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

Course: BIM introduction. Block 2: Working with BIM data. Lecture 2.1

Data management in BIM

Lecture Notes

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Learning outcomes

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

- Formulate key principles for effective BIM project management.
- Compare the technologies, software, and tools to ensure seamless interoperability between different software applications.
- List and describe techniques to optimize data workflows through collaboration.
- Select method for analysing BIM data, generating reports, and creating visualizations for support decision-making in BIM projects.

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Summary

The Data Management in BIM module contains the necessary knowledge and skills to effectively manage BIM projects and handle data during their life cycle. Participants will develop skills for comparing and utilizing cutting-edge technologies, tools, and software to ensure interoperability and collaboration among stakeholders and data exchange among applications.

Expected competences when entering the lecture

- Basic knowledge about BIM
- Basic knowledge about relational databases

Expected Workload

10 slides with learning content, 2 hours

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0.2	2023-02-28	Sanja Samanovic	Draft	Second version after reviewing process;
1.0	2024-03-14	Sanja Samanovic	Published	Edited by M. Morbidini
2.0	2025-04-29	Sanja Samanovic	Published	Updated EU logo and disclaimer. Edited by T. Näslund

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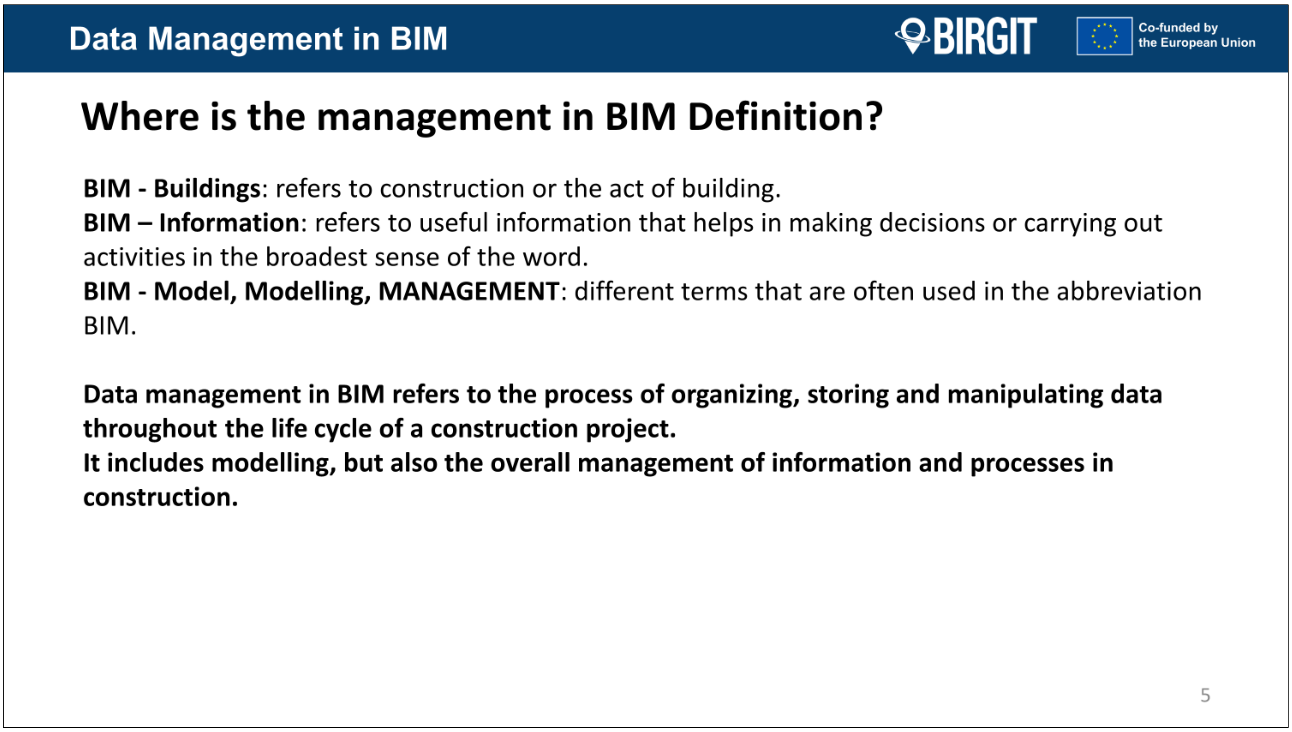
Where is the Management in BIM Definition?



BIM carrying specific meanings that are essential to understanding and effectively implementing this innovative approach in the construction industry. One key aspect of BIM is the use of various letters to describe concepts within this framework.

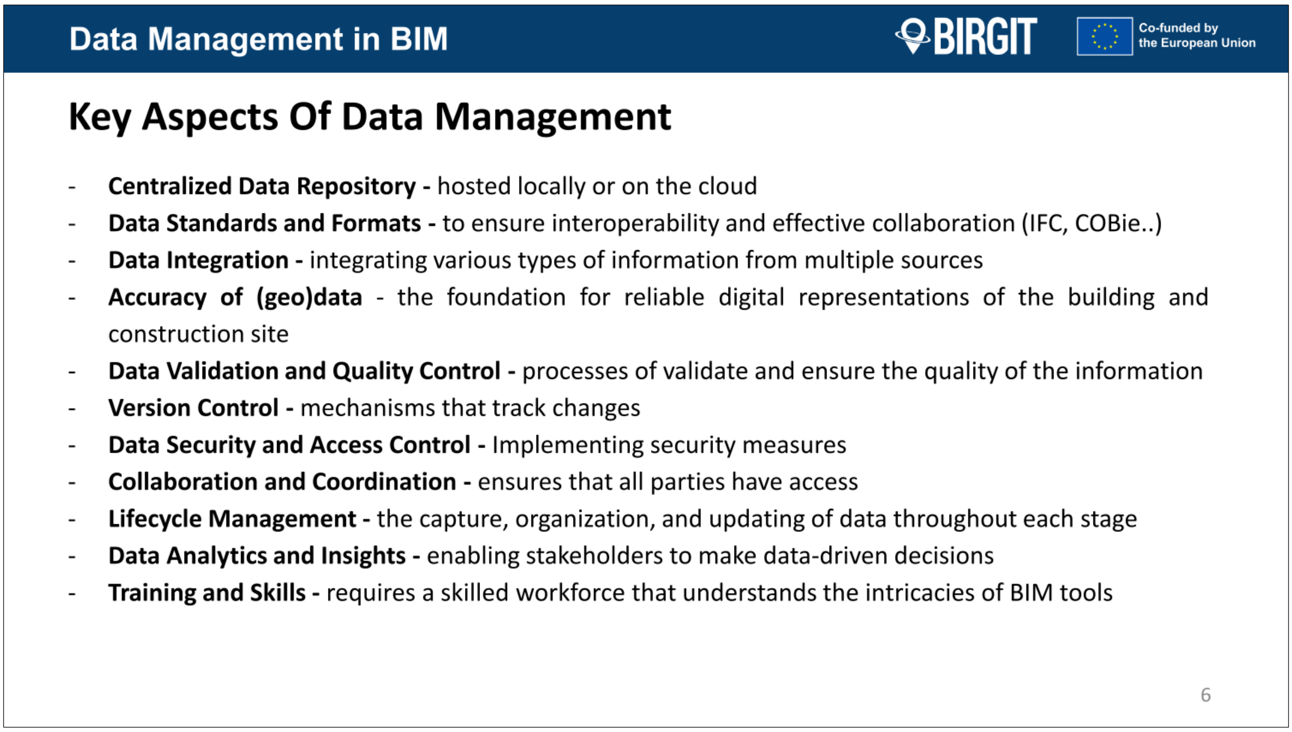
- **BIM - Buildings** goes beyond its surface definition to encompass the entire spectrum of construction activities. While it often conjures images of towering skyscrapers, this term is far-reaching, enveloping both high-rise structures and civil engineering projects. It serves as the foundation for BIM's applicability across diverse construction project.

