).

If the submission does not require a regulatory check, the PIM could be released and archived.

5.1.1.1.2 Exchange timeframe (Code Review Models)

The BIM model data submitted for regulatory control is logically separated into the views related to the disciplines submitted to the different regulatory authorities (architectural compliance, structural verification, etc.) and made available to the responsible office/application for review. ISO EN 16739-1 reports the requirement to support the split views and accordingly all changes, questions and comments made by the responsible parties are reported in a single PIM reviewed file.

5.1.1.1.3 Regulation and code validation engine

The updated BIM model will be suitable for review by the applicant, who will have access to a limited set of data, governed by an Information Delivery Specification platform, which could also define which data could/should be updated or amended. Again, ISO standards can support both the level of detail of the required data (LOIN ISO/FDIS 7817-1 and/or ISO 29481-1 & 2).

In the case of an amendment by the submitters that makes the project unsuitable for automatic checking, the amended PIM is submitted by the platform to the start of the process map, starting the full process again.

In the other case, when the project is suitable for automatic checking, the model is then submitted by the platform to the checking engine, which is software that checks the model data against a set of digital rules based on laws and/or regulatory requirements and expressed in an IFC checkable format.

5.1.1.1.4 Exchange (2) timeframe

All discrepancies detected by the checking software are collected in a BIM Collaboration Format file (BCF), which also identifies the discipline where the discrepancy was detected.

5.1.1.1.5 Result reporting engine

The nonconformities BCF file is used to generate a compliance verification report, which is evaluated by a compliance officer for approval. In case of approval, the regulatory report is saved with the approved project model. In the event that the project cannot be released due to non-conformity, the BCF file is used to update the original PIM model to generate a new project model to be submitted to the full control process.

5.1.2 Automatic checking

As we reported in chapter 3.2.5, automatic checking is not at all a new subject, at least from the conceptual point of view. Indeed, research on this matter precedes the era of BIM as a generalised methodology.

With the introduction of BIM mandates for public tendering in several countries of the world, the focus on IFC as a vendor-neutral format has come into place, as expected. The same goes for automatic checking.

Therefore, even though models are created in proprietary software with means for self-checking in many aspects, the export data to an IFC format is a fundamental step, as all relevant information must be passed to the model file in proper conditions as per the requirements of the public office receiving the file for tendering of permits or for tendering or permitting.

Much has been done in terms of IFC-based verification of rules, and establishment of software companies able to provide these services customised to governments. In the next chapter are reported some methods to transform the regulation controls into digital instructions. There are also many open-source initiatives going on that allow IFC to be queried by in-house code, and even code-checking software shared online in platforms such as github[59].

It is however remarked that the main challenge in automatic checking does not reside in the technological aspect of BIM-IFC, or even the capacity to encode rules into automatic (or semi-automatic) IFC-verificators.

The main difficulty/challenge seems to reside in the need to modernize an ecosystem of municipal rules that are often unique to each municipality (hence making it impossible for establishment of nation-wide platforms) and the tendency of most regulations to focus on paper-based verifications, which are anachronic and hard to implement in a world of digital models. (M.Azenha)

Also, it is worth mentioning that a verification of compliance for a building permit is normally involving many different regulations that almost need to be 'cherry-picked' on a per-case-basis within an intricate connection between BIM and GIS, for the applicable restrictions and regulations.

All of the above end up demanding careful work on multiple fronts for the integration of digital building permits.

There are however multiple initiatives and examples that are helping to pave the way and shed light on those willing to implement digital building permits.

5.1.2.1 How to transform a regulation in machine-operable instructions[60]

It may be possible today to check the content of most of the openBIM models to satisfy a specific code requirement. In some cases, the content of the regulation may be directly encoded into the behaviour of particular software objects. However these applications are costly to create and accept, and because of the regulatory environment significant rate of change and relatively short notice of change, the development of such code checking requires a continuing program of maintenance.

Attention has shifted from such 'black-box' applications towards separating out the knowledge embodied in the regulations, the knowledge embodied in dictionaries and classification and the knowledge about the proposal. This can ensure that a simple and highly consistent 'rule-engine' can consume rules either to validate the proposal, or to suggest or effect corrections.

