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Report on current status of BIM uses

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Introduction

Building Information Modelling (BIM) is an innovative and transformative technology in the construction industry, offering a 3D digital representation of the physical and functional characteristics of buildings and infrastructure. BIM facilitates improved collaboration, efficiency, and sustainability throughout the lifecycle of a project, from design and construction to operation and maintenance.

Europe has been at the forefront of BIM adoption, with varying degrees of implementation and maturity across countries. The Directive 2014/24/EU on public procurement, adopted by the European Union in 2014, plays a pivotal role in promoting the use of BIM across Europe. This directive encourages member states to consider digital tools, such as BIM, for public works contracts. The aim is to enhance efficiency, transparency, and innovation in public procurement processes.

The **first part of the report (I)** provides an overview of the status of BIM in Belgium, Germany, Greece, Italy, and Slovenia, the countries that are represented in the BIM4D consortium.

While traditionally focused on design and construction phases, BIM's capabilities have expanded to encompass operations, maintenance, and now, deconstruction. Deconstruction involves methodically dismantling buildings to salvage materials for reuse, recycling, or repurposing. This contrasts with traditional demolition, which typically results in significant waste. In Europe, where resource efficiency and waste reduction are critical, BIM for deconstruction could offer a structured approach to manage the complexities of deconstruction projects.

The **second part of the report** is devoted to the use of BIM for deconstruction and considers various elements: theoretical perspectives (II), benefits (III), current skills needs (IV), challenges (V), relating policies (VI) and links with sustainable waste management (VII).

Current BIM uses in the partner countries – National reports

Belgium

Regulatory environment

The use of BIM is **not mandatory** for construction projects in Belgium. The European Public Procurement Directive 2014/24/EU, which states in Article 22.4 that member states may require the use of BIM for publicly funded construction projects, has not resulted in an obligation to use BIM in Belgium for public procurement (unlike in other European countries).

Using BIM is left to the choice of the client, who can decide to impose it in the specifications. In this case, the use of BIM is voluntary and will increase the project budget. The difficulty for the client, who is generally not a BIM specialist, is to identify the purpose of BIM for his project and to choose the uses of BIM that he wants in his project.

There are no incentives or subsidies for the use of BIM in Belgium. Public authorities may decide to impose BIM in calls for tender for public works, but this is not an obligation.

The Belgian Building Research Institute (Buildwise) has been instrumental in driving BIM adoption in Belgium, providing guidelines, training, and resources to stakeholders in the construction industry.

Uses of BIM

The uses of BIM in Belgium are diverse and vary from one company to another.

BIM is used mainly in large offices or companies to facilitate work execution, planning and financial management of construction projects.

BIM is more common for large-budget projects where it is important to keep a record of the building's components for maintenance purposes.

Skills

Now

BIM uses in Belgium require the following skills:

- Digital basic skills: BIM is only relevant if the entire construction value chain is digitised and everyone involved has basic digital skills (e.g. data extraction (everyone)
- Skills in technical drawing, as well as in integrating information into BIM software (BIM modeler)
- Information management skills: for certain uses, you don't need to know how to draw in 3D, but you do need to know how to collect, classify, store and access information relating to a site
- Collaboration: learning to work collaboratively: reaching agreement, transferring information to other trades using the same protocols to facilitate exchanges and information management.

A few training centers offer training related to BIM in Wallonia. Some universities, as well as IFAPME and Forem centers, are the only ones to offer certified training programs. However, the demand for BIM skills is quite high. Major design firms and companies indeed prefer BIM modelers over 2D drawers and take advantage of BIM information for their own benefit (3D, 4D, 5D). Universities target architects and engineers, while centers like IFAPME cater to both technical drawers and those working on construction sites. Since BIM is a voluntary approach, it is notable that training for public prescribers is sorely lacking, and as a result, few projects are conceived using BIM.

Existing training programs focus on software usage and the role of a BIM manager. Informal feedback from the field indicates that there is little customized training for specific professions or companies. Those who have undergone training must then analyze what they have learned to apply it to their own business. BIM relies on collaboration: practices will differ depending on the size and projects of the companies. What construction companies currently lack is personalized support to implement a collaborative and digital work approach and manage the transition period (phase-in/phase-out). Transitioning from a siloed working method to a collaborative one is a significant challenge. Then, agreement with project partners is necessary. Existing training programs provide a good foundation, but there is a lack of support for digital transformation to break down old working habits.

Future trends

Project owners will use BIM to access as-built information and updated information throughout the building's life cycle. This will facilitate building maintenance, especially if the BIM model includes an alert system to remind of equipment maintenance (boilers, fire extinguishers, etc.) and to report defective equipment (lights, etc.). Project owners must be trained as "**BIM users**" to manage building information for proper maintenance

Designers (architects, etc) will use BIM to optimize the design, particularly regarding materials (selection and prescription of materials and techniques aimed at energy savings and facilitating future deconstruction) and the integration of special techniques in the building (to place the techniques in appropriate locations).

Contractors (construction companies, etc.) will use BIM on the worksite for site progress monitoring (with 360° camera and BIM model) and tracking respect of schedule (4D) and budget (5D).

BIM and deconstruction

In Belgium, there are specific legal and regulatory obligations regarding end-of-life and deconstruction processes.

As an EU member state, Belgium is bound by the Waste Framework Directive (2008/98/EC), which establishes a legal framework for the treatment of waste within the EU. This directive promotes the recycling and recovery of waste, including construction and demolition waste.

Deconstruction and selective demolition are also encouraged in Belgium to facilitate the recycling and reuse of materials, so that they are used in a more circular way. This involves carefully dismantling buildings to segregate different types of waste at the source. This practice is increasingly mandated in Belgian 3 regions to meet recycling targets:

- Wallonia: The Walloon Waste Plan outlines obligations for managing construction and demolition waste, emphasizing selective demolition and recycling.
- Brussels-Capital Region: The region has specific rules under the Waste Plan for the prevention, recycling, and recovery of construction waste, including mandatory waste sorting at demolition sites.
- Flanders: The Public Waste Agency of Flanders (OVAM) oversees waste management and enforces regulations to promote recycling and sustainable deconstruction. OVAM's policies require waste audits and material recovery plans for large demolition projects.

To the best of our knowledge, there are no deconstruction companies as such in Belgium (no NACE code for deconstruction), but this does not prevent construction and/or demolition companies from being active in deconstruction. It is a complementary activity that is developing and will certainly grow in importance.

The use of BIM in the end-of-life phase of buildings is still very marginal in Belgium because BIM is primarily used for new constructions that, in principle, will not be deconstructed for several decades. However, exemplary projects like the Usquare project in Brussels could serve as inspiration for future projects. The main aim is to promote the re-use of materials and to emphasise the sharing of technical information among all those involved in the project. In this example, the BIM model has proved particularly useful for circular demolition and the reuse of materials.

Usquare Bruxelles

The Usquare.brussels project is transforming the former gendarmerie barracks in Ixelles into a dynamic complex, including family housing, student residences, university facilities, and commercial spaces. The aim is to transition from a closed military complex to a new urban neighborhood with all necessary amenities.

The project is coordinated by the Société d'Aménagement Urbain (SAU), which adopted a sustainable approach from the start. The focus has been on restoring the buildings to their original state, while considering their future use. Buildings are only demolished if their stability is insufficient for renovation. The design of new constructions is made flexible to adapt to changing needs over time. The principles of circular demolition and construction are at the heart of this project. Materials recovered on-site are reused as much as possible. If this is not feasible, other places for their use or high-quality recycling options are explored. When new materials are necessary, those with the lowest possible impact, such as clay and hemp for insulation, are preferred.

To reinforce this strategy, the SAU launched a public tender to find a partner specializing in circularity. Rotor asbl won the contract and was allocated a budget of €170,000 to help define and implement a circular strategy over four years. The goal was to develop a BIM model associated with an inventory to promote the reuse of materials. The idea was to enable architects, engineers, and contractors to easily give a second life to these existing materials. All project stakeholders had access to detailed data on the dimensions, quantities, composition, location, and physical properties of the materials. This information also served as a basis to evaluate the strategy based on economic, technical, and environmental indicators.

A BIM model was developed only for the buildings intended for renovation, allowing its use throughout the building's life. Rotor provided comprehensive training so that all stakeholders could use this database. Two end-of-life scenarios were modeled for each building: preserving as much as possible or undertaking a thorough renovation. The impact of each scenario on maintenance, materials available for reuse or recycling, and the need for reuse materials was studied. The scenarios showed that the "circular demolition and reuse" approach was feasible.

Rotor, despite being a pioneer in circularity, lacked BIM experts, which caused delays. Additional measures were necessary to refine the BIM model. The complexity of the model sometimes made demolition more difficult, requiring several BIM models. Prior communication on the necessary details is crucial for better preparation. The main objective remains to integrate the developed BIM models into an as-built BIM model usable throughout the life of each building.

Despite the challenges, the BIM model was very useful for circular demolition and material reuse. The BIM model made it possible to identify reusable elements on-site and to evaluate the necessary storage space. Part of building M, destined to become a covered hall, was converted into a storage area for recovered bricks, awaiting reuse in new constructions. This information was easily accessible to the contractor via BIM.

BIM was also used to estimate the volumes of reusable materials and generated waste, setting minimum requirements in terms of reuse and recycling. Bidders had to propose creative solutions to meet these criteria. Thanks to the preparation ensured by the BIM model, the bids received far exceeded expectations, being both ambitious and realistic. The project leaders highlighted that the BIM model allowed them to significantly exceed their initial expectations.

Sources

https://vb.nweurope.eu/media/20756/la-circularite-une-priorite-dans-la-re-novation-de-usquarebrussels_fr.pdf

https://www.recyclepro.eu/artikel/circulariteit-prioriteit-in-conversie-fritz-toussaint-kazernes/

Germany

Introduction

The term BIM must necessarily be divided into the different phases, also known as maturity levels, of the BIM building modelling software.

The BIM maturity levels are therefore divided into a 0 - 3 (0 - 4) scale, whereby the higher the level, the more advanced the degree of collaboration and information exchange:

PAS 1192 / EN ISO 19650 - 3, for example, describes 4 levels of BIM maturity:

Level 0 = Low collaboration, use of 2D drawings / exchange in paper form or via PDF / dxf

Level 1 = Partial collaboration, data exchange file-based / via a Common Data Environment (CDE), 2D / 3D programmes are used, mix of 2D and 3D delivery items

Level 2 = Full collaboration, use of Common Data Environments (CDE), 3D models with attributes that open up further dimensions e.g. time (4D) & costs (5D)

Level 3 = Cloud-based collaboration incl. data exchange, further utilisation of data in the life cycle

The Erasmus project is therefore focussed on maturity level 2. This results in a clearer question regarding utilisation and the questions to be answered here.

Regulatory environment

In addition to the usual regulations of the German Public Procurement Ordinance for public sector contracts, these have now also had an impact on the previously known Public Procurement Ordinance since the European Public Procurement Directives were amended.

It is now theoretically permissible for contracting authorities to require the use of electronic means for construction data modelling when awarding construction contracts and competitions. BIM services can therefore be requested, and corresponding BIM-related suitability and award criteria defined - whereby the requirement for product-neutral tendering must be observed.

The last sentence also refers to the wide range of utilisation options offered by various software providers in this area. This means that the public sector as a client can demand the use of BIM planning. In practice, this has proven to be impossible to implement in Germany for a number of reasons.

Further legal regulations are not decisive here, as most of the new legal texts or adaptations of standards relate more to the remuneration of architects and players in the construction industry and thus create a fundamental basis for clearly structuring the use and work in and around BIM in Germany, including in the billing system.

The thin blanket of specifications and regulations already paints a picture of rather low utilisation of BIM services on a broad basis. In larger projects, BIM is used in pilot form as part of project consortia consisting of players from the construction industry.

This is part of an attempt to test the fullest possible utilisation of the possibilities offered by BIM in all its various degrees of maturity and in the greatest possible exchange.

Smaller construction projects also already use BIM, but more in the area of LEVEL 1 defined above, i.e. the use of a MIX of 2D and 3D data sets and documents for the realisation of a construction project.

The "Ministry of Homeland, Municipal Affairs, Building and Digitisation" of the federal state of North Rhine-Westphalia has also looked into this problem. As a result, the state government is providing funding to support the establishment of inter-municipal BIM management.

Furthermore, the federal state of North Rhine-Westphalia promotes innovations in the construction industry in direct cooperation with state construction contracts for municipalities and the like.

In particular, the object of the funding can be

- *Perspectives and opportunities for innovative, resource-saving manufacturing processes are to be developed in order to improve the competitiveness of the North Rhine-Westphalian construction industry and create the basis for future-oriented economic sectors,*
- *digital construction methods (3D printing, construction robotics, **building information modelling,** etc.),*
- *innovative construction methods that increase the efficiency and effectiveness of planning, construction and/or the operation (including subsequent utilisation and/or conversion) of buildings,*
- *open-source projects to increase efficiency and effectiveness in urban development, planning, construction and/or operation of construction projects,*

Uses of BIM

In terms of possible applications and the use of BIM, this must be clearly limited to the utilisation phase of planning. The execution phase is currently hardly realisable with BIM for German companies and industry.