- **BIM – Information** delves into the essence of data within the BIM realm. Here, information takes on a broader role, not merely as raw data but as knowledge that informs decision-making and drives activities. In the context of BIM, information becomes a potent tool, shaping the course of construction projects.

- **BIM - Model, Modelling, MANAGEMENT**, each contributing distinct dimensions to the BIM. These terms, although sometimes used interchangeably, carry nuanced meanings. "Management" is like the main supervision covering all aspects of the construction project. This includes not only the creation of the model, but also the coordination of all the information and steps required to successfully manage the construction project.

Data management in BIM refers to the systematic approach of structuring, cataloguing, and utilizing data from inception to completion within a construction project's life cycle. This encompasses everything from design and planning to construction and operation. BIM data management is crucial for ensuring that accurate, up-to-date, and relevant information is available to all stakeholders involved in the design, construction, and operation of a building or infrastructure. This concept of management includes modelling but it is extended to encompass the comprehensive coordination of information and processes essential for successful project in construction.

Key Aspects of Data Management



The BIM **centralized data repository** concept is related to a centralized warehouse where all data related to a particular project is stored. Storage can be on-premises, in organization or in the cloud. Both concepts provide access to users regardless of their location, and facilitate collaboration, coordination and integration among multidisciplinary teams involved in the project.

Data for the project comes in different formats. To ensure interoperability and cooperation among project stakeholders, **two formats** are most often used: Industry Foundation Classes (IFC) and Construction Operations Building Information Exchange (COBie). Also, data in BIM projects comes from different sources (architectural design, construction design, documentation, geospatial research...).

Data integration must ensure that all data sets can be brought together so that data management throughout the BIM project lifecycle flows smoothly and facilitates decision making. Ensuring data accuracy is one of the key segments of BIM project management. During the life cycle of the project, it is necessary to ensure the required accuracy during the process of data collection, processing and validation, taking into account the exact location, shape and infrastructure.

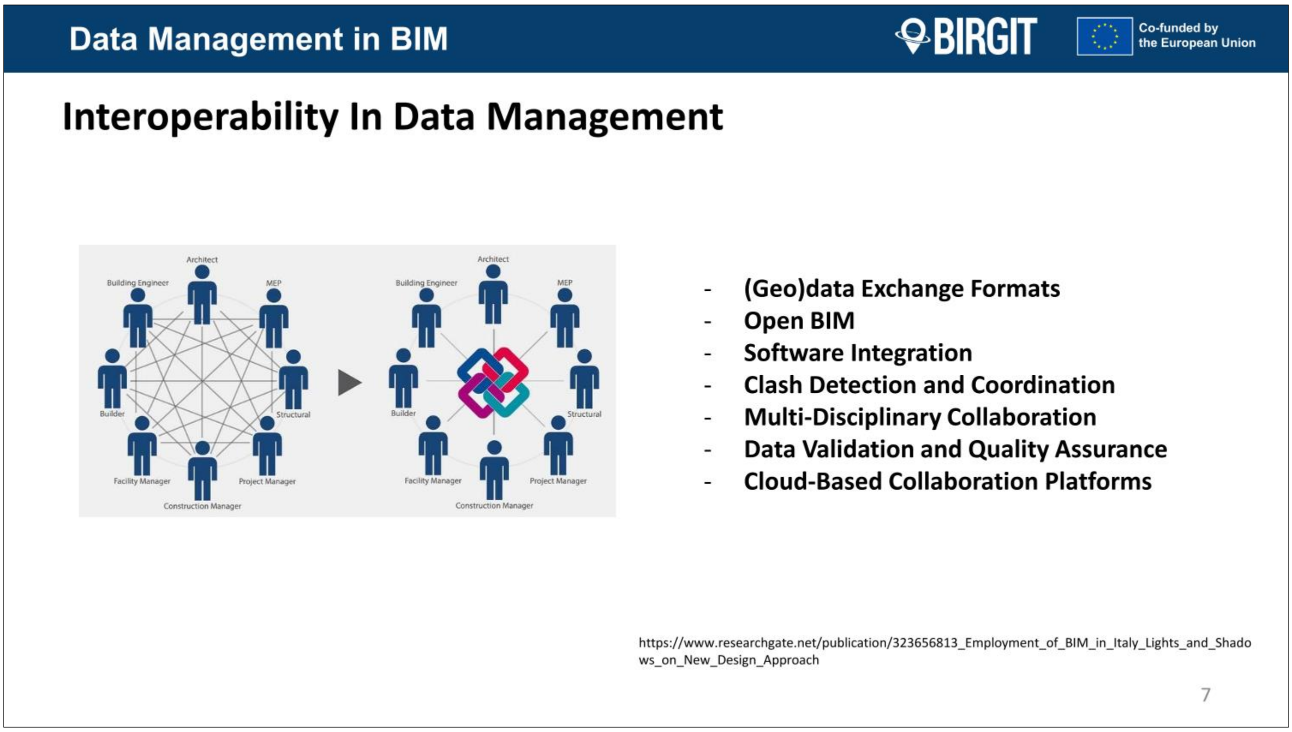
Data validation and quality control ensure accuracy, reliability and consistency of project information. For this purpose, verification protocols are being developed that should be defined for individual phases of BIM project management.

During each phase of a BIM project, it is necessary to monitor changes in digital models and project documentation. **Controlling each version** ensures easier management and monitoring of project progress. **Data security and control of access** to data and the project itself is important so that only authorized stakeholders have access to certain segments of the project. Security protocols, encryption and user verifications need to be included in project management processes.

Cooperation and coordination between the participants involved in the BIM project is the basis that enables the exchange of information in real time and the coordination of tasks. **Lifecycle management** involves collecting, organizing, and updating project data during each phase of the project's life cycle to keep project information current, relevant, and accessible to all stakeholders.

Data analytics and insights are necessary to enable stakeholders to make data-driven decisions. This segment of the management enables the extraction, definition and analysis of patterns from a large amount of data. **Training and skills** development are key for all stakeholders. Training programs, workshops and courses provide project teams with the necessary skills and knowledge to effectively use BIM tools, data analysis, collaboration and interoperability between stakeholders.

