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BIRGIT – training on Building InfoRmation models integrated with Geographical InformaTion

With the support of the Erasmus+ Program of the European Union Strategic Partnerships N° 2021-1-SE01-KA220-VET-000028000

Course: BIM introduction. Block 3: BIM applications. Lecture 3.1

BIM for infrastructures and facility management

Lecture Notes

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License

Version

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Learning outcomes

At the end of this lecture, the learner is expected to be able to

- Understand the fundamental principles and benefits of BIM in the context of infrastructures and facility management.
- Describe the application of BIM in various infrastructure and civil engineering projects.
- Understand the benefits of using GIS data in BIM infrastructure projects.
- Identify and assess different technical solutions to be used in BIM infrastructure projects.
- Identify and assess the effectiveness of BIM implementation in different facility management tasks and practices.

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Summary

This lecture introduces the use of BIM in infrastructures and facility management. It explains the fundamental principles of applying BIM in civil engineering projects, the combined use of GIS data, examples of applications, and available technical solutions. The second part focuses on BIM implementation in facility management, covering applications such as space management, asset management, maintenance planning, energy efficiency, safety, and more.

Expected competences when entering the lecture

No specific pre-requisites required.

Expected Workload

28 slides with course learning content, 4 hours.

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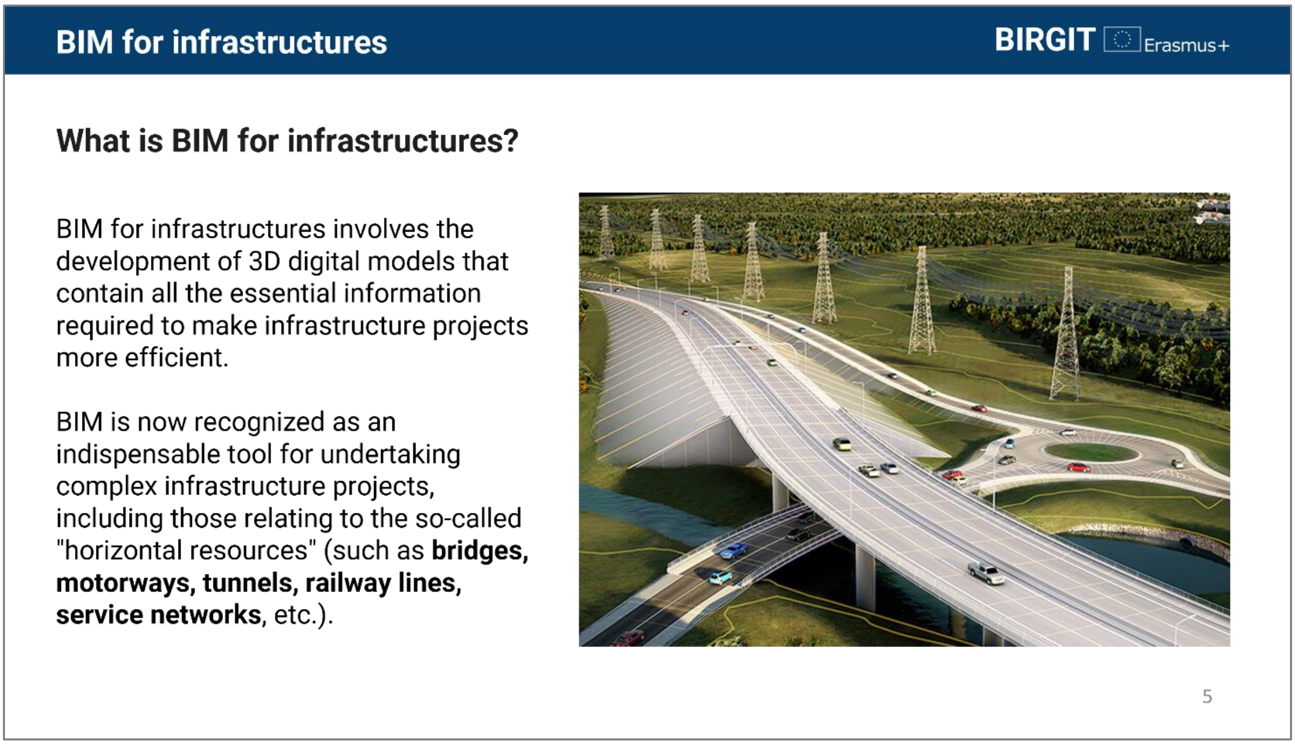
Revision History:

Revision	Date	Author(s)	Status	Description
0.1	January 2024	Roderic Molina	Draft	First draft for revision
0.2	March 2024	Roderic Molina	Draft	Second version after internal assessment
1.0	2024/03/14	Roderic Molina	Published	Edited by M. Morbidini

Content of the lecture:

What is BIM for infrastructures?



Building Information Modelling (BIM) for infrastructure is a digital representation of the physical and functional characteristics of an infrastructure asset throughout its lifecycle.

For infrastructure projects, BIM's strength lies in visualizing complex designs, coordinating diverse engineering disciplines, enhancing constructability, and supporting the long-term operation and maintenance of the asset.

BIM for infrastructures is a collaborative process that involves all stakeholders in the infrastructure project, from design and construction to operation and maintenance.

The adoption of BIM for infrastructure projects is rapidly increasing. Many public administrations have mandated the use of BIM for projects, leading to a significant increase in its use across various infrastructure sectors, including roads, highways, bridges, tunnels, water and wastewater systems, and energy infrastructure.

As the technology matures and becomes more affordable, we can expect an even wider adoption of BIM for infrastructure projects in the future.

Why use BIM for infrastructures?

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Why use BIM for infrastructures?

You still think that BIM is a methodology intended exclusively for building design?

Building Information Modeling also offers enormous potential in the infrastructure and civil engineering sectors.

BIM for infrastructure is an intelligent approach to infrastructure design that is revolutionizing the construction industry.

It helps in better coordination, visualization, and simulation of the infrastructure, leading to improved decision-making, reduced errors, and enhanced collaboration among stakeholders throughout the lifecycle of the infrastructure.

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Civil infrastructure owners, including government agencies, are increasingly making BIM usage mandatory to access these advantages. For this, professionals are realizing the necessity of embracing BIM to stay competitive and secure new projects.

There are many general benefits to using BIM for infrastructure projects, including:

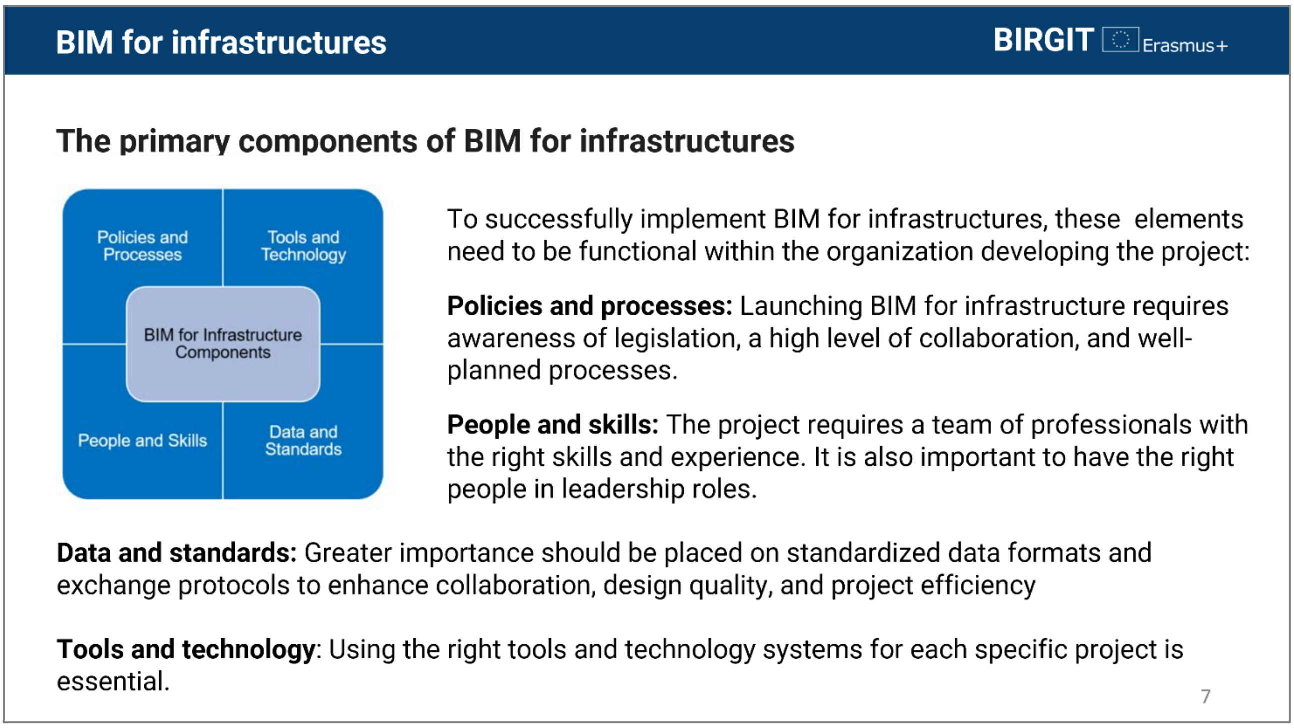
- **Improved design and planning:** BIM allows engineers to create more accurate and detailed models of infrastructure projects, which can help to identify and resolve potential problems early in the design phase.
- **Enhanced collaboration:** BIM can be used to share information between different stakeholders in the infrastructure project, which can improve collaboration and communication. This can help to identify and resolve problems more quickly and efficiently.
- **Reduced costs:** BIM can help to reduce costs by improving efficiency and eliminating rework. It can also help to make better decisions about materials and equipment, which can further reduce costs.
- **Improved safety:** BIM can be used to identify and assess safety risks early in the project, which can help to prevent accidents.
- **Reduced environmental impact:** BIM can help to reduce the environmental impact of infrastructure projects by optimizing the use of materials and energy.

Civil engineers can take advantage of the benefits of BIM at all stages of the life cycle of an infrastructure project.

By exploiting the potential of BIM, it is possible to:

- **Capture existing site conditions:** The use of BIM helps civil engineers create intelligent, large-scale 3D models that describe the characteristics of the intervention area. These models can aggregate a large amount of data, including reality capture data (using various technologies such as laser scanning, photogrammetry, or point cloud processing), 2D CAD data, raster data, and Geographic Information System (GIS) data. The collection of this data improves the accuracy of the model and allows the infrastructure project to be started more efficiently.
- **Conceptualize the project idea:** BIM modelling allows you to quickly produce various conceptual models of the infrastructure and to evaluate different scenarios already in the preliminary phase which help to choose the best design alternative.
- **Develop subsequent design phases:** the data-based approach typical of BIM supports civil works designers in developing the most advanced design phases. It allows you to keep under control all aspects related to safety, times, costs, site organisation, maintenance operations, etc.
- **Perform analysis and simulations:** BIM provides advanced solutions to perform any type of simulation on infrastructure models (such as dynamic analyses, flood simulation, traffic simulation, etc.). This allows design teams to make more informed decisions.
- **Detect clashes:** BIM Clash Detection is a process that identifies and resolves potential conflicts between different elements of the model such as walls, beams, columns, and MEP (mechanical, electrical, and plumbing) systems. BIM Clash Detection processes help accelerate infrastructure projects and eliminate potential errors by identifying clashes during the design phase itself.
- **Outline the schedule:** BIM can combine 3D infrastructure models with schedule data. This allows you to create intelligent visual construction timelines that help civil engineers improve planning.

