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Especial 2024

Journal of the Ministry of Transport and Sustainable Mobility



GOBIERNO
DE ESPAÑA

MINISTERIO
DE TRANSPORTES
Y MOVILIDAD SOSTENIBLE



It is a pleasure to present this special issue on the importance of BIM in the Spanish government's political and economic agenda for digitalization and sustainability. It is for me a great opportunity to showcase the Ministry of Transport and Sustainable Mobility's commitment to using and promoting BIM in Public Procurement, and contributing to the European Commission green and digital agenda.

Today's transport infrastructure are complex assets built through a series of design, construction and maintenance processes that endeavour to meet the travel needs of citizens and endure over time.

Under the current political agenda for transport and mobility, we are conducting a paradigm shift where infrastructure not only address their primary purpose of ensuring accessibility to fundamental rights and mobility, but also pursue new strategic goals related to sustainability, financial efficiency and energy savings. With the use of BIM and other digitalization initiatives, we are also preparing the infrastructure for the implementation of other technologies, such as Artificial Intelligence, the Internet of Things and Virtual Reality, shifting from traditional improvement strategies to innovation strategies in the transport sector.

The Ministry of Transport and Sustainable Mobility and dependent public sector (Transport Group) is leader for BIM implementation in the public sector: in 2023, the Transport Group invested more than € 1,900 million in contracts using BIM requirements, which amounted to 86 % of the total estimated value of public contracts using BIM at national level.

This experience was a key factor for the Ministry of Transport and Sustainable Mobility's advocacy in 2023 for the approval by the National Government of the BIM Plan in Public Procurement for the entire National Public Administration and its public sector, with a mandate for the gradual BIM implementation in public contracts between 2024 and 2030.

With BIM, we can build better together to integrate innovation and sustainability in mobility, transport, and transport infrastructure for the benefit of citizens.

Óscar Puente
Minister of Transport and Sustainable Mobility

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Photography: Viceministry of
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Cabinet of the Viceministry; DGC;
IGN; State Ports Authority; Aena; Adif;
CEDEX; General Directorate of State
Assets; Chief Clerk's Office; Ministry
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Design and layout:
Publications Centre.

Address: Nuevos Ministerios. Paseo
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Access to the digital publication and
purchase of the magazine in print at
Publications Centre - TRAMOS
Magazine (mitma.gob.es)

And to the magazine's history at
[https://www.mitma.es/el-ministerio/
informacion-para-el-ciudadano/
revista/listado-de-revistas](https://www.mitma.es/el-ministerio/informacion-para-el-ciudadano/revista/listado-de-revistas)

Legal Dep: M-666-1958.

ISSN: 2792-4564.

ISSNe: 2792-4572.

NIPO: 196-24-091-9 &

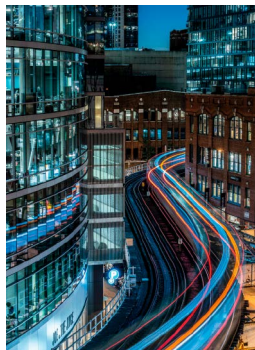
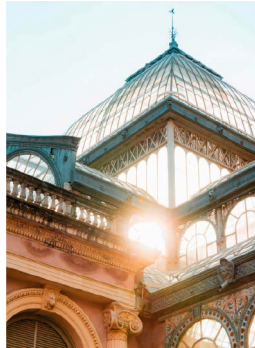
NIPOe: 196-24-092-4

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opinions expressed in the signed
contributions.

This magazine is printed on FSC
paper or equivalent

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especial 2024

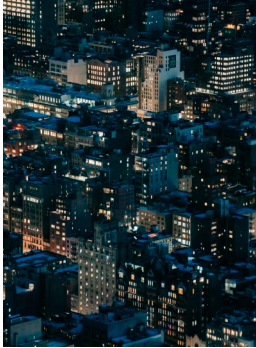


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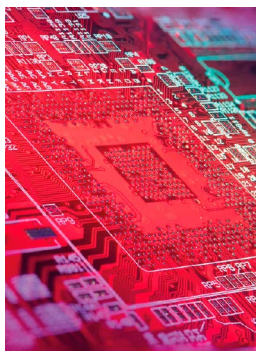
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#BIM in the economic, digital and sustainable policy agenda

BIM plays a key role to achieve the objectives of the different public strategies for digitalization, sustainability, and circular economy adopted in recent years at national, EU and international levels.

This section describes how the BIM Plan in Public Procurement adopted in Spain is articulated to achieve greater efficiency in public spending and digitalization and sustainability in the construction sector. The BIM Plan contains a mandate for the National Public Administration to gradually and progressively implement BIM within public procurement. The Plan is aligned with EU policies that consider BIM as a driver for a more resilient and competitive construction, moving towards a green and digital transition of the built environment.

Additionally, this section presents a view on the European Commission's work to improve quality of buildings and infrastructures in public works.

Finally, the section will showcase data from the Spanish BIM Public Procurement Observatory (BIM PP Observatory), arising from the quantitative and qualitative analysis of the increasing use of BIM in public procurement since 2017. These data will support the continuous improvement of the BIM Plan by the CIBIM.

A project to enhance public spending efficiency and transition to a digital and sustainable construction industry in Spain

Implementing BIM in Public Procurement

The Spanish BIM Plan in Public Procurement reflects the commitment of the government and, in particular, the Ministry of Transport and Sustainable Mobility, to ensure the digitization and sustainability of the construction sector. The BIM Plan also includes enabling and facilitating measures to contribute to a progressive and phased transition towards the use of BIM in public procurement that leaves no one behind and provides benefits not only for the government but for the whole sector.

- **Text:** Cabinet of the Viceminister of Transport and Sustainable Mobility. Secretariat of the Interministerial BIM Commission



BIM: digitalization of the construction industry and public spending efficiency

In 2018, the Spanish Government created the Interministerial BIM Commission (CIBIM) to develop a Plan to incorporate BIM in public procurement. The Ministry of Transport and Sustainable Mobility –through its Viceministry– has been responsible for its drafting and for preparing the public and private entities for a vital transformation that has fundamental implications for the construction sector. At present, the construction sector is a sector with high level of public investment and characterized by small and medium-sized enterprises with high technical capacity and low levels of digitization.

BIM provides a single source for storage and management of information about physical assets such as buildings and infrastructure to facilitate the design, construction, preventive maintenance, renovation planning and management of assets throughout their life cycle.

The use of BIM is one of the fundamental pillars of the digitalization of the construction sector, contributing to an increase on safety, sustainability and resilience of the industry and to strengthen and improve competitiveness both in the national context and international markets. Several reports have predicted that adopting BIM will generate savings of between 10 and 20%, mainly in the operation and maintenance phase. In addition, BIM can contribute to sustainability in the sector through an estimated 15% reduction in

Spain's BIM Plan is aligned with the EU Industrial Strategy, specifically the Transition Pathway for Construction, which focuses on ensuring a rapid green and digital transition for the construction industry.

waste volume and 57% reduction in waste management costs.

Using BIM in the Public Administration can benefit decision-making on assets by having more digitalized, centralised and accessible information.

BIM enables greater use of digital information with a more collaborative management throughout the whole infrastructure and buildings life cycle. The collaborative management of information gains efficiency of public spending and will help performing tasks such as auditing and regulatory compliance verification with greater agility.

Strategic use of the public procurement

As the Spanish National Public Procurement Strategy (ENCP) adopted in December 2022 points out public procurement is increasingly emerging as a key tool for public policy. The ENCP is fully in line with, among others, the Council of the European Union (2020/C412 I/01) and urges public buyers to use their purchasing power strategically to obtain better value for money and to support the transition to a greener, more innovative and circular economy, in particular by investing in sustainable infrastructure and in reusable,

recyclable, repairable and resource-efficient products, and by renovating public buildings to improve their sustainability and optimise life cycle costs.

According to the 2024 Annual Monitoring Report from the Independent Office for the Regulation and Supervision of Procurement (OIReScon), in 2023, public procurement spending accounted for 11.55% of gross domestic product (GDP) and 24.87% of total public spending. Consequently, the strategic use of procurement is an essential tool of economic policy and the political agenda of digitalization and sustainability of our country.

Public Authorities are the major promoters of the construction sector by concentrating large investments in the sector. Moreover, as asset managers, Public Authorities have significant influence to drive the digital transformation of the sector by implementing BIM in public procurement.

The Spanish approach to adopting BIM is not an isolated initiative. It is aligned with the EU's updated Industrial Strategy (Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe's Recovery), which focuses on ensuring a rapid green and digital

transition of EU industry and its ecosystems, and with the European Commission's Construction Transition Pathway, which outlines the conditions and actions needed to achieve a resilient, competitive, greener and more digital construction ecosystem, and proposes actions to support the transition to safer buildings and affordable housing for all Europeans.

EU law had already specifically recognised the role of BIM in the EU Public Procurement Directive. EU law has been encouraging to use BIM since 2014, and the European Commission considers public procurement as a key facilitator for the digitalization of the construction sector, referring to BIM in public procurement in different documents.

To conclude, the use of BIM can contribute to the objectives of several strategic instruments on the ecological and digital transition at a national level,



Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery.



Transition Pathway for Construction.

In 2023, the Ministry of Transport and Sustainable Mobility and its public institutional sector invested € 1,972 million in projects using BIM, which represented 86 % of BIM public procurement in the National Public Administration and public sector entities.

such as the 2025 Digital Agenda (2020), the Plan for the Digitalization of Public Administrations, the Circular Economy Strategy (2020), the Plan for Green Public Procurement (2019), the National Reform Programme within the Spanish Urban Agenda and, specifically within the scope of the Ministry of Transport and Sustainable Mobility in the 2030 Safe, Sustainable and Connected Mobility Strategy.

BIM may involve 25% of public procurement at National level.

Analysing the volume of public procurement at national level in 2023, (comprising the National Public Administration and the institutional public sector) this represents approximately € 50,000 million, of which it is estimated that 25 % could use BIM information requirements.

Based on this figure, the conclusion is that public procurement can significantly leverage the use of BIM within the private sector and that, considering the potential savings throughout the life cycle of an infrastructure, the use of BIM in public procurement will result in significant savings of public spending.

Tractor role of the Ministry of Transport and Sustainable Mobility in the use of BIM in public procurement

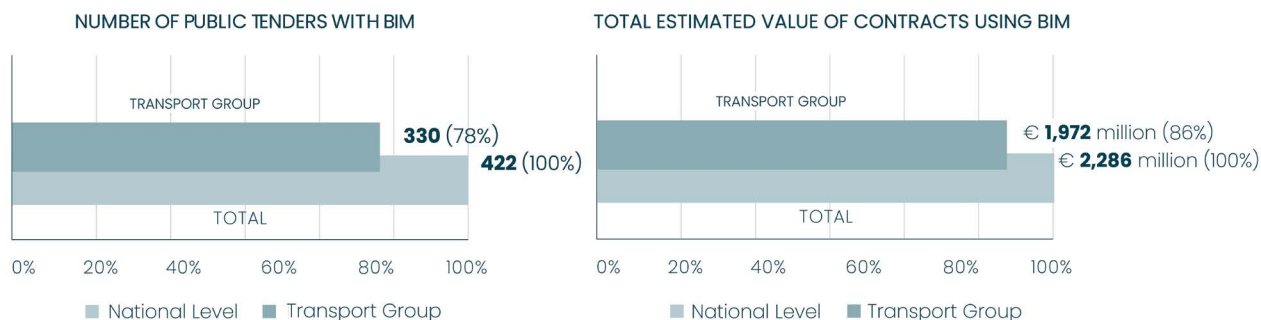
The leading role assigned to the Ministry of Transport and Sustainable Mobility in the Presidency of the Interministerial BIM Commission (CIBIM) and in the development and monitoring of the BIM Plan relates to the large share that BIM public procurement of this Ministry and its dependent public sector represent in the total BIM public procurement at National level.

Based on 2023 data, the total estimated value of contracts using BIM at the Ministry of Transport and Sustainable Mobility and its public institutional sector (€ 1,972 million) represent 86 % of the BIM public procurement at national level (National Public Administration and its public institutional sector), which reached € 2,286 million.

BIM Plan in Public Procurement

Since 2017, various analysis, studies, and stakeholder interactions have been developed, with the aim of getting a better understanding of the scenery of BIM in public procurement, as well

USE OF BIM IN 2023 AT NATIONAL LEVEL



Figures related to Estimated Contract Value
Source: BIM Public Procurement Observatory, Interministerial Commission for the Implementation of BIM in Public Procurement (CIBIM)

as the preparation of the market and the Public Administration. The initial analyses allowed the definition of the objectives and actions needed to design a Plan for the Incorporation of BIM in public procurement.

Analysis of the baseline scenario

Analysis of the starting situation took two components: on the one hand, the study of the behaviour of public procurement when integrating BIM and, on the other hand, the study of the situation of public entities and the private sector with regard to the knowledge and training on BIM of their employees.

In May 2017, the Ministry of Transport, Mobility and the Urban Agenda launched the BIM Public Procurement Observatory (BIM PP Observatory) with the aim of understanding the progress of the implementation of BIM in Spain. Since then, the BIM PP Observatory has periodically reviewed the publication of public procurement documents on the Spanish Platform for Public Procurement and on those of the Autono-

mous Regions. The Observatory identifies the integration of BIM requirements and carries out a quantitative and qualitative analysis of Spanish BIM public contracts, according to different classifications.

The Observatory's last few years reports can be accessed from the website of the Interministerial BIM Commission at the following link: <https://cibim.transportes.gob.es/observatorio/informes-trimestrales-del-observatorio>

Furthermore the global diagnosis of the situation was articulated through a series of complementary studies:

- The "Diagnosis Report on the Level of BIM Implementation at the National Public Administration and public sector entities" drawn up by the BIM Interministerial Commission in November 2021.
- The "Survey for BIM Training Planification" conducted by the Interministerial BIM Commission in October 2022 with support from the Technical Support Instrument of the European Commission. The

survey aimed at obtaining information from the National Public Administration and public sector entities units (Deputy Director General or equivalent), involved in asset management and public procurement related to assets with BIM potential use.

- The "BIM Methodology Questionnaire for SMEs" carried out by the Interministerial BIM Commission in October 2022, also with the support of the Technical Support Instrument of the European Commission. This survey was disseminated through the sector's leading associations and professional associations and aimed at identifying the advantages perceived by SMEs in the construction sector when using BIM, to analyse the current situation of the sector in relation to the use of BIM (experience and capabilities), to diagnose possible barriers and to consider measures to address the singularity of the different types of SMEs and thereby facilitate their par-

ticipation in public contracts using BIM.

- Based on these studies, a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the construction sector and its status quo with respect to BIM in the contracting authorities was carried out.

The conclusions of these studies were compiled in a SWOT-type scheme where the strengths, weaknesses, opportunities, and threats surrounding the project to implement BIM in state public procurement were identified. This initial diagnosis revealed, as a preliminary assessment, that although the level of prior knowledge and experience was initially modest, in the recent years, there was evidence of a significant commitment from contracting authorities, and expectation of widespread use. In addition, BIM in public procurement grew significantly between 2020 and 2023, highlighting the level of maturity of some of the public sector entities of the Ministry of Transport and Sustainable Mobility (Adif, Aena and the Spanish State-owned Port System). These experiences were comprehensively reviewed to define a roadmap for implementing BIM in an organisation that might be a useful example for other public stakeholders.

It was also concluded that resigning to promote BIM in public procurement could increase the risk of a fragmentary BIM implementation, rapidly becoming outdated, which would affect the sector as a whole and undoubtedly reduce the benefits to be gained from using BIM.

The above diagnosis was also accompanied by a specific analysis of the situation for SMEs, micro-enterprises constitute approximately 95.48 % of the sector and are scarcely digitised. This analysis was based on the "BIM Methodology Questionnaire for SMEs" carried out by the Inter-ministerial BIM Commission in October 2022.

The results of the diagnosis, both internal and specific to SMEs, helped, among other things, to define a key aspect of the Plan: **a gradual and phased incorporation of BIM** aimed at exploiting the strengths and overcoming the initial weaknesses present in a diverse public and private sector facing a conversion that will require continuous investment and training.

Preparing professionals and companies in the construction sector

To facilitate this private sector transition, since 2017, the Ministry has been supporting BIM training for professionals of the construction sector. Annual Budget Laws have financed almost € 1.5 million in training activities

provided by different professional associations affected by the progressive implementation of the BIM methodology.

Furthermore, during 2023, several national events for SMEs were organised in conjunction with CEPYME, the National Construction Confederation and the Construction Labour Foundation, supported by buildingSMART Spanish Chapter, to discuss relevant practical experiences of BIM implementation in SMEs and best practices for BIM implementation.

During 2023, the CIBIM joined forces with buildingSMART Spanish Chapter to produce audiovisual material on the organisational changes needed to effectively implement BIM.

BIM mandate

BIM Plan in Public Procurement was approved by the Council of Ministers in June 2023. In the elaboration of the BIM Plan in 2022, Spain received support of the European Commission's **"Technical Support Instrument"**, a programme made available to Member States to help them tackle the challenges of structural reforms.





BIM Plan in Public Procurement establishes a milestone calendar from 2024–2030, associated with different BIM Levels that require progressive complexity for information requirements in public contracts, defining a roadmap for contracting authorities.

The CIBIM was also supported by its **Technical Committee**, which gathers experts on BIM implementation and use of BIM in the public and private sectors.

The Plan aims at contracting authorities using BIM for information management and exchange in public procurement, following a phased implementation schedule, as part of a wider strategy aimed at the adaptation of the construction sector and, particularly, the small and medium-sized enterprises.

The use of BIM, specially in the public sector, is neither a breakdown nor a revolution but rather, an evolution towards the optimisation of information management and information technologies, to service public officers. It has been said BIM is

10 % technology and 90 % cultural change,

And it is important to note that the use of BIM does not require neither changes to the existing legal framework for public procurement nor the introduction of new contracting mechanisms.

Calendar and BIM levels

The Plan's graduality aims at facilitating a progressive adaptation, particularly for small administration units. The strategy ranges from 2024 to 2030, and defines a progressive milestones calendar, related to 5 BIM levels that constitute a roadmap for the contracting authorities.

The phased and gradual implementation is supported on four "BIM Levels" plus a preliminary "Non-BIM" level.

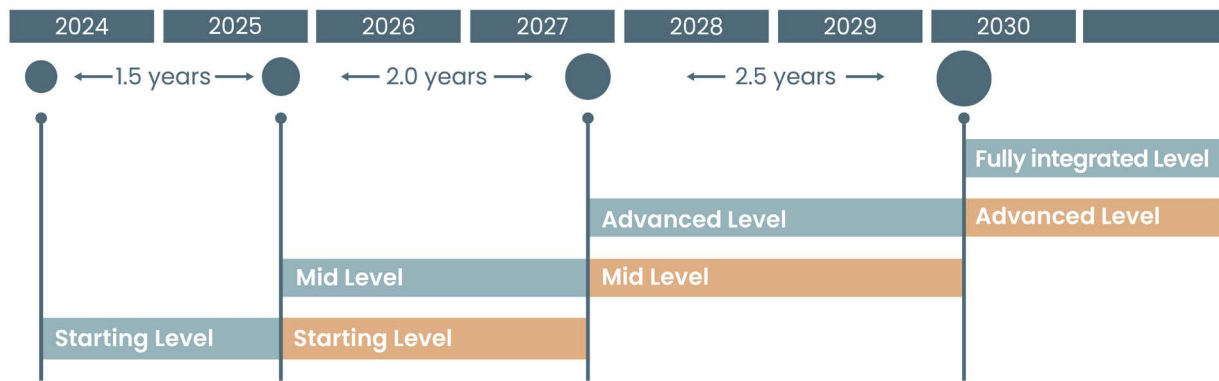
The BIM Plan adopts a gradual and phased calendar characterized by a number of BIM levels superior to those established by other BIM implementation strategies in neighbouring countries and in the length of the periods accorded to "Advanced" and "Mid" BIM Levels.

The Plan leaves it up to the contracting authority to decide on the internal strategy to be taken: resources, facilities, and steps. Finally, to avoid that BIM requirements exceed the existing capacity of a contracting authority, the Plan mandates that "BIM Level" of the contracting authority's must be equivalent to the "BIM Level" requested in a contract.

Tender documents

Use of BIM in public contracts is carried out in the tendering phase by including in the technical specifications of the procurement document or descriptive documents, where appropriate, the BIM information requirements, which will be defined according to the life cycle phase and the specific needs of the contract; and which will respond to specific objectives and uses, i.e. which BIM objectives are intended to achieve and how they are going to be used to achieve these objectives. For example, if greater consistency is to be achieved between project documents, such as plans and measurements, by detailing their specific uses.

The contracting authority may additionally request BIM considerations in the administrative specifications, as a technical and professional ability, as an award



Progressiveness in BIM implementation. BIM Plan.

criterion, or as a contract performance condition, among others, if deemed appropriate.

BIM Plan deployment in 2024

April 1st milestone

2024 is a key year for the BIM Plan. From April 1st, it is mandatory for contracting authorities to use BIM Starting Level for contracts with an estimated value above

€ 5.538 million, and BIM Starting level is recommended for contracts between € 2 and € 5.538 million.

Through the selected estimated contract value thresholds, BIM Plan reaches almost 90 % of BIM potential use at national level, which will have a knock-on effect on the digitalisation of the construction sector. The more BIM public procurement investment, the more companies will

be keen to implementing the methodology.

BIM Plan thresholds and calendar take SMEs into significant consideration, especially micro-enterprises, and provides them time enough to adapt.

Actions undertaken by the CIBIM in 2024

Some of the key actions being carried out by the CIBIM in 2024 to support contracting bodies

IMPLEMENTATION SCHEDULE AND BIM LEVELS (BIM PLAN)



M€- million euros

Source: **BIM Plan. Interministerial Commission for the Implementation of BIM in Public Procurement**

D E F I N I T I O N

M I N I M U M

B I M L E V E L S

1
PRE/NON-BIM

2
STARTING

3
MID

4
ADVANCED

5
FULLY
INTEGRATED

STRATEGY	PROCESSES		
 Strategy	 Work procedures required under the contract	 Party coordination	 Contract information
No strategy for using BIM in contracts.	No procedures required for contract information management.	Face to face meetings, virtual meetings and emails.	Visual information, such as CAD drawings, not linked automatically to data contained in other files. No use of BIM models.
BIM pilot projects or isolated tenders.	Based on quality management systems (UNE-EN ISO 9000 or equivalent).	No need to be carried out through CDE.	CAD drawings and BIM models for obtaining drawing documentation and for 3D coordination uses.
Plan for using BIM within design and construction phases.	Based on quality management systems (UNE-EN ISO 9000 or equivalent). + Specific BIM guides or manuals from CIBIM and recognised organisations.	This is carried out through CDE.	BIM models for use in obtaining plans, 3D coordination and measurements. CAD information or drawings not obtained from the model can be allowed.
Plan for using BIM within the entire life cycle and across departments.	Based on information organisation and digitisation systems (UNE-EN ISO 19650 or equivalent). + Specific BIM guides or manuals from CIBIM and recognised organisations.	This is carried out through CDE, with simulations and validations.	BIM models for use in obtaining plans, 3D coordination, measurements, maintenance or conservation and operation and asset management. BIM object libraries are managed and used. Residual CAD information or drawings not obtained from the model can be used.
Systematic procedure for integrating innovative contract management processes.	Procedures certified under UNE-EN ISO19650 or equivalent. + Specific BIM guides or manuals from CIBIM and recognised organisations. + Information delivery manual based on UNE-EN ISO 29481 or equivalent.	This must be carried out through CDE only, with simulations and validations.	BIM models for any use. BIM object libraries are managed and used. CAD information or drawings not obtained from the model can be used residually.

O F B I M L E V E L S

R E Q U I R E M E N T S

TECHNOLOGY		PEOPLE	
			
Common data environment (CDE)	File formats	Contracting authority training	Tenderer training
No common repositories for contract information management.	No standards.	No staff with knowledge of BIM required.	No staff with experience in contracts with BIM is required.
Access controlled common repository. + Rules for standardised file and folder naming.	Formats based on open standards. IFC according to UNE-EN ISO 16739 or equivalent for BIM models. Proprietary formats may also be required.	At least one person is trained on BIM and acts as BIM contract manager.	Human resources with experience in BIM requirements for contracts are required.
Access controlled common repository. + Rules for standardised file and folder naming. + Information Workflows and Information States defined, aligned with UNE-EN-ISO 19650.	Formats based on open standards. IFC according to UNE-EN ISO 16739 or equivalent for BIM models. Proprietary formats may also be required.	All staff involved in the contract are trained in BIM. A BIM contract manager is defined.	Human resources with experience in BIM requirements for contracts are required.
Technological solution specifically designed as a CDE according to UNE-EN ISO 19650 with various features. + Rules for standardised file and folder naming.	Formats based on open standards. IFC according to UNE-EN ISO 16739 or equivalent for BIM models. For IFC model related communications, use BCF format or equivalent. Proprietary formats may also be required.	All staff involved in the contract are trained in BIM in compliance with UNE-EN ISO 19650. + Previous experience in BIM managed contracts. A BIM contract manager is defined.	Human resources with experience in BIM modelling and project or site management are required.
Technological solution specifically designed as a CDE according to UNE-EN ISO 19650 with various features. + Rules for standardised file and folder naming. + Data access through web services.	Open standards-based formats are always used. IFC according to UNE-EN ISO 16739 or equivalent for BIM models. For IFC model related communications, use BCF format or equivalent.	+ All staff involved in the contract are trained in BIM in compliance with UNE-EN ISO 19650. + Previous experience in BIM managed contracts. BIM contract manager with 3 years of experience managing contracts with BIM is identified.	Human resources with experience in BIM modelling and project or works management of at least 3 years are required and implementing UNE-EN ISO 19650 and its use in contracts will be valued.

and the private sector in reaching this initial milestone of the BIM Plan are as follows:

- **Technical documents/Guidance material for the preparation of tender specifications and the execution of public contracts using BIM requirements.**

The CIBIM is completing two technical documents/guidance material documents for contracting authorities: a guide to public procurement with BIM requirements and a BIM standard for public procurement.

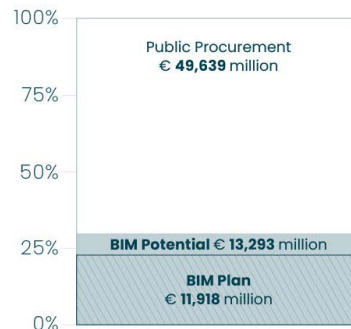
The BIM standard for public procurement will be the reference to use BIM in the information management of National Public Administration and public sector entities public procurement, while the guide to public procurement with BIM requirements will address how to include BIM requirements in the different phases of a public contract.

- **Support for contracting authorities through the BIM Pilot Projects Programme.** Support and assistance service for National Public Administration and public sector entities contracting authorities

The CIBIM launched this programme in January 2024 to help National Public Administration and public sector entities contracting authorities to choose a pilot project, define an action plan, produce tender specifications, and draw up conclusions for the integration of BIM within their organization. This support is provided by multidisciplinary expert staff through video

BIM PLAN FOR PUBLIC PROCUREMENT: SCOPE OF APPLICATION

INVESTMENT (ESTIMATED CONTRACT VALUE)



meetings, a query mailbox and a telephone support line.

- **Promotion of BIM training and dissemination actions.**

- Audiovisual BIM training programme.

Since January 2024, a BIM training programme in video format was published in the CIBIM website. The programme is organised in two blocks: a first block of 8 videos on the changes in strategy, people, processes and technology required to implement BIM in an organisation, and a second block of 6 videos aimed at public contracting bodies, which covers the practical aspects of requesting and receiving information in a contract with BIM requirements. ("How to implement BIM in an organisation" and "How to use BIM in a contract").

The training material was produced by the CIBIM, in collaboration with buildingSMART Spanish Chapter, a non-profit association formed by different agents from the construction

sector, which was created to promote the use of BIM open interoperability standards.

- Grants for delivering BIM training through professional associations.

In 2024, grants worth € 290,698.7 are funding professional BIM training through professional associations. These grants make part of the Ministry's Strategic Grants Plan and BIM Plan in Public Procurement, and will enable professional associations to provide specialised BIM training for professionals in the sector during 2024.

- BIM training in the National Public Administration and public sector entities

During 2024, the use of BIM has been integrated into the competition programmes to access the National Public Administration, as the Technical Engineers in Topography program, and the Technical Architects program, among others.

In addition, the CIBIM is preparing an e-learning

course for National Public Administration and public sector entities personnel on the technical documentation produced by the CIBIM.

- **Participation in the European BIM Community.**

- BIM and Public Procurement Community, within the European Commission's Public Buyers Community Platform.

In 2024, the CIBIM became a member of the European Commission's BIM and Public Procurement Community, where CIBIM participates in the European Commission's online seminars as a speaker and publishes relevant material CIBIM is developing to implement BIM in public procurement in Spain.

- The European Commission's High Level Construction Forum (HCLF).

The CIBIM follows the discussions and conclusions of this highly relevant forum that brings together various stakeholders involved in BIM implementation. In addition, this Viceministry of Transport and Sustainable Mobility has been invited to present the BIM Plan in Public Procurement at the HCLF forum, which holds discussions, monitors actions, analyses policies and sets new priorities for the European Union, especially with regard to the Construction Transition Pathway approved by the European Commission in March 2023.

- EUBIM Public Officials Group.

This Group was created by initiative of Spain under the Spanish Presidency of the European Union and is working on defining a common model for monitoring public procurement with BIM requirements, among other issues. The Viceministry of Transport and Sustainable Mobility has coordinated, led the group and organized preparatory meetings for the next meeting of the group of BIM ministerial-level public decision makers.

- EUBIM Task Group.

The CIBIM actively participates in the management bodies of the EUBIM Task Group, as well as in the projects in progress. In 2024, it also participated in various meetings of the group's Steering Committee and in a number of workshops on strategies for BIM implementation.

- **Presence and participation in the national BIM Community.**

- The President of the Inter-ministerial BIM Commission has attended several meetings with BIM users and professional associations to pre-sent the BIM Plan in Public Procurement and explain the actions being taken to support its implementation.

Beyond 2030

BIM is facilitating the digitalisation of construction to provide a basis for innovation. BIM in itself is a mean, not an end. BIM is a tool for the deployment of an as-yet unexplored set of innovation initiatives.

Although the BIM Plan final milestone will be reached in 2030, work will continue beyond this date. It is possible that beyond 2030 there will be little talk about BIM, once the information management has been widespread internalised; however, new challenges will arise with regard to improving public spending efficiency or the use of other "data consuming technologies" such as Digital Twins or Artificial Intelligence.

One of the main characteristics of BIM is its capacity to generate and manage data collaboratively.

It is estimated that digitalization of information in the construction sector will facilitate the incorporation of multiple achievements, particularly technological advances in the field of forecasting, simulation and, in general, assisted data acquisition by improved access to information from the built asset and from increasing systems sensorisation and monitoring.

Validation and approval processes automation and the consequent risk and time reduction will be within the reach of public employees. In the years to come, focus will increasingly be put on asset management optimisation in a more secure and sustainable way.

BIM. We build together.●

Creating the EU BIM Public Officials Group

The **EU BIM Public Officials Group** brings together national civil servants representing the ministries from EU Member States to exchange experiences and views on national BIM implementation strategies through public policies and to discuss, among other issues, the digitalisation of the construction sector, the categorisation of national BIM strategies, the implications of incorporating BIM in public procurement, its monitoring on procurement platforms and its impact on SMEs.

The group is open to all EU Member States interested in exchanging best practices, implementation success stories and strategies at ministerial level. Its vision is strategic in terms of the integration of BIM through public policies.

Its creation was driven by the Interministerial Commission for the Incorporation of BIM in Public Procurement (CIBIM) within the framework of the Spanish Presidency of the Council of the European Union in 2023, and its first meeting took place in Madrid on 25 and 26 October. Twenty-one Member States participated in the meeting with the aim of aligning efforts and identifying common challenges and solutions. At this first gathering, the participating Member States expressed their support to the initiative, which was considered particularly useful for those countries currently developing public national strategies for BIM implementation.

This CIBIM initiative is just one of a series of actions being implemented by the different BIM communities at EU level.

The second meeting of the EU BIM Public Officials Group will take place in Berlin on 14-15 October 2024, and Poland has already expressed its interest in organising the third meeting of the group in spring 2025.





The European Commission's work to improve quality of buildings and infrastructures in public works

BIM and Public Procurement

Building Information Modelling (BIM) is one of the key tools for improving efficiency and achieving better value in the delivery of construction projects. BIM allows authorities to plan works and reduce the environmental footprint throughout the entire life cycle. As about 30 % of all construction work is public construction, the European Commission is promoting the uptake of BIM through public procurement to fully utilise its potential. The European Commission has recently established the Community of Practice on this topic.

- Text: Ivo Locatelli. Senior Expert, European Commission. Directorate General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW)

*The views expressed in this paper are of the author and do not necessarily reflect the position of the European Commission.



The process of making the construction sector more sustainable and efficient entails many complex and multi-faced challenges.

The Building Information Modelling (BIM) methodology is one of the key tools for improving efficiency and achieving better value in the delivery of construction projects, as well as increasing energy and resource efficiency in the exploitation of buildings and infrastructure. Governments and public procurers across Europe and around the world recognise the value of BIM as a strategic enabler for cost and quality, while delivering on the Green Deal through innovation. BIM allows authorities to plan the construction of infrastructure to reduce their environmental footprint throughout the entire life cycle. As such, BIM represents a key tool toward the goals of a greener and more sustainable Europe.

In concrete terms, BIM is a tool to support public authorities in selecting projects non solely on price, but also on other parameters such as environmental performance, including the expected full lifecycle assessment of the public works. In this way, BIM also allows for more efficiency during the exploitation phase of building assets by ensuring the optimization of energy and resource consumption, a higher usage efficiency of lighting and shading, ventilation and air conditioning, etc.

As about 30 % of all construction work in the EU is public construction, according to data extracted from Tender Electronic Daily (TED)- Supplement

BIM enhances efficiency and sustainability in EU public construction projects.

to the Official Journal of the EU, BIM brings huge potential for a greener and more efficient public sector. At the same time, public authorities can be a strong lever in achieving increased uptake of BIM on the private side of the ecosystem too.

BIM has many benefits for public authorities such as optimising management and maintenance, reducing completion times, and improving project compliances. There are many benefits for private partners in the construction process: it supports suppliers and construction companies in their planning and use of material resources; it also allows architects to optimise their designs in terms of commercial value and environmental performance. However, a lot of work still needs to be done to allow public works to fully exploit the benefits of BIM. These are especially relevant when BIM is used in its most advanced versions - digital twins describing past, present and future states of the buildings/infrastructure eventually composing a system.

To properly exploit the collaborative nature of BIM, public procurement should embrace a more progressive process: the shift towards more collaborative contracts, awarding the contracts on the basis of the quality of the strategic approach taken, the inclusion of appropriate BIM requirements in the technical

specifications, and the use of a standardised digital information model. In simple terms, it is necessary that worlds of public buyers and that of BIM stakeholders get aligned to achieve this together.

Recognising the importance of the right interaction between BIM and public procurement, in July 2023, DG GROW of the European Commission established the Community of Practice on BIM and Public Procurement. It currently includes about 70 participants, ranging from representatives of national, regional, and local governments to universities, research unions, NGOs, private companies, and associations.

Its purpose is to facilitate the spread of knowledge and expertise while addressing challenges and problems related to the public procurement of BIM solutions. By working together, sharing best practices, and leveraging collective expertise, public authorities can overcome obstacles and build up innovative solutions to achieve their common goals.

To launch the cooperation of the Community of Practice on BIM and Public Procurement, DG GROW organised two successive introductory webinars. The first webinar was held in December 2022 and featured around one hundred participants from all over the EU. It introduced the

subject of BIM and Public Procurement for wider discussion and announced the launch of the Community of Practice. The second webinar was held in May 2024 and attracted more than 400 registrations and 140 participants. It aimed at a more detailed and targeted presentation of BIM and public procurement. It hosted the presentations

The European Commission promote a Community of Practice on BIM.

of distinguished speakers such as Mag. Dr Michael Fruhmann (director, Directorate for Public Procurement Law, Austrian

Federal Ministry of Justice) and Prof. Avv. Gabriella M. Racca (full professor of Administrative Law, University of Turin), who explained



Different views of a BIM model.

The contribution the Spanish authorities have made so far in BIM adoption is indeed significant.

the notion of BIM and its legal challenges from their different perspectives. From a practical standpoint, Ms Aida Joaquín Acosta (Chief of Cabinet of the Vice Minister, Ministry of Transport and Sustainable Mobility, Spain) contributed to the discussion by exploring the process of **BIM adoption in Spanish National Public Administration, showcasing one of the most advanced policy frames in the EU. The contribution the Spanish public authorities have made so far is indeed significant.**

Now, **DG GROW has launched a survey to collect information on the needs and challenges faced by authorities working with BIM.** The results of the survey will be presented in a third webinar, planned for autumn 2024. On the basis of the survey feedback, a new plan for future activities will be prepared to better guide the BIM Community of Practice towards a wider and easier uptake of this technology.●

Public Buyers Community

Information on the Community of Practice on BIM and Public Procurement is available on the Public Buyers Community Platform. BIM and public procurement is one of the communities of practice hosted on the platform.

The platform, launched in April 2023, is a hub that promotes the exchange of information and experience, allowing its members to learn and improve quickly through cooperation. The aim of the platform is to facilitate the spread of knowledge and expertise while addressing challenges and problems related to public procurement.

Through the Public Buyers Community Platform, members of different communities of practice can engage in valuable discussions with their peers across Europe, access precious resources, and speed up their learning process.

Furthermore, the platform offers the possibility to subscribe to the Public Procurement Gazette to stay informed on the latest developments and engage in the upcoming events.

Active participation is crucial to this journey.



Take part in the survey on the Community of Practice on BIM and PP: <https://public-buyers-community.ec.europa.eu/communities/bim-and-public-procurement>



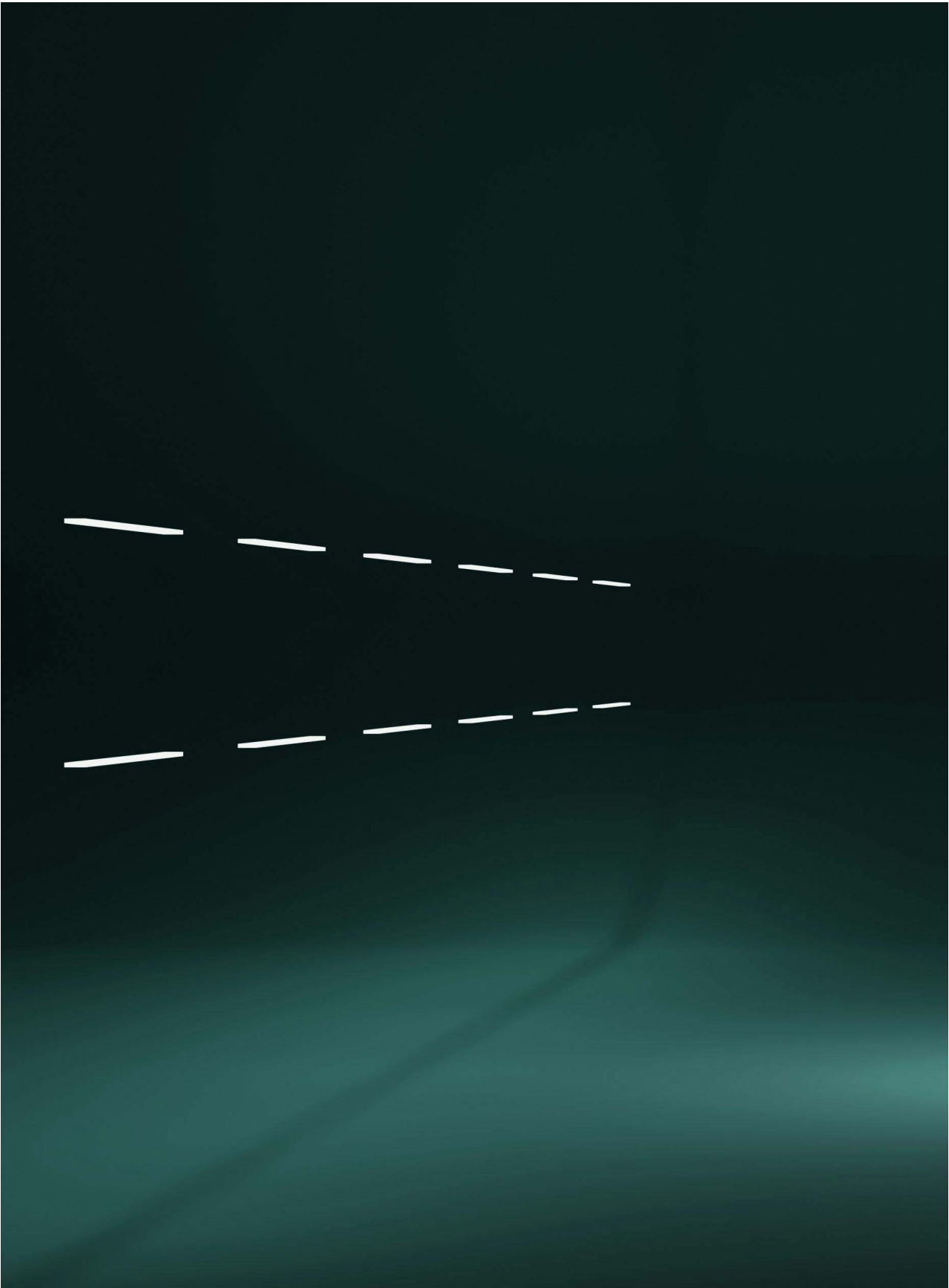
Visit the Public Buyers Community at: [Homepage | Public Buyers Community \(europa.eu\).](https://public-buyers-community.ec.europa.eu/)



Join the discussion on BIM at: BIM and Public Procurement | Public Buyers Community ([europa.eu](https://public-buyers-community.ec.europa.eu/)).



Subscribe to the Newsletter (The Public Procurement Gazette) at: [INTERNAL MARKET, INDUSTRY, ENTREPRENEURSHIP AND SMES - Newsroom Subscription Form \(europa.eu\).](https://public-procurement-gazette.ec.europa.eu/)



Monitoring BIM implementation in Spanish public procurement

BIM Public Procurement Observatory

In 2017, the Ministry of Transport and Sustainable Mobility created an observatory to monitor the BIM implementation in Public Procurement. Since then, the BIM Public Procurement Observatory (BIM PP Observatory) has been monitoring the process and providing a series of valuable data for the establishment and monitoring of the BIM Plan. Using the data published in the Public Procurement Platforms, the Observatory carries out a quantitative and qualitative analysis to prepare a monitoring visualizer, as well as quarterly reports.

- Text: Guillermo Condado Castaño, Cabinet of the Viceminister of Transport and Sustainable Mobility



The Ministry of Transport and Sustainable Mobility created in May 2017 the **BIM Public Procurement Observatory (BIM PP Observatory)** to monitor the progress of the implementation of the BIM methodology in Spain. Based on the data published on the Spanish Platform for Public Procurement and the equivalent platforms used by the Regions, the BIM Observatory identifies and conducts a quantitative and qualitative analysis of public tenders using BIM. The visualizer of the BIM Observatory provides aggregated and accumulated data that can be filtered by year (information is available from 2017 to the present day), level of public administration (National, Regional and Local administrations including their respective dependent public sector), and type of work (infrastructure and building). Data are updated quarterly and displayed by year. The BIM PP Observatory generates **a visualizer with different information and quarterly reports**, which enable to monitor BIM implementation progress and the evolution in BIM requirements accuracy. The BIM Observatory has played a fundamental role in the elaboration of the BIM Plan in Public Procurement by facilitating information for a starting point diagnose. It will be critical for monitoring implementation of the BIM Plan too, where it will help to assess the level of compliance and propose readjustments to its milestones, if required. Finally, the use of information from Public Procurement Platforms and, specifically, the use of the CPV (Common Procurement Vocabulary) no-

menclature allows to perform simulations of types of economic activities that could **potentially use BIM**. Therefore, it may serve to determine the potential use of BIM in public procurement. For all of these reasons the BIM PP Observatory is a core element of the BIM implementation strategy, as reflected in the BIM Plan in Public Procurement.

Quantitative analysis

Cumulative data for all Public Administrations

From 2017 till the beginning of 2024, the Observatory has identified 3,632 BIM public contracts amounting to an estimated value of € 11,117 million by all the Public Administrations levels (National, Regional and Local) and their respective public sector.

For the purpose of the data provided in this article, when reference is made to the National, Regional or Local level, this includes the data of the corresponding National, Regional or Local Authorities, as well as their depending public sector entities.

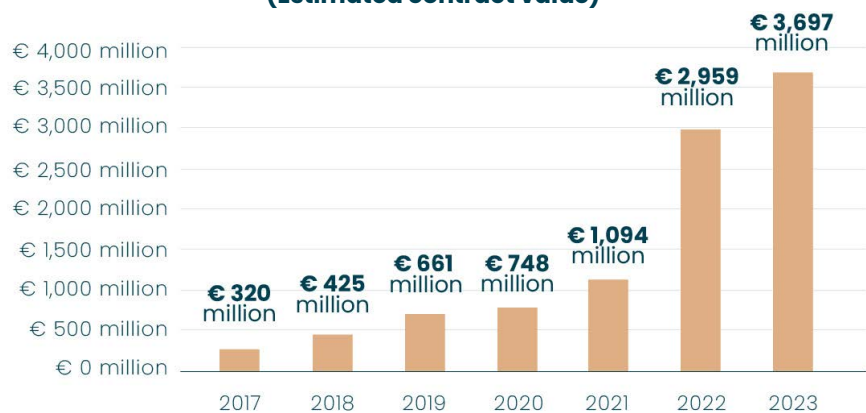
The term institutional public sector refers, in an abbreviated form, to depending public sector entities. Finally, when mention is made to ministries, the data include both the data for the ministry itself and for its respective public sector entities.

Annual data and evolution for all public administrations

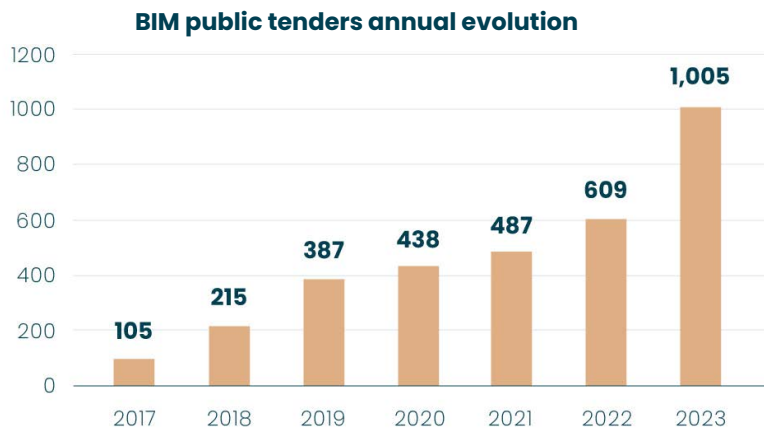
The use of BIM has shown progressive year-to-year growth since 2017, both in terms of total estimated value of contracts using BIM and number of tenders, with a particularly outstanding increase in 2022, when the use of BIM almost tripled in terms of estimated contract value compared to 2021.

Considering all the public administrations levels (National, Regional and Local) and their public sector entities, in 2023, 1,005 contracts were tendered with BIM, entailing an investment of € 3,697 million. The use of BIM for 2023 was 125% higher than for 2022 considering the total estimated value of contracts using BIM and 165% higher considering the number of tenders.

Annual evolution of the total estimated value of contracts using BIM (Estimated contract value)



Public Administrations and their public sector entities.



Public Administrations and their public sector entities.

At National level, the Ministry of Transport and Sustainable Mobility and its public sector entities amounts the largest total estimated value of contracts using BIM, reaching € 4,597 million.

Annual data and evolution at the National level

At National Administration level, in 2023, a total of 422 contracts were tendered with BIM, with a cumulative estimated value of € 2,286 million.

Compared to 2020, this represents a twenty-fold increase in the use of BIM in public contracts, in terms of the estimated

value of the contracts, and a seven-fold increase in terms of the number of tenders.

Cumulative data at the National level. Distribution by ministries

BIM PP Observatory also provides an apportionment of BIM tenders at the National level, rendering investment figures and the num-

ber of BIM public tenders, differentiating by ministries and their own related public entities.

Over the last seven years, at the National level, the **Ministry of Transport and Sustainable Mobility (and its public sector)** has been the largest BIM investor, amounting to € 4,597 million expenditure in 836 BIM public contracts.

The Ministry for the Ecological Transition and the Demographic Challenge (including its public sector) ranked second in terms of the volume of investment in BIM tenders, followed by the Ministry of Finance.

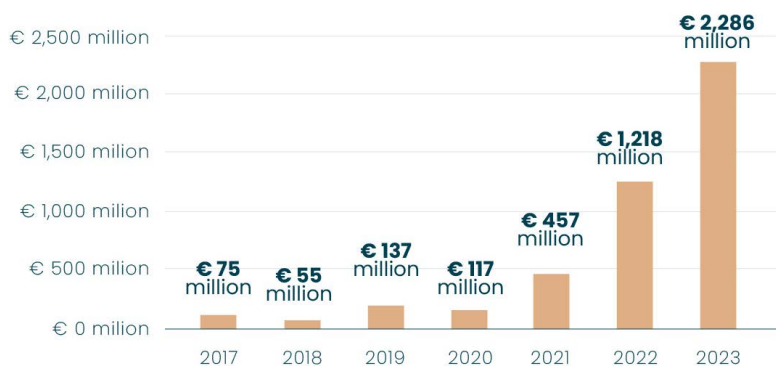
Qualitative analysis of the use of BIM

The BIM Plan in Public Procurement, approved in June 2023, establishes that to use BIM in public contracts, the contracting authority shall request **BIM information requirements in the technical specifications** of the procurement document or in the descriptive documents, as appropriate. These requirements must be defined according to the needs of the contract and the phases of the asset's life cycle to meet the specified BIM objectives and uses.

Additionally, the contracting authority may request BIM requirements as a technical and professional ability, as an award criterion, or as a contract performance condition, among others, if deemed appropriate.