However, associations such as the BIM Cluster NRW should be mentioned here, whose clear objective is to support the advancement of the digital possibilities of BIM within the framework of pilot projects and concrete exchanges or the creation/development, support and promotion of educational programmes for the BIM sector.

However, there is a long way to go until the 4D utilisation phase, where, among other things, the time conditions and the planning and use of a wide variety of trades on large projects would be implemented and realised. This would require more widespread use and training in BIM in the construction sector.

Skills

Now

Most further training opportunities are aimed at people already in technical professions in the construction sector, including draughtsmen, civil engineers and architects, but also project managers, technicians and various professional groups involved in construction management, such as foremen or supervisors.

BIM training courses are offered by a number of different educational institutions. These include various universities. The certificates to be obtained at the universities would be BIM-Professionel (CAS), for example, but courses certified via BuildingSMART are also offered by BWI-Bau and promoted, supported and also advertised by the BIM Cluster and the rest of the NRW construction industry association. Nevertheless, it must be said that an expansion of the range of courses on offer to a comparable breadth as other training content (e.g. use of Office products or handling PCs or similar) has done over the years is absolutely desirable.

Future trends

Based on the research carried out, the future trend clearly indicates that BIM will be an integral part of the construction industry. The advantages of a shared interface and a clear and regulated exchange of data offer more advantages and benefits than there are hurdles. Through the continuous expansion of training courses in this area, more and more players in the construction industry will also be prepared to make their lives in construction easier with BIM and to professionalise their construction projects to this end.

However, to achieve the major goal of full utilisation, the training courses must also be offered in a low-threshold form for the professional groups that only come into contact with BIM in shorter phases. This includes the trades falling under Level 2 and Level 3, which do not make specific entries in BIM, but must necessarily obtain the information from BIM and should therefore have familiarised themselves with the software. A general "additional subject" - "BIM basic training for the 4D phase", for example, would therefore be desirable for all main construction trades. This would ensure that everyone, from road builders to carpenters, would have the same level of technical knowledge when it comes to recognising and retrieving important information for construction work. This would make the widespread use of BIM more feasible and realisable.

BIM and deconstruction

Germany has a wide range of legal regulations regarding the demolition of buildings and the disposal of materials of various categories.

There are **2643** companies in Germany specialising in demolition and dismantling. If you include the companies that also offer other services in addition to demolition and dismantling, the number rises to **8077** companies across Germany.

One example of good green practice in relation to the end of the life cycle is the resource-efficient dismantling trend in Germany. On the one hand, this involves recognising, recording and determining a wide variety of materials and substances, and on the other, determining their usability after dismantling and using the most resource-efficient dismantling method. Here, the preservation of the resource takes precedence over destruction.

A wide variety of guidelines, developed by colleges and universities, provide a guide to how to proceed in order to maximise efficiency in this area.

For example:

VDI Centre for Resource Efficiency:

Deconstruction in building construction - current practice and potential for resource conservation

Ministry of Rural Development, Environment and Agriculture:

Brandenburg guidelines for the demolition of buildings

But also regulations and laws at state and federal level, for example:

Act to Promote the Circular Economy and Ensure the Environmentally Sound Management of Waste (Circular Economy Act KrWG)

When using BIM, particularly in the end-of-life phase, it is essential that data is entered and fed into the building modelling software reliably right from the planning phase. After that, every adjustment and any changes to materials during the execution and problem-solving phase during construction must also be entered into the building modelling software. Not forgetting all subsequent small and large construction measures that are added during the life cycle of the building.

If one were to assume that all the steps required in advance were maintained by all those involved throughout the entire life cycle of a building, then the use of BIM software in the context of a demolition project would be just as helpful in terms of quantities and mass determination as it would be in the concrete determination of the different hazard potentials of installed substances and materials. A core problem is already emerging here, which, due to the aforementioned lack of training

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of construction professionals in the field of BIM over the past 20 years, already presents a hurdle to the problem-free use of BIM in deconstruction.

This would also make it easier to implement the official requirements and automatically document them at the same time.

Where the use of BIM in dismantling is more common and actively utilised is in the dismantling of nuclear power plants. Due to the high obligation to document all changes and the sensitivity to certain groups of materials throughout the construction phase, the benefits are justified in practice in relation to the expense. Point cloud models and external scans of the building envelope and components make it possible to create a BIM model with all the necessary information regarding materials and changes or other documentation, which is used for planning and implementation during dismantling. This is probably the best practice example here. In the case of smaller demolition measures (e.g. demolition of a residential building from the 1950s), the preparatory work required for the use of BIM would already involve an enormous amount of time and money.

Sources of the German national report

https://www.bwi-bau.de/weiterbildung/termine/details/2024-11-05-vob/b-und-bgb-bauvertraege-seminarfolge-zum-bauvertragsrecht-modul-1_2121/

https://www.h-ka.de/iww/bim/ueberblick?gad_source=1&gclid=Cj0KCQjwir2xBhC_ARIsAMTXk84an-dbguD_d1CPFEHZl25OgFWHKHrxL2uNUjIq-jJsE4Q4DKSZA7IaAtu2EALw_wcB&cHash=9fbb71e2bb99c3246b991c2f33addcc3

https://www.aknw.de/aktuelles/news/details/news/bim-und-nachhaltigkeit-zirkulaeres-bauen

https://biblus.accasoftware.com/de/4d-bim-vorteile-der-bauzeitenplanung/

https://www.mhkbd.nrw/foerderprogramme/innovation-der-bauwirtschaft

https://biblus.accasoftware.com/de/pas-1192-verschwinden-die-englischen-bim-vorschriften-werden-in-iso-19650-integriert/

Greece

Introduction

European Directive 2014/24/EU brings to the foreground of the European institutional framework the term building information modeling (BIM). The term is mentioned in article No. 22 of the Directive where it is noted that in the framework of signing public works contracts and the invitation to tenders for relative studies, the member states must include the use of specialized electronic modeling tools for building construction information or similar means.

BIM is a methodology that is expressed on different maturity levels (Level 0, 1, 2, 3). BIM applies and is equally important to all project phases from RIBA 0 to 7. Products such as 3D CAD software or BIM management platforms, are technological tools of BIM methodology. The majority of the industry terminates BIM processes with the handover of the project. The “In-use” stage (RIBA 7) is fundamental as it monitors and collects data about the operational performance of a building product so that tangible evidence of building behavior can be recorded rather than predicted.

Regulatory environment

Greece currently does not have a mandate for BIM use in construction projects. The issue of BIM was limited to the representation of Greece to the EUBIM Task Group with two members: A representative of the Ministry of Environment and Energy and a representative of the Technical Chamber of Greece (TCG). Greek legislation introduced in Law 4412/2016 the use of BIMs in Greek construction projects.

The Greek government is currently considering making Building Information Modeling (BIM) mandatory for all public works projects. In January 2024, the Ministry of Infrastructure launched “The National Strategy and Roadmap for the Use of Building Information Modelling (BIM)”. The strategic objectives are mainly related to leading the change, preparing the market and the public sector and ensuring the effective implementation of BIM. To achieve these objectives, the following six (6) strategic axes are formulated:

1. Public sector leadership
2. Contact
3. Developing BIM skills and competences
4. Creating a collaborative framework
5. Development of tools
6. Supporting businesses

The wider construction industry is fully aware of the needs, shortcomings and improvements needed to make the procurement system more workable. Therefore, the advisory role of the stakeholders and the construction industry is seen as a catalyst for the reform of the regulatory framework regarding BIM and its integration into the framework of public procurement and project specifications. Thus, consultation of the new regulations with market representative bodies is being promoted in order to identify issues that may arise and to propose how to resolve them.

Uses of BIM

BIM practice introduces a different perception in the construction industry, compared to today's dominant one. It contributes to redefine the conditions of craft production of technical projects to corresponded conditions of mass production, in order to increase productivity and save expended resources.

Cost estimation based on BIM model information, building management, 3D visualization of building systems for coordination and project management, and conflict management are among the key uses of BIM in Greece. Additionally, 3D models can be visually inspected for interferences and errors before the construction stage, aiding in project planning and ensuring smoother execution.

The first national implementation of BIM was at the Stavros Niarchos Foundation. As an initiative of the Stavros Niarchos Foundation, 3 projects and especially 3 hospitals use BIM methodology in the construction stage. The three projects used a common data environment (CDE) as a common way to exchange information and a BIM collaborative design platform for real-time collaboration. They also promoted the maximization of the use of BIM models and the information extracted from them and developed a methodology according to which priorities and critical controls were defined by the design phase about the problem of potential conflicts. Furthermore, Line 4 of the Athens Metro, included in the tender process the provision for the application of BIM in the preparation of the studies and the execution of the construction.

The use of BIM in Greece is still at an early stage but is expected to grow significantly in the coming years. Increasing support from the government, combined with the benefits offered by BIM, makes its adoption an attractive option for construction professionals. Currently, the application of BIM in Greece is mainly through the Technical Chamber of Greece (TCG). In January 2024, the Ministry of Infrastructure launched “The National Strategy and Roadmap for the Use of Building Information Modelling (BIM)”.

Skills

The majority of Greek engineers are familiar with the method of BIM, but the degree of use of BIM tools is significantly low.

There are few trainings related to BIM in Greece, PEDMEDE has conducted training for the BIM in Greece. The BIM training program aimed to promote the use of BIM by enhancing knowledge and skills as well as informing the Design and Construction Sector about digital tools and their capabilities. Also, some Greek universities provide training related to BIM such as Hellenic Open University conducted training about Designing projects with BIM: Principles and practice of building projects. The Duration was 11.5 weeks. The main content of this training was: Introduction - International BIM regulations, International BIM standards - BIM project organization, BIM project design - BIM project design, Spatial coordination, Advanced BIM techniques 4d, 5d, 6d (scheduling, cost control, facility management).

In the National Strategy and Roadmap for the Use of Building Information Modelling (BIM)" in Greece, it is proposed to teach the following basic subjects related to BIM:

1. Digital technologies in engineering projects
2. BIM technology: concepts and definitions
3. BIM technology application areas
4. ISO 19650, information management documents, software and templates

To achieve the immediate adaptation of the graduates to working with BIM practical application of theoretical knowledge through the learning of tools BIM tools and the development of projects.

The purpose of the training programs is to provide adequate information to the private sector (engineers, industry professionals) and the public sector (MoEHE and contracting Authorities) on the following topics:

- Basic understanding of BIM (advantages, use of tools and standards)
- ISO 19650 content and key elements
- Use of standard BIM specification templates
- Use of BIM tools and technologies
- BIM project management
- BIM roles and responsibilities within the project
- Research news and trends on BIM

According to the National Strategy and Roadmap for the Use of Building Information Modelling (BIM)" in Greece, in the future BIM will be a useful tool for both public and private sectors, and the integration and application of BIM into the curriculum of all engineering majors graduating from the country's university institutions.

BIM and deconstruction

The legislative framework for waste management in Greece is defined by Law 4042 of 2012 'Penal protection of the environment - Compliance with Directive 2008/99/EC - Framework for waste generation and management - Compliance with Directive 2008/98/EC - Regulating issues of the Ministry of Environment, Energy and Climate Change' which transposes the EU Waste Framework Directive (2008/98/EC) into Greek law. All provisions in the WFD related to CDW are valid for Greece and form the legal basis for the management of CDW in the country.

Further legislation, regulations and guidelines concerning CDW in Greece includes:

Joint Ministerial Decision 36259/1757/E103 of 2010 stipulating measures, conditions and programs for the alternative management of excavation, construction and demolition waste (ECDW). Here, the obligations of all actors involved in the management of CDW are presented with emphasis on increasing the re-use and recovery of CDW following the waste hierarchy.

Law 2939 of 2001 for the alternative management of packaging and other products , as amended by Law 3854/201010. This piece of legislation lays down the principles of alternative waste management of the CDW waste stream, among others, and stipulates the organisation systems for the management of CDW. Also, fines and other administrative and legal sanctions are prescribed in the case of non-compliance with the regulation.

Law 4030 of 201111 'New way of issuing building permits, control of construction and other provisions'. Article 40 describes permit issuing provisions for CDW treatment facilities in inactive quarries and the rules for accepting and managing CDW in these treatment facilities.

Law 4067 of 201212 'New Building Regulation', where Article 17 stipulates that for the construction of any building and the landscaping of the building surroundings, the provisions of the relevant legislation for alternative management of waste from excavation, construction and demolition waste should be applied.

Circular13 of the Ministry of Environment, Energy and Climate Change no. 4834 of 25 January 2013 with subject the 'Management of excess excavation materials from Public Works - Clarifications on the requirements of the JMD 36259/1757/E103/2010', exempting the management of excess materials from excavation activities during public works through the certified systems of alternative CDW management, as long as the excess material is handled in sound environmental manner.