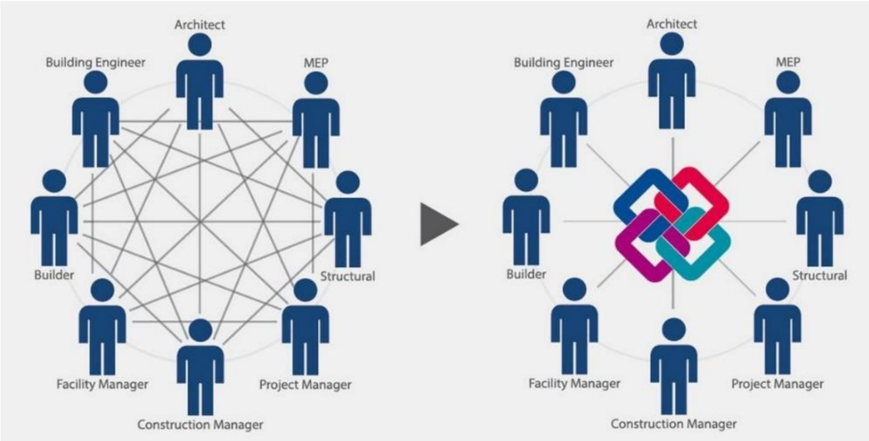
Interoperability in Data Management



Interoperability refers to the ability to integrate (data, skills, software, disciplines) involved in the life cycle of a building. It involves overcoming different software platforms and ensuring they can communicate and collaborate effectively. Interoperability in BIM between different disciplines involved in the construction process ensures collaboration, data sharing and communication in different professional domains.

Figure description

In addition to architects who are usually team leaders, BIM projects include civil engineers, MEP (mechanical, electrical and plumbing) engineers, builders, structural engineers, project managers, construction managers, facility managers and many others.



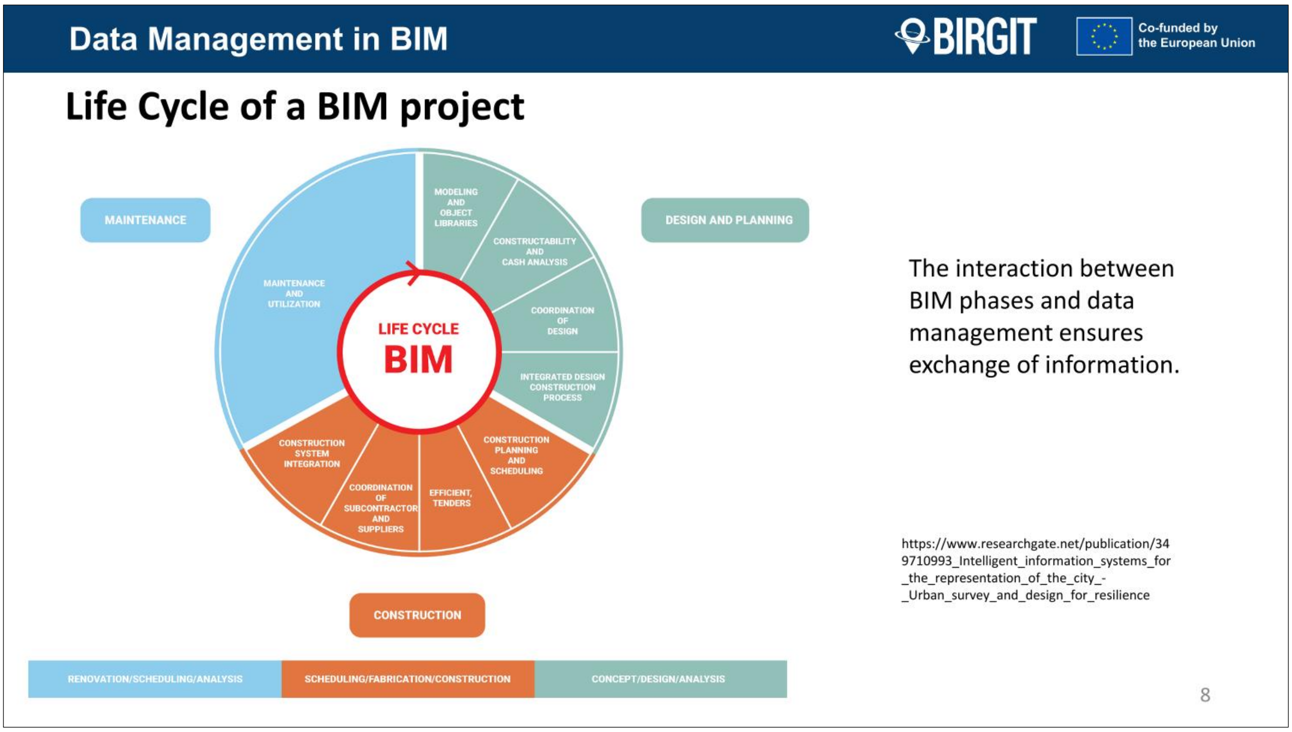
With BIM we can build a virtual model that everyone works from collaborative and simultaneous mode, promoting greater agility in elaboration projects and minimizing errors and omissions. BIM is a collaboration method that integrates construction stakeholders, technology and work organization from the first idea. This means a big change in the construction industry. In order not to get lost in this movement or take unnecessary risks, it is important to define tasks and goals together with partners and start from realistic specifications.

Within the domain of BIM interoperability, the use of standardized formats for **data exchange forms** are the backbone. The formats (IFC and COBie) facilitate the seamless transfer of BIM data across different software applications and platforms. This standardization ensures that information can be easily shared and understood across disciplines, where the concept of open BIM is extremely important.

Open BIM further encourages the **integration of software** tools from different vendors and thus encourages collaboration among users. The advantage of BIM is in encouraging **multidisciplinary cooperation** between different disciplines involved in a construction project (architects, engineers, contractors and facility managers). Interoperability enables the exchange of project information and facilitates project validation.

Cloud-based collaboration platforms strengthen interoperability by offering (a centralized hub for stakeholders) - real-time collaboration, easier control and data synchronization. Interoperability lasts throughout the entire life cycle of the building.

Life Cycle of a BIM Project



The BIM life cycle includes different phases, each of which contributes to the efficient design, construction and maintenance of a building or infrastructure.

Data management in BIM is not just data of a building. It is a process which includes continuous integration and updating of information as the project progresses. This process ensures that changes made during the construction phase are reflected in real-time. On that way contributing to a more accurate representation of the building.

The relationship between the project phases of the BIM life cycle and data are interactive. BIM's ability to manage and update data through these phases ensures collaboration and availability to data necessary building design, construction, and maintenance.

