ET4Digital – Empowering Trainers for Digital Innovation in Construction Ecosystem

Deliverable 3.2

Transnational Training for Trainers for the use of the demonstrator

Author(s)	
PP	**IIPLE**

Technical References

Project Acronym	ET4DIGITAL
Project Title	EMPOWERING TRAINERS FOR DIGITAL INNOVATION IN CONSTRUCTION ECOSYSTEM
Project Coordinator	IIPLE
Project Duration	24 M

Deliverable No.	D3.2
Dissemination level [1]	PU
Work Package	WP3
Task	TASK 3.2
Lead beneficiary	IIPLE
Contributing beneficiary(ies)	
Due date of deliverable	30/11/2025
Actual submission date	30/11/2025

[1]   PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)

Document history

V	Date	Beneficiary	Author
1	20/11/2025	IIPLE	Gianmarco Fontana
2	25/11/2025	IIPLE	Luisa Sileni , Valentina Ferrari
3			
4			

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

2

Table of content

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

3

Summary

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem is dedicated to advancing the quality, effectiveness, and innovation in training trainers and teachers within the construction sector for the seamless integration of digital technologies. The initiative involves creating innovative tools and a comprehensive capacity-building program. Trainers will engage with a specially designed digital technologies demonstrator, fostering hands-on experience. The project aims to overcome barriers hindering SMEs from adopting digital technologies by co-designing, testing, and validating training programs. The ultimate goal is to empower trainers to lead the digital transition in the construction industry, tapping into its significant but underexplored potential.

Although digital innovation has grown significantly in recent years, companies are finding it difficult to effectively exploit this enormous potential. Instead, digitization in the construction sector can offer significant opportunities for the entire value chain by not only improving existing practices but also integrating disruptive technologies and tools that can lead to new processes, business models, materials and solutions. It is important to underline that the combination of digital technologies makes it possible to maximize the benefits associated with digital transformation. For example, BIM, IoT, Augmented Reality and Digital Twins are deeply interconnected, as they refer to technologies that leverage each other and can be seen as different phases or elements of the same digital transformation.

As demonstrated by several European and national research, the construction sector is positioned far behind the other industrial fields when it comes to digitalisation.

To date, the European construction sector is facing challenges which are hampering its competitiveness. Among these:

- Labour shortage
- Lack of digital skills in some countries
- Lack of interest among entrepreneurs and workers on the digitalisation of processes
- Lack of motivation on the part of young people to work in the sector
- Need to increase productivity while improving quality, cost efficiency and project delivery
- High costs related to technologies and digital tools

Therefore, the specific objective of the project is to deliver customized programs to professional trainers, aiming to equip them with new digital strategies, tools and skills. As intermediaries, these trainers play a crucial role in demonstrating to enterprises and workers the benefits of digitalization and the positive outcomes it can yield. This approach facilitates the upgrading of workers' skills in digitalization, emphasizing that traditional materials and techniques can be innovatively supported by digital technologies, leading to reduced costs and time wastage.

Furthermore, the job market continually evolves, shaping the required profiles and skills that workers need to possess in response to the demands of companies and employers. By updating the

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

4

professional profiles required in the construction sector and digitalizing its processes, we can attract young, educated workers to a field of work still considered "traditional".

Objectives and key results of WP3

Work Package 3 (WP3) aims to transform WP2's analytical outputs (digital technology framework and trainers' skills map) into a practical pedagogical model for VET trainers, teachers, and professionals to lead the digital transition of the construction sector in SMEs.

WP3 pursues four interconnected goals.

First, it introduces new technologies (BIM, IoT/sensors, data analytics and Digital Twins) through guided practice, scenario-based activities, and problem-solving tasks. The strategy is deliberately modular, allowing it to be integrated into various curricula (namely, VET centres, technical institutes, universities) and tailored to diverse levels of digital readiness across countries and institutions.

Second, it incorporates the teaching strategy into an educational digital demonstrator that connects BIM models to live/near-real-time data streams from IoT sensors and allows for visualization. The demonstration runs in a controlled environment, allowing trainers to practice processes like data collecting, clash detection, site monitoring, energy performance analysis, and safety checks.

Third, it provides guidance and learning resources for trainers, such as organized syllabi and lesson plans, competency-based learning goals, practical exercises and assessment rubrics. Accessibility and inclusion are integrated through multilingual resources, clear instructions, and options for asynchronous use.

Fourth, it validates the approach through a transnational training that involves piloting the demonstrator with trainers from all partner countries, and obtaining evidence on usability, learning efficacy, and transferability to SME settings. Quality assurance was triangulated among participant feedback, competency self-evaluations, peer observation, and pre/post learning assessments.

Across all objectives, WP3 emphasizes pragmatism, interoperability, and scalability, ensuring that the method may be implemented by institutions with varying technical standards and sustained within long-term upskilling plans. It addresses EU priorities on digital transformation, innovation in VET, and the role of digital tools in the green transition by incorporating energy/sustainability analytics and effective resource management into training workflows.

WP3 fully aligns with horizontal needs: it advances digital transformation through high-impact, interoperable systems; it supports inclusion and access through multilingual open resources and

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

5

blended/asynchronous options; it incorporates energy and resource analytics into learning scenarios; and it fosters common values through transnational collaboration, peer learning, and open dissemination.

Most importantly, WP3 reduces the risks of adoption of new digital technologies for VET providers and SMEs: the demonstrator packed with configuration guidelines, sample datasets, and troubleshooting playbooks, which lowers the technical barrier to access it.

Validation of this approach through a transnational training reveals its transferability across institutional baselines and market contexts.

Purpose of this document

Deliverable 3.2 is the second output of WP3 and provides a description of the Transnational Training for Trainers for the use of the Demonstrator, which marked a pivotal stage of the ET4Digital project. The training acted as a bridge between the analytical work of WP2 and the large-scale capacity-building goals of WP4.

Its purpose was to equip trainers—identified as key enablers of the digital transition in construction SMEs—with the practical skills, methodological awareness, and pedagogical confidence needed to integrate digital technologies into VET teaching and SME support services. Trainers must be able to explain to companies why technology matters, the value it can create, and how it will affect their business. ET4D's Transnational Training operationalised this strategic role.

The programme centred on hands-on, experiential learning using the project's Digital Twin Demonstrator, a pedagogical tool designed to make digitisation tangible, accessible, and replicable. The training guided participants from conceptual understanding to active digital practice through scenario-based activities, coached sessions, and problem-solving tasks aimed at building concrete skills and confidence.

Beyond technical proficiency, the training also addressed how to teach these tools effectively. It included structured learning sequences—introductory orientation, coached practice, autonomous exercises, and reflective activities—to model a standardised instructional method that can be adopted in VET centres, technical institutes, and universities. This directly supports WP3's core objective: developing a teaching strategy that meaningfully embeds digital tools into pedagogical practice. First-hand experience with this model enables trainers to replicate it in their own institutions.

The training also served as a transnational testing ground to assess the demonstrator's usability, relevance, and transferability across different national contexts and levels of digital readiness. These insights inform refinements to the demonstrator and guide the design of the WP4 capacity-building programme.

At European level, bringing together trainers from several partner countries fostered peer learning, the alignment of digital VET practices, and the emergence of a shared pedagogical culture around Construction 4.0. In a sector characterised by fragmented SME structures and uneven digital uptake, such collaboration enhances the coherence, visibility, and long-term viability of ET4Digital results. It

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

6

also supports the goal of making the demonstrator a replicable model for trainers, SMEs, VET students, and professionals.