The primary components of BIM for infrastructures



In the field of BIM for infrastructures, policies, processes, and skills are implemented to effectively manage data using various tools and systems.

Policies and processes

The task of launching BIM for infrastructure is a significant endeavor. Those involved in a BIM for infrastructure project should be aware of the current legislation, standard procedures, and activities. With an increasing number of legal frameworks involving the use of BIM, public administrations and agencies play a crucial role in determining what and how data should be modeled, when the data should be updated or improved, and who should have ownership. Policies that promote collaboration through technology help to reduce data loss and oversight. Well-planned processes that guide BIM deliverables through development, quality assurance, and approval before delivery are essential for the success of a project.

People and skills

Various profiles such as BIM specialists, modelers, analysts, BIM coordinators, and BIM managers are involved in infrastructure projects, each with their own specific responsibilities and requirements. To successfully implement BIM for infrastructure, it is crucial to develop comprehensive training initiatives that provide relevant resources and enhance the necessary skills. The focus of the training should not only be on the use of proprietary software but also on the use of open standards for data modeling, organization, and exchange. Training should be customized to suit specific project types, their associated use cases, and business needs and processes. The development of strong project management skills is also essential as BIM for infrastructure requires effective communication and collaboration among various stakeholders.

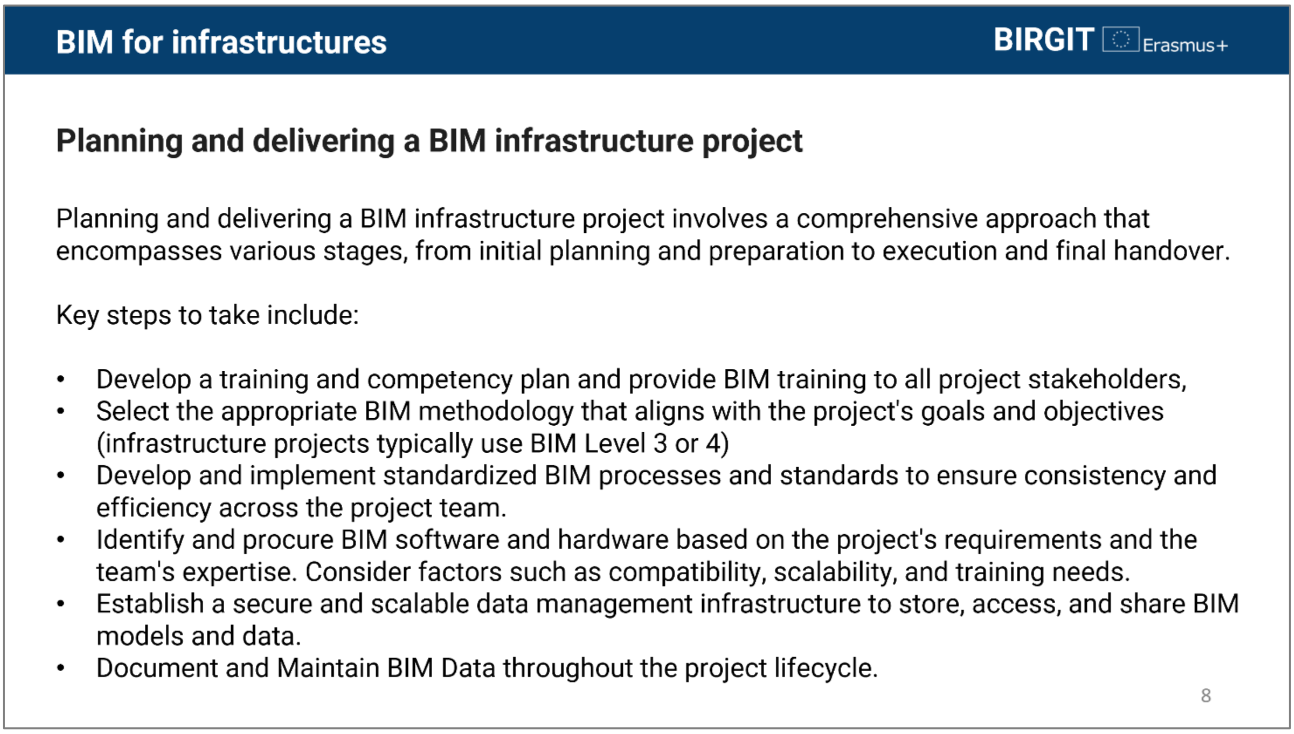
Data and standards

The use of BIM for infrastructure is a data-rich process that relies on standardized data formats and exchange protocols to ensure interoperability between systems and organizations. By using standardized data formats and exchange protocols, organizations can enhance collaboration, design quality, and project efficiency. GIS and BIM are often combined in infrastructure projects to create a more comprehensive and accurate representation of the project. Therefore, creating awareness about the use of GIS data in BIM for infrastructure projects is essential.

Tools and technology

Technical requirements for a successful BIM for infrastructure project vary depending on the specific project and its goals. Robust modelling platforms and collaborative environments will provide advanced capabilities for data management, communication, and project coordination. By selecting the appropriate tools and technologies, organizations can enhance collaboration, design quality, project efficiency, and cost-effectiveness.

Planning and delivering a BIM infrastructure project



To implement BIM effectively, it is essential to create a **project execution plan**. For smaller projects, such a plan might be simple. On a large project with many stakeholders, a highly detailed plan may be necessary to keep everyone pointed in the same direction.

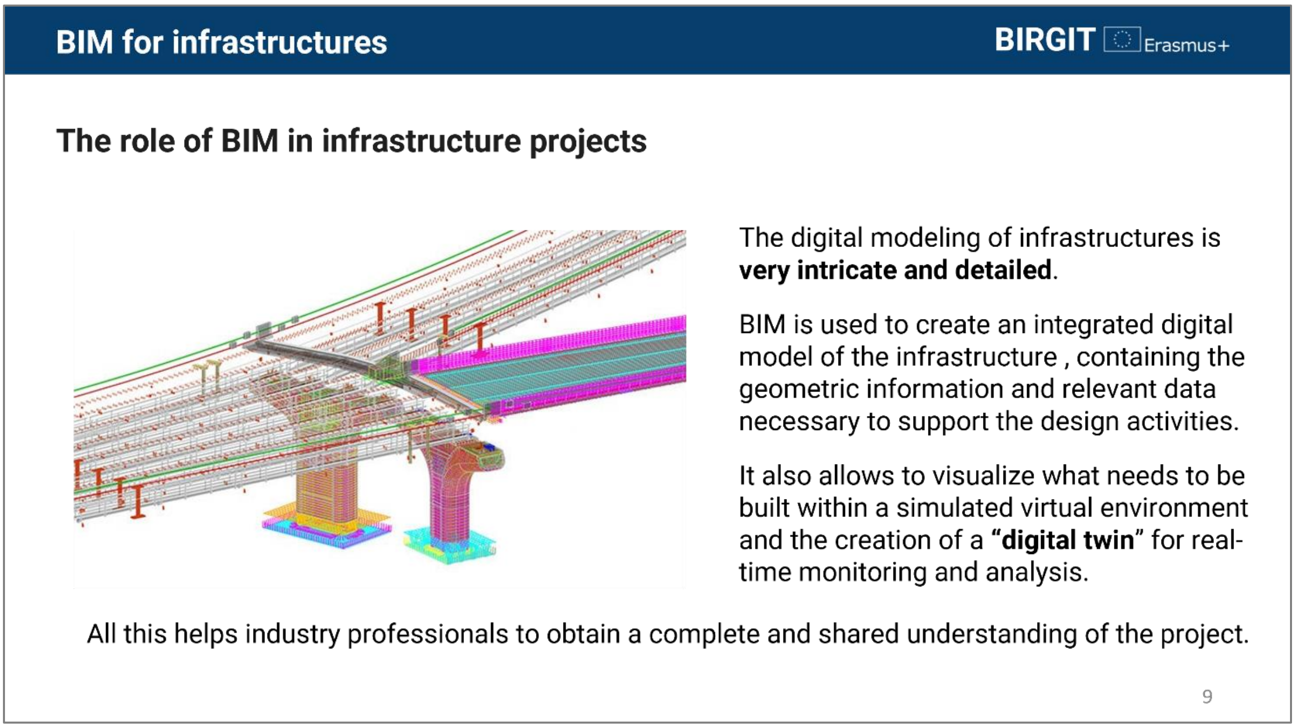
Start by establishing the standards and technology necessary to get started. Adoption of standards and asset data obligations can be daunting for inexperienced as well as more capable suppliers. Therefore, enable your team with training and achievable goals. Then, develop coordination and management workflows. Finally, ensure you capture and share knowledge gained on the project.

Select the appropriate BIM **methodology**: Large and complex infrastructure projects typically use BIM Level 3 or 4. BIM Level 3 goes further by incorporating 4D scheduling (time-based visualization of the project) and 5D cost estimation. BIM Level 4 is the most advanced level of BIM and integrates BIM with other technologies, such as augmented reality (AR) and virtual reality (VR).

Account for **software and hardware** needs: consider technology that allows you to move project information from planning to preliminary design to detailed design to construction without rework.

It is highly advisable to follow the ISO 19650 family of **standards** for information management when utilizing BIM, as this simplifies processes and ensures the application of agreed-upon best practices.

The role of BIM in infrastructure projects



Compared to the design of buildings, the digital modeling of infrastructures is much more detailed and complex as it involves a series of related problems:

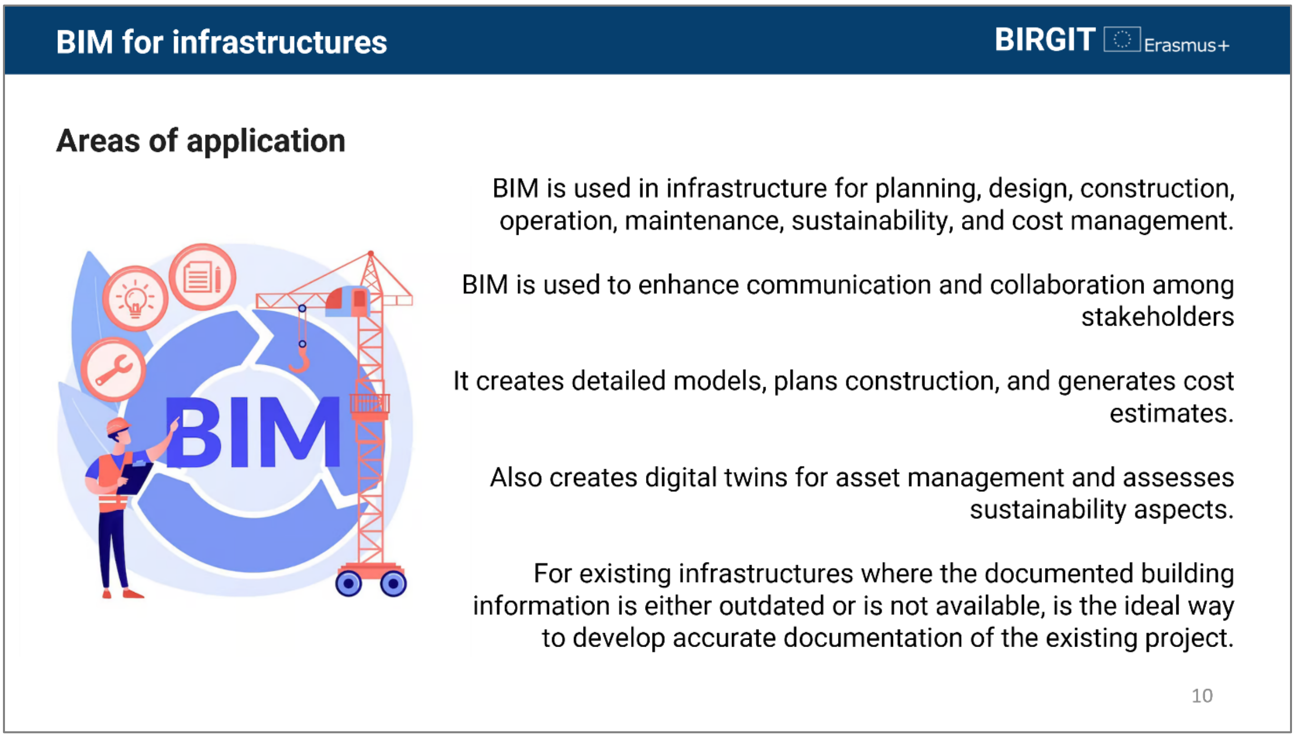
- The large extension and characteristics of the intervention area.
- The management of data relating to the territory.
- Infrastructure assets are very complex and interconnected. Interference with existing structures and the surrounding environment should be evaluated.
- The collaboration between the numerous subjects involved in the design.
- The verification and validation of models to ensure that they are accurate and reliable.
- The large amounts of data involved and need to share it in the different work phases.

