

Research Article

# Assessing the Quality of an Innovative Learning Path for BIM Education: The DIGITAL DECATHLON

Gisella Calcagno<sup>1</sup> , Sharina Alves<sup>2,\*</sup> , Gregor Grunwald<sup>2</sup> 

<sup>1</sup>Department of Architecture, University of Florence, Florence, Italy

<sup>2</sup>Department of Architecture, Jade University of Applied Sciences, Oldenburg, Germany

## Abstract

The Erasmus+ funded project DIGITAL DECATHLON addresses the urgent need to modernize educational practices in the construction industry, especially in the field of Building Information Modeling (BIM). This study investigates how interdisciplinary, international and game-based learning can improve the BIM skills of students from different academic backgrounds and institutions in Europe. The study investigates whether an immersive simulation game involving students from five universities in Germany, Finland, Italy and Poland can effectively develop BIM skills and promote international and intercultural collaboration. The research uses a mixed methods approach that includes observational analysis, expert evaluations and surveys to assess the effectiveness of learning methods used in the game, to exploit for the optimization of the second game experience foreseen by the project. The results show that the simulation successfully engages students and improves their practical BIM skills. Nevertheless, there are areas that need improvement. Key challenges include harmonizing disciplines, improving the understanding of project management and ensuring consistent and equal communication between teams. These findings emerge from both qualitative feedback and quantitative performance data. This makes it clear that the existing simulation game is well suited to teaching the basics of the BIM methodology, but that some improvements are still needed, which will be incorporated in a second run, again subject to evaluation for capitalization and future replication.

## Keywords

Building Information Modeling, Education, Design Competition, Serious Game, Evaluation

## 1. Introduction

As at global level, the run towards digitization is central in the European Union, where it is considered as the precondition to sustain the parallel and urgent green transition. The EU ambitious Green Deal, the Fit for 55 Package and the Circular Economy Action Plan are just some examples of the highly value given to digital technologies and tools to support the sustainability goals, with the green and digital transition act-

ing in synergies. The digital transformation within the construction industry necessitates that employees acquire new skill sets to meet evolving requirements. Building Information Modeling (BIM) is at the heart of this transformation, playing a pivotal role in reshaping the whole industry.

BIM has been officially introduced in EU by the Directive 2014/24/EU on Public Procurement, as a tool to improve ef-

\*Corresponding author: [sharina.alves@jade-hs.de](mailto:sharina.alves@jade-hs.de) (Sharina Alves)

**Received:** 5 September 2024; **Accepted:** 25 October 2024; **Published:** 29 October 2024



Copyright: © The Author(s), 2024. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

iciency and transparency. Notwithstanding this common background, the BIM adoption in the EU is still jeopardized, revealing a wide range of standards and levels of implementation [1]. Given the communitarian will to create a common EU workspace, it is imperative that all EU universities innovate education to adequately prepare students for the new professional landscape, ensuring that graduates are equipped with the necessary competencies to thrive in a digitized and European construction environment.

The Erasmus+-funded DIGITAL DECATHLON (DD) project exemplifies an innovative educational approach designed to address contemporary challenges in construction education [2]. The core of the project is an interdisciplinary simulation game that introduces students in the application of the BIM methodology. It must be noted that the project idea and format come from previous project experiences developed by the German partners, such as the BIM Game [3, 4]. Enlarging to a European scale, the DD involved students from the five project partners Jade University of Applied Sciences (Germany), Karelia University of Applied Sciences (Finland), University of Florence (Italy), University of Warsaw (Poland) and University of Wuppertal (Germany). Given the spirit and the nature of the Erasmus+ funding program, the project highly promotes international connections and intercultural skills, supporting the creation of a European community, starting from the young generation of students.

The simulation game is carried out twice during the project period. The first round has been completed, so that the following research questions are now to be answered:

- 1) How effectively does the DD promote interdisciplinary collaboration and digital skills in the field of BIM through the use of gamification and international teams?

- 2) What optimization strategies can be derived from the first round of the DD to make future competitions more successful?

## 2. The Digital Decathlon Project

The following is a brief summary of the content and procedure of the simulation game. More detailed information has already been published [5-8].

The core objective of DD is to offer students a gaming experience to learn collaborative and interdisciplinary design processes by leveraging the full potential of BIM across ten distinct disciplines / BIM use-cases (Table 1).