Overall, the transnational training was designed not only to teach digital technologies, but to empower trainers as agents of change capable of supporting SMEs, modernising education programmes, and sustaining Europe's digital transition in the construction sector.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

7

Transnational Training for Trainers for use of the demonstrator

Agenda overview

ET4Digital- Empowering Trainers for Digital innovation in construction Ecosystem

Project no. 2024-1-IT01-KA220-VET-000249119

WP3: New teaching approach for digital transition

Transnational Training for the use of the demonstrator

<u>**Face to face event**</u>

@ IIPLE, Via del Gomito 7, Bologna, Italy

18 -19 November 2025

<u>**Agenda**</u>

Tuesday 18, November 2025

10:00 - 10:05	**Event opening**	**IIPLE**
10.05 – 10.15	**ET4D: an overview**	**IIPLE**
10.15 – 11.15	**WP3 New teaching approach for digital transition (pt.1)** **Technical contributions:** Bragadin, CDT implementation for ET4 Digital Project Ballabeni, The Open Project BIM platform Assumma, Value Analysis of Construction projects	**UniBo**
11.15-11.30	*Coffee Break*	
11.30-12.40	**WP3 New teaching approach for digital transition (pt.2)** **Technical contributions:** Coccolini, Lean Construction & sustainability Balzani, Project Scheduling for Safety of construction	**UniBo**

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

8

	Poudel, BIM modelling for the ET4 Digital Twin implementation	
12.40-13.00	**Technical contributions of project partners**	
13.00-14.00	*Lunch break* *(Offered by IIPLE)*	
14.00-15.00	**Pilot Digital Twin presentation & Guidelines**	**UniBo**
15.00-16.00	**Site visit**	**UniBo**
16.00-16.30	**Questions and Clarifications**	
16:30	**End of the first day**	

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

9

Wednesday 19, November 2025

10:00 - 10:05	**Event opening**	**IIPLE**
10.05 – 10.45	**Pilot CDT demonstration**	**Unibo**
10.45-11.00	*Coffee Break*	
11.00 – 12.45	**Workshop / working with CDT** Practical implementation of CDT-based activities by participants (IIPLE IT lab – on-site)	**All Partners**
12.45 – 13.00	**Feedback from ET4 Participants / question and Answers**	**All Partners**
13.00-14.00	*Lunch Break* *(Offered by IIPLE)*	
14.00-16.00	**Synergies between Digital Twin and Augmented Reality in practice**	**Luca Vitale,** **Touch Labs**
16.00-16.30	**Conclusions and remarks**	**UNIBO and IIPLE**
16.30	**End of the second day**	

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

10

Profile of participants and added value of the Transnational Training for Trainers

The Transnational Training for Trainers brought together a multidisciplinary group of representatives from Estonia, Germany, Italy, Spain, Greece, and North Macedonia, ensuring a broad and qualified exchange of expertise and practices. In line with the specifications of Work Package 3, each partner organisation selected trainers, teachers, and professionals with proven experience in the digitalisation of construction processes. The group included BIM instructors, BIM managers and coordinators, construction techniques teachers, university professors and researchers in construction site management and digital methodologies, as well as on-site technicians with hands-on experience in applying digital tools. This composition guaranteed the presence of highly specialised profiles capable of contributing meaningfully to the testing of the Digital Twin demonstrator and of integrated technologies such as photogrammetry, BIM, IoT and sensors, as outlined in WP3.

The participants' contribution extended beyond their technical competences. They acted as primary evaluators of the demonstrator, playing a crucial role in identifying strengths, technical and operational challenges, and potential areas for improvement. Their feedback was essential for the validation of the demonstrator and for refining its usability and pedagogical applicability, in accordance with the objectives set out in WP3. This evaluation process also provided valuable insights for the future replicability of the model across other VET institutions in the partner countries.

Moreover, the involvement of Project Managers and Partner Coordinators ensured an effective supervision of the training activities and supported strategic alignment with the overall project objectives. The interdisciplinary nature of the group promoted a collaborative learning environment in which academic, operational, and managerial competences complemented each other. The practical activities implemented during the training, including demonstrations, exercises, audiovisual documentation, and structured feedback, will form an integral component of the guidelines for the replicability of the demonstrator, a key output of WP3.

Overall, the participation of thirty-one individuals on the first day and thirty on the second day confirmed the strong engagement of the consortium partners and their interest in the pedagogical and operational potential of the Digital Twin. The qualified and diverse contributions of the participants significantly supported the refinement of the demonstrator and established the foundations for its future integration into VET training pathways across Europe, in full coherence with the objectives of Work Package 3.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

11

Event contributions

On November 18 and 19, 2025, the IIPLE headquarters (Via del Gomito 7) in Bologna hosted the Transnational Training for the Use of the Demonstrator. The two-day program offered participants—two technicians/experts from each partner organization—a comprehensive experience, both theoretical and practical.

Between April and October 2025, the University of Bologna team (WP3 lead partner) set up the demonstrator for educational purposes, developing a Construction Digital Twin for the development of the Open Project BIM platform, as a supporting tool.

The first day began with an engaging morning of presentations by experts from the University of Bologna, who illustrated the processes undertaken to develop the Digital Twin and addressed additional topics related to digitalization in the construction sector:

- **Marco Bragadin (UniBo):** *CDT implementation for the ET4Digital Project* – introduced the conceptual and technical framework for integrating Construction Digital Twin (CDT) into project workflows.

During the Transnational Training for Trainers, the presentation delivered by Professor Marco Bragadin provided a comprehensive overview of the conceptual foundations and practical implementation of the Digital Twin demonstrator developed within ET4Digital. The contribution contextualised the initiative within the broader digital transformation of the construction sector, highlighting the structural challenges faced by small and medium-sized enterprises in adopting digital tools—among them fragmented interoperability, limited standardisation, high implementation costs, and scarce internal competences. Against this background, the Digital Twin was introduced as a strategic enabler capable of improving the integration of processes, enhancing coordination across the construction value chain, and supporting informed decision-making through the use of dynamic, data-driven virtual models.

The session clarified the conceptual underpinnings of the Digital Twin, described as the digital counterpart of a physical asset, system, or process, continuously updated through data exchanges that maintain alignment between the real and virtual environments. Bragadin traced the evolution of the concept from its origins in Product Lifecycle Management to contemporary applications in architecture, engineering, and construction, illustrating how Digital Twins support monitoring, simulation, optimisation, and predictive analysis. The presentation distinguished between different generations of Construction Digital Twins—ranging from basic monitoring platforms (Generation 1) to smart semantic systems integrating BIM and IoT (Generation 2), up to agent-based autonomous systems (Generation 3)—thereby offering participants a clear framework to understand emerging technological trajectories.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

12

Building on this theoretical foundation, the presentation shifted to the practical implementation of the ET4Digital demonstrator, developed in collaboration with the IIPLE construction school. The pilot project consisted of the construction of a small one-storey masonry mock-up serving as the Physical Twin, paralleled by a Digital Twin incorporating a BIM model created in Revit, 3D LIDAR scans, environmental sensors, and the full set of project documents including the WBS, bill of quantities, and Gantt schedule. The implementation followed the PDCA cycle, demonstrating how Digital Twin methodologies can support systematic planning, execution, control, and refinement of construction processes in an educational context.

A central component of the demonstrator was the use of OpenProjectBIM as the Common Data Environment. The platform enabled the integration of the BIM model, LIDAR-derived point clouds, project schedules, cost breakdowns, work packages, and sensor readings. By providing functionalities such as IFC visualisation, as-planned vs as-built model comparisons, and structured documentation management, OpenProjectBIM made it possible to construct an operational Digital Twin aligned with Generation 1 capabilities and with the potential to evolve towards more advanced configurations through the combined use of BIM, IoT and data analytics.