For this reason, other tools of the BIM PP Observatory focus on analysing the use of BIM within contract specifications, enabling access to the most frequent BIM requirements in technical

Annual evolution of the total estimated value of contracts using BIM (Estimated contract value)



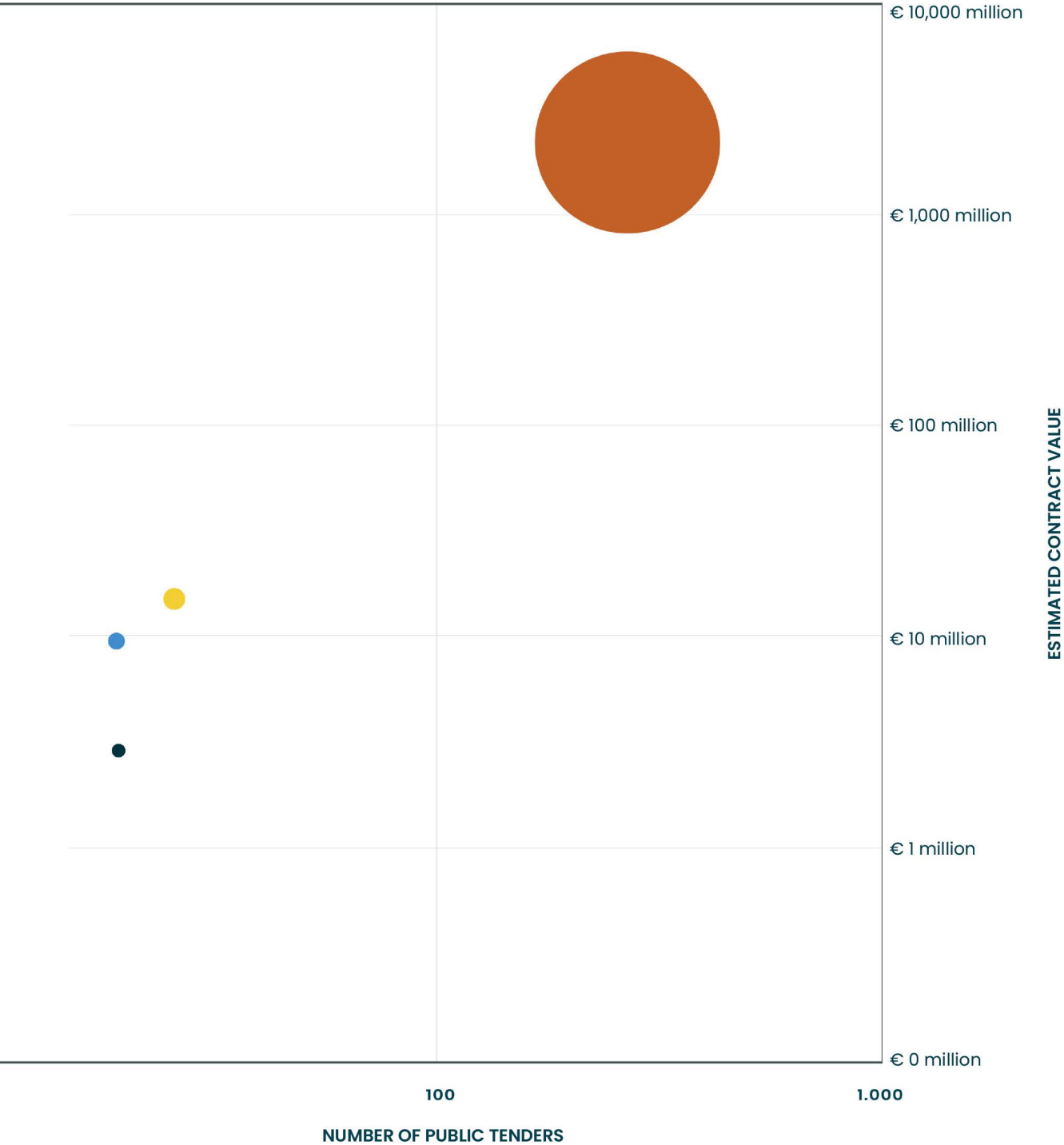
National level.

DEPARTAMENTAL OF BIM TENDERS



Cumulative data collected by the Ministries since 2017, in terms of total value and number of contracts awarded. The names of the Ministries and the departmental structure varied during the fiscal year, and corresponds to those established in RD 2/2020, of January 12, which was in force for the majority 2023.

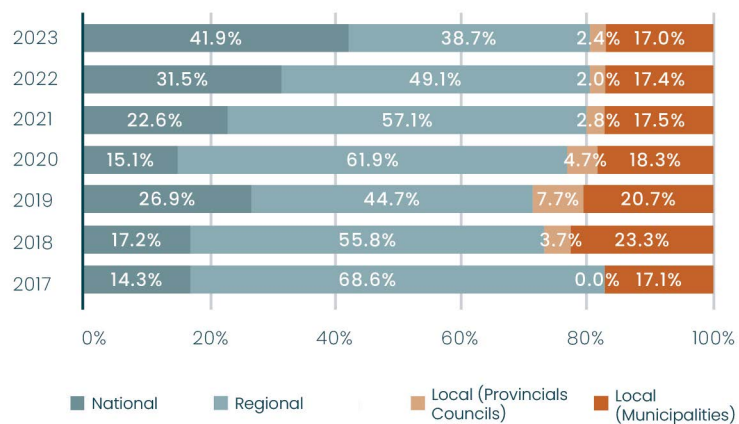
DISTRIBUTION IN 2023



Annual data. Comparison between administrations

In 2023, for the first time in the annual series, BIM public procurement at National level overtook BIM public procurement at regional level. Considering BIM public procurement in 2023, BIM tenders at National level amounted to 62% of the total investment, compared to 24% at regional level, and amounted to 42% of the number of BIM tenders compared to 39% at regional level.

Number of BIM tenders by year and level of Public Administration



Total Public Administrations and their public sector entities

specifications: BIM uses, BIM deliverables, level of information of the requested model, requirements of the Common Data Environment (CDE), element classification systems and BIM standards.

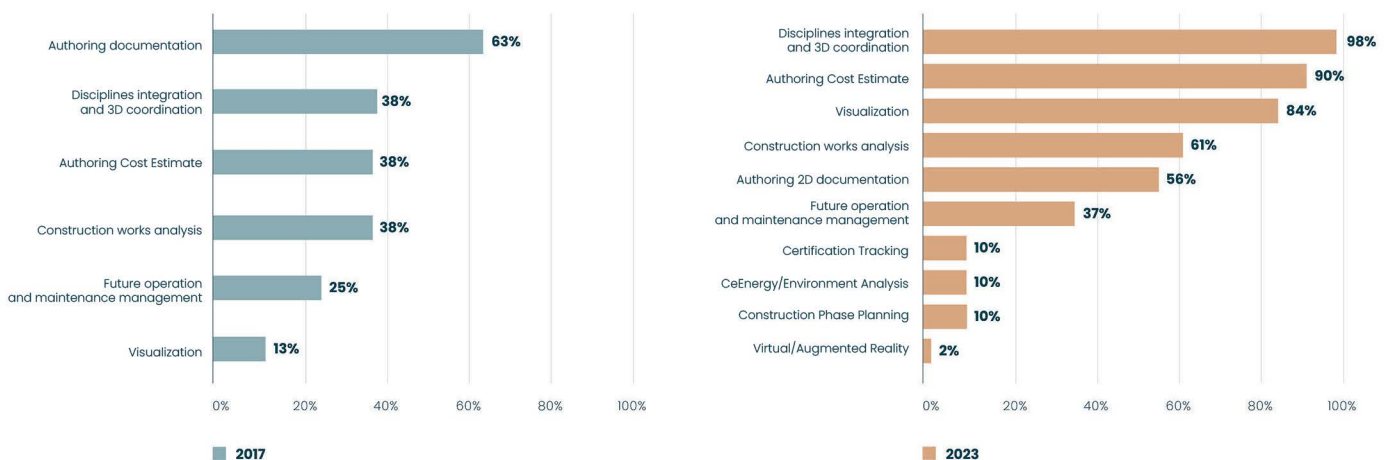
BIM uses

The term "BIM uses" refers to the intended use of the BIM model of the contract. The contracting authority have to refer to the required "BIM uses" in the contract, and it is recommended to choose only the BIM uses relevant to that particular contract,

considering the entire life cycle of the infrastructure.

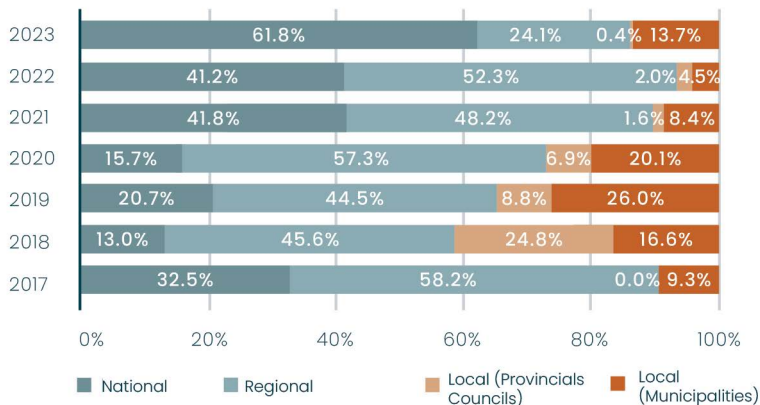
The BIM Plan foresees that the number of "BIM uses" increases according to the five BIM Levels as the BIM implementation process progress. Thus, it states that the Starting Level will require "3D Coordination" and "Documenta-

BIM uses requested in technical specifications documents, comparison within 2017 and 2023



National level.

Accumulated Estimated contract value of BIM Tenders by year and level of Public Administration



National Public Administrations and their public sector entities.

tion" (obtaining drawings) uses; the Mid-Level will require "Cost Estimation" uses; and the Advanced Level will require "Maintenance or Conservation" uses, as well as "Operation and Management".

This progressive use of BIM is reflected in the evolution of the

requests for "BIM uses" analysed by the BIM PP Observatory. At National level, since 2017, the most frequently requested "BIM uses" included "3D Coordination", "Visualisation", and the extraction of "Measurements".

At National level, in 2023, the request for '3D Coordination' BIM

use amounted to 98% of the tenders that defined "BIM uses", "Cost Estimation" amounted to 90%, 'Visualisation' amounted to 84% and "Construction Simulation" amounted to 61%.

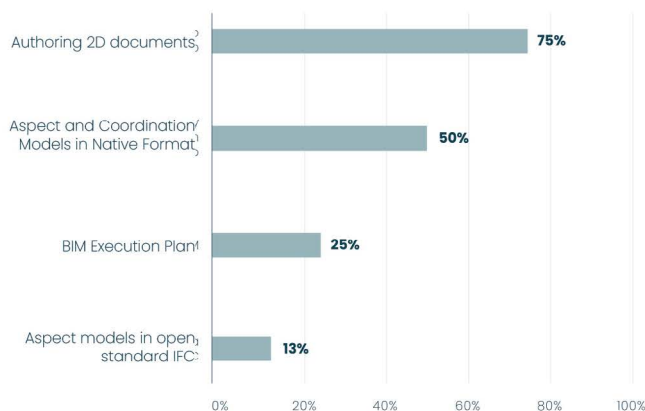
BIM deliverables

"BIM deliverables" are contents obtained in whole or in part from the BIM model. For example, one of the most frequently requested deliverables is the "BIM Execution Plan (BEP)". This living document sets out the methodology for fulfilling the BIM information requirements requested by the contracting authority.

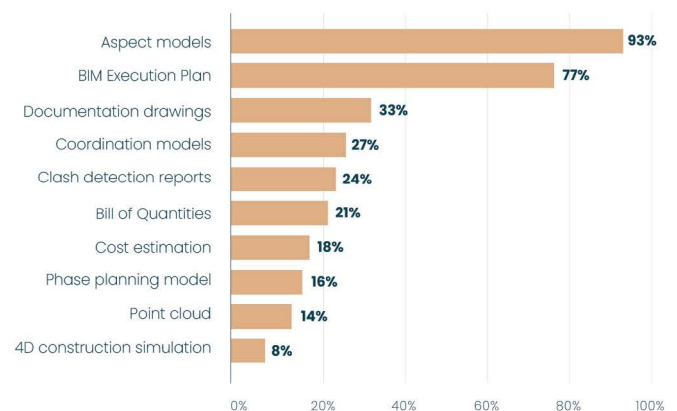
At National level the number of BIM contracts requesting a BEP Execution Plan has risen substantially since 2017, from no BEP requested in 2017, to all public contracts requesting a BEP currently.

Currently, some of the most requested BIM deliverables include "Discipline-specific models", which are requested in 93% of BIM tenders defining BIM deliverables, the BEP, requested in 77% of tenders, and derivatives

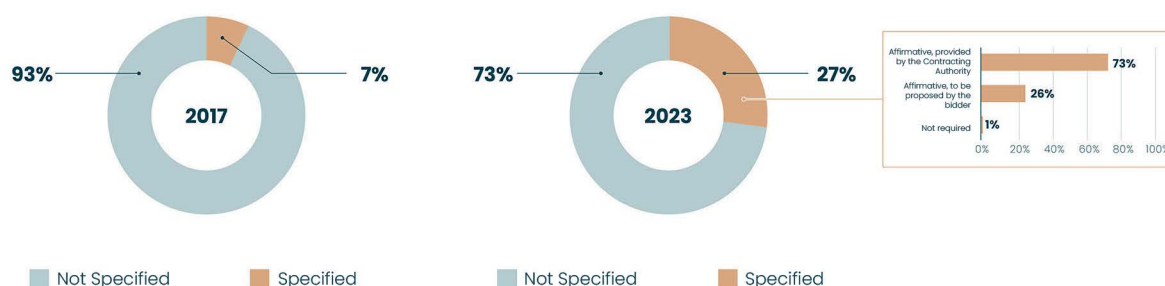
BIM deliverables requested in technical specifications documents, comparison within 2017 and 2023



National level.



Common Data Environment requests in technical specifications documents, comparison within 2017 and 2023



National level.

of the BIM model, such as "Drawings", which are a requirement in 33% of tenders, in addition to other deliverables shown in the figure.

Common Data Environment

Common Data Environment (CDE) is a shared-access repository that facilitates and improves the interrelationships between the different agents involved in a contract.

As established in the BIM Plan, usually tender documents require a shared repository with additional rules, workflows and functionalities as a higher level of BIM maturity is reached.

The BIM PP Observatory analyses whether the tenders include a requirement for collaboration in a CDE, whether it is the tenderer who proposes and provides the CDE, whether the contracting authority must provide the CDE, or whether particular collaboration requirements are required but do not include the use of a CDE.

There is a clear evolution regarding the use of CDEs, from only 7% of tenders initially requiring a collaborative environment, to 2023 figures, where more than 25% of BIM public contracts require to use a CDE.

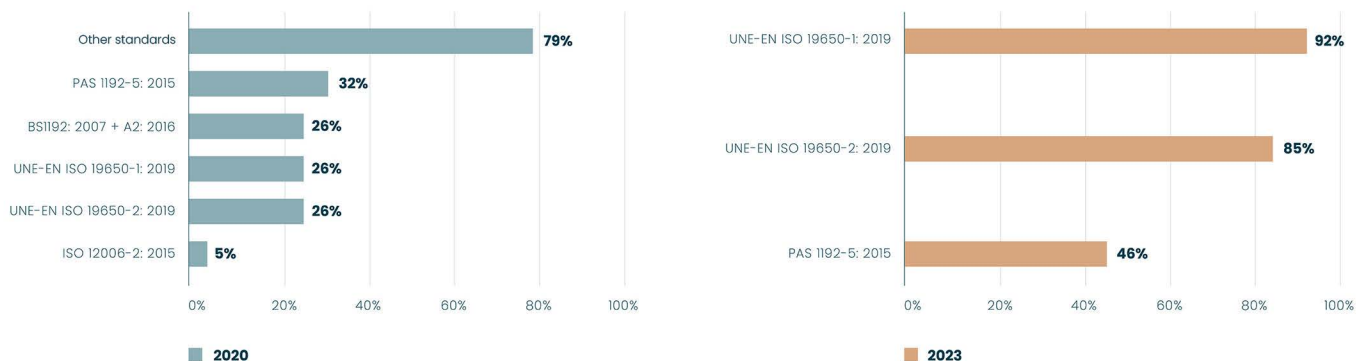
It is worth noting that 73% of BIM public tenders at the National level in 2023 specified the contracting authority would provide the CDE.

Standards

The BIM Plan envisages increasing complexity in the work procedures as the BIM maturity level progress. Thus, at the Advanced BIM Level, it is envisaged that contracts will require work procedures based on organisation and digitalisation information systems that use BIM, such as those compliant with the UNE-EN ISO 19650 series of standards or equivalent, as well as specific BIM guides or manuals published by the Interministerial BIM Commission or other recognised bodies, for the management of the contract information.

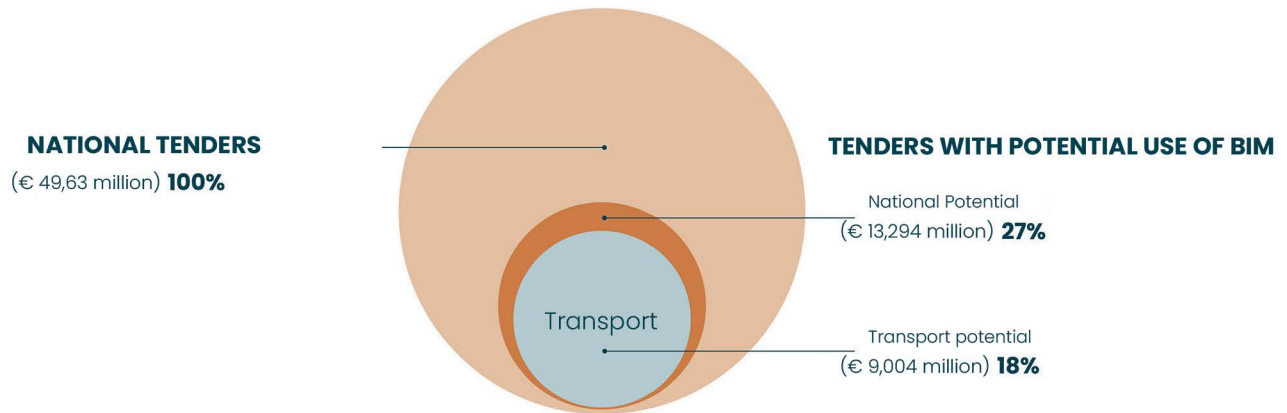
It should be noted that the use of the UNE-EN ISO19650 standard on the organisation and digitalisation of information in building and civil engineering works using BIM has been growing since 2020, following its approval the year before. In 2023, 92% of

Standards requested in technical specifications documents, comparison within 2020 and 2023



National level.

Potential use of BIM in 2023 in national-level contracts



National-level BIM public tenders requiring the use of standards referred to UNE-EN ISO 19650-1 Concepts and Principles and 85 % to UNE-EN ISO 19650-2 Asset Development Phase.

Potential use of BIM

The CIBIM has defined the concept of the potential use of BIM to estimate the scope and impact of the use of BIM in Public Procurement.

What is the potential use of BIM?

It can be defined as the total estimated value of contracts or the number of public contracts related to assets that a contracting authority could tender with BIM requirements during a specific period of time.

As BIM is used with assets (infrastructure, buildings), the potential use of BIM indicator considers different asset-related public contracts published on the Public Procurement Platforms.

The indicator analyses public works, and service and supply contracts within the construction sector. For instance, service contracts might include contracts

for direction of works, technical assistance, works monitoring and supervision, health and safety coordination, studies and projects drafting, assets maintenance and conservation, etc., all of which have the potential to include BIM clauses in their specifications.

The annual potential use of BIM indicator is an estimation obtained by analysing the CPVs of contracts published on the Public Procurement Platforms after the end of the year to which the data refers.

The Common Procurement Vocabulary (CPV) is a unique classification system for Public Procurement that aims to standardise the references used by contracting authorities to describe the content of their contracts.

During 2024, the CIBIM is using the 2023 potential use of BIM

indicator, based on public contracts awarded in 2023.

Potential use of BIM at National level

At National level, using the 2023 indicator, the potential use of BIM might amount to € 13,294 million worth of public procurement representing 27% of public tenders. In terms of the number of contracts, 9,700 National-level contracts could use BIM (out of a total of 44,133 contracts).

Potential use of BIM within the Ministry of Transport and Sustainable Mobility

The Ministry of Transport and Sustainable Mobility (including its public sector) plays a key role in BIM implementation in Public Procurement. Using the 2023 indicator, the Ministry's potential use of BIM may represent

It is estimated that National-level contracts worth € 13,294 million could make use of BIM, i.e. 27% of all National-level Public Procurement.

68% of the whole potential use of BIM at National-level and may represent 18% of all national-level Public Procurement. In terms of the number of contracts, the potential use of BIM would amount to 2,324 contracts, i.e. 24% of the contracts with potential use of BIM at National level.

For the Ministry of Finance (and its institutional public sector), the potential use of BIM would amount to € 1,331 million, i.e. 10% of the potential use of BIM at National level. In terms of the number of contracts, 4,472 contracts could use BIM (out of a total of 9,700), i.e. 46% of the contracts with potential use of BIM at National level.

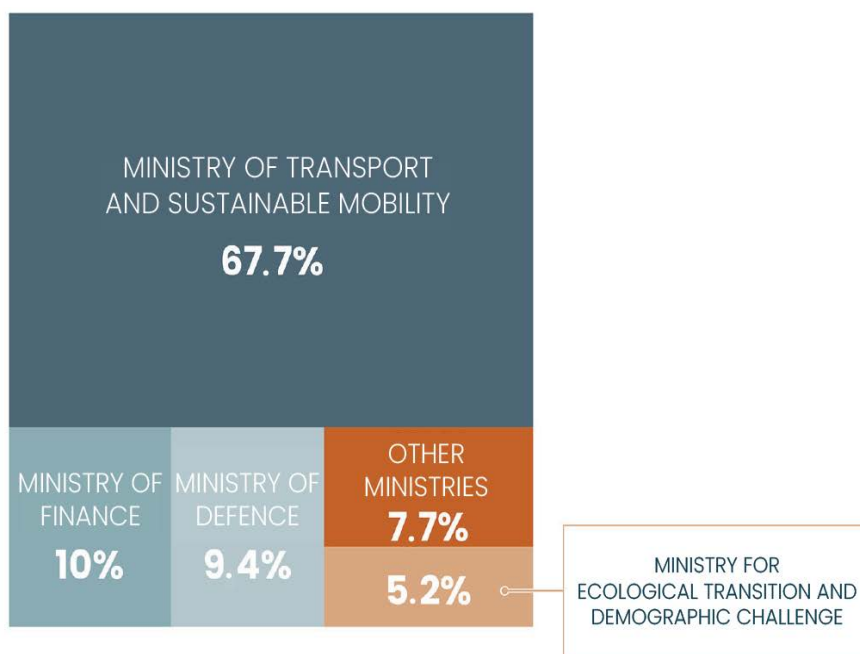
The BIM Public Procurement Observatory and the BIM Plan

The data provided by the BIM Public Procurement Observatory, through its visualizer and its quarterly reports, shows an evident growing trend in BIM implementation in public procurement: quantitatively, BIM methodology is increasingly included in procurement, and qualitatively, the incorporation of BIM in tender documents sheets is becoming increasingly mature and complete. The coherence between the obligations contained in the BIM Plan and the existing trend towards using BIM in public procurement illustrates that the BIM PP Observatory was one of the main sources of information

consulted by the CIBIM when drafting the BIM Plan.

Moreover, the Observatory's monitoring of public procurement platforms enables the calculation of the potential use of BIM annual indicator, i.e. the number or the total estimated value of public contracts that might integrate BIM requirements though this year. This information can be used by the CIBIM to monitor the BIM Plan for Public Procurement milestones accomplishment, and therefore, to eventually improve its mandate and recommendations, in order to achieve the double objective of improving public spending efficiency in public procurement and serving as a leverage for the digital transformation of the construction sector. ●

Distribution of the potential use of BIM at National-level (total estimated value of contracts that could use BIM)







#Transforming transport infrastructure with BIM

Transport infrastructure are the backbone of social cohesion and have the potential to drive the economy and its sustainable and digital transformation. BIM plays a key role in transforming in infrastructure the potential use of BIM into current use of BIM.

Along with the creation of a more sustainable, efficient and effective sector, the digitalization of infrastructure seeks to achieve strategic objectives that are difficult to accomplish through traditional analogical means.

This section describes the experience of deploying BIM in transport infrastructure in different areas of the National Public Administration and its dependent bodies: from roads, ports, railways and airports management and maintenance to innovative BIM applications in dams construction and geospatial information integration, among other initiatives.

The digital transformation of the Directorate General of Roads with BIM

BIM in the National Road Network

The Ministry of Transport and Sustainable Mobility's General Directorate of Roads (DGC) manages 95% of the National Road Network, with an annual budget of approximately € 2,600 million.

With numerous projects and works carried out each year, the potential for using BIM methodology is substantial. The implementation of this work methodology is, in conjunction with the development of a digital twin of the National Road Network for the maintenance and operation phase, one of the fundamental cornerstones of the ambitious digital transformation of the DGC. Thanks to these initiatives, the DGC is fully aligned with the BIM Plan in Public Procurement.

- Text: Antonio Muruais and Jose Menchén, Deputy Director of Sustainability and Innovation, DGC



The General Directorate of Roads (DGC), which reports to the General Secretariat for Land Transport of the Ministry of Transport and Sustainable Mobility, is responsible for managing the National Road Network (RCE), together with the Government Subdelegation in the National Toll Motorway Concession Companies and SEITT, SA. Specifically, the DGC manages 95% of the RCE, making it the largest road infrastructure manager in Spain.

The DGC has a matrix structure consisting of five General Deputy Directorates (plus a Support Unit) and fifteen Territorial Districts covering the Spanish territory served by the RCE. It is worth remembering that the RCE consists of some 26,500 km of main trunk roads on which 53% of the total traffic in Spain and 67% of heavy traffic circulates.

It is, therefore, a complex organisation with a workforce of approximately 1,400 people and an annual budget of € 2,600 million (General State Budget for the year 2023, not including funding from European programmes such as the Next Generation EU funds), which is used to manage the RCE throughout its life cycle (planning, design, construction, maintenance and operation). The entire organisation is managed through the new prism of sustainability, digitalization and innovation, which have been incorporated as the DGC's guiding operational principles and are coordinated by the new Deputy Directorate of Sustainability and Innovation.

In particular, the digital transformation of the DGC, which includes the use of BIM as a key

The digital transformation of the DGC has become a priority objective, as it is the only way to maximise efficiency when managing limited resources.

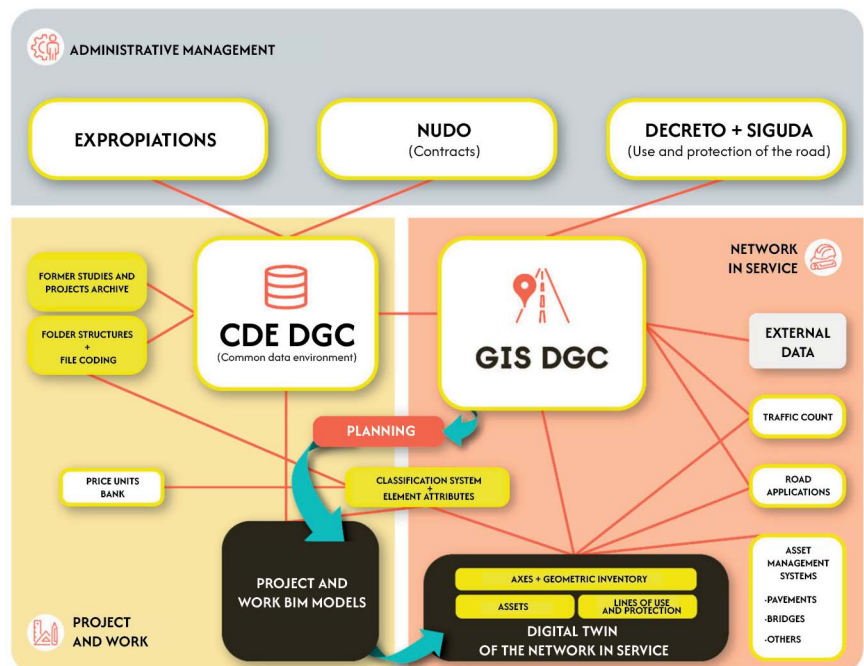
element, has become a priority objective for the organisation, as it will maximise efficiency in the management of the limited human and financial resources currently available to carry out all the processes and activities necessary to guarantee a safe and quality RCE, open 24 hours a day, 365 days a year.

This digital transformation will also serve to standardise the processes of the Territorial Districts and General Sub-Directorates, which will result, in addition to enhanced efficiency, in a more robust "RCE" brand, both internally and for the people.

Lines of the DGC's digital transformation

A few years ago, the DGC began an ambitious process of digital transformation based on three main lines of work: one relating to the digitalization of the existing road network, another concerning the digitalization of projects and works for the development of new infrastructure, and a third relating to the digitalization of administrative management, which is a cross-cutting measure that impacts every phase of the life cycle of a road.

Sketch of the DGC's digital transformation.



1. BIM in the management of the existing road network

The activities within this line of work, such as the digitalization of the more than 26,500 km of roads in service, are focused on obtaining two fundamental products: a digital twin of the existing network and a corporate GIS platform for the DGC, all under the BIM methodology, which is explained later on.

- The **digital twin** is constructed on the basis of the work carried out using the BIM methodology, which includes creating the RCEclass system (Element Classification System), which, in turn, will provide the library that will guarantee interconnection between project and construction activities and those relating to the maintaining and operating the existing network.
- The **DGC's corporate GIS platform**, currently being developed by the Ministry's Deputy Directorate of Technologies and Digital Administration (SGTIAD), will allow the digital twin of the existing network to be viewed and consulted, along with other internal DGC data (such as traffic data, data relating to road surface auscultation, etc.) and external data (such as data relating to natural spaces, climatological data, etc.). The ability to visualise and consult this data will enable analyses to be carried out and conclusions to be drawn, which, in turn, will support decision-making related to maintaining and operating the network and planning new projects.

The digital twin of the National Road Network

The digital twin of the in-service network will serve as the reference model for the operational phase of the roads and will support other dedicated management systems.

This digital twin is currently under development and will be made up of the following elements:

- **Calibrated axes of the various sections of the network**, which will provide a linear reference (road and kilometre point) for any element in the network (structures, signs, transverse drainage works, etc.).
- **A geometric inventory of the network**, which will provide additional geometric information for each point in the network, such as the number of lanes and their width, the width of the shoulders, the cross and longitudinal gradients, etc., and will allow various analyses and studies to be carried out, including studies to identify needs to extend or improve the network. This inventory will be obtained from a *mobile map-ping-generated* point cloud upon which the vectorisation of lines and surfaces will be carried out and by obtaining the main parameters of the geometry of the roadbed and the surrounding area.
- **The inventory of network assets**, i.e. the various elements in the network (pavements, bridges, tunnels, signs, lighting, etc.), which will form the basis of the asset management systems used to prioritise maintenance work on these assets.
- **The lines of use and protection**, which, once identified and digitalised, will make it easy to identify road protection zones, which, in turn, are legally protected from the activities and actions of private individuals.

2. BIM in the DGC's projects and construction work

When it comes to digitalising projects and construction work, implementing BIM methodology plays a particularly important role. It should be noted that the DGC is responsible for implementing, within the framework of its competences, the BIM Plan in public procurement approved by the Council of Ministers in June 2023, which establishes a gradual and progressive incorporation of the BIM methodology in public contracts of the National

Public Administration and the state public sector related to construction.

This implementation will be dealt with in greater detail in the following sections, although it is worth mentioning that it will be based on two fundamental pillars:

- The creation of digital models which will reflect the planned actions and the works actually carried out, and which will generally be characterised by being three-dimensional and fed with information (technical specifications of

the different elements of the road, documents relating to the quality controls carried out, bills of quantities, etc.).

- The deployment of a Common Data Environment (CDE), which will constitute the repository in which the technical documentation associated with all the DGC's projects and works developed using the BIM methodology is filed and shared with all the agents involved.

Over the past several years, the DGC has been laying the necessary foundations to be able to implement the BIM methodology in its projects and construction work, taking into account the multiple conditioning factors intrinsic to the RCE and the functioning of the DGC itself, and maintaining coherence with its overarching digitalization strategy.

As a result of this work, in the coming months BIM requirements will begin to be incorporated into the tenders associated with the DGC's projects and construction work, which will enable the progressive implementation of the methodology and, with it, the achievement of the following strategic objectives:

- Improved efficiency in public spending associated with the development of new initiatives.
- Improvement of the necessary transfer of information from the works phase to the operation phase.
- Promotion of the digitalization of the construction sector.

As a complement to the implementation of the BIM methodology, two additional issues are being addressed in this line of digitalization:

Implementing the BIM methodology in the DGC's projects and construction works will improve the efficiency of public spending associated with the deployment of new actions, facilitate the necessary transfer of information from the construction phase to the operation phase and bolster the digitalization of the construction sector.

- The development of a digital price bank of the DGC, which will include, in addition to the corresponding set of work units and their prices, the technical specifications and associated environmental data. This price bank will serve as a reference for the consultants involved in drafting the DGC's studies and projects and for the DGC's own staff.
- The collection, scanning and codification of the DGC's "historical" studies and projects in order to digitise and archive them in a common, easily accessible repository. The georeferencing of the main site plans of these studies and projects is also being addressed, so that they can be visualised and compared in GIS environments.

Work on-going in relation to the implementation of BIM

Some of the most important tasks currently being carried out to enable the progressive implementation of BIM methodology in the DGC's projects and construction works include the following:

1. Creation of the DGC's Common Data Environment

As mentioned above, the Common Data Environment (CDE) will constitute the repository in which the technical documentation associated with all the DGC's projects and works developed using the BIM methodology is filed and shared with all the agents involved, and its deployment will represent a major step forward towards single data.

In addition to having functionalities associated with document management, the CDE will also have other more advanced functionalities associated with viewing BIM models and consulting the information they contain, as well as allowing integration with other DGC tools, such as NUDO, the corporate GIS platform and the EXPROPIACIONES tool, among others.

Given the need to guarantee the technological neutrality required for a public administration, the DGC's CDE is being developed by the SGTIAD, with the DGC participating by defining and prioritising its functionalities, which will be gradually deployed. The CDE will be the official point

The DGC's CDE

The CDE that will be used in the projects and works undertaken by the General Directorate of Roads will have two fundamental features: the Ministry of Transport and Sustainable Mobility will make it available to its companies and the whole of the National Public Administration and its institutional public sector, and it will be developed in-house.

The combination of these two factors will provide the General Directorate of Roads with a series of advantages, such as standardisation in terms of how the documentation generated is archived, total control over this documentation, no dependence on third parties and their commercial solutions, and the possibility of integration with other internal developments such as the NUDO tool, the DGC's corporate GIS platform and the Ministry's signature area, among others.

of access for the DGC's subcontractors and for the monitoring of their projects and works.

2. Definition of folder structures and file coding

In parallel to the development of the CDE, the DGC is defining the folder structures of the contracts whose technical documentation will be filed in it.

The aim is to use the same folder structure for the same contract typology, previously agreed upon by the different units of the DGC, to facilitate subsequent searches for information.

In addition, the coding criteria for the files to be stored in these folder structures are being defined, which will facilitate the search for information within the CDE, making it possible to locate specific files by filtering according to the corresponding coding fields.

In short, the aim is to ensure that all documentation is well organised within the CDE, with pre-established and agreed folder structures for each type of contract that will host the

documents, which, in turn, will be coded according to pre-established rules.

3. Development of a specific RCE classification system:

The DGC is also developing an RCE-specific classification system (called RCEclass), which will be characterised by being multi-table and applied to both file names and 3D elements of the BIM models.

This classification system will provide three key functionalities:

- It will standardise the nomenclature of elements and files, in all life cycle phases and actions.
- It will enable the establishment of BIM requirements at element level. For example, it will be possible to define whether or not a particular element needs to be modelled, the degree of detail with which it must be modelled and the specific attributes it must have.
- It will enable the filtering of elements in BIM models according to different criteria, e.g. according to the main



Cover of the RCEclass Manual.

function of the element or its constituent materials.

4. BIM pilot project: A-67, Polanco-Santander section

To test the benefits of applying BIM methodology in a DGC intervention, a pilot project is underway to implement BIM methodology in the project to increase the capacity of the Polanco-Santander section of the A-67 motorway.

The BIM pilot project initially involved modelling the original conventionally drafted construction project, and the subsequent construction work will soon be monitored using BIM methodology and the new model as a reference.

Also within the framework of the BIM pilot project, we tested the ability of point cloud technologies to capture the existing terrain surfaces and the road to be widened, with the ultimate goal being to experiment with using them as tools to support the subsequent monitoring of the work.

Transforming transport infrastructure with BIM

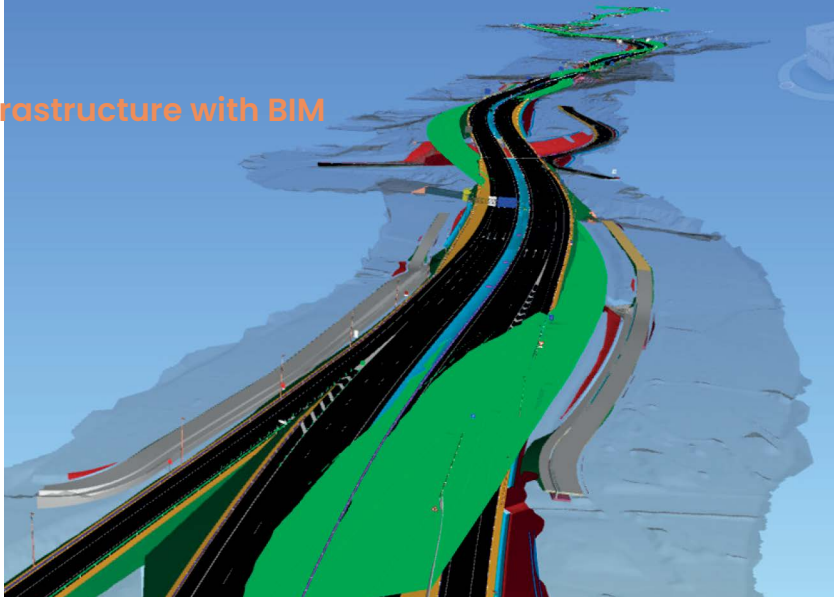
The execution of the BIM pilot will allow the DGC to identify the BIM applications that may be relevant and useful to its projects and construction work, in addition to detecting possible requirements for or barriers to more generalised BIM implementation.

5. Definition of the BIM requirements to be included in tender specifications

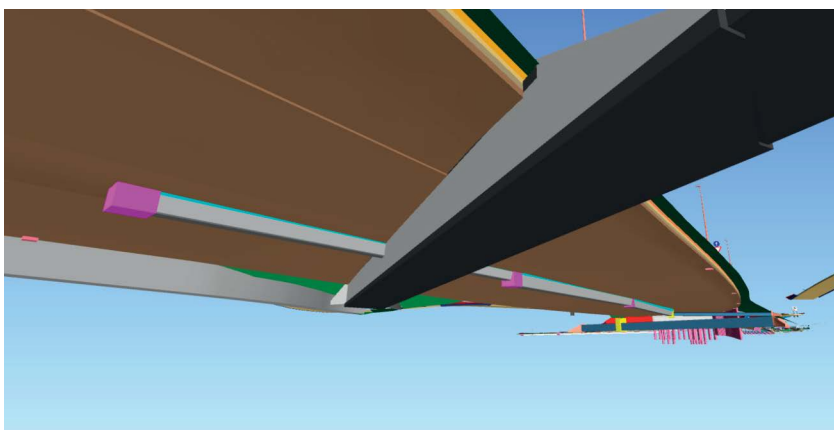
The DGC is currently in the process of specifying and defining the BIM requirements to be included in the tender specifications for contracts affected by the BIM Plan.

This process is being approached on several fronts:

- Firstly, the "high-level" BIM requirements are being defined and agreed upon internally for each of the different contracts affected by the BIM Plan. These "high-level" BIM requirements include the BIM models to be delivered in the contract, the



Model derived from the conventional construction project for the work to increase the capacity of the Polanco-Santander section of the A-67, together with the surface of the current A-67 (in green).



Example of a collision detected during the modelling of the conventional project for the work to increase the capacity of the Polanco-Santander section of the A-67.

Infographic obtained from the model generated in the Polanco-Santander BIM pilot.



BIM applications associated with the models, their delivery deadlines, and the personnel with BIM expertise assigned to the contractors. The BIM requirements will be customised to fit different contract types, and defining them will require a high degree of consensus between the various units concerned.

- Secondly, these "high-level" BIM requirements will be developed and translated into BIM annexes that will be attached to the Technical Specifications of the corresponding contracts. As a reference for BIM Annexes, the DGC will use the BIM annexe models being prepared by the Interministerial BIM Commission, in which the DGC itself participated by contributing its criteria.

Future lines of work related to BIM implementation

In addition to the work carried out to date to initiate the implementation of BIM in the DGC's projects and construction works, additional work will be undertaken in the near future to further materialise and refine the implementation of BIM. This work could include the following:

- Defining both the general and specific attributes of the different elements of the BIM models so that the information that these BIM models must have is clearly defined.
- Drafting BIM guides and manuals to explain and complement the information provided in the contract specifications for contracts subject to BIM requirements.

- Defining procedures and rules for reviewing the BIM deliverables that the DGC will start receiving upon initiating future contracts subject to BIM requirements and establishing the necessary means to carry out these reviews and facilitate the verification and quality assurance of the BIM deliverables.
- Developing training plans for DGC staff to facilitate the management and supervision of future contracts subject to BIM requirements.
- Analysing the DGC's current processes, procedures and workflows to evaluate the potential for optimising them with the BIM methodology and a Common Data Environment.

Finally, specific mention should be made of the continuous updating and improvement to which all the integral elements of the BIM implementation must be subjected, which will be reviewed in the light of accumulated experience and according to the obstacles and opportunities identified during the DGC's digital transformation process.

3. BIM in the digital transformation strategy of the administrative management of the DGC

BIM also plays a role in the digitalization of the administrative management of the DGC. In fact, it could be said that the seed that planted the DGC's current digital transformation process was the development of the NUDO tool, which was initially conceived for processing

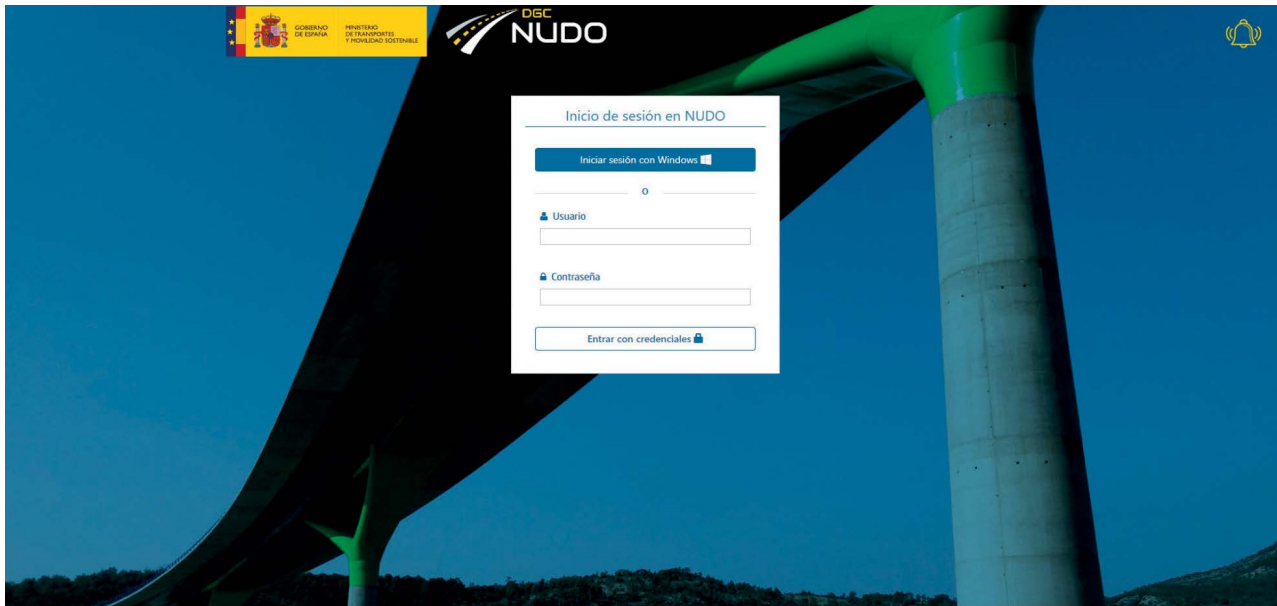
the monthly certifications of the DGC's administrative contracts (replacing the traditional paper-based processing of these monthly certifications) and which today is fundamental in the daily work of both the DGC staff and the companies contracted to execute the various contracts.

Work to implement new NUDO functionalities and integrate the tool with other DGC systems is ongoing. In particular, work will be carried out to integrate it with the CDE developed within the DGC's BIM framework so that the administrative documentation managed by NUDO for contracts subject to BIM requirements can be consulted from the CDE.

The following figures highlight the current importance of the NUDO tool from the date of its creation until April 2024:

- The number of contracts managed in NUDO stands at 1,800.
- The number of monthly certifications managed in NUDO is 32,681, with an average in recent years of around 7,000 certifications/year.
- The total sum certified through the NUDO tool amounts to about € 7,000 million, with an average in recent years of about € 1,600 million/year.
- The NUDO tool is used by a total of 1,659 users (962 internal and 697 external).

The first monthly certification managed by NUDO was processed in April 2017. Over the years, and given the NUDO's potential to improve administrative efficiency, additional procedures and functionalities were implemented, such as the processing of work completion certifications



Initial screen view of NUDO.

and the readjustment of annual payments, or the development of dashboards that allow us to exploit the financial data of the contracts managed in NUDO.

Furthermore, and linked to the digitalization of the DGC's administrative management, a series of additional tools have already been or are currently being developed that will also contribute to improving administrative efficiency.

Of particular note are the DECRETO and SIGUDA tools. The first of these is used to support and monitor the allocation of administrative tasks generated through the National Public Administration's Electronic Office or General Registry, and the second, SIGUDA, is used as a document manager to process the RCE's use and protection files (exploitation phase).

It is also worth mentioning the EXPROIACIONES tool, currently in the development phase, which will enable the management of the processing of expropriation

files associated with the execution of new actions, as well as the asset management of land expropriated due to the needs of works that have already been executed. Linking the EXPROIACIONES tool with the CDE developed by the BIM methodology will also be fundamental.

Lastly, another line of action consists of developing an application that will provide information on the status of any intervention on the National Road Network (ordinary maintenance work, informative study, construction project, work in progress, emergency work, etc.) at any kilometre point on the network, linking the CDE and the digital BIM models in the project and work phases, and connecting to the DGC's corporate GIS to pinpoint its location on the network.

Conclusions

The DGC is working on many fronts to achieve a profound digital transformation, among

which the implementation of the BIM methodology plays a central role. This is not an easy task due to the complexity of the organisation itself and the high degree of interlinkage between initiatives, which complicates every step.

However, thanks to the approach and efforts of the various working groups on digitalization in the DGC in previous years and also to the restructuring of the DGC, which has made it possible to equip the digitalization process with more human and financial resources, we can confidently say that the lines of work undertaken are slowly but surely making progress and that, in the medium term, this progress will make the DGC a model for transport infrastructure administration, potentially even at international level, in terms of the digitalization of its processes and, particularly, the use of the BIM methodology. ●

The digital transformation of the DGC is not an easy task, due to the complexity of the organisation itself on the one hand, and the high degree of interlinkage between initiatives on the other.



Integrating Geographical Information Systems in the BIM methodology

GIS-BIM. Synergy for efficiency and sustainability

The integration of geospatial information, typically through Geographical Information Systems (GIS) and Building Information Modelling (BIM), offers great potential for the construction and civil engineering industry. This article aims to highlight the benefits of this integration, which include improved decision-making, planning and scheduling, collaboration and the consequent impact on cost reduction. In addition, the explosion of emerging technologies, which have been rapidly adopted in the geospatial world, such as Artificial Intelligence (AI), and Big Data, applied to the territory digitalization, will shape a more efficient and sustainable sector in the future.

- Text: Francisco Javier González Matesanz, Deputy Director for Cartography and Territorial Monitoring (IGN)

Coloured point cloud from LiDAR flights (MapaLiDAR) / National Geographic Institute.



The importance of having access to the two related worlds of GIS and BIM

Each phase of the BIM methodology involves making decisions that can be summarised as a question and for its answer information related to the territory, i.e., geographical or geospatial information, is required. What is the optimal location for this project in terms of accessibility and compliance with local regulations? What initial design features best align with the client's objectives and the project's functional requirements? What impact will this project have on the immediate environment, and how can we mitigate any negative effects, or what sustainability

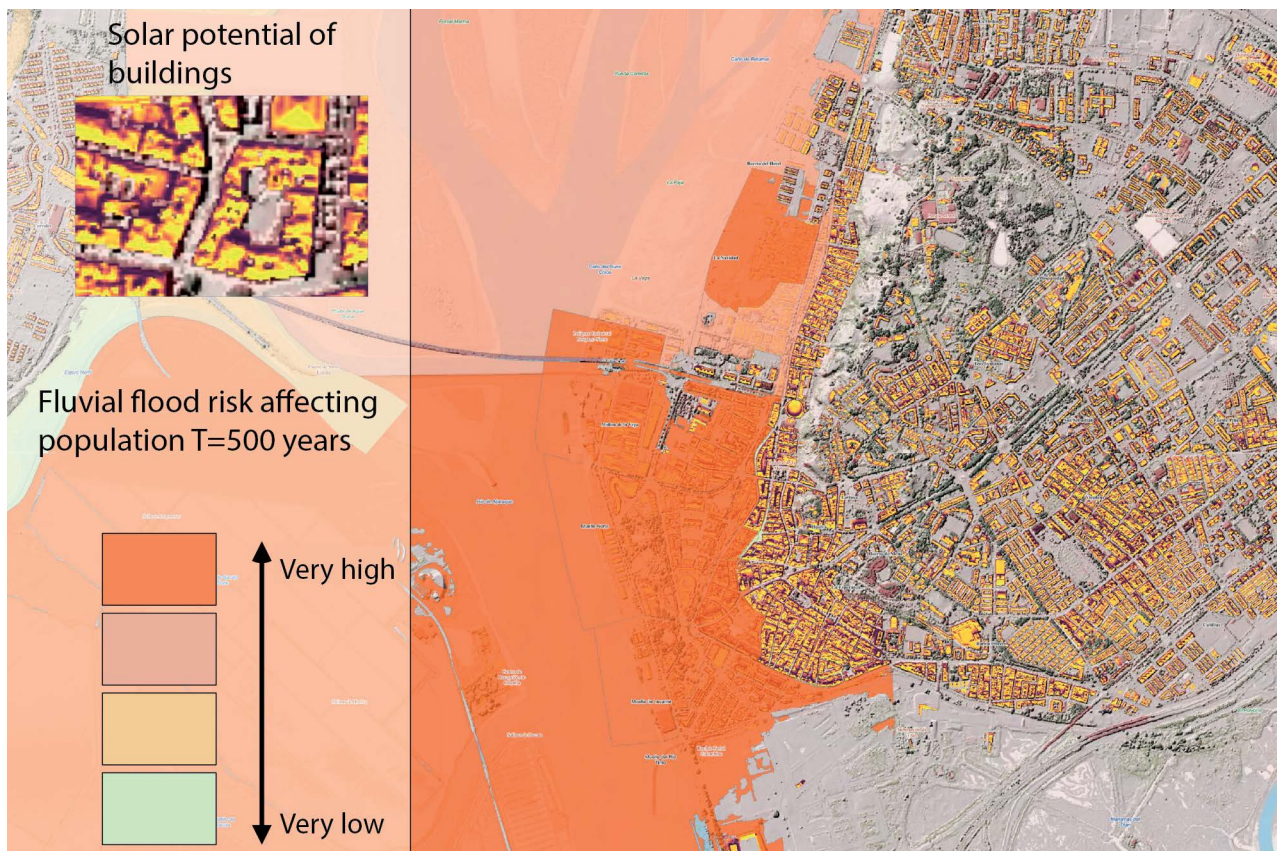
strategies can be implemented during the maintenance or demolition? These are just a few simple examples of very complex decisions that inevitably require knowledge of the environment. Understanding the environment involves two groups of geospatial information that are highly useful in BIM methodology: the digitization of the territory and the availability of highly specialized and high-value geospatial data that provide reliable answers for decision-making.