In such a context, BIM represents the only tool capable of effectively overcoming this complexity. In fact, it allows you to create not just an integrated digital model of the infrastructure containing the physical and functional characteristics of the asset throughout its lifecycle but also a "**digital twin**" that can be continuously updated with real-time data from sensors and other sources.

The digital twin represents an accurate and up-to-date representation of the physical asset, that allows monitoring the condition of the asset, identifying potential problems, and optimizing its performance.

All this helps industry professionals to obtain a complete and shared understanding of the project, identify potential problems in advance and resolve errors with maximum efficiency and productivity.

Areas of application



BIM can be used for a wide variety of applications in the infrastructure sector. Here are some of the key areas where BIM is being used:

- **Design and engineering:** BIM can be used to create highly detailed and accurate models of infrastructure projects, which can help to improve the design and engineering process. BIM models can be used to identify and resolve potential problems early in the design phase, which can save time and money on the project.
- **Construction:** BIM models can be used to create 4D models of the project, which can help to visualize the project schedule and identify potential conflicts. BIM models can also be used to generate detailed site plans and as-built drawings.
- **Collaboration:** BIM is key to enhance communication, ensure regulatory compliance, and promote public involvement in infrastructure projects.
- **Operation and Maintenance:** BIM can be used to monitor and manage the assets throughout their lifecycle. Digital twins can be used to track in real-time the condition of assets, identify potential problems, and schedule maintenance activities.
- **Sustainability:** BIM can be used to assess the sustainability of infrastructure projects. An example is the use of BIM to calculate the energy consumption of infrastructure assets.
- **Cost Management:** BIM models can be used to generate detailed cost estimates, which can help to identify and avoid cost overruns. BIM can also be used to track the cost of the project during construction, and to generate cost reports.
- **Scan to BIM:** For existing infrastructures, such as factory buildings, where the documented information is either outdated or is not available, BIM is the ideal way to develop accurate documentation of the existing project.

Examples of use

Some examples of infrastructure projects using BIM include:

Transportation: Roads, highways, metro stations, sidewalks, broadways, waterways, and many other transportation projects. BIM help avoid any clashes with the existing facilities like gas piping, water lines, electricity, etc. BIM help with effective decision-making on geometries, quantity take-offs, resources, lane configurations, cut and fill analysis, site grading and analysis, and many more aspects. Also, BIM provides a common platform for all parties involved to share each phase of the project and resolve any conflicts before the actual construction of the work.

Railways: BIM is widely adopted in the railway sector. Railway engineers and planners is used to create a detailed 3D model of the entire railway infrastructure, including tracks, stations, bridges, tunnels, and other components. BIM software can identify clashes or conflicts in design early in the planning phase. This helps prevent issues that could lead to costly construction delays and revisions.

Land development: Land development projects involve the modeling of topographic surfaces, buildings, retaining walls, roads, parking areas, landscape elements, and so on. All these elements can be aggregated within a single BIM model with the aim of helping the competent authorities to obtain a more in-depth understanding of the project, and thus facilitate the issuing of permits and authorizations. In this context, Landscape Information Modeling (**LIM**) is a new trend in spatial projects that utilizes BIM technology. Land development elements are considered just as essential as building objects. Additionally, GIS data can be used to model larger areas by combining data from GIS and BIM models.

Civic structures: BIM is essential supporting complex geometries like malls, stadiums, parks, pools, commercial centers, and other facilities involving inter and intra disciplines. BIM can synchronize the architectural, structural, and MEP (Mechanical, Electrical, and Plumbing) components for a clash-free model for any civic structure.

Offshore structures: Floating facilities, oil platforms, dock harbors, cofferdams, pipe lays and various other offshore projects are particularly complex structures characterized by considerable size. The adoption of BIM technology helps to organize all phases of design, construction, operation and dismantling of these works. It also allows you to resolve all problems related to security and accessibility.

Tunnels: The process of designing and building tunnels and galleries involves considerable risks due to the high complexity of these works. The use of BIM provides a realistic 3D representation of the components involved in the construction of these structures, which allows inconsistencies to be detected and mitigated even before excavations begin. As-built drawings and models help tunnel operators and managers efficiently operate, maintain, repair, and renovate.

Bridges and dams: The design of horizontal structures, such as bridges and dams, involves numerous engineering disciplines. BIM models are able to integrate and coordinate all the services and elements that come into play in the construction of these works, including support structures, power and lighting systems, underground pipes and services, wastewater management, road and rail transport systems, etc.

In addition to the examples just described, BIM also provides an essential contribution in the design of **purification plants**, **water and wastewater** treatment facilities, **service networks** (both overhead and underground), **airports**, **hospitals**, **power plants** and **renewable energy facilities** and complex structures of all kinds.

BIM-based digital twins can be used for a variety of applications in infrastructure, including:

- **Bridges and tunnels:** Digital twins can be used to monitor the structural integrity of bridges and tunnels and identify potential cracks or corrosion.
- **Water and wastewater systems:** Digital twins can be used to monitor the flow of water and wastewater in systems and identify leaks or blockages.
- **Energy infrastructure:** Digital twins can be used to monitor the performance of power plants, transmission lines, and renewable energy facilities.
- **Transportation systems:** Digital twins can be used to monitor traffic flow and identify congestion areas. This information can be used to improve traffic management and reduce congestion.

Data and standards: ISO 19650

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Data and standards: ISO 19650

ISO 19650 is an international standard that provides a framework for the management of information in the built environment, including BIM.

It defines the roles and responsibilities of different stakeholders in the construction process, and it provides guidelines for the creation, exchange, and sharing of BIM data.

When applied to **infrastructure projects**, ISO 19650 ensures that BIM is used effectively to manage and maintain infrastructure assets, improving efficiency and reducing costs over the asset's life cycle.

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ISO stands for International Organization for Standardization, and it is an organization dedicated to the development of international standards.

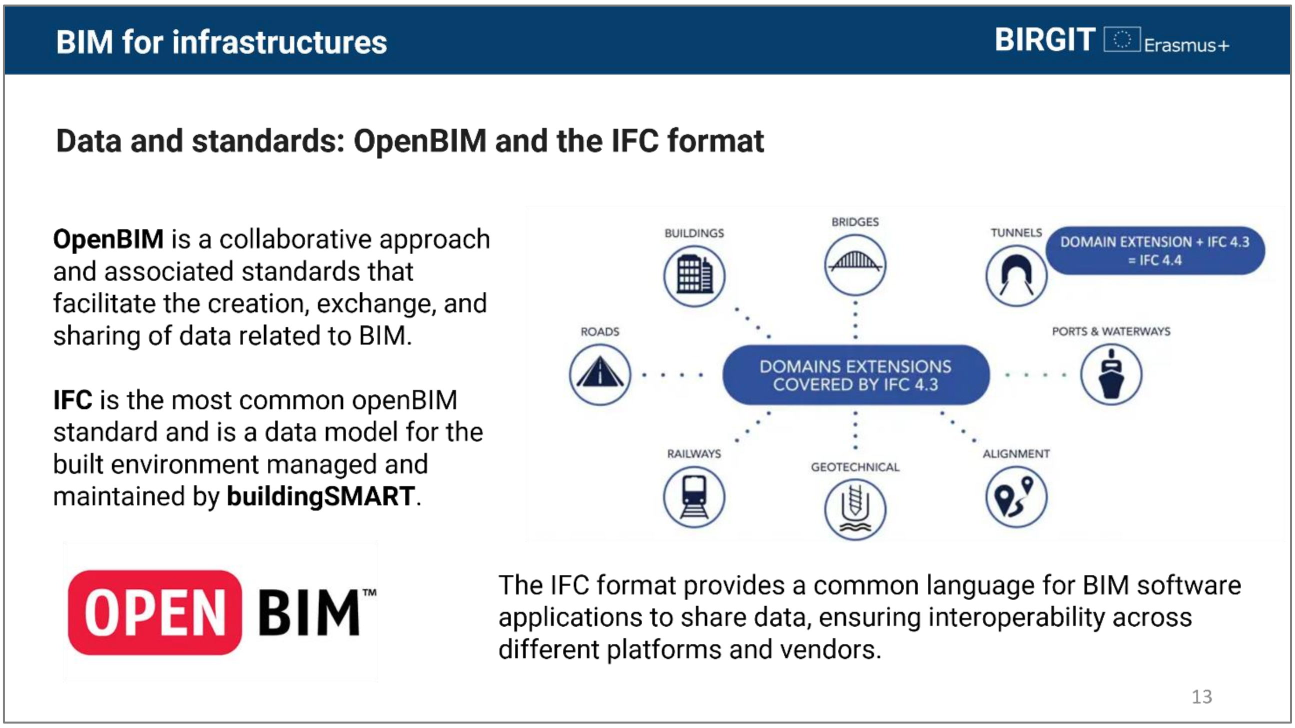
ISO 19650 is a globally recognized set of standards designed to facilitate the organization and management of data created during construction projects. The ISO 19650 series of standards are the most comprehensive BIM / information management standards available in the world today.

With the adoption of ISO 19650 in multiple countries (at a government level), ISO 19650 is becoming the global BIM standard.

ISO 19650 is particularly relevant to BIM for infrastructures, as it provides a standardized approach to the creation, exchange, and use of BIM data in complex projects. Following the ISO 19650 family of standards for information management when using BIM is highly recommended to make things simpler and to apply agreed good practices.

An ISO 19650 **National Annex** is an appendix document for any country to add their local/specific requirements for implementation of the standards in their region.

Data and standards: OpenBIM and the IFC format



There is no universal solution for implementing BIM that can be applied to every project or asset type, but open standards offer an opportunity to specify neutral handover formats as well as exchange format requirements.

In this sense, **OpenBIM** is a collaborative protocol and associated standards that facilitate the creation, exchange, and sharing of data related to BIM. It promotes interoperability and standardization across various BIM software applications.

Increasingly government mandates for project delivery require openBIM to improve interoperability for infrastructure projects. OpenBIM serves as a crucial enabler for infrastructure projects, where complex and interconnected systems require a comprehensive and interoperable approach to modelling and data management. By adopting OpenBIM standards, infrastructure stakeholders can effectively collaborate, exchange data, and make informed decisions throughout the project's various phases.

Why is openBIM important?