The presentation also detailed the operational workflow adopted during development: the creation of the first Digital Twin prototype, the identification of technical and pedagogical requirements, the design of the system architecture, the installation and calibration of sensors, the collection of manual and automated data, and the integration of digital content within the CDE. While acknowledging the inherent limitations of an educational case study, the speaker emphasised its value as a realistic reference for demonstrating methodological principles and testing practical applications of Digital Twin technologies in vocational training.

In conclusion, the contribution highlighted the educational and operational benefits achieved through the implementation of the demonstrator. The Digital Twin facilitated improved situational awareness, structured information management, enhanced coordination between physical and digital activities, and a more robust connection between theoretical instruction and practical execution. For trainers and learners, the demonstrator provided a clear and tangible example of how Digital Twin approaches can be applied in construction education, offering a replicable model to support digital upskilling and innovation across VET providers and SMEs in the sector

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

13
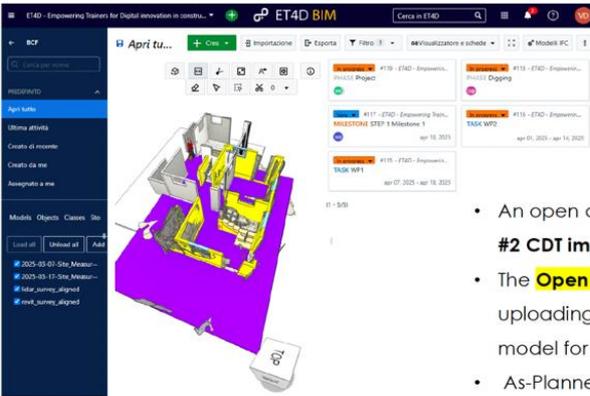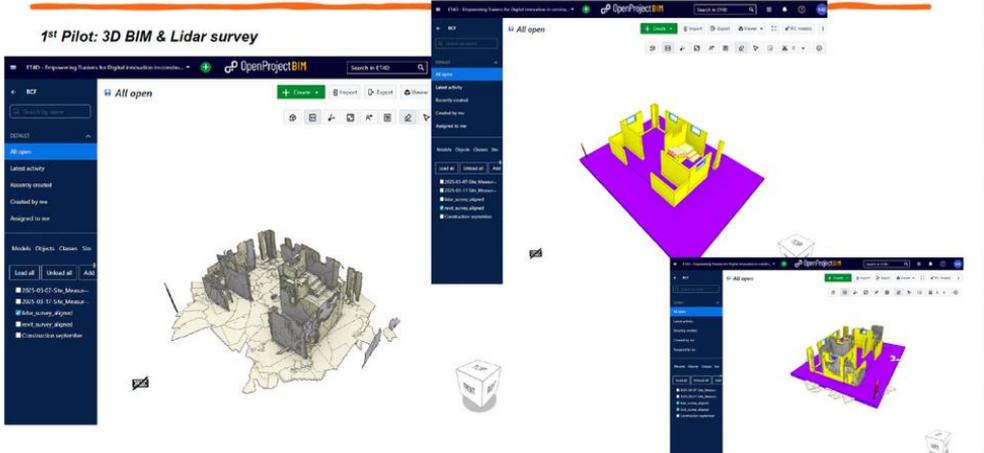
- **Andrea Ballabeni (UniBo):** *The OpenProject BIM platform* – explored functionalities and benefits of OpenProject for managing BIM-based processes.

  OpenProjectBIM constitutes the central digital infrastructure of the Construction Digital Twin demonstrator, providing the integrated environment in which geometric models, project information, sensor data and operational workflows are organised and managed. Acting as a

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

14

Common Data Environment (CDE), the platform ensures the interoperability required among the various components of the demonstrator and supports coordinated access for trainers and learners during the transnational training activities. Its role is foundational in enabling the Digital Twin to function simultaneously as a technological ecosystem and a pedagogical tool, facilitating a data-driven learning experience aligned with contemporary digital construction practices.

A key technical aspect of the demonstrator is the integration between BIM authoring tools and OpenProjectBIM. Through the Revit add-on, compatible with versions 2019 to 2022, IFC models can be exported, visualised and linked to issue-management workflows directly within the platform. This allows the Digital Twin to operate as a dynamic and continuously updated reference model, where design information, model revisions and coordination actions are systematically captured through BCF workflows and REST API interoperability. This combination ensures a structured flow of information across tools and supports collaborative problem solving within the training context.

In addition to model and data integration, OpenProjectBIM supports the full lifecycle of the demonstrator through its project-management capabilities. The platform enables the structuring of work packages, the scheduling of activities, the definition of phase gates and constraints, the visualisation of timelines through Gantt charts and calendars, and the organisation of team workloads. These functionalities allow the Digital Twin to mirror real-world construction management processes and provide trainees with a realistic simulation environment in which planning, monitoring and coordination tasks can be analysed and practised. The collaborative dimension is further enhanced through integrated documentation tools such as wikis, news modules and budget-management features.
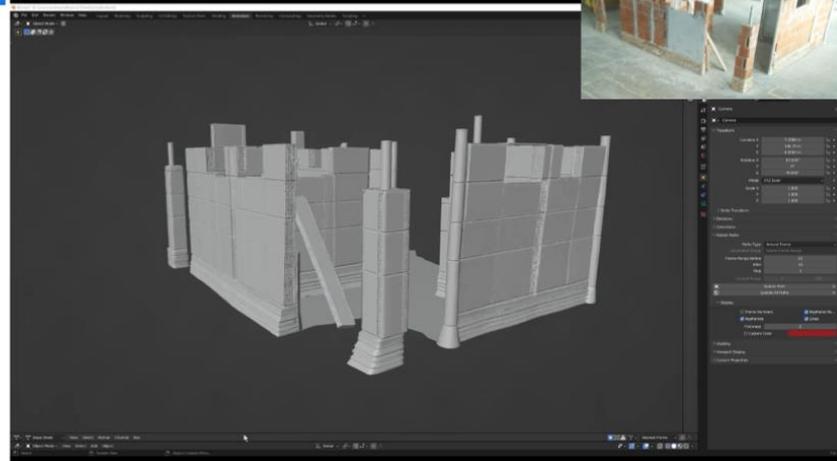
A further strategic element of the demonstrator is the integration of sensor networks into OpenProjectBIM. The system incorporates multiple sensing devices—including BME280, LTR-559, MIC-6814, PMS5003 and the Sony IMX500 AI camera—connected through Raspberry-Pi units configured to acquire environmental and visual data. The workflow includes defining a dedicated measurement work-package type within the platform, configuring custom fields and transmitting data to OpenProjectBIM via Python scripts and API calls. A dedicated Sensors Dashboard, implemented as a platform plugin, enables real-time and historical visualisation of these measurements, demonstrating how physical site conditions can be incorporated into the Digital Twin to maintain an accurate and continuously updated representation of the environment.

The technical presentation also illustrated the deployment strategies used to install and maintain the system, including Docker-based installation, Kubernetes orchestration and direct deployment on Ubuntu or Debian servers with PostgreSQL. Development, testing and production environments were established to support the progressive integration of models, APIs, sensors and dashboards, ensuring reliability throughout the implementation process.