Commission Decision 2011/753/EU establishing rules and calculation methods for verifying compliance with the targets set in Article 11(2) of Directive 2008/98/EC of the European Parliament and of the Council14.

Law 4280 of 2014 'Environmental upgrading and private urbanization - Sustainable development of settlements. Forest law regulations and other provisions', Article 52 stipulates the possibility of deposition and processing of CDW in inactive mines and quarries by the certified systems of alternative CDW management.

There are no End of Waste criteria established in Greece.

BIM is not yet widespread in the end-of-life phase of buildings in Greece. However, BIM has the potential to significantly improve deconstruction practices by providing detailed information about building components and materials. This can help with selective demolition and material reuse.

Demolition businesses in Greece are included in specialized construction activities, there are 6302 businesses in this field. Of these companies, 1.691 are dedicated to demolition and site preparation.

Sources of the Greek national report

Εθνική Στρατηγική και οδικός χάρτης για την εφαρμογή του Building Information Modelling (BIM). http://www.opengov.gr/yme/?p=5318

Deloitte, 2015. Construction and Demolition Waste management in Greece – Fact Sheet. https://ec.europa.eu/environment/pdf/waste/studies/deliverables/CDW_Greece_Factsheet_Final.pdf

Bakogiannis E, Papadaki K, Kyriakidis C, Potsiou C. How to Adopt BIM in the Building Construction Sector across Greece? Applied Sciences. 2020; 10(4):1371. https://doi.org/10.3390/app10041371

https://www.eoan.gr/%ce%b5%ce%bd%ce%b1%ce%bb%ce%bb%ce%b1%ce%ba%cf%84%ce%b9%ce%ba%ce%ae-%ce%b4%ce%b9%ce%b1%cf%87%ce%b5%ce%af%cf%81%ce%b9%cf%83%ce%b7/%ce%b1%cf%80%cf%8c%ce%b2%ce%bb%ce%b7%cf%84%ce%b1-%ce%b5%ce%ba%cf%83%ce%ba%ce%b1%cf%86%cf%8e%ce%bd-%ce%ba%ce%b1%cf%84%ce%b1%cf%83%ce%ba%ce%b5%cf%85%cf%8e%ce%bd-%ce%ba%ce%b1%cf%84%ce%b5%ce%b4%ce%b1/

https://www.bimconference.gr/history/

Italy

Regulatory environment

The initial reference from which to start on the subject of BIM is article 22, point 4, of **Directive 2014/24/EU** of 26 February 2014 according to which for public works contracts and design competitions, Member States could request the use of specific electronic tools, such as electronic simulation tools for building information or similar tools.

To implement these indications, **Ministerial Decree no. 560/2017** (also known as the Baratono decree) was first adopted which provided a regulatory and organizational framework to promote the adoption of BIM in the public construction sector in Italy, with the aim of contributing to modernizing processes and improving the results of public works.

The decree established the objective of improving the efficiency, quality and safety of public works through the adoption of BIM. It provided guidelines and requirements for the introduction and use of BIM in the design, construction and management processes of public works.

Furthermore, it provided for a progressive introduction of the obligation to use BIM for public works, with different time periods linked to the amount and characteristics of the interventions. This gradual approach has allowed institutions and operators in the sector to gradually adapt to the new methodology.

The decree has in fact defined a detailed calendar for the entry into force of the BIM obligation, with six time bands that followed one another from 2019 to 2025. These time bands established the minimum values of the interventions for which the use of BIM was required BIM, allowing a transition period for adaptation.

In addition, this decree underlined the importance of adapting organizational structures and ensuring adequate training of personnel involved in BIM processes. It required the definition of training plans and the adoption of adequate hardware and software tools for the digital management of decision-making and information processes.

The requirements for the tender documentation relating to the awarding of planning and execution services for public works have been established. This documentation had to include strategic and specific information requirements, as well as all elements necessary for the management and transmission of information data in the context of BIM.

In 2019, Italy took a significant approach to the public construction sector by introducing mandatory Building Information Modeling (BIM) design. This decision was motivated by several factors, such as:

- Internationally, the use of BIM was becoming increasingly widespread in the construction industry. Countries around the world were adopting this methodology to improve the efficiency, quality and sustainability of their infrastructure. Italy, wanting to keep up with these global trends, has decided to adopt BIM also for its public works.

- The construction sector was experiencing an accelerated digitalization process. BIM, as an integral part of this process, offered an innovative approach to the design, construction and management of public works. Its adoption promised to revolutionize traditional working methods, bringing significant benefits in terms of efficiency, collaboration and cost reduction.

- Through the introduction of BIM, it was possible to improve the quality and safety of public works. Thanks to BIM's ability to provide an integrated and detailed view of a project, designers and operators could identify potential problems in advance and take preventative measures to ensure workplace safety and compliance with construction regulations.

- The adoption of BIM also promised to increase efficiency in the design and construction processes, reducing the time and associated costs. The ability to easily share information and data between the different project actors would have fostered better collaboration and coordination, allowing for the avoidance of duplication and costly errors.

As of **2023**, there has been a significant lowering of the threshold for mandating the use of BIM in public works in Italy. This change made the use of BIM mandatory for works with a minimum value of 5 million and 300 thousand euros. This value has been established as a new threshold until 2025.

This progressive lowering of the threshold was strategic to prepare the ground for a wider diffusion of BIM in the public construction sector. By reducing the minimum value of works subject to the BIM obligation, a greater number of projects have been given the opportunity to benefit from the advantages of this methodology. This has enabled a gradual transition towards greater adoption of BIM, paving the way for a broader transformation in the way projects are conceived and implemented in the public construction context in Italy.

Uses of BIM

BIM is a methodology that includes more software used during the building construction planning and realization. All the software used in these development stages involve various actors that need to collaborate at the same construction. When it comes to BIM, we refer to an innovative methodology that in addition to facilitating the planning and the realization itself is as well an essential preventive method for controlling and reduce errors in all the phase of the construction execution.

BIM allows collecting the construction data combining them digitally, it should be remembered that BIM is not only a software but is a complex and innovative methodology essential for the construction sector because of strategic interest in the next future.

BIM methodology affects, new buildings, renovations, renewals and management of cultural heritage.

On EDILPORTALE website, there is a survey published in 2018 reporting that 17% of the participants has already completed the transition to BIM, 30% are in the learning phase and 48% are evaluating whether to undertake a training course to start using BIM. At this survey participants were architects (37%) engineers (28%) surveyors (17%), designers and industrial experts.

Up to now, if for a large international construction's sites, BIM is a standard, in Italy, despite the undoubted value of BIM, its adoption is slow, according to a report made on 2023 from OICE. The report highlights that only 8% of public tenders for Engineering and Architecture services require the use of BIM.

The reasons that slow down the adoption of BIM in the construction projects are connected (following some interview we have carried on) to factors such as:

Costs of the software and access to the clouds to share the data and cost for training the staff.

Skilled workers' absence in the labor market and lack of time to follow a training course or to keep updated in this evolving methodology.

Difficulty to work in BIM environment and software not capable of being interoperable.

Scarcity of cases in which the use of BIM is mandatory (following the data published on CRESME, in 2016 there were 26 calls – we may say as well that this data is growing in the following years with the project value decrease).

Skills

In Italy, the current BIM landscape requires a series of skills from construction professionals to effectively use BIM methodologies.

Some of the key skills include:

- Expertise in BIM software. Construction professionals need to be proficient in using BIM software such as Autodesk Revit, ArchiCAD or Bentley MicroStation, which are commonly used to create BIM models and manage project data.

- Understanding of BIM methodologies. Professionals should have a solid understanding of BIM principles, processes and workflows. This includes knowledge of how to develop and manage BIM models, collaborate with project stakeholders and extract relevant information from BIM data.

- Interdisciplinary collaboration, given the collaborative nature of BIM projects, professionals need strong communication and collaboration skills to work effectively with multidisciplinary teams including architects, engineers, contractors and clients.

- Data management and analysis as BIM involves the management and analysis of large amounts of project data. Therefore, professionals should be well versed in data management techniques and able to analyze BIM data to derive information useful for decision making.

- Knowledge of the procurement code and construction regulations.

While BIM skills are quite widespread among professionals, in particular among designers, there is an almost total lack of knowledge and skills among small and medium-sized construction companies in Italy.

Even in Italy the UNI 11337 standard has played a crucial role in the organization of the professional figures involved in BIM processes. This standard provides guidelines and defines the knowledge, skill and competence requirements for the different professional figures involved in the management and implementation of BIM processes. For example, the UNI 11337-7 document outlines the roles and responsibilities of key figures such as the BIM Manager, the BIM Coordinator, the BIM Specialist and the CDE Manager, providing a clear structure for collaboration and communication within projects BIM. Furthermore, the UNI 11337 standard helps to ensure greater consistency and quality in BIM processes, providing nationally recognized guidelines for the development of professional skills in the construction sector.

As defined by the UNI 11337-7 standard, the CDE Manager (Common Data Environment Manager) is the one who has responsibility for and manages the data sharing environment, to be identified as the single digital area where all the data relating to a job converge in an organized form , making them shareable among the different actors in the implementation process; has, among other things, the task of guaranteeing the correctness and timeliness of the various information flows that converge in the environment, which increases the effectiveness of decision-making processes, and at the same time of identifying the best techniques that guarantee a series of interests and needs such as, for example, the traceability of passages and the protection of information and related intellectual property; operates in support of the BIM Manager's own activity.

The BIM Manager is the hierarchically highest professional figure in the chain, responsible for the creation, management and updating of the BIM Model and is equipped with the widest margins for managing digitalized processes; has the supervision or general coordination of ongoing contracts and assigns human resources to each of them; draws up the Information

Specifications and, based on these characteristics, could correspond, in the organization of a structured Local Authority, to the top figure of the Technical Office.

The BIM Coordinator is the coordinator of the information flows of the individual order and operates according to the indications of the BIM Manager; in the case of orders with high degrees of complexity, there may be multiple BIM coordinators; is the guarantor of the efficiency and effectiveness of the digitalized processes and is responsible, among other things, for verifying the correctness and coherence of the BIM model, and, in accordance with the above hypothesis, it could coincide, according to the setting of the new code, with the RUP or with the Procedure Manager of the technical phase.

Finally, the BIM Specialist is the advanced operator of information management and modeling activities who acts within the scope of the individual contract and works in support, among other things, in the drafting of the Information Management Plan.

Regarding the availability of BIM training in Italy, there has been an increasing emphasis on the provision of BIM education and training programs to meet the growing demand for qualified professionals. Many educational institutions, training centers and professional organizations offer BIM courses, workshops and certification programs tailored to the needs of construction professionals. However, the suitability of BIM training offerings may vary depending on factors such as geographic location, access to resources and industry demand. Efforts are underway to expand and improve BIM training opportunities to ensure that construction professionals have access to the skills and knowledge needed to succeed in the BIM-enabled industry.

There is a growing trend towards BIM adoption across all sectors of the construction industry in Italy, driven by government mandates, industry standards, and the recognized benefits of BIM implementation. However, challenges such as a lack of skilled professionals, fragmented supply chains, and resistance to change may hinder the widespread adoption of BIM.

Efforts are being made to address these challenges through increased BIM training and education programs, industry collaboration, and the development of standardized processes and guidelines.

While progress has been made, further efforts are needed to ensure that the expectations regarding BIM adoption align closely with the reality on the ground. This includes addressing barriers to adoption and fostering a culture of collaboration and innovation within the construction industry.

BIM and deconstruction

In Italy the concept of demolition has now changed to "deconstruction", which is a process of dismantling both manually and mechanically a building in order to optimize the recovery of its construction materials, followed by the removal and confinement of contaminating materials, including dangerous ones, such as asbestos in its various forms.

Italian companies consider sustainability a strategic priority, even if the economics factors are limiting, most companies indicate the lack of knowledge as well as the lack of clear rules and regulations as the factor blocking development in this area.

In Italy, excavation companies are often used to carry out major demolitions only because they have machinery capable to crush the material to be deconstructed, such as an excavator with crushing clamps.

In recent years, companies specializing in demolition have equipped themselves to deal with all the problems arising from deconstruction. For every material there is its own expert and using specialized companies is, at the moment, the best choice.

Deconstruction phases follow this procedure:

Design consists in some steps:

First is referred to examining the site to search for materials subject to special treatments (asbestos in its various forms or pollutants in concrete).

Second includes the construction project valuation to study and define how to demolish the building avoiding materials falling from above or damaging the structures in the area around.

Third, check the disconnection of services of water, gas, electricity, and other plant lines, then check if there are pipelines under pressure or containing materials that could end up spilling out. Ensure that there are no hidden tunnels or cellars that could collapse when machinery crosses over them. It is essential to coordinate relations with neighboring buildings and provide adequate provisional works.