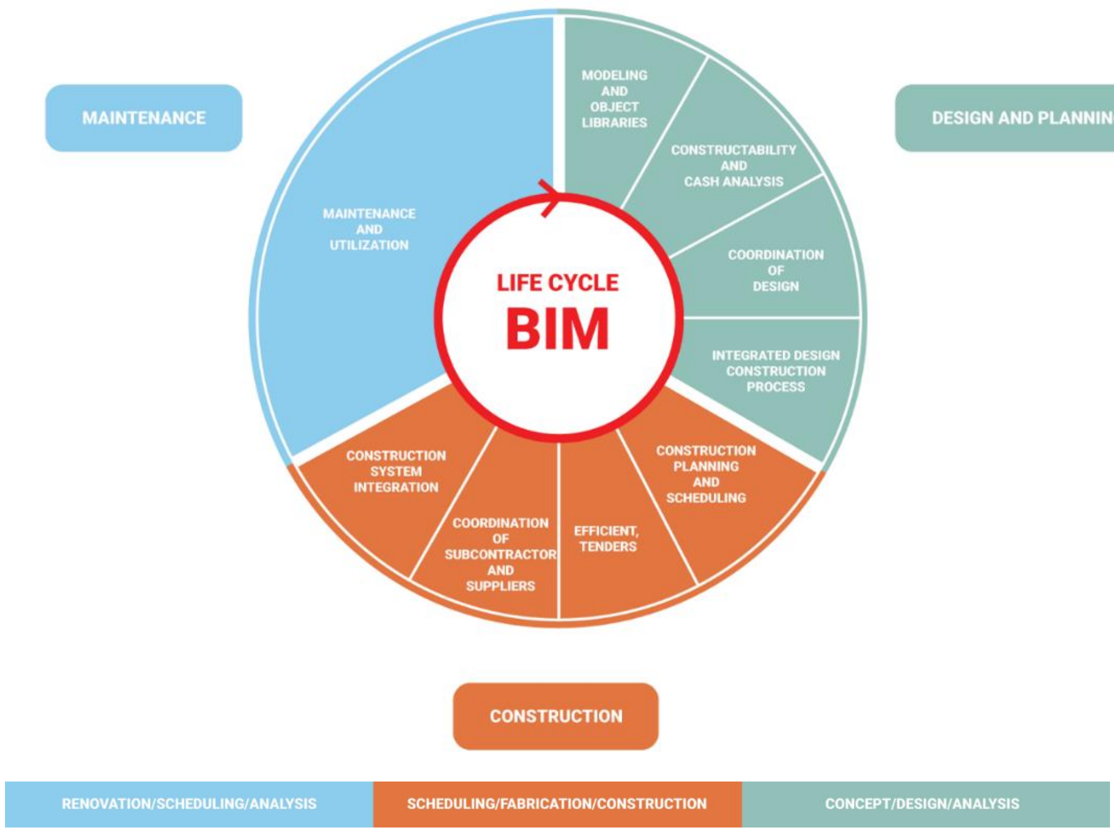


Figure description

Image depicts the relation between project phases (or cycles) and data management, and the relationship between the various phases of the BIM life cycle (Design and Planning, Construction and Maintenance and Utilization) is tied to effective data management.

The BIM life cycle integrates the Design and Planning, Construction, and Maintenance and Utilization phases, using by data management practices. Stating with the creation of a detailed 3D model in the Design phase, BIM create a centralized data base. This data base includes the geometry and facilitates efficient data management, ensuring consistency of object through data base and clash analysis.

As the project start with Construction, BIM's data management extends, integrating project timelines through Construction Planning and Schedules (4D BIM). Real-time updates to the model providing stakeholders accurate and current information. Continuous system integration during construction creates dynamic data management and ensuring that changes are promptly see in the 3D model.

In the Maintenance and Utilization phase, BIM's data management capabilities transform the 3D model into a comprehensive Data Warehouse (6D BIM). Data Platforms for Monitoring and Maintenance utilize real-time information, allowing facility managers to optimize building performance.

The interaction between BIM phases and data management ensures exchange of information. The transformation of the 3D model shows changes made during construction in real-time, enhancing the accuracy of the data base.

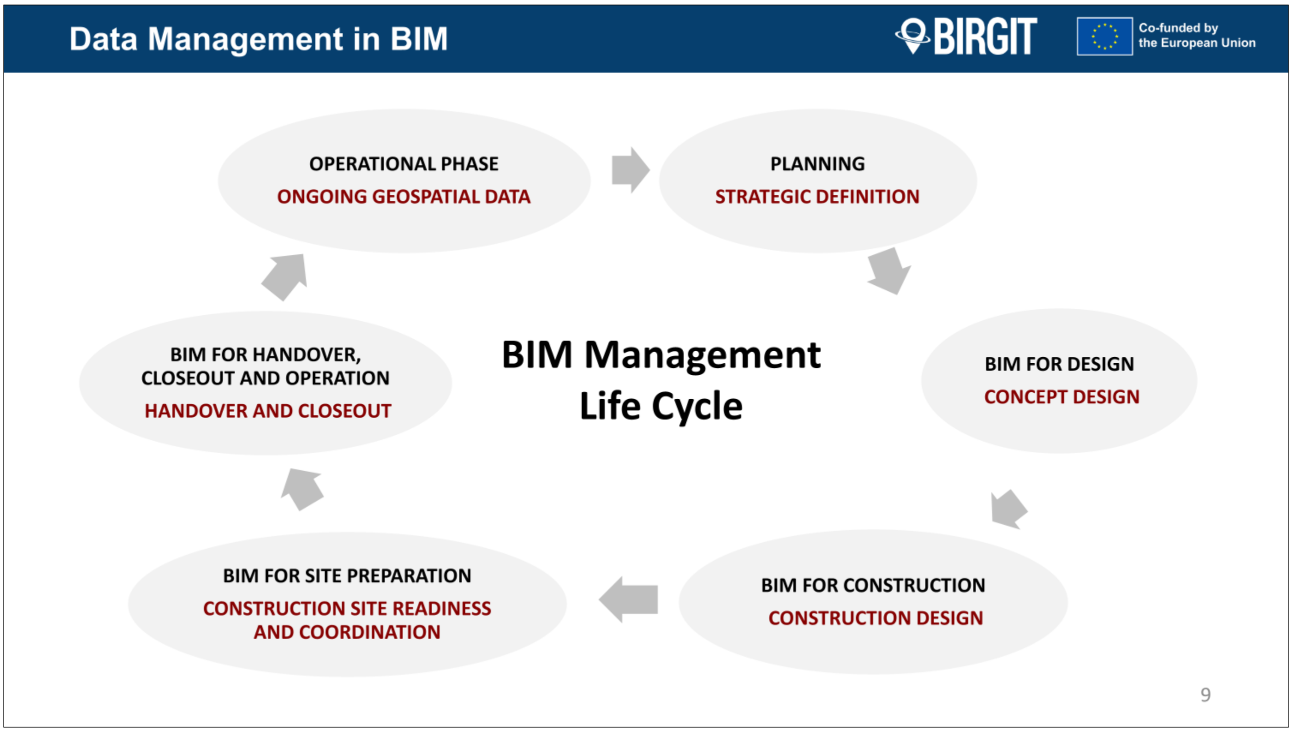
BIM is a process that utilizes digital representations of the physical and functional characteristics of a building to support its life cycle management.

- ***Design and Planning:*** In the design and planning phase, BIM use as the foundational data base for project information. All data are integrated into a 3D model to foster collaboration among stakeholders. The comprehensive data model facilitates visualization and serves as the basis for analysis, clash detection and integrated design processes. This is very important phase because the early-stage data management ensures that all other project phases have quality base.

- ***Construction:*** The second phase is construction phase during the data management becomes dynamic. It includes the fourth dimension - time. Construction Planning and Schedules (4D BIM) integrate project timelines with the 3D model, enabling stakeholders to visualize the construction process over time. processes.

- ***Maintenance:*** In the maintenance and utilization phase, BIM extends its data management capabilities to support ongoing operations. Initial 3D model incorporating the sixth dimension -operational and maintenance data (6D BIM). This approach (base on the data) assists facility managers in making decisions regarding maintenance, monitoring performance, and optimizing building over its life cycle.