Integrating BIM methodology with Geographical Information Systems (GIS) to manage construction projects brings numerous advantages and creates a highly efficient management ecosystem. BIM offers a detailed

geometric and semantic representation throughout the life cycle of a project, i.e. it is asset-focused and, therefore, has a "vertical" vocation. For its part, GIS completes this information with advanced analysis capabilities that support decision-making based on spatial components, relationships based on complete information and the detailed data provided by geospatial modelling, thus providing a comprehensive understanding of the project and its context. The power of GIS lies precisely in this ability to analyse context, and in this sense, one could say that its behaviour is "horizontal".

In addition, BIM-GIS integration facilitates quality management by enabling dynamic explora-

Geospatial data for solar radiation potential and flood risk on LiDAR data.



tions of risk factors and potential defects and improves efficiency in the time and progress management of Architecture, Engineering and Construction (AEC) projects through construction simulations, visualisation and analysis. Modelling and dynamic exploration is the process of creating computational representations or models that can simulate the behaviour of complex systems over time, for example, to simulate how a building will react to different environmental factors, such as changes in temperature, thermal load, sunlight or wind over the course of the year.

Models generated from BIM methodology are also very useful in GIS. BIM models provide a high level of detail and accuracy when representing structures and elements in the built environment. By integrating this information with geospatial data, we can improve the accuracy and completeness of geospatial databases.

In addition, the BIM methodology, in principle, allows for dynamic real-time updating. This means that any changes in the terrain, infrastructures or buildings can be quickly incorporated into these databases, and, in addition, it opens the door to the incorporation of additional information that enriches the geospatial data, providing more valuable and more detailed contexts that can be used for more complex and precise GIS analyses.

These analyses can cover compliance with norms or standards, such as those related to land use or occupation, heritage

and cultural protection, environmental legislation and any other aspect linked to the territory. They can also include the specific regulations applicable within the field of a given BIM asset throughout its entire life cycle.

The importance of digitization for the GIS-BIM cycle

Since their conception, both GIS and BIM systems have evolved significantly, transforming how civil engineering and urban planning projects are designed, planned, constructed and managed. GIS, through its ability to analyse and visualise geospatial data, and BIM by providing a detailed digital model of the physical and functional characteristics of a building or civil engineering infrastructure. Their integration implies a deeper understanding throughout the project's entire life cycle coupled with improved decision-making capabilities due to the wealth of information contained in both technologies. However, above all, it has opened the door to unseen levels of project management in which efficiency and sustainability are not just aspirations but

The digitalization of the territory, also considered an asset, and the great availability of reliable digital geospatial data allow for more accurate and up-to-date analyses, thus facilitating the informed and agile decision-making essential in BIM methodology.

achievable goals that minimise “scope creep” effects, i.e. when the scope of a project is continually called in question during its life cycle due to unforeseen events or contingencies.

Urban and rural spatial planning has historically faced numerous challenges, mainly stemming from the use of traditional methods that are often based on inaccurate data and manual processes, resulting in sub-optimal decisions that can affect the sustainable development of communities. The inaccuracy of traditionally used geospatial and socio-economic data has led to inaccuracies when estimating requirements, resources, or the actual return on a planned asset. In the past, this fact, coupled with a lack of available data for analysis, has hindered the effectiveness and the ability to respond to emergencies or rapid socio-economic change.

The digitization of the territory and the adoption of reliable digital geospatial data have emerged as solutions that provide decisions with a higher probability of success. These technologies can provide more accurate and up-to-date rep-

representations and analyses of a physical space or territory, thus facilitating informed and agile decision-making.

BIM technology integrates not only the digital version of buildings, structures, civil works or similar but certain functionalities of those assets. Thus, it facilitates analyses that take into account the individual asset (e.g. collision detection), but more importantly, it allows analyses that consider an asset's relationship to the digitalised territory. The territory itself is an asset as it generates economic, social or environmental value.

Examples include: 1) the integration of GIS in the planning of routes between amenity spaces optimises routes, reducing costs and response times; 2) the planning of new residential areas that overlap with existing or planned civil engineering infrastructures ensures a better adaptation of urban design to the natural terrain through detailed geospatial analysis; or 3) agriculture, water resource management and natural habitat conservation allow planners to design strategies that balance economic growth and environmental protection.

BIM and the acquisition, observation and digitization of the territory

A BIM project begins with the initial analysis phase or preliminary studies. In this initial stage, precise research and analysis of the project site are undertaken, encompassing environmental and topographical elements, potential restrictions derived from the local culture and possi-

Having access to a vast amount of data, be it localised and highly detailed information on the BIM asset or its surroundings or on the territory as a whole, makes it possible to use Artificial Intelligence (AI) techniques to carry out a broad range of analyses, such as simulations and predictive maintenance.

ble legal or property limitations, among many other aspects. That is a detailed and deep understanding of the context and territory, in which the project will be developed in order to draw the first sketches of it. That will ensure that every future decision is informed, feasible and respectful of the environment that hosts it

The basic support used in this phase is a digital model of the physical terrain. Both human activity and natural processes are profoundly influenced by the orography of the place in which they occur, the terrain being a critical socio-economic factor and a key determinant for a multitude of natural phenomena. Land elevation is so essential that it has been recognised as a fundamental global geospatial data by the United Nations (UN-GGIM), the INSPIRE directive and the National Cartographic System.

Detailed knowledge of elevations, in the form of Digital Elevation Models (surfaces, terrain or buildings), is crucial for multiple purposes: defining suitable sites for human development through "geoprocessing" to create three-dimensional models, defining water basins, mapping flood-prone areas, conducting

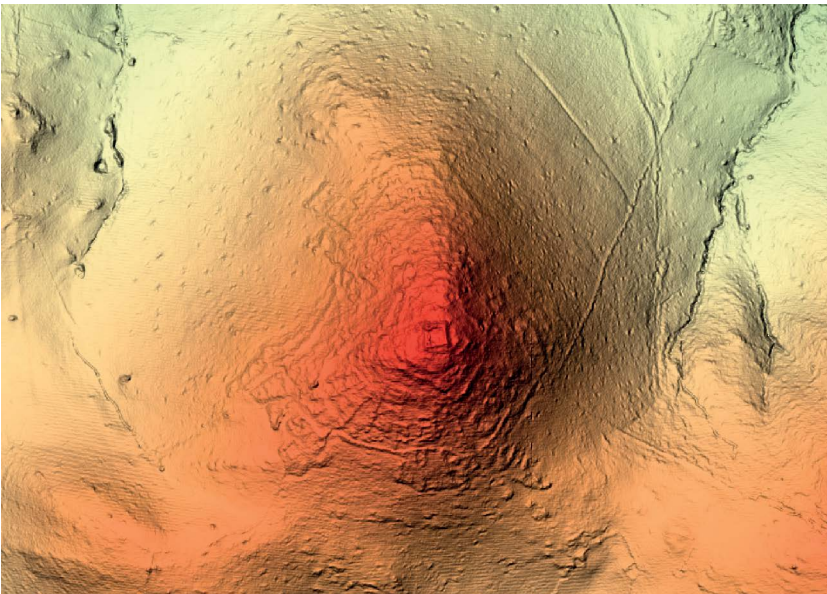
forest inventories, predicting the spread of physical phenomena such as pollution, landslides or the progression of fires, etc.

LiDAR is the technology predominantly used to capture this information with a high degree of accuracy, which have evolved considerably during the 20th century. LiDAR is an active remote sensing technique that employs sensors located on aerial or ground-based platforms that emit pulses of light and capture the resulting echoes. This makes it possible to calculate the distance the light has travelled and thus generate an accurate three-dimensional representation of the terrain and its features. One of LiDAR's unique features is its ability to penetrate vegetation, revealing the underlying forest structure and other details hidden by the foliage, as shown in the image.

In Spain, the 2008 PNOA-LiDAR project, a joint venture undertaken by the autonomous communities and the National Public Administration (AGE), coordinated by the National Geographic Institute, pioneered the collection of three-dimensional data on the national territory. LiDAR flights generate dense point clouds and



Archaeological site under the tree layer detected by PNOA-LiDAR.



Digitization of the territory and detection of power lines.

high-precision Digital Elevation Models (DEMs) with coverages that are regularly updated. The project has provided essential data for a wide range of applications, improving land management and infrastructure development. Its third survey, which began in 2023 and will end in 2026, will remain being an indispensable resource for multiple users, specially the public administrations.

On a more detailed level, in addition to the territory, the digital ecosystem that shapes BIM also encompasses existing assets that have to be digitalised. Thus, we use the term Heritage Building Information Modelling (HBIM) for assets with significant heritage value and Existing Building Information Modelling (EBIM) for existing assets, both of which can be digitalised and inserted into the territory.

A study carried out in the city of Nanjing, China, addressed the effectiveness of the Scan to BIM method for assessing the retrofitting of existing buildings to the nearly-zero energy standard, highlighting its usefulness as a reproducible and effective tool in energy efficiency research. With this technology, it was able to prove that energy consumption can be reduced by around 8% and carbon emissions by more than 85%. It demonstrates the feasibility of employing this approach, which is referred to as digital twin-based assessment, to achieve more sustainable and efficient buildings.

Combined terrestrial laser and photogrammetry measurements to determine the digital twin of the VLBI (Very Long Baseline Interferometry) geodetic and astrometric radio telescope

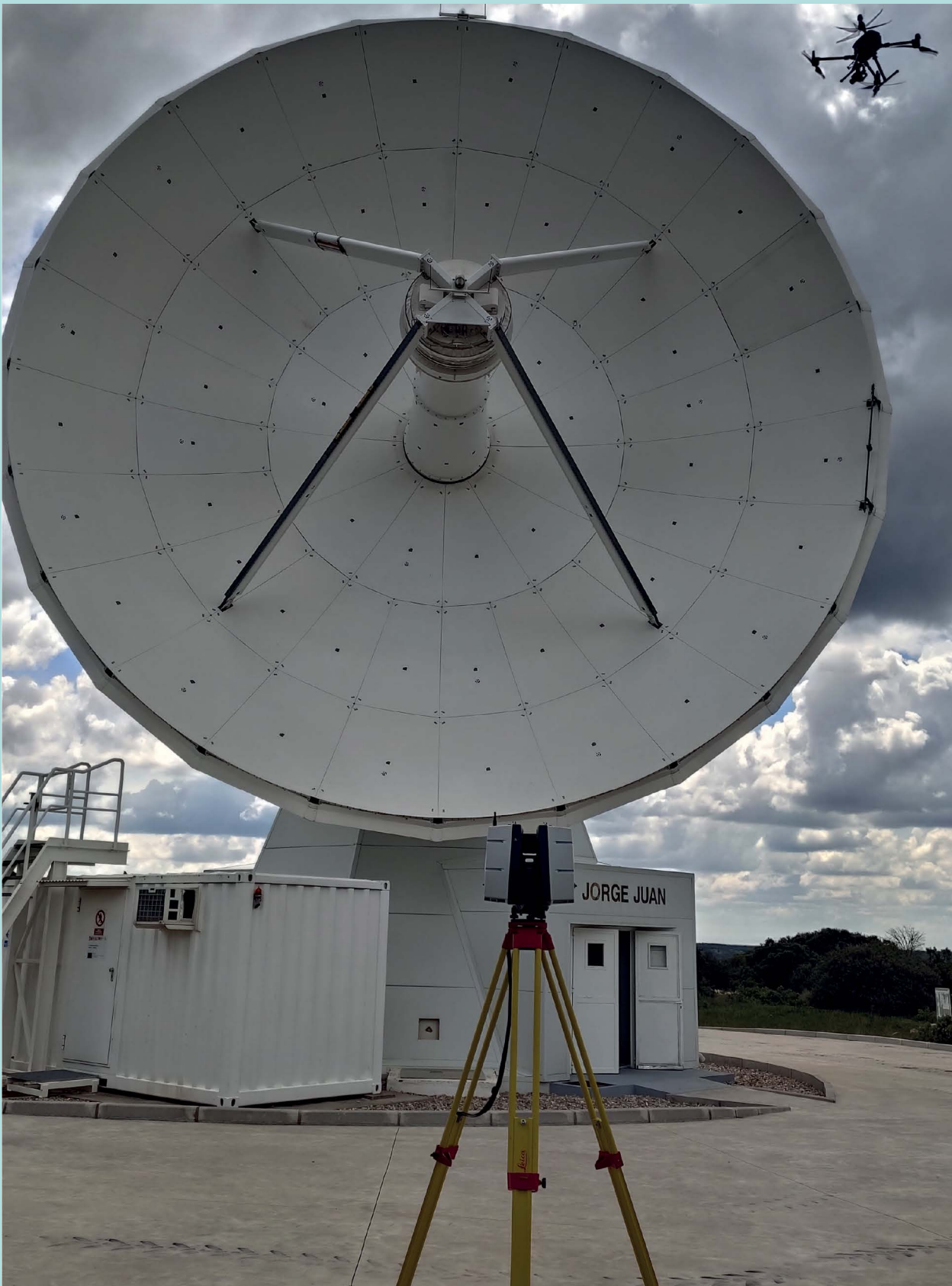
The BIM methodology covers all the possible phases of an asset, including the surveying of existing assets (Scan to BIM) to optimise their efficiency, as was done for the National Geographic Institute's radio telescopes.

The efficiency of a reflecting antenna is conditioned by the ratio between its physical surface area and its ideal geometric shape. The lower the wavelength of use, which in this case is 90 GHz, the greater the precision required. Microwave or radio holography techniques allow us to optimise the reflecting surface of radio telescopes, and are currently the best available method for determining the shape of the reflector surface. Terrestrial laser measurements and drone photogrammetry then complement this technique to make the surface adjustments required to maximise the parabolic reflector's radioelectric efficiency (or aperture).

The reflecting surfaces of radio telescopes consist of precisely fabricated reflector panels (usually made of aluminium) that are bolted onto a beam structure. The National Geographic Institute's Yebes observatory has two radio telescopes, one of 13.2 m and one of 40 m. In the case of the latter, more than 400 separate panels are needed to create the parabola.

The efficiency with which radio waves are captured depends on the degree of approximation to the theoretical parabola with respect to the wavelength of the signal to be captured. When the mean squared error approaches a fraction of a twentieth of the wavelength, this efficiency is halved. Thus, for frequencies of 100 GHz, the precision required to obtain this efficiency is about 150 microns of mean squared error. The wind, gravity and the temperature can all influence these deformations. Consequently, the aforementioned techniques are used to determine how much each panel should be adjusted to recover the ideal parabolic shape by making the necessary adjustments to each panel.

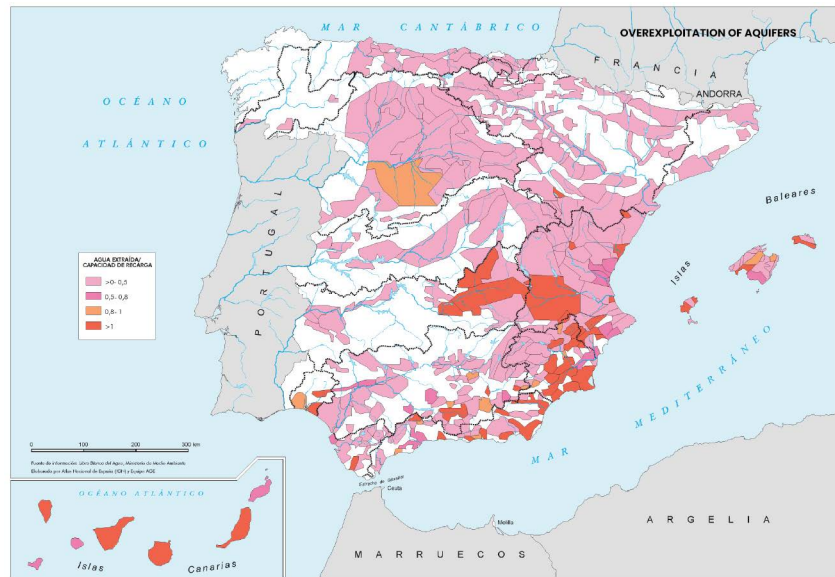
Thanks to these complementary techniques, we can now obtain a digital twin (Scan to BIM) of both the parabola and the entire structure to study the deformations of the radio telescope caused mainly by the position of the parabola (orientation and, to a greater extent, the elevation). As a result, we can make the necessary adjustments to each of the elements that make up this 'physical' parabola until we get it as close as possible to an 'ideal or theoretical' parabola with a high level of precision.



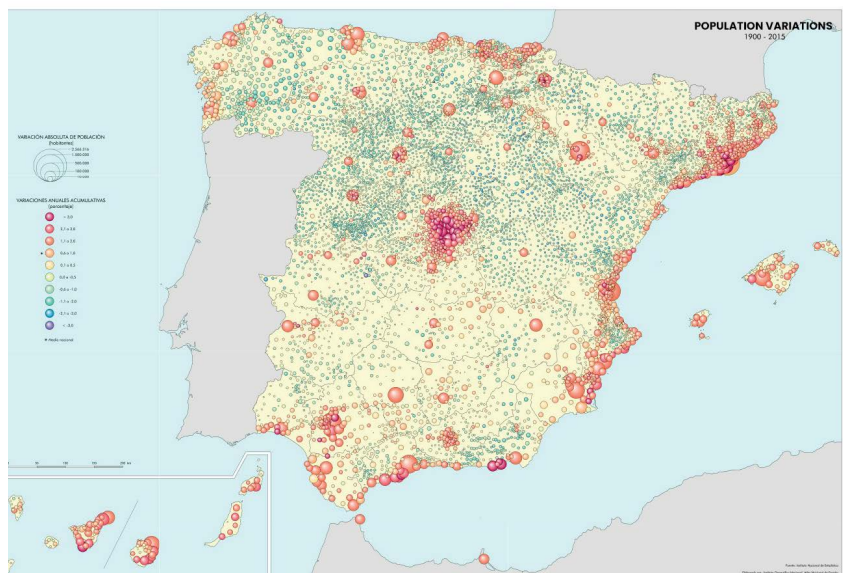
About the availability of high-value geospatial data in BIM

The need to make decisions about a given BIM asset includes not only relating or contextualising it to the digitalised territory but also to much more specialised geospatial information with superior semantic richness. Having superior semantic richness implies being able to provide more targeted answers in a specific knowledge domain, such as water, populations or mobility.

Over the next 40 years, the number of urban inhabitants in the developing world is expected to increase by almost three billion people, and this urban demographic shift will occur alongside the impact of climate change on the global hydrological cycle. Human-induced greenhouse gas emissions are expected to make increase average global temperatures, most acutely near the poles, and to alter precipitation patterns. These climatic and demographic trends will be a fundamental challenge in some regions, and decision-makers will have to work out on how to ensure a sustainable water supply for the growing urban population. Approximately 150 million people in the world are already facing water scarcity, and that number is expected to increase to almost one billion by 2050 due to the factors cited above. As a result, investments in infrastructure will be needed to ensure the water supply and protect water ecosystems. Scenarios such as these would be intractable without geospatial information. This is why the



Aquifer overexploitation problems (above) and population variations between 1900 and 2015 (below).



European Commission, through its Directive (EU) 2019/1024 of 20 June on open data and the re-use of public sector information, recognises its importance and promotes the availability of high-value geospatial data. The impact of this data must be maximised by facilitating its re-use and publishing it free of charge and with minimal legal restrictions through application

programming interfaces (APIs).

Similarly, Commission Implementing Regulation (EU) 2023/138 of 21 December 2022 classifies high-value data into six thematic categories: geospatial, Earth observation and environment, meteorology, statistics, companies and company ownership, and mobility. The first three categories are thus inherently geospatial, although geospatial

components are also prominent in the remaining categories, particularly mobility.

The European Commission anticipates that the list could be expanded in the future to adapt to technological developments and market changes. The data must be made accessible in machine-readable formats, through APIs and, in some cases, as bulk downloads. This approach not only facilitates the re-use of data but also strengthens interoperability, including legal interoperability, thus promoting the efficient use of high-value data resources across various cross-border applications and services.

An example of high-value data is the Geographical Hydrography Information produced by the National Geographic Institute, which is essential for detailed geographical and hydrological analyses. Responsibility for this information is distributed, depending on its nature, between the National Geographic Institute, the Directorate General for Water, and the water catchment confederations and organisations, implying a co-ordinated effort between these entities. These practices respond to the need to harmonise data and comply with existing regulations on the management, protection and representation of water resources, underlining that water is common patrimony, not a commercial good. The specifications of this network are aligned with the Water Framework Directive (2000/60/EC) and the INSPIRE Directive (2007/2/EC). Linking water and population data is an essential aspect of territorial management, as can

be seen in the image showing the overexploitation of aquifers and the high rates of population variation.

At a more global level, combining this geospatial information with population data allows us to generate models such as NASA's Global Rural-Urban Mapping Project (GRUMP), which, together with global hydrological models, allows us to accurately analyse the urban population distribution and the availability of water. This enables the forecasting of future water scarcity and allows for proactive measures to address this issue, particularly in regions already facing water shortages. Factors such as water quality and delivery infrastructure must also be considered.

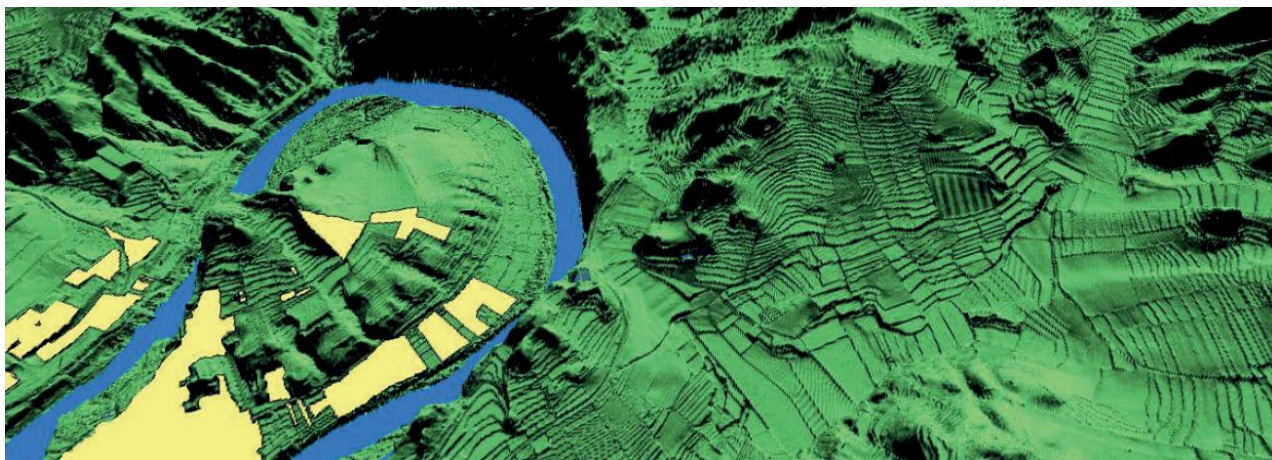
As mentioned above, another important and more granular geospatial data source than the high-value data managed by administrative departments is the Geographical Reference Information on Populations (IGR Poblaciones), which is designed to manage and continuously update the location and geometrical features of population settlements in Spain. This resource includes three types of geographical objects: clusters of residential buildings (such as urban centres and housing estates), social infrastructures (e.g. hospitals and schools), and industrial facilities, all of which have distinctive characteristics but are connected by continuous flows of people, communications, goods and activities.

This spatial dataset not only reflects the location and shape of settlements and their related buildings but also identifies those

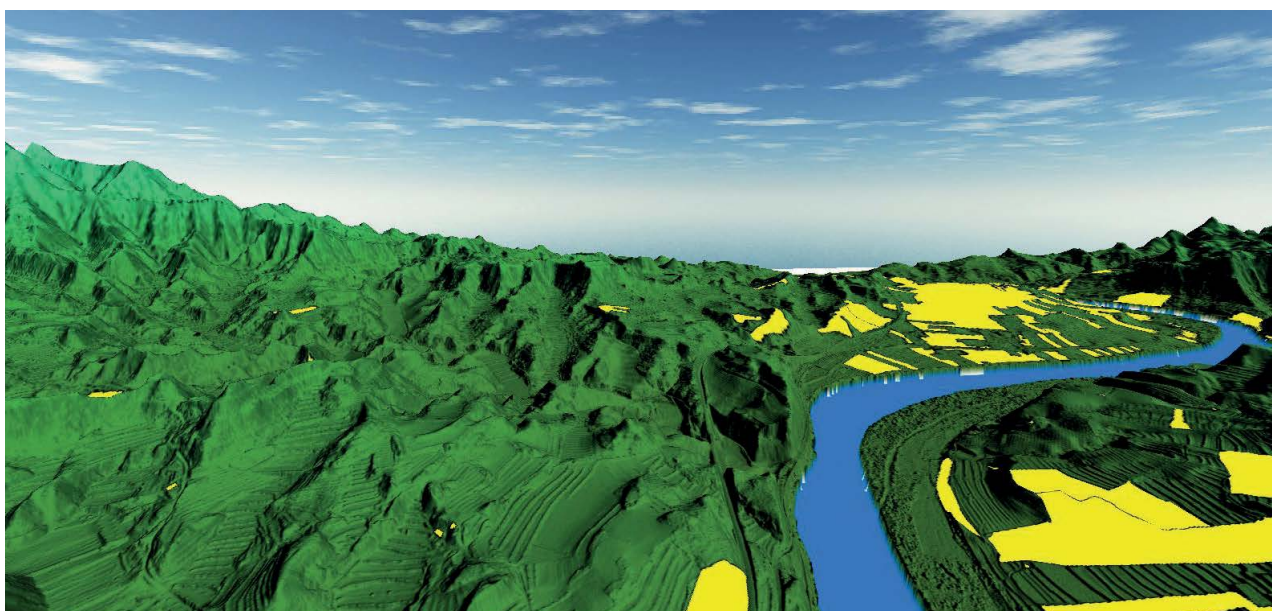
with their own name and identity as independent units. In addition to houses, these groupings include buildings and spaces that serve various purposes to complement the primary residential function, ranging from hospital complexes to industrial estates. The geographical reference information on populations is closely linked to statistical units and integrated with urban planning and the cadastre, using cadastral mapping as a geometrical basis. This approach ensures a detailed and flexible representation of residences and clusters of non-residential buildings, which are essential for demographic analysis, urban planning and land management.

The transport sector is one of the top five CO₂ emitters globally and it is estimated to be the second largest contributor; however, there are many initiatives aimed at sustainable, healthy and safe mobility (M3S), such as road electrification and the expansion of existing railways. These sustainability-oriented projects often involve multiple stakeholders and take advantage of the economies of digitalization in terms of decision-making.

Aware of this fact, the third example of high-value data is the Geographical Reference Information on Transport Networks (IGR-RT), which covers different modes of transport such as the road network (including the complete network of highways, streets and roads), railways, inland waterways and air and cable transport, together with their intermodal connections. Each transport mode is distinguished



Geographical Reference Information on elevations (green), hydrography (blue) and population (yellow).



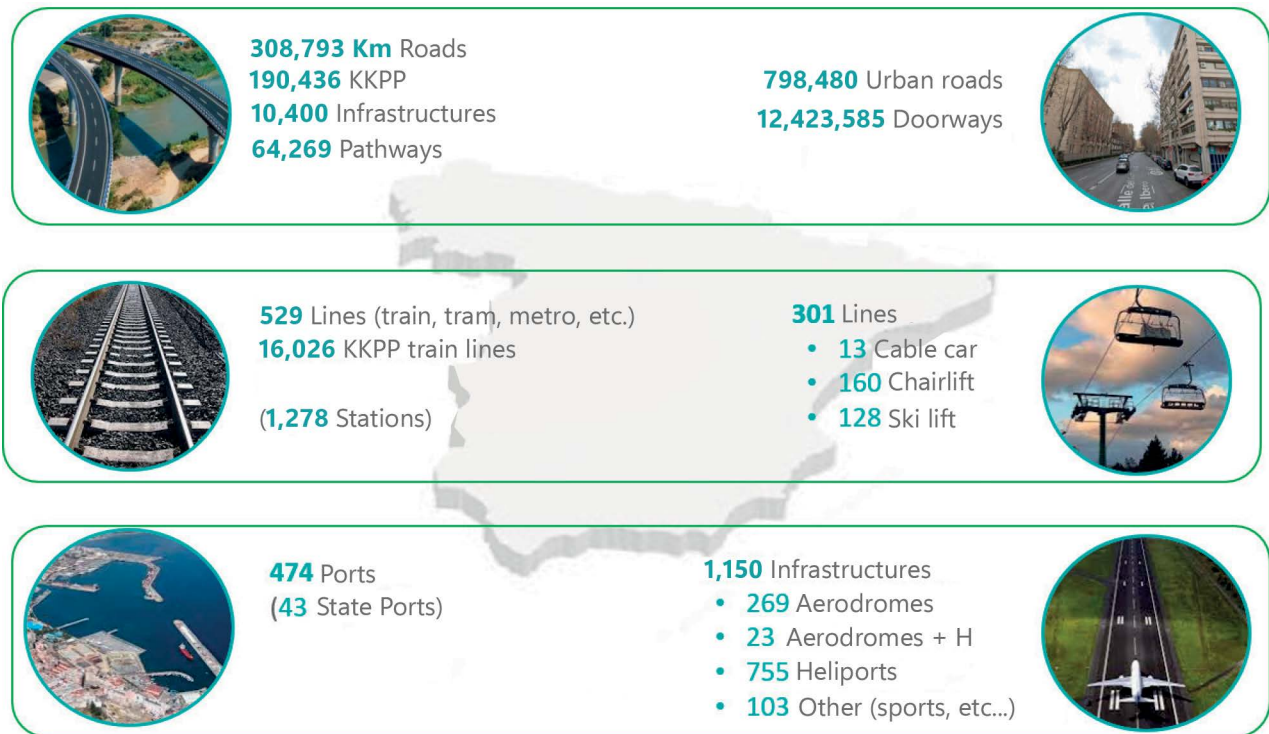
by a series of specific descriptive and official naming and identifying attributes and by detailed geospatial information on the infrastructures, such as roads, railways, ports, airports and cable transport systems. The transport network represents not only the physical infrastructure but also the spatial relationships between the different elements of each transportation mode (e.g. the road network is connected to the urban street network as it moves further into towns) and

the connections between them (intermodality), which facilitates its analysis and utilisation in Geographical Information Systems (GIS).

New technologies, new paradigms

When implementing the BIM methodology, sometimes, having high-value geospatial and georeferenced digitalised information on the territory may not be sufficient. Occasionally the use macro-data, which

can be diffuse or imprecise by its very nature, is needed within the realm of usability. In the BIM process, information that is complex to process because it is incomplete, ambiguous, imprecise, etc., can generate too many possibilities or valid solutions. This can be solved by making approximations that produce sufficiently good results without strictly being a classical, unique or algorithm-based analytical solution. Whenever there is an over-abundance of data, macro



Geographical Reference Information on transport, data volume.

data, or Big Data, these issues can be addressed with disruptive technologies such as Artificial Intelligence (AI).

For example, the location of a transport hub depends on several factors, including the mode of transport, the terrain and the population density in the surrounding area. Ideally, a transport hub should be located at an intersection of multiple transport routes to make it easily accessible from different parts of the city or region, and its location should be carefully chosen to maximise utility and accessibility for travellers. At the same time, it must be centrally located and easily accessible by multiple modes of transport, such as motorways, railways and airports; therefore, special care has been taken to ensure the intermodality of the aforementioned transport

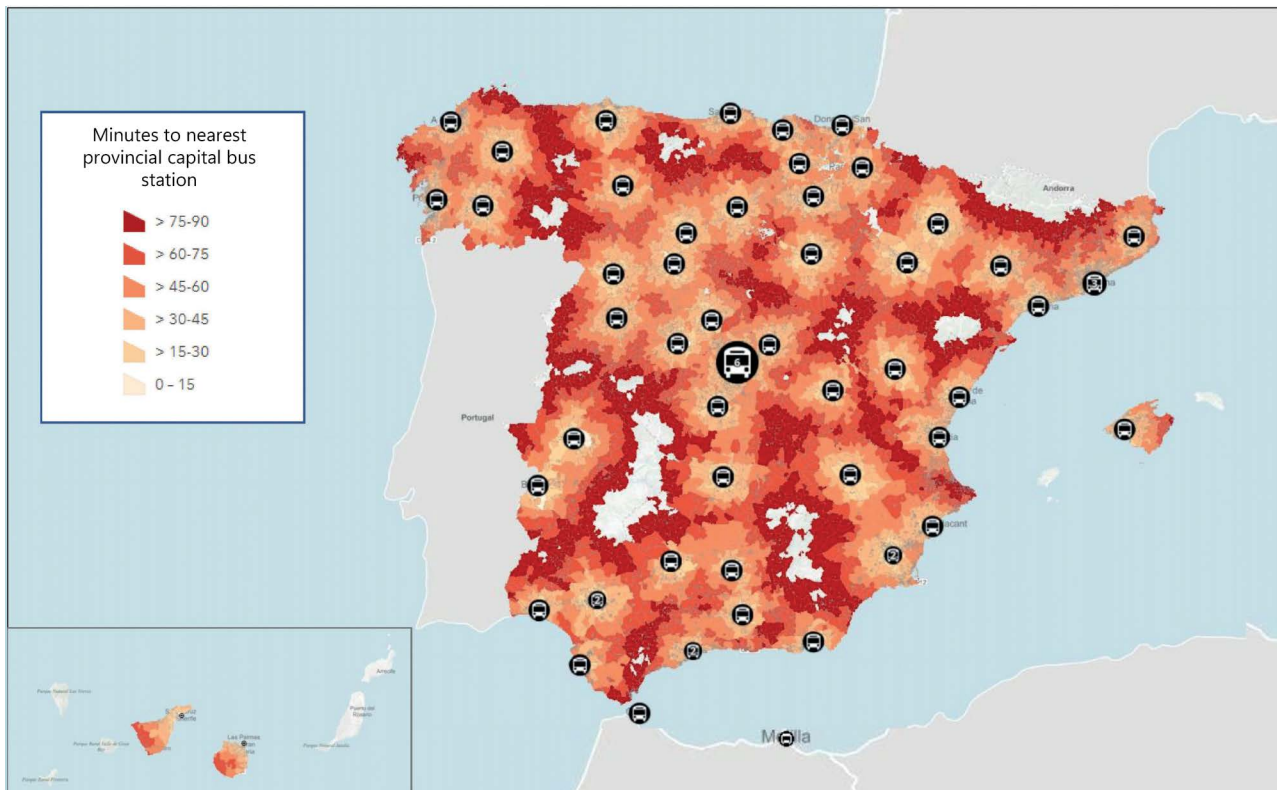
network. In addition, it should be located close to key destinations such as city centres, shopping areas and tourist attractions, which are defined as POI (Points of Interest) in the National Topographic Base.

By using detailed 3D models and simulating different scenarios, BIM and GIS technologies can help optimise space utilisation and improve safety and the overall travel experience for passengers. Using AI models to design a transport hub can optimise its design, construction and operation, especially when the input data is diffuse or vague, such as the congestion level in the area or the network's potential for future growth and expansion.

Current simulations can consider parameters or aspects that are difficult to measure

with the necessary accuracy. Some aspects can also be highly time-variable, such as travel and waiting times, passenger flow, traffic volume, energy consumption per m², carbon emissions, emergency response times, traffic patterns, weather conditions, etc. However, based on the infrastructure's design and the digitalization of the territory, they can simulate and infer efficiency in terms of environmental sustainability. The true capability of these models is determined by the abundance of data and not necessarily by classical mathematical models.

During the design phase, AI algorithms can analyse data from various sources, such as data on traffic patterns, passenger volumes and weather conditions, to optimise the design and layout of the transport hub while



Spatial analysis on the Geographical Reference Information on the Transport Network (IGN) for the evaluation of travel times to the nearest bus station.

minimising costs and environmental impact. During the construction phase, AI can be used to automate repetitive tasks and optimise the orchestration of the construction schedule by all agents involved or reallocate resources, leading to greater efficiency and cost improvements.

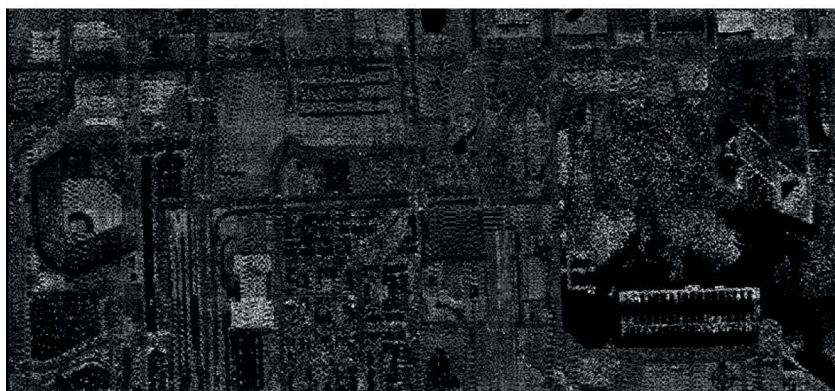
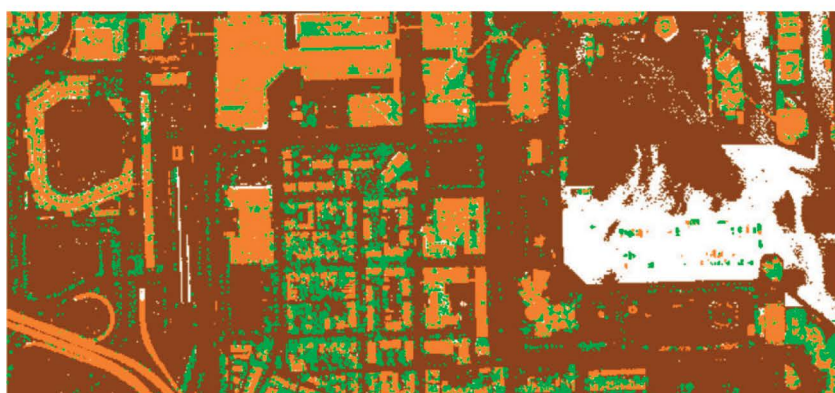
In the operation and maintenance phase, BIM can be used to support predictive maintenance and optimise the performance of the buildings within the transport hub. AI can analyse data from sensors and other sources to identify patterns and trends in passenger flows, energy consumption and other key indicators to optimise operation and maintenance schedules, reduce energy

costs and improve passenger experience through Big Data.

By analysing data from building sensors and other sources, AI algorithms can predict when equipment is likely to fail and schedule maintenance accordingly. This can help reduce downtime and repair costs while improving building performance and reliability.

AI has also been used for some years to reduce low value-added, repetitive or data-intensive tasks in an attempt to input the most reliable and up-to-date geospatial information possible into the BIM methodology phases where it is most relevant, such as preliminary studies or simulations of the digital asset in the context of the territory.

This union of BIM and GIS capabilities, together with disruptive technologies such as Artificial Intelligence (AI) or Big Data, is not only improving the quality of the available geospatial information but will also multiply our abilities to simulate or plan BIM in Public Procurement assets in a more accurate and informed way. Furthermore, the approval of the Plan for the incorporation of BIM methodology in the Public Procurement of the National Public Administration and its dependent bodies and related or dependent public law entities, under Order PCM/818/2023 of 18 July, will promote the integration of BIM models in geospatial databases so that both technologies or methodologies benefit from each other.●



Geoprocesses integrating AI: New building detection, classified LiDAR point cloud, original LiDAR point cloud and automatic detection of road markings to update the Geographical Reference Information on Transport and the IGN's National Topographic Base (from top to bottom).

BIM in the Spanish State-owned Port System

BIM implementation in the 28 Port Authorities, with heterogeneous BIM maturity levels, is coordinated by the State Ports Authority (Public Authority in charge of the Spanish State owned Port System). This section refers to some BIM projects developed by different Port Authorities (Port Authority of Santa Cruz de Tenerife, Port Authority of Valencia, Port Authority of Cargena and Port Authority of Barcelona), and considers some coming challenges. The approach is complemented by the Guía BIM del Sistema Portuario de Titularidad Estatal (the State Ports BIM Guide), adopted by the State Ports Authority.

- **Text:** Manuel Arana Burgos, Director of Planning and Development; **Ignacio Martínez Pérez**, Head of the Infrastructure Projects Division; **Ana Lope Carvajal**, Head of the Infrastructure Planning Department **and Gonzalo Gómez Barquín**, Head of the Infrastructure Projects Department; **State Ports Authority**



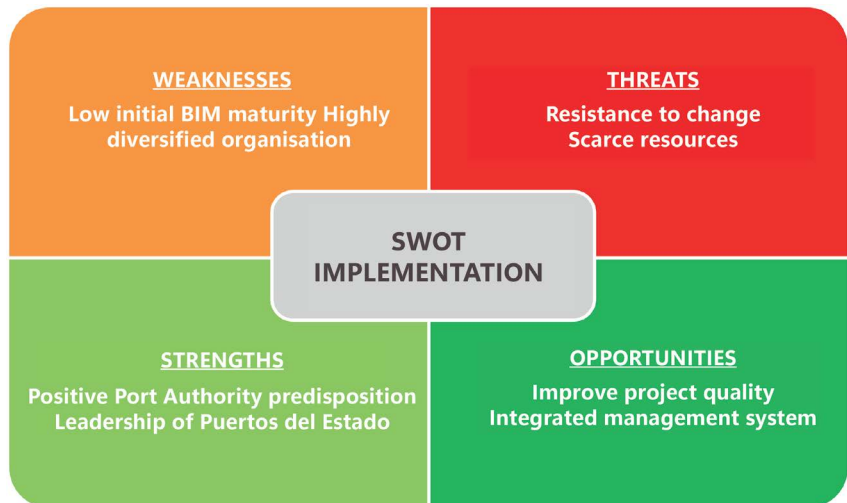
Transforming transport infrastructure with BIM

The State Ports Authority's first contact with BIM dates back to 2018, when the then Ministry of Public Works had just published the Plan for Innovation in Transport and Infrastructures (PINTI), which placed significant emphasis on BIM methodology and included an initiative called "Integration of BIM models in the smart port", with the State Ports Authority taking the lead in its implementation. Within the framework of this initiative, the first step was to diagnose the status of BIM methodology implementation in the State-owned Port System.

The diagnosis aimed to analyse the degree of BIM maturity in State Ports and the different Port Authorities and consequently to establish guidelines to be followed in the implementation of BIM and the drafting of a BIM guide. This analysis, informed by a series of questionnaires and interviews, revealed a low level of BIM maturity and the difficulty of implementing it in a highly heterogeneous structure like the Port System. However, it also pointed to a positive predisposition within the Port Authorities towards implementing BIM methodology and identified an opportunity to improve project quality and, potentially, achieve an integrated management system. It also recommended the organisation of BIM training sessions and the implementation of a pilot project using BIM methodology.

Following the diagnosis and the establishment of the lines of action, a working group led by the State Ports Authority with the participation of several Port Authorities – A Coruña, Bahía de Algeciras, Balearic Islands, Bar-

SWOT matrix derived from the diagnosis of BIM methodology implementation status in the State-owned Port System carried out in 2018.



celona, Bilbao, Melilla, Santa Cruz de Tenerife and Santander– was set up. Its work concluded in June 2019 with the publication of the *State Ports BIM Guide*.

The Guide aims to provide a reference framework for deploying BIM methodology in port projects, addressing issues such as BIM strategy and objectives, BIM information requirements and their levels, and the human and

technical means necessary for its implementation. It also includes several annexes with examples of BIM information requirements for different types of contracts, element classification systems and file coding standards.

Following the guidelines set out in the PINTI and the conclusions of the diagnostic study, in 2021, a pilot project on an existing installation was launched to

Front cover of the State Ports BIM Guide, published by the State Ports Authority in June 2019. ([Click here to download](#)).

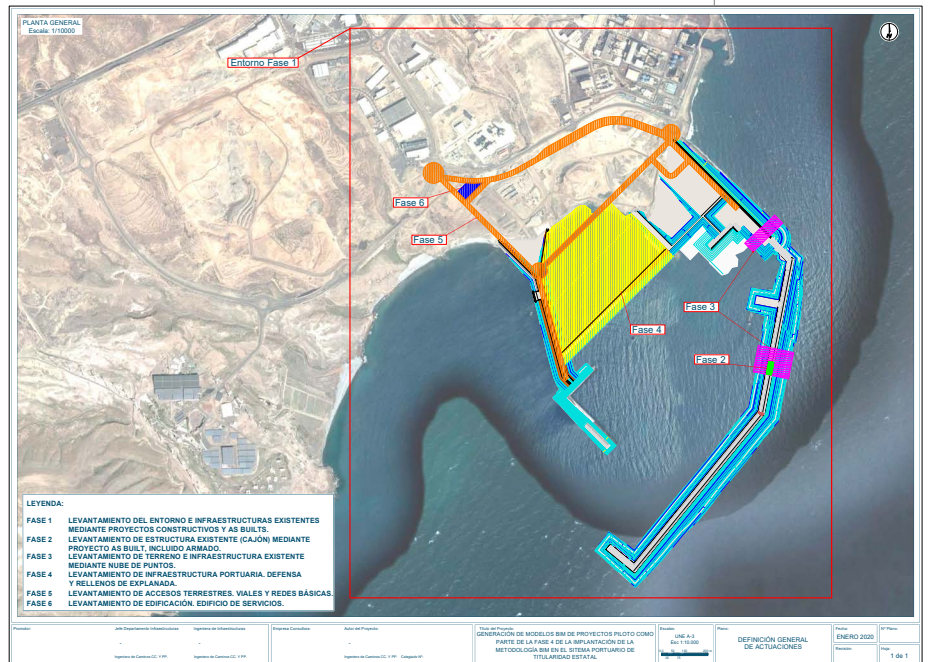


The pilot project in the Port of Granadilla allowed the application of the main concepts of the State Ports BIM Guide.

apply the BIM methodology to a real-world port scenario. The aim was to validate the practical application of the previously drafted BIM Guide and update and improve it where necessary.

The pilot project, undertaken in the Port of Granadilla on the island of Tenerife, was structured in multiple phases: a survey of the existing environment and infrastructure (main and secondary breakwaters), a more detailed survey of part of an existing structure (reinforced concrete caisson in the breakwater), a point cloud survey of the terrain and existing infrastructure, a survey of the land accesses (roads and basic networks), a survey of the building (port services building, which was under construction) and a study of the integration of BIM and GIS models.

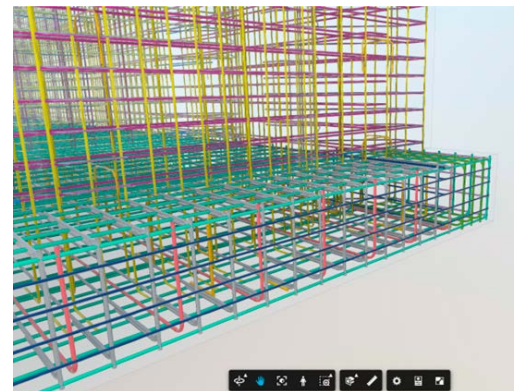
The implementation of the pilot project allowed for the application of the main features of BIM methodology (information repositories, programmes for the visualisation of models, detection of interferences, flow and exchange of information, etc.) and prompted the organisation of various dissemination and training sessions. The models gener-



In the image above: plan with the different phases of the Port of Granadilla pilot project.

In the image on the right: reinforcement of a caisson with definition level LOD 500 in phase 2 of the Port of Granadilla pilot project.

In the image below: point cloud survey of the breakwater in phase 4 of the Port of Granadilla pilot project.





Images of the roundabout and roads obtained from the model developed in phase 5 of the Port of Granadilla pilot project.



The State Ports Authority is leading the implementation of the BIM methodology in the State-owned Port System, as set out in the lines and objectives established in the 2022 Strategic Framework and aligned with the BIM Plan in Public Procurement.

ated during the pilot project were subsequently made available to the Port Authority of Santa Cruz de Tenerife to assist with its work to enlarge, maintain and operate the Port of Granadilla. Thus, one of the first examples of the use of the models generated was the parallel monitoring of the work on the multiple services building through the BIM model of the building project created during one of the pilot project phases.

Additionally, since its creation, the State Ports Authority has participated on the Technical Committee of the Interministerial BIM Commission (CIBIM), together with other public entities such as Adif, Renfe, Aena and the General Directorate of Roads, as a result of whose work the BIM Plan and several other documents were drafted.