When planning the working progress phase, it is necessary to ensure that at the end of the day, when everyone is leaving the site, everything is putted on safe to avoid any inconvenient that may lead any material left on a slab or on any place on the site itself to be carries into the street or away from the deconstruction site, an adequate dust suppression should be set up and even the remotest possibility that work or left material could cause inconvenience to third parties must be excluded as well all the possibility of anyone getting hurt must be avoided.

Worksite. The deconstruction site must be set up in a way that can guarantee the safety of all the workers involved. A decent and non-improvised profile must be maintained and must be rigorous avoiding any access to outsiders. Operators must be able to communicate with each other using transmitters. The daily program and the demolition project must be well known by those who follow the deconstruction phases in order to avoid any improvisation. The preparation of the staff is the most important thing, being specialized means knowing how to recognize a source of danger, being aware of the limitations of the equipment and the reaction effects that a risky or borderline manoeuvre can generate. Machines and equipment must always be up to the level of the operations to be carried out in terms of safety and performance.

Timing. Execution times must be calculated on the basis of some fundamental aspects: safety, size of the construction site, fleet of vehicles used. Maintaining a constant work pace and avoiding downtime is essential. Rushing or trying to make up time is a serious mistake that can cost you dearly; These are operations that do not allow errors.

Disposal of materials. The material coming from demolitions is waste and as such must be assessed in depth to decide where it should be sent. The choice of destinations takes into account not only the price, but also the regulations listed in the decree of (CAM) minimum environmental criteria.

UNI has published a reference practice on "Selective deconstruction - Methodology for selective deconstruction and waste recovery from a circular economy perspective" (UNI/PdR 75:2020) which is currently a voluntary standard.

Selective demolition consists of separation operations into homogeneous fractions, also through the use of machinery and equipment, which has as its primary objective the maximization of C&D waste addressed to the reuse and recycling process (end of waste).

In Italy there are companies specialized in deconstruction such as DEPRE, a leading demolition and controlled deconstruction company which is able, thanks to technologies designed by themselves, to separate the CER codes (European Waste Catalogue) and recover 98% of the deconstructed material.

Slovenia

Regulatory environment

It is not mandatory yet to use BIM in Slovenia. Starting January 1, 2025, the use of BIM will be mandatory for all construction projects of public importance in Slovenia, including transportation infrastructure, educational institutions, and healthcare facilities (for further details, you can refer to the official documentation available https://www.zveza-dgits.si/wp-content/uploads/2024/02/GV-02-2024-clanek2.pdf).

There are no governmental initiatives (subsidies, incentives, etc) to promote BIM implementation in Slovenia, but there are initiatives from siBIM – Slovenian BIM society, buildingSMART Chapter Slovenia, Chambers of engineers, architects and Chamber of Commerce and industry of Slovenia. These organizations have supported pilot projects and public procurement that incorporate BIM technologies.

Uses of BIM

In Slovenia, BIM is predominantly used for the design and construction phases of various infrastructure and architectural projects.

Approximately 5% of large construction companies have integrated BIM into their operations. BIM adoption is primarily observed in large-scale projects, though there is growing interest in applying it to smaller projects.

Skills

Now

Currently there are no formal requirements regarding skills, but proficiency in BIM software and understanding of BIM management are generally expected. Professional certification through programs like the buildingSMART International Professional Certification is recommended (see more info about the training: https://www.sibim.si/obvestila/buildingSMART_International_Professional_Certification_Program/) .

Practically, companies require BIM skills for BIM management and using different BIM software products.

Currently, a small percentage of construction professionals possess the necessary BIM skills, but the number is expected to grow as the mandatory implementation date approaches.

Adequate training is available through various professional bodies and educational institutions, aligning with the current training demand, which is anticipated to increase significantly post-2025.

<u>Future trends</u>

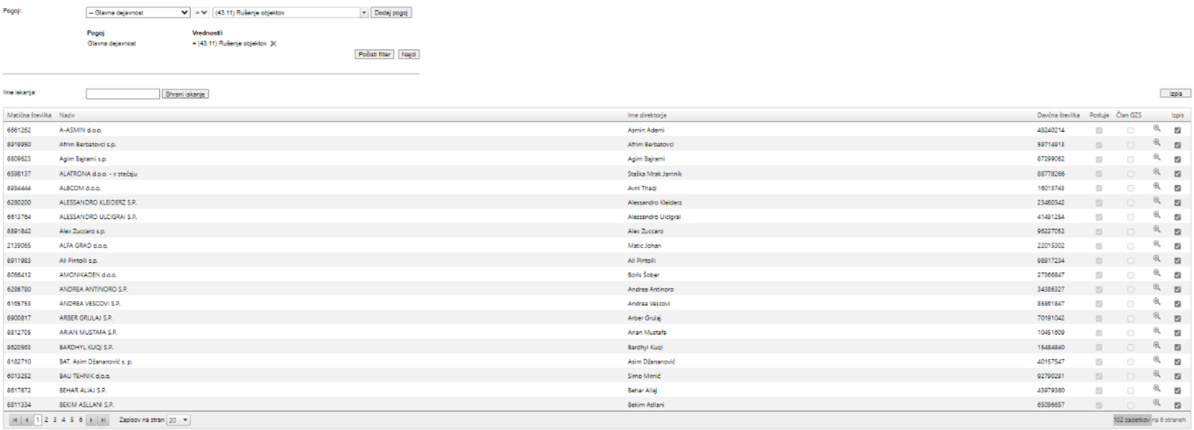
In the future, for which uses is BIM MOST likely to be used by

- project owners: maintenance and operations, asset management, communication flow related to rectifying defects in the building
- designers (architects, etc.): optimized design, clash detection, collaboration
- contractors (construction companies, etc.): optimized construction, clash detection, collaboration

BIM and deconstruction

There a no legal or regulatory obligations in Slovenia regarding end-of-life and deconstruction.

102 companies are registered under NACE 43.11-DECONSTRUCTION as main activity, we cannot extract the one who perform these activities as other business activity. See bellow info from national public business register.



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Pogoj: Glavna dejavnost — Vrednost/i: = (43.11) Rušenje objektov

Počisti filter | Najdi

Ime iskanja: Shrani iskanje

Izpis

Matična številka	Naziv	Ime direktorja	Davčna številka	Posluje	Član GZS		Izpis
6661262	A-ASMIN d.o.o.	Asmin Ademi	48240214	☑	☐		☑
8919950	Afrim Berbatovci s.p.	Afrim Berbatovci	59714913	☑	☐		☑
8809623	Agim Bajrami s.p.	Agim Bajrami	87299062	☑	☐		☑
6598137	ALATRONA d.o.o. - v stečaju	Staška Mrak Jamnik	88778266	☑	☐		☑
8934444	ALBCOM d.o.o.	Avni Thaqi	16013743	☑	☐		☑
6280200	ALESSANDRO KLEIDERZ S.P.	Alessandro Kleiderz	23460342	☑	☐		☑
6613764	ALESSANDRO ULCIGRAI S.P.	Alessandro Ulcigrai	41491254	☑	☐		☑
8891842	Alex Zuccaro s.p.	Alex Zuccaro	96227052	☑	☐		☑
2139065	ALFA GRAD d.o.o.	Matic Johan	22015302	☑	☐		☑
8911983	Ali Pintolli s.p.	Ali Pintolli	98917234	☑	☐		☑
8056412	AMONIKADEN d.o.o.	Boris Šober	27366847	☑	☐		☑
6286780	ANDREA ANTINORO S.P.	Andrea Antinoro	34386327	☑	☐		☑
6165753	ANDREA VESCOVI S.P.	Andrea Vescovi	85861847	☑	☐		☑
8900817	ARBER GRULAJ S.P.	Arber Grulaj	70191042	☑	☐		☑
8812705	ARIAN MUSTAFA S.P.	Arian Mustafa	10451609	☑	☐		☑
8620563	BARDHYL KUQI S.P.	Bardhyl Kuqi	15484840	☑	☐		☑
8182710	BAT, Asim Džananović s. p.	Asim Džananović	40157547	☑	☐		☑
6013252	BAU TEHNIK d.o.o.	Simo Mimić	92790291	☑	☐		☑
8617872	BEHAR ALIAJ S.P.	Behar Aliaj	43979360	☑	☐		☑
8811334	BEKIM ASLLANI S.P.	Bekim Asllani	65096657	☑	☐		☑

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Examples of good green practices regarding end-of-life and deconstruction in Slovenia:

Material Passport Implementation: One innovative practice could be the use of BIM to create and manage material passports. These passports provide detailed information about the materials used in a building, allowing for more effective recycling and reuse at the end of its life.

Lifecycle Assessment Integration: Integrating lifecycle assessments (LCA) within the BIM models to monitor environmental impacts throughout the building's lifecycle, including the deconstruction phase. This practice helps in making informed decisions on the most sustainable methods of demolition and waste management.

Modular Construction Techniques: Promoting modular construction facilitated by BIM allows components to be disassembled and reused or recycled, minimizing waste and environmental impact.

As of now, BIM's application in the end-of-life phase of buildings in Slovenia is limited. However, there is potential for growth as awareness and technological capabilities increase.

Potential Examples and Best Practices:

-Simulation of Deconstruction Processes: BIM can be used to simulate deconstruction processes to optimize the sequence of dismantling, reducing time and costs while maximizing safety and material recovery.

-Resource Recovery Strategy: Utilizing BIM to track and manage resources during deconstruction for better sorting, recycling, and reuse of materials, ensuring a circular economy approach within the construction sector.

-Integration with Waste Management Systems: By linking BIM models with waste management databases, companies can more effectively plan for the disposal or reuse of materials, reducing environmental impact and facilitating compliance with recycling regulations.

Theoretical perspective of BIM uses in end-of-life

PEDMEDE

Introduction to BIM and End-of-Life

Construction and deconstruction are different in terms of process and waste creation. The waste created from construction can be from the excavation for underground construction, road planning and maintenance materials, geotechnical engineering works and worksite waste materials. Additionally, waste can be created from all the materials from operations or worksite construction. The construction industry in the European Union, is responsible for 50% of raw material consumption, 42% of energy use, and 35% of greenhouse gas emissions to generate 10% of the Gross Domestic Product (GDP) per year. As a consequence, the construction industry consumes an excessive amount of resources, energy, and carbon dioxide when compared to other industrial sectors. Waste typologies vary from country to country.

Deconstruction waste is debris from structural and non-structural demolition of a building. The main feature of deconstruction is that there may be hazardous materials such as asbestos waste contained in the deconstruction process. The demolition of a building produces a large quantity of different types of solid waste. Deconstruction is a building end-of-life scenario that allows efficient recovery of building components.

End-of-life (EOL) refers to the final stage of a structure/product or material's phase of use. Buildings and structures are demolished at this phase that produces debris, thrown away along with many recoverable building elements, components, and materials for future use.

Building Information Modeling (BIM) is "a *digital representation of physical and functional characteristics of a facility"*. BIM is an emerging technology that is frequently used to optimize design, construction, and maintenance efficiency throughout their whole lifecycles. It is uncommon to use BIM for deconstruction or demolition; in particular, BIM models do not take building fixtures and fittings into account.

The application of Building Information Modeling (BIM), which has enabled broad project management capabilities throughout the whole life cycle, has drastically changed the building sector. BIM offers significant potential in various stages of a building's lifecycle, including its end-of-life phase. BIM offers remarkable cost and time reductions, potentially saving up to 20% in costs and 40% in time during the design and construction phases. BIM potentials for construction and demolition waste management listed a similar number of BIM uses for planning, design, construction, and operation phases, but also no "specific BIM uses that can be implemented in the demolition phase.

The increasing adoption of Building Information Modeling (BIM) has led to various innovations, particularly in building design, cost estimation, 3D coordination, facility maintenance, and building performance analysis. Furthermore, there has been notable progress in enhancing BIM's capabilities and integrating it with technologies like RFID, GIS, big data, Internet of Things (IoT), among others. However, despite the numerous benefits associated with BIM and its widespread adoption, there tends to be a lack of emphasis on its application in end-of-life scenarios. While most BIM implementations concentrate on stages from planning to maintenance, only limited attention has been given to leveraging BIM for end-of-life scenarios.

Most previous BIM-based deconstruction studies can be categorized under one of two approaches. The first approach focuses on BIM for waste management. The second approach focuses on BIM to assess deconstructability during the design. As part of sustainable buildings, BIM can help with the efficient planning of deconstruction and open the door for digital deconstruction. But this is an area that has been neglected. Most BIM implementations focus on the planning to the maintenance stages of the building and only few works have been done on BIM for end-of-life scenario. The EOL phase should be considered as part of the asset lifecycle and should be linked to the design phase.

Various dimensions linked to BIM; 3D represents the three geographical dimensions (x, y, z) of a building structure. The 4D BIM and 5D BIM, where the fourth dimension is linked with time, and the fifth dimension is linked with cost. The 6D BIM includes sustainability and energy analysis, enabling the evaluation of environmental performance. The 7D BIM integrates facility management information, such as operation and maintenance manuals (Figure 1).

