

Lecture Notes in Civil Engineering

Maria Rosário Oliveira

Diogo Ribeiro

João Carlos Gonçalves Lanzinha

Eduardo Linhares Qualharini *Editors*

Proceedings of CIRMARE 2025

VII International Congress on Recovery,
Maintenance and Rehabilitation
of Buildings

 Springer

BIM and Digitalization in Heritage Rehabilitation

Application of BIM (Building Information Modelling) and Digital Twins (DTs) in the Lifecycle Management of Bridges and Viaducts	229
<i>Felipe Mantuano, Glauco José de Oliveira Rodrigues, and José Guilherme Santos da Silva</i>	
Assessment of the São Gonçalo Viaduct Project (RJ-104) Based on the Use of BIM (Building Information Modelling) Methodology	241
<i>Bruno Pedro Nadal, Glauco José de Oliveira Rodrigues, Luiz Octavio de Souza Bueno Oliveira, and José Guilherme Santos da Silva</i>	
BIM and Structural Diagnostics Analysis: State of the Art and Future Perspectives	253
<i>Zsolt Szűrös, Ádám Bukovics, Kitti Ajtayné Károlyfi, and Mohammad K. Najjar</i>	
Digital Collaboration and BIM-Based Reality Capture: A Case Study from KEA's 5th Semester Architectural Technology and Construction Management Programme	268
<i>João Luis Pereira de Sá and Pablo Hector Gonzalez Alfaro</i>	
Current Perspectives on Heritage Building Information Modeling (HBIM) in Latin America: A Review	280
<i>Thiago Ribeiro da Paixão, Cristiano Saad Travassos do Carmo, Hannah Mariah Carvalho Coutinho, and Renata Gonçalves Faisca</i>	
BIM-Enabled Strategy for the Digital Integration of Laboratory Data	292
<i>F. Andrade, C. Ribeiro, R. Santos, Rosário Oliveira, and Diogo Ribeiro</i>	
Advanced 6D BIM Framework for Energy Performance Optimization: HVAC System Enhancement in Commercial Buildings	301
<i>Rodrigo Betim, Maria João Falcão Silva, and Fernando Pinho</i>	
Modelling Techniques for Gothic Built Heritage: An HBIM Case Study of the Founder's Chapel, Batalha Monastery	313
<i>Gabriel Sugiyama, Fernanda Rodrigues, and Hugo Rodrigues</i>	
BIM-AR Applications for Urban Planning: A Proposal for the Portuguese Context	323
<i>J. Torcato Almeida, Mário Coelho, José Granja, and Miguel Azenha</i>	



Advanced 6D BIM Framework for Energy Performance Optimization: HVAC System Enhancement in Commercial Buildings

Rodrigo Betim¹ , Maria João Falcão Silva² , and Fernando Pinho¹

¹ FCT-NOVA, Lisbon, Portugal
r.betim@campus.fct.unl.pt

² LNEC, Lisbon, Portugal
mjoaofalcao@lnec.pt

Abstract. Integrating Building Information Modeling (BIM) with energy analysis supports the validation of sustainable rehabilitation strategies, offering benefits to building owners, stakeholders, and managers. This study presents a case involving a large commercial building, detailing the development of an energy-focused BIM model. Key steps included incorporating thermal and regulatory parameters into the design, assigning thermal characteristics to materials, generating an energy simulation model, and validating it using actual utility consumption data. The validation process guided design adaptations based on the building's new functional requirements and enhanced thermal load assessments. The HVAC system's performance was influenced by external heat gains, occupancy, and space typology. Comparative analysis of energy consumption and cost per square meter showed that the proposed rehabilitation scenario, adapted to new space usage, was less energy-efficient than the existing configuration. The modeling software offered strengths in user interface, component integration, and flexibility in adjusting energy parameters and space types. However, limitations in accurately representing real-world occupancy and space usage affected the model's reliability, posing challenges in validating both existing and proposed energy scenarios. In summary, while BIM-based energy modeling provides valuable insights for sustainable retrofitting, current software limitations in simulating real conditions can hinder the accuracy and applicability of energy performance evaluations.

Keywords: BIM · Energy retrofitting · Buildings rehabilitation · Commercial buildings · HVAC systems

1 Introduction

Buildings account for around 40% of total energy consumption in Europe, and account for a third of global greenhouse gas emissions [1]. Rehabilitating is to make buildings more efficient, allowing them to achieve several objectives simultaneously, either by reducing energy consumption and greenhouse gas emissions, or by increasing the useful life of buildings, with consequent profitability of environmental resources already invested [2, 3].