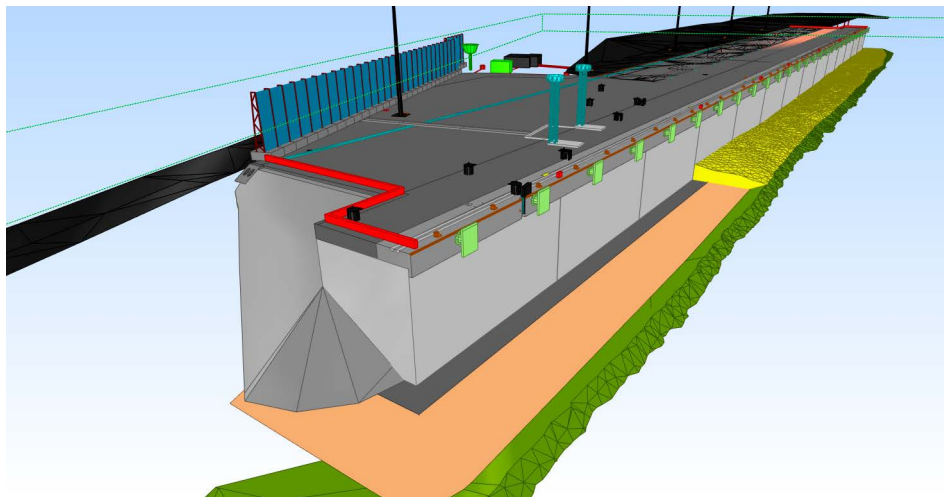
Application experiences in three Port Authorities

The State-owned Port System comprises Port Authorities with very different characteristics dictated by, among other things, their size, type, and volume of traffic, as well as the organisation and structure of their workforce. This diversity involves a significant disparity when it comes to BIM methodology and the extent of its implementation. For this

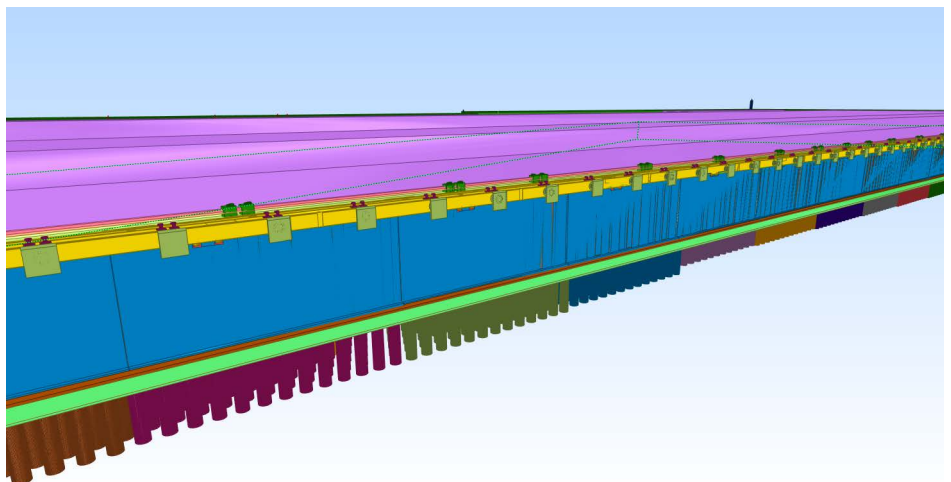
reason, in recent years, several Port Authorities have had to adapt and customise the BIM Guide to their respective operating realities.

In addition, work has been carried out on the development of libraries of elements modelled in BIM, and several Port Authorities are already working on pilot projects to create a *digital twin* of their port, supported by the Ports 4.0 programme launched by the Port System as an aid to innovation.

The number of projects and works incorporating BIM methodology is clearly on the rise. As an example, the following section outlines the experiences of three Port Authorities who have each



Images taken from the models created in the pilot projects carried out by the Port Authority of Valencia, of the South Quay (above) and the North Terminal (below).



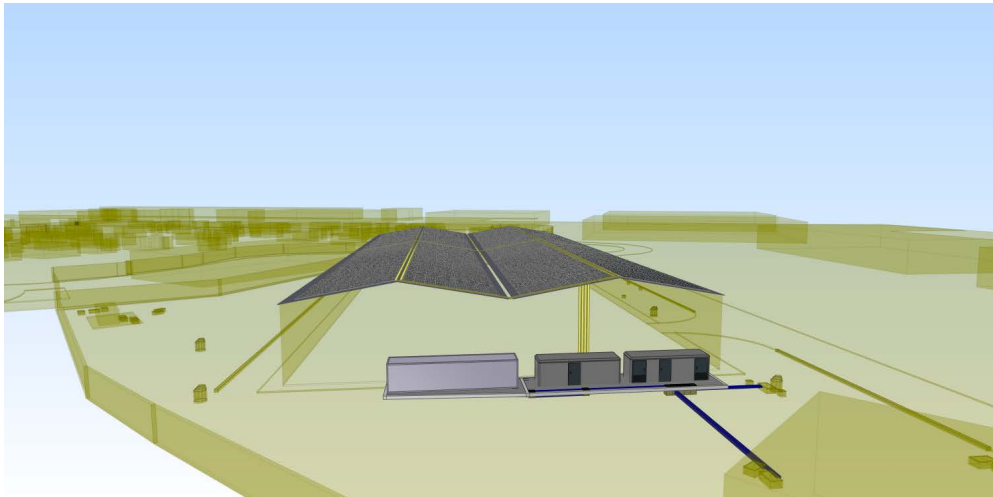
taken a different approach to BIM implementation.

1. Port Authority of Valencia

The Port Authority of Valencia (APV) is one of the pioneers in the introduction of BIM, having tendered works with BIM information requirements in the field of building as early as 2018. Between 2019 and 2020, APV contracted technical assistance, in the framework of which several training workshops were held for Port Authority staff and, taking the State Ports BIM Guide as a reference, two BIM pilot projects were implemented (South Quay and North Terminal), focused on specific port typologies.

In 2021, the APV published its own BIM-GIS manual, which adapted the State Ports BIM Guide to meet its specific needs. It is currently developing several projects and works with BIM methodology, such as the new north container terminal, new railway networks in Sagunto and Valencia, the new promenade in the Port of Sagunto, various buildings and housing developments, photovoltaic installations, etc. APV recently purchased a drone to capture data by photogrammetry and generate point clouds of the existing infrastructure, for which it is in the process of registering the APV as a UAS (Unmanned Aerial System) operator with AESA (Spain's Aviation Safety Agency) and training its technical department staff as drone pilots. Furthermore, in the short term, the APV will be contracting the preparation of the Port Authority's BIM strategy, which will define the BIM action

BIM methodology may and has to play a fundamental role in the operation and management of ports, and therefore, its implementation has to be extended to all the involved actors.



Images taken from the BIM model of the photovoltaic installation in the Port of Gandía (above) and a photograph of the same building.



plan for the 2024-2027 and 2027-2030 periods.

2. Port Authority of Cartagena

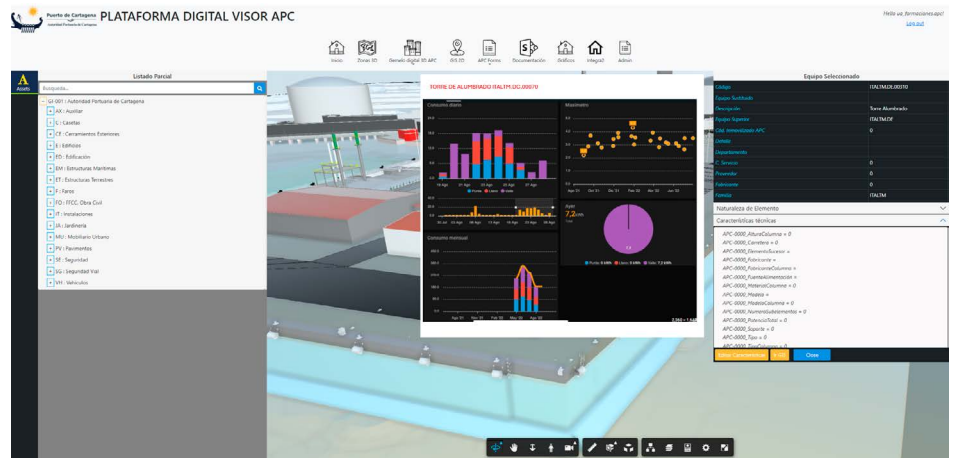
The Port Authority of Cartagena (APC) is another pioneer in the process of digital transformation and innovation. In 2021,

APC took the first steps towards digital transformation and the use of digital methodologies in the infrastructure department. The objective was to initiate the implementation of BIM-GIS and transform conventional work methodologies by incorporating new technologies. Since then, significant efforts have been made to develop implementation strategies and create BIM information requirements and standardisations, among other initiatives. Additionally, a basic 3D model of the APC's facilities was developed using a GIS and a VISOR integration platform, in which the 3D BIM model and the 2D GIS model (digital twin) were connected to the different APC databases (such as ROSMIMAN, INTEGRADOS, CATASTRO, etc.) that support the various APC departments in areas such as the management of land registry references, concessions, assets, etc.

The transformation of the APC's work methodology also encompasses the supervision of projects and works in BIM and GIS and the provision of digital support for maintenance contracts from the APC Technical Office. Looking ahead, the APC is committed to its transformation and innovation strategy and ready to tackle new challenges and objectives. These include the integration of dynamic data (sensorisation) and the development of prediction and optimisation tools for land and maritime traffic, safety, dock congestion, and more.



Image of the Port of Cartagena in the viewer (digital twin) developed by the Port Authority of Cartagena.



Prototype image (mock-up) of the monitoring that the Port Authority of Cartagena is working on to implement in the digital twin.

3. Port Authority of Barcelona

The Port Authority of Barcelona (APB) has a map of the port in GIS format, which has been generated over the last 30 years by inventorying more than 800,000 elements within its boundaries. Based on this inventory, a 3D library of BIM elements linked to the 2D map is being developed, which, in future stages, will make it possible to achieve objectives such as creating a digital twin of the port or generating augmented reality models. One of the initial tasks involved in producing

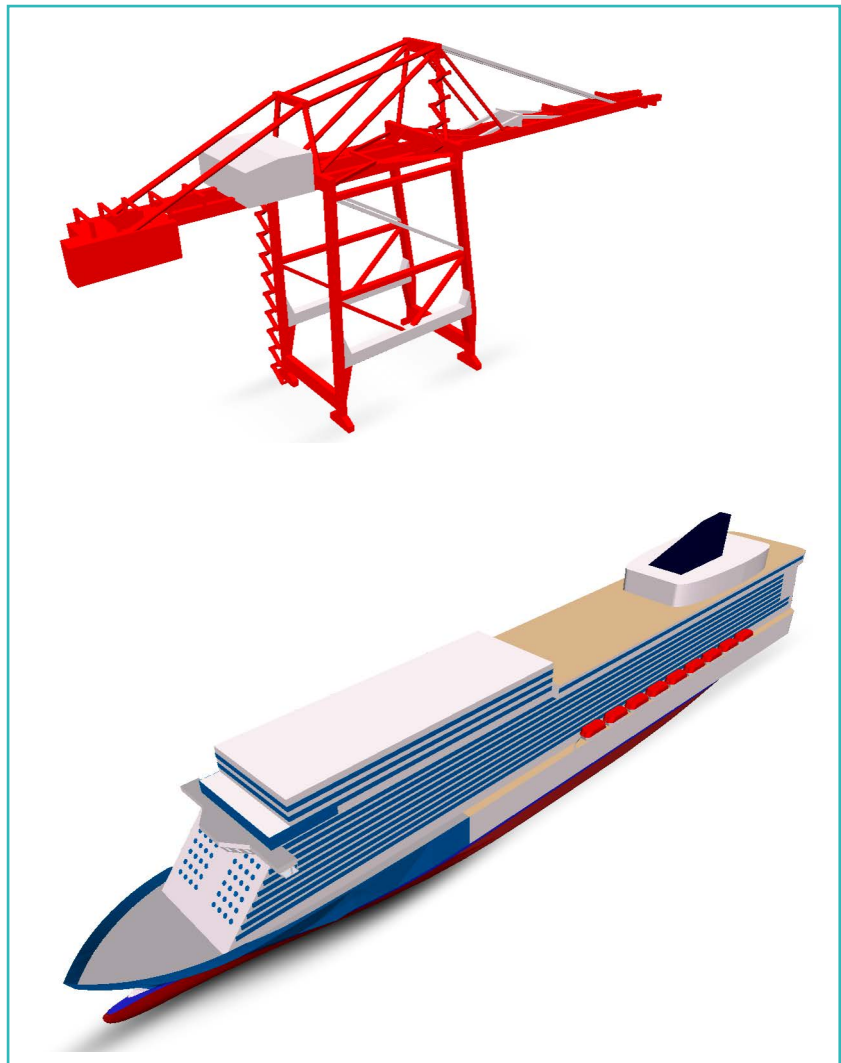
the library was to determine the elements that could be modelled in 3D and establish the most appropriate level of detail for their representation (LOD); thus, the elements were captured (mainly utilising photogrammetry), and the corresponding images were taken and referenced. This process also led to improvements in the inventory, with some elements being classified more accurately. The first phase saw the addition of 400 items to the IFC library (mainly urban elements), and the second phase saw the addition of buildings and

Transforming transport infrastructure with BIM

other port elements. Currently, the library has more than 500 IFC elements, corresponding to more than 80,000 GIS elements. Two models were created for each element: one more detailed, fulfilling one of the essential functions of BIM by presenting the elements in a realistic way and another more simplified, which, being smaller in size, allows the thousands of elements that make up the map to be presented in a more agile 3D format.

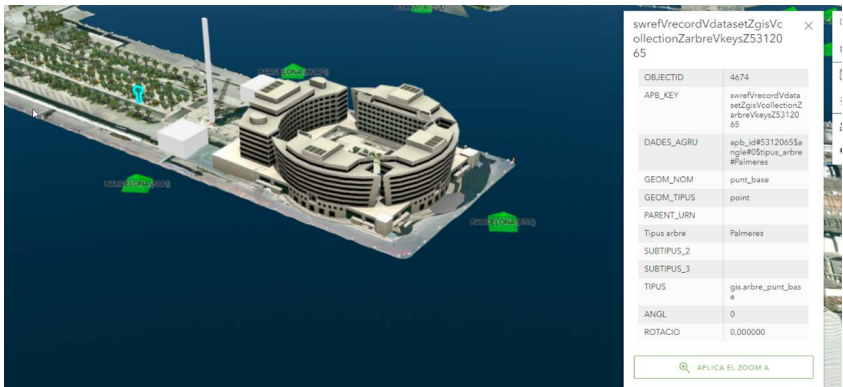
Challenges for the future of the Port System

The already acknowledged challenges of implementing a new working methodology in an organisation are magnified in the case of the Port System due to the complexity of its operation and the multiplicity of actors involved in the different processes. Not only the different realities and management autonomies recognised by the legislation of the 29 Public Bodies (28 Port Authorities and the State Ports Authority) must be taken into account, but it will also be necessary to coordinate and lead the public generation of infrastructure and its subsequent maintenance and management, as well as the provision of services and the use of the public domain for private initiatives through the issue of licences and concessions. It should also be borne in mind that approximately half of the total investment in the area of port services is made by private operators, who invest in infrastructures, superstructures and equipment, many of which



Example of two elements from the Port of Barcelona's 3D library of BIM elements.

Infographic of the APB's offices in the World Trade Center, in which some elements of the BIM library can be seen.



will revert to the Port Authorities when their concessions expire.

These circumstances create a scenario in which the public sector must exercise leadership by developing policies that help improve the management of assets and services to make them more efficient and productive. In this sense, BIM methodology can and must play an essential role. In particular, within the scope of its remit, the State Port Authority's mission is to coordinate and create synergies for the Port System as a whole. Therefore, to continue leading the application of BIM methodology in ports, new initiatives designed to implement it will need to be launched, not only internally within the 28 Port Authorities but also externally, among the operators providing port services to achieve

enhanced operating and management conditions for the port overall. With this in mind, internally –after five years of experience in its use– an update of the *State Ports BIM Guide* that also takes into account the criteria set out in the National Government Administration's BIM Plan in Public Procurement and the CIBIM's publications is planned in the short term, and the training of personnel and dissemination of experiences among the Port Authorities will continue.

The changing technological landscape demands to continue working to achieve full implementation of BIM methodology throughout the port sector.

The new Strategic Framework for the General Interest Port System, approved by Ministerial Order in October 2022, estab-

lishes three dimensions for ports: economic, environmental and social, and its implementation is envisaged through seven priority criteria, one of which is digitisation. It goes without saying that this includes implementing BIM methodology, which will foster the gradual development of digital platforms in every port as spaces for gathering and processing data for the benefit of the port community's stakeholders. Once the appropriate standards have been adopted and the platforms have been equipped with the necessary digital enablers, it will be possible to move towards the realisation of smart ports, which will be capable of radiating optimisation options to the other nodes and arcs of the chains on which they are based. ●



With BIM, Aena will be able to manage its airports more efficiently and tackle future projects successfully

Managing Aena's airport infrastructure with BIM

This article looks at the impact of implementing BIM in an infrastructure management company. At Aena, implementing BIM involves substantially transforming the way in which airport documentation is currently managed, both graphically and in terms of data and documents. The benefits and possibilities of BIM technology are vast, surpassing the capabilities of CAD. However, to ensure that the different areas of the organisation can consume BIM information, it's not enough to simply define and generate it; a structured work methodology and processes must be in place to facilitate its management during each phase of the asset's life cycle.

The process of transitioning from CAD to BIM at Aena began in 2018 with the formulation of a plan. Based on a progressive and gradual implementation, this plan is designed to be compatible with the existing situation and level of BIM maturity. It establishes four stages to address the challenge posed by this organisation-wide change through a staggered process.

- Text: Marta Terrero Manzano, head of BIM development and implementation at Aena



www.pexels.com. Signature: Radubradu

The value of being able to access specific pieces of information at a precise moment in time can be incalculable. Although some studies have attempted to quantify the benefits of implementing BIM in a project or an organisation, given the enormous potential and range of uses and applications that can be envisaged, it's extremely difficult to measure the long-term impact that managing infrastructure in a BIM environment could have.

Traditionally, we have developed and established improvement mechanisms designed to ensure access to up-to-date and accurate information that will allow us to manage airport infrastructure efficiently. This has led to the adoption of measures such as the creation of shared repositories to store different types of information, the standardisation of project documentation, the delivery of final work documentation, the establishment of templates, and rules to standardise the loading of information into tools or databases for subsequent use.

However, these important advances, whose approach is very much in line with BIM's focus on centralising and standardising information to facilitate its integration and transfer, were conditioned and limited by traditional technologies.

The BIM methodology represents an opportunity for Aena to improve its processes and better manage information about its assets to extract their full potential.

The implementation of BIM in Aena is a challenge that has been readily accepted by a team of professionals who are committed to change and convinced of the advantages offered by this new way of working.

BIM will make teams more productive and provide more cost-effective and sustainable functional design solutions.

Implementing BIM in Aena: an opportunity to improve processes

This change of concept from CAD drawings to BIM models is the key to having a source of related information, but it requires a substantial change in the way in which projects are drawn up and executed and, above all, from the airport manager's point of view, in the way in which the documentation associated with the infrastructure is recorded, exchanged and kept up to date.

This is why the process of implementing BIM in Aena has been approached gradually. In 2018, Aena developed a plan to progressively implement the BIM methodology with the aim of **being able to use the information models throughout the life cycle of the infrastructure**. Given the complexity and impact of moving from CAD to BIM, a roadmap with four distinct stages was established.

Stage 0

The main objective of this first stage was to establish the **BIM requirements for the execution of the projects**. The first projects

were developed with minimum requirements and used as pilots as a basis for establishing increasingly more detailed specifications adapted to the needs of the organisation, and, at present, these are the ones that are generally requested for the drafting of all Aena's centralised projects.

Examples of some of these early BIM projects include the south dock at Barcelona and the functional design of Seville Airport.

These requirements were established with the aim of being able to respond to the uses indicated below:

- **3D visualisation.** Using the geometry of the models to communicate the proposed solution facilitates the understanding of the project. This key element is indispensable during project meetings, as, compared to the CAD-based methodology, it allows stakeholders to visualise the project information much more quickly.
- **Extraction of the project plans.** Extracting the plans from the project model ensures consistency and simplifies any possible errors arising from changes that may be made, especially in the later stages of the project.



Image of the project model for improvements to the terminal building according to the functional design of Seville Airport.

- **Extraction of quantities and estimates.** Obtaining quantities and estimates from the model significantly reduces the time conventionally spent on this task and minimises the errors that often occur.

- **3D Coordination.** The identification of interferences allows us to guarantee the quality of the project by minimising exposure to risks during execution that could lead to delays or failure to meet deadlines.

Establishing a coherent interference matrix that aligns with the unique needs of each project is crucial. It allows us to distinguish real interferences

from those that are irrelevant to the project's overall development, such as an issue that could be resolved, for example, by making a hole in a partition wall.

The application of these uses is intended to contribute to improving the quality of the construction project.

Within the overarching framework of the BIM methodology implementation, Stage 0 involves "starting to work with BIM", which implies the inclusion of new processes, new roles and the acquisition of new tools. However, the processes, roles and tools will

have to evolve and adapt to the needs and objectives of each stage.

Stage 1

Parallel to introducing the models as part of the project documentation, Aena has acquired and configured a **Common Data Environment (CDE)**. The purpose of this environment is to be able to share the documentation relating to all the projects undertaken on airport infrastructure so that all the agents involved in defining the projects, executing the works and managing the asset can exchange and consult

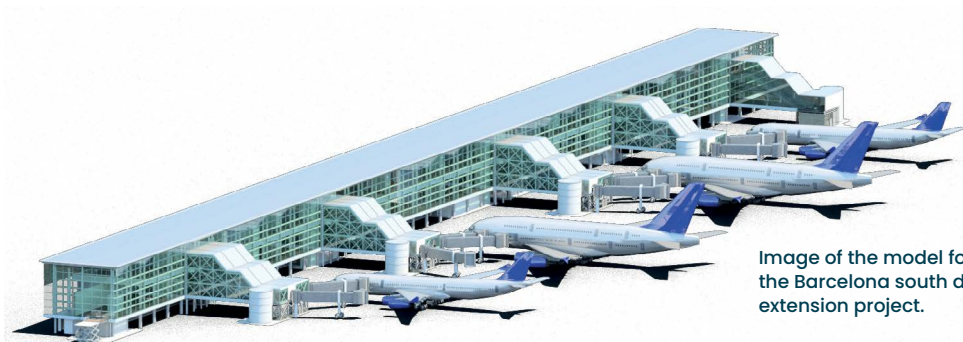


Image of the model for the Barcelona south dock extension project.

the documentation quickly and efficiently.

The CDE will make it easier to use the models when reviewing and developing projects, allowing them to be viewed in a BIM environment, in which the geometry, data and all the related documentation will be available. Implementation of the CDE is expected to begin once the previous stage has been consolidated and reached a level of maturity sufficient for it to be used by the teams from different areas of the organisation to review the project.

To guarantee the quality compliance of the models distributed, Aena has acquired an auditing tool to ensure compliance with the standards and requirements.

Stage 2

Given the duration of the projects and works and the service life of the infrastructure, and comparing the investment costs with the operating and maintenance costs, we anticipate that the greatest potential for implementing the BIM methodology in Aena will be in the **operational phase**.

Due to the volume of existing infrastructure and, therefore, the inherent challenges involved in implementing BIM methodology in this phase, a comprehensive asset digitalisation plan has been drawn up and is currently being piloted at Valencia Airport. The objective of the pilot is to establish and validate a strategy for digitalising Aena's assets in a BIM environment and identify the necessary data models, processes, and tools.

Aena's Common Data Environment

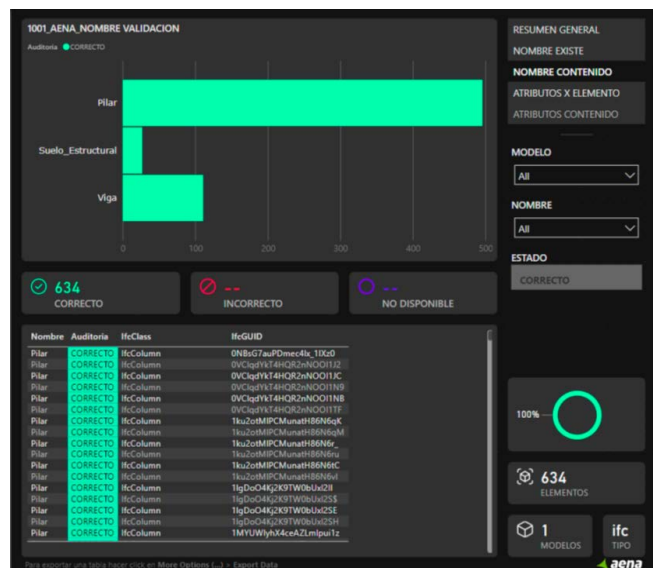
Airports need a Common Data Environment (CDE) in which to manage and maintain their digital assets.

A CDE is an excellent solution for addressing and managing disconnected data from different sources in order to transform it into related information that facilitates the effective management of airport infrastructure. A CDE also facilitates communication and the exchange of information between the different companies and agents involved in the various phases of the infrastructure life cycle.

Aena's CDE has a model viewer that will be used as a support tool during project reviews. The CDE allows comparisons to be made, making it easier to identify any changes in the documentation received and monitor the reviews carried out. Any comments made are recorded and managed through this platform, facilitating traceability and access to them.

In addition, the CDE will be used to keep track of the project's planning and budget and will enable the management of all the documentation produced during the work.

Aena's CDE will provide a platform on which both external and internal contractors, as well as employees of the organisation, can share and manage airport infrastructure information in a related way. Furthermore, it will be connected to the organisation's other tools with a view to ensuring traceable, unique and accurate information that will improve the effectiveness and efficiency of the services.



Example of an audit report.

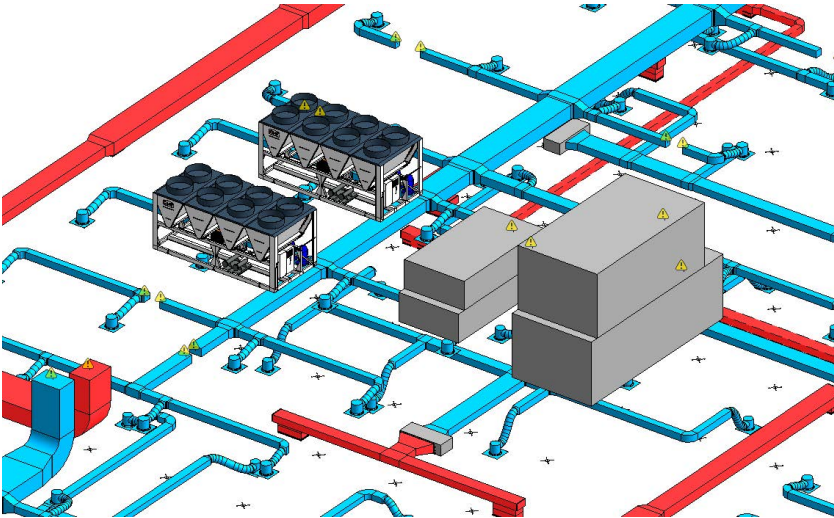


Image extracted from an air conditioning model.



Image of a parking apron at Málaga Airport.

Selecting an optimal process for generating and updating the asset information models that will be stored in Aena's CDE is crucial for obtaining maximum potential from BIM in the future.

The data collection for this digital survey was carried out using point clouds, existing graphic documentation and additional information extracted from other management tools. These geometric models will be uploaded to Aena's CDE, together with the

structured documentation. The same platform will be used as for project management. As a result, Aena will have two different but connected environments, one for projects and the other for assets.

Once the digital models of each airport are stored in this environment and the processes for updating and integrating them into existing methods have been implemented, each area or airport will be able to determine the specific applications they

wish to integrate and develop in this centralised database, which will then be generated for the particular airport and built progressively. Applications in areas such as sustainability, emergencies, regulatory compliance, analytics and simulations will unlock the full potential of the models. In addition, their integration with other technologies, such as Internet of Things (IoT), Augmented Reality (AR), or any other emerging technology, will change the concept of airport management as we know it today.

Stage 3

Once the way in which Project Information Models (PIM) and Asset Information Models (AIM) will be managed has been established, this last stage will involve implementing the **transfer and integration from PIM to AIM and from AIM to PIM**.

It is at this point in the asset life cycle that most information loss occurs. One of the main objectives of BIM implementation in Aena is to transform and improve this process, which is currently based on CAD technology. BIM models offer an opportunity to improve this transfer, but in order to capitalise on it, the information in the models must be selected and structured appropriately.

To carry out this task, which will undoubtedly require an enormous effort, Aena has a team of professionals who are not only committed to change but convinced of the importance of investing in BIM in order to successfully overcome the company's future challenges. ●

Transforming transport infrastructure with BIM

Life cycle of Aena's assets

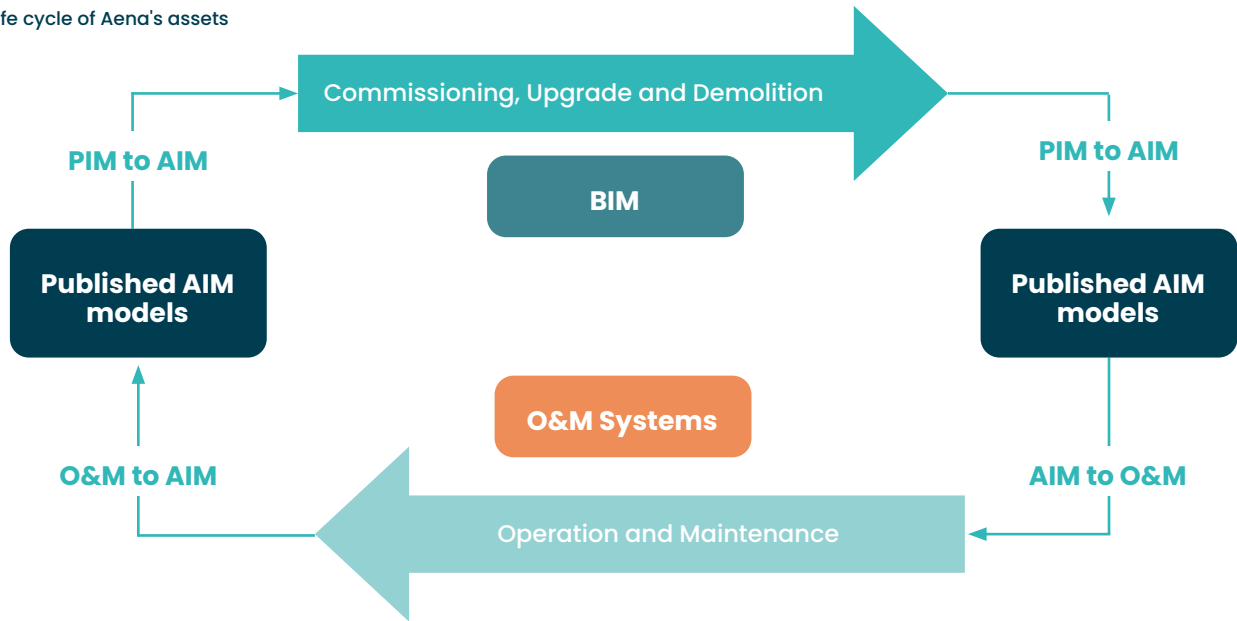


Image extracted from the project for the architectural integration of the terrace at Palma de Mallorca Airport.





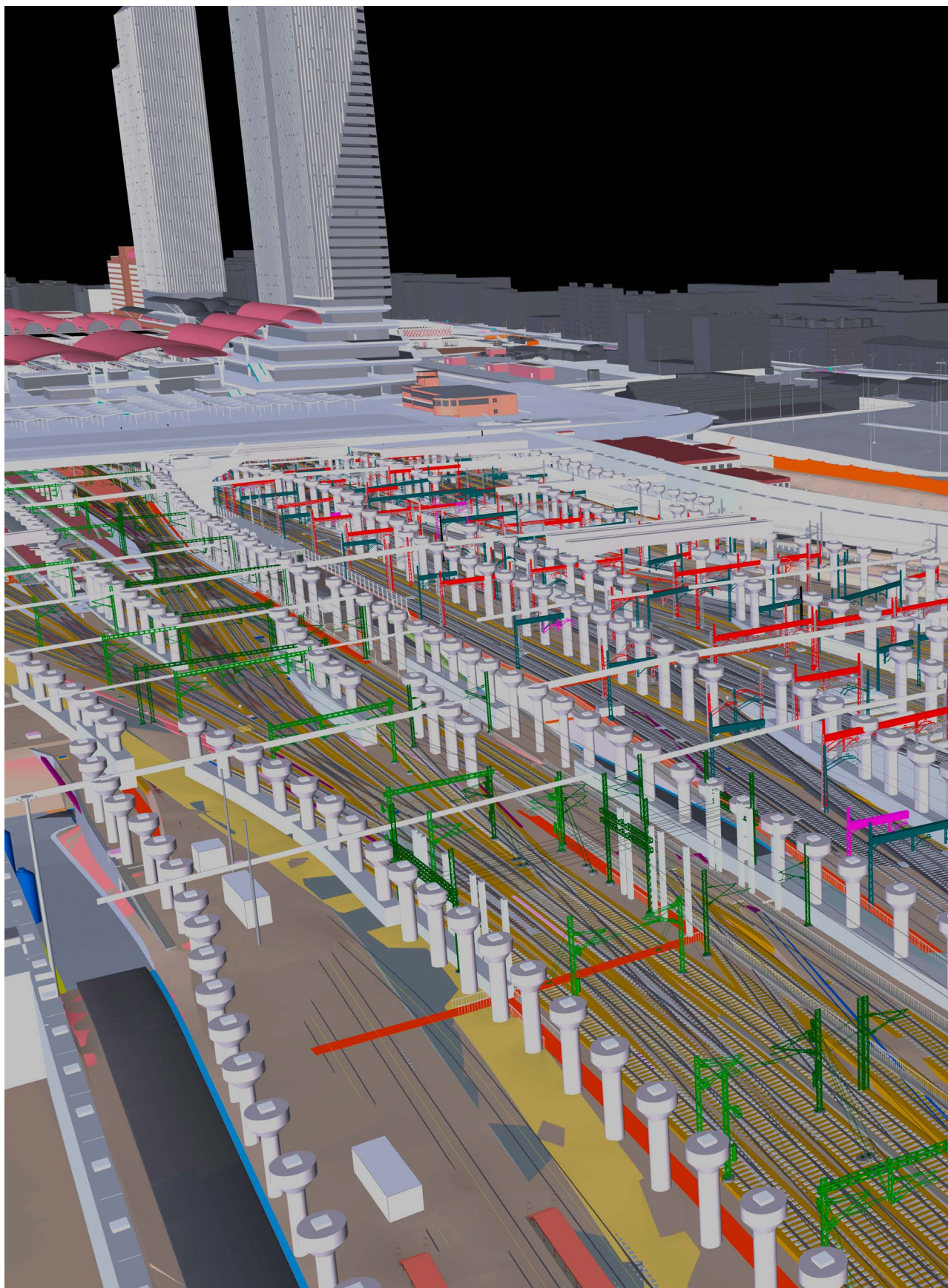
**BIM Methodology Implementation Plan
forms part of the 2030 Strategic Plan for Adif
and Adif Alta Velocidad**

BIM Implementation within Adif and Adif Alta Velocidad

Adif's BIM methodology implementation Plan aims to improve investment and expenditure efficiency, sustainability, safety, quality and collaboration in the management of railway infrastructure throughout the asset life cycle by utilising digital information models and by putting people and processes at the heart of the transformation.

- Text: Javier Lozano López, Deputy Director of BIM and Digital Continuity and Alberto Alcañiz Amat, Head of Construction of the Deputy Directorate for Integration in Cities. Adif Alta Velocidad.

BIM model Chamartín Clara Campoamor.



Itinerary

The history of Adif and Adif Alta Velocidad (hereinafter Adif) is a testament to a series of remarkable achievements. These successes have enabled Adif to manage a vast railway network, comprising 11 675 km, 1251 stations and 38 main freight terminals, and Adif Alta Velocidad to manage 3974 km and 46 stations. This demonstrates the exceptional capacity of its staff and companies in the sector to contribute to the development, maintenance, and operation of one of the most advanced rail infrastructure in the world.

At the same time, the significant challenges confronting the transport and mobility infrastructure sector in Spain, particularly the railway sector, such as climate change, energy transition, economic sustainability, diversity, equality, social action, generational replacement, comprehensive safety, and the impact of disruptive technologies, necessitate concerted actions guided by technical, economic, environmental, and social sustainability criteria.

In this context, the BIM methodology represents a formidable opportunity to successfully address the challenges of today and tomorrow, not only in the field of design and construction but also in the maintenance and management of railway assets, by considering their entire life cycle. It does so through the contribution of a set of new processes and technologies that enable information to be managed more efficiently and securely.

Eight years have passed since, in 2016, Adif decided to study the

feasibility of implementing BIM and analyse whether it could help corporate activity. In that year and during part of 2017, an interdisciplinary working group representing different departments studied the fundamentals of the methodology in depth, concluding that its benefits could undoubtedly reinforce and improve the way in which work was being carried out to achieve Adif's objectives and, therefore, those of the Ministry of Transport and Sustainable Mobility.

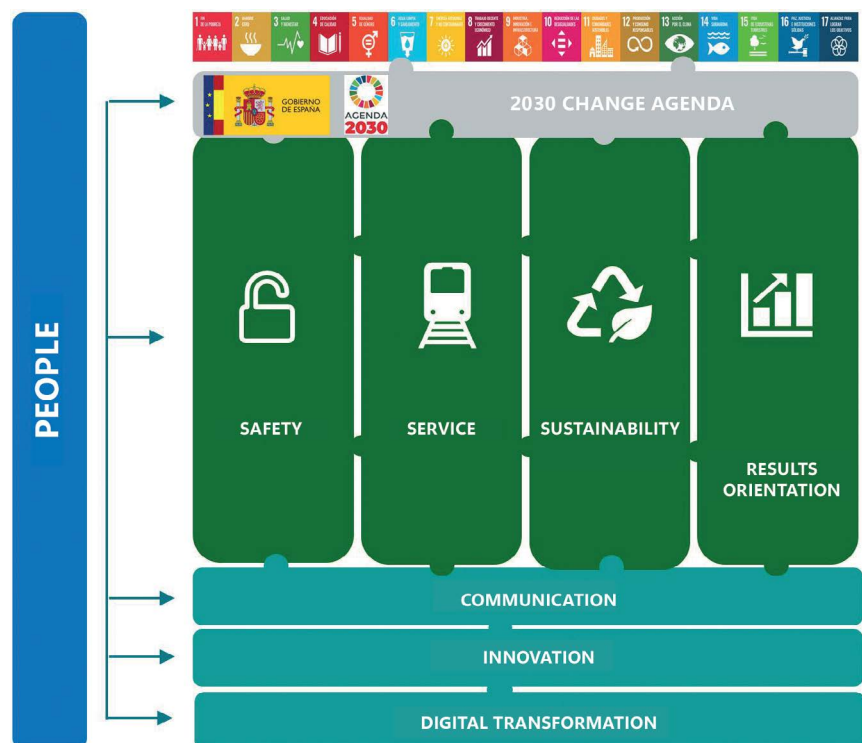
In 2018, the Adif BIM Implementation Plan was incorporated as a strategic initiative into the Transforma 2020 Plan, the first BIM requirements for project drafting specifications were drawn up, and various teams had their first experience of applying the methodology in the design phase, primarily in the field of stations. In addition, it be-

came clear that an implementer would be required to help generate the documentation necessary to ensure the coherence of Adif's BIM. This implementation would have to address the development of five key building blocks:

1. Processes
2. Information requirements for specifications
3. BIM standard
4. Training
5. Information and communication technologies (ICT)

Also in 2018, several key objectives were defined for the implementation, including the incorporation into Adif's management system of the necessary documents, as well as the modification of existing ones, the training of Adif staff, the deployment of a Common Data Environment to support the new digital activities and the formation of a BIM Tech-

Architecture of the Adif 2030 Strategic Plan.



nical Office to assist corporate areas.

The implementation assistance contract was tendered in 2019, the founding year of the Adif BIM Committee, a body set up by the Presidency and comprised of members representing the areas impacted by the methodology. In total, they number more than 50, a figure that undeniably illustrates the cross-cutting nature of BIM and the footprint that its adoption can generate in a necessarily complex organisational structure like Adif's.

In 2020, Adif's BIM requirements evolved and improved, more than 20 projects were put out to tender, and the training of more than 400 people was initiated. In addition, the BIM Implementation Plan was integrated into Adif's 2030 Strategic Plan as a powerful lever for digital transformation, with a strong focus on the Service pillar.

Tenders continued in 2021: the Adif BIM Technical Office was set up with five experts, and the tender for the supply, deployment, and implementation of the Adif Common Data Environment (CDE) was put out.

In 2022, the first BIM standard for design and construction was completed, which, thanks to the tests carried out, it was possible to finish the CDE parameterisation and the development of an user guide Adif's Steering Committee made the decision to approve the mandatory use of the CDE for the management of new projects and works as of 1 January 2023.

As a result, by the end of the first quarter of 2024, more than 150 companies and more than

2,000 users were working in the CDE on more than 300 projects with BIM requirements, figures that make possible to measure the impact of BIM implementation in Adif's activity and whose overall assessment is significantly positive and an extraordinary example of transformation and improvement.

The 2019-2023 period saw the roll-out of phase 1 of BIM implementation in Adif and culminated, in addition, with the publication of the *BIM Plan in Public Procurement* promoted by Interministerial BIM Commission (CIBIM) in Public Procurement (CIBIM) after the work carried out by the Technical Committee that assists it and in which Adif participates. Phase 2, initiated in 2024, will advance its implementation in maintenance and asset management processes and incorporate new uses for digital models that will improve aspects such as occupational risk prevention at worksites, BIM-GIS integration, compliance with railway

interoperability and operational safety, among other aspects.

Strategy

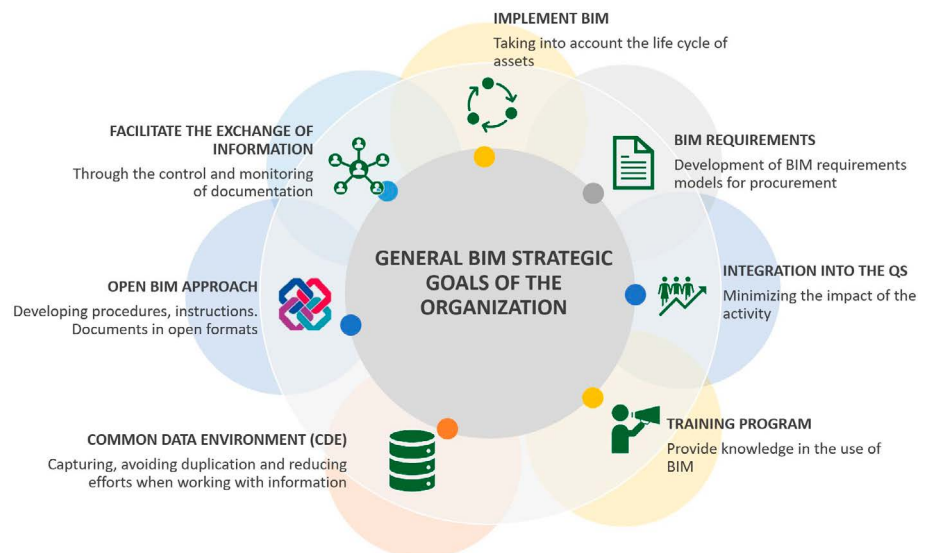
In terms of the aspects that are key to understanding the implementation of BIM in Adif, the organisational dimension is essential, as are solid criteria and the necessary in-depth company knowledge required to focus and plan the implementation of BIM. A strategy was defined with several general BIM strategic objectives that sought better collaboration, governance and integration in all phases and life cycles of assets, thanks to the information models, their potential uses and the availability of a single source of information.

A number of specific BIM strategic objectives were also defined.

Processes

Adif has a complex management system made up of more than a thousand documents, and right from the conceptual origin of BIM implementation, it

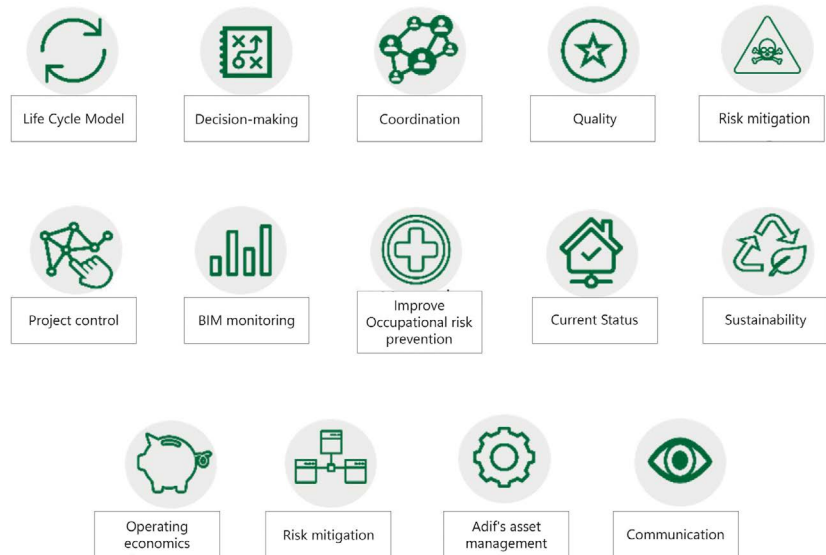
General Strategic BIM Objectives.



Transforming transport infrastructure with BIM

was determined that the methodology should be incorporated organically into this system, thus facilitating the alignment of activities towards the achievement of results, enhancing the generation of value through convergence with the documents that govern it.

This process-based approach to BIM implementation at Adif has represented a colossal challenge, as it involves revising the documents that make up the management system, requires process re-engineering and is comparatively slower than exclusively generating BIM reference documentation without integrating it with other corporate processes. Nevertheless, in



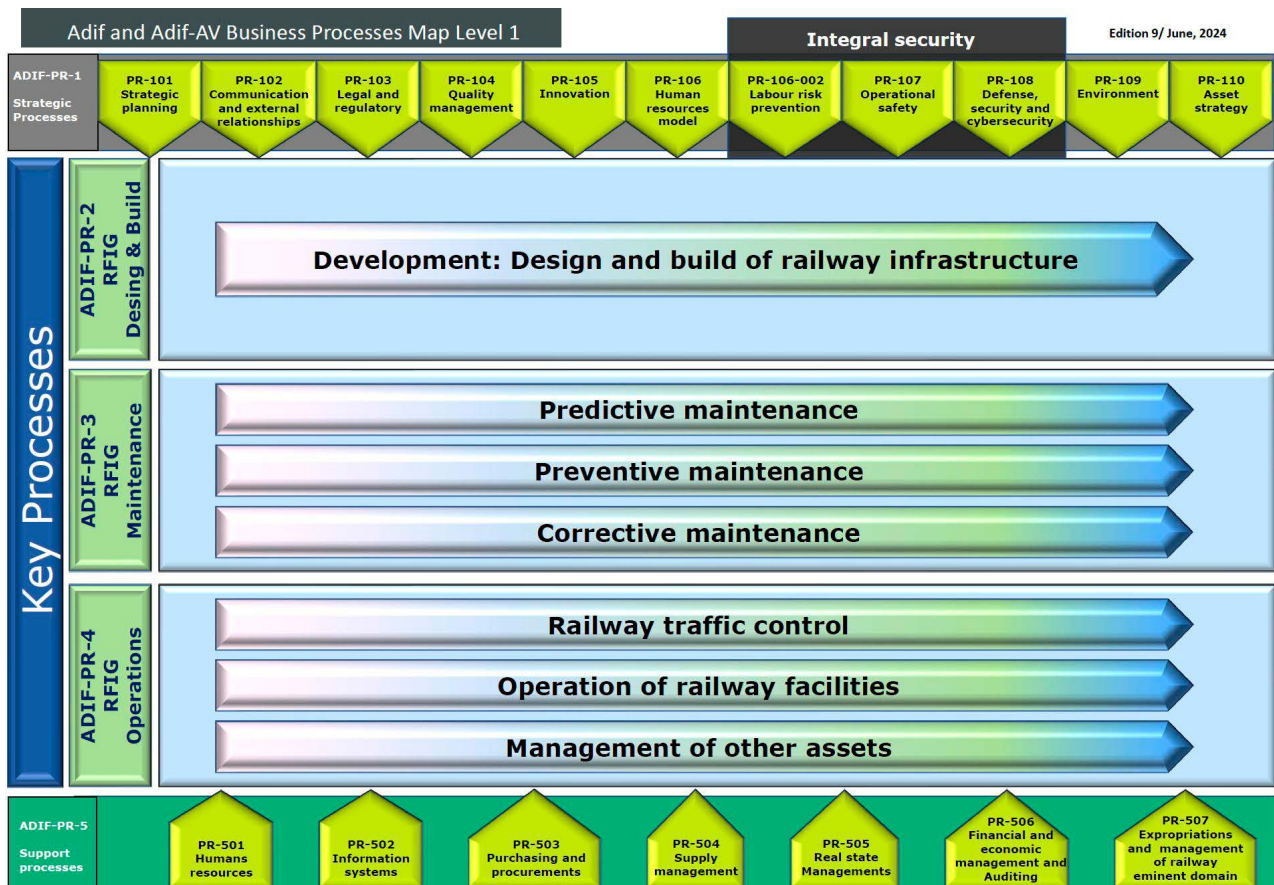
Specific Strategic BIM Objectives.

the medium and long term, it will prove more robust.

In order to tackle the analysis of the management sys-

tem documentation, a working methodology was created to determine, as straightforwardly as possible, whether the docu-

Process map Level 1.



ment under analysis was directly impacted by BIM because the information that managed the process was susceptible to being stored in a BIM model, indirectly impacted by BIM because the information might not form part of a BIM model but was part of a database relating to the visible elements of a model, or was a document that was not impacted by BIM at all.

In total, 220 documents have been impacted by BIM, which again highlights the scope of the methodology. In turn, a new process called "Development and management of BIM methodology" has been generated to regulate its activity within Adif.

BIM Standard or System

Since several Adif departments manage projects involving different railway technologies and the construction departments are regionalised, there was a need to standardise all purely BIM activity through a global standard, specifying whatever was necessary. In addition, both the general and specific objectives are connected with the model uses (the practical applications that will be given to the BIM models), which conditions the information that must be entered into the objects that make up these models.

Objectives, uses, types of models and attributes constitute just a fraction of the fundamentals that the BIM methodology contributes to information management in the field of engineering. These fundamentals are developed in the Adif BIM Standard, constituting a comprehensive set of documents aligned with the reference docu-

More than 800 Adif employees have been trained in the fundamentals of the methodology, in the new work processes, and in the use of the CDE.

mentation being finalised by the Interministerial BIM Commission (CIBIM).

Within this block, in addition to the standardisation documents themselves, essential elements have been developed, such as the functions of the people who will work with BIM requirements, both internal and external to Adif.

One of the big changes brought about by BIM is the emergence of new roles, although not all of them will be required at all times. The roles are, for the moment at least, not job titles, so they must be taken on by existing staff or new staff entering the activity. This induces, among other things, two undoubtedly positive outcomes, the first being the creation of new professional opportunities for the people who will perform the new BIM functions, and the second, a social and economic dynamising effect on the whole sector, from the worthwhile training being offered by universities, academies and professional associations, to other areas, both public and private, that enhance employability in the sector. While this all requires investment, given the objectives of efficiency and quality being pursued, the return on investment is more than assured.

Training

Training and developing the skills of Adif's workforce has played a vital role in the implementation process. A total of 196 dedicated

training hours have been devised with the aim of maximising the effectiveness of the classes and training programmes. More than 800 people have been trained in the fundamentals of the methodology, in the new work processes, and in the use of the Common Data Environment (CDE). Three types of training courses were held: the first to cover general aspects of the methodology, the second to explain the BIM processes in more detail, and the third to delve more deeply into the standard and promote the all-important change management. Numerous workshops have also been organised to explain various aspects of the methodology, and two e-learning courses have been developed for Adif's virtual training platform, making it possible for any Adif employee to receive training.