Suggestions allocate the eighth dimension (8D) to the activities related to SEOL management. The 8D will refer to EOL management enabling to simulate several scenarios of EOL management. As the 3D associated with 4D allows simulating the constructability of buildings, the 8D could be linked to 4D to provide simulation of different scenarios of EOL.

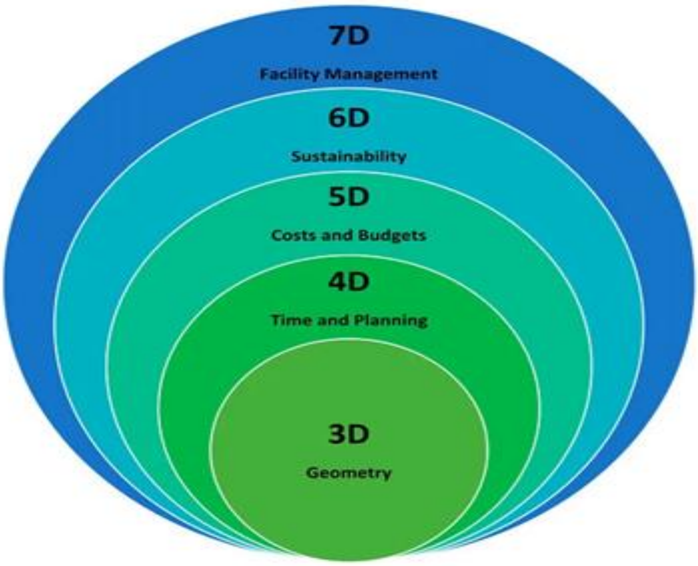


Figure 1: Dimensions of Building Information Modelling (BIM). Source: Han, D., Kalantari, M., & Rajabifard, A. (2021). Building Information Modeling (BIM) for Construction and Demolition Waste Management in Australia: A Research Agenda. Sustainability, 13(23), 12983. https://doi.org/10.3390/su132312983

BIM for deconstruction (BIMfD)

In recent years, Building Information Modeling (BIM) has been an emergent research topic recommended for construction and demolition waste (CDW) estimation and management. A key feature that makes BIM stand out is intelligent modeling which provides the ability to embed key assets and process information into building models right from the early planning stage and throughout the life of the building.

The construction sector must shift from demolition to deconstruction in order to reevaluate the asset lifecycle. The aim of building deconstruction is to eliminate demolition as an end-of-life (EoL) building disposal choice. Designers and EOL contractors would collaborate "hand in hand" to address waste using an effective deconstruction or disassembly at the asset's end of life. Focusing more to the end-of-life of building is significant on the grounds that demolition activities represents more than 50% of the total CDW output of the construction industry.

The construction sector in the European Union produces 820 million tonnes of construction and demolition waste (CDW) every year. More than one-third of all the waste generated in the European Union consists of concrete, bricks, ceramics, wood, and glass. Waste generation is associated with poor design decisions and end-of-life (EoL) performance considerations. Research shows that using BIM can reduce the cost of CDW management by up to 57%, compared with conventional CDW management methods. Buildings are not persistent and at their end-of-life, are demolished, most of the time. Although recycling practices started to be considered, a huge amount of waste generated is still simply landfilled, e.g. 0.68 billion tons in 2020 in the EU.

With the construction sector under pressure to reduce waste from construction and demolition, there is a growing interest in the shift from demolition to deconstruction procedures for end-of-life performances. Sustainable demolition is made possible by building information modeling (BIM). However, the concept of BIM for deconstruction (BIMfD) is still relatively new. To facilitate deconstruction, innovations in the construction sector including building information modeling, offsite construction, and the circular economy are receiving increased attention these days. Building Information Modeling (BIM) is a cooperative process supported by digital technologies that enable more effective ways to design, create, and maintain built assets and facilities.

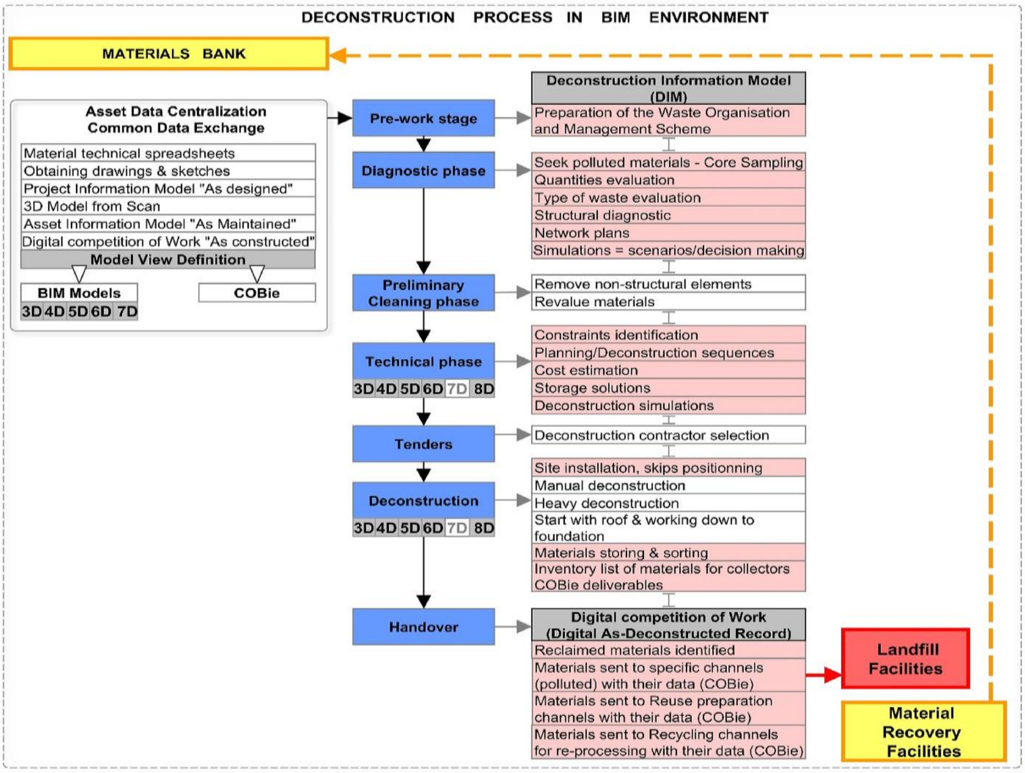
Effective demolition planning is pivotal in construction projects, as it dictates safety, costs, and environmental impact. Building Information Modeling (BIM) enhances the demolition process by providing accurate building information for method selection and stage development. By simulating sequences and processes beforehand, BIM facilitates informed decision-making, ensuring optimal utilization of resources and adherence to safety protocols. Moreover, BIM enables prioritization of tasks, such as the removal of hazardous materials, thereby mitigating risks associated with demolition activities. Additionally, BIM aids in distinguishing waste items suitable for reuse, recycling, or disposal, allowing for the development of waste management strategies. The benefits and costs of using different demolition methods can also be compared.

According to the research of Gen et. al (2017), the use of BIM provides accurate estimations of deconstruction materials and thus makes waste management plans more accurate and timely; the accurate identification and estimation of deconstruction material assists in formulating tailor-made demolition and waste management strategies. This improves rates of reuse and recycles and saves costs of deconstruction and logistics and avoids mismanagement. Based on the estimation, the cost savings of $1,509,200 for landfill can be achieved from the implementation of recycling activities.

Another research has indicated that the implementation of BIM-based methods changed the organization of three deconstruction activities: analyzing existing conditions, labelling reusable elements and planning deconstruction. They identified inefficiencies and performance issues in each of these activities due to the use of traditional drawings, schedules and instructions before the use of BIM. The new BIM uses have several implications for end-of-life practices and

BIM facilitates deconstruction planning and execution and enables a culture for digital deconstruction as a part of a sustainable and circular Building Stock 4.0. In a building EoL scenario, deconstruction supports component reuse and material recycling through a systematic disassembly or dismantling of building structures.

Integrating building information modelling (BIM) in deconstruction is considered an effective pre-deconstruction audit to assess the recovery, re-use and recycling potential of building components and materials. Design for deconstruction (DfD) is another benefit of BIM by changing the design and offering the possibility of deconstruction instead of demolition—such as using joints instead of welding elements in steel structures. The adoption of BIM could significantly increase the performance of Design for Deconstruction (DfD) tools. A tight integration of BIM and DfD would therefore be an effort in the right direction since evidence suggests that planning for effective construction, operation and end-of-life management of buildings must start from the design stage.



Deconstruction process in BIM environment. **Source:** Charef, R. (2022). The use of Building Information Modelling in the circular economy context: Several models and a new dimension of BIM (8D). Cleaner Engineering and Technology, 7, 100414. https://doi.org/10.1016/j.clet.2022.100414

Demolition contractors can use BIM to organize their site activities. Additionally, this opens up opportunities for BIM software providers, training institutes, and experts in modeling to expand into this new area. This can gradually lead to more digital technology-oriented demolition contractor roles. Stringent legislation and policies, design process and competency for deconstruction, design for material recovery, design for material reuse and design for building flexibility are the generally acceptable success factors for approaching the EoL disposal of buildings in a sustainable way. BIM can help with the estimation of the EoL properties of materials while improving the disassembly process and sequence stimulation.

Case study of use BIM in deconstruction

BIM was successfully applied to waste management and recycling during the demolition of a 47-storey residential tower in Hong Kong. In this project, used cutting-edge BIM with the aim of maximizing the recycling and reuse of building materials. In order to precisely determine the amount of recyclable materials, they first performed a thorough BIM analysis of the entire structure. Afterward, they used Revit software to go deeper into the specifics of each component. The team's evaluation of the various material types allowed them to precisely estimate the quantity of transport vehicles needed, and they also gave the construction team specific ideas on how to ensure a smooth workflow. With the use of this technology, the contractor was able to reduce trash disposal expenses by over 70%. The procedure produced an astonishing 80% recycling and reuse rate for garbage. This example shows how BIM has a lot of possibilities when it comes to trash management and building demolition. Building destruction is no longer a mindless, aimless process thanks to the advent of BIM.

Sources:

- Akinade, O. O., Oyedele, L. O., Omoteso, K., Ajayi, S. O., Bilal, M., Owolabi, H. A., Henry Looney, J. (2017). BIM-based deconstruction tool: Towards essential functionalities. International Journal of Sustainable Built Environment, 6(1), 260–271. doi:10.1016/j.ijsbe.2017.01.002

- Charef, R. (2022). The use of Building Information Modelling in the circular economy context: Several models and a new dimension of BIM (8D). Cleaner Engineering and Technology, 7, 100414. https://doi.org/10.1016/j.clet.2022.100414

- Ge, X. J., Livesey, P., Wang, J., Huang, S., He, X., & Zhang, C. (2017). Deconstruction waste management through 3d reconstruction and Bim: a case study. Visualization in Engineering, 5(1). doi:10.1186/s40327-017-0050-5

- Han, D., Kalantari, M., & Rajabifard, A. (2021). Building Information Modeling (BIM) for Construction and Demolition Waste Management in Australia: A Research Agenda. Sustainability, 13(23), 12983. https://doi.org/10.3390/su132312983

- Nikmehr, B.;Hosseini, M.R.;Wang, J.; Chileshe, N.; Rameezdeen, R. BIM-Based Tools for Managing Construction andDemolition Waste (CDW): A Scoping Review. Sustainability 2021, 13, 8427. https://doi.org/10.3390/su13158427

- Marc van den Berg, Hans Voordijk & Arjen Adriaanse (2021) BIM uses for deconstruction: an activity-theoretical perspective on reorganizing end of-life practices, Construction Management and Economics, 39:4, 323-339, DOI: 10.1080/01446193.2021.18768

- Obi, L.; Awuzie, B.; Obi, C.; Omotayo, T.S.; Oke, A.; Osobajo, O. BIM for Deconstruction: An Interpretive Structural Model of Factors Influencing Implementation. Buildings 2021, 11, 227.https://doi.org/10.3390/buildings11060227

- Nurul Ahsha Binti Haji Roslim et al 2024 IOP Conf. Ser.: Earth Environ. Sci. 1303012012

- Waqar, A.; Othman, I.; Hayat, S.; Radu, D.; Khan, M.B.; Galatanu, T.F.; Almujibah, H.R.; Hadzima-Nyarko, M.; Benjeddou, O.Building Information Modeling -Empowering Construction Projects with End-to-End Life Cycle Management. Buildings 2023, 13, 2041.https://doi.org/10.3390/buildings13082041

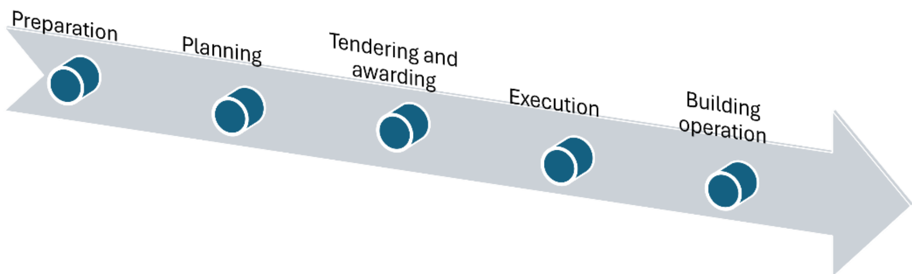
Benefits of BIM uses on deconstruction

BFW-NRW

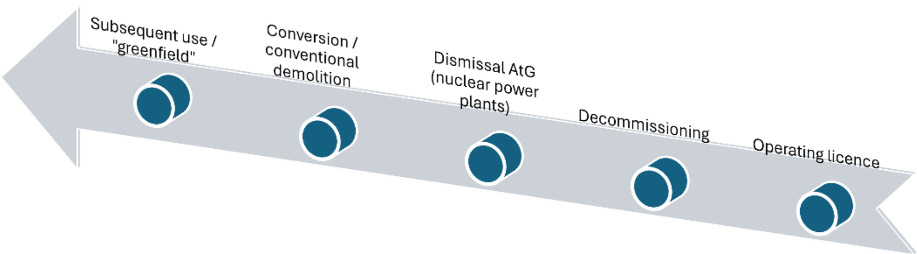
BIM in demolition has some very significant advantages in terms of the effectiveness of a demolition project.