Such 'rule-engines' need a machine-operable representation of the regulations. Currently there are four methods, all of which are being trialled internationally.

a. The first alternative has been to effect a manual transcription of the regulatory text, tables and diagrams into a computer programming form, but the transcription process is notoriously unreliable.

b. Mapping the rules to a library of rule templates embedded in a particular application. These rule templates assume that the nature of the checks can be listed and that there are a manageable number of checks. Unfortunately, rule templates are not natively dependent on the scope of the control and its exceptions, and sophisticated work is required on the checking process to ensure it is well defined and consistent.

[59] https://en.wikipedia.org/wiki/GitHub
[60] With the kind collaboration of Nick Nisbet

c. In the last decade there has been investigation of the use of Natural Language Processing (NLP), a branch of AI, to parse text and use the grammar constructs to interpret the text in to rule templates. To date NLP has not yet been accurate in taking the context of a single sentence into account, nor in recognising the role of lists and tables. Regulations sometimes contain detailed knowledge that is expressed in complex sentence structures that may not fit into the fixed number of templates.

d. There is a hybrid approach which allows regulatory experts to document their understanding of the regulations to highlight the roles of key phrases and sections. This mark-up can be reviewed, corrected, and improved by consensus. This RASE[61] (requirements, application, selection, exception) method has been used in USA, England and Wales and in Scotland.

Once the content of a regulation has been captured, it can be used to drive a 'rule-engine' or to drive semi-automated check lists. For example, the checking of door and corridor widths is repetitive and error prone and may best be processed mechanically.

5.1.3 Data archiving

As previously reported, one of the key features of openBIM is to ensure the long-term readability of building data, with each evolution of the standard designed to ensure compatibility with previous versions of openBIM data.

This feature is key from a regulatory perspective, and for this reason more and more national institutions are converging on it the use of IFC data as a legal archiving format for building models.

Often, the declaration of openBIM standards as a legal archiving format is the driving point for the regulatory process change to the use of the open 3D model in all institutional digital building management in the country, as has happened in 2022 in Finland.

The Finnish declaration for IFC as a legal archiving format[62]

The National Archives has issued a decision (KA/18770/07.01.01.03.02/2022) on the archival format of the building's data model.

Building Information Model (BIM) design refers to a set of building information in a machine-readable and interoperable data structure. The structure contains the location of the building, the geometry and shape of the building as a three-dimensional model and the building data. Data models are used, for example, by building control authorities to manage information during the building and construction process.

The format to be archived under the Decision is an… IFC file … conforming to the STEP standard (ISO-10303-21). The IFC file version shall be 4.0.2.1 (IFC4 ADD2 TC1, ISO 16739-1:2018).[63]

Translated from Finnish with www.DeepL.com/Translator (free version)

[61] Nisbet, N., Wix, J. and Conover, D., 2009. 17 The future of virtual construction and regulation checking. Virtual futures for design, Construction and Procurement, p.241.
[62] https://kansallisarkisto.fi/-/rakennuksen-ifc-tietomallista-kansallisarkiston-paatos
[63] https://www.youtube.com/watch?v=JwQ46dXF3Ew

6 The Building Regulatory digital transformation project

The digital transformation of building regulation is recognised globally as a very complex challenge that no one takes lightly, and the scale and uncertainty of the activity burden and concerns about the actual digital readiness of the ecosystem are often the reason for postponing the decision to tackle it.

A recent study aimed to understand municipalities' challenges in adopting digital building permits. They found organizational factors to be key barriers to implementing a fully digital process. Technology growth often outpaces the organizational and personnel changes needed for its implementation. The necessary transformations for cutting-edge technologies are frequently slow and costly.

Thus, a thoughtful plan and a defined system can effectively guide the digital transition.[64]

With everyone agreeing on the need for a structured and well-managed project to meet the challenge, an early question for the 'brave' regulators who decide to embark on transformation is how to manage the whole digital transformation project.