- OpenBIM supports a transparent, open workflow, allowing project members to participate regardless of the software tools they use.
- OpenBIM creates a common language for widely referenced processes, allowing industry and government to procure projects with transparent commercial engagement, comparable service evaluation and assured data quality.
- OpenBIM provides enduring project data for use throughout the asset life-cycle, avoiding multiple input of the same data and consequential errors.

- Small and large (platform) software vendors can participate and compete on system independent, 'best of breed' solutions.

In OpenBIM, a combination of open data modelling and exchange standards can be used, including, for example: IFC, LandXML, TransXML, InfraGML, CityGML, JSON and RDF. Using such standards ensures the data created during these phases provide interoperable and technology-neutral content for the information models.

IFC in infrastructure projects

In 1994, a consortium of 12 companies (the International Alliance for Interoperability, or IAI) was formed to develop a software sharing format. Two years later the first version of the Industry Foundation Class (IFC) format was released. The new format had to be open and neutral and the collective commitment was to develop software that was IFC-compatible. Since 2005, the IAI was established as a non-profit organization with the name **buildingSMART**, active worldwide with various national chapters.

BuildingSMART itself gave life to the OpenBIM aproach. The objective is the promotion of a working method based on the use of neutral formats, first and foremost IFC but also XML, BCF, COBie, etc. BuildingSMART also collaborates with the **OGC** (Open GeoSpatial Consortium) to define points of contact between the BIM and GIS worlds.

IFC is the most common OpenBIM standard and is a data model for the built environment managed and maintained by buildingSMART and their community. IFC is also an open international standard (ISO 16739-1:2018) and promotes functionality that is vendor-neutral or agnostic and usable across a wide range of hardware devices, software platforms and interfaces for many different use cases.

As IFC tries to describe the entire built environment, there are understandable limitations in coverage, particularly for infrastructure. In this sense the new **IFC 4.3** standard was recently introduced, specifically designed to simplify the interchange of infrastructure models and introduce a more specific classification for the elements that make up these projects. IFC 4.3 represents an undeniable breakthrough in the AEC industry, bringing a series of key modifications and enhancements that have a significant impact on infrastructure projects.

By adopting IFC, it becomes feasible to extend all the benefits of OpenBIM to what are referred to as "*horizontal resources*". The utilization of the IFC format is therefore pivotal in infrastructure projects, facilitating smooth data exchange, collaboration, and well-informed decision-making across the entire project lifecycle.

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Policies and and mandates

Policies and mandates

The EU has issued several policies and guidelines to promote the use of BIM in infrastructure projects.
The most relevant is **Directive 2014/24/EU** on public procurement:

This directive encourages member states to consider BIM when evaluating bids for public contracts for the design, construction, or refurbishment of infrastructure projects, such as roads, railways, and bridges.

National BIM Policies and Mandates
In addition to the EU directive, many EU member states have implemented their own BIM policies and mandates. These mandates vary in scope and stringency, but they all reflect the growing recognition of the benefits of BIM.

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Nowadays, many civil engineering contracts are demanding the use of BIM, adoption of standards, and asset data obligations. Governments and public procurers across Europe and around the world recognise the value of BIM and are taking proactive steps to foster the use of BIM in their construction sectors and public asset delivery and operations.

In 2014, the **European Union** issued a recommendation (Directive 2014/24/EU on public procurement) that member states should use BIM to deliver public projects. The EU's recommendation is not mandatory, but it is expected to encourage member states to adopt BIM using common standards (such as ISO 19650) and operating methods (such as OpenBIM).

Other policies and guidelines to promote the use of BIM in infrastructure projects include:

- 2016 Rolling Plan for ICT Standardisation: This plan outlines the EU's ongoing efforts to promote and standardize the use of BIM in the construction sector.
- 2017 BIM Task Force Report: This report provides recommendations on how to accelerate the adoption of BIM in the EU.

Many member states have already issued their own BIM mandates, the following are some relevant examples.

- In **Italy**, BIM is now a consolidated reality thanks to the introduction and continuous regulatory and legislative updating. 2019 was a decisive year for the affirmation of BIM with a Ministerial Decree which required, on a mandatory basis, the use of BIM in works of an amount equal to or greater than €100m. From 1 January 2022, however, the use of BIM methodologies has become mandatory for public works with a value equal to or greater than 15 million Euro's.

- In 2017, the **French government** mandated the use of BIM on all major infrastructure projects. The mandate applies to projects with a budget of over €100 million.
- The **Netherlands** has a voluntary BIM mandate for public projects. The mandate encourages the use of BIM for all projects over €15m in value and provides guidance on how to implement BIM.
- **Norway** has been a pioneer in implementing BIM for infrastructure projects. The Norwegian Public Roads Administration (NPRA) has been a strong advocate for BIM, and, from 2014, has developed several policies and mandates to encourage its use.
- **Germany** does not have a nationwide BIM mandate, but several federal states have implemented their own mandates. For example, the state of Baden-Württemberg requires the use of BIM for all public projects over €10m in value.
- In **Spain**, the government has taken several steps to promote BIM adoption in infrastructure projects. In 2018, the Ministry of Public Works, Transport, and Mobility (Mitma) published the "BIM Strategy for Infrastructure Projects" which outlines the government's vision for BIM adoption in the sector. Several public sector agencies in Spain have mandated the use of BIM for infrastructure projects. For instance, ADIF mandates BIM for all new rail projects with a budget of over €25 million. The DGT mandates BIM for all new road projects with a budget of over €50 million.
- **Croatia** has been gradually implementing BIM for infrastructure projects over the past decade. The Croatian Ministry of Construction and Physical Planning (MCPP) policies, mandates, and investments in training and support are helping to drive the adoption of BIM. In 2019, the ministry mandated the use of BIM for all new road projects with a budget of over HRK 50 million. The mandate was phased in over a three-year period, with all new road projects requiring BIM by 2021.

In addition to BIM mandates, many European countries have also published BIM **guidelines** for public projects. These guidelines provide recommendations on how to use BIM in public projects.

- **Sweden**: The Swedish government has published BIM guidelines for public projects. The guidelines cover a wide range of topics, including data management, collaboration, and training. BIM has now become a part of Sweden's culture, and the Swedish Transport Administration requires it for certain infrastructure projects.
- **Denmark**: The Danish government has published BIM guidelines for public projects. The guidelines are based on the BIM Level 2 standard and provide recommendations on how to use BIM for different types of projects.
- **Finland**: The Finnish government has published BIM guidelines for public projects. The guidelines are based on the BIM Handbook published by BuildingSMART International.

Use of GIS in BIM infrastructure projects

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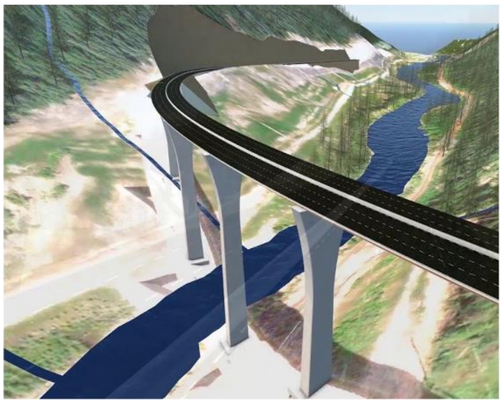
Use of GIS in BIM infrastructure projects

GIS can play a crucial role in BIM infrastructure projects, providing a comprehensive understanding of the physical environment.

GIS integration provides a number of benefits:
- ✓ Enhanced visualization of the project site
- ✓ Improved site planning and design based on land use and environmental aspects.
- ✓ Prevent conflicts between infrastructure elements and other structures.
- ✓ Cost optimization and project efficiency

Examples of GIS data usage
- ✓ Road and bridge design
- ✓ Railway design
- ✓ Underground network design



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The integration between BIM and GIS aims to support the planning, design, construction and management of works, considering the territory, ecosystems and natural resources to be enhanced or protected.

GIS software and data can play a crucial role in BIM infrastructure projects, providing a comprehensive and up-to-date understanding of the physical environment and supporting informed decision-making throughout the project lifecycle. Thanks to GIS databases and the use of appropriate BIM applications, it is possible to reconstruct three-dimensional and realistic models of the territory, overlay planning and environmental data, topography, utility lines and other geospatial data and on top of this data, design BIM infrastructures.

The continuously expanding availability of openly licensed online geospatial data allows for the reconstruction of realistic 3D models of cities and territories, facilitates the integration of these data in infrastructure projects such as roads and railways.

By integrating GIS into BIM workflows, we introduce the concept of "**Geodigital Twin**", which extends beyond just creating digital twins of a project to encompass the entire territorial context. The Geodigital Twin can prove incredibly useful for the Green Building and Green Infrastructure approach, integrating the territorial, climatic, social and economic dimensions of sustainability with traditional BIM design processes.

Green building and green infrastructure represent two sides of the same coin, aiming to create a more sustainable built environment. Both BIM and GIS play crucial roles in promoting these approaches, in a way that minimizes environmental impact, conserves resources, and promotes a more sustainable future.

Geospatial digital twins can be extremely useful in the management of infrastructure assets, such as roads and bridges. Another field in which the addition of GIS data becomes fundamental is that of sustainable construction site management, where the BIM information process is integrated with the potential of GIS analysis for environmental monitoring.

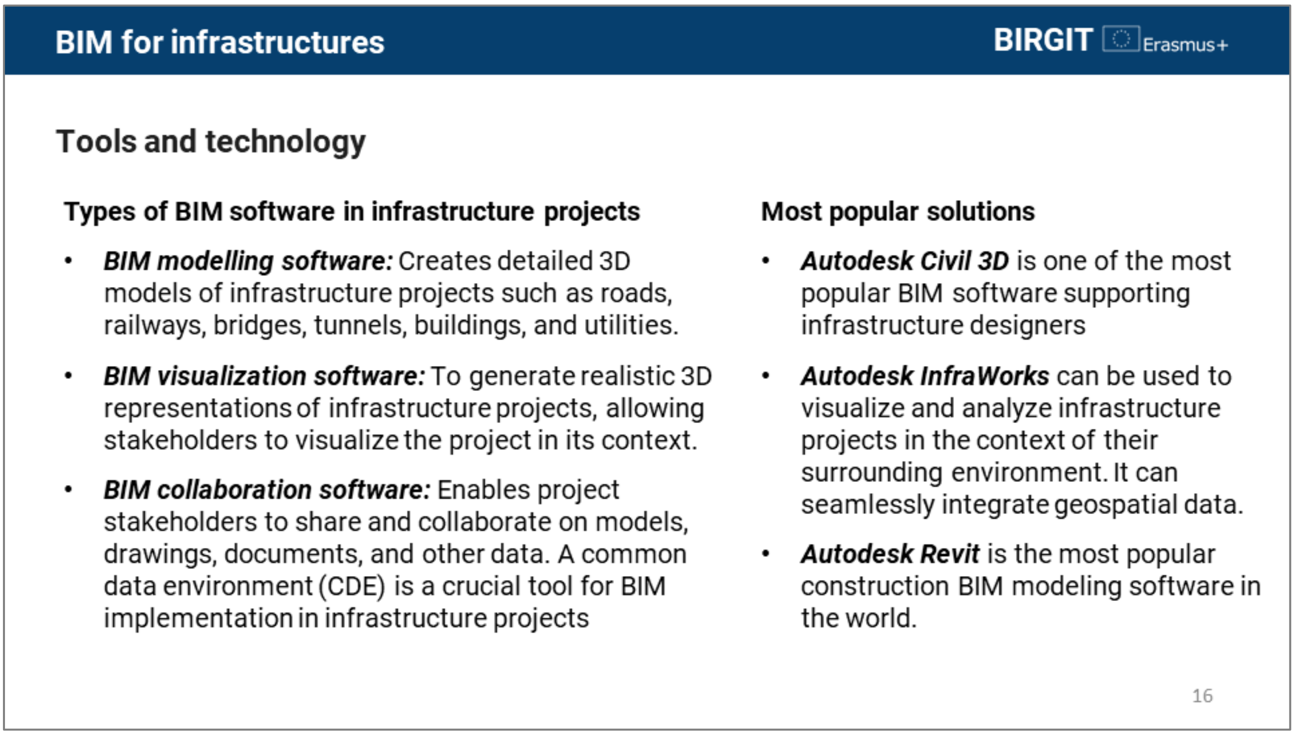
BIM and GIS integration creates a holistic representation of the infrastructure project site, facilitating a range of benefits:

- **Enhanced visualization:** GIS and BIM integration allows for the creation of 3D visualizations that combine the physical context of the project site with the BIM model. This immersive visualization enables stakeholders to better understand the project, visualize potential conflicts, and identify opportunities for optimization.
- **Improved site planning and design:** GIS data can inform site planning and design decisions, ensuring that infrastructure projects are aligned with existing land use, environmental constraints, and transportation networks. For instance, GIS data can help identify areas with high soil moisture content, potential landslide zones, or proximity to protected areas, which can influence foundation design and construction methods.
- **Clash detection and coordination:** GIS data can be used to detect and prevent clashes between infrastructure elements and existing underground utilities or other structures. This clash detection capability can significantly reduce the risk of costly rework and delays during construction.
- **Cost optimization and project efficiency:** By integrating GIS data with BIM models, project teams can identify potential cost savings opportunities, such as reusing existing utility lines or modifying design parameters to avoid conflicts. This can streamline project workflows and lead to more efficient project delivery.

Here are some examples of how GIS data is being used in BIM infrastructure projects:

- **Road and bridge design**: GIS data, including topography, land use, and existing road networks, can be used to optimize road alignments, minimize environmental impacts, and ensure compliance with regulations. For bridge design, GIS data can help identify suitable locations for bridge foundations, assess bridge clearances, and consider potential scour hazards.
- **Railway design:** GIS data, including terrain features, existing railway lines, and environmental constraints, can be used to optimize railway alignments, identify suitable locations for tunnels and bridges, and ensure adherence to railway standards.
- **Underground network design:** GIS data, including utility lines, underground structures, and geotechnical information, can be used to plan and design underground networks such as sewer systems, water pipelines, and telecommunications cables. This integration helps avoid conflicts between underground infrastructure and other structures.
- **Asset Management:** GIS data can be used to store and manage information about existing infrastructure assets, including their location, condition, and maintenance history. This data can be used to develop effective asset management plans, prioritize maintenance activities, and identify potential risks to infrastructure integrity.

Tools and technology



Which BIM software to use in infrastructure projects?

BIM isn't just software, it's a process, but of course you'll need software to create the models that drive the BIM process. We can use a plethora of tools; however, this creates its own set of complications as technology is changing so quickly that it can be hard to keep up and decide what is most appropriate to use.

Below are a few of the numerous BIM tools available for infrastructure projects. We believe we have listed the most essential ones, although the specific tools used may vary depending on the project type, the preferences of the project team, and the project's requirements.

BIM software offers a wide range of functionalities to support the different stages of an infrastructure project. Therefore, the list of software tools is divided by the main types of BIM software.

BIM modelling software

This type of software focuses on creating detailed 3D models of infrastructure projects such as roads, railways, bridges, tunnels, buildings, and utilities.

Autodesk is widely recognized as the software leader in BIM. They offer a comprehensive suite of commercial BIM solutions for infrastructure projects, encompassing the entire project lifecycle from planning and design to construction and maintenance. Key Autodesk solutions for BIM modelling in infrastructure projects include:

Autodesk
Revit is a popular BIM software that is used for modelling and designing a wide variety of infrastructure projects, including buildings, bridges, roads, and tunnels. Revit is mostly applied in infrastructure projects for modelling road structures such as bridges, footbridges, underpasses, culverts, tunnels, and retaining walls.
Civil 3D is a powerful civil engineering software providing tools for designing, modelling, and analysing infrastructure projects, including roads, bridges, pipelines, and utilities. Nowadays, Civil 3D is the most used and effective authoring BIM-oriented software for the modelling of a transport infrastructure.
InfraWorks focuses on infrastructure modelling and visualization. Is a 3D city modelling and simulation software that can be used to visualize and analyse infrastructure projects in the context of their surrounding environment. This specific software works very well with GIS data since it can seamlessly integrate geospatial data into designs, and model existing conditions that represent the actual construction site.

It is worth noting that Autodesk has been partnering with buildingSMART International and AEC professionals to support openBIM. For instance, now you can use IFC 4.3 for Civil 3D 2024 version to improve interoperability for multidisciplinary project teams.

Trimble BIM software (also known as Tekla software products by Trimble) is a comprehensive suite of tools that helps architects, engineers, and contractors design, build, and manage buildings and infrastructure projects.

Trimble
Tekla Structures is a powerful structural BIM software, specialized for structural engineering, particularly for designing and detailing complex steel and concrete structures. It provides tools for creating detailed 3D models, analysing structural performance, and generating fabrication and erection documentation.
Trimble Novapoint is the most popular BIM software in Scandinavia for infrastructures. It enables civil engineers for creating complex 3D models of roads, railways, sewage networks, tunnels, or bridges.

Graphisoft is another important software brand that provides a comprehensive suite of BIM tools for collaboration, analysis, and visualization. Graphisoft is member of the buildingSMART Alliance and among the companies who initiated OpenBIM.

Graphisoft
ArchiCAD is a complete design suite with 2D and 3D drafting, visualization and other building information modelling functions for architects, designers and planners. It is worth mentioning that The first BIM software was Archicad. ArchiCAD is primarily used for architectural design. While it offers some features for infrastructure projects, it is not specifically designed for this purpose and there are other BIM software options that are better suited for infrastructure modelling and design.

Bentley BIM software includes a variety of tools for creating, editing, and analysing BIM models.

Bentley
MicroStation is a computer-aided design (CAD) software (can be compared with Autodesk AutoCAD) for creating precise 2D and 3D drawings for infrastructure projects. It is well-suited for infrastructure modelling. It generates 2D/3D vector graphics objects and elements and includes BIM features. It is known for its powerful 3D modelling capabilities, geospatial data integration, and analysis tools. MicroStation is often used for projects that require a high level of precision and detail.
OpenRoads ConceptStation is a road network conceptual design software that allows users to create 3D models of roads, bridges, and other transportation infrastructure quickly and efficiently.
OpenBuildings is a BIM software for civil engineers that can be used for multiple applications – architectural, mechanical, structural, and electrical systems design, construction documentation, and visualisation.

Other relevant software products used for BIM infrastructure projects are:

- ***Vectorworks:*** Is a BIM software that can be used for infrastructure projects. It offers a variety of tools for creating and managing 3D models of infrastructure elements includes a built-in civil engineering calculator that can be used to perform calculations for infrastructure projects.
- ***Rhino:*** Is primarily used for 3D modelling and design, and it can be used for a variety of applications, including infrastructure projects. However, it is not specifically designed for infrastructure BIM and is not as widely used as some other software options.
- ***SierraSoft Roads:*** Is a BIM software for the design of roads and highways. The BIM functions of SierraSoft Roads allow for the production, modification, sharing, and analysis of road information models.
- ***Allplan Engineering:*** A popular BIM software among civil engineers that offers a comprehensive range of tools to design and manage projects and estimate costs.

BIM visualization software

This type of software can generate realistic 3D representations of infrastructure projects, allowing stakeholders to visualize the project in its context and make informed decisions. Most of this tools are free to use but have limited features. BIM software world is intrinsically linked to the proprietary software. there is a large number of free viewers, some of which are free although developed by commercial companies.

A selection of relevant software products used for visualizing BIM infrastructure projects are:

- ***Autodesk Viewer:*** A free browser BIM software for viewing 3D models.
- ***Autodesk Navisworks:*** Gives the possibility to view the model from different perspectives.
- ***Trimble Connect:*** Offers a range of features for design coordination, project management, and also BIM visualization.
- ***ACCA usBIM:*** Application for viewing large sized BIM models online. ACCA usBIM is a cloud-based platform made of a suite of tools that offers a free version that includes the possibility of creating and manage BIM models (with some limitations) and publish and share BIM models in IFC format.
- ***Bentley Viewer:*** A free desktop application with a range of features to view the geometric model.

Selection of BIM software for viewing the information included in IFC files (3D objects and tabular view of the information)

- ***BIM Vision:*** A freeware BIM model viewer that supports the IFC format. It is a lightweight and easy-to-use tool that can be used to view, analyze, and measure BIM models.
- ***Solibri Anywhere:*** A free desktop program from Nemetschek. The program supports the preview of IFC files.
- ***Areddo:*** A free BIM viewer for IFC and point clouds. It is a lightweight and easy-to-use tool that can be used to view, explore, and analyze BIM models.
- ***BIMCollab Zoom***: A free software from KUBUS company.
- ***Dalux Viewer***: A free program supporting IFC file viewing.

Regarding OpenSource BIM software, there are several options available. However, the use of this tools in BIM for infrastructures if very limited. Some of the most popular options include:

- ***FreeCAD:*** A free and open-source parametric 3D modeling software that can be used for a variety of purposes, including BIM.
- ***BlenderBIM:*** An open-source extension for the popular Blender 3D modeling software that adds BIM functionality.
- ***IfcOpenShell:*** A free and open-source C++ library for reading, writing, and manipulating IFC files.

More engineers are seeking ways to take advantage of new technologies to enhance their workflows and improve productivity. In this sense the use of ***Virtual Reality and Augmented Reality*** is increasingly common for the visualisation of rail, highways, and bridge structures. This technology not only allows us to move the designed object from a flat screen to a more "immersive" environment but also improves the decision-making process of choosing the designing solutions.

BIM collaboration software

This software enables project stakeholders to share, review, and modify BIM models in real time. A critical aspect of achieving a successful BIM project is ensuring effective information management. The use of a so-called Common Data Environment (CDE) is a process to ensure information is prepared, quality checked, issued, and used in a controlled and consistent approach. In the context of BIM for infrastructure projects, the CDE (specially the cloud-based solutions) plays a crucial role in streamlining collaboration, enhancing project coordination, and improving project outcomes.

Examples of relevant software for CDE in BIM for infrastructure projects include:

- ***Autodesk BIM 360:*** An advanced cloud-based Common Data Environment from Autodesk. Provides a centralized location for storing, managing, and sharing project information for infrastructure projects.
- ***Autodesk Navisworks:*** Also offers some collaboration features, such as markup and annotation tools. However, it is not as fully featured as dedicated collaboration platforms.
- ***Autodesk BIM Collaborate:*** A cloud-based BIM collaboration platform that helps teams work together more effectively throughout the project lifecycle. It provides a centralized platform for storing, sharing, and managing BIM data, as well as tools for collaboration, clash detection, and issue management. Autodesk BIM Collaborate and Autodesk Navisworks are typically used for different stages of the construction process.
- ***Trimble Viewpont:*** A cloud-based document and information management solution for sharing, controlling and collaborating on project information with dispersed project teams.