The following graphic illustrates very well that, in theory, BIM utilization during the planning and construction of a building can be used in reverse chronological order for deconstruction. In this example, the focus is on the deconstruction of nuclear reactors and/or nuclear-operated or nuclear-contaminated facilities. However, the basic principles and opportunities also apply to all other building projects and construction programs.

Planning and execution



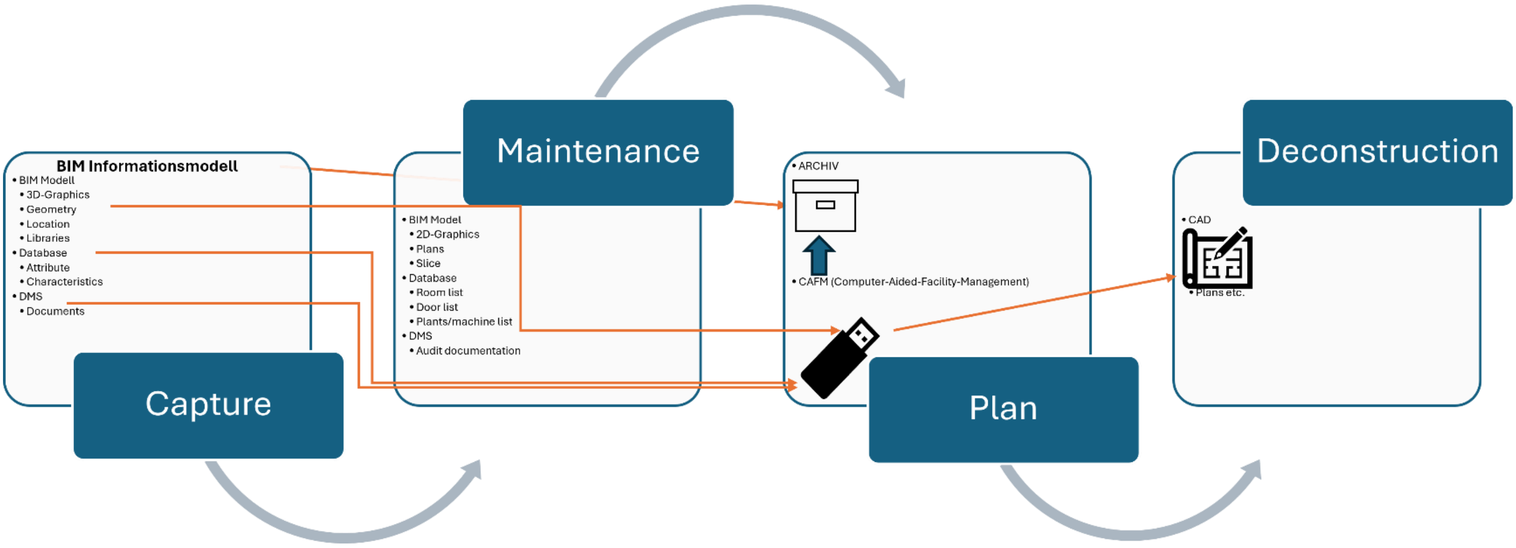
Deconstruction



The biggest hurdle here, as already mentioned at the beginning in the general description of the use of BIM in deconstruction, is the continuous maintenance of the structural changes to our building in the BIM model. Of course, the data has to be checked intensively here.

After a concrete comparison of data with the actual building fabric and a satisfactory match, it will be possible to realise a successful demolition using the BIM software. Otherwise, the additional cost of adapting the data set to the actual state must be factored in at this point during the planning phase.

Because only with a proper data basis can sources of error and problems be excluded as far as possible in the planning phase. One example is the auxiliary support of buildings during demolition in order to maintain their structural properties for as long as possible. To do this, all current loads and components or machines in the building must also be correctly recorded in the BIM model.



Deconstruction measures already completed with the use of BIM

Deconstruction of the large hot cells by JEN at the Jülich site

__JEN__ is responsible for the deconstruction *of the AVR high-temperature reactor, the chemical cells, the FRJ-2 research reactor (DIDO) and the large hot cells at the Jülich site.*

Jülicher Entsorgungsgesellschaft für Nuklearanlagen mbH began deconstruction the hot cells in 2010. Initially, a great deal of time was invested in preparing the deconstruction measures in accordance with the Radiation Protection Ordinance.

In 2023, the removal of the coating of radiological hotspots was completed and manual deconstruction was initiated and completed.

You can find a virtual tour here:

https://www.ewn-gmbh.de/VR/kte_001/?s=pano23

Phase of BIM utilization:

Preparatory measures:

- Creation of a hazardous substances register
- Upgrading the infrastructure to adapt to the deconstruction requirements

- deconstruction of remaining facilities
- Adaptation of fire protection and implementation of necessary structural support measures

Brief description of the process:

The deconstruction of the GHZ will take place in individual sections. These are shown in the schematically very simplified framework schedule. The **"preparatory measures" include** the determination of important basic data for the deconstruction planning, the verification of the spatial and technical conditions as well as the planning and realization of conversion measures. In this context, the radiological plant characterization, the conventional (building) pollutant determination and the inventory data collection are carried out. The planned conversion measures also primarily serve to adapt the spatial capacities, e.g. of the sanitary and recreation areas, to the increase in personnel resulting from the deconstruction.

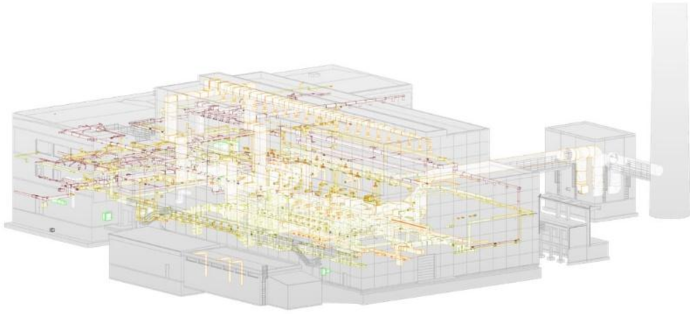
The "**as-built data acquisition**" in the GHZ is supported by "Building Information Modelling" software (BIM for short). To this end, laser scanning work was carried out inside and outside the GHZ between March and May 2020. The scan data of the entire building complex was merged and supplemented with photographic information. The point cloud model already allows virtual plant inspections and the measurement of visible surfaces.

The solid model is derived from the point cloud model. Modern CAD software recognizes geometries and replaces them with corresponding components from extensive component libraries. Despite the good preliminary work, there is still enough work to be done, including checking the components and modelling hidden (invisible) fixtures.

One of the challenges in the modelling process is the review of as-built documents from the 1960s. The drawings, some of which were created on parchment paper, are heavily yellowed and difficult to read.

Image of the GHZ (point cloud and volume model superimposed)

When the components are created, they are summarized into component groups according to requirements. This grouping enables, among other things, the visualization of individual components of the technical building equipment (TGA), in this specific case, the ventilation system.



Volume model TGA ventilation

After modelling, information such as the type of material, details of radiological contamination and building pollutants are assigned to the components. This is where planners derive the greatest benefit. On-site inspections can be significantly reduced and the search for documents is simplified.

Once the work has been completed, the deconstruction team will have a tool at their disposal that will make planning much easier and thus speed up the deconstruction process.

[Source: https://www.jen-juelich.de/startseite/bim-building-information-modeling-fuer-den-rueckbau-der-grossen-heissen-zellen]

Phase in which the information/plans resulting from BIM serves as support:

Deconstruction work:

- Removal of the boxes including transport channel, then shielding made of lead bricks deconstruction.
- Media and power supply as well as exhaust air connections were disconnected, then the glove boxes and isotope fume cupboards were deconstruction.
- deconstruction also takes place at the same time in the hot cells, where the remaining fixtures were removed and then the boxes and the transport channel were deconstruction.
- This was followed by the demolition of the existing barite concrete shielding

Other deconstruction projects (international)

A prominent example is the project to renovate and demolish the old Heathrow Terminal 2 in London, where BIM was used to better manage the complexity of the demolition and optimize the process. The use of BIM helped to create accurate as-built surveys and minimize risks from hidden structures and asbestos (Pinnacle Infotech) (Planning, uBuilding & Construction Today).

In Germany, the deconstruction project for the old Stuttgart Central Station also utilized BIM. Here, BIM was used to convert the historical building plans into digital models, which made the planning and execution of the demolition more efficient and safer. The accurate documentation and modelling of the building structures enabled more precise planning and reduced the risk of unforeseen problems during demolition (Pinnacle Infotech) (Planning, Building & Construction Today).

Other notable deconstruction projects utilizing BIM have taken place in the Asia-Pacific region, particularly in Japan and Singapore, where large-scale infrastructure projects have used BIM technology. These projects have benefited from the detailed modelling and improved communication capabilities that BIM offers, allowing deconstruction projects to be completed faster and more cost-effectively (Pinnacle Infotech) (BIMobject for manufacturers | BIMobject).

Summary of theory and practice

In recent years, BIM has become established not only in new construction, but also in the field of demolition. Deconstruction involves the controlled demolition or deconstruction of structures. The use of BIM in demolition offers numerous advantages that lead to more efficient, cost-effective, and environmentally friendly processing.

Advantages of using BIM in demolition

1. **Precise planning and documentation**
   - **As-built surveys**: BIM enables a detailed as-built survey of the building to be demolished. By using 3D laser scanning and photogrammetry, accurate digital models can be created that reflect the current condition of the building. [*All of these techniques were used in our practical example to create the BIM model or point cloud models*]
   - **Digital twins**: These digital models, also known as "digital twins", provide a precise basis for planning the demolition. All structural details and material information are recorded and can be called up at any time.
2. **Efficient project management**
   - **Time and cost control**: BIM-supported deconstruction projects benefit from better control over schedules and budgets. By simulating the entire demolition process, potential delays and additional costs can be recognized and avoided in advance.

- **Coordination**: All parties involved, from the client to the demolition company, can access a common information platform. This facilitates coordination and communication, reducing misunderstandings and errors.

3. **Security management**
   - **Hazard analysis:** By simulating the deconstruction process in BIM, potential hazards can be identified and safety measures planned in advance. This helps to reduce accidents at work.
   - **Training courses**: Virtual models make it possible to provide staff with targeted training and prepare them for specific challenges and risks.
4. **Sustainability and resource efficiency**
   - **Material reuse**: BIM models contain detailed information about the materials used in the building. This makes it easier to identify and sort materials that can be reused or recycled, thereby reducing waste and conserving resources.
   - **Environmental compatibility**: The ecological footprint of deconstruction can be minimized through precise planning and simulation. Transport routes and waste disposal strategies can be optimized to reduce emissions.
5. **Documentation and tracking**
   - **Transparency**: All steps of the deconstruction process are documented in detail. This data can be used for future projects to further optimize processes.
   - **Traceability**: Changes and decisions made during the course of the project are traceable at all times, which improves quality assurance and can serve as evidence in the event of any legal disputes.

Conclusion

The use of BIM in demolition offers numerous advantages, ranging from precise planning and efficient project management to increased safety, sustainability and resource efficiency. The integration of digital technologies not only makes the deconstruction process more economical, but also more environmentally friendly and safer. BIM therefore represents significant progress in the construction industry, which also has considerable potential in the field of demolition.

Current skills needs

IIPLE

Introduction

The construction industry often struggles with inefficiency and low productivity due to its fragmented nature and reluctance to adopt new technologies. However, the introduction of new technologies such as Building Information Modeling (BIM) aims to address these challenges by streamlining processes, enhancing skill development, and improving productivity.