Figure 11: Example of project and organizational scheme[65] (LATAM & CARIBE)

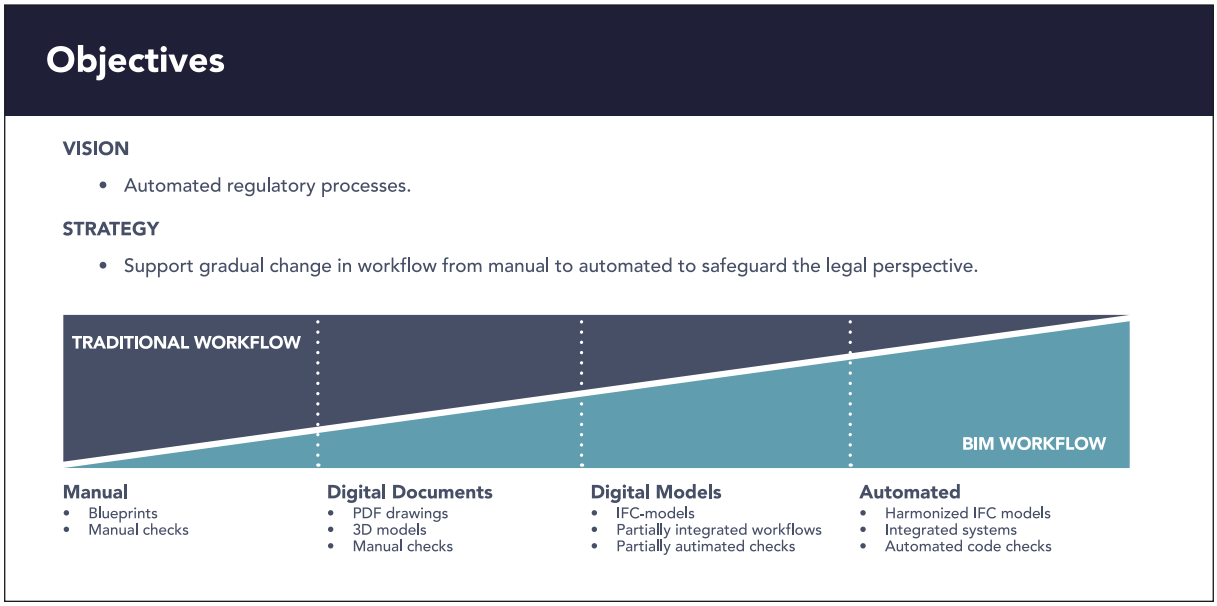
Of course, local or national business and jurisdictional constraints underlie the general project approach, the resources involved and the detailed definition of plans, so a project planning proposal is beyond the scope of this international guide, but we'd like to highlight some tools and/or lessons learned from analogous experiences to help define the project.

[64] Digital Transformation of Building Permits: Current Status, Maturity, and Future Prospects - Mariana Ataide, Orjola Braholli and Dietmar Siegele Oct 10, 2023

[65] GUÍA BÁSICA BIM PARA FUNCIONARIOS PÚBLICOS : Estrategia para el fomento de la metodología BUILDING INFORMATION MODELING (BIM) en América Latina y el Caribe. (automatically translated with Deepl translator, see the original image in the small window)

6.1 Sponsorship and consensus

In general, any project towards an automated regulatory process will define gradualism and legal certainty as non-discussable constraints for the result, for all activities and any intermediate progress.



But regulatory digitisation is in some ways a disruptive project, changing the structure of communication, so almost any successful project plan should include a parallel route for updating the rules and regulations that govern construction accordingly.

This does not mean that the digitisation project has to start after these digital-ready laws are in place, which never happens, but focuses on the need for good government support from the project planning stage.

However, a broad consensus among all stakeholders, not only the political ones, is essential as the national regulatory digitisation project is a long (and almost endless) journey. The communication necessary to achieve consensus would then be an essential part of the project to be developed from the outset.

The discussion in Finland

Pekka Virkamaki, Senior Legal Advisor at the Finnish Ministry of the Environment, synthetically shows the problems that Finland experienced with its e-permitting strategy and the lengthy discussion with all stakeholders that took place in order to gain broad support for its RAVA 3 project, showing the different issues, focuses and perceptions along the road to the happy end.