A total of 25 students took part in the first round of the project. It corresponded to the duration of a semester and was characterized by three main events. At the start event in Wuppertal (Germany), the participants got to know each other, were divided into international groups of five, and received an introduction to the topic of BIM, the disciplines and the task. Here, they had the opportunity to develop and present an initial concept design and the strategy to approach the various disciplines. At home, they continued their collaboration and fully developed their project. The homework was interrupted by the midterm event at which the groups presented their interim results online. The game finished with the final event at the Med Green Forum in Florence (Italy), where the groups presented their final results to a jury. The winning project was chosen, and the competition finished with an awards ceremony.

The design task of the game, to approach in a full BIM environment, was to transform a logistics center in Wuppertal (Germany) into a multifunctional cultural center.

**Table 1.** Digital Decathlon disciplines and Learning Objectives.

Discipline	Learning Objective
D01 Architecture	Develop a design idea/spatial program in a 3D model with corresponding visualization (2D)
D02 Construction	Design timber wall elements in IFC and native format
D03 MEP	Develop a proposal for a building services solution and prepare a BIM model for HVAC system
D04 Model Checking	Test the quality of models through selected software
D05 Design Coordination	Understand the multi-branch coordination process and use BIM coordination software in IFC and BCF format
D06 Construction Scheduling	Manage and represent time in a construction project digitally
D07 LCA	Understand LCA calculations, rules and databases and use LCA calculation tools
D08 Simulation	Perform different environmental simulations (energy, indoor daylight and solar radiation) with authoring software
D09 Construction Product Traceability	Carry out BIM-based building documentation using selected software

Discipline	Learning Objective
D10 Reporting	Reflect on own work, document progress, summarize complex issues, communicate appropriately

The game uses simulation, competition and mentoring as teaching methods to encourage collaborative learning between students from different disciplines. The simulation method emphasizes rapid immersion in practical tasks, moving from short theoretical lectures to hands-on BIM modeling activities that simulate real-world challenges [9]. The simulation is run as a competition, motivating students through clear assessment criteria that ensure consistent and objective evaluation [10]. The additional mentoring offered provides personal guidance and promotes a positive error culture that normalizes problem solving and prepares students for real-life scenarios [4].

### 3. Evaluation Methodology

Given the innovative nature of the DD digital learning format and serious game approach, a special attention has been dedicated by the project team to a systematic evaluation, with the overall objective to guarantee the quality of the learning path. The evaluation methodology has been structured to cover all the project's phases, foreseeing two cycles of evaluation parallel to the two competitions, with the objective to learn lessons from the first in order to improve the second; moreover, the overall two-cycles evaluation allows to define a final document on the lessons learned, highlighting benefits and criticalities for capitalization and future replication. This structure consented to define and have control on the quality in terms of continuous improvement, consistent results and resources maximization, adopting a scientific method of change (e.g. Deming cycle). To have a complete picture of the project and learning path, three typologies of evaluations have been developed according to the responsible actor groups, as in the following paragraphs.

#### 3.1. Expert Evaluation

Two external experts are involved in the evaluation of the project. One of these experts, who conducts research in the field of BIM and game-based learning, is evaluating the DD project as a whole, while the other expert evaluated the learning management in particular. These results can also be used for the further development of the simulation game. The qualitative survey is carried out via non-participatory and open self-observation. The data collection procedure is predominantly unsystematic, direct and unmediated [11]. In preparation for the observations carried out during the three

events, a catalog of key questions was drawn up. Observations were noted for these key questions, and these were then interpreted and evaluated. The results can be seen as supplementing or underlining the results of the surveys.

#### 3.2. Teacher Evaluation

The evaluation of the students' work was not only based on the determination of a winning team, but also to determine how successful the students were in the various disciplines. Each discipline is divided into its subtasks (Table 2) and evaluated by the jury members (two persons from each partner university and one external jury member with practical expertise in the field of BIM) on the basis of the learning objectives, the provided learning material, the design task and the mini-EIR (Exchange Information Requirements). The scoring is based on the Rubrics evaluation [12], corresponding to 1 - limited application of concepts and methods, 2 - basic understanding with some application, 3 - solid understanding with effective application and 4 - advanced understanding with strategic and categorical application.