- ***Trimble Connect:*** A cloud-based BIM collaboration platform that allows project stakeholders to share and access BIM models, drawings, and other project data in real time.
- ***BIMcollab:*** A cloud-based collaboration platform that enables project stakeholders to share, review, and comment on BIM models in real time.
- ***Bentley ProjectWise:*** A project collaboration software that helps project teams to manage, share and distribute engineering project content and review in a single platform.
- ***Asite:*** A cloud based CDE that helps construction project teams collaborate, manage, and share information.
- ***BIMServer:*** A cloud-based open-source platform for managing and sharing Building Information Models (BIM). It is a popular choice for infrastructure projects because it offers several features that are specifically designed for this type of work.
- ***usBIM:*** Complete BIM management system for the digitization of constructions and infrastructures in a simple, secure and shared workflow

BIM software adoption: Global variations

The adoption and use of BIM software varies significantly across different countries. This can be attributed to several factors, including market trends, regulatory requirements, educational infrastructure, and cultural factors.

BIM adoption is very high in North America, with over 80% of projects using BIM in some capacity. This is due to several factors, including the maturity of the construction industry, government policies, and the availability of BIM training and education.

BIM adoption is also high in Europe, with over 60% of projects using BIM in some capacity. Government policies in many European countries have encouraged the adoption of BIM, and there is a growing network of BIM training and education providers.

There is no single dominant BIM software across all regions. However, Autodesk Revit is the most widely used BIM software in North America, Europe, and Latin America. Bentley software is also a popular choice in these regions, especially for infrastructure projects. Graphisoft Archicad is another popular BIM software, particularly in Europe and Asia. Tekla Structures is a specialized BIM software for structural engineering, and it is commonly used in Europe and Asia for high-rise buildings and infrastructure projects.

BIM and GIS integration

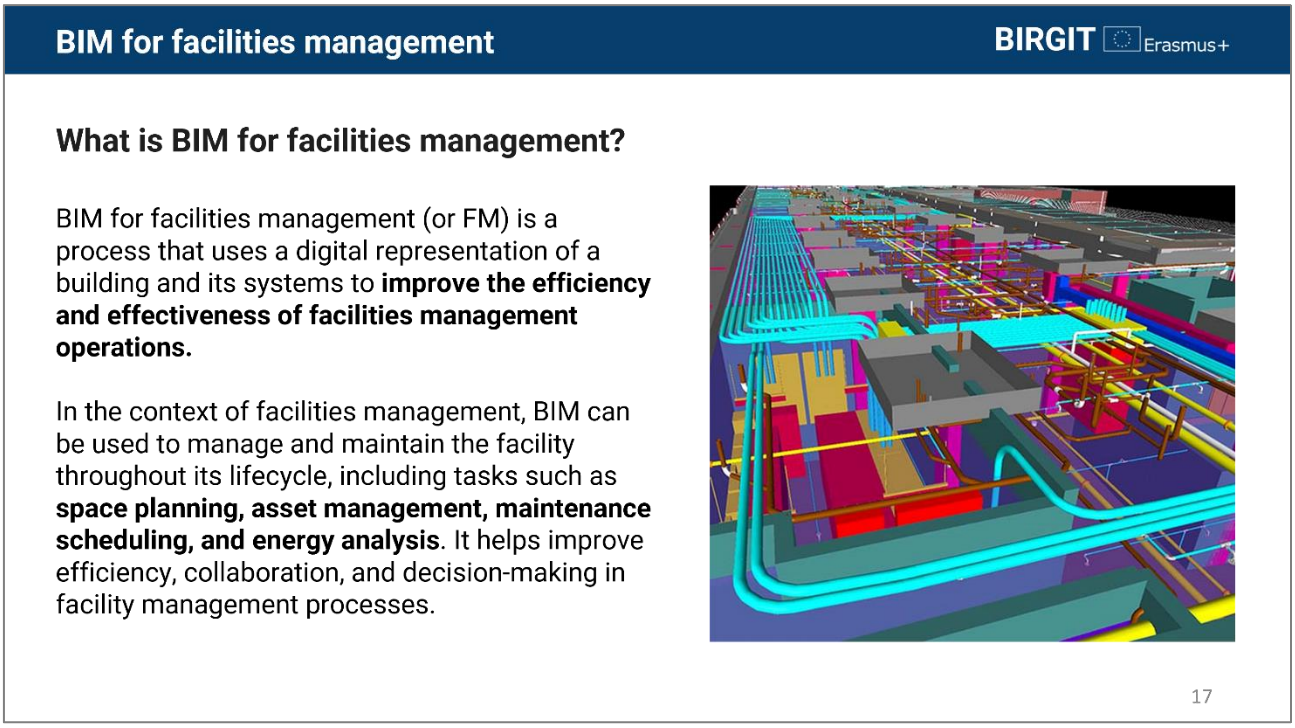
The collaboration between Autodesk, leader in the BIM sector, and Esri, leader in geospatial solutions, has increasingly improved the interoperability between different software involved in the design process.

To date, Esri's main GIS software, ***ArcGIS Pro***, allows direct reading of Autodesk Revit , Civil 3D dwg , and the IFC BIM interchange format . Furthermore, the possibility of connecting with BIM360 and Autodesk Construction Cloud has been added, to add geographical context to the models stored in the Cloud. It is then possible to publish Revit and IFC models also within the Esri ArcGIS Online cloud. The tool ***ArcGIS GeoBIM*** app, available on ArcGIS Online is proposed as a "bridge" between the GIS environment and the BIM world.

More information regarding BIM and GIS integration can be found in the dedicated BIRGIT course “BIM-GIS Integration”.


ArcGIS Online
ArcGIS GeoBIM
AUTODESK CONSTRUCTION CLOUD
AUTODESK BIM 360 DOCS

What is BIM for facilities management?



Facilities management (FM) involves the operation and maintenance of a building's infrastructure and services.

BIM has transformed architecture, engineering, and construction. Another great potential of BIM is to provide accurate, timely and relevant information not just during design and construction for a single building or infrastructure, but also throughout the **lifecycle** of facilities.

A BIM dimension refers to the different levels of information or data integration within a BIM model. Each dimension adds a layer of complexity and detail to the modeling process. These dimensions enhance the BIM model and make it more useful throughout the lifecycle of a structure.

Among the "dimensions" of BIM, **7D BIM** addresses all aspects of facility management and deals with the management and maintenance of existing assets through actions that ensure quality of services and safety of users and workers.

BIM is a transformative technology in the field of facilities management, offering a comprehensive and detailed digital representation of a facility's physical and functional attributes. This digital representation serves as a centralized repository of information, enabling facilities managers to effectively plan, monitor, and maintain their assets throughout their lifecycle. BIM for facilities management, also called "**lifecycle BIM**" can be used for efficient facility management, maintenance planning, and space utilization.

Facilities management encompasses multiple disciplines with the aim of ensuring optimal functionality of the built environment – integrating people, places, processes and technology. It covers everything from maintenance and cleaning, real estate and financial management. The variety of these services highlights the complexity of the argument. Furthermore, there is a significant economic and environmental need to enhance the management of new and existing facilities in an efficient manner, and BIM can be extremely beneficial in this regard.

Benefits of BIM for facilities management

Collaboration is a key component of a BIM workflow. For facility managers, this means that they can exchange information with key people involved in the design and construction phases to get a better understanding of the building lifecycle. Besides, facility managers can also participate during the design phase to ensure that the facility is cost-effective and meets the day-to-day objectives of facility managers.

When the facility's model is updated regularly, maintenance teams can access important performance and condition data about the building assets. For example, a user can examine the 3D model of an HVAC unit to get details about performance, maintenance schedules as well as manufacturer information. With this data, preventive maintenance plans for the unit can be created.

The 3D model of the facility also allows technicians to become completely aware of exact asset locations, enabling them to locate the problem and fix it quickly. And, whenever there's a change in the asset location, the information gets updated for every stakeholder, ensuring a single source of truth for everyone.

A BIM model also facilitates the effective utilization of space as it becomes easier for the facility managers to visualize the building and the available space within the envelope. With access to accurate layout information, facility managers can optimize the allocation of assets, optimize evacuation routes, identify weak security points, and ensure ease of access, safety, and comfort for the occupants.

Energy savings is one of the critical priorities for most commercial buildings. This is especially true for green buildings developed to reduce environmental impact. BIM offers access to data on energy consumption, offering facility managers an opportunity to analyze and compare different energy alternatives to meet energy goals.

BIM is equally useful for existing facilities built without an informative digital model. It is possible to generate an integrated BIM model of the existing facility using a laser scanning technique along with original design plans. Facility managers can utilize this 3D model to suggest retrofitting opportunities to optimize the building for improved operational efficiency and energy savings.

BIM uses for facilities management

BIM for facilities management — BIRGIT Erasmus+

BIM uses for facilities management

Facility managers are finding value in a number of areas of **building operations** that benefit from enhanced BIM data.

BIM applications in facilities management include:

- Space management
- Asset management
- Maintenance planning
- Energy management
- Safety and security
- Cost estimation and budgeting
- Construction sustainability

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BIM for space management and optimization

BIM for facilities management

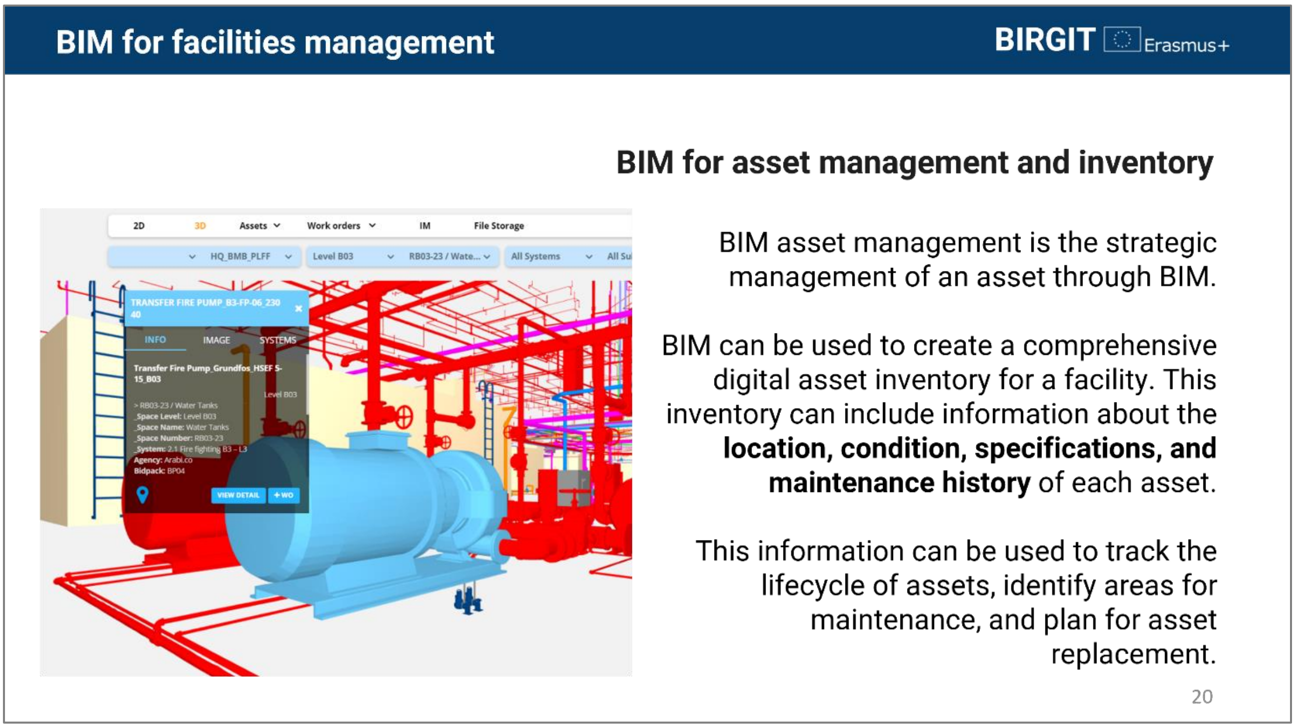
BIM for space management and optimization

BIM models provide 3D visualizations of spaces, enabling facilities managers to optimize space utilization, identify underutilized areas, and plan for future expansion.