BIM is a recent technological advancement in the construction industry that integrates processes throughout the project lifecycle. It facilitates collaboration, conflict detection, cost reduction and clear planning. However, the effective implementation of BIM is hampered by skills challenges within the industry.

Multiple research and analyzes have identified various skills required to work with BIM, including technical, managerial, interpersonal and administrative skills. Addressing skills issues is key to maximizing the benefits of BIM in the construction industry and improving overall productivity.

In construction, Building Information Modeling (BIM) technology involves using digital tools to create and manage detailed 3D models of buildings and structures. Unlike traditional 2D drawings, BIM provides richer data and information during the design, construction and operational phases of the project.

Overall, BIM is **a collaborative approach aimed at improving efficiency, communication and decision making throughout the construction lifecycle**.

During the design phase, architects and designers create 3D models that highlight the building's visual identity and integrate material and structural data. This dynamic model serves as the canvas on which future phases of the project are built. These models contain detailed information about every component of the project, from walls and windows to plumbing and electrical systems.

In addition to geometric design and 3D renderings, BIM software includes material specifications, cost estimates, planning data, performance attributes and more. This integrated data helps stakeholders make informed decisions by providing a comprehensive view of the financial health and viability of the project.

BIM promotes collaboration between all project stakeholders, including architects, engineers, contractors, subcontractors and owners. Everyone can work on the same shared model, reducing misunderstandings and conflicts.

Engineers, contractors and other subcontractors contribute their expertise, adapting the model to address various aspects such as structural integrity, HVAC systems and electrical layouts. This collaborative effort reduces the potential for conflict, saving time and resources otherwise spent resolving issues on site.

Additionally, BIM models offer realistic visualizations that help stakeholders better understand the design and intent of the project. This facilitates communication, particularly with non-technical stakeholders such as customers and end users, improving project planning and ensuring smoother and more efficient real-world construction phases.

BIM renderings also allow construction teams to start building with a high level of confidence. Every stakeholder, from architects to subcontractors, is equipped with a digital blueprint that guides their actions, minimizing errors and improving coordination. This synergy reduces delays, cost overruns and change orders.

After construction, the BIM model can continue to be used for facility management, allowing owners and operators to access valuable information about building systems, be proactive about maintenance schedules. Finally, the BIM system is able to guide the demolition process of the building work.

The **skills needed to use the BIM system at all stages of the process** include:

- **3D Modeling Skills**: ability to create and manage detailed three-dimensional models of structures and buildings using the various BIM software currently available on the market and often a combination of them.

- **Technical Skills**: in-depth knowledge of the BIM software used, including its advanced features for design, documentation, collaboration and analysis.
- **Data Analysis and Interpretation Skills**: ability to interpret and analyse data integrated into BIM models, including material requirements, cost estimates, planning data and facility performance.
- **Collaboration and Communication Skills**: ability to work in teams and collaborate with diverse stakeholders, including architects, engineers, contractors, subcontractors and owners. This also includes effective communication skills to ensure a clear understanding of project requirements and decisions made.
- **Project Management Skills**: ability to manage projects using the BIM system, including planning, resource allocation, progress monitoring and cost control.
- **Visualization and Presentation Skills**: ability to create realistic visualizations of BIM models to effectively communicate project design and intent to all stakeholders, including clients and non-technical end users.
- **Facility Management Skills**: ability to use the BIM model for post-construction facility management, including maintenance planning and operations optimization.
- **Decommissioning Skills**: ability to use the BIM system to guide the demolition process of structures efficiently and safely.

Combination of soft and hard skills

The current skills needed for Building Information Modelling (BIM) professionals encompass a combination of soft and hard skills. Soft skills include **leadership, communication, collaboration, problem-solving, decision-making, and experience**. These skills are essential for effective teamwork, project management, and problem resolution throughout the BIM implementation process.

Leadership skills are crucial for guiding teams towards common goals and managing conflicts effectively. Effective communication fosters smooth collaboration among team members and ensures project progress. Collaboration involves working together towards a shared objective, sharing knowledge, skills, and resources. Problem-solving skills enable BIM professionals to identify and address challenges encountered during construction projects. Decision-making skills are essential for selecting the best course of action based on criteria and alternatives. Experience enhances one's ability to perform tasks efficiently and effectively.

On the hard skills side, proficiency in BIM software is vital for construction planning, design, modeling, and maintenance. Software such as Revit, Tekla, and Navisworks are commonly used for creating accurate 3D models, structural designs, and project coordination. Technical skills, including planning, design, modeling, and maintenance, are essential for various stages of construction projects.

There are several **BIM tools** available for the construction market, each offering unique features and capabilities. Below are some of the current BIM software, most widespread at European level:

Autodesk Revit: Revit is undoubtedly the most popular BIM tool. Known for its comprehensive suite of architecture, structure, and design features, Revit enables collaborative modeling and data sharing across disciplines.

Graphisoft ArchiCAD: ArchiCAD is known for its user-friendly interface and strong 3D modeling capabilities. It offers tools for architectural design, documentation, and collaboration, making it a favorite among architects.

Trimble SketchUp: While not traditionally considered full-fledged BIM software, SketchUp offers a robust platform for 3D modeling and visualization. Their product aims to help contractors reduce rework, prevent revisions, and detect conflicts.

Plannerly: Helping streamline workflows, Plannerly helps create visuals of a project and its scope. This includes compliance, modeling and document organization.

Trimble Tekla: Working to help construction projects reduce waste, Tekla helps with design, detailing and construction. Tekla emphasizes the importance of helping contractors find data and create detailed workflows to optimize their projects.

Each BIM software has specific skills required to use it effectively. Below are some of the skills necessary for the BIM software mentioned:

Autodesk Revit:

- In-depth knowledge of architectural, structural and MEP (mechanical, electrical, plumbing) modeling.

- Ability to create and modify families and parametric components.
- Proficiency in using visualization and rendering tools to create realistic representations of models.
- Knowledge of model coordination processes, including collision detection and conflict resolution.
- Skill in data management and implementation of project standards and collaborative workflows.

Graphisoft ArchiCAD:

- Familiar with 3D modeling tools and creating detailed construction plans.
- Ability to use documentation features to create technical drawings and construction plans.
- Knowledge of the ArchiCAD user interface and its customizable settings.
- Proficiency in organizing and managing projects within the ArchiCAD environment.
- Collaboration and communication skills with other team members using ArchiCAD's data sharing capabilities.

Trimble SketchUp:

- In-depth knowledge of SketchUp 3D modeling tools and its extensions.
- Ability to create accurate and detailed models of buildings and structures.
- Proficiency in using rendering and visualization tools to create realistic images of models.
- Familiar with integrating SketchUp with other BIM and project management software.
- Ability to resolve conflicts and detect collisions using plugins and extensions available for SketchUp.

Plannerly:

- Understanding planning and project management processes in the construction industry.
- Ability to use Plannerly's modeling and visualization features to create visual representations of projects.

- Knowledge of regulations and compliance standards in the construction industry and their implementation in Plannerly.
- Ability to organize and manage documents and resources within the Plannerly environment.
- Proficiency in using Plannerly's collaborative features to communicate and work with other team members.

Trimble Tekla:

- In-depth knowledge of Tekla modeling and detailing tools for structural design and creating detailed drawings.
- Ability to use Tekla planning and project management features to optimize workflows and reduce waste.
- Expertise in structural analysis and using data generated by Tekla models to make informed project decisions.
- Ability to collaborate with other team members using Tekla's data sharing and collaboration features.
- Knowledge of industry best practices and compliance regulations in the construction industry and ability to implement them effectively using Tekla.

Preparation Across Architectural, Structural, and Plant Engineering Disciplines

It should be underlined that BIM optimization can only be possible with in-depth preparation of each individual discipline, i.e. architectural, structural and plant engineering. This knowledge lays the foundations for multidisciplinary and interoperable modeling with which all the protagonists of the building process will come into play. However, knowledge of 3D modeling alone cannot be considered the only training necessary for the BIM process as the entire model management system comes into play: Regulations and Management, for example, are necessary and indispensable knowledge.

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entire model management system comes into play: Regulations and Management, for example, are necessary and indispensable knowledge.

Adequate skills are required for all professional figures within the BIM process: BIM Manager, BIM Coordinator, BIM Specialist and CDE Manager.

BIM Manager and BIM Coordinator

The essential training path for the managerial figures of BIM Manager and BIM Coordinator is the BIM Management course, where professionals have the opportunity to train on all management and process aspects in compliance with current legislation UNI 11337. Within the course the rules and procedures for information management, the logical and functional structure of the collaboration environments and planning and scheduling of the delivery of information models will be defined. You will also have the opportunity to draw up the Information Specifications and the Offer and Information Management Plan, essential documents for the BIM contract. These notions will be administered as BIM managerial figures must deal with all possible fields of application of the model and exercise supervision in each contractual area, designating responsibilities between the disciplines.

BIM Specialist

The preparation and skills of the BIM Specialist are essential to achieve a multidisciplinary and efficient BIM model. The knowledge of this figure moves across the various modeling disciplines, supporting the BIM Coordinator. To make all this happen, One Team has structured various training courses where it is possible to assimilate the knowledge necessary to operate fully in the various disciplines and to support, if required, the national certification as a BIM Specialist.

Among the various training courses starting are those of basic Architectural Revit and basic Revit MEP. Within these courses, participants will have the opportunity to deepen their knowledge of the BIM world in the two disciplines, moving from the creation of stairs and fixtures to electrical and mechanical systems. Knowledge of these tools allows the designer to boast better control of the project, both from a spatial and functional point of view and from the point of view of costs and times: superior control over the project implies a greater possibility of realizing it.

CDE Manager

Interoperability is fundamental within BIM processes and in this sense a new professional figure, called CDE Manager, who takes care of the data sharing environment and network or cloud IT solutions, comes to the rescue. It is precisely from these needs that the CDE Manager course was born, a training course where you will learn the ability to guarantee the correctness and timeliness of information flows. Furthermore, participants will be able to identify and apply the best information and intellectual property protection techniques.

TRANSVERSAL BIM KNOWLEDGE

Ability to use current digital instruments for the survey of the existing on site, (3D scanner, laser, photogrammetry for the digital survey and recovery of the existing (the so-called SCAN to BIM); the possible connections between BIM and georeferencing techniques for architectural and urban scale (Q-GIS software and configurational analysis methods) for the production of construction components using three-dimensional printers and digital fabrication;

BIM FOR CULTURAL AND MONUMENTAL HERITAGE

skills to operate in the field known as HBIM: Heritage BIM, with the use of specific software for on-site recovery with relevant digital instruments.

BIM FOR STRUCTURES

skills for using software used in the structural field (such as Tekla). The relationship between structural geometry and calculation is also explored in depth.

BIM FOR TRANSPORT INFRASTRUCTURES

skills to apply the BIM method for road and transport infrastructures (such as Civil 3D and Infraworks).

BIM FOR THE CONSTRUCTION SITE

skills for those who deal with construction sites, skills relating to methods dedicated to the relationship between design and construction on site. Specific software for construction (such as Synchro) and in-depth monitoring and control techniques.

WORK PLANNING AND ACCOUNTING (4D AND 5D)

skills on tools and methods aimed at calculating the works and verifying the construction phases, coordination and simulation of construction with the help of Synchro, Navisworks.

ASSET MANAGEMENT AND MAINTENANCE (6D AND 7D)

Knowledge on intelligent buildings and cognitive buildings based on the reduction of the energy, environmental and economic costs of buildings, which are more influential in the life cycle of the building than in its construction phase, is increasingly required. To this end, it is important to have skills that allow you to create models or informative digital twins, capable of interfacing with the most widespread management and home automation tools. Knowledge and skills relating to home automation tools and technologies are needed for the energy and environmental management of works throughout their entire life cycle.

GENERATIVE DESIGN

skills for generating scripts for parametric design. This approach allows you to understand the connection between programming and design procedures as well as teaching relevant software (such as Dynamo).

BIM FOR SYSTEMS (MEP)

specific skills for "plants". The relationship between geometric modeling and state-of-the-art sizing calculation possibilities is explored in depth (BIM software considered specific for the sector such as MagiCad).

BIM to MEP and BIM to BEM (Building Energy Modeling)

Knowledge and skills relating to tools for the design of MEP systems in the Revit and DDS Cad environment, as well as the Building Performance Analysis for energy and environmental design LCA (lyfe Cycle Assessment). Skills on the interfaces between the architectural model, the system model and the one aimed at static and dynamic energy analyses.

Challenges

SCVAP

The use of Building Information Modeling (BIM) in construction, both in Italy and globally, offers numerous advantages, but unfortunately is associated with different challenges. The main ones are:

Cultural change of mind/habits: the adoption of BIM requires a cultural change in the construction industry, since new way to collaborate and work between the different actors involved in the project are needed. This meet resistance by those who are used to more traditional practices.

Adoption: the actors involved in the construction industry, as, architects, engineers, manufacturers and buildings owners, to adopt BIM must face important investments in terms of training and not only for training.