The development work also highlighted several open challenges, such as the need for improved sensor calibration, the management of visual occlusions in image-based acquisition and the persistent gap between physical and modelled geometry. Future developments foresee the adoption of AI-based 2D-to-3D reconstruction from video

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
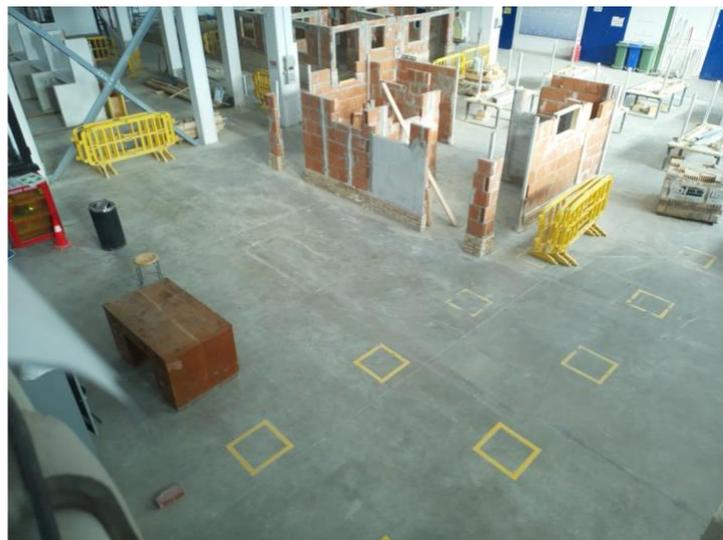PROJECT no. 2024-1-IT01-KA220-VET-000249119

15

sequences to enable dynamic geometric updates and further increase the fidelity of the Digital Twin.

Taken together, these elements demonstrate how OpenProjectBIM serves as both the organisational backbone and the integration point for BIM data, sensor readings and project-management workflows. Its use within the demonstrator supports the creation of an accurate, scalable and continuously updated digital representation of the built environment, and provides trainers with a comprehensive environment in which to explore and teach data-driven construction processes.

FUTURE IMPLEMENTATIONS – AI 2D-2-3D

VIDEO SEQUENCE

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

16

Erasmus + KA2 Action (KA220-VET-FF3D720D) co-funded by the Erasmus+ Programme of the European Union.
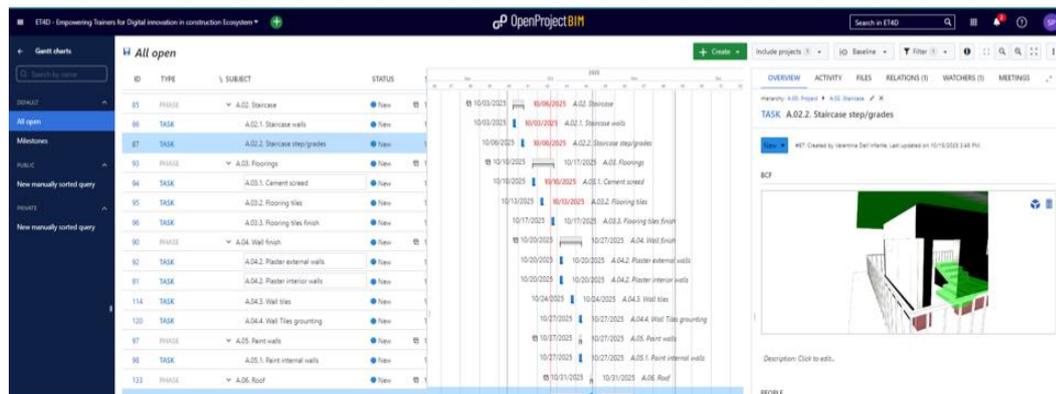
Erasmus + KA2 Action (KA220-VET-FF3D720D) co-funded by the Erasmus+ Programme of the European Union.

- **Shrinija Poudel:** *BIM Modelling for ET4 Digital Twin Implementation* – demonstrated how BIM models serve as the foundation for DT integration.

Within the framework of the transnational training, the presentation on BIM Modelling provided participants with a structured introduction to the conceptual and operational principles of Building Information Modelling, illustrating how BIM underpins the digital transition strategy adopted in the ET4Digital project. BIM was described as the digital representation of a building's

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

17

physical and functional characteristics, supporting the management of information throughout the entire lifecycle of a construction asset and enabling a consistent, data-driven approach to design, execution and facility management. The presentation clarified the advantages typically associated with BIM—including improved collaboration, higher design accuracy, enhanced visualisation, clash detection, and more reliable estimations of time and cost—while also acknowledging a set of challenges such as initial implementation costs, increased data-management requirements, interoperability constraints and the differing levels of digital readiness among stakeholders.

The presentation illustrated the notion of BIM "dimensions", explaining how information layers progressively enrich the geometric model. Starting from 2D representations, BIM evolves into 3D modelling for geometric and visual analysis, 4D modelling through the integration of scheduling data, and 5D modelling by incorporating cost estimation. These examples were demonstrated with reference to architectural transformation scenarios and project-management tools, offering participants a practical understanding of how multi-dimensional BIM information supports decision-making across project phases. The slides also introduced the concept of BIM maturity levels, emphasising the organisational and procedural aspects needed to progress from traditional drafting towards integrated, collaborative digital workflows.
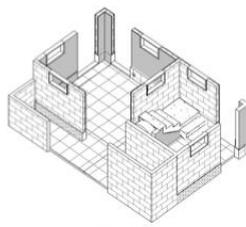
A central part of the presentation focused on the wide range of stakeholders involved in BIM-enabled processes. Participants were introduced to the distinction between technical and non-technical actors, highlighting the importance of interdisciplinary collaboration across architects, engineers, BIM specialists, project managers, contractors, suppliers, investors and regulatory authorities. The mapping of stakeholder categories underscored the need for shared digital environments to ensure coordinated communication and information exchange throughout project development.

To contextualise this requirement, the presentation examined the role of collaborative platforms in the Architecture, Engineering and Construction (AEC) sector. Two forms of collaboration environments were distinguished: model-based platforms, which rely on technical formats such as IFC, RVT or DWG and demand strict version-control procedures and advanced computational skills; and management-based platforms, centred on documentation workflows and supporting easier, cost-efficient interaction for a broader range of users. OpenProjectBIM was introduced within this framework as a management-centred collaborative environment capable of interfacing with BIM models while also supporting project-management functionalities required for the Digital Twin demonstrator.
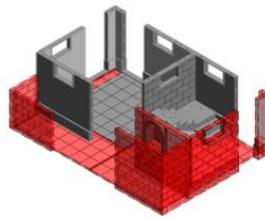
The presentation concluded with an overview of the pilot project developed for ET4Digital, demonstrating how BIM modelling and collaborative platforms converge within the overall pedagogical architecture of the demonstrator. Through this contribution, participants gained a clearer understanding of how BIM constitutes the informational and methodological foundation upon which the Digital Twin and its associated teaching activities are built, preparing trainers to integrate digital practices into VET programmes with coherence and technical awareness.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

18

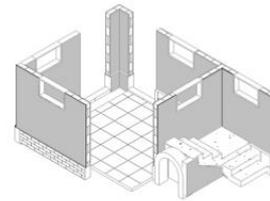3D BIM-geometry and visualisation

3D Visualizations
(Revit)

Initial Form   Partial demolition   Final Form

Erasmus + KA2 Action (KA220-VET-FF3D720D) co-funded by the Erasmus+ Programme of the European Union.

The afternoon featured a presentation of the Pilot Digital Twin and practical guidelines, complemented by a visit at IIPLE's construction site – built by IIPLE's students - to observe its application.

As the final part of the training, participants visited the laboratory where IIPLE students and teachers built the small single-storey brick model that served as a physical twin, with an explanation of the various steps taken by the students who built it.

- **Davide Coccolini (UniBo):** *Lean Construction & Sustainability* – highlighted lean principles and their synergy with digital tools for sustainable practices.

Lean Construction (LC) is a modern method to improve project delivery by reducing waste, enhancing security, and optimizing processes. It started with the broad pressures on the construction industry such as rising material costs, lack of resources, climate challenges, and new EU sustainability goals, and framed Lean as a solution to increase both environmental performance and project efficiency.