BIM Management Life Cycle

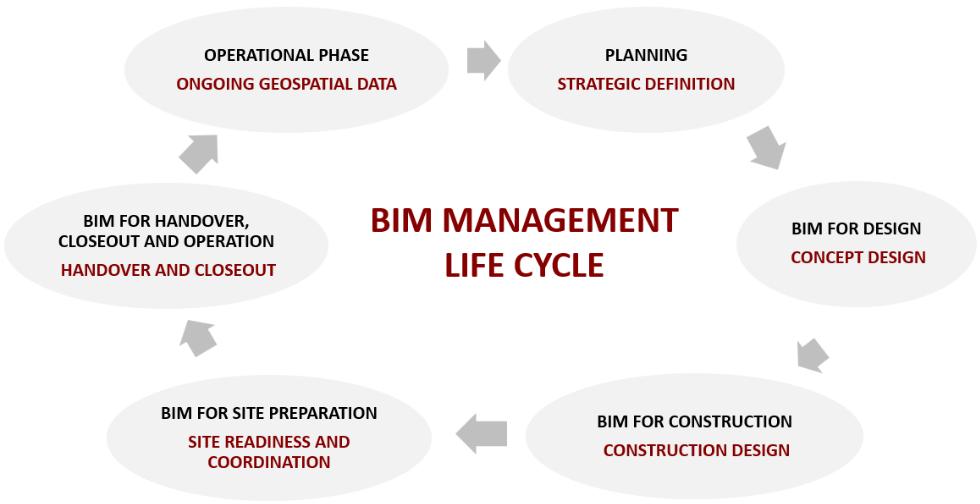


The BIM process unfolds seamlessly and continuously across distinct stages, beginning with strategic definition in Planning BIM. This is the base for the entire project (defines goals and objectives). In the Concept Design phase, BIM for Design involves creative and conceptual aspects, fostering collaboration among stakeholders to refine design ideas. The circle continues to BIM for Construction in the Construction Design phase (implementation and detailed planning for construction activities).

In the construction site preparation phase, the focus is on activities related to construction site preparation and coordination in terms of geospatial data collection. BIM for Handover, Closeout, and Operation completes the cycle, ensuring a transition from construction to operation by incorporating data for facility management and operations.

Finally, operational phase included continuous use of BIM for facility management and maintenance and ongoing geospatial data updates for monitoring changes in the site environment. **This circular schema underscores the iterative and interconnected nature of BIM management.**

Figure description



- **Strategic Definition (Planning):**

In the goal-setting phase, project stakeholders define strategic goals and objectives for BIM implementation (determining the scope of BIM use, defining key performance indicators (KPI), outlining the overall BIM strategy of the project). Resources (software, hardware and personnel) are allocated based on the BIM requirements of the project. The establishment of BIM standards and protocols ensures consistency in data management, modelling and information exchange.

- **Concept Design (BIM for Design):**

During the conceptual modelling phase, initial conceptual BIM models are created that represent project ideas. BIM facilitates iterative design processes (quick adjustments and improvements). BIM models are used to coordinate designs and maintain design goals.

- **Construction Design (BIM for Construction):**

BIM models (architectural construction and MEP systems) are developed into more detailed representations of a building or infrastructure. BIM data is used for accurate quantity estimation and cost estimation, and the benefit of BIM in planning and construction, streamlines the process.

- **Construction site readiness and coordination (BIM for site preparation)**

In this phase, the focus is on leveraging advanced geospatial data collection techniques to create a comprehensive digital representation of the site. This includes conduct detailed topographic surveys and geospatial data collection for accurate representation of the site's physical features and attributes, perform analysis to understand suitability for construction, utilizing geospatial information to map underground utilities, ensuring proper planning and preventing clashes with existing infrastructure. Also include 3D modelling to visualize site conditions and optimize construction sequencing. The use of 3D modelling and the establishment of a digital twin further enhance the visualization and management of site conditions.

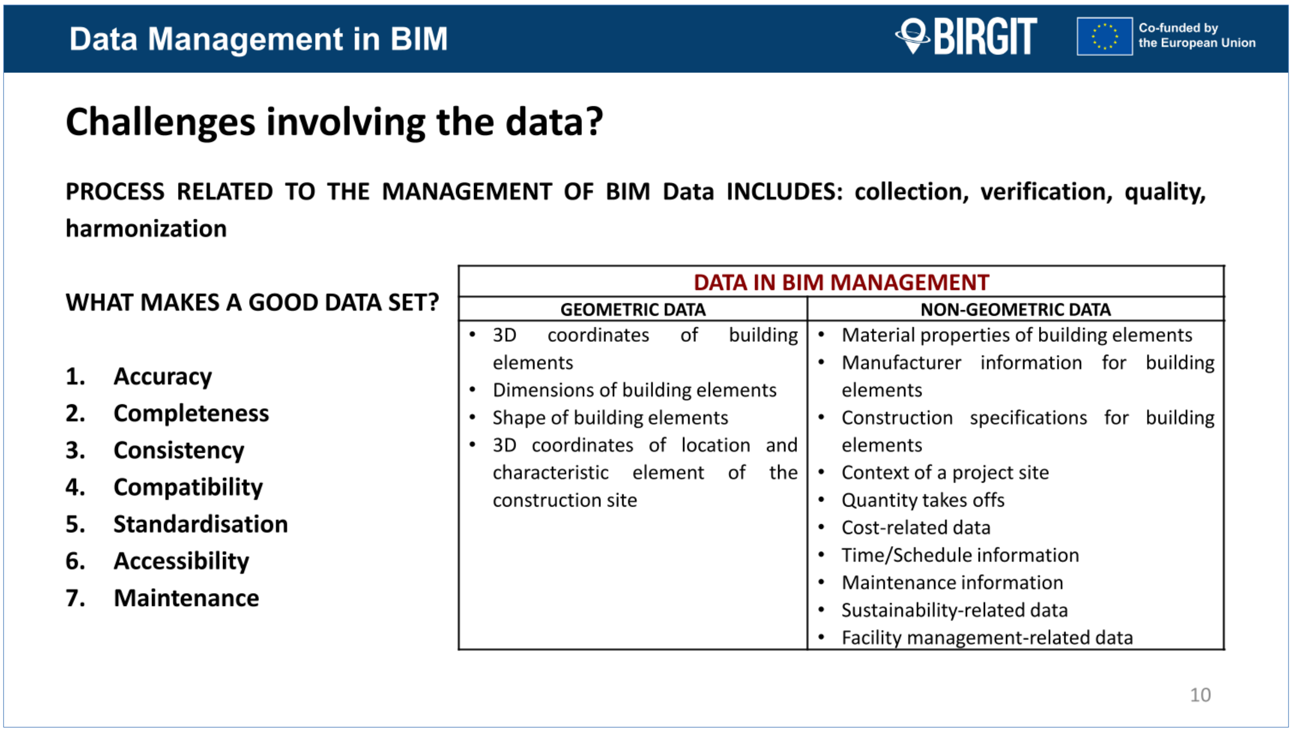
- **Handover and Closeout (BIM for Handover, Closeout, and Operation):**

BIM models are updated to ensure that the final product represents what was intended. BIM data (model information, specifications, documentation) is used in further operation and maintenance. BIM provides valuable information about building systems, maintenance schedules and equipment.

- **Operational phase (Ongoing geospatial data)**

This phase includes regularly update and maintain the digital twin of the construction site for real-time monitoring and utilizing geospatial data for spatial analysis. This phase also using historical data to create future decision-making for updating or expansions. Predictive maintenance based on geospatial data helps optimize performance, and historical data improve future decision-making for facility improvements.

What are the challenges involving the Data?