Costs: the adoption and the implementation of BIM needs significant initial investments in software, hardware as well as staff training. These costs could be particularly relevant for small and medium - sized businesses in the construction sector.

Standardization: it is necessary to standardize BIM protocols to ensure interoperability between different software and the systems used by the various actors involved in the building project.

Interoperability: interoperability between the different BIM software used by the various professionals may be a challenge. It is important to ensure that BIM models are compatible and that the information can be exchanged without any data loss.

Rules and regulations: in Italy, as in other countries, there are some challenges related to the adaptation of the rules and regulations existing to integrate BIM in the building processes. This lead to the needs to update rules and regulatory to clear the responsibilities other than the standards to be followed.

Data management: BIM generates a large amount of data, and effectively managing these data along the entire life cycle of the project could be a challenge. It is important to have adequate systems and processes for the management, organization and sharing of BIM data, but also skilled workers able to do it.

Relating policies

CCIS

The European Commission has adopted several initiatives and legislative frameworks that align with the development of green and digital skills, particularly in areas like Building Information Modeling (BIM) at the end-of-life phase of buildings. These initiatives are part of broader strategies aimed at fostering a circular and sustainable economy while integrating digital transformation. These initiatives demonstrate the EU's commitment to integrating digital solutions like BIM into broader environmental and sustainability goals. The focus on creating a framework that supports the lifecycle management of products aligns well with the use of BIM in managing building deconstruction and material reuse, thus fostering both green and digital skills in the construction industry.

Circular Economy Action Plan: This plan emphasizes the transition to a circular economy, encouraging sustainable product design, reuse, and recycling practices. It integrates digital tools like BIM to enhance product lifecycle management and promote sustainable practices across various industries, including construction (https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en) .

Ecodesign for Sustainable Products Regulation (ESPR): The ESPR proposal, under the umbrella of the European Green Deal, aims to make products placed on the EU market more sustainable. It sets specific requirements for product durability, reparability, and recyclability, aspects directly relevant to BIM's role in managing the lifecycle of building materials and components (https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en).

Digital Product Passport: Part of the ESPR, the Digital Product Passport is intended to provide detailed information about the sustainability attributes of products, such as durability and reparability, which are crucial for end-of-life management. This initiative can be instrumental for integrating BIM at the end-of-life phase, as it will allow stakeholders to access essential data needed for effective deconstruction or recycling (https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en).

There is also one EC publications: *Techno-economic and environmental assessment of construction and demolition waste management in the European Union* (https://circulareconomy.europa.eu/platform/sites/default/files/2024-01/JRC135470_01_1.pdf) which will be further discussed on EC autumn workshop ON 26.9.2024 for invited experts only.

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BIM uses in EOL in relation to sustainable waste

Centre IFAPME LHV

Source
The texts are mainly taken from the presentation given by Sophie Trachte, professor at the University of Liège, at the « ***Vers un « zéro déchet / zéro émission » en construction*** *» ("Towards zero waste/zero emissions in construction") meeting held in Namur on October 3 and 4, 2023, which brought together construction professionals, training organizations and the Walloon Public Service.*

Construction and demolition waste generated in Wallonia represents around 7 million tonnes/year, or around a quarter of the total waste generated in Wallonia.

Worldwide, the construction sector is a major consumer of resources and produces almost 50% of all waste generated worldwide.

Belgium is no exception. According to national statistics, in 2014 Belgium produced over 26 million tonnes of construction and demolition waste, a pile almost twice as high as the Great Pyramid of Giza.

In Europe, construction waste production corresponds to 1,725 kg per inhabitant per year, or 37.5% of total waste....

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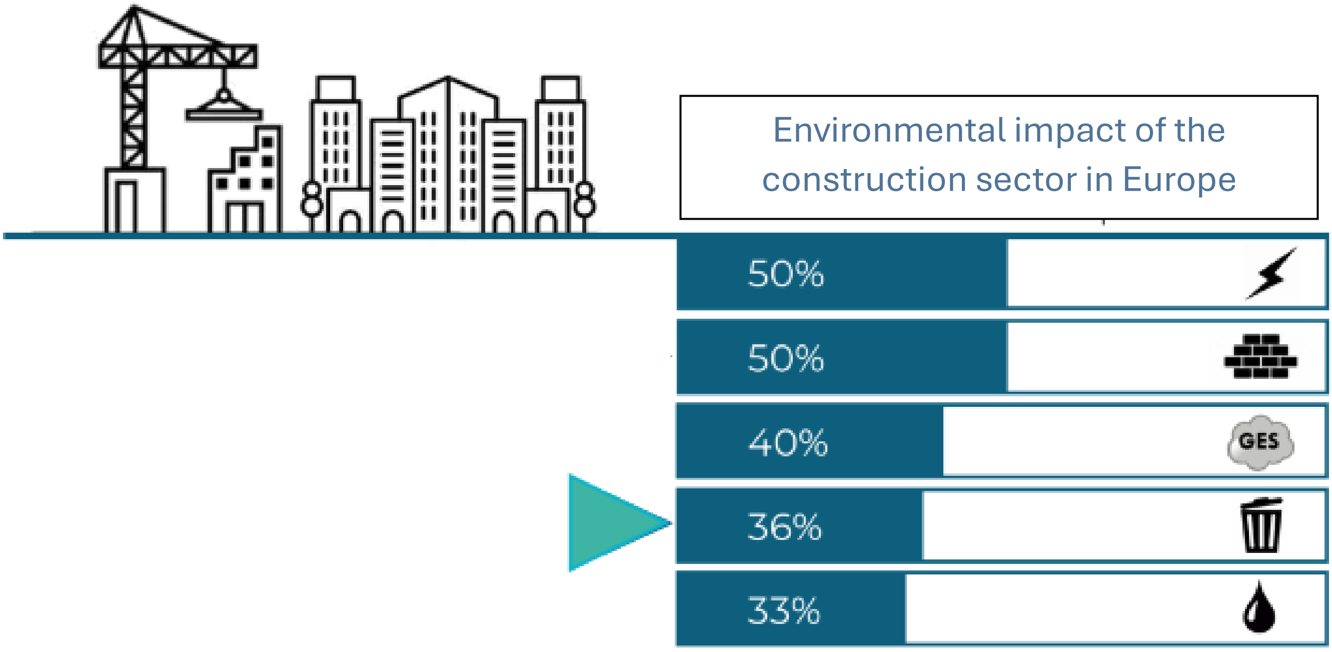

Circular economy is an opportunity to curb and limit this trend towards over-consumption. As shown on the Lansink scale, the prevention and reuse of materials should be given priority.

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Thoughtful renovation thus becomes an important lever for limiting our waste.

It involves 3 complementary axes:

1. Considering buildings as a resource of materials for other buildings: **Urban mining**
2. Creating added value by local businesses for local use: **Business models**
3. Building with end-of-life in mind from the design stage: **Concevoir et construire**

The objective of renovating is to retain as many materials as possible while revalorizing waste to keep it within the construction circuit. Therefore, the term "demolition" should be replaced with "**deconstruction**," and "waste" should be replaced with "**resources to manage**."

Managing waste on construction sites requires:

- Time (estimation, planning, on-site sorting),
- Space (storage area),

- Trained and aware workforce,
- And tools (awareness, quantification, planning, monitoring, etc.)

It involves the commitment and involvement of all actors on the site, from the municipality to the worker, including the manufacturer, as well as a change in practices.

This implies the **emergence of new professions** to:

- Create an inventory of materials at the source of buildings to be renovated or deconstructed
- Acquire the right techniques for selective deconstruction
- Adequately valorize materials introduced into the sector
- Resell at an affordable price while offering maximum guarantees
- Design differently, whether
  - from the start of the project,
  - during implementation on site (promoting deconstruction, dismantling),
  - during the transformation of materials that need a second life.

Behind these new functions, the **necessity of training** becomes increasingly pressing.

Renovating while managing waste (sorting, storing, evacuation to appropriate channels) means the involvement of all actors and a change in practices.

The policymaker/legislator

- Encourage inventories (waste and reusable materials) and management plans before the start of the project
- Encourage the reuse of a mandatory percentage of materials on each site
- Equip the sector, especially companies, for better waste management on site
- Encourage the return of waste (scraps and demolition) by producers

The project owner

- Strengthen requirements for inventories, management plans, and deconstruction in the specifications, identifying them as key indicators for winning contracts
- Encourage "clean site" charters

- Strengthen requirements for "in situ" reuse whenever possible
- Invest more in waste monitoring and management

The architect and/or consultancy firm

- Change their perspective on waste
- Strengthen waste management and reuse requirements in specifications

The contractor

- Raise awareness and train site personnel
- Share knowledge and interact/collaborate with the architect, subcontractors, manufacturers
- Use new management/logistics/communication tools
- Change site practices

The material manufacturer

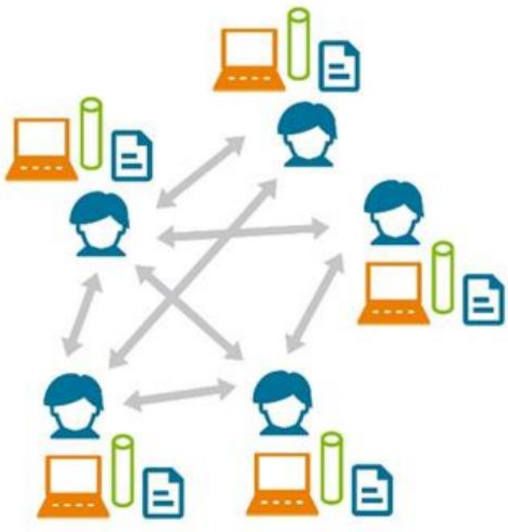
- Offer collection and waste take-back channels
- Develop recycling and/or remanufacturing channels
- Develop "material passports"

One essential point to emphasize is the need to **change information management practices**, which concerns all actors in construction. The more information about the building and its components is known and clearly presented in the project's basic documents (specifications, measurements, plans), the easier it will be to implement the new stages of building transformation to make the best use of it with minimal waste.

The **traditional approach** of allowing each party to handle information as they see fit must evolve into a more collaborative approach, BIM.

The **BIM approach** allows for wider sharing of information among all stakeholders on a site, thereby improving the benefits each can derive from it. The digital path proves to be the most effective in this context.

The traditional approach



The same information is reproduced multiple times in a disorderly fashion

The BIM approach

Information is digitized and shared efficiently and without duplication between stakeholders

Renovation must avoid producing waste **on the worksite and in the future**.

Renovation work will require new materials whose selection must limit the overall **environmental** impact of the operation:

- **Implementation must limit waste production.**
- During transformation, **disassembly must be easy and allow for reuse**.

To facilitate future disassembly and the reuse of so-called "new" components, it is necessary to **ensure the tracking of information related to the building and its components throughout their life cycle**.

A balanced choice must be made between technical performance and environmental performance.

1. Rationalize the use of materials
2. Choose materials that are:
    - Long-lasting

- Robust, able to withstand assembly/disassembly phases
- High in recycled content
- Using local and renewable resources
- Highly recyclable
- Actually reused and recycled (local channels)
- Simple et non composite
- Minimally processed and with few or no additives
- Low in environmental impact

3. When possible, work on standardization and prefabrication
    - Standardized and prefabricated elements help avoid cutting and waste on site
4. Consider embodied energy and potential emissions (LCA)
    - Favor materials that are low in energy consumption and pollutants

Today, renovating involves making material choices that are no longer solely focused on their direct use on site but are thoughtfully considered with a long-term vision, already thinking about their reuse even before they are implemented.

Definition of reuse given by the Waste Framework Directive (2008/98/EC):

Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.

It is important to work on technical reversibility during implementation to promote the "undamaged" recovery of elements and components. This is referred to as **technical reversibility**. Two aspects are mainly analyzed :

- Connection geometry: favor open, linear, or overlapping geometries,
- Choice of assemblies: favor dry, independent assemblies, with or without connectors.

To ensure information tracking, the idea of a **material passport** is proposed. Material passports aim to provide, throughout the life cycle of a product or material, all the necessary information to various stakeholders, to support reuse, repurposing, and valorization, as well as maintenance, repairability, and remanufacturing.

In the long term, the "material passport" is the guarantee of a coherent, robust, and efficient circular economy in the construction sector, where all phases of the life cycle, from design to reuse or recycling, are perfectly coordinated and interconnected. This requires total transparency on the materials and components used, their value, and their properties. It is the foundation of a new shared economy, new business models, and a high-quality built environment.

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Conclusion

BIM for deconstruction represents a significant step towards sustainable construction practices in Europe. By leveraging BIM for deconstruction, the construction industry can enhance resource efficiency, reduce environmental impact, and support the transition to a circular economy. While challenges remain, the regulatory support, industry initiatives, and technological advancements driving BIM for deconstruction adoption are paving the way for a more sustainable future in the European construction sector. As Europe continues to prioritize sustainability, BIM for deconstruction will undoubtedly play a critical role in shaping the built environment for generations to come.