The presentation explored LC's origins in the Toyota Production System and its development through scholars research that exposed the flaws of traditional construction management. It discussed fundamental Lean principles such as the Last Planner System®, Takt Time Planning, Integrated Project Delivery, and Target Value Delivery.
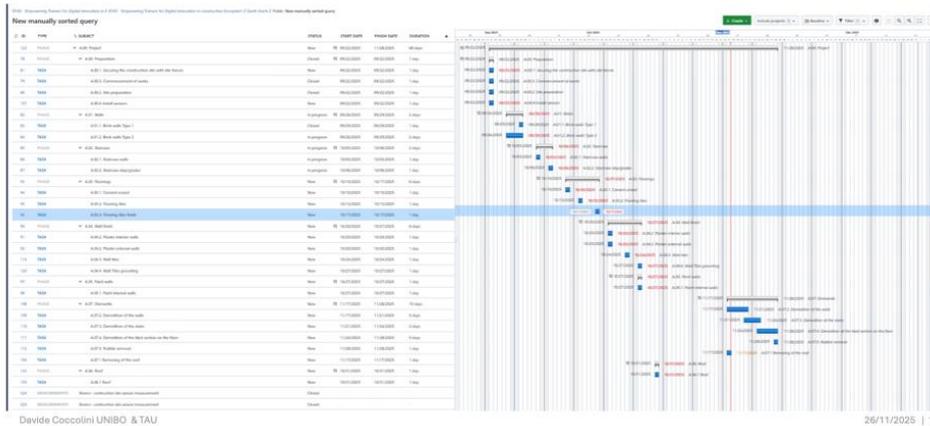
The talk focused on the current integration of digital tools into Lean frameworks, stressing how, over the last decade, digital twins, real-time collaboration, BIM-based processes, VR simulations, and generative AI have all improved Lean's ability to enable decision-making, monitoring, and continuous improvement.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

19

The contribution then connected Lean Construction directly to the ET4Digital initiative: it identified synergies - including digitalisation to decrease process waste, ongoing operator training, increased coordination using digital tools, and emissions monitoring using Lean and Green techniques. The presentation provided illustrations and practical examples to show how Lean principles support SMEs' digital transition by enhancing site procedures and fostering a culture of continuous improvement.

Overall, this session presented Lean Construction as both an organizational approach and an operational toolkit that complements BIM and digital twin technologies, hence increasing the relevance of ET4Digital's training objective.

ET4D Project (2/4) Scheduling and Learning

ET4D Project (3/4) and Lean for Teaching-Training

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

20

- **Benedetta Balzani (UniBo):** *Project Scheduling for Safety in Construction* – focused on digital scheduling techniques to enhance safety compliance.

This study addresses the management and scheduling of construction activities, with particular attention to occupational safety, which remains is a significant issue today, as demonstrated by approximately 200 fatal accidents in the construction sector in 2023.

One of the main causes of accidents is time–space conflicts, occurring when multiple activities overlap in the same location. Such conflicts can generate safety hazards, congestion, design clashes, and potential damage to equipment or structures. Mitigating these risks requires careful scheduling, coordination among workers, and the implementation of safe operating procedures. Consequently, various methodologies have been developed over the years to manage interference risks.

The approach proposed in this thesis integrates spatial and temporal management and was applied to the restoration of the Covered Market of Forlì, a historical two-story building. The ground floor remains operational for commercial activities, while the first floor is being converted into administrative offices. The study demonstrates that worker safety and site efficiency can be achieved through systematic project scheduling and strategic allocation of total float.

The method involves eight phases:

1) Context analysis: identifies potential hazards due to the proximity of the construction site to active commercial areas.
2) Location Breakdown Structure (LBS): assigns codes to work areas to detect spatial conflicts.
3) Work Breakdown Structure (WBS): categorizes activities into 4 macro-areas (demolition, structural works, systems, and construction works).
4) Activity duration estimation.
5) Creation of the PDM network: integrates spatial and temporal information, including crew movements.
6) Clash matrix: highlights potential interference zones.
7) Identification of the clashes: importing the network into MS Project to generate a Gantt chart and detect conflicts.
8) Optimization using total float allocation.

The analysis identified key conflicts, including obstructed crew movements and excessive number of simultaneous activities relative to available resources and storage areas. Optimization using total float ensures that overlapping activities are rescheduled by adding link delays, maintaining both safety and operational efficiency.

This approach provides comprehensive project control, enabling detailed evaluation of individual activities while preserving overall site efficiency. Although resource-intensive for

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

21

complex projects, the methodology supports future digital automation, combining initial manual planning with software-assisted monitoring of interferences.
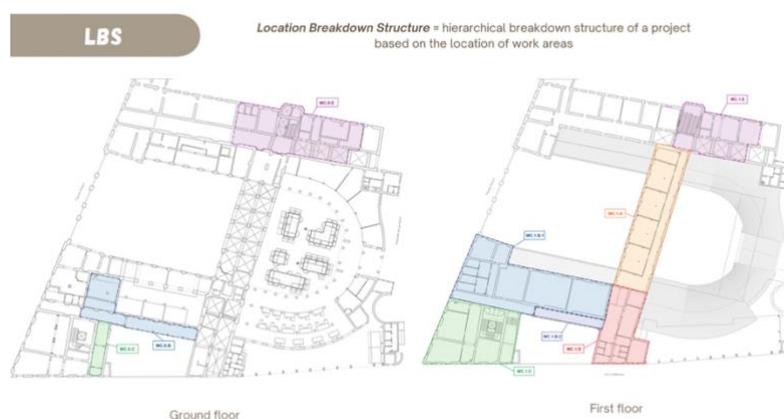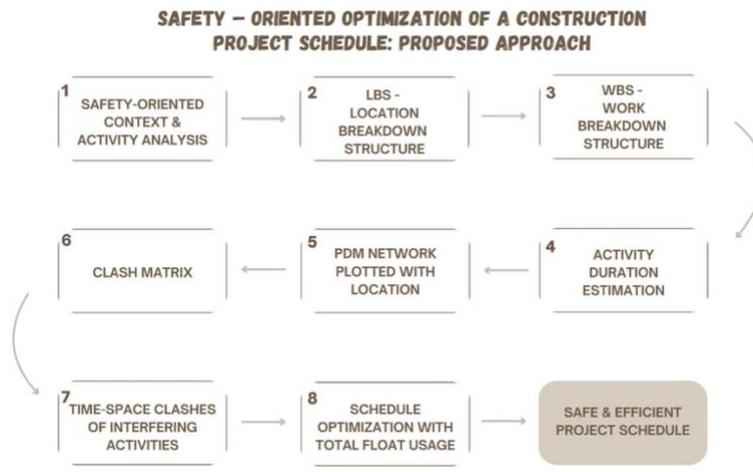
- **Vanessa Assumma (UniBo):** *Value Analysis of Construction Projects* – discussed methodologies for assessing project value in digital contexts.