The **collection** process involves gathering relevant data that will be used to create and maintain the BIM, while ***verification*** checking the accuracy and reliability of the collected data. ***Quality*** involves maintaining a high standard of accuracy, completeness, and consistency throughout the model's lifecycle. In the **h*armonization*** *phase* the process of integrating data from various disciplines and sources became a coherent and consistent. BIM **data management** involves organizing, storing the data over the entire project lifecycle.

To ensure good data, the following requirements are essential:

1. **Accuracy:** Data in BIM should be precise and reliable, reflecting the real-world conditions of the building or infrastructure project. Accurate data improves decision-making, reduces errors, and enhances collaboration.
2. **Completeness:** All necessary information relevant to the project should be included in the BIM model. This includes architectural, structural, mechanical, electrical, and other discipline-

specific data. Complete data ensures a comprehensive understanding of the project and supports various analyses and simulations.

3. **Consistency:** Data consistency is crucial for effective coordination and collaboration among project stakeholders. All elements within the BIM model should adhere to consistent naming conventions, units of measurement, and classification systems to avoid confusion and misinterpretation.

4. **Compatibility:** BIM data should be compatible with the software applications and tools used throughout the project lifecycle. Interoperability ensures smooth data exchange between different platforms, enabling seamless collaboration and avoiding information loss or distortion.

5. **Standardization:** Following industry-recognized standards and guidelines for BIM data helps ensure consistency and interoperability across projects. Standards such as IFC (Industry Foundation Classes) provide frameworks for data exchange and information management.

6. **Accessibility:** BIM data should be easily accessible to all authorized project stakeholders. Access controls and permissions should be implemented to manage data security while allowing relevant parties to view and modify the information as needed.

7. **Maintenance:** Regular maintenance of BIM data is crucial to keep it up to date throughout the project lifecycle. As changes occur, data should be revised, reviewed, and synchronized across the model to maintain accuracy and integrity.

Table description

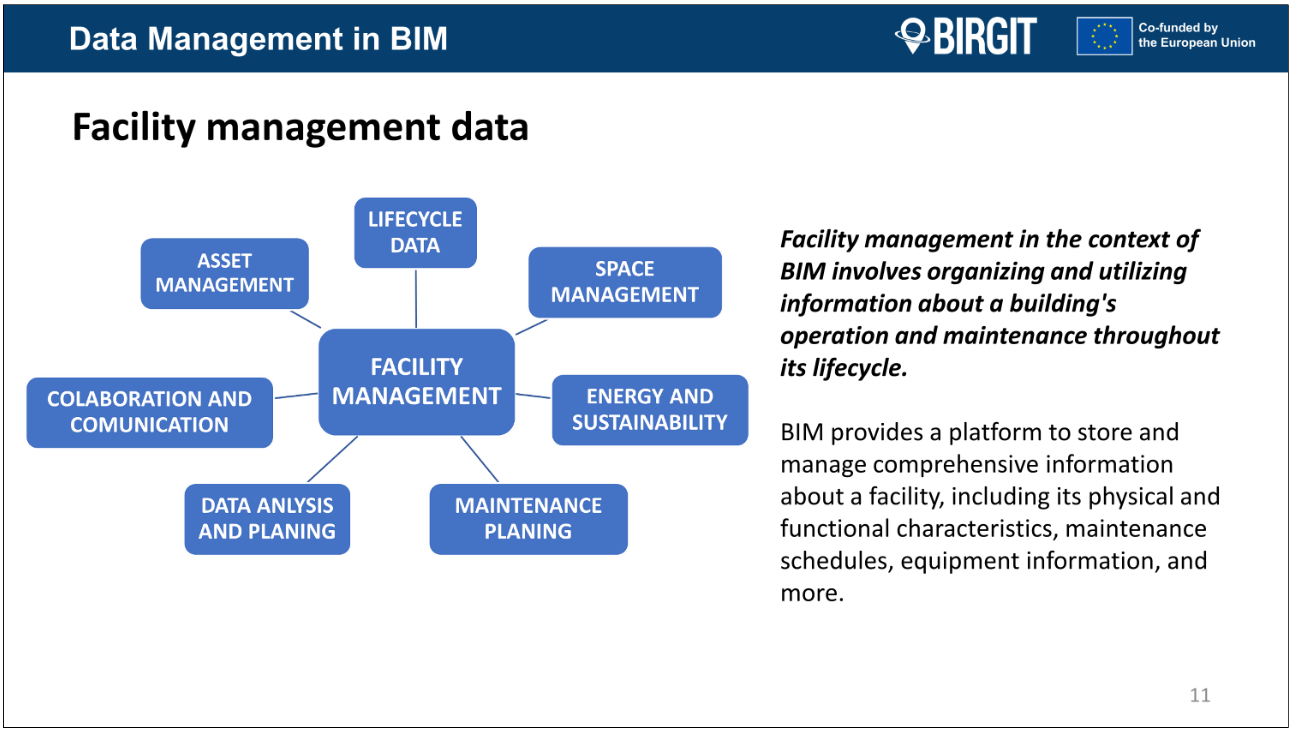
DATA IN BIM	
GEOMETRIC DATA	**NON-GEOMETRIC DATA**
• 3D coordinates of building elements • Dimensions of building elements • Shape of building elements • 3D coordinates of location and characteristic element of the construction site	• Material properties of building elements • Manufacturer information for building elements • Construction specifications for building elements • Quantity take-offs • Cost-related data • Time/Schedule information • Maintenance information • Sustainability-related data • Facility management-related data

Here are some specific examples of types of data that can be stored in a BIM model divided in two basic types:

Geometric data: This type of data represents the physical shape and size of the building elements (such as walls, floors, roofs, doors, and windows). It is typically stored in a 3D model file format, such as IFC or RVT. 3D coordinates of location and characteristic element of the construction site provides information about the location and includes topography, land use and proximity to other structures or infrastructure. It contributes to the creation of digital twins of physical buildings or infrastructure. This facilitates visualization, analysis, and monitoring of the project in a digital environment, supporting decision-making throughout the project life cycle.

Non-geometric data: This type of data includes all the other information about the building elements, such as their material properties, manufacturer information, and construction specifications. Provides additional information about building elements beyond their physical appearance. It is typically stored in a database or spreadsheet file format.

Facility Management Data



Facility management in data management refers to the management and use of data related to the operation and maintenance of a built facility during its life cycle.

Facility Management Data - benefits:

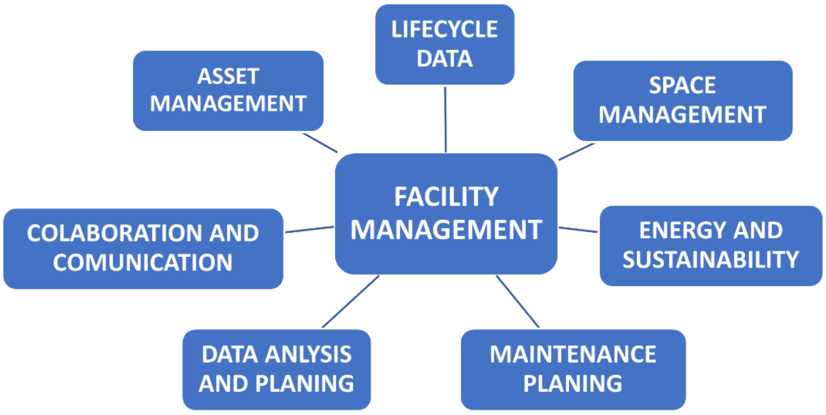
- **Saving Time and Money** - Facility Management have lots of benefits, saving time and money through proactive maintenance and streamlined operations. Facility management in data management enables more efficient automation of routine processes through data management (interoperability, availability), facilitates processing processes and frees up stakeholders' time. All this increases efficiency and reduces costs.