*Table 2. Digital Decathlon disciplines and Assessment Criteria.*

Discipline	Assessment Criteria
D01 Architecture	Inventiveness
	Appropriateness and Contextual
	Integration
	Model design and spatial representation
D02 Construction	Visual and constructive strength
	Appropriate selection of types of wooden elements
	Feasibility and compatibility
	Explanation
D03 MEP	Design decisions
	HVAC concept
	Water and sewerage systems
	Electrical / lighting and BEMS
D04 Model Checking	3D model quality
	Test completeness of test report
	Description of the individual issues
	Use of new rules
D05 Design Coordi-	BEP

Discipline	Assessment Criteria
nation	BIM quality assurance and control reports BIM coordination reports
D06 Construction Scheduling	Construction sequence video Correct sequence and grouping of technological elements
D07 LCA	Realistic LCA calculation results in the report Realistic energy performance
D08 Simulation	Efficient positioning of solar renewable system Verification of indoor visual quality Simulation data
D09 Construction Product Traceability	Selection of objects for documentation Number and quality of linked objects
D10 Reporting	Frequency of posts in social media Contents Layout Presentation

### 3.3. Student Evaluation

As principal target group of the DD project, students have been asked to provide feedback about their experience in the innovative and pilot DD learning path. This has been done throughout online surveys (Google Form platform). Students' feedback was collected in the three evaluation moments, at the beginning, at the midterm and at the end of the competition. Based on the same evaluation criteria, the sequential surveys have been intended to capture the initial aspirations of students, to assess their work-in-progress experience, and to obtain a final comprehensive evaluation.

Six evaluation criteria were defined as surveys' sessions to assess the overall quality of the DD learning path: 1. BIM adoption: heart of the DD, both as object of learning and tool for the development of the design proposals; 2. Learning Quality: considering the learning in 10 DD disciplines in terms of knowledge, skills and competencies; 3. Digital Environment: evaluation of the DD digital infrastructure supporting learning and collaboration (e.g. Moodle and Common Data Environment); 4. Design Competition: quality of the design competition launched in the context of the DD, with the design task encompassing the 10 disciplines; 5. Collaboration and Support: level of collaboration between students in the implementation of the competition; support refers to the level of interaction between students and trainers; 6. Value for the Future: impact of the DD on the students' academic path and future professional life. According to the criteria, a set of questions were defined for each of the three

sequential surveys, specifically formulated to capture the evolution of the project in the students' experience.

## 4. Results and Analysis

### 4.1. Results of the Expert Evaluation

The observations have produced many findings that can be condensed into the following points resulting recommendations in the area of learning management.

Providing students with a more comprehensive map to contextualize and interconnect the disciplines could enhance their understanding and foster more independent exploration. This would reduce disorientation among participants and enable them to navigate the simulation with greater confidence.

Ensuring a balanced focus across all disciplines can improve the overall learning experience. While the strong emphasis on D01 demonstrates student engagement, encouraging a more even distribution of attention will provide a more holistic educational experience.

Integrating additional training on the principles of project management could greatly benefit the students. By equipping them with these essential skills, we can enhance their efficiency and effectiveness within the simulation, thereby enriching their overall learning experience.

Introducing further control mechanisms, such as mandatory joint appointments with mentors, can facilitate smoother cooperation within teams. This proactive approach can help identify and address challenges early on, promoting a more collaborative and supportive team environment.

To ensure consistent and equitable communication, adhering to the agreed communication tool, and adding a chat function can be highly beneficial. This will standardize the information dissemination process, ensuring all students receive the same guidance and support, regardless of their group or nationality.

The learning materials and software solutions provided effectively supported students, with the identified gap in D05 suggesting the integration of a CDE solution to improve the efficiency and quality of collaboration and promote students' digital competences.

### 4.2. Results of the Teacher Evaluation

The results of the students in the individual disciplines are rather heterogeneous. Certain disciplines such as D03, D04 and D07 seem to be more difficult for students than others such as D02, D08 and D10 (Figure 1). This means that, on average and considering the standard deviation, students' learning successes mostly remain at level 2, which corresponds to a basic understanding. A basic understanding of the

application of the BIM method can be regarded as a successful result in the context of the research project, as it represents a first playful and practical introduction to the topic for the students. However, the disciplines D03, D05 and D07 need to be considered in more detail here to ensure a basic understanding among the participants in future game runs.