As ongoing training is vital for proper change management, it is essential that Adif continues to offer courses and activities that will enable its personnel to consolidate and broaden their knowledge. Consequently, during 2024 and in subsequent years, the training programmes are expected to continue.

ICT (Information and communication technologies).

One of the key elements of Adif's BIM implementation is the deployment of a Common Data Environment (CDE) as a platform

Change management

The implementation of BIM represents a profound transformation in the way we work. It is a means, rather than an end, that technology and the maturity of specific processes have made available to the sector. It's important to remember that the cornerstone of this transformation is people, and only collective teamwork can guarantee its success.

Although not the only factors in change management, training and capacity building are crucial, and one of the keys to success is to get them right. To achieve the implementation objectives, one of the most critical tasks has been the creation of an internal website that has become the corporate BIM information centre, along with a dedicated e-mail account to handle any incidents or queries related to the methodology.

Another central tenet upheld by Adif is that BIM implementation must be practical and provide tangible value, and, as always, good communication is an indispensable element that must be addressed with the utmost care.

The management of expectations and the importance of persevering with BIM as a matter of habit and as an attitude, if approached correctly, can also be immensely beneficial to the change management strategy, which is ultimately the greatest challenge of any BIM implementation.



that provides a shared space for collaborative work, as well as the tools to produce, manage and share all the information related to projects, works and other associated activities. In the future, it will be integrated with the maintenance and asset management tools.

Adif's CDE is based on the ISO-19650 standard with the refinements necessary to accommodate the nature of the activities defined in the management system documents. Its characteristics are as follows:

- It constitutes the sole source of information for the design and construction activities.
- The information is shared securely and collaboratively

among the agents involved in an action, guaranteeing the traceability of all communications and documents.

- It is used to collect, manage and disseminate all relevant information documents, in addition to the multidisciplinary information necessary for proper coordination between teams.
- It facilitates the holding of digital meetings, allowing the recording of comments, assignment of responsibilities, visualisation of graphic documentation and management of interferences between BIM model objects.

A user guide has been drawn up for all those involved in informa-

tion management, covering tasks such as their roles and responsibilities, how to register and de-register users, document review, communication flows between the different parties involved in the exchange of information, storage of the documentation generated in the course of all the activities, etc. Furthermore, the naming of files and the structure of the folders in which these files are stored have been standardised.

Proper use of the CDE is one of the most transformative facets of the BIM methodology, and its deployment represents a major challenge, whether using a market platform or opting for customised development.

BIM model of La Sagrera.



Case study. Implementation of BIM and CDE in the La Sagrera works

In February 2023, the Sagrera team at Adif began implementing the CDE and BIM methodology in the La Sagrera works. In just five months, 70 % of operations were assimilated, and currently, 95 % of the processes for managing construction plans and reports, the planning of different phases of the work and quality documentation are managed using the CDE BIM environment. This progress represents a significant milestone in managing large infrastructure projects within Adif.

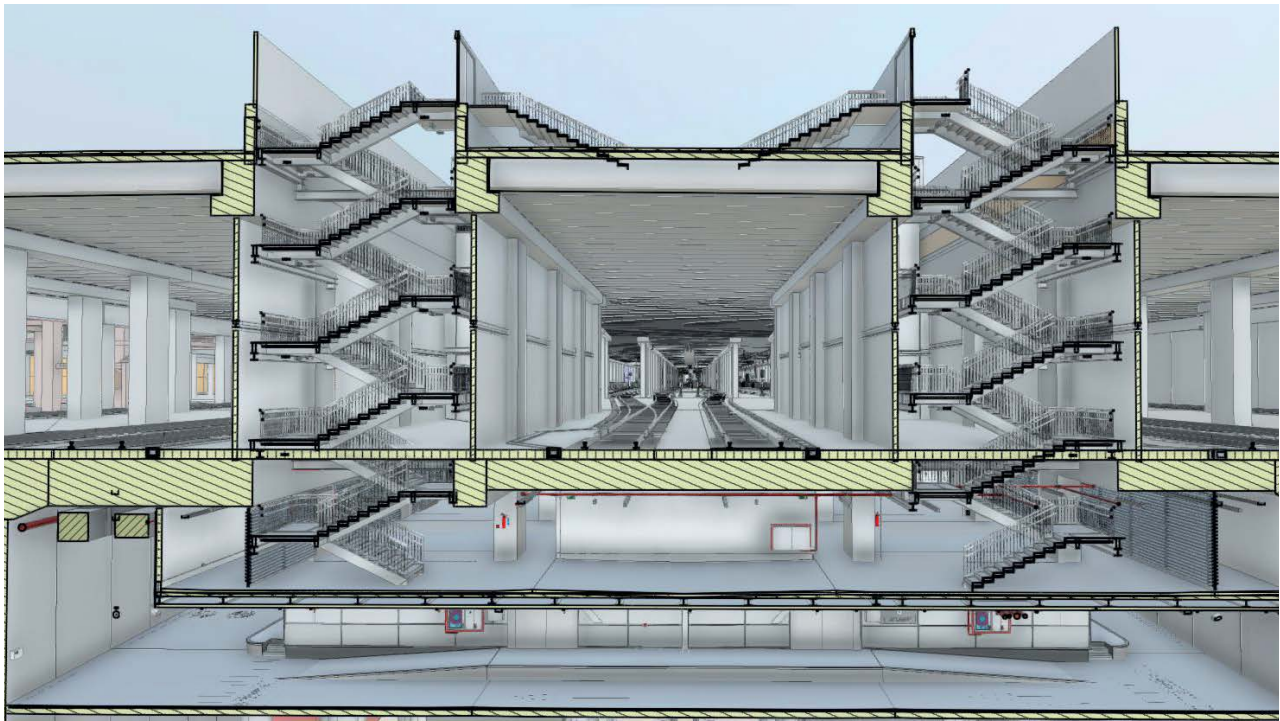
Complexity and coordination of the project

La Sagrera is an extremely complex project that entails the contribution of multiple works, which require coordination to ensure overall project control, both in terms of time and cost. Currently, 11 of the 25 projects that comprise the overall Sagrera-San Andrés operation, which has a budget of 1.7 billion euros, are being executed. The ultimate goal is to build a structure that will house four stations: two conventional train stations, one high-speed station, another area for the technical management of trains, a metro station, and a bus station. Subsequently, the entire

area will be covered with a park and gardens.

Synergy between the CDE and BIM implemented by Adif in major projects

The functioning of BIM as a work system shared between the different agents involved in the work is understood as essential. Based on Adif's experience, it is impossible to understand how BIM works without a collaborative data-type environment, as otherwise, the advantages of working with the model would be underused. The CDE platform acts as a centralised point that efficiently stores, manages and shares all the project data and documents. The synergy be-



BIM model of La Sagrera.

tween the CDE and BIM maximises the benefits of the model and the collaborative working methodology, providing multiple advantages:

- **Centralisation and distribution of documentation**

This system allows for the centralisation of all relevant project documentation, facilitating its distribution to all stakeholders. This includes both incoming and outgoing documentation, ensuring that all information flows in an orderly and efficient manner.

- **Access for Adif managers**

Provides Adif managers with direct access so that they can stay up to date with the status of the project, improving transparency and decision-making capacity.

- **Synchronisation of works planning**

Enables synchronisation of works planning, anticipating potential

conflicts and ensuring that all parties work in a coordinated manner.

- **Single BIM coordination model**

A single BIM model serves as a central coordination tool, ensuring that all actions are integrated and managed coherently.

Results

The implementation of the CDE and BIM methodology in the La Sagrera project has proven a successful strategy. The combined use of these technologies has optimised document management and workflows, setting a new standard for efficiency and collaboration in the construction industry.

Ninety-five per cent of the processes related to the management of drawings, reports, planning, and quality documentation for each individual construction site are now managed through

the CDE BIM environment. This approach has significantly improved coordination, traceability, transparency, documentation control, process simplification, time savings and, above all, confidence in the team.

In conclusion, the experience at La Sagrera underlines the importance of adopting advanced technologies and innovative methodologies to manage complex projects. The use of the CDE and BIM environment not only guarantees greater quality and control but also facilitates collaboration and success in the execution of large infrastructure. The centralisation of documentation, provision of direct access to information for managers and the synchronisation of planning have all been crucial to the success of this implementation.

Conclusion

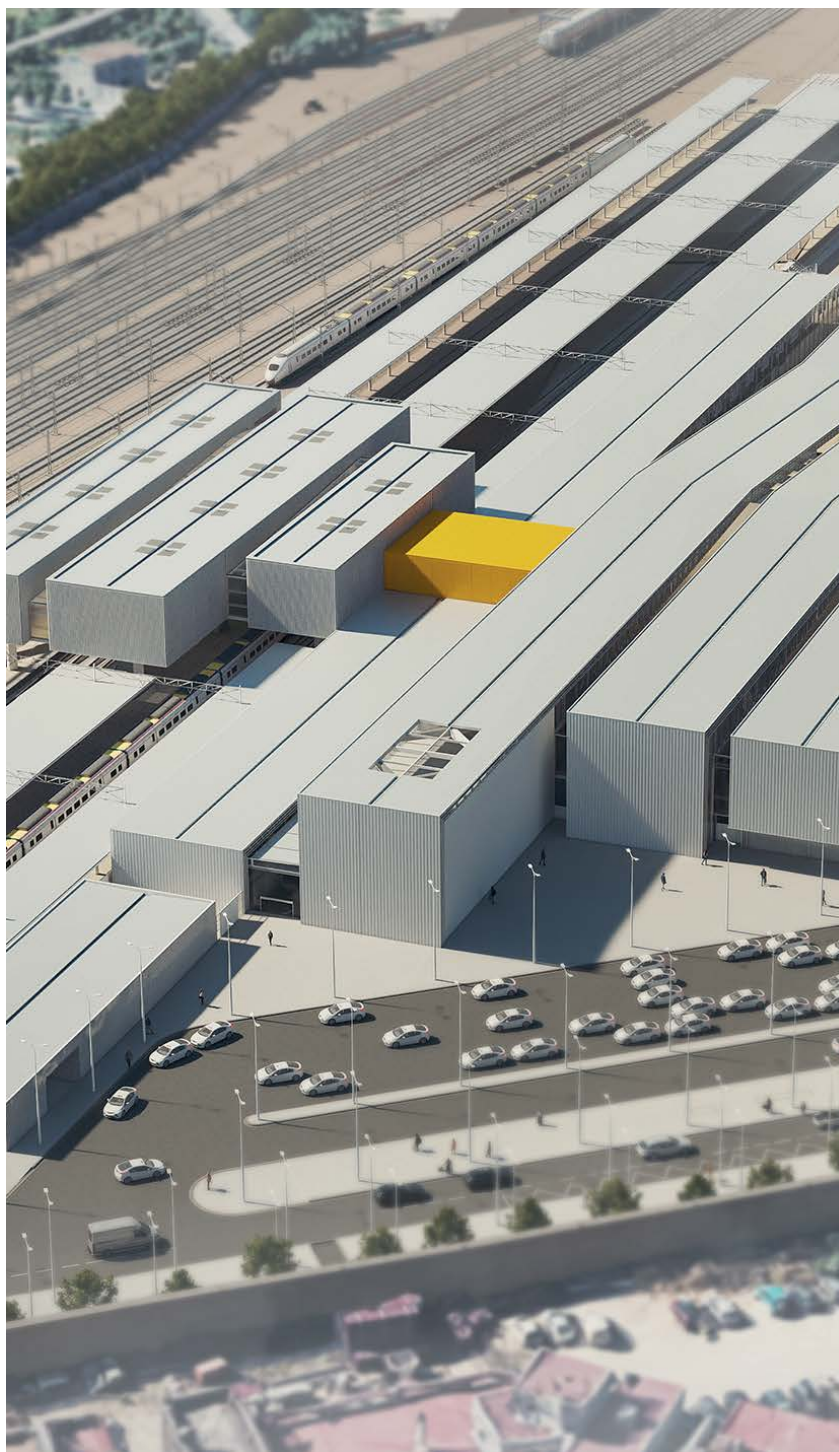
Implementing BIM successfully in any organisation, whether large or small, requires a capable and motivated team. The support of top management is also essential, and Adif has enjoyed both this support and that of outstanding professionals who, with extraordinary perseverance, have made it possible to achieve the objectives. All the personnel in the departments collaborating in the implementation have contributed in an exemplary manner, and the admirable work ethic and proactivity of the areas responsible for managing projects and executing works have enabled the change to take place in a practical and tangible way, reaping the benefits of BIM implementation. It is in these project and site teams that two generalised assessments arise:

- The first BIM project represents a major effort.
- There is no turning back. BIM brings unquestionable value.

The experiences described above have served to ensure that, following the publication of the *BIM Plan in Public Procurement promoted by the Interministerial BIM Commission (CIBIM)*, Adif is now ideally placed to comply with the prescribed BIM Starting Level. The planning and requirements of the BIM Plan will serve as a powerful catalyst for transforming the sector, and the BIM Fully Integrated Level, targeted for 2030, will act as the driving force behind the establishment of Adif as a paradigm of the cutting edge of infrastructure management. ●

Model of Valencia-Joaquín Sorolla station.

Implementing BIM successfully in any organisation, whether large or small, requires a capable and motivated team.



The application of BIM in research on civil engineering and environmental assessments

BIM innovation at CEDEX

BIM methodology is acting as a vector for change, driving innovation and digital transformation in the construction sector. CEDEX is joining forces with the Public Administrations to promote more efficient and sustainable civil engineering. As a result, the organisation is currently researching the applicability of BIM in civil engineering and environmental studies through the gradual implementation of unique pilot projects, including works to evaluate the collapse of a large roof, monitor a dam and protect a stretch of coastline. It is also reflecting on the strengths, challenges, and opportunities of using BIM in civil infrastructures.

- Text: Vanesa García Alcocer and Áurea Perucho Martínez, CEDEX
- Photos: CEDEX



Introduction

The diverse range of scientific and technical activities carried out in the centres and laboratories of the Centre for Studies and Experimentation in Public Works (CEDEX) provides a great opportunity to investigate the applicability of BIM (Building Information Modelling) methodology in the civil engineering and environmental sectors. CEDEX's activity covers projects related to the conservation of built infrastructure within the competencies attributed to the Ministry of Transport and Sustainable Mobility and the Ministry for Ecological Transition and the Demographic Challenge, which means that it is ideally placed to explore and implement this technology, both due to its broad scope of intervention (roads, railways, ports, coasts, structures, hydraulics, hydrology, geotechnics, environment and heritage) and the type of work it undertakes (specialised technical assistance, promotion of Research, Development and Innovation (R&D&I) and knowledge transfer). As an independent body and instrument of the National Public Administration (AGE), CEDEX is aligned with the recently approved BIM Plan for the incorporation of BIM methodology in the Public Procurement

of the National Public Administration, and its dependent bodies and related or dependent public law entities and is represented on the Technical Committee that assists the Interministerial BIM Commission (CIBIM).

The BIM journey at CEDEX began in 2019 with an R&D&I project focused on defining a general digitalization procedure that, in turn, would be adaptable to the specific requirements of the activity of its different centres and laboratories. Through case studies, this research outlined a work plan comprising a preliminary requirements analysis phase and three development phases (data collection, modeling and integration) intended to lay the foundations for building the digital twin.

Building on this approach, a phased process of BIM roll-out is being implemented through a series of actions that the agency is undertaking in the building, engineering and natural environment sectors.

This article describes this process in terms of the degree of consolidation of the methodology: the first block describes three pilot projects carried out in the fields of construction, hydraulic works and coastal restoration; the second describes two ap-

plications being developed to assess the environmental impact of the road network and protect and publicise the heritage of public works; and the third block identifies lines of opportunity in sanitary and railway engineering, building conservation, geo-technical performance and the restoration of ecosystems. Given their considerable heterogeneity, while all these examples share a common approach strategy, they differ in the specific tactics used to address each scenario. Lastly, a series of conclusions and reflections on CEDEX's experience of implementing and using BIM are provided.

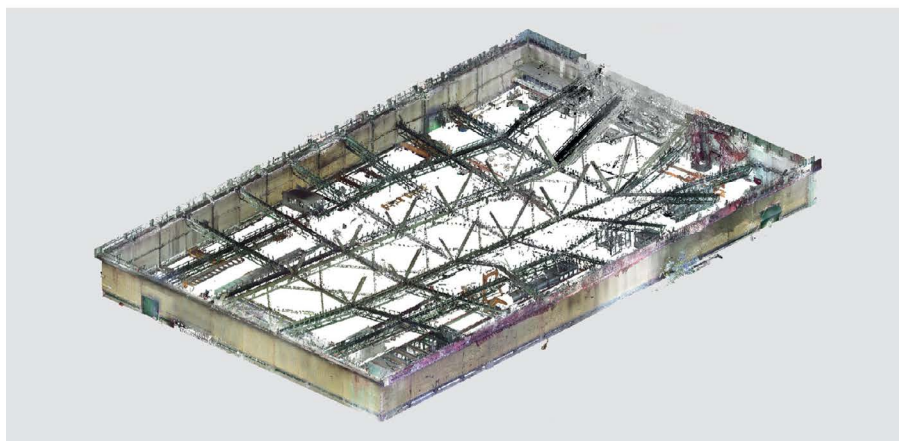
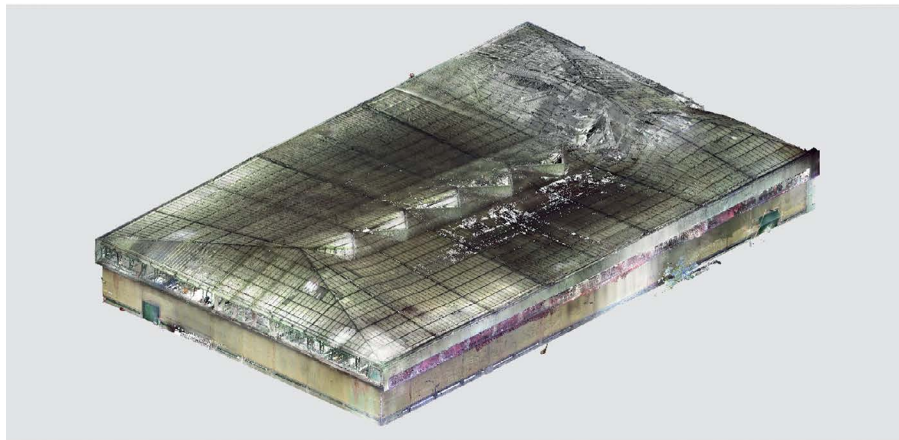
BIM pilot projects

Three-dimensional survey of the roof of CEDEX's CEPYC Maritime Experimentation Laboratory for its reconstruction with BIM requirements

In 2021, CEDEX's Central Laboratory of Structures and Materials (LCEYM), in collaboration with the Centre for the Study of Ports and Coasts (CEPYC), carried out the 3D scanning of the roof to inspect and assess the condition of its structure after its collapse at the beginning of that year as a result of the damage caused by

Phases of applying BIM methodology to the digitalisation of constructed works.





Exterior, axonometric and interior views of the 3D point cloud of the roof of the CEPYC Maritime Experimentation Laboratory.



Downstream elevation view of the BIM model of El Atance dam in its topographic context (with 3D point cloud overlay).

storm Filomena. The survey results made it possible to precisely identify the position and level of deterioration of the structural components, as well as to assess the optimal intervention strategies. They also served as a starting point for drafting proposals and identifying the elements that would be affected by the works.

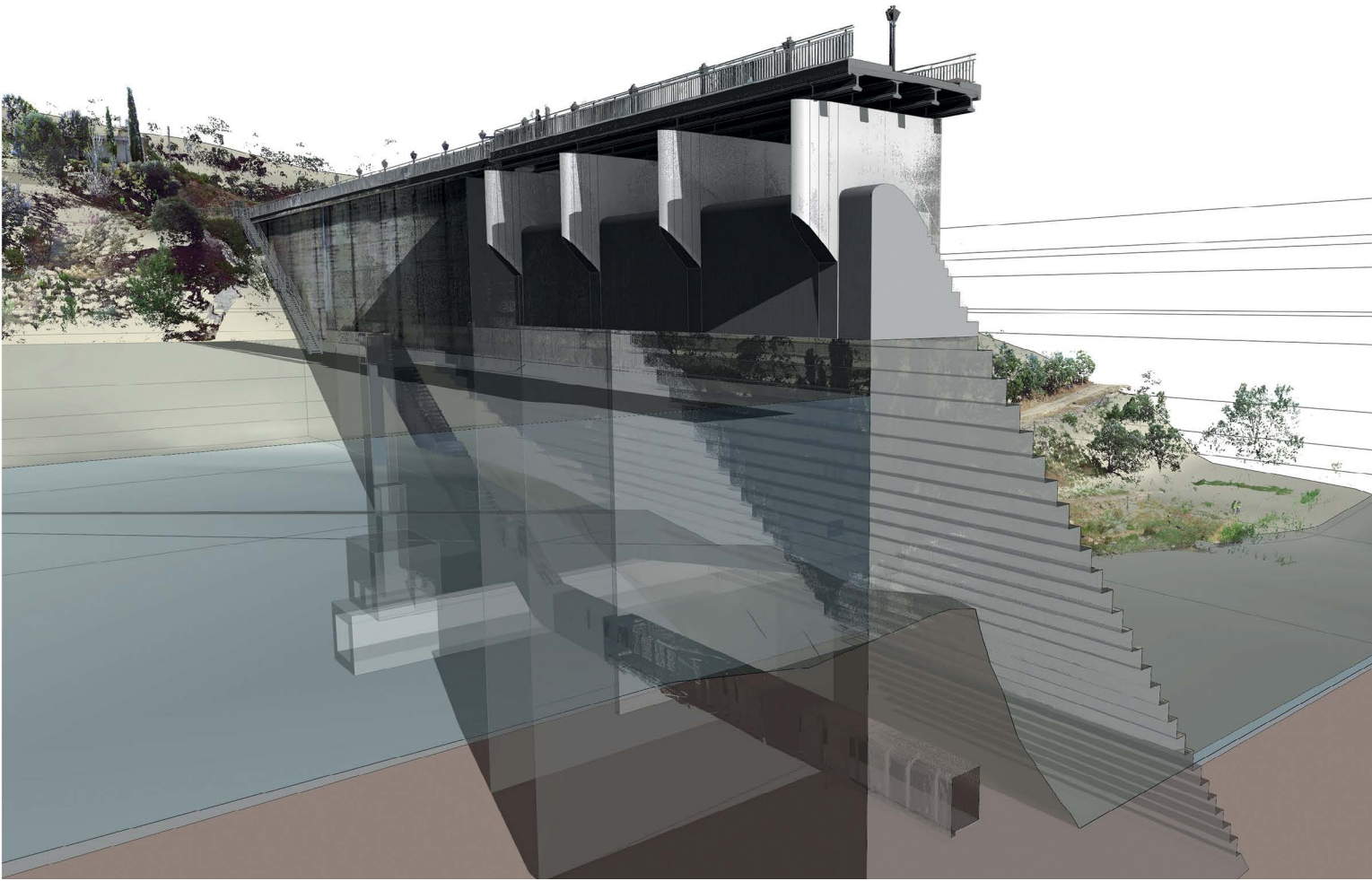
Notably, BIM was integrated into the design and execution phase of the roof reconstruction, whose emergency work cost more than 12 million euros. To this end, an annex to the tender was issued with the Client Information Requirements (CIR),

which defined the technical and management requirements, as well as the specifications regarding objectives and uses, levels of development, equipment and experience, common data environment, quality system, software and formats; to obtain a final model of the *as built* work, which will allow CEDEX to carry out integral and efficient management of the maintenance and preventive conservation of the building.

Digitalization of El Atance dam to improve its maintenance and operation management

The dam is located on the Salado River (Guadalajara), was built in 1997 and belongs to the Tagus Hydrographic Confederation (CHT). The research, part of CEDEX's BIM R&D&I base project, began in 2021 at the request of the Directorate General for Water (DGA), of the Ministry for Ecological Transition and Demographic Challenge.

A BIM model linked to the built reality was obtained, making it possible to centralise and manage all the information generated during the life cycle (design, construction and operation) of the infrastructure. This case study



Cross-section view through the spillway of El Atance dam BIM model from the upstream elevation (with transparent galleries and facilities).

allowed us to assess the applicability of the BIM methodology to the needs of this type of hydraulic infrastructure.

The research consisted of four phases.

- In the first phase, the dam was scanned using the Scan-to-BIM process to capture its geometry, materials and state of conservation in a high-precision point cloud, using a drone for general shots and a terrestrial laser scanner to record interior spaces and details. The combined results of these capture techniques allowed us to obtain orthopho-

BIM digitalization of the dam aims to integrate the auscultation system in order to manage and monitor it in real time.

tos, take measurements and identify lesions in the dam's structure. They also served as the basis for constructing the BIM model.

- In the second phase, the model was geolocated by entering the GPS coordinates of several control targets, and it was set up to represent the constructive, structural and

installation elements necessary to define the 3D geometry. The dam characterisation parameters were also entered, which is key for configuring the database linked to the model, as it allows information to be entered in a classified manner and guarantees its traceability and interchangeability.

- In the third phase, we integrated other available information on the dam (plans, reports, tests and photographs) so that it could be registered and managed from the model. The graphic documentation was stored in the virtual space, while the non-geometric inputs were integrated into the project parameters and their associated data. As an example of the latter, it was suggested that the results of the study of the dam's concrete, carried out by CEDEX's LCEYM, be included so that the concrete's mechanical and physical characterisation data could be consulted in its location in the model, in addition to the damage maps of the detected pathologies. The entire process was conducted in accordance with standardised modelling and information management specifications.
- Currently, the research is advancing in its fourth phase:

Applying BIM to control coastal recovery actions will allow us to adapt the coastline of Denia to the effects of climate change.

the generation of the digital twin through the integration of the dam's auscultation system and a real-time communication protocol, which will allow it to be managed from the BIM model itself. In the operating phase, the digital twin will be crucial for scheduling the corrective and preventive maintenance of the infrastructure and having full control over its life cycle.

Digitalization of Denia's coastline to monitor recovery measures and climate change adaptations.

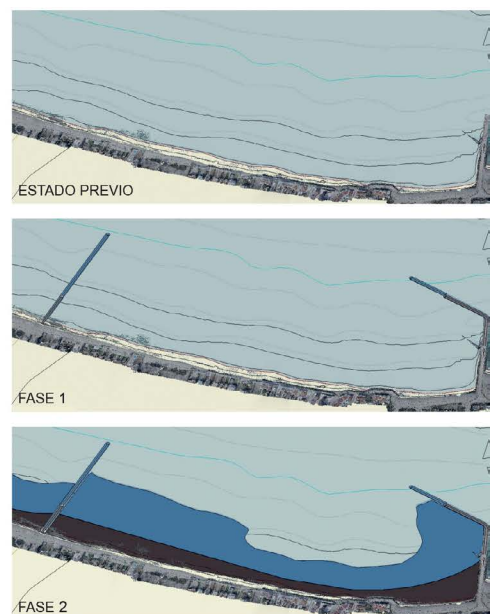
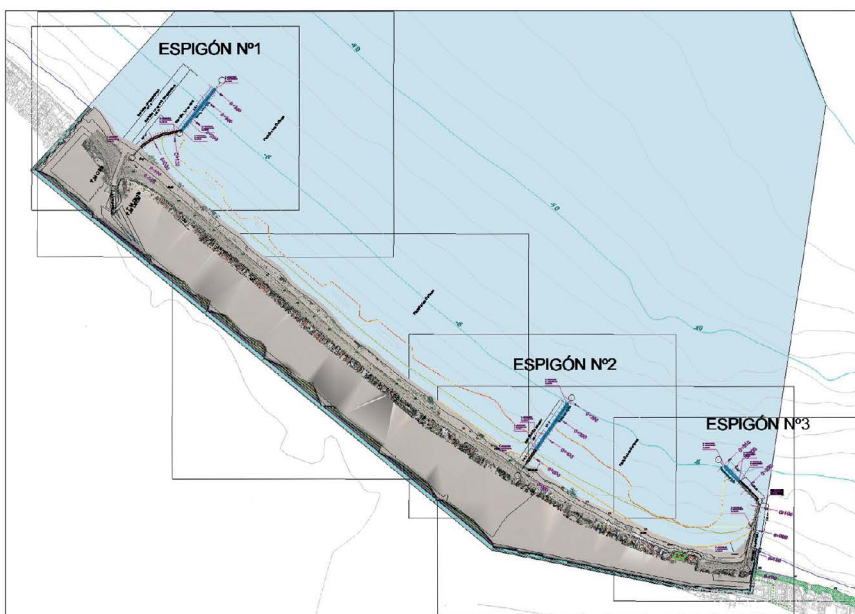
In 2023, the Directorate General for the Coast and the Sea (DGCM), another department of the Ministry for the Ecological

Transition and Demographic Challenge, commissioned CEDEX to carry out applied innovation, technological development and innovation in areas of its remit. As part of this assignment, it was suggested that a pilot project be developed to study the application of BIM methodology to an intervention in a coastal area in order to visualise and contrast the advantages and disadvantages of various alternatives for the beach restoration project.

The work was carried out in two stages.

- The first consisted of a 3D point cloud survey of Les Deveses beach using aerial photogrammetry with drones.
- In the second stage, a digital model of the environment

Ground plan view of the BIM model of Denia beach (with CAD planimetry and 3D point cloud overlay) and comparison of construction phases.



was generated to support the management of the planned intervention using BIM methodology.

The study area is more than 3 kilometres long, which posed a major challenge in terms of its digitalization. The modelling of the beach focused fundamentally on the creation of the topographic and structural elements necessary for it to be correctly defined on a georeferenced cartographic base. In addition, this information was organised into different construction phases in order to differentiate the original coastal elements (previous state), such as the 3D point cloud obtained from the drones and the topography generated from its contour lines, from those proposed in the restoration project, such as the breakwaters to protect the coast and the interventions to supply sand to regenerate the beach (phases 1 and 2 respectively). This approach allowed us to re-

cord the pre- and post-intervention states and thus to establish comparisons *in situ* between the different constructive and chronological phases. Importantly, the resolution and precision of the topography, obtained by digital photogrammetry, makes it easier to monitor the evolution of the coastal dynamics along this stretch of coastline.

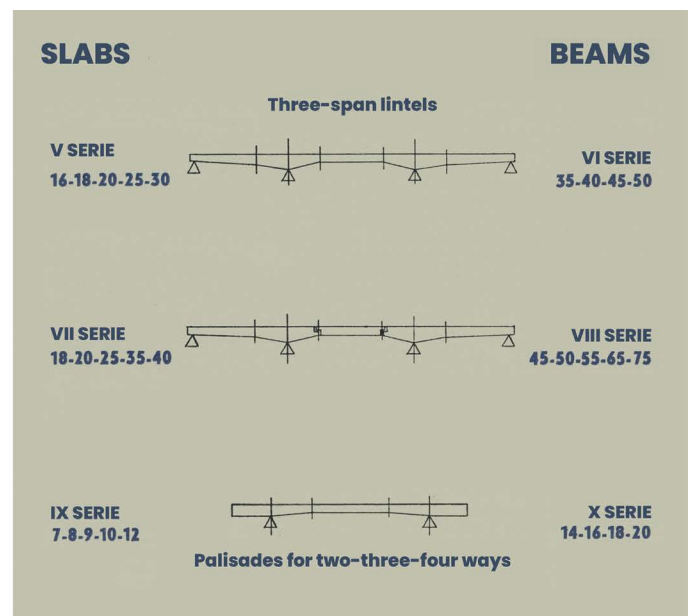
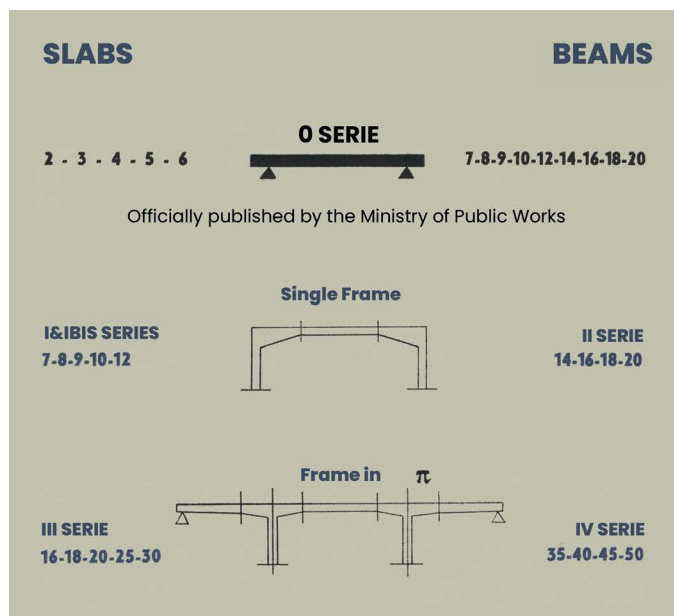
BIM applications in progress

The first project, is in initial phase and connects with the **need to assess environmental impacts on the National Road Network (RCE)**. The Centre for Transport Studies (CET) of CEDEX is cur-

rently working with the Ministry of Transport and Sustainable Mobility's Directorate General of Roads (DGC) to *study and quantify the environmental impacts of road-related activities by carrying out Life Cycle Assessment (LCA) studies of the products and services involved in their construction and maintenance*. The complexity of the evaluation process requires IT support to overcome the difficulties arising from handling the data, making the necessary calculations, and analysing the results.

Accordingly, the final objective of the work is to develop an LCA tool for sections of road surface in the National Road Network

Catalogue of structural solutions from the Puentes de Altura Estricta Collection.
Author: Carlos Fernández Casado.



Heritage-BIM brings historical heritage closer to society

In the rehabilitation and conservation of historical public works and urban planning heritage, research plays a fundamental role in our efforts to understand, preserve and revitalise these infrastructures. With the integration of digital technologies, CEDEX seeks not only to provide accurate information and methods for protecting and safeguarding this heritage but also to help us understand its cultural context, thus promoting its value and significance in today's society. In the multidisciplinary study of built heritage, Heritage-BIM (H-BIM) models, both 3D digitalizations of existing works and virtual reconstructions of those that have disappeared, are essential for achieving these objectives.

H-BIM makes it possible to visualise the works in 3D and associate data on the construction techniques, materials, and auxiliary means used in their execution with the virtual model while facilitating the traceability of the documentary and physical sources on which its modelling is based. This crossover between built and virtual realities and information on the past and present of the work, which is provided by BIM methodology, is essential for transmitting the relevance and functionality of these assets to current and future generations.

Using H-BIM brings heritage closer to society in an innovative and accessible way by integrating audiovisual content and interactive tours that enrich the exhibition experience for all audiences. Ultimately, the aim is to raise social awareness of the importance of heritage preservation.

(RCE). To do this, we first need to obtain the necessary reliable and nationally representative environmental information on all related products and activities, which will be stored in a specific database and support the LCA tool. The database will be built with future compatibility with BIM and the DGC price database, which is currently being digitised and improved, in mind. This project focuses strongly on digitalization and sustainability, which

are key issues in the construction sector, both at a European and national level.

The second project, started recently and it consists of the **research and protection of civil engineering heritage**. In 2024, the CEDEX's Center for Historical Studies of Public Works and City Planning (CEHOPU) started a *research project on the Puentes de Altura Estricta Collection (CPAE) designed by Carlos Fernández Casado*. This three-year pilot

project aims to enhance the value of Spain's public works heritage. The project proposes the development and testing of a research methodology transferable to other projects using the CPAE as a case study and applying digital technologies, including Heritage-BIM (H-BIM) to document, analyse, disseminate and publicise the collection, and promote its conservation.

Studying the CPAE using H-BIM is relevant because of the conceptual affinity that exists between this work dating from the 1930s and the functionalities offered by BIM in terms of its ability to standardise elements and systematise the construction process, which can be exported to other projects. The collection was originally conceived as a detailed catalogue of structural models that have served as the basis for the construction of at least 50 bridges throughout Spain. Given the dual documentary and constructive aspects of the CPAE, the research involves three simultaneous phases of investigation: the first, documentary; the second, empirical; and the third, synthesis. H-BIM plays a vital role in all of them.

In the first two phases H-BIM is used as a unified data repository to generate 3D models that replicate a selection of the bridges in the collection. On the one hand, the modeling is supported by the extensive and varied 2D documentation of the CPAE, belonging to the Fernández Casado Archive and preserved by the CEHOPU. On the other, it is based on data collection from the existing bridges. In this second phase of fieldwork, drones

and 3D scanners are used to capture the current condition of the bridges through point clouds, and GIS is used to analyse the territory and geographical context of the works. The two data sources (documentary and empirical) are linked to the models through the traceability of the codes integrated in their parameters and serve as the basis for the third phase. In this final synthesis phase, a digital platform integrating the 3D models and the information associated with them, including a rich intangible heritage (testimonies, films, photographs), will be used to publicise and emphasise the value of the CPAE. The aim is to provide researchers and professionals with a complete database of extensive and easily accessible information about the CPAE. With regard to disseminating the results of the research, the plan is to organise an exhibition that will include physical models, plans and other original documents, as well as a digital exhibit that will allow interaction with the BIM models through virtual and augmented reality. This application of BIM in museography will allow us to explore its potential as a communication tool.

As a whole, the project seeks to advance in the use of H-BIM and support the digital transition of CEHOPU as a centre for the study and dissemination of public works and urban planning. Initially, our goal is to validate the usefulness of this technology in projects to research and disseminate exemplary civil works such as the CPAE, which, interestingly, shares its project logic –based on the systematisation

BIM facilitates the conservation and operation of infrastructures, serving as a collaborative inventory and temporal registry of actions.

and standardisation of solutions—with BIM. In the future, the intention is to replicate the methodology tested in this project and perfect it in order to extrapolate it to other engineering heritage sites in Spain.

Opportunities for using BIM

The following paragraphs outline several lines of opportunity identified in various CEDEX centres. These opportunities are expected to facilitate the study and testing of public works by applying BIM methodology in areas that have not yet been explored.

- The Centre for Hydrographic Studies (CEH) has proposed **integrating BIM into sectoral planning for sanitation and wastewater treatment to improve their sustainability..** Utilising parametric design in the modelling of hydraulic infrastructures facilitates the adaptation of their configuration to various structural conditions (type of terrain, water table, etc.) and to different scenarios depending on the bases proposed in the project, in order to be able to quickly estimate the surface and cost requirements, which are generally the most important factors in the planning of the project. In addition, parametric design makes it easier to undertake the dimensioning needed to analyse alternatives

and thus justify the choice of the definitive treatment line. With this in mind, making a catalogue of parametric models of the main water treatment processes available to the public would be a positive step forward.

- The Railway Interoperability Laboratory (LIF) has proposed **digitizing the railway network with BIM to manage maintenance and plan preventive maintenance, so to facilitate the centralisation and registration of digital maps of infrastructures.** Furthermore, applying it in the track laboratory will enable the monitoring of signalling assets (signals, markers, switches), verifying whether the condition of these elements and their configuration are appropriate to the line. Implementing these measures will facilitate life cycle analysis simulations, optimise maintenance interventions and coordinate the agents in charge of these tasks.
- The Geotechnical Laboratory (LG) suggests having **detailed and reliable BIM models of the infrastructures studied, which incorporate the history of the actions undertaken and the record of auscultation and monitoring data in order to adequately plan reconnaissance campaigns** and facilitate the evaluation of the stability of the structures.

Transforming transport infrastructure with BIM

- The Centre for the Study of Applied Techniques (CETA) is considering the **possibility of designing the construction of wildlife crossings on motorways and highways with BIM**. By generating parametric models of the crossings, their design can be adapted to the studied cases of confluence between animal and vehicle traffic, seeking to improve the coexistence of both flows, recover the ecological connectivity on both sides of the linear infrastructure and prevent accidents.

Lastly, CEDEX, through the Works and Maintenance Department of

its Secretariat, has proposed that BIM could be used to improve document management for intervention projects and conservation work on the organisation's ten buildings. This application would facilitate both the recording of interventions and repairs carried out and the scheduling of maintenance and incident management. Going forward, these benefits could be extended to environmental management and documenting the energy savings associated with the measures implemented.

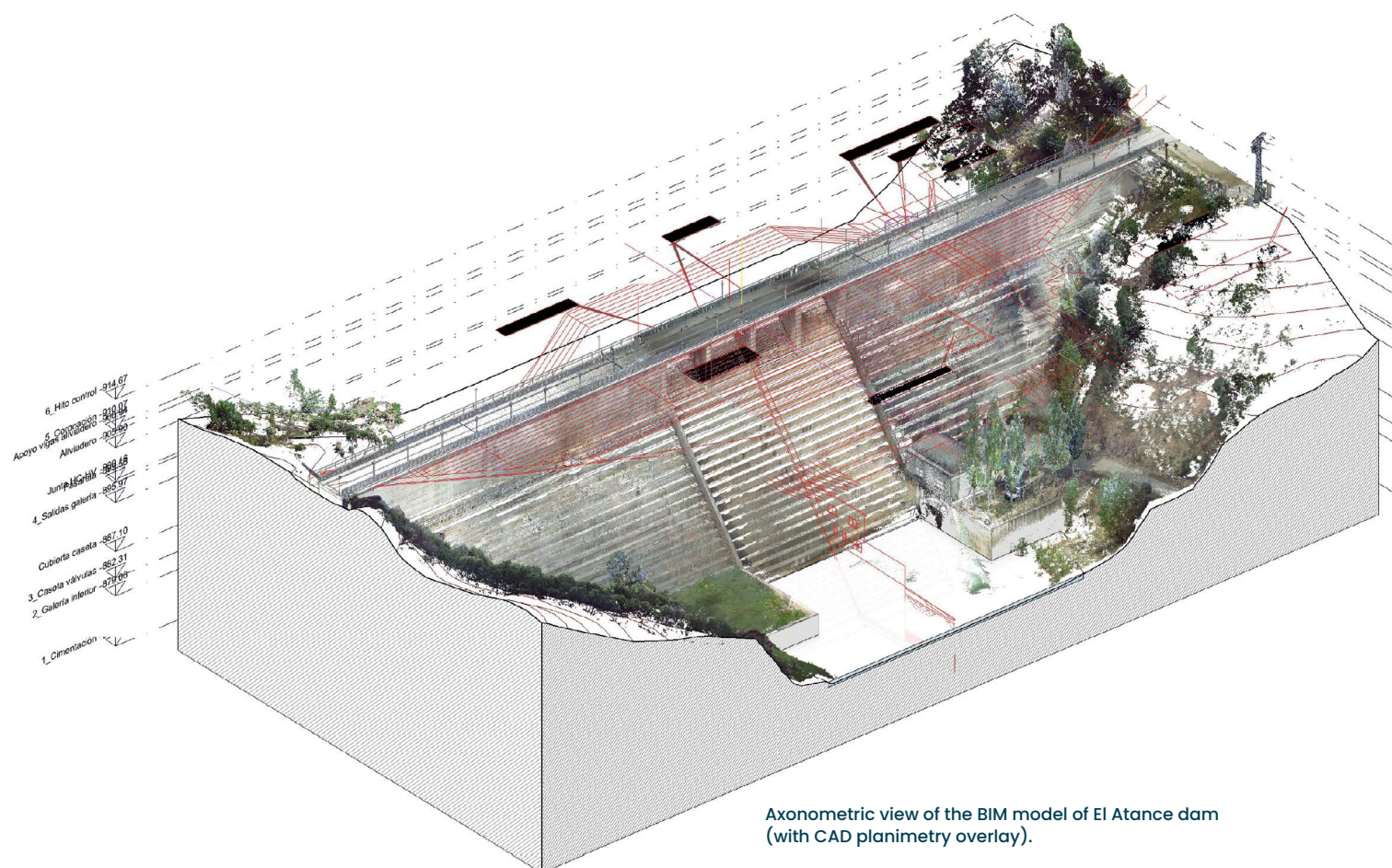
These valuable insights point to some of the future avenues that efforts to maximise the po-

tential of BIM technology in building, engineering and the natural environment could be directed towards.

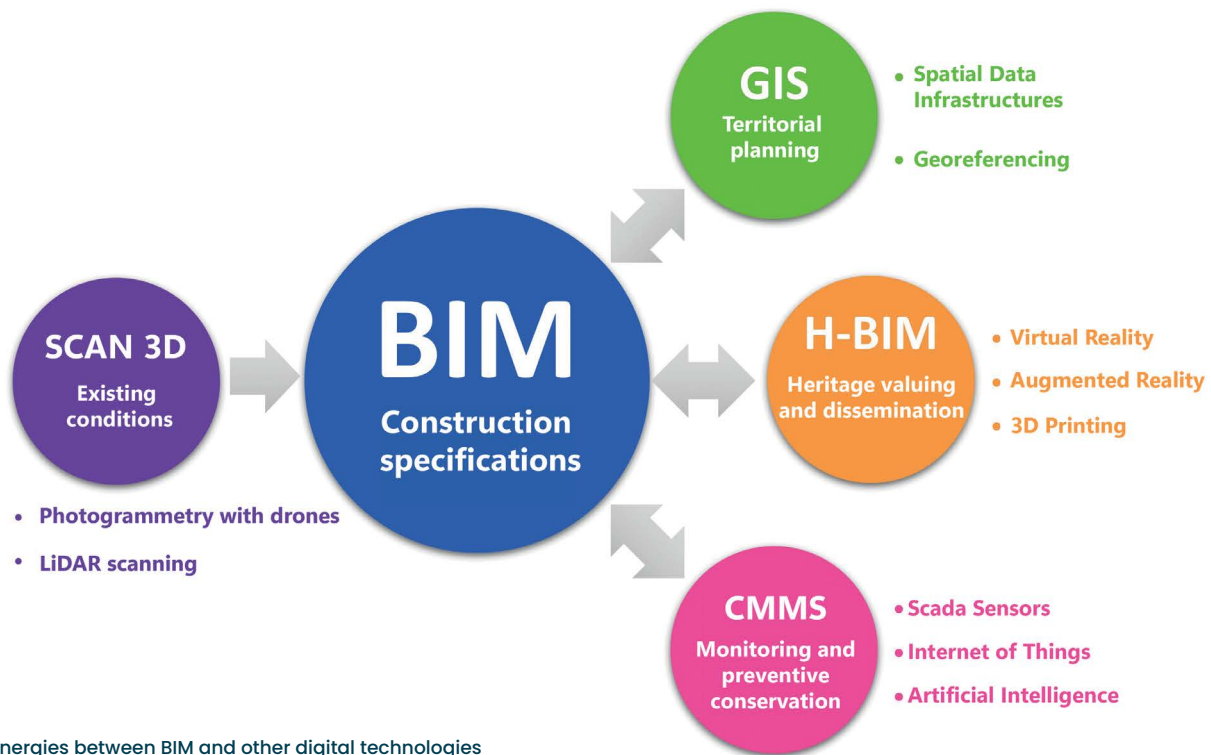
Conclusions

CEDEX's commitment to the application of the BIM collaborative work methodology is driven by its innovative nature and because it offers a comprehensive and integrated approach to resolving scientific and technical challenges in the building engineering and natural environment sectors.

Numerous positive results were obtained during the process of setting the basis for the gradual incorporation of BIM, and our



Axonometric view of the BIM model of El Atance dam (with CAD planimetry overlay).



Synergies between BIM and other digital technologies

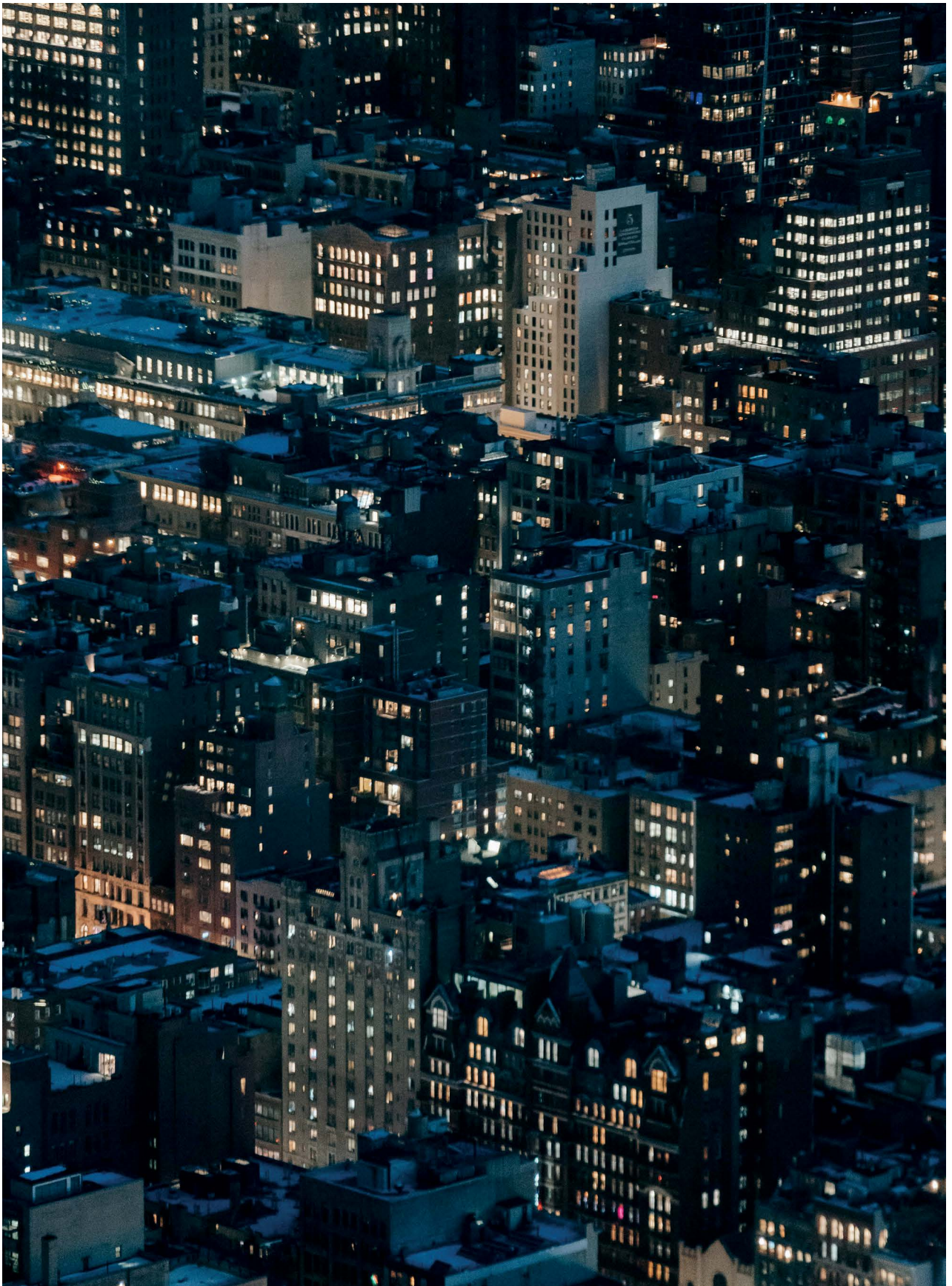
experiences have shown that digitalization using BIM methodology can achieve a comprehensive, and unified virtual model that is linked to its built reality. As a result, its application improves the precision of the construction design (thanks to the granularity of the data), the coherence between the 3D visualisation and consultations of the related information, and document management (all the files are registered in the model by their nomenclature). It is also clear that digitising the construction process with BIM facilitates the management and operation of infrastructures with a dual purpose: to serve as a collaborative inventory between the agents responsible for their maintenance and to function as a registry of actions and life cycle monitoring. Another positive aspect is that the BIM files generated in the projects described are

delivered in open format (Open BIM), using the current versions of the Industry Foundation Classes (IFC) interchange standard, to guarantee the interoperability of the model and allow it to be exchanged irrespective of the origin of the data and the creation or visualisation software used.