Professor Assumma introduced Value Analysis as a strategic and holistic approach for improving decision-making in construction projects. It started by explaining the multifaceted nature of "value," which varies across stakeholders and changes over time. Drawing on academic sources, the presentation emphasised that value emerges from the balance between fulfilling needs and the efficient use of resources.
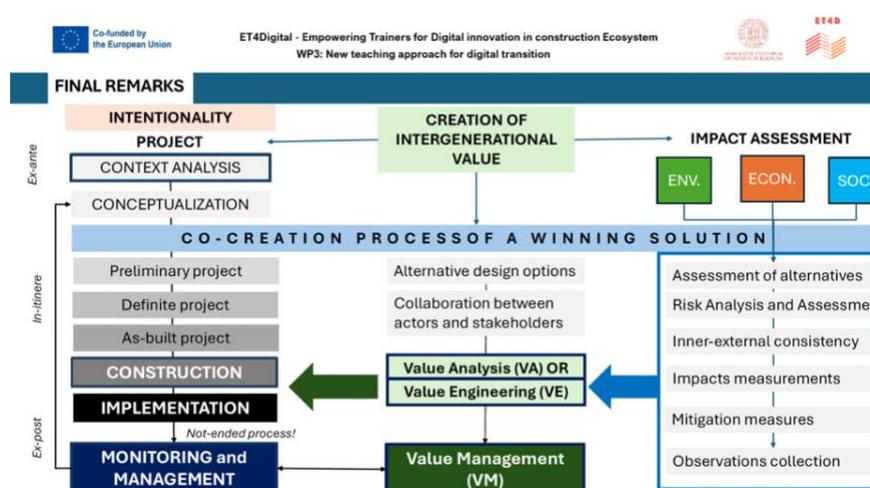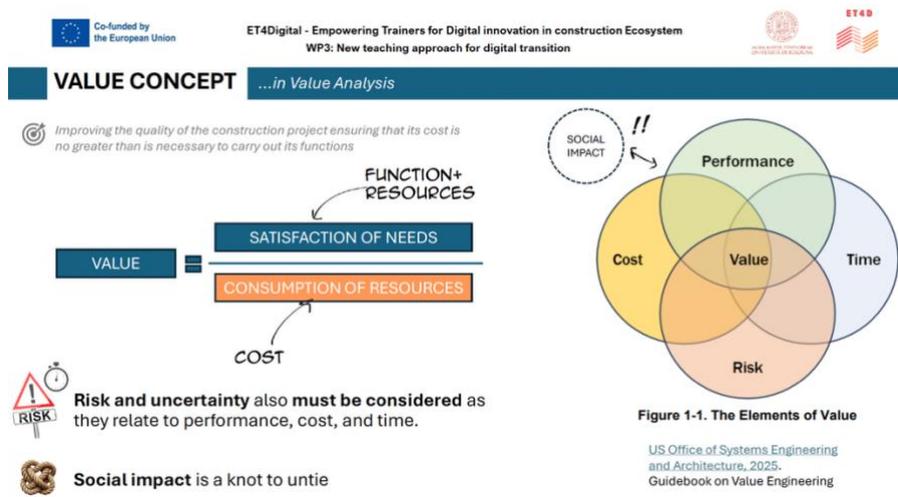
The contribution highlighted key pressures that complicate value creation today, especially project delays, increasing safety risks, fluctuating material prices, and mismatches between actual performance and EU-required quality standards.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

22

It also illustrated the widespread challenges of keeping Italian construction sites on schedule, demonstrating the urgency of new evaluative methods.

The British Standard BS EN 12973 was presented as a framework for organisations seeking to strengthen value culture, improve productivity, support innovation, and integrate value-based decision-making across teams. This aligns with the ET4Digital objective of equipping trainers with advanced evaluative tools.

The presentation then reviewed a broad set of decision methods (namely, BIM, LCA, LCC, MCDA, WBS, risk analysis, cost-benefit evaluations) that can support value-oriented project assessments. It provided particular attention to Multicriteria Decision Aiding (MCDA), unpacking its structure, problem typologies, and participatory nature (with activities like surveys, interviews, and focus groups).

This contribution equipped trainers with frameworks to understand value in construction more broadly—beyond cost optimisation—and to teach decision-making skills that align with sustainability, societal expectations, and digital transformation pathways.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

23

The second day focused on hands-on experience and collaborative learning. It began with a live demonstration of the Digital Twin (CDT) Pilot Construction, followed by a hands-on workshop at the IIPLE IT lab, where participants completed CDT-based activities under the guidance of the University of Bologna team. This session allowed participants to directly experience the Digital Twin environment and the OpenProjectBIM platform on which the demonstrator is based, and to better understand its application in training contexts.

The day concluded with a presentation by **Luca Vitale** (TOUCHlabs) entitled "**Synergies between Digital Twins and Augmented Reality in Practice**." The presentation explored how Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) can be integrated with Digital Twin systems to improve usability, visualization, and decision-making. TOUCHlabs presented cutting-edge solutions integrating immersive technologies into industrial and commercial workflows, delivering measurable improvements in efficiency, cost reduction, and innovation.

Particular emphasis was placed on the role of digital twin technology in enabling real-time monitoring, predictive maintenance, and optimization through virtual replicas of physical assets. The opening keynote highlighted how VR/AR solutions can support layout design, ergonomic testing, and operational simulations, while improving knowledge retention and significantly reducing training and operating costs. By creating a strong sense of presence and real-time interaction, these tools effectively connect the physical and digital environments.
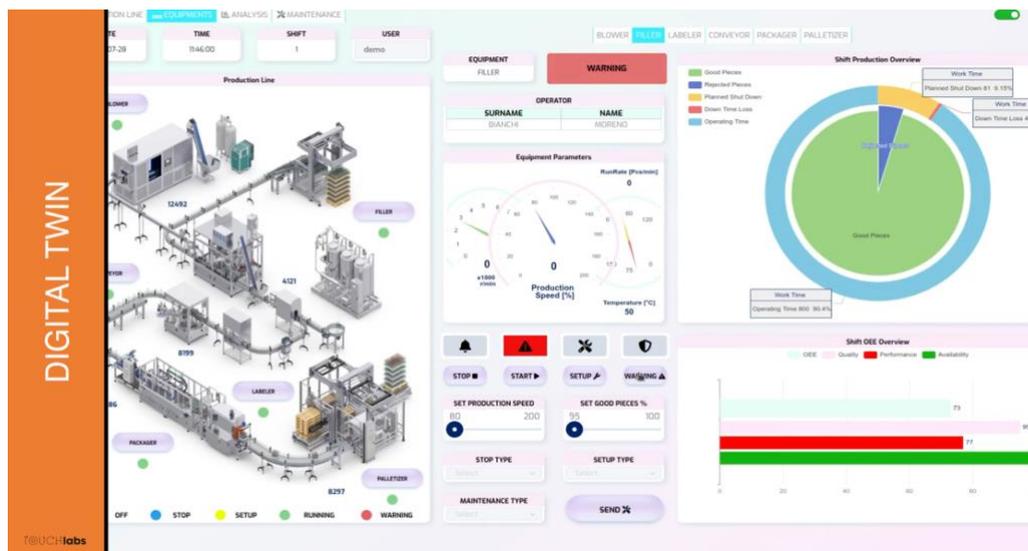
In the afternoon session, the focus shifted to opportunities for practical integration between digital twin technologies and immersive tools in the construction industry. The presentation illustrated concrete use cases and discussed the importance of overcoming barriers related to accessibility, usability, and replicability to ensure effective adoption in training and professional practice.