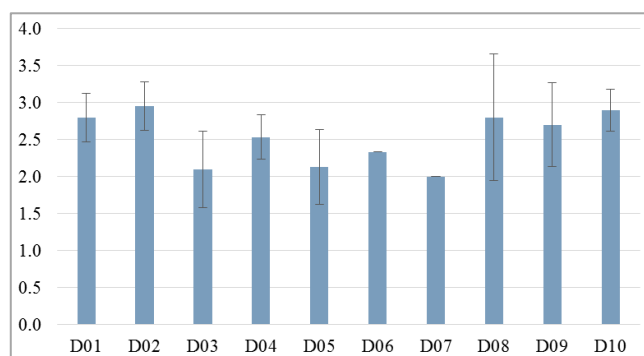


Figure 1. Evaluation of participants' performance: Disciplines.

When examining the performance of the teams, the ratings exhibit a high degree of similarity. The range between the lowest and highest ratings is merely 0.16 points (Figure 2). Additionally, the standard deviation for all teams' hovers around 0.5, further underscoring the consistency in performance across teams. These observations suggest that the teams were relatively equally proficient across all disciplines.

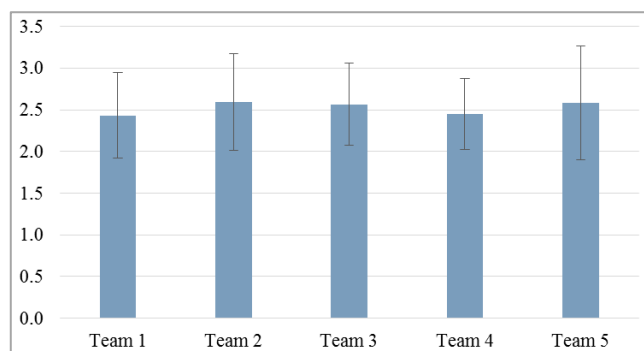


Figure 2. Evaluation of participants' performance: Teams.

### 4.3. Results of the Student Evaluation

The majority of students involved in the DD participated in the evaluation surveys (starting survey: 19/25 answers received; midterm survey: 16/25; final survey: 18/25).

The initial survey revealed a very high interest of students on BIM, together with a common positive consideration (Figure 3); at the same time, it revealed variety in the pre-existing knowledge of students, mainly referring to low levels. More than half of the surveyed students (63%) reported

to not having received any specific training on BIM; students who instead participated in previous BIM learning paths referred to very different typologies of attended courses. In the midterm, it was possible to assess the efficacy of the BIM introductory course (prepared by the University of Wuppertal), while in the final survey the majority of students (more than 70%) considered improved their BIM skills.



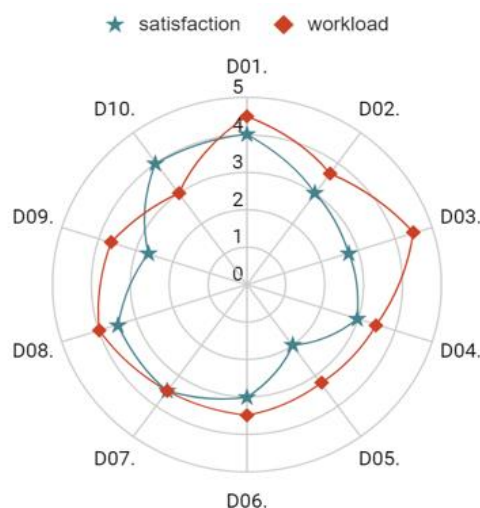
Figure 3. Words cloud visualization of students' answers on BIM consideration.

Answers received from students in the initial survey revealed that the proposed novel learning format highly stimulated a positive attitude and feeling, with students recognizing the opportunities in improving international collaboration and exchange, BIM skills, interdisciplinary understanding, language proficiency and confidence, matching the ambitions of the trainers. When inquiring about their competences and interest levels in the 10 proposed disciplines, the responses varied significantly; therefore, students were given the freedom to choose the two disciplines they wished to focus on within their team. In the midterm and final surveys, students were asked to provide feedback about the prepared learning material, suggestions for improvement and their perception on the effective workload. Students appreciated the "click tutorial" format of the learning material (consisting in step-by-step guidelines, considered as "satisfactory"), but also asked for more interactive formats, such as video tutorials and more traditional frontal lectures. At the end of the competition, they considered the workload too much intensive, referring to the D01 Architecture, D03 MEP and to the energy simulation in D08, but in general they declare a good level of satisfaction with the developed work in most disciplines (Figure 4).