This approach ensures that space allocation aligns with organizational needs and maximizes utilization efficiency.

By understanding the details of how space is used, facility professionals can reduce vacancy and ultimately achieve major reductions in real estate expenses. The room and area information in BIM models are the foundation for good space management.

BIM for asset management and inventory



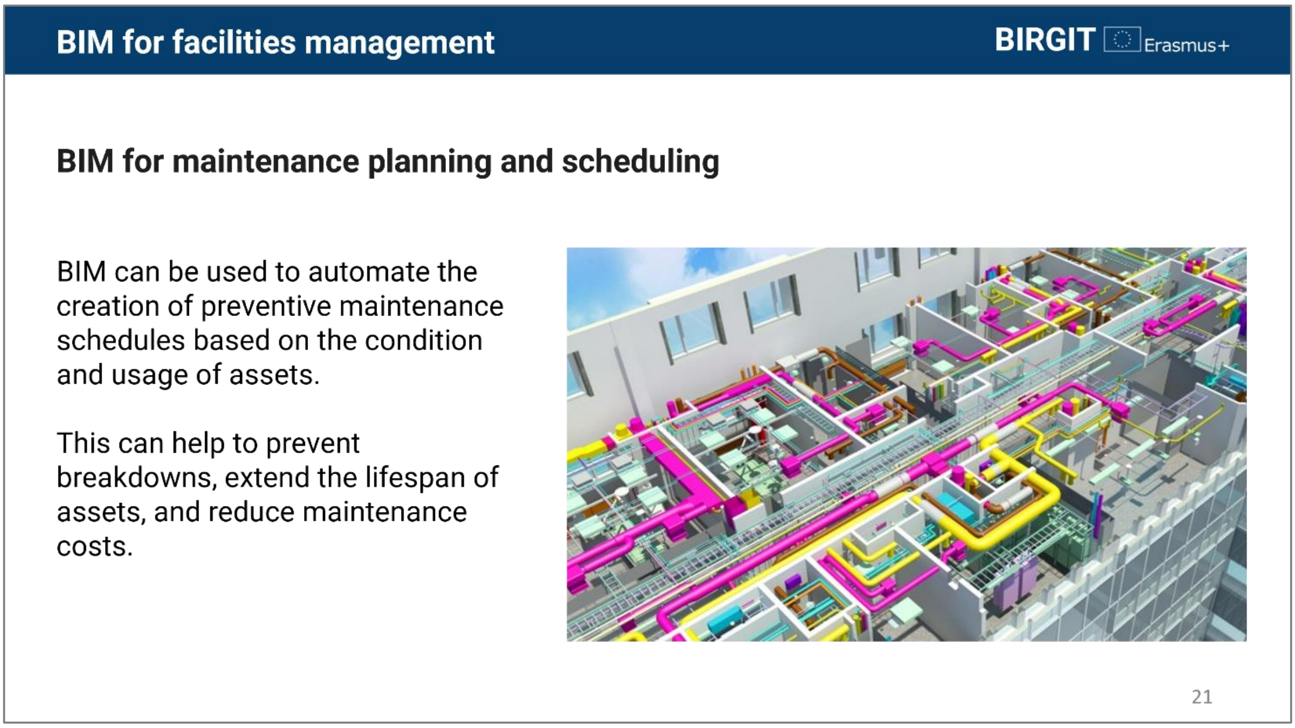
BIM Asset Management is the management and maintenance of an asset carried out in a strategic and advantageous way through the application of BIM. This phase of the life cycle of an asset is the one in which the asset is used by the end user and at the same time must be managed and maintained. The management of an asset addressed with the support of BIM technology represents a fundamental service for facility managers and has several benefits:

- Facilitates the organization and management of the various components of the asset - structural, architectural, plant engineering, etc.
- Allows the Facility Management operator to simplify routine operations such as surveying, information collection, production of documents data from maintenance activities, etc.
- Allows for a more reliable and detailed knowledge of the actual consistency of the artefact.

The key challenge in developing a maintenance program is entering the product and asset information required for preventive maintenance. Information about building equipment stored in BIM models can eliminate months of effort to accurately populate maintenance systems. By BIM Asset Data we mean all the information which concerns the management and maintenance phase of the asset, and which enriches the information assets of the BIM model. The BIM model will thus be converted into an **AIM, Asset Information Model.**

BIM **Asset Tagging** literally means labelling the model and consists of updating model information with management data. The project team can add **COBie** (explained in the slide 26) or other data to the model relating for example to patrimonial identity, serial numbers, manufacturer information, warranties, and estimated lifetimes. This information allows Facility Management (FM) teams to use the model for maintenance information.

BIM for maintenance planning and scheduling



BIM can be used to automate the creation of **preventive maintenance** schedules based on the condition and usage of assets. This can help to prevent breakdowns, extend the lifespan of assets, and reduce maintenance costs.

The key challenge in developing a maintenance program is entering the product and asset information required for preventive maintenance. Information about building equipment stored in BIM models can eliminate months of effort to accurately populate maintenance systems.

BIM can be used to analyze asset data patterns and identify potential issues before they lead to breakdowns or failures. This can help facilities managers to proactively address problems, minimize disruptions, and reduce unexpected repair costs.

BIM and construction sustainability

6D BIM goes beyond the conventional approach that focuses only on initial project costs but helps to estimate the full cost of operating an asset to meet certain sustainability and efficiency criteria.

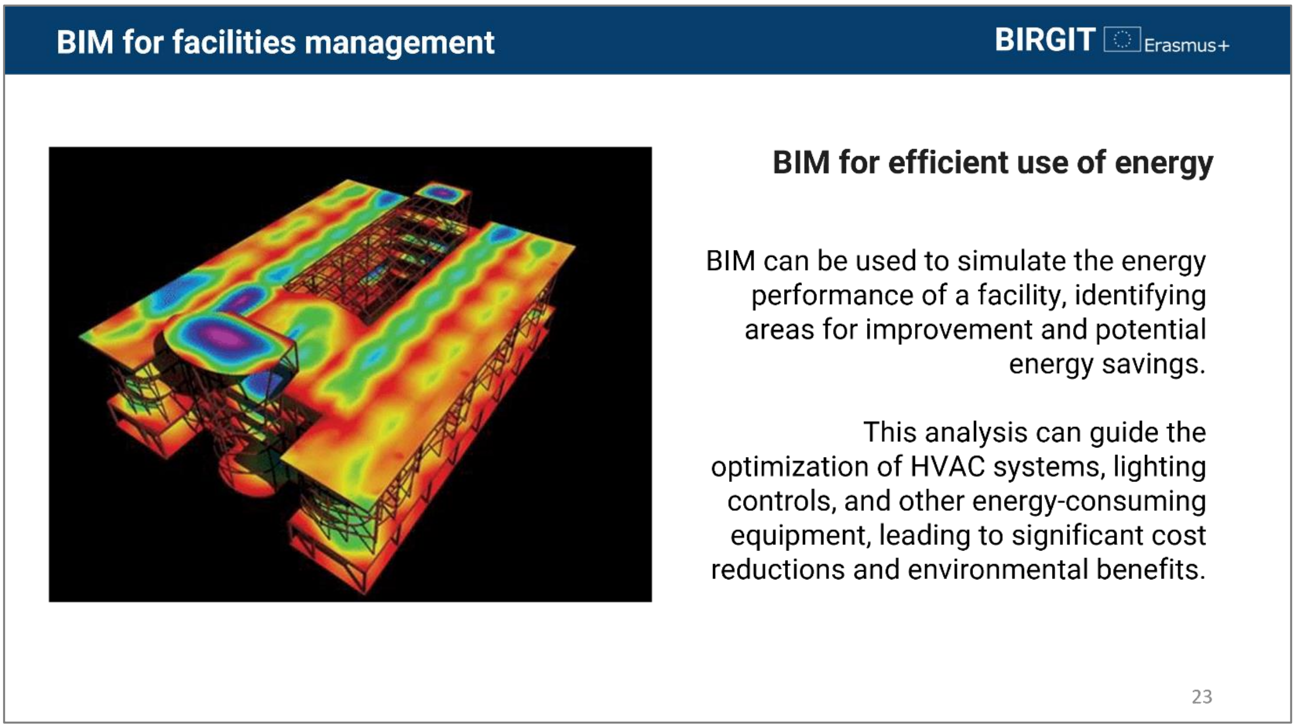
Often in construction, sustainability is only associated with the energy requirements of a building: A building intervention is only defined as sustainable when it leads to energy savings. However, sustainability is multifaceted and concerns the achievement of a sustainable balance between economic, environmental, and social requirements.

BIM can provide the framework for bringing together all these aspects by offering the possibility to manage a complex information system in an integrated way, referring to the various technological systems, the building components, and the different phases of its life cycle.

In fact, 6D BIM also comes into play during **operations and maintenance**; it streamlines asset management by including detailed information about the building's components, such as expected lifespan, maintenance schedules, and replacement costs. This, in turn, aids teams with managing energy systems that can impact the building's environmental footprint.

It is important to highlight that there is a need to provide comprehensive training to future professionals to empower them to effectively utilize BIM to identify and implement energy-efficient solutions throughout the building lifecycle.

BIM for efficient use of energy



One of the most important aspects of BIM 6D modelling is the **energy model of the building**, with which it is possible to study possible alternatives to improve energy efficiency, comfort and well-being for users and include other more efficient and sustainable forms of energy.

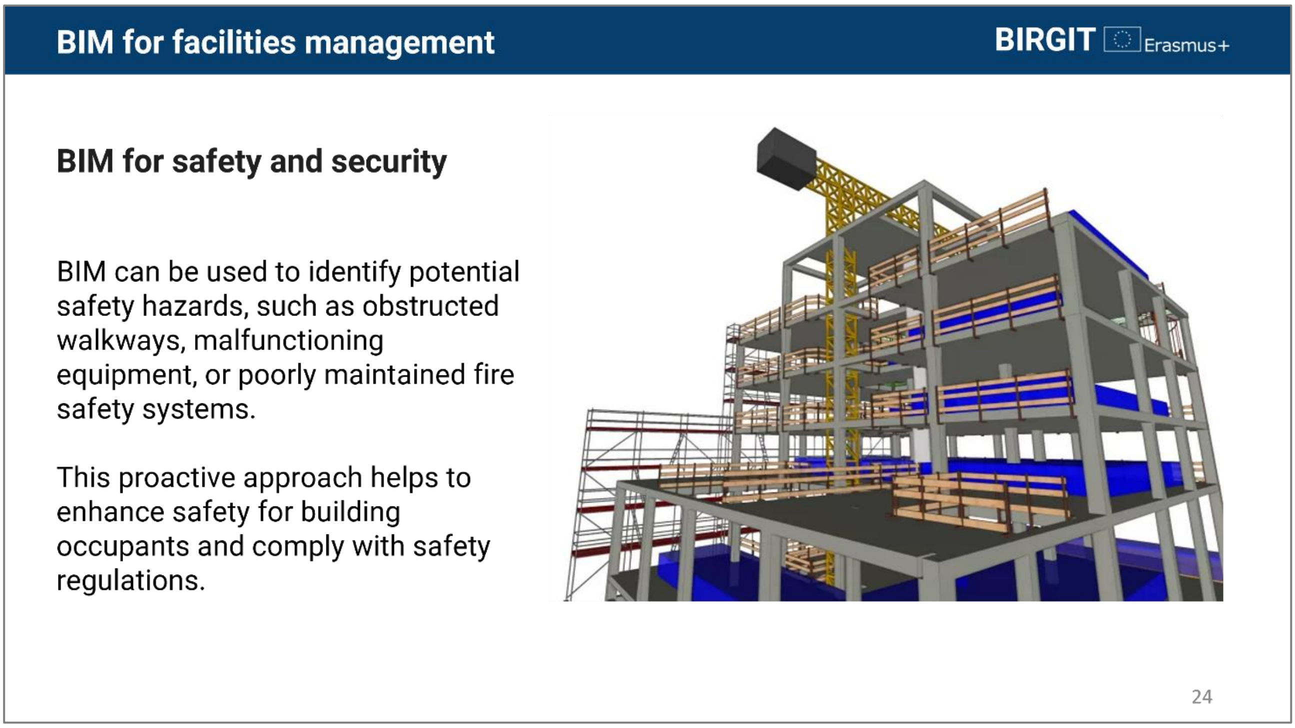
In fact, BIM can be used to analyse and compare different energy alternatives, helping facility managers significantly reduce environmental impact and operating costs. By evaluating the costs and savings associated with various building improvements and system retrofits, facility managers can optimize building performance throughout its lifespan.