- **Improving Accuracy -** Improving accuracy is a base of Facility Management (FM), achieved through data-driven decision-making and comprehensive documentation. In the area of decision-making based on data, FM relies on accurate real-time data pertaining to asset performance. The integration of BIM data enables facility management systems to access detailed information about facilities (characteristics, condition and maintenance history data). The management of this information within the BIM system enables the use of reliable data for the purpose of management and decision-making.

- **Optimizing Resource Allocation -** The integration of BIM data enables facility management systems to gain detailed insight into the use of space, resources and equipment within the project. The analysis of such data enables the identification of areas with insufficient utilization, that is, on the other hand, spotting the potential for optimization. This allows to adjust the allocation of resources to better match the real needs and requirements of the project.

- **Futureproofing -** Futureproofing encompassing technology integration and sustainability planning. FM incorporate advancements to keep facilities current and adaptable. The integration of smart building technologies and Building Information Modelling (BIM) ensures futureproofing, simplifying the incorporation of emerging technologies. Data integration enable quickly identify potential improvements or changes in infrastructure to adapt for future requirements.

Figure description



BIM supports data integration by bringing together different facilities management data sources (asset information, maintenance records, equipment specifications, energy use data and occupancy information). BIM data management is essential in maintenance planning and implementation (it helps in organizing and analysing data, schedules and maintenance history). Facilitates the integration of energy use data and sustainability information. It includes data related to the use of space, information on occupancy and resource allocation. BIM data management serves to provide information about the property of the object (specifications, maintenance history, location).

Asset management Data

Data Management in BIM

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Asset management data

Asset management in BIM **involves the systematic and strategic management of physical assets throughout their lifecycle, from design and construction to operation and maintenance.**

Various range of aspects related to asset management:

- Asset Information
- Asset Identification and Classification
- Maintenance Planning
- Asset Performance Analysis
- Integration with Facility Management Systems
- Collaboration and Communication
- Asset Tracking and Visualization
- (Geo)Data Integration and Interoperability
- Data Security and Access Control

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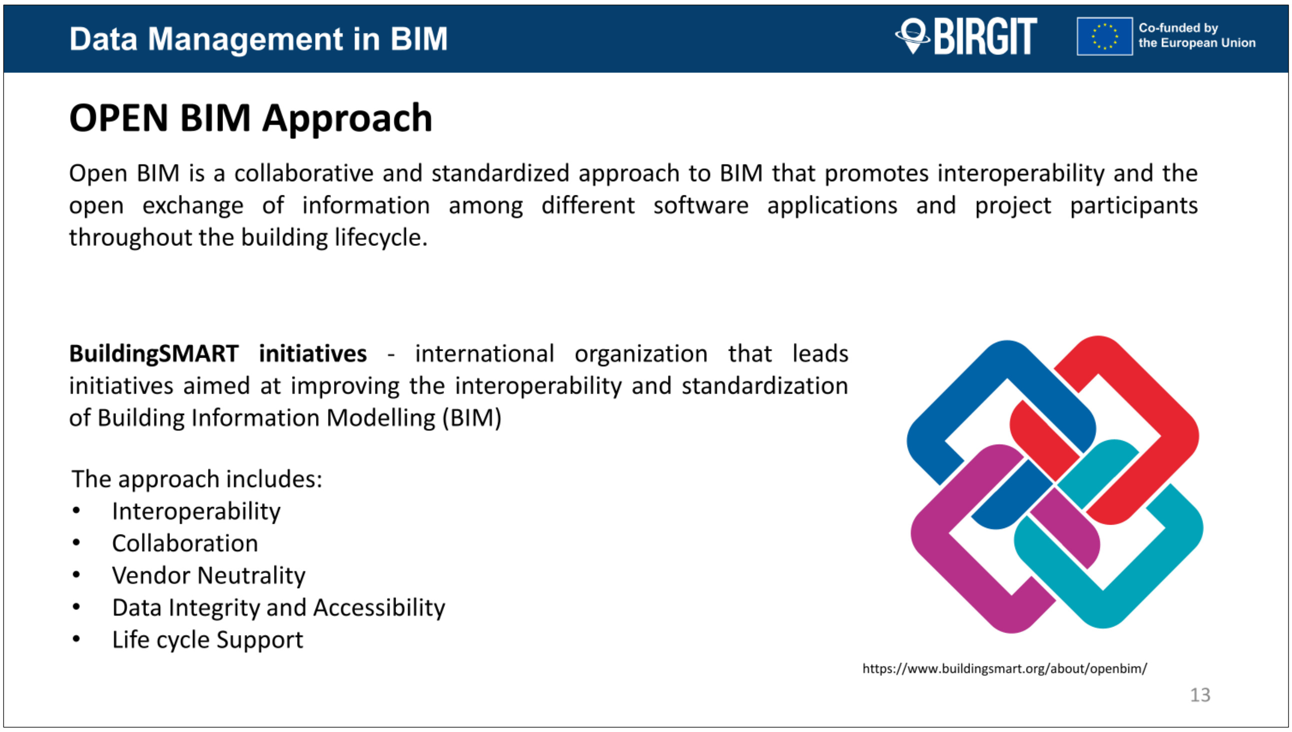
Asset management in BIM is an approach that includes systematic and strategic management of physical assets throughout the entire life cycle (initial stages of design, construction, maintenance).

The central repository contains data information (physical and functional characteristics, specifications, maintenance schedule, warranties and historical records). BIM provides a framework for asset identification and classification (each asset is assigned a unique identifier).

Maintenance planning benefits significantly from BIM (allowing monitoring and planning of maintenance activities) which extends the life of the asset and reduces wasted time. Integration with systems such as Computerized Maintenance Management Systems (CMMS) or Enterprise Asset Management (EAM) systems enable the exchange of data and information. Real-time sharing and access to asset information makes coordination easier. Interoperability enables data integration (financial systems for monitoring costs, energy management systems for monitoring energy consumption, GIS for spatial analysis). Access control mechanisms ensure that only authorized persons can access and modify data.

Open BIM Approach



Open BIM is a collaborative and standardized approach to BIM that promotes interoperability and the open exchange of information among different software applications and project participants throughout the building lifecycle. Open BIM is not a specific software or tool but rather a set of principles, standards, and workflows that facilitate collaboration among various stakeholders involved in a project.

Data management in the context of Open BIM is crucial for ensuring that information is effectively shared, exchanged, and utilized across different BIM tools and platforms.

This initiative is championed by buildingSMART and enjoys support from numerous leading software vendors within the building industry.

BuildingSMART is an international organization that leads initiatives aimed at improving the interoperability and standardization of Building Information Modelling (BIM) and digital data in the architecture, engineering, construction, and operations (AECO) industry. BuildingSMART initiatives are focused on developing open standards and workflows that enable seamless collaboration and data exchange among various software applications and stakeholders involved in the lifecycle of a built asset.