The main obstacle has been incorporating the built environment into the BIM models, which involves complex processing of the data captured in 3D to ensure that the information is operable, reusable and easily exportable to open formats and that it can be interconnected with other environments in the Scan-to-bim workflow.

Finally, the synergy of BIM with other digital technologies opens up new avenues for exploiting 3D information models. Among these, the BIM-GIS (Geographi-

cal Information System) synergy is particularly interesting as it provides a significant advantage in the management of linear large-scale infrastructures, with BIM complementing at a building level (construction process) the information provided by GIS at a territorial level (strategic planning). Similarly, pairing BIM with CMMS (Computer Aided Maintenance Management) systems represents yet another fundamental application that can be used to monitor the life cycle of assets. Lastly, in the context of using BIM for public works heritage and urban planning, H-BIM will allow us to explore its potential to convey the relevance, cultural context and functionality of these assets, thus promoting their value and meaning in today's society. ●



#Transforming building development with BIM

BIM represents and evolution in building management and maintenance, also transforms urban planning and facilitates the integration of other public interest objectives such as sustainability, safety and accessibility, efficiency and cost reduction into projects.

This section provides a context for the use of BIM at national and European urban planning and architecture strategies and explains how BIM can be used as a tool to support urban planning and management, greenhouse gas emissions reduction, sustainable waste management, architectural quality, safer and more accessible buildings, and the reduction of construction and maintenance costs over building life cycle.

Additionally, in this section different Nacional Public Administration Departments present BIM use in their building projects and works: Ministry of Finance (Directorate General for State Assets), Ministry of Housing and the Urban Agenda, and Ministry of Transport and Sustainable Mobility.

The Ministry of Transport and Sustainable Mobility, for instance, is developing a centralised information model of its headquarters and the “Nuevos Ministerios” Complex (Madrid) to undertake its digital management and improve its operational efficiency.

Promoting BIM from State Assets

The Directorate General for State Assets, of the Ministry of Finance, which holds the Vice-Presidency of the Interministerial BIM Commission, contributes to the process of implementing BIM methodology in the public sector from a two-fold perspective:

Firstly, as the coordinating authority for public procurement, the Directorate General for State Assets, offers fundamental support to the roll-out of BIM in the public sector, aiming to extend its scope and harness its full potential in public procurement procedures.

Moreover, the Directorate General for State Assets comprises different entities that promote projects and works in which the use of BIM methodology has been consolidated. In the building sector, in addition to the technical services provided by the Directorate General for State Assets, two state-owned companies are of particular note: SIEPSE and SEGIPSA. Their experience constitutes a benchmark in terms of adapting to new technological competencies and the transformation that the use of BIM has entailed.

- Text: Ángel Montero Cabrera, Deputy Director General for Coordination of Administrative Buildings and Enrique Rollón Escudero, architect for State Assets. Deputy Directorate General for Governance and Coordination of Public Procurement. Directorate General for Public Assets Ministry of Finance



BIM (Building Information Modelling) is establishing itself as a fundamental vector of change for the digital transformation in the architecture, engineering and construction sectors. It enables the use of a single source of information and the digital and collaborative management of the documentation generated throughout the life cycle of an asset, making it possible to achieve improvements in productivity and process efficiency, investment monitoring and the development of more sustainable projects.

In this innovative scenario, it is a public sector priority to fully incorporate the advantages of the BIM methodology to optimise public resources and achieve sustainable and competitive growth.

The Directorate General for State Assets plays a fundamental role in promoting BIM in the building projects of the National Government Administration and its dependent public law bodies and entities from a two-fold perspective:

- Firstly, within the scope of the competencies of Directorate General for State Assets in terms of governance and coordination of public procurement, which serves as a strategic lever policy for implementing BIM with full respect for compliance with the regulatory framework,
- and secondly, as a management authority developing building projects, the Directorate General for State Assets is promoting the incorporation of BIM in projects undertaken by its own technical services, as

Directorate General for State Assets offers fundamental support to the roll-out of BIM in the public sector, aiming to extend its scope and harness its full potential in public procurement procedures.

well as in projects promoted by various state public companies under the direction of State Assets, which –as will be shown in examples throughout this article– are making good progress in adopting the BIM methodology in their organisations.

Promoting the use of BIM methodology through the coordination of public procurement

Firstly, within the framework of its authority to coordinate public procurement, **the Directorate General for State Assets is firmly committed to promoting the BIM methodology.**

In exercising its functions of formulating proposals and standards for public procurement, Directorate General for State Assets provides essential support for the roll-out of BIM in the public sector, seeking to broaden its uptake and fully exploit its potential in public procurement procedures.

In this context, the Cooperation Committee on Public Procurement, which is the authority responsible for governing and coordinating public procurement with the various regional administrations –as per the provisions of Article 334 of Law 9/2017, of 8 November, on Public Sector Con-

tracts– and which is chaired by the Director General of State Assets, devised the **National Public Procurement Strategy 2023–2026**, approved by the Independent Office for the Regulation and Supervision of Procurement (OIReScon).

This National Strategy includes objectives aimed at increasing the professionalisation of public agents involved in procurement processes (Objective C), promoting economic efficiency in the procurement of goods, services and supplies for the public sector, stimulating the aggregation of demand and the appropriate use of award criteria (Objective D); using the potential of public procurement to support environmental, social and innovation policies (Objective F); promoting the participation of SMEs in the Public Procurement Market (Objective G); and promoting a clear and stable regulatory framework in order to provide legal certainty in public procurement (Objective H).

From the point of view of public real estate management, these lines of action contribute to the effective implementation of BIM methodology in organisations.

Similarly, Directorate General for State Assets provides essential technical and legal support to the **Interministerial**

Commission for the Implementation of BIM in Public Procurement (CIBIM). The CIBIM, whose vice-presidency is held by the Director General of State Assets and whose composition includes two members from this management authority, has developed **the BIM Plan for the implementation of BIM methodology in Public Procurement of the National Government Administration and its public bodies and related or dependent public law entities**, which was approved by the Council of Ministers on 27 June 2023 and published by Order PCM/818/2023, of 18 July 2023.

As BIM Plans reflects, it is aligned with the European Commission's policy of promoting innovation through strategic public procurement and with the aforementioned objectives of the National Public Procurement Strategy.

In addition, the CIBIM manages the BIM Public Procurement Observatory, which aims to quantify the progress of the implementation of BIM methodology in public procurement, and whose quarterly reports show triple-digit year-on-year growth rates –investment in BIM and the number of tenders with BIM requirements are doubling year-on-year–. When preparing these reports, the BIM Public Procurement Observatory refers to, among other sources, the **Public Sector Procurement Platform (PLACSP)**, the management of which is entrusted to the Directorate General for State Assets.

Finally, it should be noted that the Directorate General for State Assets is designated as the point of reference for cooperation with

European Union (EU) institutions and other international organisations in the field of public procurement. In fulfilling this role, Directorate General for State Assets took part in the first meeting of the **EU BIM Public Officials Group**.

This Group, whose creation was a Spanish initiative under the Spanish Presidency of the European Union, is intended to serve as a forum for sharing ideas and experiences relating to the development of public policies aimed at incorporating BIM, analysing the challenges involved in implementing it in EU countries, adapting it to the legislative framework, its impact on SMEs and its technological implementation.

BIM in the building works undertaken by the Directorate General for State Assets

In addition to the above, Directorate General for State Assets promotes BIM by incorporating it into its projects.

In this respect, the **Sub-Directorate General for the Coordination of Administrative Buildings**, in exercising the functions of construction, conservation, reform and repair of administrative buildings, has consolidated the use of the BIM methodology as a way of managing projects and construction works comprehensively and collaboratively, improving the efficiency and quality of these interventions.

Transitioning to the BIM model has entailed overcoming initial obstacles, allocating resources to train the department's staff,

technical assistance from expert bodies, and upgrading computer equipment and software licences. After the incorporation of pilot projects in the BIM implementation strategy, it is expected that progress will be made towards an era of consolidating achievements and generating further changes.

In the field of projects and works carried out by the Directorate General for State Assets, BIM methodology has been incorporated into the refurbishment of existing buildings –as in the case of the complete refurbishment of the headquarters of the Ministry of Foreign Affairs, European Union and Cooperation, and the headquarters of the Court of Auditors at Calle Padre Damián 19, both in Madrid–, as well as in new buildings.

An example of a new building project using BIM from the initial design stages is the **new government building in Cádiz**. This project involves the construction of a new 7200 m² multi-service headquarters, which will enable the integration of departments scattered throughout the city, improving functionality and efficiency in the provision of services.

The drafting of the Basic and Construction Plans –between 2023 and 2024– has been carried out in full compliance with the BIM methodology, which was conducive to the design of a building that met stringent architectural standards and offered exceptional functionality and spatial flexibility, while at the same time facilitating decision-making in regard to the high



Project for a new administrative building in Cádiz. Directorate General for State Assets. Ministry of Finance.

level of bioclimatic and sustainability performance required.

The entire process is being supported by specialised technical assistance designed to analyse and validate correct compliance with the BIM usages in each project phase. In addition to reviewing the BIM Execution Plan (BEP) submitted by the project architects, the continuous audit reports verify aspects related to taxonomies, collaboration and communication; model structuring; BIM standards; use of model data; obtaining measurements for the construction plans; collision control in accordance with the matrix integrated into the BEP; deliverables; and metadata.

It is expected that the construction work will also be executed following the BIM methodology by employing techniques such as construction staking, 4D planning to highlight critical points in the construction work, stockpile planning, taking

measurements and verifying the correspondence between the built reality and the plans, among other tasks based on BIM models.

In the area of **state-owned public companies within the State Assets Group** that undertake work in the construction sector, several have implemented BIM methodology in their public tenders.

For example, the **state-owned agricultural infrastructure company Sociedad Mercantil Estatal de Infraestructuras Agrarias (SEIASA)** is promoting BIM methodology as a way of working to improve document management and communication with contractors by incorporating BIM requirements and implementing a Common Data Environment (CDE) in its tenders.

In addition, the public water companies reporting to Directorate of State Assets: **Aguas de las Cuenas de España, S.A. (AC-UAES)** and **Aguas de las Cuen-**

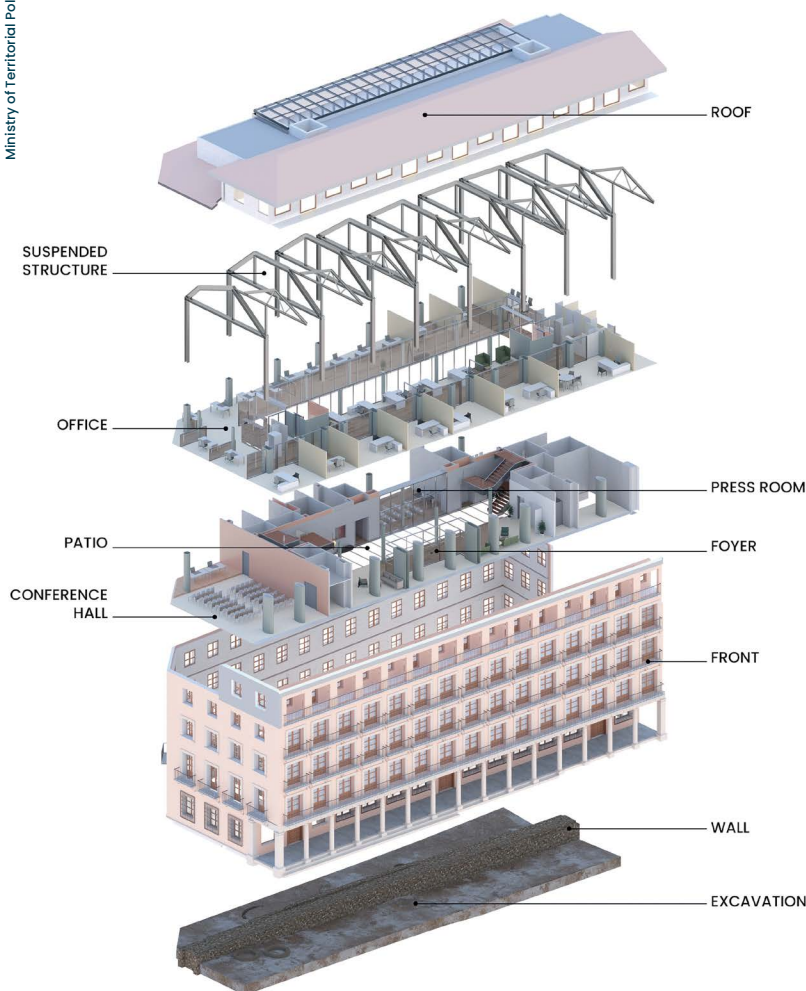
cas Mediterráneas, S.A. (AC-UAMED) incorporate the use of BIM in tenders relating to hydraulic projects and works to increase their efficiency and cost savings, verify possible design errors and support a better understanding of infrastructure.

Another two public companies are particularly noteworthy for their projects in the building sector: the **Sociedad Mercantil Estatal de Gestión Inmobiliaria de Patrimonio, M.P.S.A. (SEGIPSA)** and the **Sociedad de Infraestructuras y Equipamientos Penitenciarios y de la Seguridad del Estado S.M.E., S.A. (SIEPSE)**.

SEGIPSA is an instrument and technical service of the National Government Administration and its dependent entities providing services related to real estate assets. Its areas of activity include real estate projects and management, project management, cadastre work, document processing and custody and, in

The use of BIM is particularly favourable in facilitating the conception of a building of high architectural quality, functionality and spatial flexibility, as well as in decision-making with regard to the high bioclimatic and sustainability performance that is required.

Ministry of Territorial Policy



Project for the comprehensive renovation of the building of the Government Delegation in Castilla-La Mancha, Toledo. (General Directorate of State Assets. Ministry of Finance).

general, technical and architectural consultancy and advice.

SEGIPSA's BIM implementation process began in 2016 with specialised training for Planning Department technicians and the execution of an initial pilot project to convert a court building at Calle Prim 12 in Madrid into a flexible shared workspace. This intervention entailed a comprehensive transition from CAD tools to BIM, coordinating with other multinational teams to define spaces, facilities and specific furniture models, all of which were tabulated and standardised.

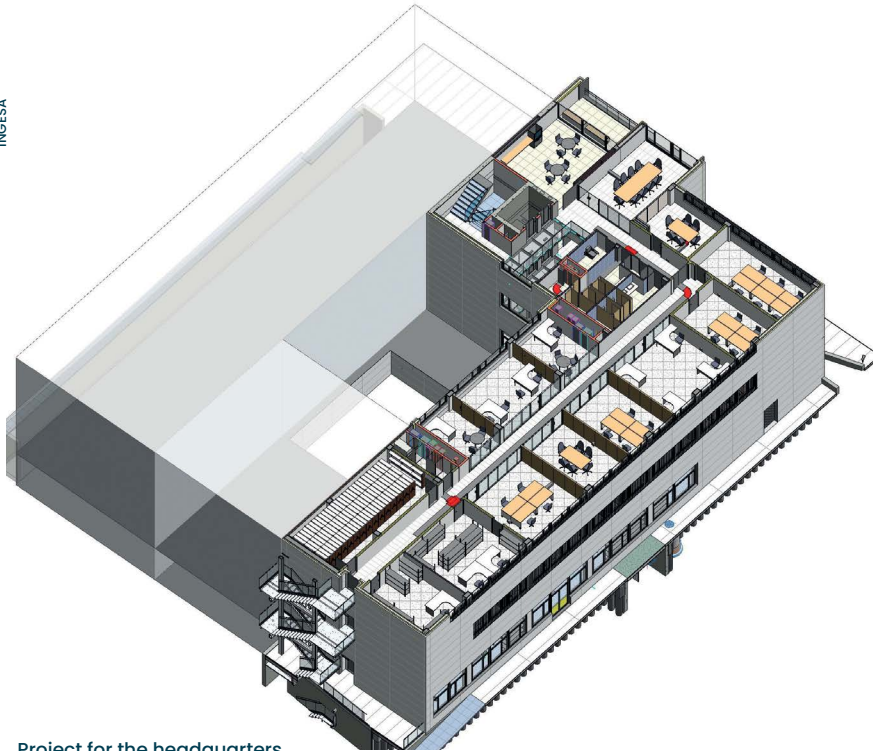
SEGIPSA, therefore, has made significant progress towards an effective and sustainable digital transformation and is now extending the use of BIM to new building projects.

Also notable is the use of BIM in interventions in existing buildings, such as the **complete refurbishment of the headquarters of the Central Government's Delegation in Castilla-La Mancha**, in Toledo. With a surface area of nearly 4,000 m², the interior of this emblematic building is being completely reconverted. The project involves restoring and enhancing the uncovered archaeological remains and designing a new structural configuration suspended from porticoes on the roof, with a modern functional layout around a glass interior courtyard.

Another example of a project driven from the outset by the BIM methodology is the new headquarters of the **National Dosimetry Centre (Centro Nacional de Dosimetría) in Paterna** (Valencia), which is being developed by the National Institute for

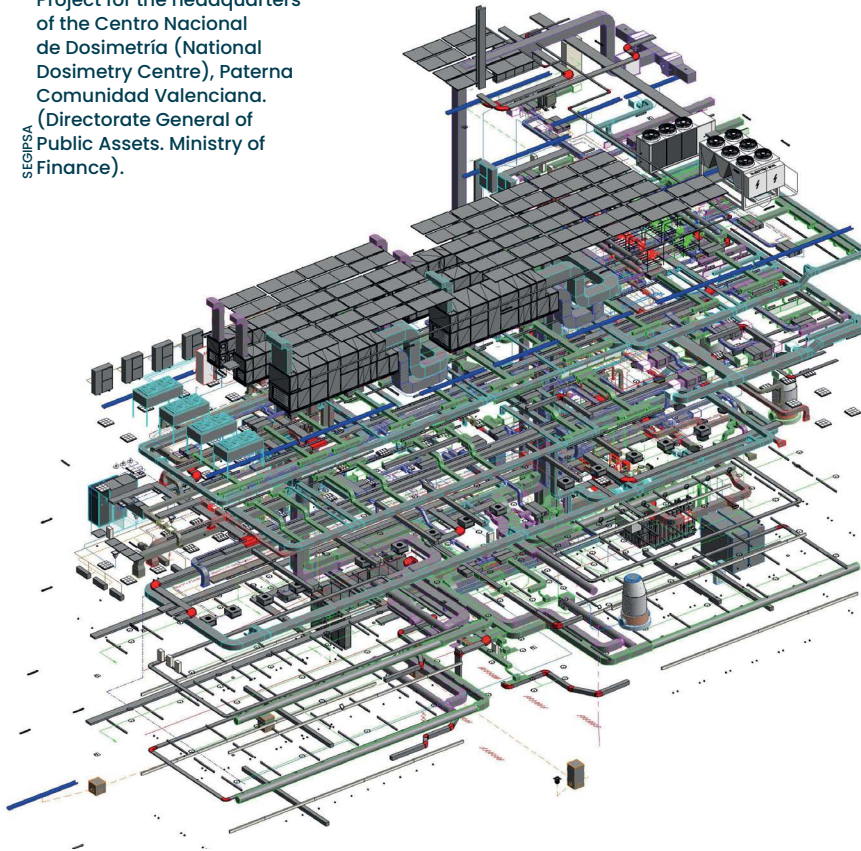
Transforming building development with BIM

INGESA



Project for the headquarters of the Centro Nacional de Dosimetría (National Dosimetry Centre), Paterna Comunidad Valenciana. (Directorate General of Public Assets. Ministry of Finance).

SEGISPA



Health Management (Instituto Nacional de Gestión Sanitaria - INGESA). In this project, BIM is helping to make this new building a reference in terms of dosimetry

system installations, both nationally and internationally.

SIEPSE, another public company within the State Assets Group, carries out a large number of building works within the frame-

work of State security infrastructures: penitentiary centres, facilities for the National Police and Civil Guard, and Immigration Detention Centres; as well as those corresponding to the Plan for State Security Infrastructures for the Energy Transition, within the Recovery, Transformation and Resilience Plan, financed with NextGenerationEU funds.

SIEPSE stands out in terms of its high degree of BIM implementation and the level of digital transformation achieved by using the methodology in its processes, and its successful BIM implementation continues to progress through various stages: initial analysis, BIM transition proposal, technical training, planning, specialised consultancy, execution, and evaluation.

SIEPSE's initial experience with BIM took place in 2015 with the design of the first version of the Norte III Penitentiary Centre in San Sebastian, in which the BIM model was configured as a powerful tool that brought sustainability and energy efficiency criteria into the project.

Subsequently, by agreement of the Council of Ministers, SIEPSE received the commission for the Plan for State Security Infrastructures 2019-2025, which is providing significant impetus for improvements to existing buildings and the creation of new ones across the length and breadth of the country. Since then, the documentation generated by SIEPSE's technical departments during both the design and construction phases has been stored in a reliable and secure Common Data Environment for each infrastructure, which then

serves as a digital collaboration area that can be accessed by all members of the work team, so that they can make revisions or modifications depending on their role.

In April 2024, as part of the Plan for State Security Infrastructures, a new **Provincial Police Station for the National Police in Soria** was inaugurated following a construction process undertaken using BIM methodology. This new police station has a built surface area of around 5,500 m² and comprises two blocks connected by a central section that acts as a communications hub.

The building was designed to be sustainable, with particular emphasis placed on environmental aspects to achieve a Nearly Zero Energy Consumption Building (NCEB), which has earned it a "4-leaf" Green rating from the Green Building Council Spain (GBCe). The use of BIM technology to manage the project made a decisive contribution to the strategies employed to accomplish sustainable design, energy savings and efficiency.

Lastly, another example of a BIM initiative being developed by SIEPSE is the future **National Centre for Penitentiary Studies (Centro Nacional de Estudios Penitenciarios) in Cuenca**. This new facility will be located on the 14,500 m² plot of land formerly occupied by the San Julián School in Cuenca.

The four-storey main building will have an administrative area, a media library and conventional library, a study and research area, a gymnasium and six classrooms. Each of these rooms

can also be divided into two areas to adapt the space to different educational needs. A 500-seat auditorium will be located in the same building and has been designed with the same concept of versatility in mind, employing movable partitions that will allow the space to be transformed.

A second building of the same height will be oriented towards practical training and reproduce the facilities found in a penitentiary centre.

The construction plans for the new centre are currently being drafted using the BIM methodology and in compliance with the design principles of efficiency and sustainability.

SIEPSE's Common Data Environment (CDE)

At SIEPSE, each contracted technical assistance service shares a CDE for each project or construction job during the execution of the work, using standard market platforms.

An administrator then manages the access permissions to the CDE for each project and construction job. Currently, in line with the matrix of responsibilities, this is usually the BIM Manager of the external company, with rules for access defined by SIEPSE. The permissions are restricted on the one hand for security reasons, given the sensitive nature of the information, and on the other for organisational reasons, so as not to compromise the order of the information.

SIEPSE is currently in the development phase of a common CDE for State Security infrastructures that will house the models of each client once the finished property has been delivered for use.

The structure of this CDE will initially be basic and compliant with ISO 19650 (WIP, Shared, Published, Archive), although the end client will be able to complement or develop some aspects of the information if they consider it necessary and valuable for its subsequent management.

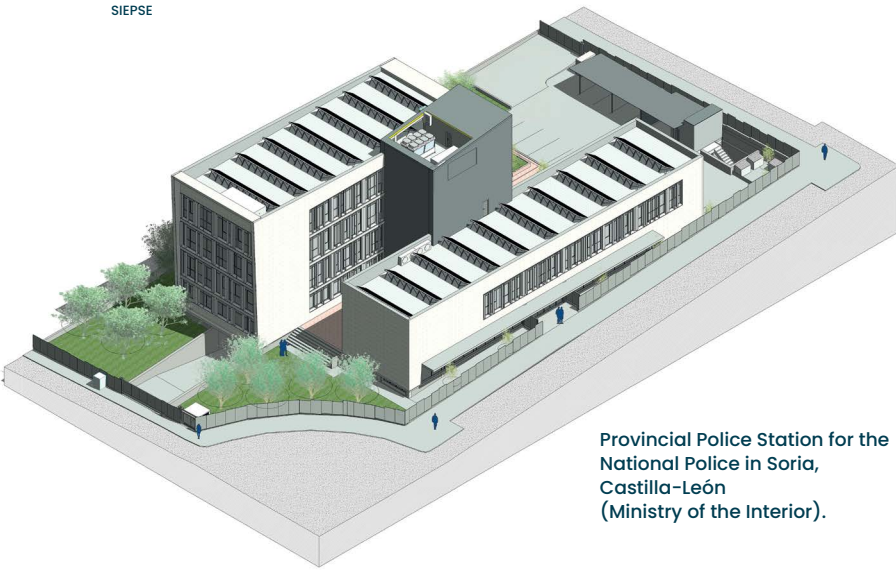
In the future CDE, the current organisation and infrastructure-based access will be customised to meet the needs of the client or end user of the property.

In conclusion, the Directorate General for State Assets, of the Ministry of Finance, is playing a significant role **in the digital and sustainable transformation of the building sector, implementing actions to promote BIM from a two-fold perspective.**

Firstly, by exercising its powers as the **coordinating authority for strategic public procurement**, and secondly, by setting an example and **incorporating BIM methodology in the tenders for projects and works** undertaken by the Directorate General for State Assets and the state-owned public companies under its remit. ●

Transforming building development with BIM

SIEPSE



Provincial Police Station for the National Police in Soria, Castilla-León (Ministry of the Interior).

Using BIM methodology to manage the project made a decisive contribution to the strategies employed to accomplish sustainable design, energy savings and efficiency.

Provincial Police Station for the National Police in Soria, Castilla-León (Ministry of the Interior).

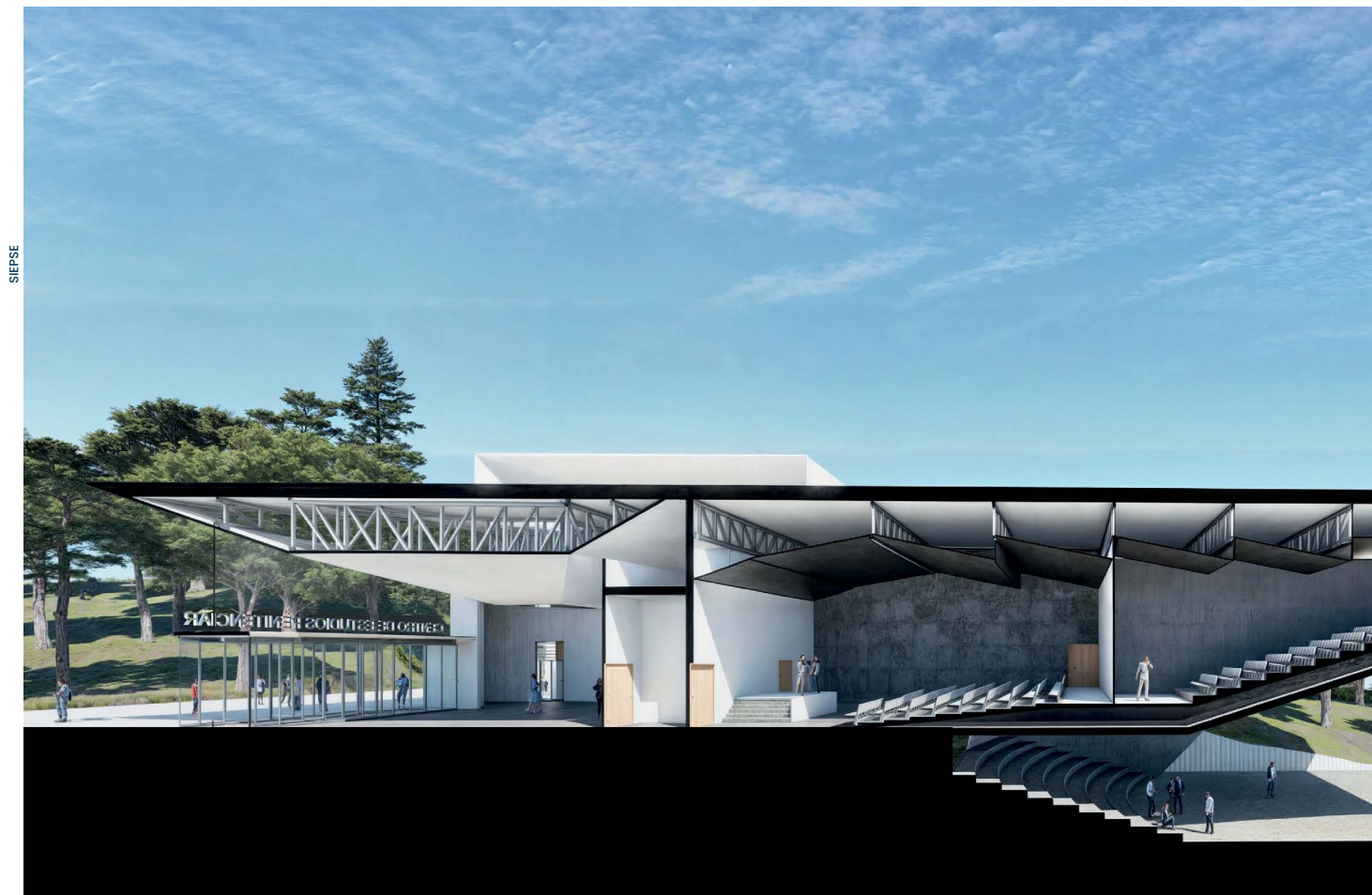
SIEPSE





National Centre for Penitentiary Studies, Cuenca. (Ministry of the Interior).

National Centre for Penitentiary Studies, Cuenca. (Ministry of the Interior).



Point cloud survey and modelling of the Ministry of Transport and Sustainable Mobility headquarters with BIM methodology

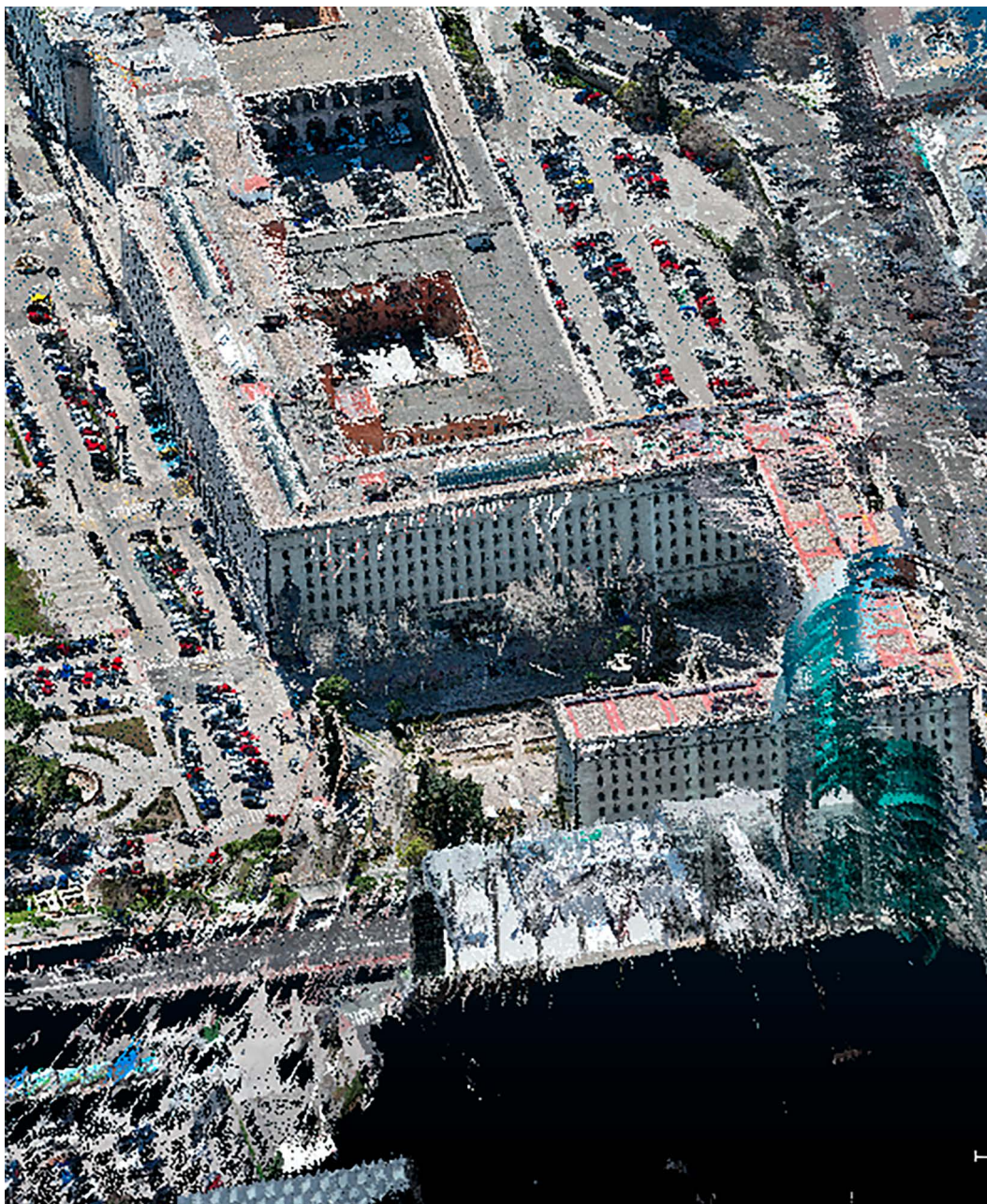
Moving towards digital management with BIM in the Chief Clerk's Office of the Ministry of Transport and Sustainable Mobility

The Ministry of Transport and Sustainable Mobility (MITMS), which holds the Presidency of the Interministerial Commission for the Implementation of BIM in Public Procurement (CIBIM), is implementing BIM methodology within the Department as an example and driving force for other administrations, and in line with national and European plans and strategies for the digitalisation of the Administration.

Within the framework of the Ministry's digital transformation actions, the Chief Clerk's Office has undertaken to carry out a point cloud survey and subsequent modelling with BIM methodology of the headquarters building, the employee's nursery school, and the urban development of the Nuevos Ministerios complex, (Madrid) which will help to carry out the operation and maintenance of the building and the management of spaces and assets, more effectively.

The point cloud is under elaboration and the BIM model contract is in contract award phase.

- Text: Chief Clerk's Office, Ministry of Transport and Sustainable Mobility



Point cloud of the exterior of Nuevos Ministerios.

The Chief Clerk's Office, within the General Directorate of Organisation and Inspection of the Ministry of Transport and Sustainable Mobility, is immersed in the process of implementing the BIM work methodology based on a three-fold requirement: the need to advance in the improvement of production processes in the context of infrastructures, the need to align with national and European plans and strategies for the digitalisation of the Administration, and the need, as the supervising Ministry of the Interministerial Commission, to be a driving force for the Public Sector.

As a result, the Chief Clerk's Office is working on the challenge of implementing BIM, understood as a working methodology rather than as a new technology or software, which would be a mistake and probably lead to an inadequate implementation. This incorporation of BIM goes hand in hand with a change of paradigm in management.

To ensure the implementation was approached correctly, a roadmap was drawn up with an initial phase involving a study and analysis of the organisation to understand which operational aspects of the Chief Clerk's Office could benefit from implementing BIM. The study analysed the functions of the Office and the existing procedures, as well as its organisational and functional relationships.

With regard to the functions, the Chief Clerk's Office, which reports to the General Directorate for Organisation and Inspection under "Royal Decree 253/2024 of 12 March, which governs the

Implementing BIM in the Chief Clerk's Office will improve effectiveness and efficiency in the operation and maintenance of assets.

basic organic structure of the Ministry of Transport and Sustainable Mobility and modifies Royal Decree 1009/2023 of 5 December, which establishes the basic organic structure of the ministerial departments", has been assigned the exercise of the functions set out in Article 15.1, including, among others, those relating to the management of the internal regime and accommodations, the acquisition policy for material resources, the direction and organisation of documentation services and the programming and management of the Department's asset policy, including the construction and conservation of the buildings and installations not assigned to other management centres.

These functions are carried out by different areas, services and sections of the Chief Clerk's Office, including, but not limited to:

- The Assistant Deputy Director's office is mainly responsible for the operation and maintenance of the building, as well as for holding the Ministry's documentary collections. It, in turn, is divided into different areas, such as:
 - The Maintenance Department, which is responsible for the proper functioning of the facilities in the buildings, monitoring maintenance work, major breakdowns and minor repairs, checking

work in the field of quality control, coordinating projects for the renovation of facilities, etc.

- The Conservation Department, which is primarily responsible for ensuring the correct conservation of the buildings housing the central services, mainly the Headquarters and the Nuevos Ministerios complex, as well as the peripheral buildings of the DGC (General Directorate for Roads), through repair, refurbishment and rehabilitation works.
 - The Assets Department has a wide range of functions that will be affected to a limited extent by the new methodology, although some services will be impacted, such as, for example, the Internal Regime Service in charge of cleaning and accommodation, managing spaces and generating building occupancy plans.
- Coordination between the different departments of the Chief Clerk's Office will, therefore, be essential for the proper implementation of BIM and the achievement of the following objectives:
- Compliance with national plans and applicable legislation.
 - Improved management of warehouses and other spaces.

Responsibilities	Goals	Comply with legislation and planning	Improve building informatio to...						
			Improve warehouse and other space management	Improve interdepartmental communication	Avoid rework on maintenance and operation	Perform and efficient maintenance of equipment and devices (information)	Optimize the functional distribution of the building	Facilitate conservation, refurbishment and rehabilitation works	
Building maintenance									
Maintenace work		X		X	X	X			
Projects and Work		X		X				X	
Facilities		X			X	X			
Preservation		X			X	X	X	X	
Refurbishment		X				X	X	X	
Building operation								X	
Space management		X	X	X					
Meeting room		X	X			X	X		
Offices		X	X		X	X	X		
Asset management		X		X					
Supplies and services		X		X					
Security		X	X						
Third-party services (cafeteria, hairdresser,gym...)		X	X		X	X	X		
Movable assets		X							
Furniture		X							
Acquisition		X							
Warehouse		X	X		X				
Workspace management		X	X				X		
Mobility		X							
Vehicles		X							
Drivers		X							
Licences (drivers and vehicles)		X							
Insurance		X							
Purchase and maintenance		X							
Removals		X	X		X				
Human resource management								X	
Library and documentation management								X	
General Registry		X	X	X					
Archive		X	X	X					
Library		X	X						
Transport Documentation Centre		X	X						

- Improved communication between departments.
- Avoidance of repetition of maintenance and operational tasks.
- Efficient maintenance of equipment (information).
- Optimisation of the functional distribution of the building.
- To facilitate conservation, remodelling and rehabilitation

works by making the processes for drafting projects more effective, favouring the early review of projects and works and decision-making in accordance with a management oriented towards meeting objectives.

The following table shows how achieving these objectives will impact the functions carried out

by the Chief Clerk's Office. The table shows how the order in which the objectives have been arranged in the list above coincides with the impact of these objectives on the functions of the Chief Clerk's Office. Effective communication between different units will be a key issue in the successful implementation of BIM.

The BIM methodology documents the entire life cycle of a building or infrastructure, i.e., the planning, design, construction and operational phases, generating a single repository containing all the information that anyone involved in the project might need.

The study of the different areas and competencies of the Chief Clerk's Office revealed that although implementation could potentially affect all four stages mentioned above, most of the work carried out will be in the operational and maintenance phases rather than the planning, design and construction phases. Therefore, efforts must be focused on implementing the methodology in the building management phase.

With this in mind, the Chief Clerk's Office is taking the first steps in the transformation towards digital management, seeking to improve asset maintenance by obtaining information from a single repository or BIM model and thus enabling digital management and monitoring of the condition of the assets.

This initial BIM implementation process is being carried out in two stages:

First stage: point cloud survey

The first stage consists of conducting a point cloud survey and taking 360° photographs of the headquarters of the Ministry of Transport and Sustainable Mobility (approximately 96,500 m²), the employee's nursery school (approximately 3,300 m²) and the urban development of the Nuevo

Point cloud

A point cloud represents a specific geometry: a building, a facility of any other type of object, through a three-dimensional set of millions of georeferenced points. This three-dimensional survey is conducted using laser scanners.

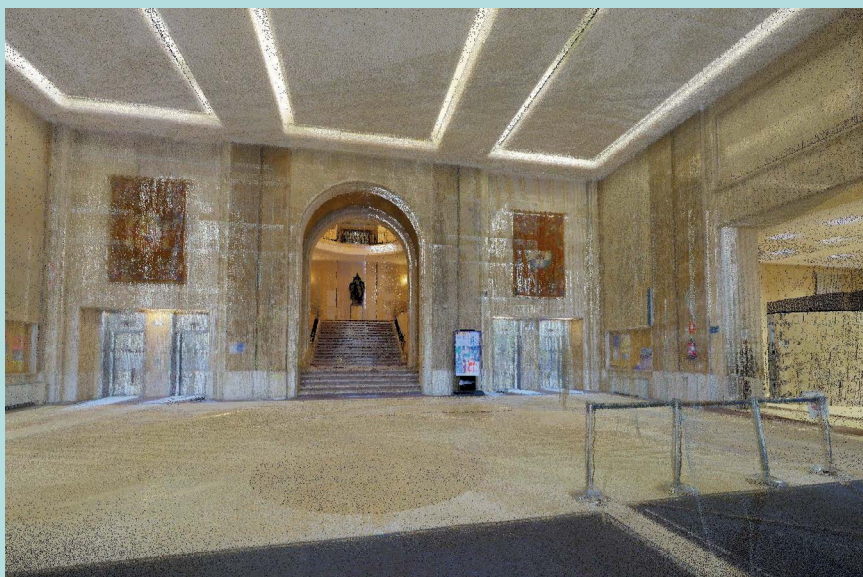
The point cloud generated by a terrestrial laser scanner serves as a valuable tool for the subsequent BIM (Building Information Modelling) modelling of a building. The main features are as follows:

- 1. Capturing reality:** The terrestrial laser scanner measures the distances and shapes of the built environment with millimetre precision, creating millions of points that represent the internal and external surfaces of the building. This results in an extremely accurate representation of the existing architecture, structure and visible facilities.
- 2. Creating accurate models:** The point cloud serves as a detailed and accurate basis for the creation of 3D digital models. Architects, engineers and information managers use these points to develop or update BIM models, ensuring the virtual design matches the as-built reality.
- 3. Conflict detection and planning:** By comparing the point cloud with the proposed or existing BIM model, discrepancies and potential conflicts can be identified before the intervention on the existing asset begins. This avoids costly errors and delays once work on the building has started.
- 4. Integration and updating:** In intervention projects (renovation or extension), the point cloud provides detailed information about parts of the building that may not be documented in old plans or files. This allows for efficient integration of new elements and the updating of existing BIM models.
- 5. Documentation and management:** The BIM model enriched with point cloud data can serve as a living document through out building life cycle, facilitating the management of maintenance and future refurbishments.
- 6. Visualisation and analysis:** With a BIM model based on accurate point cloud data, building managers can produce 3D visualisations to better understand the project and evaluate design options for future interventions.

Therefore, the point cloud provides an extremely accurate and detailed geometric database that is indispensable for the effective creation and management of BIM models and ensures that all aspects of a building's design, construction and maintenance are based on the exact reality of its existing condition at the time of point cloud data collection.



Point cloud of a corridor in the Ministry.



Point cloud of the *hall* of the Ministry building.



Point cloud of the *façade* of the Ministry of Transport and Sustainable Mobility.

Ministerios complex (approximately 85,000 m²), in Madrid.

To do this, a series of topographical studies were carried out to generate a Basic General Network for the urban space bordering the Nuevos Ministerios complex and the interior gardens and surface car parks.

The proposed survey methodology uses RTK GPS with GNSS connection to the Network of Permanent GNSS Stations (fixed network) of the Community of Madrid, establishing positioning and inter-visibility criteria between bases where these serve the Approximation Network.

Based on this, an Approximation Network is generated. The aim is to “zoom in” on project coordinates in the TLS measurement areas inside buildings. These took the form of targets placed on window sills in different spaces and heights so that the laser scanner could also accurately capture them from the inside.

Once the positioning was done, the survey was carried out using a static laser scanner, specifically, one of three Leica scanners (RTC360, BLK360GI and BLK360G2), depending on the needs of the spaces.

This first stage, which is essential for generating the digital parametric model, is nearing completion.

Second stage: Modelling with BIM

The second stage of BIM implementation in the Chief Clerk's Office consists primarily of modelling the buildings and urban development of the Nuevos Ministerios complex using BIM

The parametric model will facilitate the management of energy efficiency, lighting and climatic conditions.

methodology and establishing, as a source of information for this modelling, both the point cloud files that are being developed and the planimetry and databases used by the Chief Clerk's Office in information management.

For this stage, specifications were drawn up to establish the minimum requirements in terms of objectives, uses, levels of development of model elements (LOD), nomenclature and data structure, collaborative environment, deliverables, technical team, quality control and project monitoring.

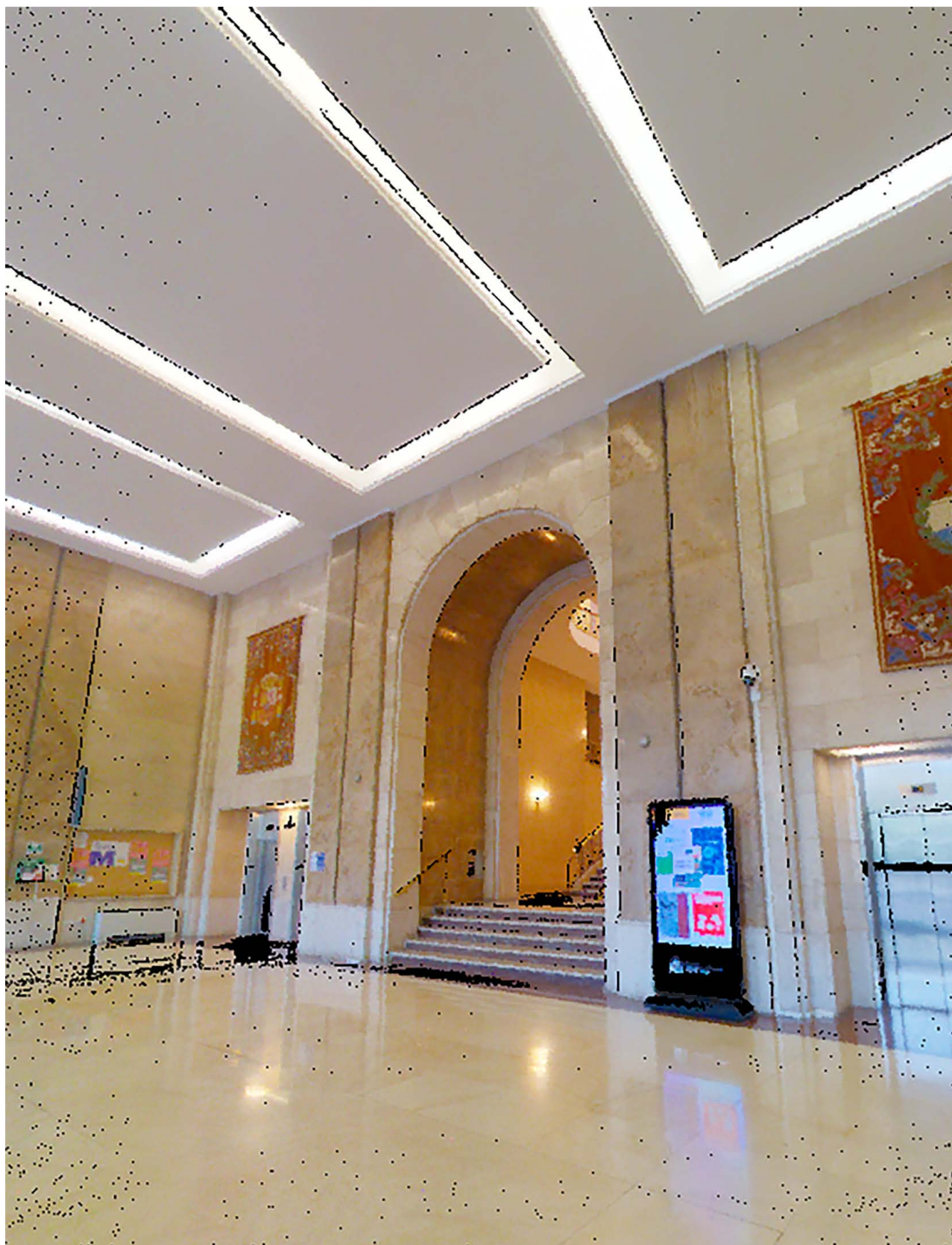
All this data must be included in the BIM Execution Plan (BEP), a comprehensive document to be drawn up by the contractor, in which the bases, rules and internal standards will be defined to ensure coordination between the various agents involved.

The incorporation of BIM technology will generate an information-model-based centralised management system that is complete, traceable and accessible according to the responsibilities defined in both the role matrix and the Common Data Environment (CDE) management process.

In summary, the main objective for BIM implementation in the Chief Clerk's Office is to establish a centralised information model that can be updated with real-time information on the

interventions carried out in each of the spaces, the maintenance of the facilities, the monitoring of occupancy, the allocation of furniture, etc., and that tends towards the digital management of the spaces and the improvement of operational efficiency. Not all asset information will be included in the model. Some assets are also managed in other databases, such as CMMS (Computer Aided Maintenance Management) for maintainable assets and Sorolla II for inventory. However, the necessary attributes will be defined in the modelled objects to achieve a direct link between these databases and the BIM model. This combination of the building model and the asset information stored in the various databases that will provide the basis for the transition to an integrated digital asset management system.

To conclude, BIM implementation in the Chief Clerk's Office of the Ministry of Transport and Sustainable Mobility, and the availability of a BIM model of the Ministry's headquarters in Madrid, will facilitate future tenders with BIM information requirements in the headquarters, as required by the BIM Plan for Public Procurement. ●



Point cloud of the hall of the Ministry of Transport and Sustainable Mobility.