While BIM has proven effective in optimizing construction solutions and achieving energy savings, there is a need for greater interoperability between BIM and energy analysis tools. Additionally, more integration with other technologies, such as GIS, would further enhance the benefits of BIM for energy efficiency.

To manage 6D modelling, specific software is needed to create a three-dimensional model of the building and insert parametric objects with data and information relating to the energy performance of each element. All these aspects converge in a single BIM model that simulates the real behaviour of all the physical asset. This model is also known by BEM (Building Energy Modeling).

Among energy analysis tools, ***EnergyPlus*** is the most widely used, followed by EcoTect, Green Building Studio, IES-VE and of TerMus PLUS. Autodesk Revit stands out as a central hub in the BIM-energy analysis network, seamlessly connecting with the four most prevalent energy analysis tools and even custom-developed tools. ArchiCAD, on the other hand, currently integrates with only one energy analysis tool, EnergyPlus.

BIM for safety and security



The use of BIM extends to safety and security, covering construction safety, emergency planning, security design, cost analyses, and ongoing operations. **8D BIM** is the dimension of BIM that adds information relating to safety during the design and execution phase of the work.

BIM supports safety and security by offering a comprehensive digital representation of the building's infrastructure, including fire safety systems, emergency exits, and security features. It also provides detailed programming and design capabilities, allowing for conceptualization, planning, scheduling, estimating, coordination, verification, and 'what-if' analyses.

This enables facility managers to access critical safety information, conduct virtual safety drills, and plan for emergency response more effectively. Furthermore, BIM facilitates the integration of **real-time sensor data** for monitoring and managing security systems, contributing to proactive risk mitigation and ensuring a safer environment for occupants.

In the context of fire protection, BIM offers clear and detailed visualizations, enabling precise design detailing and practical advantages for fire safety layouts. It also helps in detecting and resolving clashes with MEP services, ultimately saving time in the integration of fire safety services.

BIM for cost estimation and budgeting

BIM for facilities management BIRGIT Erasmus+

BIM for cost estimation and budgeting

BIM can be used to generate **accurate** cost estimates and budgeting for maintenance, repairs, and upgrades, providing a reliable basis for financial planning.

This transparency ensures that costs are managed effectively and aligned with organizational goals.

Here are some of the ways that BIM can be used for cost estimation and budgeting:

- ✓ Generate accurate quantity **take-offs** for all materials and components of a building. This can help to ensure that estimates are based on real data, rather than guesswork.
- ✓ Identify conflicts between different trades or over-specifying materials.
- ✓ Identifying opportunities to reduce material usage or simplify construction methods.
- ✓ Develop life-cycle cost estimates for a building, which consider the costs of operation, maintenance, and disposal.

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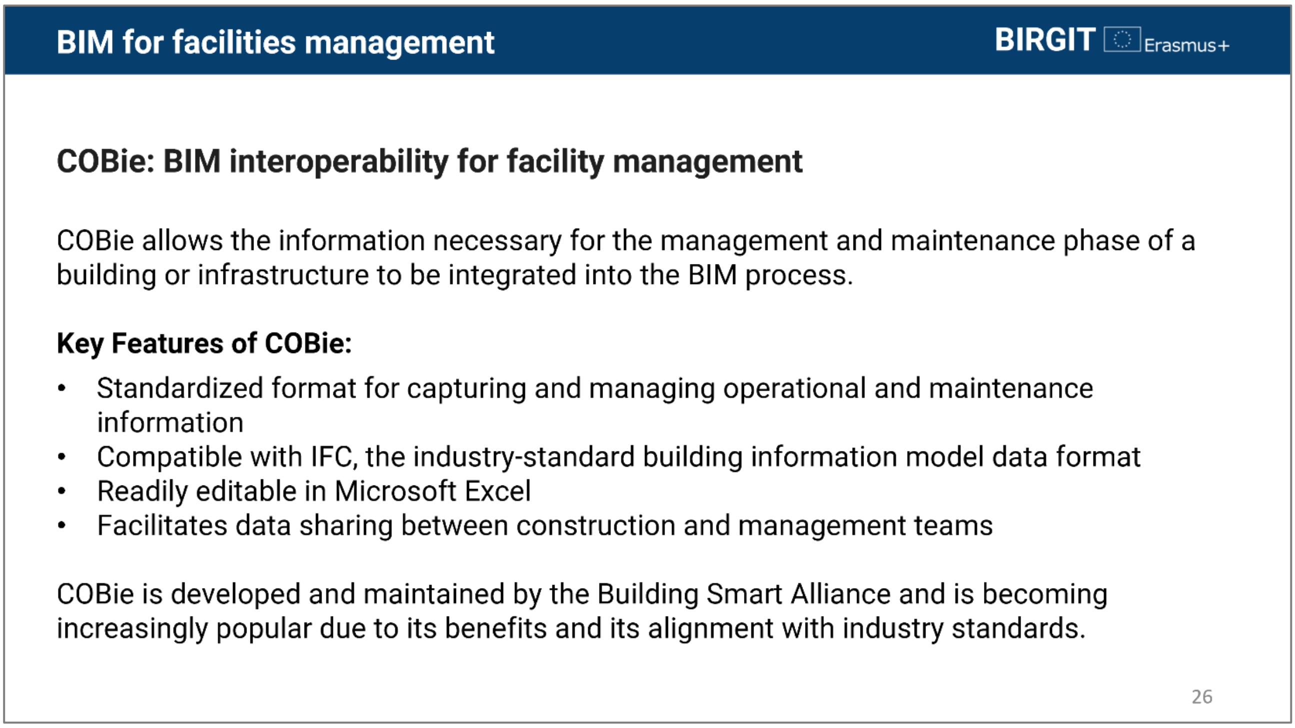
One of the advantages of the BIM methodology is the saving of time and costs, at every stage in the life cycle of a building or infrastructure (planning, construction, operation, maintenance, and demolition). **5D BIM** is the dimension of the application of the BIM methodology that explicitly corresponds to cost estimation.

During the design and construction phase, BIM-based cost estimation offers a plethora of advantages, streamlining the bill of quantities (BOQ) preparation process to deliver accurate cost estimates for projects. This automation empowers project teams to proactively identify and mitigate cost risks early on, significantly reducing the likelihood of cost overruns and safeguarding project profitability. The BIM model enables the direct capture of quantities from the 3D model, resulting in more accurate calculations with fewer errors and omissions.

But the management and maintenance phase of a work is perhaps among the most onerous in terms of time and costs of the entire life cycle of a work. BIM models can be used to track maintenance needs, schedule repairs, and optimize resource allocation. BIM can include also data on life expectancy and replacement costs.

Project teams require training to effectively utilize BIM for extracting cost data. In some cases, BIM integration with other project management systems, such as estimating and budgeting software, is necessary. BIM-based cost estimation systems such as ***BIMestiMate*** and ***Navisworks Manage*** can automate the valuation process at any stage of the project. Additionally, software tools like CostX, QuickBid Estimating, Bluebeam Revu, and On-Screen Takeoff Pro are also designed for creating and managing BOQs and generate quantity take-offs from BIM models.

COBie: BIM interoperability for facility management



COBie, acronym for Construction Operations Building Information Exchange, is a **data exchange standard** that allows the information necessary for the management and maintenance phase of a building or infrastructure, to be integrated into the BIM process.

COBie was initially developed by the US Army Corps of Engineers and is currently undergoing further development and maintenance by the Building Smart Alliance, also responsible for the development of IFC. It has gained popularity in Europe and has been in use in the United States for several years, with widespread adoption in the United Kingdom, where it is now mandatory for all public projects.

COBie data is typically used to capture operational and maintenance information about building components. This information can then be used for a variety of purposes, such as planning and scheduling maintenance activities, tracking the condition of assets, and generating reports for facility managers.

While IFC is useful for creating and exchanging building information models, COBie is most useful for capturing and managing operational and maintenance information. However, there is some overlap between the two standards, and some COBie data can be exported to IFC and vice versa. COBie can also be defined as an **IFC Model View Definition** (MVD) which selects only the information necessary for Facility Management.

In the traditional building process, the means of communication between the construction and maintenance phases was represented by paper. Using COBie as an information vehicle between the construction and management of a work means making Facility Management data interoperable. This standard in fact brings together in a single standardized digital structure all the information useful in the management and maintenance phase (technical data sheets, guarantees, use and maintenance manuals, etc.).

COBie files are produced in XML format, a simple tabular format editable via Microsoft Excel, this means that it is readable by both machines and humans and that no special software is required.

The importance of COBie is linked to its ability to integrate multidisciplinary and often heterogeneous data and information on Facility Management. Using this format means guaranteeing the complete sharing of all information useful for the management and maintenance of the work and guaranteeing correlations thanks to the standardized structuring of the spreadsheet.

How COBie Works:

- BIM data is exported to COBie format: Information about building components and their attributes is extracted from the BIM model and stored in COBie files.
- COBie data is used for management and maintenance: COBie data is used to plan and schedule maintenance activities, track the condition of assets, and generate reports for facility managers.
- COBie data is integrated with other systems: COBie data can be integrated with other building management systems, such as HVAC systems and asset management systems.
- COBie proves to be particularly important in cost evaluation because it allows the evaluation of the effectiveness of investments aimed at the management and maintenance of assets.

COBie is becoming more popular in Europe thanks to several reasons:

- Government Mandates: European governments such as UK, Netherlands and Germany have mandated or issued guidelines for the use of COBie for public projects. This has helped to increase awareness of the standard and encourage its adoption by private sector organizations.
- Cost Savings: COBie can help to reduce costs by improving efficiency and reducing the risk of errors.
- Sustainability: COBie can help to improve the sustainability of buildings by making it easier to track and manage energy consumption and other environmental impacts.

Further reading and references

What is openBIM?

https://www.buildingsmart.org/about/openbim/openbim-definition/

IFC standard

- https://technical.buildingsmart.org/standards/ifc/
- https://www.iso.org/standard/70303.html

ISO 19650

https://www.iso.org/standard/68078.html

COBIe standard

https://nationalbimstandard.org/files/COBie-v3-Standard_Executive-Summary_DRAFT061322.pdf

EU BIM Task Group Handbook 2017

https://eubim.eu/handbook/