Regarding the digital environment, students referred to a low experience in this kind of learning (mainly adopted during the Covid period), expressing the need for clearer guidance. They suggested different ways to improve the digital environment (Moodle), such as a Q&A page with the most asked questions and chat-boxes with tutors. It must be noted that the main critical points were referred to the BIM operative/working digital environment, and not to the learning one.



Students encountered difficulties in handling the numerous software and plug-ins required to manage and exploit the BIM model, in terms of interoperability and workflows, asking for the creation of a comprehensive list/picture of programs/platforms and their specific intended uses.



**Figure 4.** Students' evaluation of the DD disciplines, in terms of satisfaction and workload.

Some critical points emerged in the design competition: whereas students were highly excited in taking part in international and interdisciplinary working teams, considered as an "opportunity to more advanced stuff in comparison to basic university courses", the design task has been considered as time consuming and difficult to conduct "not in presence". In particular, students recognized the problem of dependency within the disciplines, expressing concern with tasks that rely on others' completion (e.g. slow development of D01 Architecture).

Similarly, some issues emerged in the section collaboration and support about the interpersonal experience. While considering stimulating teamwork as preparation for professional life, students noticed the different commitment among team members and varying levels of experience and BIM competencies, which led to demotivation and sometimes pressure. Moreover, given the difficulties in conducting a smooth and integrated design process, students suggested to foresee one tutor for each group (avoiding the adopted system of "on request" revisions) with whom there is regular consultation.

All the students agreed on the value of the participation to the DD for the future, as innovative and valuable experience to highlight in their curricula and in their future professional life.

## 5. Discussion

In the light of the applied evaluation methodology and results, comprehensive of the contribution of external experts, DD trainers and students, it is possible to delineate some focal points, presenting at the same time positive and negative aspects:

- 1) Intercultural dimension: Working in international teams gives students an unique opportunity to improve soft skills, English proficiency, intercultural inclusion, and a common European spirit, matching the objectives of the Erasmus + projects;
- 2) Interdisciplinarity: The involvement of students from different disciplines promotes a comprehensive understanding of BIM and simulates real project environments. At the same time, the lack of experience in interdisciplinary teamwork resulted in a timid development of a truly integrated project, and in the over attention and engagement solely in architectural aspects;
- 3) Cooperation and management: even if the experience of interdisciplinary and international team working has a greater potential for the preparation of future professionals, it requires basic project management skills, comprehensive of mechanisms of control and support;
- 4) Practical application: The rapid involvement of students in practical BIM modeling activities after short theoretical introductions promotes effective learning. Conversely, the immersion in the practical work resulted in the lack of comprehensive orientation, with students having difficulties in linking the disciplines and understanding the overall context of the project;
- 5) Gamification through competition: The simulation of a design competition motivates students and ensures consistent assessment based on predefined criteria. Yet, some students do not catch the game approach, experiencing performance anxiety and receiving pressure from the more motivated teammates.

Based on these findings, some practical suggestions have been derived to improve the second foreseen competition:

- 1) New concept for BIM pre-course: A mandatory pre-course or a more intensive introduction to the individual disciplines could ensure that all students start the project with the necessary basics;
- 2) More comprehensive introduction and orientation: Develop a guide to help students in understanding integrated projects and the link between the different disciplines;
- 3) Ensure balance between disciplines: Encourage a more even distribution of attention across all disciplines to create a balanced learning environment, with distributed responsibilities and engagement, such as a fair distribution of the workload;

- 4) Strengthening project management skills: Integrate additional training on project management principles to improve efficiency and coordination within teams;
- 5) Early intervention in team dynamics: Introduction of regular joint meetings with mentors to promote collaboration and recognize team problems at an early stage. discussion.

## 6. Conclusions

The DD project has shown that interdisciplinary, international and game-based learning can improve basic BIM skills.