Shaping environmental, economic and social sustainability through the digitalization of Architecture

BIM and digitalization as a vector of architectural quality

The Ministry of Housing and Urban Agenda is working to ensure that cities find comprehensive and environmentally integrated solutions to societal challenges based on the principle of quality architecture. In doing so, it is crucial that we grasp the economic, environmental, social, and cultural dimensions of Architecture, as they not only reflect the circumstances of our society but also directly influence individual and collective development. Digitalization and the increasing use of BIM will contribute to the reduction of greenhouse gas emissions, to the sustainable management of waste and to the construction of safer and more accessible buildings, as well as to the reduction of construction and maintenance costs throughout the life cycle of buildings.

- Text: María Teresa Verdú Martínez and Álvaro José Fernández-Iruegas Pombo. General Directorate of Urban Agenda and Architecture



La Casa de la Arquitectura.

A commitment to BIM and digitalization in strategic urban and territorial planning

The Spanish Urban Agenda (AUE Agenda Urbana Española, www.aue.gob.es) says that more than half of the world's population now lives in cities. According to UN-Habitat in its *World Cities Report 2022. envisaging the Future of Cities*, by 2050, this figure will rise to more than 68%, with cities being responsible for more than 70% of greenhouse gas emissions and consuming 60% of resources. In Spain, these figures are even more pronounced, as 81% of the population lives in urban areas that occupy just 7% of the country's surface area. For this reason, we face city planning challenges not just for the long term, but also for more urgent demands, that require immediate action.

However, as the AUE also states, "the traditional intervention mechanisms, both in terms of cities and land, have significant limitations and frameworks that have already largely been surpassed", which is why, given its status as a National Urban Policy, the Spanish Urban Agenda is in itself an innovative methodology for planning and defining the future of towns and cities based on a strategic and cross-cutting vision that seeks to improve sustainability. With this in mind, the AUE is articulated around 10 strategic and 30 specific objectives, which, by way of a systematic and flexible tool, are made available to other public administrations and agents with powers to influence the design of urban policies, orient their own

The application of BIM constitutes a paradigm shift that promotes collaboration, efficiency and error reduction.

decisions based on the reflection that a prior diagnosis demands and guarantee the necessary coherence to face the social, environmental and economic challenges that 21st-century towns and cities require.

From this perspective, since its approval in 2019, the Spanish Urban Agenda has transformed the way we look at towns, cities and land by devising new work methods that focus on improving governance and transcend rigid jurisdictional schemes to seek synergies and align proposals that converge in common goals. If this is to be accomplished, we must acknowledge the role of architecture as a general interest asset and remain committed to upholding its quality, which requires recognition from the public authorities responsible for its protection, development and dissemination.

At the same time, the Spanish Urban Agenda is aware of the need to approach these challenges by promoting innovation, technologies and knowledge. To this end, as a catalyst, its Strategic Goal (SG) 9 is dedicated to "favouring the knowledge society" and to leading and promoting digital innovation through actions that encourage the incorporation of technologies such as Big Data, data mining, Artificial Intelligence, Cloud Computing and BIM methodology in urban planning and management with

the aim of transitioning towards smart and sustainable urban and territorial models.

Good examples of this tripartite vision of strategic planning, architectural quality and commitment to digitalization can be found in many of the Action Plans currently being drawn up and/or implemented by many local authorities, which also respond to the principles of the New European Bauhaus. Examples include the municipalities of Sant Feliú de Llobregat (Catalonia-autonomous region) whose Digital Agenda establishes a reference framework for the development of a digital, sustainable and resilient municipality; Ermua (Basque Country-autonomous region), whose Fibermua project offers an ultra-broadband communications network, the deployment of which has been directly driven by the City Council and which offers fibre optic coverage to some 8,500 real estate units; Alcoi (Valencian Community-autonomous region), which has made a clear commitment to the *smart city* concept, seeking to modernise municipal services in its digital transformation to effectively and efficiently resolve the needs and desires of citizens and is setting a pioneering example of how to transform the city into

a test laboratory for innovation through its urban *sandbox*; Seville (Andalusia-autonomous region) and its Seville+Digital Plan, which is a process of strategic reflection initiated and developed by Seville City Council to achieve a city that is more liveable, sustainable and adapted to people and businesses by capitalising on solutions based on digitalization and technologies, etc.

In this context, BIM methodology is in direct alignment with the objectives of the Urban Agenda as it can be utilised to contribute to their achievement by enabling, among other aspects, a reduction in greenhouse gas emissions (SG3 of the AUE); the sustainable management of waste (SG4 AUE); the construction of safer and more accessible buildings (SG2 AUE); and the reduction of construction and maintenance costs throughout the life cycle (SG7 AUE).

Furthermore, numerous municipalities with Action Plans or Local Urban Agendas have opted to use BIM methodology, either internally or in their tenders. Examples include: Valencia, Sant Feliu de Llobregat, Sant Boi de Llobregat, Sestao, Barakaldo, Alzira, Zaragoza, Alicante, Seville, Valladolid, etc.

BIM as a means of improving architectural quality

In the interest of policy coherence, the General Secretariat for Urban Agenda, Housing, and

The Spanish Urban Agenda (AUE) is promoting digital innovation by incorporating BIM and other new technologies in urban planning and management with the aim of transitioning towards smart and sustainable urban and territorial models.

Architecture and the Directorate General for Urban Agenda and Architecture have made an unequivocal commitment to promoting the principle of Quality in Architecture. Law 9/2022, of 14 June, on Architectural Quality, aims to guide these public policies in order to promote this necessary quality, ensuring that the design, planning and management of works enable the achievement of the economic, environmental and social sustainability objectives through innovation. We must encourage respect for a number of criteria that will guarantee environmental improvements and enhance people's quality of life, and which go hand-in-hand with the three values pursued by the European New Bauhaus initiative: inclusiveness, sustainability and beauty.

Architectural quality also contributes to creating and maintaining an environment with cultural values that are recognisable to the society for which it is intended, and design decisions must account for site-specific conditions and harmonious integration into the urban fabric and landscape. In addition to complying with the requirements of technical regulations, quality architecture must consider its sensory dimension and contemplate its spatial, lighting and acoustic

characteristics to create a pleasant physical, mental and social environment for people.

In terms of the regulatory framework, the Law on Architectural Quality is intended to promote research, innovation, digitalization, industrialisation and creativity, as well as foster knowledge of traditional and local techniques. In addition, it highlights the essential role of the public authorities, which must, above all, strive for excellence and sustainability in the projects in which they act as promoters, setting an example for other sectors of society.

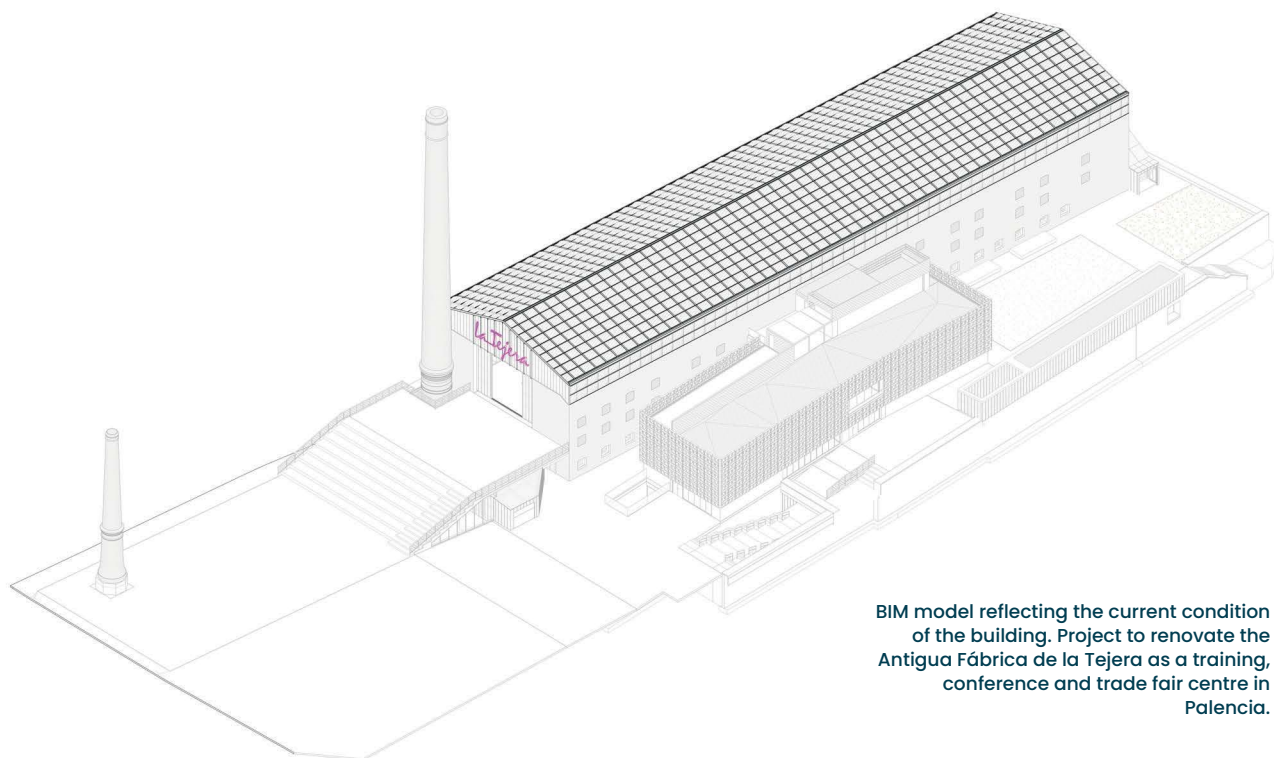
Digitalization and the use of technologically innovative tools will facilitate the drafting of projects and the management of the construction work, as well as the use and maintenance of the building. In particular, the Law states that the use of specific electronic tools, such as digital building information modelling methodologies, BIM or similar, and the incorporation of innovative techniques must be encouraged in public sector projects.

At present, the implementing regulation of the Law on Architectural Quality that will establish the creation of the Council for Architectural Quality is still in the process of being drafted. However, as soon as the Council is up

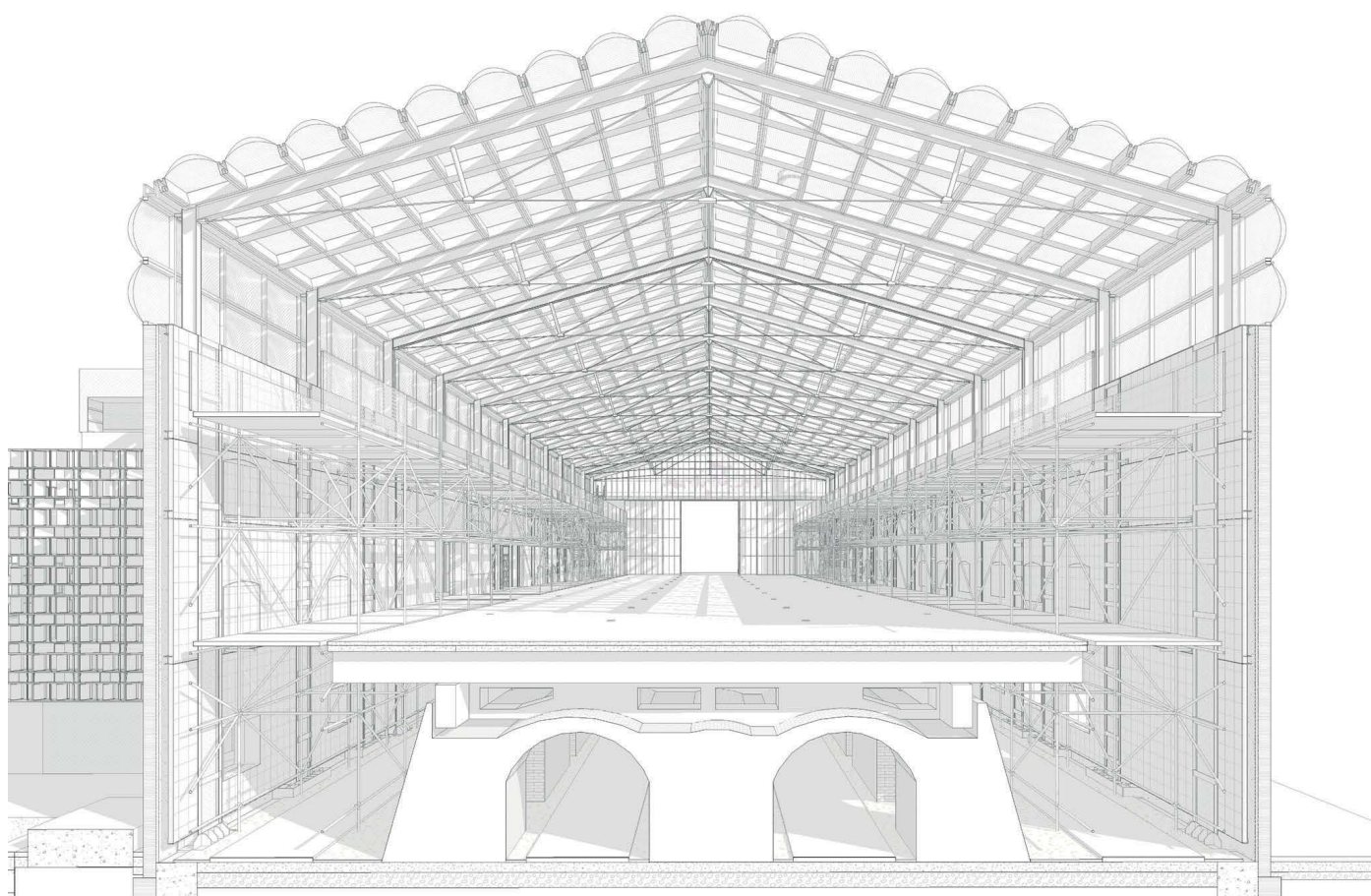


Photogrammetric survey of the existing building. Project to renovate the Antigua Fábrica de la Tejera as a training, conference and trade fair centre in Palencia (Castile and León-autonomous community)





BIM model reflecting the current condition of the building. Project to renovate the Antigua Fábrica de la Tejera as a training, conference and trade fair centre in Palencia.





Can Fabra social housing building. Source: Catalogue of Best Practices.

and running, given its transcendence and importance, digitalization in the construction sector will be one of the priority issues on its agenda. Thus, the aim is to facilitate, in coordination with the Interministerial Commission for the Implementation of BIM in Public Procurement (CIBIM), the digitalization of construction processes in the field of Architecture and the gradual incorporation of integrated information models in public heritage in order to facilitate, optimise, and improve the sustainability of its operation and maintenance.

If architecture has the transformative power to create cities that respond to societal challenges, digitalization and innovation are two of the tools it has at its disposal to achieve this

transformation. Implementing technologies such as BIM (Building Information Modelling) leads to digitalised and efficient project management that, in turn, helps us reduce greenhouse gas emissions, manage waste sustainably, and build safer and more accessible buildings. Consequently, it becomes an indispensable tool for improving the quality of architecture.

Innovation is the engine of evolution. In the building sector, it means adopting new technologies, construction methods and creative approaches that boost efficiency and improve quality of life. Investing in research and development, collaborating with companies and institutions and adopting innovative practices will help us overcome today's

challenges and anticipate future needs. Innovation translates not only to more advanced buildings but also to the creation of more resilient and connected communities.

The BIM initiative will ensure consistency and efficiency at all levels of the construction process, from planning to execution and life cycle management, thus contributing to building a greener and more digital future for Europe. In addition, it enables the reduction of administrative processes and costs while, at the same time, improving energy efficiency, cost-effectiveness, circularity and climate resilience by monitoring the current condition of buildings and integrating existing digital technologies.

The digitalization process will also improve the safety, health and comfort of building occupants by integrating data-driven modelling tools and optimising functions. The European Parliament's "Report on the implementation of the Energy Performance of Buildings Directive" quantifies that more than 85 % of Europe's buildings will still be in use in 2050, which means measures must be taken to preserve their integrity and value.

In short, the New Bauhaus European initiative and the publication of Law 9/2022 on the Quality of Architecture signal a present and future of building that is inherently linked to digitalization and the use of BIM to achieve its objectives.

BIM's contribution to the fight against climate change in the field of architecture

Climate change and environmental degradation pose an existential threat to Europe and the rest of the world. The building stock must be transformed to assist decarbonisation through improved energy efficiency, environmental protection and resilience to climate change. Considering that more than 60 % of the current stock was built before any regulation on the thermal performance of buildings even existed, and that buildings account for around 40 % of Europe's energy consumption (according to the European Commission's Construction Transition Pathway), there is enormous potential for renovating buildings to reduce energy consumption and improve their indoor comfort.

La Casa de la Arquitectura

The headquarters of La Casa de la Arquitectura are located in Nuevos Ministerios (Madrid), which serves as an interesting example of how existing architecture is transforming to adapt to a changing and evolving city. The first phase of the project to build Secundino Zuazo's complex lasted from 1932 to 1937, and work was finally completed in 1958 with some modifications to the original project. The complex consists of an expansive open-plan central space with squares, fountains and pools, around which the different ministries are arranged, and a large arcade on the side facing the Paseo de la Castellana, which houses the museum.

In 1982, José María Aparicio and Adolfo Morán were commissioned to create an exhibition hall within the arcade, and it was inaugurated in October 1983 as the Exhibition Hall of the Ministry of Housing, known as "La Arquería". Subsequently, after a period in which it housed the ENAIRE Foundation's collection, the works to convert it into an exhibition centre began in 2020. The architect in charge of the project was Juan Pablo Rodríguez Frade,

who was awarded the contract after it was put out to public tender, and the works, which consisted primarily of upgrading the original installations and adapting the envelope to improve its hygrothermal performance, were completed in January 2023. The most notable intervention is the new access hub next to the entrance, with a multiple-level staircase and a large glass lift connecting all the building's floors.

The location of La Casa de la Arquitectura, within the Paseo de la Castellana, as an extension of the Paseo de Recoletos and Paseo del Prado in Madrid, has established itself as a major cultural itinerary that is now further enhanced by this museum. Moreover, its position in one of Madrid's major interchanges attracts a diverse public from beyond the sector, making it a point of reference for architecture and the dissemination of its values.

Projects must ensure an optimal management of resources, including the use of secondary raw materials and the precise application of construction materials and solutions in line with the principle of the circular economy, with planning to be carried out throughout the building's entire life cycle: from the design phase through to demolition and the reuse and recycling of the materials used.

Similarly, government deployment of exemplary public

procurement policies can also be transformative in the building sector, as committing to contractor selection processes based on ethical and sustainability criteria not only raises the quality of public construction but sets the standard for the sector as a whole.

Moreover, promoting fair, inclusive and transparent practices in procurement processes strengthens business ethics and builds a more sustainable, just and equitable society.

As stated in the preamble of Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast), "Member States should encourage the use of digital technologies for analysis, simulation and management of buildings, including with regard to deep renovations".

The effective implementation of BIM will revolutionise the way the public sector conceives, designs and builds. In its "Digitalization in the construction sector, Analytical Report", the European Commission estimates that BIM furthers sustainability in the construction sector by generating an estimated reduction of up to 15% in waste volume and up to 57% in waste management costs. This reduced waste generation, together with optimised design, leads to a reduction in the emissions associated with the life cycle of a building, making digital building information modelling key to environmental sustainability and circularity of the construction.

BIM pilot project: La Casa de la Arquitectura

The 9/2022 Act on the Quality of Architecture created La Casa de la Arquitectura, a state-owned and managed museum in Madrid attached to the Ministry of Housing and Urban Agenda that opened its doors on 18 December with the aim of becoming a national and international reference for the dissemination of Architecture and promoting the discipline as a tool for cultural diplomacy.

As a contemporary museum, La Casa de la Arquitectura

provides a platform for meetings, exchange, communication and learning for a cross-disciplinary and intergenerational public. The museum is conceived as a creative entity that extols the transformative potential of architecture and is committed to encouraging innovation in the discipline in order to improve the quality of the built environment, enhance its sustainability in social, economic and environmental terms, and foster its resilience in a changing context.

To this end, it is essential that we collaborate with the educational sector to improve knowledge of architecture from an early age, implementing didactic strategies for architectural training in pre-university education through educational and awareness-raising activities related to architecture, understood in its broadest sense. The physical headquarters of the museum is located in Nuevos Ministerios, which serves as an interesting example of how existing architecture is transforming to adapt to a changing and evolving city.

La Casa de la Arquitectura can also be reached online via a web page designed to amplify the institution's mission by displaying the online collection in an advanced digital repository, thereby fulfilling the objectives of disseminating and positioning Spanish architecture in a way that is both dynamic and suited to the digital era. You can visit the website at the following link: The ETSO can be found at the following link. [Home - La Casa de la Arquitectura](#).

For La Casa de la Arquitectura to be able to carry out all

of its functions, work is currently underway on a project to extend its physical headquarters in the Arquería de Nuevos Ministerios. The Ministry of Housing and Urban Agenda has chosen the museum enlargement project to pilot the use of BIM methodology across all its phases (design, execution of works and maintenance of the building during its useful life cycle) due to its importance and visible profile, marking a milestone in the Ministry's commitments. To this end, work is underway to draw up the technical specifications for a tender for ideas in which the BIM requirements for the execution and operation phase of the building will be integrated.

The museum extension is one of the actions included in the BIM Pilot Projects Programme developed by the Interministerial Commission for the Implementation of BIM in Public Procurement (CIBIM), which provides advice and assistance through the BIM Office in order to support the adoption of BIM methodology in pilot projects implemented by the Directorate General for Urban Agenda and Architecture.

Incorporating BIM methodology in this project will be fundamental to its success because it centralises all the information on both the existing building and the envisaged extension in a digital model, thus providing a detailed and realistic visualisation of the project at all its stages. It will also allow the teams involved to identify and resolve potential problems before they arise during the execution phase, which will reduce the project costs by an estimated 10-20%, as well as the



La Casa de la Arquitectura.

resources required.

In addition, it will facilitate coordination between all the agents involved in the project, allowing for more instant access to up-to-date information. By providing a centralised platform for data sharing and task coordination, BIM facilitates seamless communication and more informed decision-making, reducing conflicts and delays.

As a preliminary step, a Common Data Environment that will store all the project information is being developed by the Deputy

Directorate of Information Technologies and Digital Administration of the Ministry of Transport and Sustainable Mobility. The specifications will provide for the use of this environment to guarantee the operability of the new work system being developed in the museum, ensuring the traceability of the information. In addition, as one of the different tasks required for the future enlargement, a point cloud survey of the surroundings of La Casa de la Arquitectura has been carried out, creating a digital model

of the current conditions, which will be used as a starting point for the participants in the ideas competition.

The application of BIM methodology represents more than just the implementation of a technological tool; it constitutes a paradigm shift that promotes collaboration, efficiency and error reduction. By adopting BIM in Public Procurement, we can not only speed up the design and construction process but also improve the quality and accuracy of projects. ●



#BIM for people

Some experts emphasize that BIM is 10% technology and 90% cultural change. BIM fundamentally affects people and, therefore, impacts other sectors besides AECO (Architecture, Engineering, Construction and Operations), such as education and lifelong learning.

This section features insights from representatives of some regulated professions, sharing how to prepare professionals for a gradual move towards BIM, and analysing the technologies which, alongside with BIM, will shape the development of the profession in the coming years, such as Artificial Intelligence, the Internet of Things and Augmented Reality.

BIM is particularly valuable in the field of health and safety at work. More than half of work accidents on construction sites are related to unsatisfactory architectural and/or organisational decisions or poor planning of the works at the design stage. In this section, the Spanish National Institute of Safety and Health at Work (Instituto Nacional de Seguridad y Salud en el Trabajo), as the public administration's scientific technical reference authority on that field in Spain, explains the advantages of using BIM to improve occupational health and safety at work.

Exploring the opportunities offered by BIM methodology from the perspective of health and safety at work

BIM and the management of occupational hazards throughout the life cycle of a construction site

The implementation of BIM represents a significant departure from the conventional way of managing construction projects, and its attributes can be harnessed for the benefit of occupational risk prevention. The possibilities are wide-ranging and can be extended to all stages of the life cycle of a construction project.

- Text: Elena Limón García, Spanish National Institute of Safety and Health at Work



BIM from the perspective of occupational risk prevention

BIM (Building Information Modelling) is a collaborative working methodology used in the design and management of building and civil engineering projects

that centralises all the information in a digital model. The data contained in the BIM model is then used to manage the elements of the building or infrastructure throughout its life cycle.

Following the recent approval of the BIM Plan in Public Procurement, a strategic

initiative that aims to gradually and progressively incorporate this methodology into public construction-related contracts at the national level, we must now lay the foundations for occupational health and safety so they can be integrated into it. In parallel, the Spanish

BARRIERS IDENTIFIED	CONSEQUENCES	BIM OPPORTUNITIES
Diversity of agents involved	Complexity in their organisation and coordinated management	Collaborative environment in which actions are planned from the outset
Fragmentation of processes	Complexity in their organisation and coordinated management	Agents elaborate their own information based on the pre-existing data
	Insufficient long-term or life-cycle vision	Incorporates –from its conception– the requirements, uses and actions of the whole life-cycle
Mere formal compliance with obligations	Insufficient risk prevention efficacy of actions carried out	Methodology based on information management, not documentation management
Misalignment between the design processes of the final product (project) and the execution process (contractor's planning)	Difficult to integrate constructability* of the asset and working conditions in the project definition	Facilitates the inclusion of the construction systems and procedures in the project phase, allowing for preventive analysis
Lack of a collaborative culture and a disinclination to innovate	Difficulty in developing process improvements	Promotes information sharing and collaboration between the agents involved
Time and budget constraints	Difficulty in developing process improvements	Anticipates the planning of actions and design improvements in the initial phases
Insufficient integration of risk prevention in the design of the construction works	Limited improvement of work processes and methods	Facilitates the process of integrating ORP in the project for safer construction and maintenance
Single project approach (full-scale prototype)	Missed opportunities for risk avoidance and design of safer construction solutions	Possibility of having a digital twin and improving analytical capabilities
Insufficient involvement of promoters and planners in risk prevention	Loss of the advantages of eliminating or controlling risks before the works get underway	Concentrates a large part of the actions, including risk prevention measures, in the design phase

*Constructability understood as the ease and efficiency with which the construction of an asset can be designed.

Analysis of existing barriers to the integration of risk prevention in the construction sector.

Source: BIM methodology: opportunities for integrating ORP throughout the life cycle of a construction (INSST).

Strategy on Health and Safety at Work 2023–2027 stresses that "technological development, and in particular digitalization, present opportunities from the perspective of occupational risk prevention" and urges us to boost research in order to improve our knowledge and be able to manage the challenges presented by the digital transition efficiently.

In this context, the National Institute of Safety and Health at Work (INSST), as the public administration's scientific-technical authority on occupational risk prevention (ORP), has carried out a study to examine the characteristics of BIM in detail and determine how they can be harnessed for the benefit of occupational health and safety.

BIM thus seeks to optimise the design process, concentrating resources and actions in the initial phases to improve the project's functionality at the lowest possible cost. It provides an evolutionary approach and promotes early participation from the different agents involved in the various life cycle phases of the future construction. This implies a shift in the conventional individual and fragmented way of working towards a more coordinated approach in which information is generated and shared among all the parties involved in the different phases of the process. The foundation of this new way of working is collaboration, articulated around a BIM or digital model that is fed with an extensive database of construction data.

Building on the attributes described above, the use of BIM

DESIGN DECISION	INFLUENCE OF WORKING CONDITIONS
Time planning of works: deadlines and work schedule	Determines the concurrent activities and possible incompatible works during the execution of the construction work
Construction solutions: typologies and execution methods to be used	Determines the hazards involved in each activity and the risks to which workers will be exposed in subsequent stages
Management and organisation of spaces both during the execution of the work and in subsequent stages	With regard to the execution of the work, it defines the accesses, storage areas, auxiliary installations, evacuation conditions, and any interferences with the environment and with third parties
	Determines the accesses and ergonomic conditions of the operating and maintenance workstations and configures dangerous areas such as confined spaces
Choice of materials to be used at each stage	Determines the possible presence or absence of hygiene hazards at the different stages of the constructed asset
Configuration of the asset for subsequent stages	Determines the conditions under which the asset can be safely redeveloped, renovated or, if necessary, demolished

Influence of design decisions taken during the project on risk prevention.

Source: BIM methodology: opportunities for integrating ORP throughout the life cycle of a construction (INSST).

—provided it has a preventive approach— can go a long way towards overcoming some of the most common barriers to integrating workplace safety into construction, as shown in the table on the previous page.

BIM: opportunities for integrating occupational risk prevention throughout the life cycle of an asset

From the point of view of risk prevention in the field of construction, it should be emphasised that the decisions taken at the initial design stage have an enormous impact on the working conditions associated with the rest of the life phases of the building or the civil works constructed. The explanatory memorandum to *Council Directive 92/57/EEC of 24 June 1992 on the implementation of*

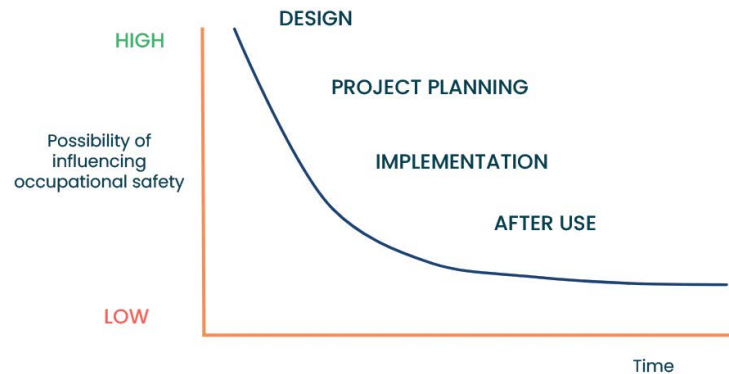
minimum safety and health requirements at temporary or mobile construction sites states that unsatisfactory architectural and /or organisational options or poor planning of the works at the project preparation stage have played a role in more than half of the occupational accidents occurring on construction sites. In other words, a large part of the risks arising from the execution of a project and during its subsequent use and maintenance could have been eliminated or reduced at the time of its conception. When it comes to incorporating risk prevention into the design of a construction, articles 5.6, 6.3 and 8 of Royal Decree 1627/1997, dated 24 October, outline the minimum health and safety requirements that must be met during construction work.

With this in mind, and as reflected in the time-safety influence curve throughout the life cycle of a project, it's important to understand that the ability to influence risk prevention decreases significantly as the project moves from the design phase to the execution phase. Additionally, it's worth noting that the cost of making changes tends to increase as the construction process progresses.

It is, therefore, crucial to begin with a design that integrates preventive and productive aspects and fulfils the required needs at all stages of construction. To this end, those responsible for designing the building or infrastructure in question should take actions such as the following:

- Compile information to gain an understanding of the en-

TIME-SAFETY INFLUENCE CURVE



Time-safety influence curve. Source: author's elaboration based on Construction Project Safety Planning (Szymberski, R. T. 1997).

BIM is an eminently collaborative methodology, its very configuration encourages the involvement of different stakeholders in both the modelling and subsequent revisions.

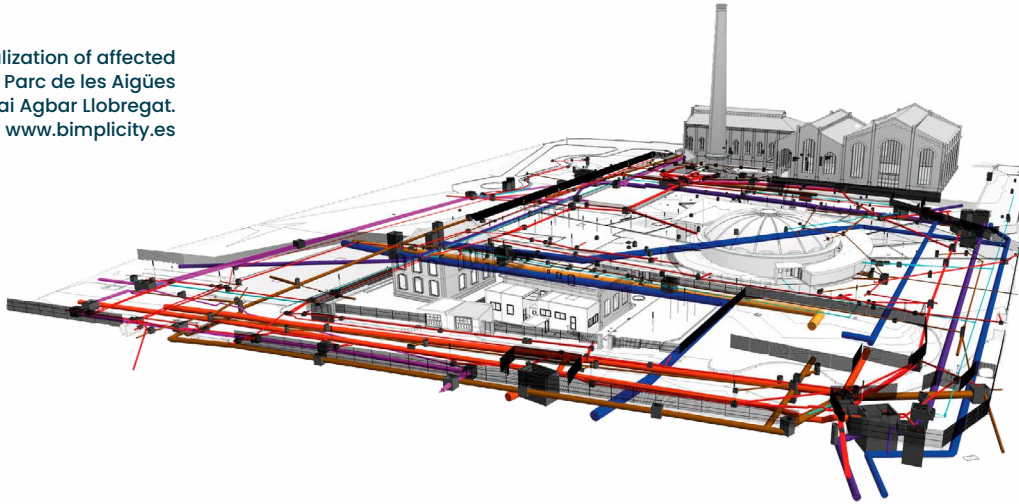
vironmental conditions that may influence the safety of the work or the precautionary measures required for the different equipments and facilities.

- Analyse the different design alternatives to eliminate risks and, where this is not possible, to mitigate and improve the control of remaining risks. Assess the health and safety consequences of each possible alternative and prioritise the most favourable.
- Define the design solution and communicate the necessary information on occupational health and safety to inform the subsequent stages.

Using BIM models for occupational risk prevention

The BIM methodology offers substantial advantages over traditional methods of carrying out these actions. For example, with regard to the compilation of information, the mere fact of having an appropriately parameterised Common Data Environment (CDE), which serves as a single source of permanently up-to-date and accessible data, already implies a significant improvement in terms of coordination and efficiency. In addition, the digitalization of the environment can help to detect hazardous conditions.

Digitalization of affected services. Parc de les Aigües
Espai Agbar Llobregat.
Source: www.bimplycity.es



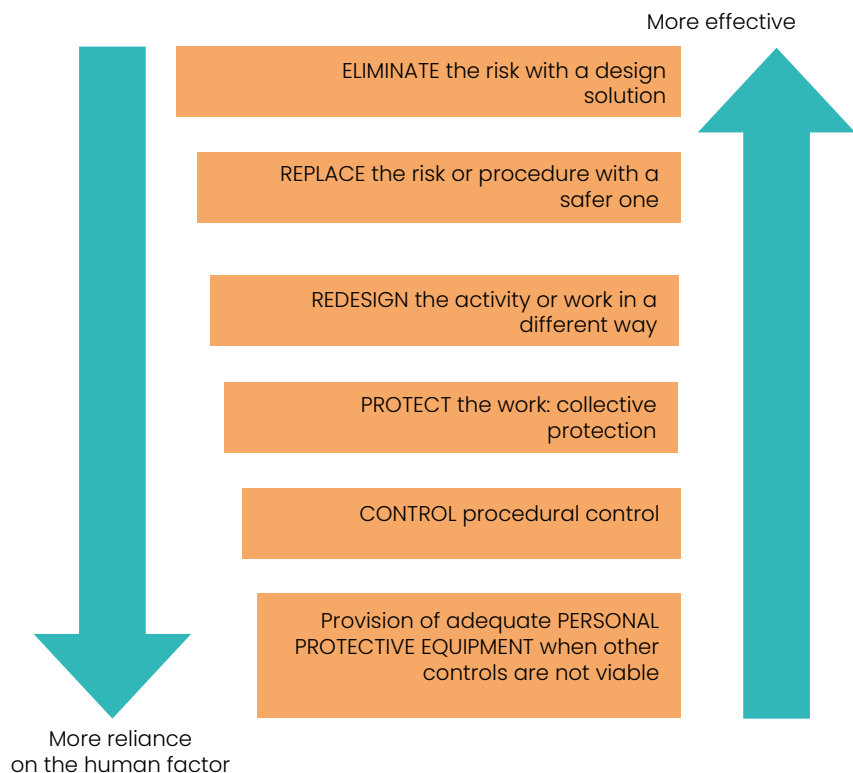
Similarly, having a digital model with linked information makes it easier to assess the different design options from an occupational health and safety point of view, using the hierarchy of controls. The application of this hierarchy –whose order of priorities is coherent with the principles of risk prevention set out in Law 31/1995 of 8 November on the Prevention of Occupational Risks– means that, in organisational processes, the analysis of construction procedures and/or the planning of works, priority is given to solutions that allow the elimination of the most significant occupational risks in terms of frequency and severity.

This process can be expedited by simulating the various alternatives being considered, identifying the potential risks associated with each of them and determining the best way to eliminate them or, when this is not feasible, reduce them.

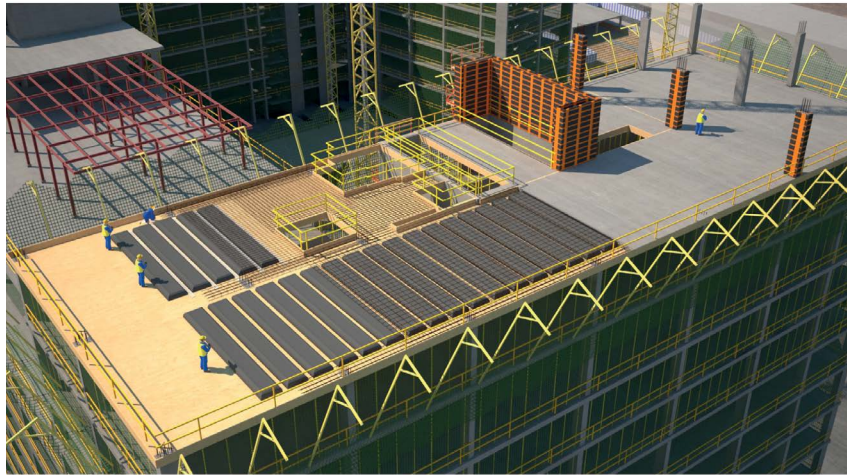
Furthermore, since BIM is an eminently collaborative methodology, BIM encourages the involvement of different stakeholders in both the modelling and subsequent revisions, allowing

Using the BIM model with a focus on risk prevention leads to improvements in the working conditions associated with the execution, operation, maintenance and eventual demolition stages of the assets.

Hierarchy of controls: Risk prevention priorities in decision-making at the design stage. Source: Prevention Technical Note NTP 1126 Integration of ORP in the design of construction works (I): fundamentals (INSST).



Digital models make it easier to assess the different design options from an occupational health and safety point of view.



Construction simulations: execution of unidirectional framework and execution of roof.
Source: OBRASCON HUARTE LAIN S. A.



their risk prevention needs to be addressed from the outset.

Finally, with regard to the definition of the design solution and the sharing of information, BIM relies on a digital model that is used throughout the life cycle of a built asset. In simpler terms, the risk prevention information incorporated at the design stage will be available throughout the various project stages of construction, operation, maintenance, upgrading and, if necessary, demolition.

In conclusion, the inherent attributes of BIM mean that it has the potential to incorporate occupational health and safety into the entire life cycle of a construction project. Obviously, to generate an improvement in the working conditions associated with the execution, operation, maintenance and eventual demolition stages, the BIM model needs to be used with a focus on risk prevention. Therefore, it's vital to include occupational risk prevention in the intended uses

and objectives established for the model.

Moreover, although BIM opportunities can be spread throughout the life cycle, focusing efforts on the design stage is crucial because it is this stage that offers the most significant potential to influence improvements in occupational health and safety, resulting in maximum benefit for workers. ●



Interview:

BIM from the perspective of Spanish AECO Professional Associations

A vision of the future of AECO Professions

Interview with:



- **Marta Vall-Ilossera Ferran**, President of the Council of Architects Professional Associations (CSAE), Spain.



- **Miguel Ángel Carrillo Suárez**, president of the Civil Engineers Professional Association (Spain)



- **Germán Fernández Marín**, president of the Council of Technical Designers Professional Associations (Spain).

The implementation of BIM in the AECO sector (Architecture, Engineering, Construction and Operation), needs a fundamental change in culture and constitutes a crucial step on the path towards driving innovation and enabling professionals to adapt to new technologies. Professional Associations, together with other stakeholders and the Government, have an essential role to play in promoting BIM and contributing to the digital transformation of the construction industry by providing training and education to professionals, ensuring a smooth transition to more efficient and collaborative work methods and participating in the deployment of support material for BIM implementation.



BIM in public procurement

BIM implementation in Public Procurement is not a simple change, but a systemic change where people matter. In the AECO sector transformation, the main challenges, technological leap forward and cultural change, have to be addressed by tomorrow and today professionals. This latter group, comprising highly qualified experts, with wide experience and in-depth knowledge of the profession, will require additional attention, to ensure that the challenges above mentioned do not lead to uncertainty or insecurities in an ever-changing technological landscape. In this context, professional associations will have a pivotal role to play.

Which are Professional Associations' expectations after the BIM Plan adoption and the transformation it requires? What key challenges and opportunities have you identified?

CSCAE: The recent publication of the BIM Plan in Public Procurement, which sets out a gradual and progressive implementation schedule from 2024 to 2030 and establishes escalating levels of complexity, will represent a major turning point for the construction sector and, of course, for the architecture profession. Although the Plan only affects public contracts within the National Public Administration, it will have implications for the entire sector. Also, the forthcoming publication of a BIM standard will serve as a ca-

talyst for the digital transformation of the construction sector.

CICCP: The BIM Plan, promoted by the Ministry of Transport and Sustainable Mobility, aims to unify a collaborative working methodology across all *stakeholders* involved. Our main challenge is to provide quality training so that engineers can work in these environments, offering them the opportunity for an advantageous position in the internationalisation of our companies and professionals.

CONPRODEL: We expect BIM Plan to be extended beyond public procurement and into the education sector to ensure that the responsibility for training professionals to adapt does not fall solely under the companies. The professional associations play a key role in facilitating the transition, since BIM makes part of the construction industry, and providing continuous improvement by educating and training our professionals in BIM methods. Interdisciplinary integration, an essential element of BIM implementation projects, requires increased collaboration and communication between the sector's professional associations: architects, engineers, technical designers..., during the implementation process. Another major challenge lies in ensuring the professional associations work together to raise awareness and promote the use of BIM.

Are your professionals prepared for the transformation that incorporating BIM into public procurement will entail? What are the main

challenges they face?

CSCAE: Architecture studios are already implementing BIM, mostly at their own initiative. According to recent surveys, BIM level of implementation is still low, and BIM level of collaboration with other stakeholders is even lower. Significantly, the use of the methodology is concentrated in the project phases that are most closely linked to the conception, architectural design, and the generation of project deliverables, while BIM use is still low in project phases that involve collaboration with other professionals.

To respond to the challenges involving BIM implementation, apart from economic investment, we will need to ensure its use extends widespread among the different agents in the sector, and continue to promote professionals' training.

CICCP: Our professional is used to tackle new challenges, by adapting to the state of the art. We can adapt to new technologies to continue developing projects with the Public Administration, following its criteria. In addition to training, as mentioned above, one of the biggest challenges will be the use of new Information Technologies (IT). New technological equipment will be needed to support BIM projects when sharing them with the Public Administration e-governance information technologies.

CONPRODEL: Technical Designers are well prepared to tackle the challenges due to their long-standing use of the software ecosystem and acquaintance with digital tools.





CONPRODEL: “We address the challenges associated with BIM, taking advantage of the opportunities afforded by the digital and sustainable transformation of the construction industry.”

Our principal challenges will be addressing any resistance to change, acquiring expertise on protocols and regulatory frameworks, structuring and managing BIM models, facilitating integration with stakeholders from other disciplines and keeping up to date in an evolving technological environment.

Which is your opinion on the Ministry of Transport and Sustainable Mobility's grant programme for BIM training by professional associations? What results are you seeing?

CSCAE: The grant programme of the Ministry of Transport and Sustainable Mobility for BIM training by professional associations is a truly positive initiative. Thanks to the support received in 2023, the training that the CSCAE is offering to the regional architect's associations and, by extension, to their members is free of charge or available at a nominal cost that is affordable to all. This helps to break down the financial barriers to training. As to the outcome of the BIM training cofinanced by the Ministry in 2023, the provisional results report 5% of our associates, 2,500 persons, have followed the course. We

consider this wide training results is a success.

CICCP: The Ministry's programme has given us the possibility of providing this training, for a large number of professionals. The subsidy has been used to fund various training groups for more than 300 students, many of whom are civil servants. These numbers highlight the need to train the professionals themselves in order to implement BIM methodology as a work method.

CONPRODEL: The programme benefits the professional associations and their members, and contributes to the training democratisation, providing access to high-quality courses to any associate, strengthening the collective BIM technical skills.

During the past three years, the Association has received wide acknowledgement of the initiative by the associates.

The role of professional associations in BIM training and skills development

Specific BIM training needs to be incorporated into the curricula of future professionals; furthermore, training and professional development programmes are

required in order to update the skills and knowledge of current professionals in the use of BIM and other digital tools. This includes not only technical aspects but also change management and teamwork skills.

What actions are professional associations taking to facilitate the transformation for their members? What results are you seeing?

CSCAE: Due to the constantly changing regulations and their implication for the safety of people, architects have always been keen to acquire the necessary technical and technological skills in order to apply them to architecture. The complexity of an architectural project requires the use of various tools, both to calculate structures and installations and to assess the energy demand of buildings. This is complemented by work to justify, verify, and monitor the construction work, which is also carried out using digital media. To facilitate professional practice, the architects' associations offer, among other things, courses on software applied to the architectural sphere.

CICCP: The Civil Engineers Professional Association has been promoting digital competences of the associates for years, from teaching courses to obtain "Project Manager" certificates (more than 500 accredited professionals), to the "Master degree in Digital Technology and Innovation in Engineering" in collaboration with the Universidad Nacional de Educación a Distancia (UNED), (five editions), or the "Profes-





CSCAE: "To respond to the challenges involving BIM implementation, apart from economic investment, we will need to ensure its use extends widespread among the different agents in the sector, and continue to promote professionals training."

sional Certificate in Sustainable Infrastructure", with the Institute for Sustainable Infrastructure", among others. The results obtained indicate an outstanding interest in continuous BIM training with more than 1,000 student per year, facilitating their access to the changing labour market.

CONPRODEL: We have provided content for the "BIM specialisation Course", and free BIM training at an "Introductory level", for members, to ensure they can take advantage or more specialised BIM training. We have also given lectures in vocational training centers all over Spain and participated in public regulatory projects. The results indicate a positive impact. The focus was initially set on BIM software training, but over time, it has evolved toward more generalised BIM training. This capacitation has increased public sector demand of BIM trained labour force in our profession. This demand reveals the importance of BIM training in our sector.

How could professional associations help SMEs with

their adaptation process?

CSCAE: The implementation of BIM methodology in architecture studies needs to be accompanied by a general and cross-cutting knowledge of its potential. It cannot be limited to incorporating software or tools that accelerate the production of deliverables. As established by the regulatory frameworks, BIM implementation maturity is measured by the level of collaboration with the other agents involved in a project.

CICCP: The Civil Engineers Professional Association was selected as Digital Transformation Office (OTD) early in 2018 in the Community of Madrid by the European programme Red.es, and assumed the mission of advising on the development of the project to SMEs and entrepreneurs in their digitalization process. Within the Civil Engineers Professional Association structure, to Commissions (Entrepreneurship and Self-Employment) have been constituted to address SME digital adaptation.

CONPRODEL: The Technical Designers Professional Associations

bring SMEs professionals expert BIM training and technical advice. By analysing the company, we can advise SMEs on the BIM roles needed case by case.

How are practitioners acquiring BIM competence?

CSCAE: Architects are acquiring BIM competence in three ways: through training offered by the professional architects' associations with the support of the CSAE, via self-training, or through courses provided by private BIM training centers.

CICCP: For the last five years, the Civil Engineers Professional Association has been offering professionals continuous training in BIM through different training activities. Among these, those carried out in collaboration with the Ministry of Transport and Sustainable Mobility have been the most demanded

CONPRODEL: BIM competence may be obtained as Technical Designer by following Public Vocational Training courses. Public Vocational Training courses currently offer an "Specialisation Course on BIM modelling". Other BIM training possibilities are BIM Masters, or BIM training by Professional Associations funded by the Ministry of Transport and Sustainable Mobility.

Education and training in BIM for the professionals of the future: students of university degrees, BIM specialisation courses in vocational training and advanced vocational training programmes

What's your opinion on the training being provided to prepare new professionals with BIM training?

CSCAE: BIM teaching study plans is very diverse, depending on the Public or private universities. To facilitate professional training to our associates, the Architects professional Associations are providing training in different levels and formats, some of them, with public funding, which are being highly estimated.

CICCP: At university level, our view is that grades and masters for civil engineers are adapting to the future.

CONPRODEL: BIM training for Technical Designers in Vocational Training is under adaptation. Study plans need to conform to labour force demand and include expert BIM training, to facilitate the technological labour force required both by the public and private sector.

How have BIM and other technological tools impacted the existing training programmes?

CSCAE: BIM and other technologies teaching study plans is very diverse, depending on the Public or private universities.

CICCP: Study plans are decided by the Universities. Adaptation to the digitalisation needs of the AECO sector will be needed in the near future.

CONPRODEL: BIM methodology and BIM software impact in the AECO ecosystem must be considered in Study Plans, addressing the development of new skills and the incorporation of new roles and responsibilities. The integration of software must ex-

tend beyond modelling to areas such as planning, coordination and document management, requiring investment and continuous training for teachers.

Are young professionals joining the labour market familiar with BIM?

CSCAE: Although it depends on the curricula taught by the architectural schools, being initiated in the new technological tools and, specifically, in BIM, at a basic level, is usually easy for young professionals who are already accustomed to using digital technologies. They are a generation well-versed in the digital sphere, although improving their knowledge requires specific and continuous training and facilitating access to these tools.

CICCP: Young graduates from Civil Engineering High Schools are aware of BIM importance, and ask the Civil Engineers Professional Association to provide BIM quality training.

CONPRODEL: Young technical designers tend to have, for the most part, a basic knowledge of BIM. Their expertise is generally more solid in the use of 3D design tools and coordinating models. However, given the different degrees of BIM knowledge and requirements, companies insist on their need to incorporate trained BIM experts.

Promoting BIM

There is a need to promote a culture of collaboration and open communication to overcome resistance to change and encourage the adoption of new practices. This involves joining and participating in the

BIM Community, creating spaces for the exchange of ideas and experiences, and recognising and celebrating successes and achievements in the implementation of new technologies.

What actions are you taking to facilitate communication? What results are you seeing?

CSCAE: With the aim to provide wide-scale BIM training to our associates, we have prepared communication plans for the training courses funded by the Ministry of Transport. The provisional figures amount to 2,500 professionals trained. We very much value the extent of this training action.

CICCP: The Spanish Civil Engineer Association organizes workshops to share the BIM and digitalisation benefit for the profession. Some workshops are organized together with the Public Administration. High attendance at workshops indicates the public and private interest to have a common view on BIM implementation.

CONPRODEL: The Council of Technical Designers Professional Associations organises lecture in secondary schools to enhance communication between teachers, students and companies and to share technical experiences. We also offer advice to companies and consumers via services available on our web portal. In addition, we use social media to disseminate technological advances and connect members and students with innovations. Our collaboration with secondary schools and our social media presence has significantly



increased community engagement with the digital platforms.

What actions are you taking to facilitate collaboration?

What results are you seeing?