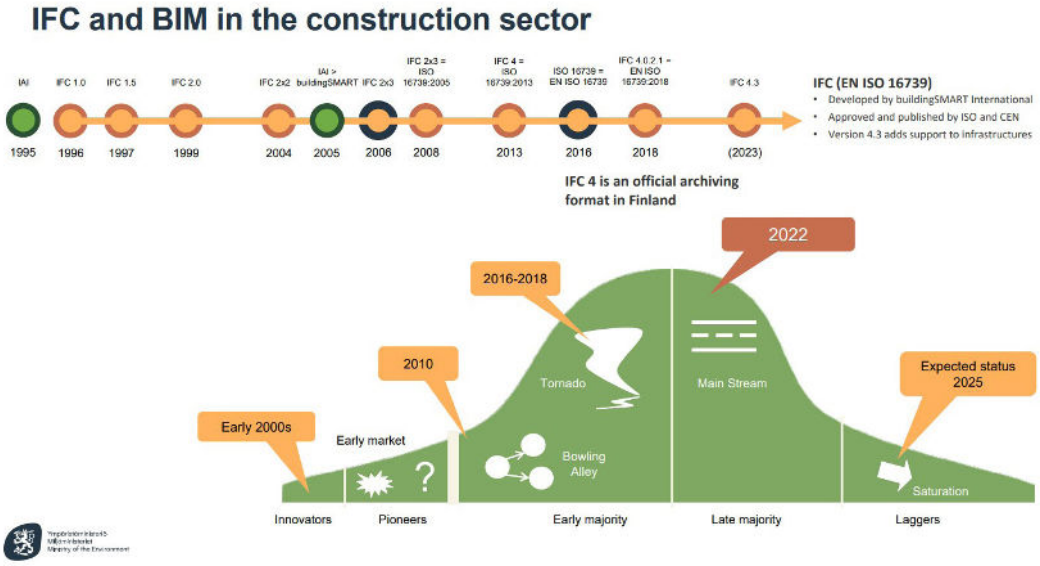


Figure 12: IFC to become a mandatory building permit document in Finland – history – P.Virkamaki 2023

And the Finnish story is very close to its happy end, because when the updated Finnish Building Act enters into force in 2025, building information models and machine-readable data will become an essential part of building permit applications.

6.1.1.1 Building open data adoption promotion

As there is no doubt that a consistent, open and interoperable 3D building data base is essential for any building permit digitalisation project, it is not surprising that most countries start their building permit digitalisation strategy with a gradual, enforced promotion of open BIM and GIS data adoption.

In Italy, the new Public Tendering Regulation (DECRETO LEGISLATIVO 31 marzo 2023, n. 36[66], aka Codice degli appalti) introduces a gradual obligation to provide openBIM models to building authorities. The digital model will initially only be mandatory for the largest tenders but will be extended to smaller tenders year by year.

This could consist of a strong promotion of concepts and tools, often jointly managed by institutions and technical bodies such as the national buildingSMART chapters, which anticipates the essential step of defining these model and data formats as legally accepted for the management and archiving of regulatory data.

Figure 13: Singapore CORENET X project roadmap – take note of the onboarding process

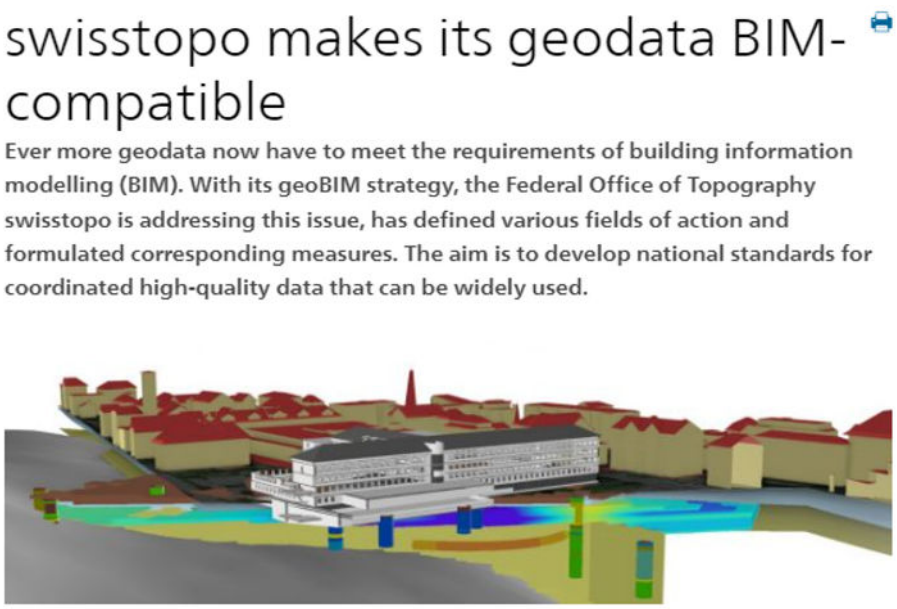
There are many examples of methods used by authorities to support consensus, and fortunately many of these are available in papers and shared documents, some of which have already been cited in the case studies reported in this guidance.