Valuing the contributions of DD actors (trainers and students), combined with an external perspective, the proposed evaluation methodology enables control over the innovative learning path and facilitates its progressive improvement, adaptation and optimization over time, both within the project and beyond, for future replication, consolidation and capitalization. The optimization process begins with the development of the second competition, which will also be subject to the same evaluation procedure. Findings from the evaluation of the first competition significantly influence the preparation and organization of the second one, which will involve twice the number of participating students (50). For example, given the main objective of preparing the young generation of students for the digital professional future, there is a shift towards emphasizing BIM methodology and technology in the competition, rather than the design process. This adjustment aims to balance the workload and avoid overemphasis on architecture, thereby preserving the interdisciplinary contribution.

The ongoing effort is to improve the prototypical serious game learning format to such an extent that it can be used to prepare future student to the digital and collaborative requirements of the construction industry, essential to support the green transition of future sustainable buildings and cities.

## Abbreviations

BIM Building Information Modeling  
DD DIGITAL DECATHLON

## Acknowledgments

This contribution is the result of the collective results achieved by the Digital Decathlon team, composed by: Grunwald Gregor, Zeisberg Loreen, Alves Sharina, Holtermann Sebastian, Christian Heins (Jade University of Applied Sciences); Laakkonen Ossi, Matveinen Mikko (Karelia

Ammattikorkeakoulu), Czmoach Ireneusz, Piotr Bartkiewicz, Dudzińska Emilia (Politechnika Warszawska); Meins-Becker Anica, Kelm Agnes (Bergische Universität Wuppertal); Calcagno Gisella, Bertelli Matteo, Trombadore Antonella, Pierucci Giacomo (Università degli Studi di Firenze).

## Author Contributions

**Gisella Calcagno:** Methodology, Investigation, Formal Analysis, Data curation, Writing – original draft, Writing – review & editing

**Sharina Alves:** Methodology, Investigation, Formal Analysis, Data curation, Writing – original draft, Writing – review & editing

**Gregor Grunwald:** Project administration, Resources, Supervision, Validation

## Funding

The creation of these resources has been (partially) funded by the ERASMUS+ grant program of the European Union under grant no. 2022-1-DE01-KA220-HED- 000086134. Neither the European Commission nor the project national funding agency DAAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.

## Conflicts of Interest

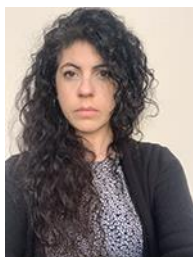
The authors declare no conflicts of interest.

## References

- [1] Mitera-Kielbasa, E., Zima, K. BIM Policy Trends in Europe: Insights from a Multi-Stage Analysis. *Applied Sciences*. 2024, 14(11). <https://doi.org/10.3390/app14114363>
- [2] Digital Decathlon Website. Available from: <https://digitaldecathlon.projekt.jade-hs.de/index.html> (accessed 30 June 2024).
- [3] Grunwald, G., Heins, C. BIM Game: A Testing Ground for Specifying, Modelling, Evaluating, and Visualising Information in IFC Formats. In *Proceedings of the 5th International Conference on Civil Engineering and Architecture*, Singapore, 2022; pp. 677–688. [https://doi.org/10.1007/978-981-99-4049-3\\_52](https://doi.org/10.1007/978-981-99-4049-3_52)
- [4] Heins, C., Grunwald, G., Helmus, M. Gamification and BIM: The Didactic Guidance of Decentralised Interactions of a Real-Life BIM Business Game for Higher Education. In *Proceedings of the 38th ISARC*, Dubai, UAE, 2021; pp. 932–939. <https://doi.org/10.22260/ISARC2021/0126>