CSCAE: Currently, both the CSCAE and the Professional Architects' Associations are focused on responding to the training demands of our members in order to advance and expand on the methodology. This is a preliminary phase, and without doubt, we will have to create spaces to facilitate the exchange of experiences and celebrate successes and achievements during implementation, which will require collaboration and cooperation with the Public Authorities and the sector as a whole.

CICCP: Our training activities, both courses and workshops, are addressed to Civil Engineers, but open to any other interested professions. We are interested in facilitating access and knowledge to any professionals interested in making part of the BIM practice community.

CONPRODEL: The Council of Technical Designers Professional Associations has been actively collaborating with Public Administrations to address technological needs and improve the integration of our members by participating in consultations, talks and events relevant to the profession, thereby ensuring their involvement. The results have been positive for all the parties involved in the collaboration, both the private companies and the Public Administration. Thanks to our collaboration and participation, they have gained a better understanding of our profession

and the processes involved in BIM integration.

A future vision of the profession

Digital technologies and multidisciplinary collaboration are playing an ever more central role in the creation and management of sustainable, efficient and resilient built environments.

How do you see the future of the profession in this dynamic context in which technologies like BIM, AI, IoT, etc., are becoming increasingly important?

CSCAE: Architects are aware of the change we are facing and the need to provide to adapt to these challenges. We value the new technologies as enablers to improve process efficiencies, obtain time reduction and face new regulatory requirements, while preserving architecture quality.

CICCP: Our profession has always been a driving force in the transformations of society, adapting to its needs, and following all the advances that arise with the improvement of professionals. We don't think of BIM as a future, but as a today's technology, as drones, renewable energies or 3D printing.

CONPRODEL: The profession is being strengthened by the combination of new technologies that feed each other to optimise results, reducing the time spent on repetitive or productive processes and allowing technicians to devote more time to improving the quality of projects.

How are professional associations approaching

this profession of the future?

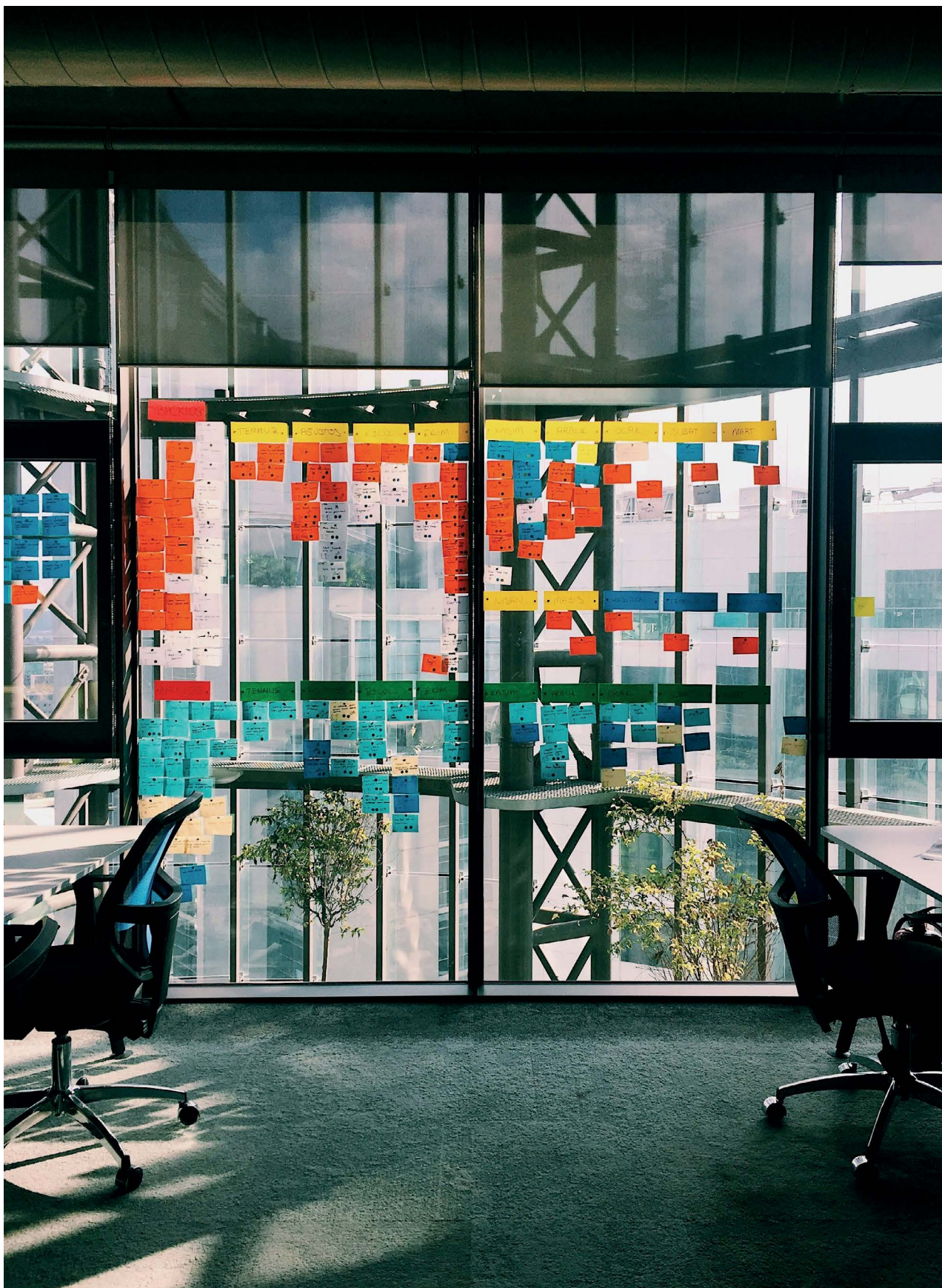
CSCAE: We will continue promoting the ongoing training of architects, facilitating their professional practice so that they can carry out their work reliably and to the best of their ability, thus providing the optimum response to the major challenges of the future.

CICCP: Our purpose is clear: we will continue to contribute to Spain economic development, advocating for continuous training in new technologies and approaches and promote innovation, sustainability and interdisciplinary collaboration to ensure that our professionals are equipped to meet future challenges.

CONPRODEL: We intend to be more visible and increase our interaction with the Public Administration. We aim at being consulted on changes that affect the collective. We will also offer initiatives to improve curricula, promote continuous and up-to-date training, and encourage communication and collaboration to support adjustment to the changes.

Which technologies do you think will shape the future of the profession?

CSCAE: In our opinion, Artificial intelligence (AI), digitalization and new technologies should be understood as tools to help optimise and manage processes at the service of professionals, who, through knowledge, thought and creative capacity, will provide personalised responses to the needs of individual clients and projects based on variables such as location, climate, environment and culture. These tools must





CICCP: “We are looking to the Public Authorities for support and collaboration so that we can turn the BIM Plan into a reality in all the administrative departments; more investment in subsidies for training; data exchange platforms that guarantee the confidentiality and integrity of information; and agreements on standardising processes, protocols and requirements, all in the interest of accelerating the preparation, adaptation and implementation in the sector's companies.”

help us place architecture quality at the service of the common good and preserve the emblems of culture and identity that generate feelings of rootedness and belonging to a specific place, as pursued by the New European Bauhaus and the Law on Architectural Quality.

CICCP: New technologies are here to stay. Some will burst onto the scene and shape our profession, such as Artificial Intelligence (AI), interconnections between entities and professionals, Virtual Reality (VR) Augmented Reality (AR), Information and Communications Technologies (ICT), Internet of Things (IoT), etc. Internet of Things (IoT), etc.

CONPRODEL: Some software are still not ready to leverage the series of BIM advantages. IA and

programming will create additional possibilities in the future. The integration of BIM and AI will improve efficiency and accuracy in design, while the Internet of Things (IoT) will facilitate the creation of smart homes and infrastructure.

Conclusions

CSCAE: Architecture and the role of architects play a decisive role in guaranteeing the well-being and safety of people through the construction of housing and infrastructures, urban planning and the conservation of natural and cultural heritage. For this reason, for the CSCAE it is imperative to work hand in hand with Public Authorities to facilitate access to continuous training in BIM methodology and its tools. This

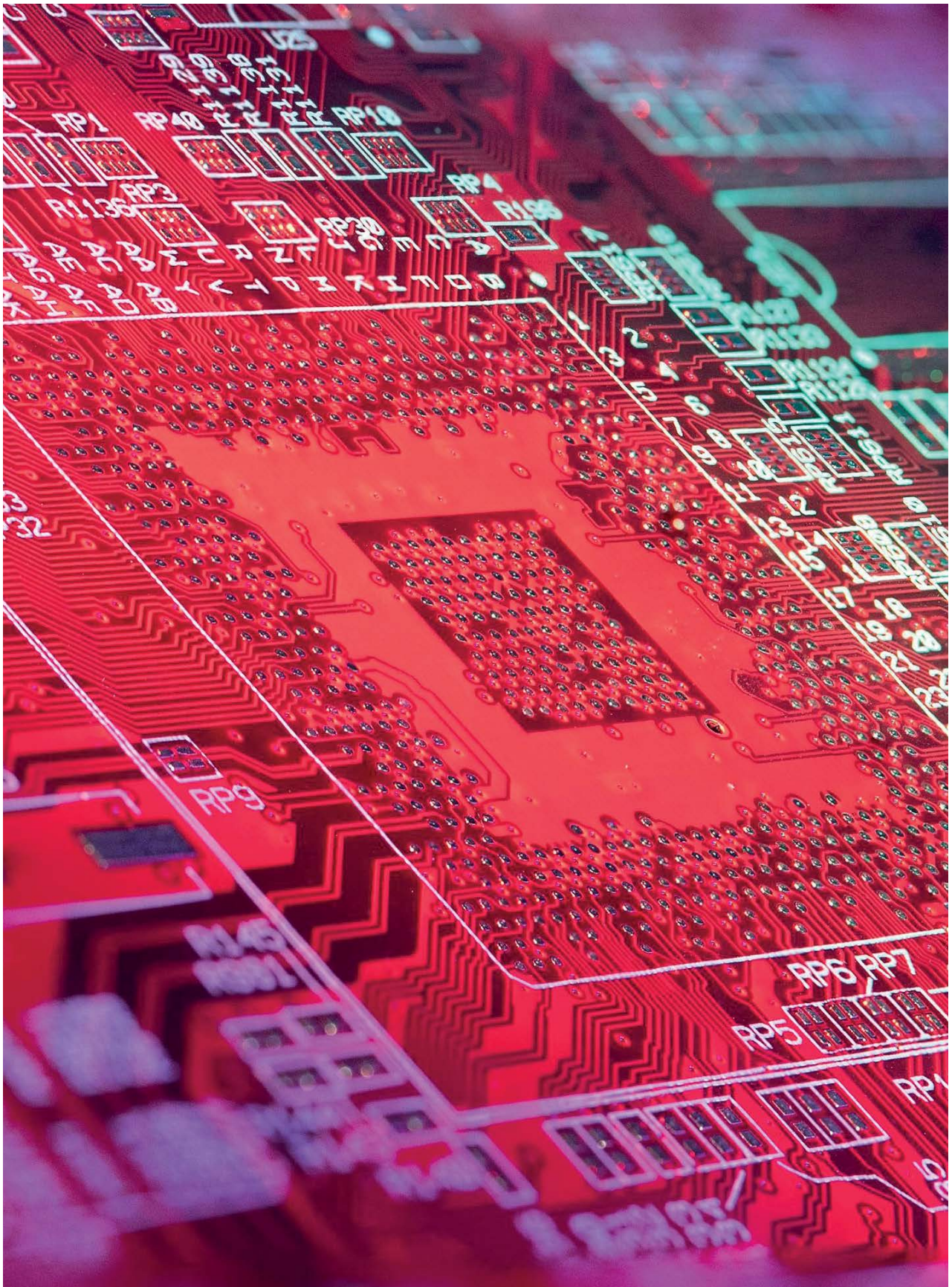
will not only improve the efficiency of building processes but also elevate architectural quality for society as a whole, which is the ultimate goal of our work.

CICCP: We value professional associations as professional's continuous training providers. Most remarkably, we value the Civil Engineering Professional Association contribution to build BIM capacity for the AECO sector. Overall, we are committed to providing our professionals with better access to new technologies.

CONPRODEL: The Council of Technical Designers Association plays an active role for the profession, and for the preparation of future professionals to serve the community. We address the challenges associated with BIM, taking advantage of the opportunities afforded by the digital and sustainable transformation of the construction industry. Our focus on continuous learning, collaboration and the integration of emerging technologies is crucial to our professional future. We are committed to providing the resources and support necessary for our workforce to adapt and thrive in an ever-evolving world of work. And to do so, we need support and reinforcement from Government Agencies to highlight the value of our associated technical designers. ●







#BIM for the digital transformation

The BIM Plan identifies, as a key element of BIM implementation, the technological solution needed to integrate workflow and allow all the involved agents to manage, deliver and review information, and assigns the CIBIM to build up a Common Data Environment (CDE) at National Government level.

With BIM models and CDEs, all the information on work contracts and related services is available in a structured way, which enables the transition towards single, unified data. This organization of information is the starting point for the digitalization of the construction sector and the Public Administration, which, in turn, will lead to a more efficient asset management, and to the development of innovative services to support new layers, such as Artificial Intelligence or data analytics technologies.

This section looks at the experience of the Ministry of Transport and Sustainable Mobility, which, as Chair of the CIBIM, launched, through the Deputy Directorate General for Information Technologies and Digital Administration of the Ministry of Transport and Sustainable Mobility, an ambitious plan to develop a CDE for the Directorate General of Roads that can be used by the National Public Administration in different use cases.

In line with the requirements set out in the BIM Plan for Public Procurement, this CDE platform is designed and customized to manage the entire life cycle of a construction project, considering the specific needs of the Public Administration, and guaranteeing technological neutrality.

A key technology platform for the implementation of the BIM methodology

A Common Data Environment for the Public Administration

The Ministry of Transport and Sustainable Mobility, under the direction of the Deputy Directorate General for Information Technologies and Digital Administration, is developing a Common Data Environment.

This collaborative platform allows information to be exchanged between the Public Administration and the different agents involved in the life cycle phases of projects and construction works that implement the BIM methodology.

The Common Data Environment, in line with the requirements of the BIM Plan, provides advanced document management functionalities, including role-based access control and the possibility to define nomenclatures for folders and files. It also provides viewers for a variety of formats, including the visualisation of 3D models. As it is an in-house development, the Public Administration has control over the data and the platform's evolution while allowing for the standardisation of formats and the use of open standards.

- Text: Carlos Martín-Nieto González and Francisco Gijón Romero, Directorate General for Information Technologies and Digital Administration

Use of a 3D viewer to analyse a road in real time. Composition developed by the Ministry of Transport and Sustainable Mobility.



Introduction

On 1 April 2024, the Starting Level of the Plan for the incorporation of BIM methodology in the public procurement of the National Public Administration and its dependent bodies and related or dependent public law entities, approved by the Council of Ministers on 27 June 2023, came into force.

This Plan contributes to the objectives established by several strategic instruments on the green and digital transition at global, EU and national levels, such as the 2030 Agenda, the European Green Deal and the Spanish Circular Economy Strategy. It is also aligned with the policy of promoting innovation through strategic public procurement promoted by the European Commission and with the National Public Procurement Strategy.

BIM is an acronym for Building Information Modelling. It is a method of working in the construction sector, which, using digital models, is based on collaboration between the agents involved during the life cycle phases of infrastructures or buildings. The UNE-EN ISO 19650 series of standards defines BIM as the use of a shared digital representation of a built asset to facilitate its design, construction and operation and provide a reliable basis for decision-making.

Adopting BIM in projects enables more efficient collaboration between project teams, facilitating early identification of potential conflicts or errors in the design. This avoids costly changes during construction and reduces the risk of delays. In

The CDE is an online platform that integrates workflows to facilitate the management, delivery and review of information in construction projects. Its objective is to unify the information generated and guarantee collaboration and interoperability between the agents involved.

addition, BIM makes it easier to carry out advanced analyses in order to optimise the design and minimise costs.

What is a CDE?

The Common Data Environment (CDE) plays a key role in this new collaborative way of working. It is a technological solution in the form of an *online* platform that integrates the workflows necessary for all the agents involved to manage, deliver and review the information in construction projects, with the aim of unifying the information generated and guaranteeing collaboration and interoperability.

The CDE workflows are based on statuses and review processes that are transitioned according to the information's maturity level and the purpose for which it is shared with the other participants. This ensures control and traceability throughout the process of generating, sharing, reviewing and approving the information.

In addition to workflows, the platform allows metadata to be attached to documents, which makes it easier to search and classify information. It also keeps a detailed record of modifica-

tions, including who made each change and when. Moreover, the platform can issue automatic notifications to stakeholders when relevant updates occur. Nowadays, platforms of this kind offer many other functionalities that, although not defined in ISO-19650, are leading to the development of commercial solutions.

A CDE for the Administration

The Ministry of Transport and Sustainable Mobility is leading the development of a CDE platform adapted to the usage scenarios of the National Public Administration. Among the actions entrusted to the CIBIM in the BIM Plan is the study of the possibility of developing a specific CDE for the use cases of the National Public Administration.

The Ministry of Transport and Sustainable Mobility, as Chair of the CIBIM, has launched this ambitious initiative.

The goal is for the CDE to comprehensively manage a construction project's entire life cycle from an administrative perspective.

The project typically begins with a needs assessment and the collection of baseline and

The Ministry of Transport and Sustainable Mobility is developing a CDE platform that meets the usage requirements of the National Public Administration. This platform will facilitate the management of the entire life cycle of a construction project from an administrative perspective.

background data. These initial steps are then followed by the tendering procedure and subsequent evaluation of the tenders.

It continues with the implementation phase, which involves the handover and periodic review of the documentation generated. It is important to note that in this phase, the Administration's CDE is a complementary platform and not a substitute for the contractors platforms, which they will continue to use for their day-to-day work and internal reviews prior to the delivery of information to the Administration's CDE.

The final phase involves the definitive archiving of the project and, where appropriate, integrating key information into the operations and maintenance management systems, also known as Facility Management or CMMS (Computer Aided Maintenance Management).

Opting for an in-house development

Although commercial solutions for this type of collaborative platform for BIM projects are already available on the market, the Ministry of Transport and Sustainable Mobility has opted to develop

an in-house solution for several reasons, including the following:

- Direct control over the platform to guarantee the security of information, in accordance with the National Security Scheme, as well as the principle of technological neutrality.
- Standardisation through a single platform that can be re-used for different government projects and bodies, enabling integration and interoperability with other systems and stability over time.
- Facilitation of the mechanisms and guarantees inherent to the digital functioning of the Public Administration, in accordance with the regulations applicable to the activity and the functioning of Public Administrations in aspects such as the identification and signature of interested parties, registration or interoperability standards.

Commitment to interoperability and open standards

The platform has been designed with a focus on interoperability and is compatible with the leading industry standards to ensure that information can be

exchanged in open, non-proprietary file formats. Examples of these standards are:

- IFC (Industry Foundation Classes), an open file format used to represent both geometric and alphanumeric information about building objects in BIM models.
- BCF (BIM Collaboration Format), an open file format that allows textual comments and screenshots to be added on top of the IFC model layer.
- IDS (Information Delivery Specification), a very recent standard designed to improve the requirements exchange process in BIM projects. It allows the project's needs to be represented by a list of information requirements that IFC models must comply with.

It is also committed to using open-source software, which is evidenced by the fact that almost all of the integrated third-party libraries are open-source, including, for example, the base technology that enables the visualisation of 3D models.

A platform open to the National Public Administration, other organisations and the general public

The platform can be opened up to different areas and usages to enable the dissemination of information on projects relevant to citizens, as well as the participation of various actors in the construction sector and digitalization with BIM.

Another important feature of the architecture is that it follows the principle known as multi-te-

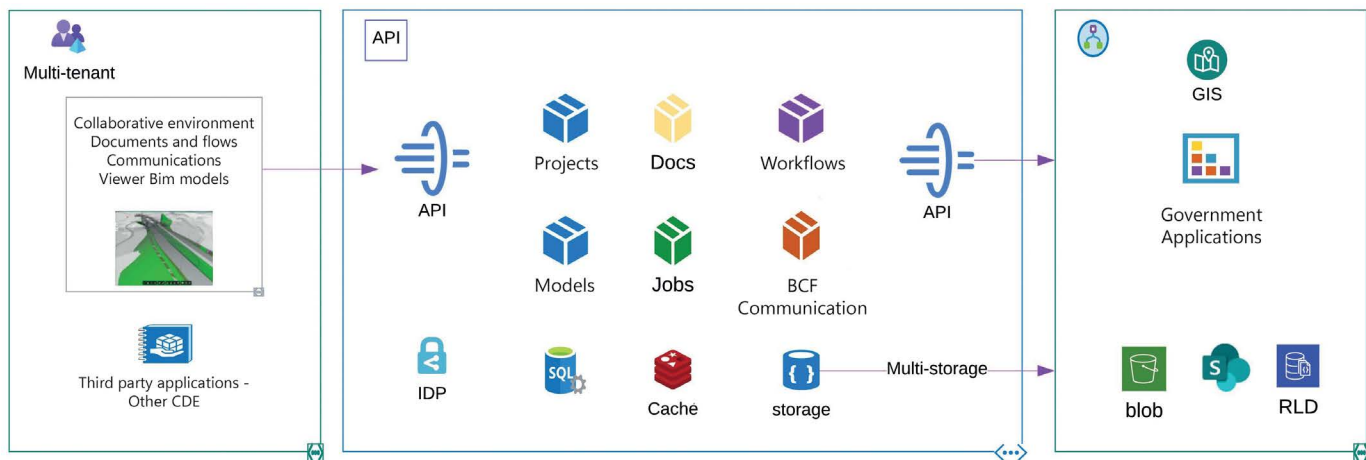


Diagram of CDE platform components.

nancy, which means that a single platform instance and servers can be used to offer services to organisations and projects, each with independent data and configurations. This enables the platform to serve different public bodies and organisations, optimising the use of technological resources. Even within the same organisation, the information from different projects is kept separate, and people involved in various projects from multiple organisations do not need to create different user accounts.

A modular, scalable, integrable and secure platform

The platform consists of different modules, mostly based on open-source software components, which are designed to be deployable on a cloud-independent infrastructure and be appropriately scalable, i.e. to adapt and respond as their usage needs grow.

Furthermore, it will offer an API (application programming interface) destined for use by different client applications, whether user interfaces or third-

party applications, including the possibility of integration with the contractors' CDEs or with management applications. This means that the solution will be able to meet the requirements of the last level of the BIM Plan, the so-called Integrated Level, whose minimum requirement is to allow access to the platform's data via web services.

In terms of platform security, secure access to the platform is provided by an identity provider component, which, apart from enabling access to the CDE itself, allows the integration of different applications, systems and even document repositories.

Main functionalities of the CDE

The CDE platform organises its functionalities into modules, which include the document manager, communications and viewers.

● Document management

The document management module allows you to upload documents, add attributes for sorting and searching, and store them in a folder structure. It also allows templates of standard

projects to be created, which facilitates the configuration of predefined folder structures and naming rules for the documents in these projects.

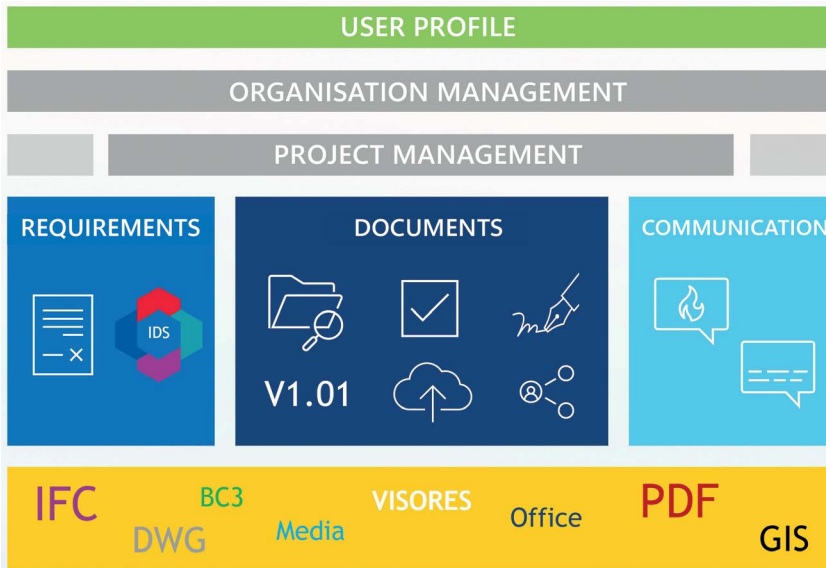
In addition, it has a powerful version control to maintain the traceability of changes in the documents.

The folders have read and write permissions to control the information accessed by individual users, and users can be organised into teams, grouping those with homogeneous permissions for project folders.

It also has a tool for approvals so that users can request the review and approval of deliverables and another for sharing documents or complete folders with external agents who participate in the contract on an ad hoc basis.

● Communications

The communications module allows you to create tickets, tasks and announcements, assign them to one or more users, set a deadline, attach documents and screenshots, make comments, and change the status of tickets, e.g. from open to resolved.

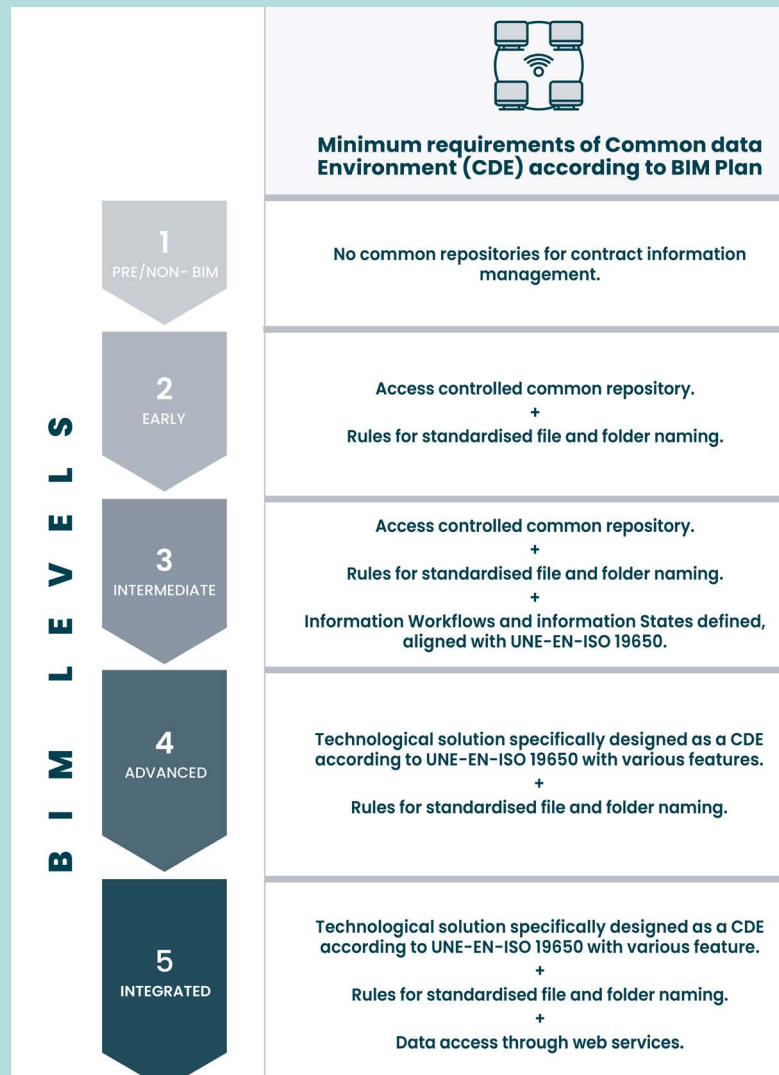


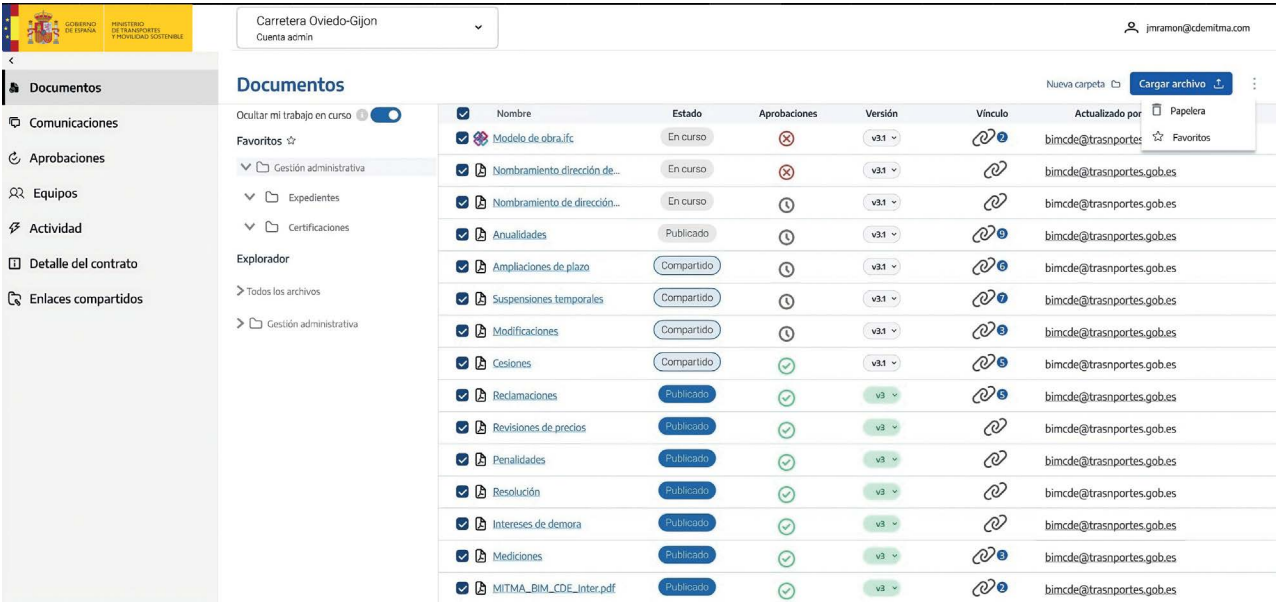
Main functionalities of the CDE platform.

It is based on the open BCF standard, allowing users to create and consume these communications on third-party platforms that support it. Although BCF offers significant advantages over traditional email for incident and task management in construction projects, such as the ability to make specific annotations on particular views and model elements to improve the accuracy of communications between users, it is not a widely known standard. Therefore, the

Requirements of the CDE according to the BIM Plan

The BIM Plan in Public Procurement defines the BIM levels (Pre-BIM and Starting, Mid, Advanced and Fully Integrated Level) to be achieved at each milestone of the Plan and the BIM requirements to be requested by the contracting authorities for each level, grouped into several areas: strategy, processes, technology and people. In the area of technology, it explicitly states the minimum requirements that the information repository or technological solution must meet.





Appearance of the document management module.

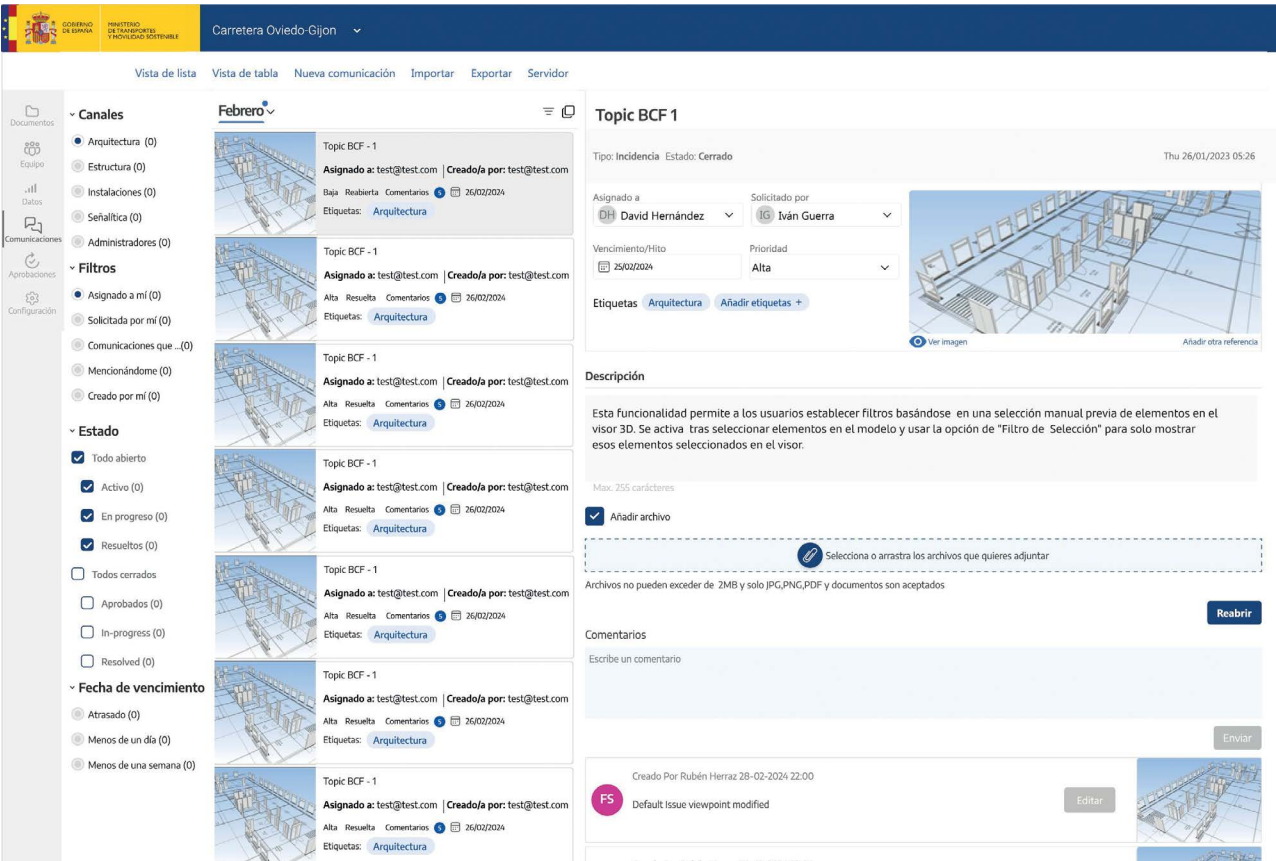
interface has been designed to be as similar as possible to a traditional mail manager to facilitate its adoption and effective use by users.

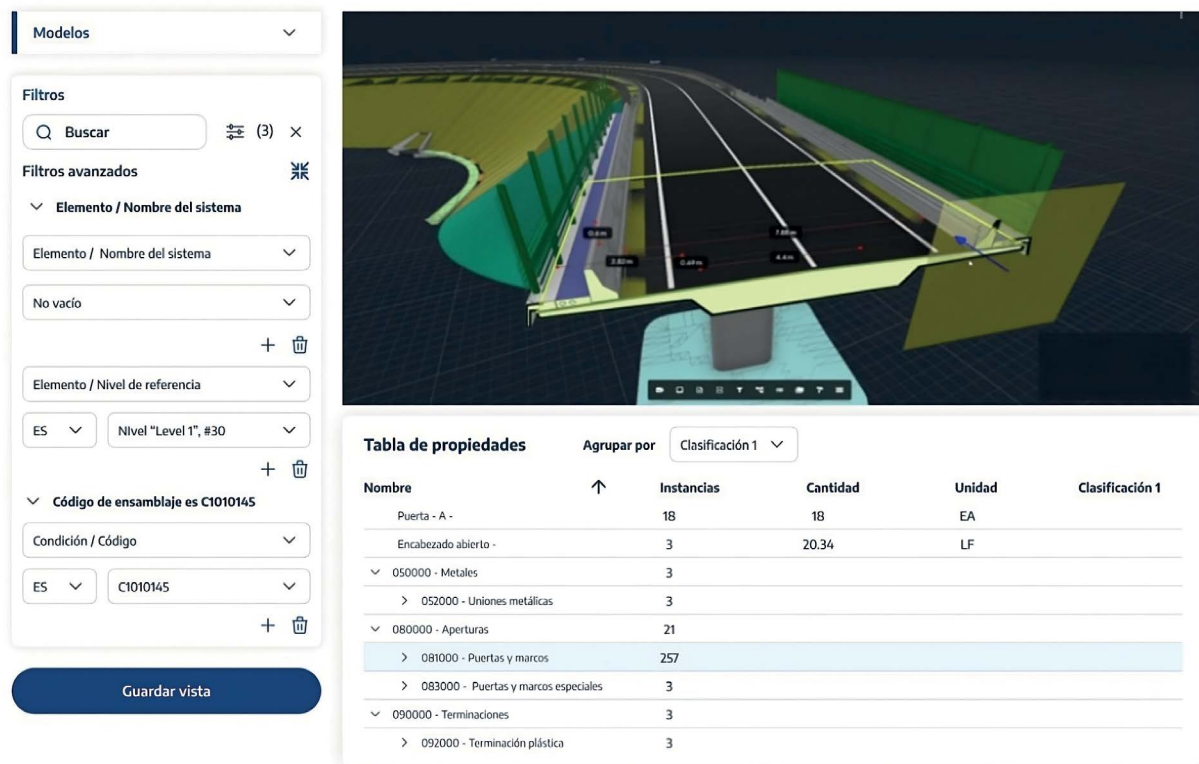
● Viewers

The platform integrates several viewers that allow you to view documents in the most common formats without having to download them. These viewers range from the most typical office

document formats such as PDF, DOCX and XLSX to the visualisation of designs and models in 3D. In the case of 3D model visualisation, the IFC support, as

The communications module makes use of the BCF standard for incident and task management.





The platform viewer allows the geometries and parameters of the models to be examined.

mentioned above, is an open format used in the construction sector to store 3D designs containing all the information on the construction elements. Given that the IFC format is not well known and many users do not have desktop applications capable of opening it, the viewer provided is particularly valuable because it takes advantage of the latest web browser graphics rendering technologies to explore and examine the designs in the user's browser, without the need to install additional software on their computer. In addition, the viewer is equipped with specialised tools that enable actions such as hiding and displaying objects, consulting their specific details, linking them to their corresponding documentation, etc., thus making

project management more efficient.

One of the distinguishing features of the viewer is that it is optimised for linear projects (roads, railways, etc.), an aspect rarely found in commercial viewers but one that is extremely important in the majority of projects carried out within the scope of the Ministry of Transport and Sustainable Mobility.

The viewer is based on an open-source technology that will allow the development and extension of specific functionalities, such as road maps indexed by their kilometre points or performing longitudinal and transversal sections of the road axis, which are supported in the recent IFC 4.3 version, which includes, among others, the addition of road infrastructure extensions.

Current and future work

At present, the Ministry of Transport and Sustainable Mobility's Deputy Directorate General for Information Technologies and Digital Administration is continuing to develop and evolve the platform.

In April, the first version of the CDE, as per the Starting Level requirements defined in the BIM Plan, was released to users of the General Directorate of Roads. Throughout this year, in line with the project's roadmap, successive evolutionary versions of the platform will be released, with the aim that in the short term, the General Directorate for Roads will be ready to conduct pilots based on real projects. Furthermore, in addition to continuous technical support programmes,

The 3D viewer developed by the Ministry of Transport and Sustainable Mobility offers functionalities for the most common model visualisation and consultation scenarios. Among its distinguishing features are the native support for IFC and the built-in optimisations for linear work projects, an aspect that is rarely provided by commercial viewers but is essential for the Ministry's projects.

specialised services will be offered to support the implementation of BIM technology in the projects and best practices in using and managing the models. The information and feedback obtained in these first real experi-

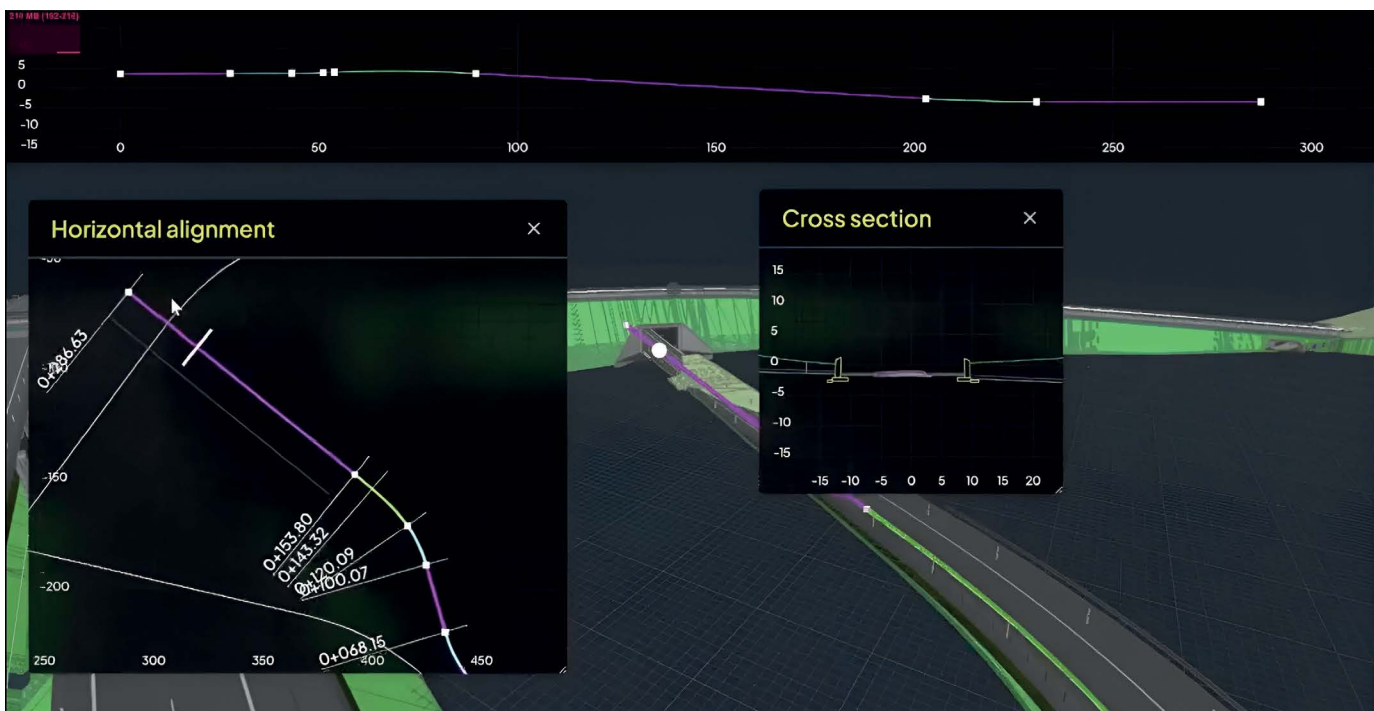
ences will be key to the platform's evolution in the medium term.

In addition to the significant participation of the Directorate General of Roads, which is expected to be one of the most active users of the platform due

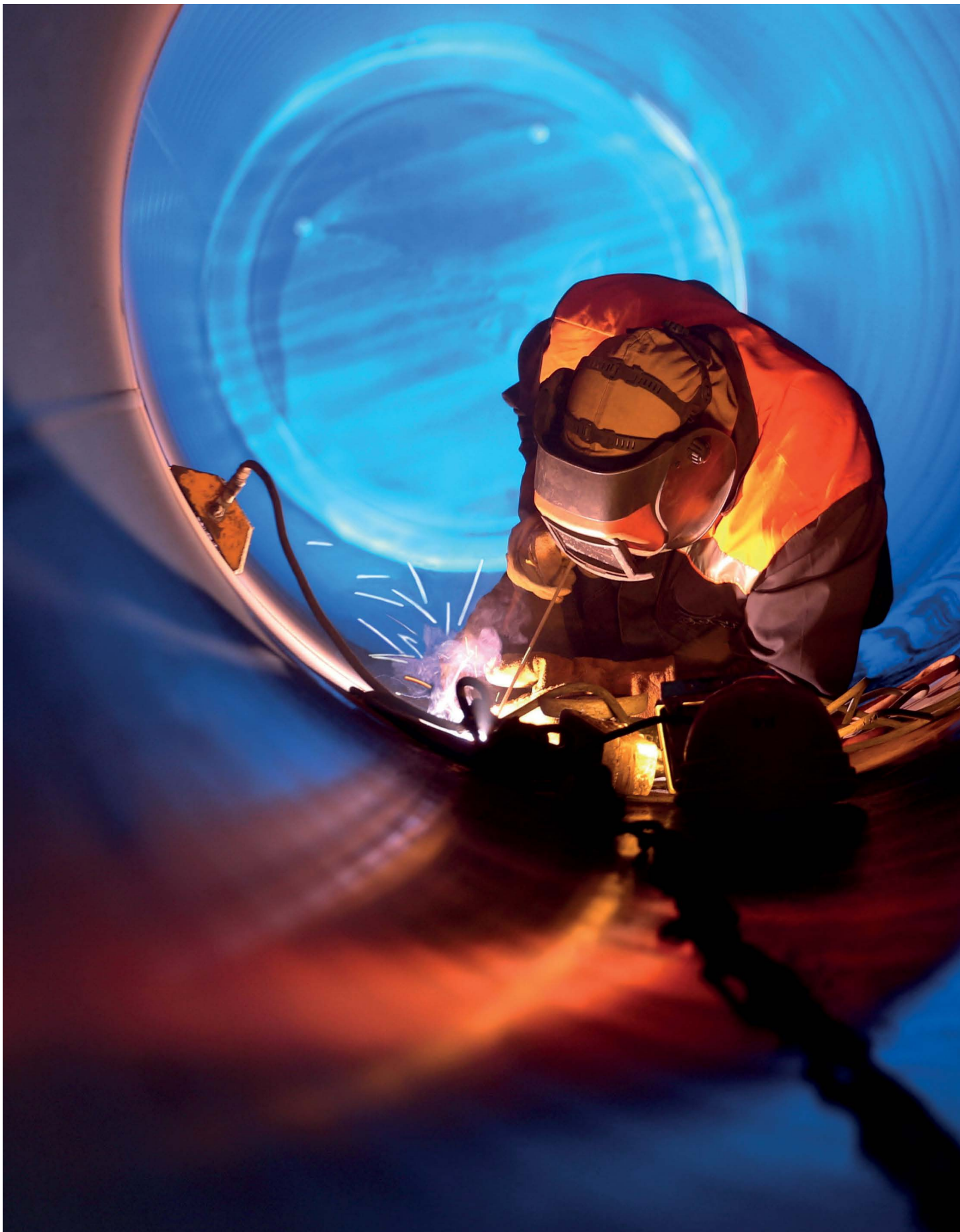
to the volume and complexity of projects it handles, the CDE desing and development have been conceived with an open and flexible vision to respond to the needs of other Government Departments and public entities, as proposed by the BIM Plan.

In parallel with the development and implementation tasks, a comprehensive communication and training strategy will be defined in the coming months with the aim of maximising the reach and effectiveness of the platform. This strategy will encompass the drafting of informative and educational materials, the organisation of workshops and seminars, and the implementation of dissemination campaigns to ensure that all potential users are fully informed about how to use the platform. and take full advantage of its capabilities.●

The IFC Alignment entity allows a reference system to be defined for positioning elements in linear construction works.

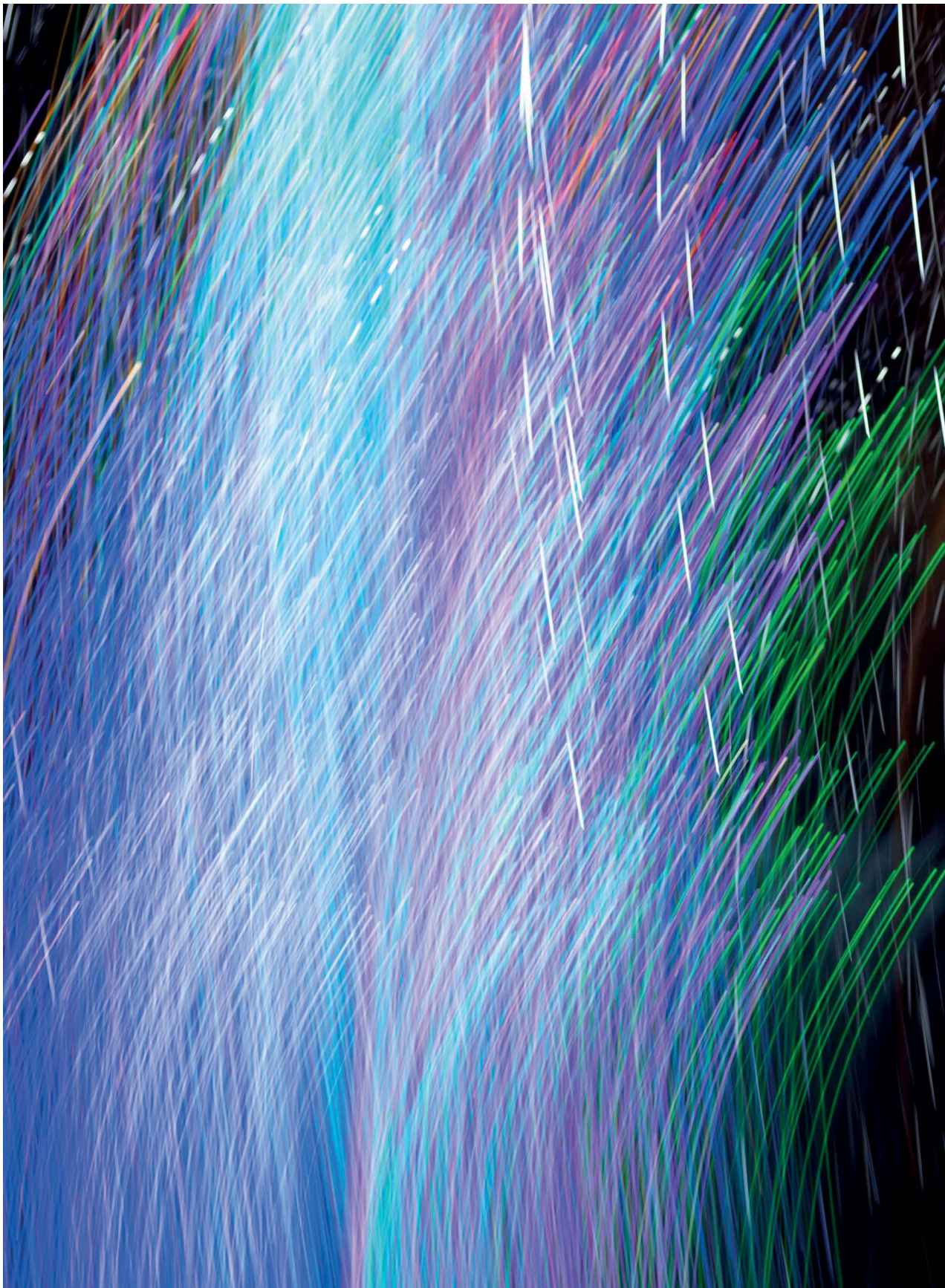








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