An informal example of methods to support the spread of consensus and reassuring citizens and building companies can be seen in the FAQ published in the run-up to the mandatory introduction of the new openBIM platform, as for digital building permits in Dubai[67] or in Singapore[68].

[66] https://www.gazzettaufficiale.it/eli/id/2023/04/13/23A02179/sg
[67] Ibrahim Fahdah - Dubai's Mandatory BIM Submission for Building Permits - Your FAQs Answered : https://www.linkedin.com/pulse/dubais-mandatory-bim-submission-building-permits-your-fahdah-qofwf/
[68] https://www1.bca.gov.sg/regulatory-info/building-control/corenet-x/corenet-x-faq

6.2 Project scoping

The scope of the building regulatory digital transformation projects has often to fulfil not only the typical permitting goals but also interlaced requirements coming from concurrent innovation projects, as sustainability or security governance evolutions.



*Fgure 14: Swiss global project for country mapping includes **BIM***

So the Digital Building Permitting project itself is embedded in larger projects and even larger strategies, including requirements, often unrelated to what is in this guide. In these cases, usually it seems easier to support the demonstration of project's ultimate benefits, the long-term planning and effort that such projects require, and to help broaden consensus and sponsorship, as the Swisstopo[69] project shown in the figure might suggest.

In any case, large project/strategies should require additional effort to isolate the Digital Building Permitting project scope, and special attention should be paid to some other aspects, such as

- Timing of deliverables and milestones in coordination with concurrent work packages.

- Communicating and possibly convincing the AECO industry of possible project constraints and/or additional activities not strictly related to the needs of the building ecosystem.

- Ongoing review and sharing of the benefits of using an open building database for concurrent project requirements (e.g. use of openBIM digital twins for safety).

6.3 Change management.

Among the many reasons why openBIM is not easy to integrate into the regulatory environment, probably the most important is that it requires a large majority of the business to be willing to share information and adopt the changes proposed by the regulators, and at the same time to have the resources of the regulators ready and supporting the change.

This requires changes within an organisation or industry, as well as the implementation of strategies to develop and train integrated teams from both sides.

[69] https://www.swisstopo.admin.ch/en/swisstopo.html

BIM for Municipalities - Canada[70]

This [openBIM in regulatory] integration entails the transparent use of technology and training of qualified personnel, to do this, it is essential to identify needs to implement BIM rather than simply promoting the use of its technology (Howard & Björk, 2008). A number of sites have identified issues at the root of ineffective BIM deployment (Egan, 1998; Latham, 1994; Wolstenholme et al., 2009).

The primary issue is lack of collaboration.

While BIM underlines the links between members of a project, it does not foster closer collaboration between different companies. (Dossick & Neff, 2011; Xiao & Noble, 2014). Zutshiet et al. (2012) highlight the importance of organizational alignment with project objectives and priorities to succeed collaboratively.

Another widely used method to support change is to pilot[71] the process in a reduced test instance of the e-permitting platform, often involving both industry and regulators in coordinated workflows. Piloting is included in most of the project plans of the digital permitting pioneers we have reported on in this guide, and documentation is widely available.