The event concluded with closing remarks from the organizing partners, who reiterated the strategic importance of digital and immersive technologies in shaping the future of training and skills development in the construction sector.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

24

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

25

Validation of Demonstrator for didactic purposes

Post training feedback form

An insightful feedback and discussion sessions allowed for reflection on the training outcomes. Participants evaluated the overall training quality as excellent, with clear objectives and an adequately planned agenda. The material was deemed extremely relevant to professional contexts, particularly for professionals involved in construction, project management, and digitization activities.
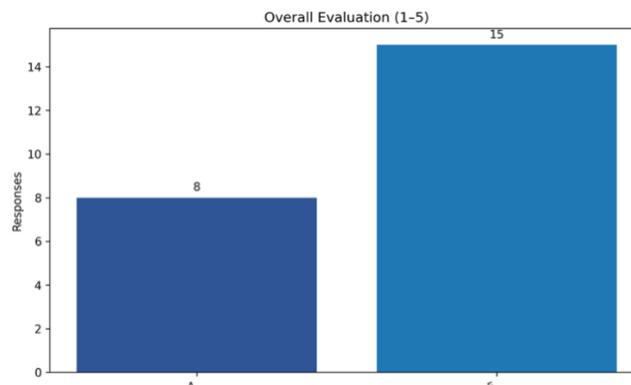
The content of the feedback form spaced from general to more technical questions about the activities involved, as listed here:

- Overall quality of the training programme
- Clarity of training objectives
- Coherence and structure of the agenda (presentations, CDT demo, workshop, AR session, site visit)
- Relevance of training content to your professional context
- Session that contributed most to your learning
- Aspects of the training to be improved
- Clarity of the Digital Twin process (Digital twin ↔ Physical Twin)
- Understanding of the steps required to develop a DT from a real project
- Most challenging step (Open-ended)
- Confidence in explaining the process to others
- Effectiveness of the Digital Twin demonstrator
- Clarity of sensor usage for detecting and tracking elements
- Most valuable feature of the demonstrator
- Additional technologies needed to complete the digitalisation process
- Usefulness of the CDT workshop (learning-by-doing)
- Did the practical session help you understand CDT implementation?
- Clarity of instructions provided during the workshop
- Main challenges encountered during CDT practice (Open-ended)
- Use of OpenProjectBIM during the training
- Usability of the platform
- Feature used
- Technical issues encountered
- Effectiveness of BIM–DT integration
- Understanding of DT for real-time monitoring / control
- Ability to link BIM objects to WBS / cost elements

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

26

- Upload or interaction with 3D models
- Format used
- Usefulness of linking tasks to 3D elements for sequencing
- Suggestions for improving OpenProjectBIM or the Digital Twin demonstrator
- Preparedness to support digitalisation in SMEs after the training
- Ability to replicate the Digital Twin process in your organisation
- Resources or tools needed for replication
- Confidence in training others on Digital Twin / OpenProjectBIM
- Additional skills required to feel fully autonomous
- Do you plan to integrate this content in your future courses or activities?
- Likelihood of implementing DT-based activities within 6 months
- Usefulness of this approach for digitalisation in SMEs
- Potential of DT for SMEs (cost, efficiency, control)
- SME processes that may benefit most
- Overall evaluation of the training (1–5)
- Would you recommend this training to other trainers/professionals?
- Topics to be included in future training activities (Open-ended)
- Additional comments and suggestions

The feedback collected from participants across multiple partner organizations demonstrates a strong appreciation for both the general structure and technical depth of the transnational training. Overall satisfaction was high, with 65% of respondents rating the training 5/5 and 35% assigning 4/5, and 96% stating they would recommend the programme to other professionals. These figures confirm that the event met expectations in terms of relevance and quality.

At the end of the training of trainers, the demonstrator developed by UNIBO with contributions from all project partners, was validated.
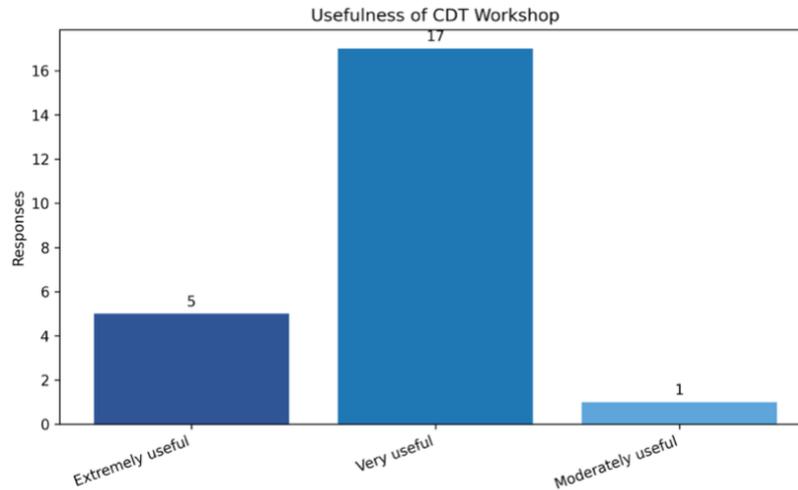

Overall Evaluation (1–5)

Understanding of the Digital Twin Demonstrator

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

27

A key objective of the training was to ensure participants understood the Digital Twin (DT) concept and its practical implementation. Results indicate this goal was largely achieved: 96% of participants reported they understood the steps required to develop a DT from a real project either completely or sufficiently, while only one respondent indicated partial understanding. Similarly, 91% confirmed that the practical session helped them grasp CDT implementation, reinforcing the importance of hands-on activities. Clarity was also rated positively, with 61% describing the DT process as "very clear" and 39% as "fairly clear".

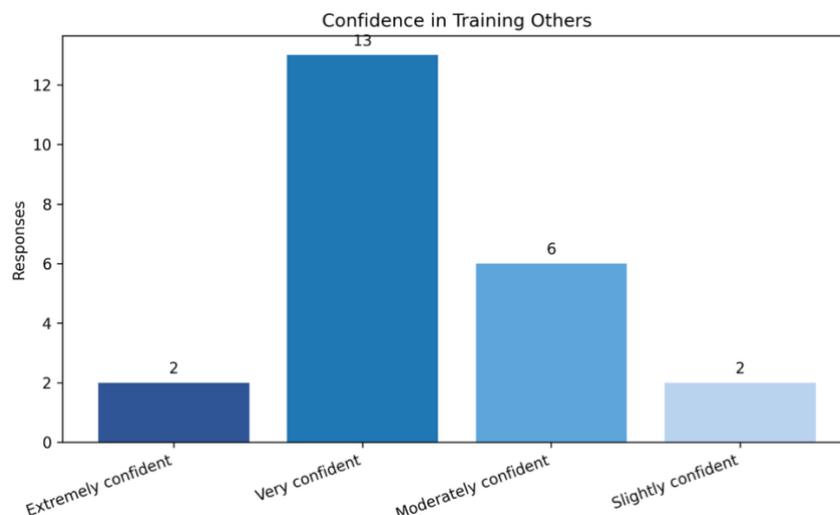Understanding Steps to Develop a DT (n=23)
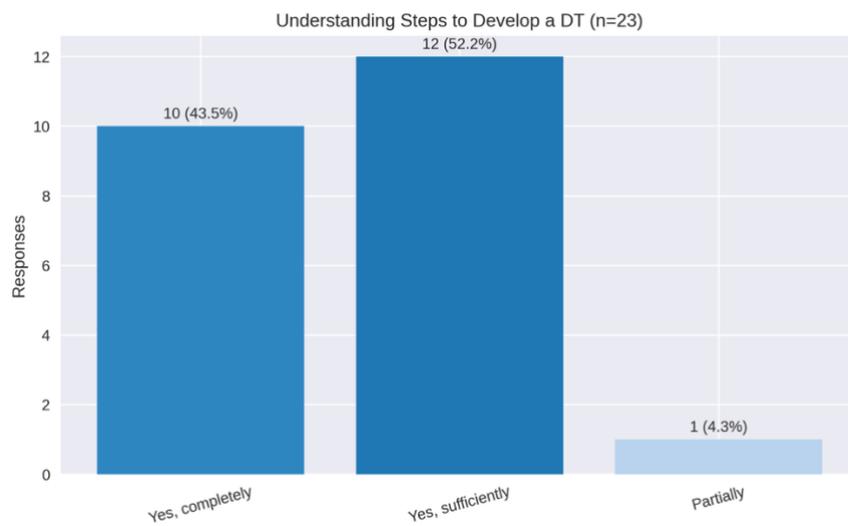
Perceived Usefulness and Technical Effectiveness

The demonstrator and associated tools were widely considered effective and valuable. 87% of respondents rated the Digital Twin demonstrator and BIM–DT integration as "very" or "extremely effective", while the CDT workshop was highlighted as a cornerstone of learning: 96% found it "very" or "extremely useful". Beyond the workshop, the approach was seen as relevant for broader digitalisation goals, with 43% rating it "very useful" and 57% "moderately useful" for SMEs, and 57% perceiving high potential for cost, efficiency, and control improvements. These figures underscore the strong alignment between the training content and participants' professional contexts.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

28

Usefulness of CDT Workshop

The combination of presentations, CDT demonstrations, and hands-on workshops was praised for its practical approach. The CDT Workshop (hands-on) and CDT Demonstration (Day 2) were consistently ranked as the most impactful sessions, as they allowed participants to put theoretical principles into reality, strengthening their comprehension of DT implementation. Most participants claimed a clear understanding of the Digital Twin process, including the steps required for developing a DT from real projects.