- [5] Grunwald, G., Alves, S., Bertelli, M., Calcagno, G., Czmocho, I., Dudzinska, E., Heins, C., Hollermann, S., Kelm, A., Kokkonen, J., Laakkonen, O., Matveinen, M., Meins-Becker, A., Piotr, B., Trombadore, A., Zeisberg, L. Building BIM Competence: Learning in the DIGITAL DECATHLON. In Sayigh, A., Trombadore, A., Calcagno, G., Eds., GETTING TO ZERO. Beyond Energy Transition Towards Carbon-Neutral Mediterranean Cities. Selected Papers from the World Renewable Energy Congress Med Green Forum 2024. Chennai, India: Springer Nature; 2024 (in publication).
- [6] Calcagno, G., Bertelli, M., Grunwald, G. The Digital Decathlon: A Journey in Building Information Modelling Education. In Proceedings of the International Conference of Contemporary Affairs in Architecture and Urbanism – ICCAUA, Alanya, Turkey, 2024 (in publication).
- [7] Grunwald, G., Hollermann, S., Kawasaki, J. BUILD DIGITAL. BUILD BETTER. The “Digital Decathlon” a European Erasmus+ Project. In Proceedings of 2023 JSEE Annual Conference, Hiroshima, Japan, 2023; pp. 2–5. [https://doi.org/10.20549/jseer.2023.0\\_2](https://doi.org/10.20549/jseer.2023.0_2)
- [8] Zeisberg, L. BIM Practice and Experience: Digital DECATHLON. In Luhmann, T., Sieberth, T., Eds., Photogrammetrie Laserscanning-Optische 3D-Messtechnik – Beiträge der 21. Oldenburger 3D-Tage, Berlin/Offenbach, Germany: Wichmann Verlag; 2024.
- [9] Özener, O. Ö. Context-based learning for BIM: simulative role-playing games for strategic business implementations. In Smart and Sustainable Built Environment, 2024, 13(4), pp. 908-933. <https://doi.org/10.1108/SASBE-08-2022-0184>
- [10] Aibinu, A. A., Evelyn, T. A. L., Rojas-Quintero, J. S., Hosseini, M. R., Dey, C., Taban, R., Ahmad, T. Using gamification and competitions to enhance BIM learning experience. In BIM Teaching and Learning Handbook, New York, NY: Routledge, 2022, pp. 305-324. <https://doi.org/10.1201/9780367855192-24>
- [11] Byrman, A. Social Research Methods. 4th ed. Oxford, UK: Oxford University Press; 2004.
- [12] Preskill, H., Russ-Eft, D. Building Evaluation Capacity: Activities for Teaching and Training. 2nd ed. Los Angeles, CA: Sage; 2016.

## Biography



**Gisella Calcagno** is an architect, MSc and PhD, with expertise in green and socially responsive architecture. She graduated from the University of Florence (Unifi), where she also completed a postgraduate interuniversity master's degree in bioecological architecture and innovative technologies for the environment. Her PhD research focused on the impact of the architectural and urban space on the vulnerable population of asylum seekers. Since 2020, she has been working at beXLab (building environmental eXperience, Unifi) on the application of Digital Twins to support awareness in sustainable building/urban renovation projects, and as project manager for several EU projects. Expert in environmental design, she is lecturer in bioclimatic and green architecture at Unifi and in the international Master SUArch (Sustainable Architecture, with International University of Rabat, Morocco). Contract professor in traditional/innovative textile fibers for the Textile and Fashion Design program (Unifi).



**Sharina Alves** is a research associate at the Jade University of Applied Sciences at the Institute for Database-Oriented Engineering. She completed her M.Eng. in Management and Engineering in Construction in 2019 and subsequently worked in the field of technical building management and computer aided facility management. She is currently a PhD student researching Building Information Modeling in Facility Management and game-based learning. She is a lecturer for infrastructural facility management and information management and is involved in various research projects on BIM, serious gaming and digitization of small and medium-sized enterprises in construction.



**Gregor Grunwald**, Prof. Dr.-Ing. is an architect. He received his diploma in architecture from the Technical University of Aachen. He completed his doctorate at the Technical University of Berlin in 2007. After ten years of professional experience in the construction industry, gained in the planning and construction management of major international projects, he was appointed Professor of Building, Planning and Construction Management at the Jade University of Applied Sciences in Oldenburg in 2018. Here he teaches architecture students in the bachelor's and master's degree programmes in the fields of building design, construction management and digital planning.

## Research Field

**Gisella Calcagno:** Sustainable architecture, green buildings, environmental design, energy efficiency, building renovation, ethic design, digital twin, comfort and wellbeing, social awareness, people engagement

**Sharina Alves:** Facility management, building information modeling, game-based learning, computer aided facility management, artificial intelligence in civil engineering, lean construction

**Gregor Grunwald:** Building Information Modeling, Setup and Training of Artificial Intelligence, Artificial Intelligence in Architecture, Robotic Process Automation, Digital Twins, Augmented Reality in Design Processes, Parametric Design, Membrane Structures, Pre-fabricated, modular building units, Didactic in Architecture