[International - https://www.buildingsmart.org/](https://www.buildingsmart.org/)

[Croatia - https://www.buildingsmartcroatia.org/](https://www.buildingsmartcroatia.org/)

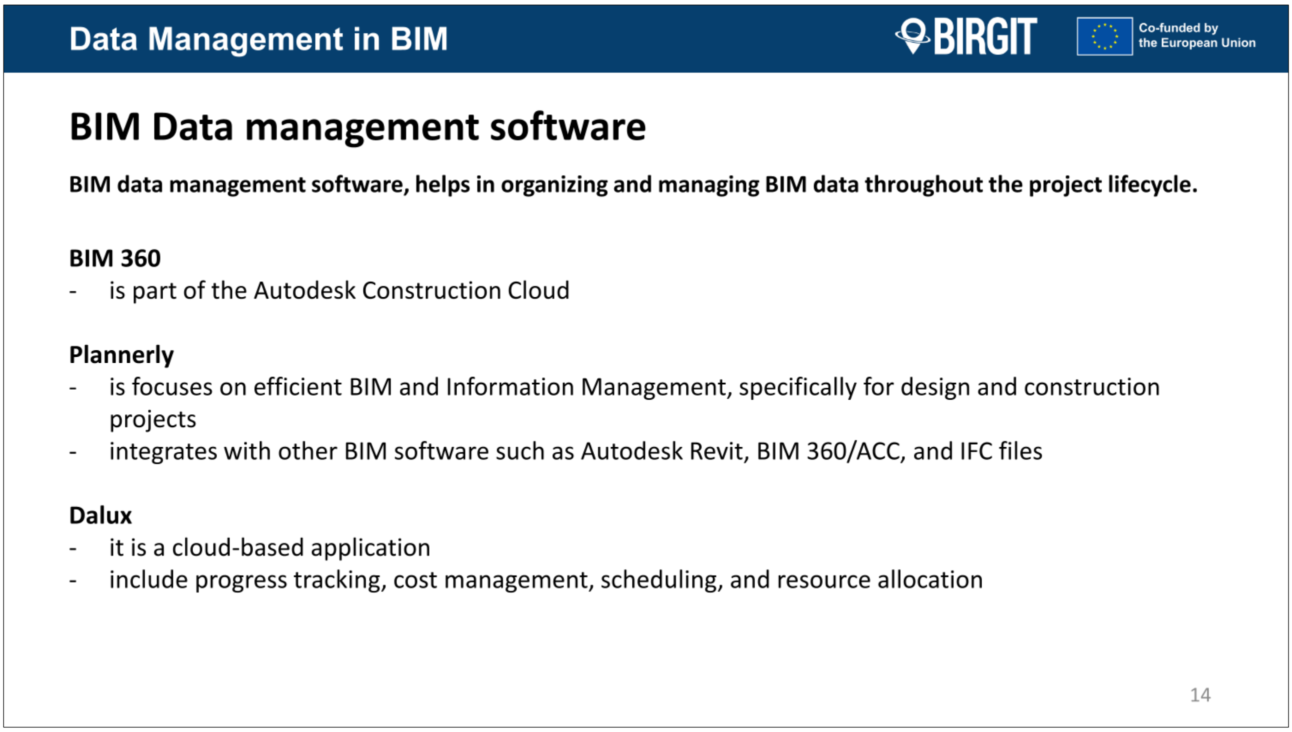
It establishes methodologies for the object-oriented description of buildings via open data formats, facilitating integrated project delivery. Open BIM serves as a shared language for information exchange across multidisciplinary project teams.

Within an open BIM workflow, the entire process relies on standard formats, such as IFC, for sharing data between software applications, as opposed to proprietary formats. This seamless data sharing via open standards enhances cross-application compatibility, streamlines workflows, and minimizes errors.

Open BIM enhances the advantages of BIM by fostering collaboration among project stakeholders, ensuring transparent workflows, and guaranteeing the longevity and accessibility of data for constructed assets through training activities, certified software, well-structured processes, skills acquired through practical experience.

Interoperability is the foundation of Open BIM and includes encouraging the use of open standards (data can be seamlessly shared between stakeholders). A feature of Open BIM is vendor neutrality. Unlike restrictive approaches, Open BIM does not force project participants to use the tools of a specific supplier (it is possible to choose software applications that best suit their needs). Open BIM places great emphasis on maintaining the integrity and availability of data during the project life cycle (use of open standards, open data formats).

BIM Data Management Software



Unlike BIM software that is focused on creating and managing building models, BIM data management software is focused on facilitating collaboration, information sharing, and project management within a BIM environment. BIM data management software helps organize and manage BIM data throughout the project lifecycle (version control, access permissions and document management capabilities).

- ***Autodesk® BIM 360™*** is a cloud-based construction management platform that improves project delivery and outcomes. BIM 360 supports informed decision-making throughout the project lifecycle for project, design, and construction teams.

BIM 360 connects teams and data in real-time, empowering project members to anticipate, optimize, and manage all aspects of project performance. BIM 360 is accessible from mobile devices, enabling on-site teams to access project information, update models, and collaborate while in the field.

It enables the execution of a series of actions such as:

- provides a central repository for storing and managing project documents, drawings, models, and other project-related files;

- facilitates model coordination and clash detection by enabling teams to upload and compare different discipline-specific models;
- support construction and quality control processes;
- offers analytics and reporting features that provide insights into project performance, allowing project stakeholders to make informed decisions based on real-time data;
- includes cost management capabilities that help track and manage project budgets, change orders, and expenses;
- facilitates the submission, review, and approval of project submittals and RFIs (Requests for Information);
- integrates with various Autodesk software products as well as third-party applications, allowing for seamless data exchange and workflow integration.

The BIM 360 name represents several product offerings: BIM 360 Docs, BIM 360 Build, BIM 360 Design, BIM 360 Coordinate, BIM 360 Layout, BIM 360 Plan, BIM 360 Ops

https://help.autodesk.com/view/BIM360D/ENU/?guid=BIM360_Product_Limitations

- ***Plannerly*** is focuses on efficient BIM and Information Management, specifically for design and construction projects. Plannerly is unique because it focuses on efficient BIM and Information Management specifically for design and construction projects. It’s also possibly the simplest of all BIM tools.

It enables the execution of a series of actions such as:

- comes jam-packed with all the BIM document templates required for EIRs, BEPs;
- it meets all the critical ISO 19650 requirements straight out of the box;
- integrates with other BIM softwares (Autodesk Revit, BIM 360/ACC, and IFC files);
- can easily transfer data between many platforms;
- it is free BIM software for students in university.

https://plannerly.com/

- ***Dalux*** is a software company that provides cloud-based solutions for building information modeling (BIM), construction management, and facility management. It is a cloud-based application and include progress tracking, cost management, scheduling, and resource allocation.

It enables the execution of a series of actions such as:

- offers tools for BIM collaboration, allowing project stakeholders to upload, share, and review BIM models and data in a centralized cloud-based platform;
- users can view and annotate BIM models directly within the software (useful for design reviews, clash detection, and identifying issues before construction begins) ;
- provides mobile apps that enable users to access BIM models, documents, and project information on smartphones and tablets;
- users can track issues, deficiencies, and tasks within the BIM model (helps in maintaining a clear overview of project status and progress) ;
- allows for the management and distribution of project documents, drawings, and specifications;
- includes features for quality control and snagging;
- enabling users to manage building assets, maintenance schedules, and other post-construction activities;
- can integrate with other BIM software and tools.

https://www.dalux.com/

Co-funded by
the European Union

References