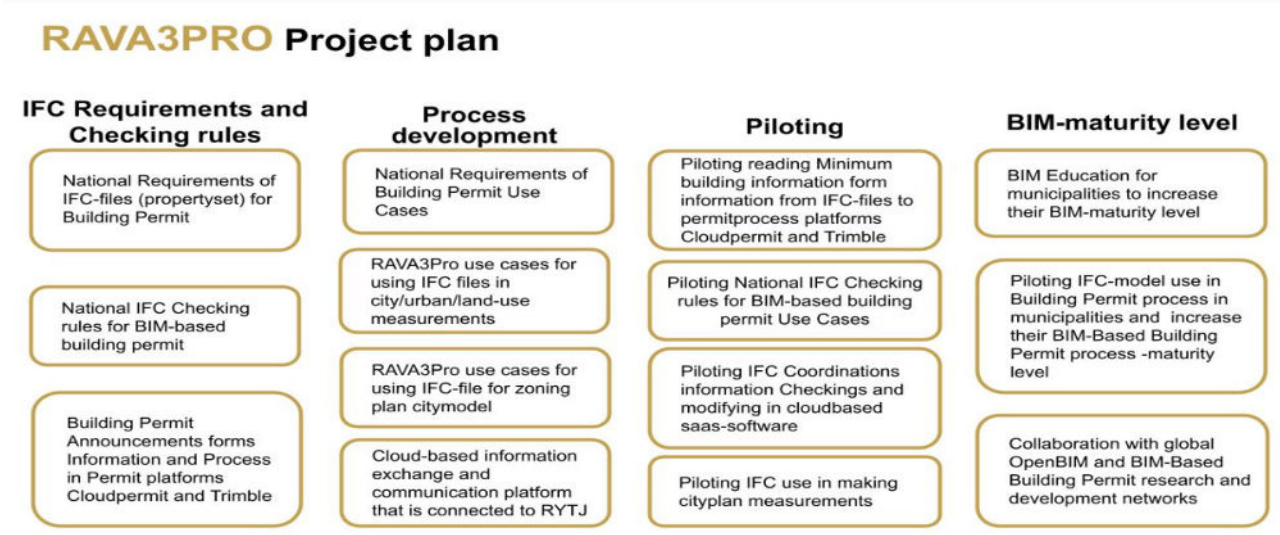


Figure 15: Finland RAVA3 project roadmap

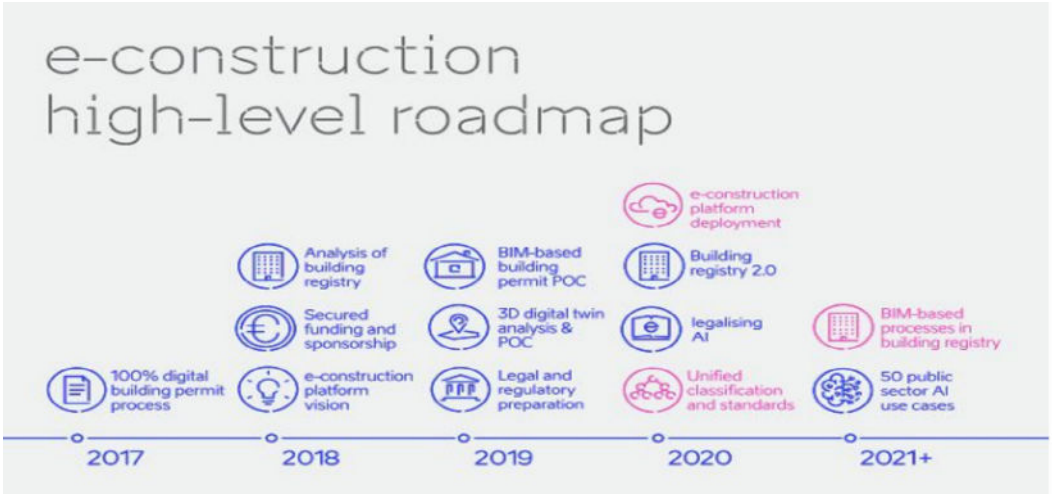


Figure 16: Estonia - digital building permitting project roadmap

[70] https://www.researchgate.net/publication/365114691_BIM_4_Municipalities
[71] Also reported as POC, (Proof of Concept)

Recently a common standardisation of the change management process has been drafted especially by the EU multinational DBP projects (CHEK (https://chekdbp.eu/), the ACCORD project (https://accordproject.eu/), the DigiChecks project (https://digichecks.eu/)), that needs to apply a common project methodology to different national environments.