Confidence in explaining the procedure to others varied from moderate to highly confident, showing significant knowledge acquisition. The DT workshop was rated as highly to extremely helpful, with most participants agreeing that the practical session helped them grasp CDT implementation. This is consistent with one of ET4D's primary goals, which is to provide real and replicable access to existing digital technologies that are frequently overlooked owing to a lack of sufficient training, particularly among SMEs.

Confidence in Training Others

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

29

The OpenProjectBIM platform was used during the training, and the majority of participants assessed the usability as easy or very easy. The integration of BIM and DT was regarded as very to highly effective, and participants displayed a strong comprehension of real-time monitoring and control. Participants demonstrated willingness to promote digitalization in SMEs, with the majority feeling moderately to highly prepared.
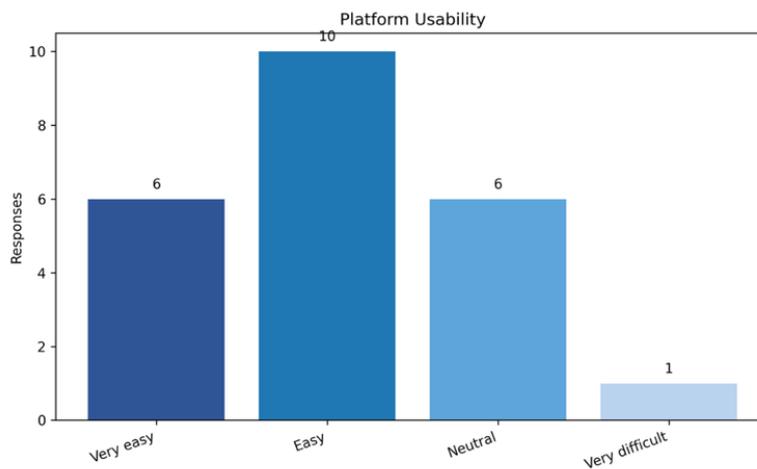
The majority of respondents indicated that they could reproduce the DT procedure in their organizations. IFC models, servers, user-friendly guidelines, and extra practice time were all regarded as key resources for replication.

Most respondents intend to integrate the training content into future courses or activities, with a strong possibility of implementing DT-based activities within the next six months. The method was deemed extremely beneficial for SME digitization, with substantial possibilities for cost reduction, efficiency, and process monitoring. Project control, planning, and lifecycle management were identified as the SME processes that would benefit most.
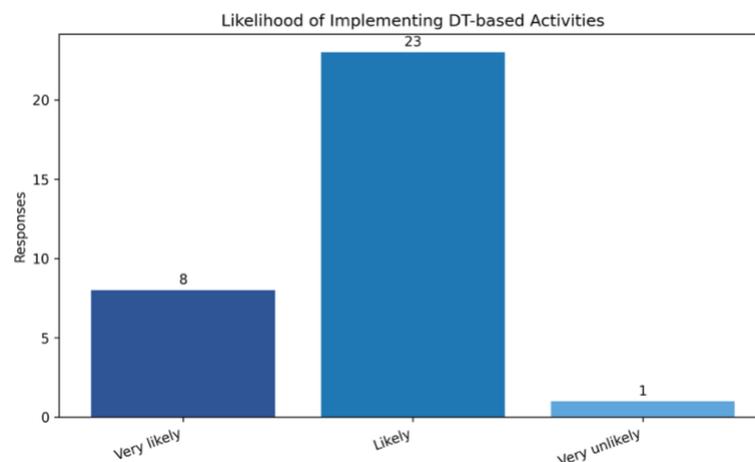
Finally, every participant acknowledged they would suggest the program to other professionals. Overall, the training earned high marks, and the event successfully blended academic knowledge with practical application, developing skills critical to furthering digitalisation in the construction sector. Feedback questionnaires were completed by 23 participants.

Core Training Contributions and Supporting Resources for Digital Twin Replication

During the Transnational Training for Trainers, participants were introduced to the key methodological and technical elements necessary to understand, implement and replicate the Digital Twin demonstrator within VET environments. The interventions delivered by the main speakers covered the essential methodological and technical components of the Digital Twin demonstrator, including its conceptual foundations, BIM-based modelling workflow, sensor integration architecture, and the role of OpenProjectBIM as a Common Data Environment. All presentations were recorded in full and will form an integral part of the guidelines to be provided to trainers and educators. These video resources, together with the accompanying documentation, will support VET providers in replicating the Digital Twin demonstrator within their own educational contexts, ensuring that they have access to clear, structured and comprehensive instructions on how to adapt and implement the system according to their training needs.

Key outcomes and conclusions

The implementation of Work Package 3 (WP3) within the ET4Digital project resulted in a number of significant achievements that enhance the project's aim of empowering trainers as catalysts for digital innovation in the construction industry.
The first significant result is the development of a standardised, practice-oriented training paradigm aimed at reducing the gap between theoretical knowledge of digital technologies and their actual implementation in construction workflows. This paradigm combines BIM, IoT/sensors, AR/VR, and Digital Twin technologies to provide coherent learning paths that allow trainers to connect with real-world applications such as site monitoring, energy and comfort analytics, safety assessments, and workflow optimisation.

A second important accomplishment is the creation and comprehensive documentation of an educational demonstrator, a Construction Digital Twin (CDT) environment that combines BIM models, real-time sensor data, and immersive technology. The demonstrator, developed by the University of Bologna in collaboration with all partners and tested on an educational construction site built by VET students, provides a controlled but realistic environment in which trainers can safely

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

31

experiment with digital workflows. The supporting documentation contains technical design scenarios, onboarding materials, setup guidelines, and troubleshooting tools, lowering adoption barriers and allowing replication by other VET centres across Europe.

Another important outcome was the successful validation of the training model at a transnational training session attended by trainers, coordinators, and technical specialists from six partner countries. The two-day training in Bologna featured expert-led presentations, live demonstrations of the Digital Twin, and hands-on exercises. Feedback from participants confirms the training's effectiveness: 96% reported that the CDT workshop significantly improved their understanding of Digital Twin implementation, 87% rated the BIM-DT integration as highly effective, and all participants stated that they would recommend the program to others. Participants also showed high confidence in implementing the demonstrated processes in their institutions, with many planning to include CDT-based activities into future training courses within six months. These results give strong evidence of learning progress and transfer-to-practice intentions.

Collectively, these results show that WP3 successfully translated analytical insights into practical training solutions that were validated through real-world application, laying a solid platform for scalable digital capacity building in the construction industry.

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

32

ET4Digital

Empowering Trainers for Digital Innovation in construction Ecosystem

PROJECT no. 2024-1-IT01-KA220-VET-000249119

ET4Digital – Empowering Trainers for Digital Innovation in construction Ecosystem
PROJECT no. 2024-1-IT01-KA220-VET-000249119

33