By example, it has been possible to compare the level of maturity both in digitisation and the BIM/GIS competence of different municipalities in different countries as their data processing were from a general point of view similar[72], and a standardised methodology has been proposed.

However, a detailed approach to change management will obviously vary from project to project, as these activities are often closely linked to specific jurisdictions and the structure and scope of different projects.

Fortunately, change management in DBP projects can be included in the broader class of change management in digitisation projects with complex structures, and many techniques and tools can be transferred and managed using well-established and known project management skills associated with this class of projects,.

6.3.1 Methodology

Another lesson learnt from existing DBP projects is the need for a methodology that grants a flexible approach to project management to address the issues arising from both the complexity and dynamism of the digital building ecosystem, including frequent changes in regulations.

Figure 17: Estonia – Agile Methodology

[72] M.Ataide et al : Digital Transformation of Building Permits: Current Status
[73] https://eehitus.ee/wp-content/uploads/2022/02/Final-work-report-second-phase-BIM-based-permit-procedure.pdf

6.3.2 Training and support

Will all people involved in digital building permits need to become experts in BIM? The answer is NO. In fact, the quantity of expertise fields in BIM is so wide that there would be a very limited number of people (or even none) in the world with experience in all relevant fields of application of BIM.

Those involved in the side of the permit-issuing will of course need some basic training in BIM, as to understand the process as a whole (e.g. the intricacies of IFC, IDS, etc). This kind of training is already certified by buildingSMART with the foundation level (see details in https://education.buildingsmart.org/).

This level of training/certification only requires circa 20 hours training (which may even be taken totally/partially online), and it offers the needed transversal knowledge to understand the processes. Additional training is also necessary in order to master the platform/software to use for model-checking. This part needs to be delivered by the supplier of the platform/software and has a very much practical side, rather than handling new complex concepts. This additional training could be as small as 20h as well, providing the capacity to use.

Of course, from the side of practitioners (Architects, Engineers, etc) submitting processes for the building permits to be issued, training is also necessary.

However the training needed for the submittal to building permit is not more than the training one would need for working properly in BIM. In many countries, this is already happening due to BIM public procurement mandates.

As BIM becomes mandatory in public procurement, several necessary steps are being taken towards the country-wide capacitation of AECO stakeholders. This kind of training/capacitation is considered out of scope of the present document.

7 Conclusion

It's increasingly clear that digitising building regulation processes is an unstoppable trend.

At the core of this shift is the digital permitting process, serving as the foundation for the entire digital transformation in building regulation. The construction industry faced first the challenge of embracing digital models to boost productivity in response to globalisation, new technologies, and sustainability demands. The complex nature of the building ecosystem, alongside its fragmentation and specificities such as internal complexity, customisation, and the vast amount of assets yet to be digitised, highlights the need for a fully open and interoperable digital standard to guide digital evolution strategies.

openBIM, developed by buildingSMART International in collaboration with the construction industry has taken the regulatory into account from the outset, is precisely designed for this purpose, and its features align well with the requirements and logic of regulatory processes too.

As a neutral, open, non-proprietary, interoperable and long-lasting sustainable set of standards, openBIM is the most, if not the only, strategic standard currently available to support a building regulatory digital framework.

As an official ISO standard, it can ensure legal compliance at every stage of the permitting process. Moreover, many countries recognise openBIM as their national digital format for document archiving and exchange.

openBIM not only enhances the productivity and quality of regulatory organisations by fostering dialogue with stakeholders of the construction industry but also streamlines internal processes within regulatory bodies. However, perhaps its most significant advantage lies in its ability to automate project checks during permitting.

These substantial advantages have spurred activities in many countries toward the adoption of e-permitting using openBIM. While experiences from these endeavours underscore the complexity and effort required for digital transformation, they also offer valuable insights and suggestions for regulators at various stages of their projects.

We hope that the content of this guide will help to disseminate these lessons and assist regulators who are starting or are currently involved in similar building permitting initiatives.

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