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FAIR 3D HERITAGE
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Formalising documentary provenance for unbuilt heritage: implementing source paradata in bSDD for an HBIM reconstruction framework

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Abstract

This paper presents an interoperable HBIM workflow for documenting and virtually reconstructing Giovanni Antonio Antolini's triumphal arch in Faenza, a Napoleonic urban proposal conceived in 1797 and never fully realised.

The study addresses a key issue in current 3D cultural heritage research: how to make virtual reconstructions of lost or unbuilt architecture transparent, semantically structured, and reusable within open digital infrastructures.

In line with current debates on standards, metadata, paradata (Denard, 2009; Kuroczyński, Apollonio, Bajena, & Cazzaro, 2023; López-Menchero & Grande, 2017; Münster et al., 2024), and the long-term preservation of 3D heritage data (Bajena & Kuroczyński, 2025; "DFG 3D-Viewer," 2007; "WISSKI Infrastructure," 2008), the paper argues that hypothetical reconstruction should be understood not solely as a geometric output but as a documented knowledge system in which each reconstructed element is explicitly linked to its evidential basis.

The Faenza case study is particularly suitable for this purpose because it combines architectural, urban, and documentary complexity (Bertoni, 1978; Scotti, 1989). Antolini's project included not only the triumphal arch but also a broader reconfiguration of the *extra-moenia* area along the Via Emilia, with porticoed residential buildings, a circular square around the monument, gardens, tree-lined walks, leisure pavilions, canals, and an English garden.

The project survives today only through heterogeneous documentary traces, including historical drawings, plans, descriptive texts, and later critical studies.

Previous research has already demonstrated the relevance of HBIM for reconstructing this lost urban fragment and for connecting the 3D model to archival sources and metadata. Building on that foundation, this paper proposes a further methodological step: the formal implementation of paradata based on a source classification taxonomy within the buildingSMART Data Dictionary (bSDD) to structure the source corpus semantically and connect it to the HBIM environment (Giovannini & Bono, 2026; Sanseverino & Giovannini, 2026b).

The proposed workflow is source-driven and unfolds in two complementary environments. First, the available documentary corpus is identified, digitised, metadatafied, and

interpreted through a classification process based on IDOVIR (Grellert, Wacker, Bruschke, Clausen, & Beck, 2026; Grellert, Wacker, Bruschke, Stille, & Beck, 2023). In this phase, source categories such as technical drawings, written documents, cartographic materials, and other documentary resources are mapped to bSDD classes, properties, and controlled values, enabling semantic interoperability and machine-readable description (Sanseverino & Giovannini, 2026c). Second, the HBIM model is developed as a geometric and informative environment in which reconstructed components are linked to the relevant documentary references. Rather than assigning reliability or certainty as fixed values from the outset, the workflow uses LoRef (Giovannini, 2017) as a primary epistemic layer that records which sources support each architectural element; only in a later analytical phase can reliability, consistency, or interpretative distance be assessed on the basis of the typology and completeness of those references.

The paper argues that this approach is particularly valuable for unbuilt and lost heritage, where the scientific validity of the reconstruction depends less on geometric precision alone than on the explicit management of paradata and provenance. By integrating IDOVIR, bSDD, and HBIM, the Faenza case becomes a scholarly, critical 3D edition in which archival evidence, interpretative modelling, and semantic description are brought together within a single openBIM framework. The outcome is not only a virtual reconstruction of Antolini's project but also a reusable documentation model that supports transparency, interoperability, and future web-based dissemination of 3D cultural heritage data. In this sense, the paper contributes to the wider discussion on sustainable 3D infrastructures by proposing a replicable method for documenting the evidential structure of virtual reconstructions in cultural heritage.

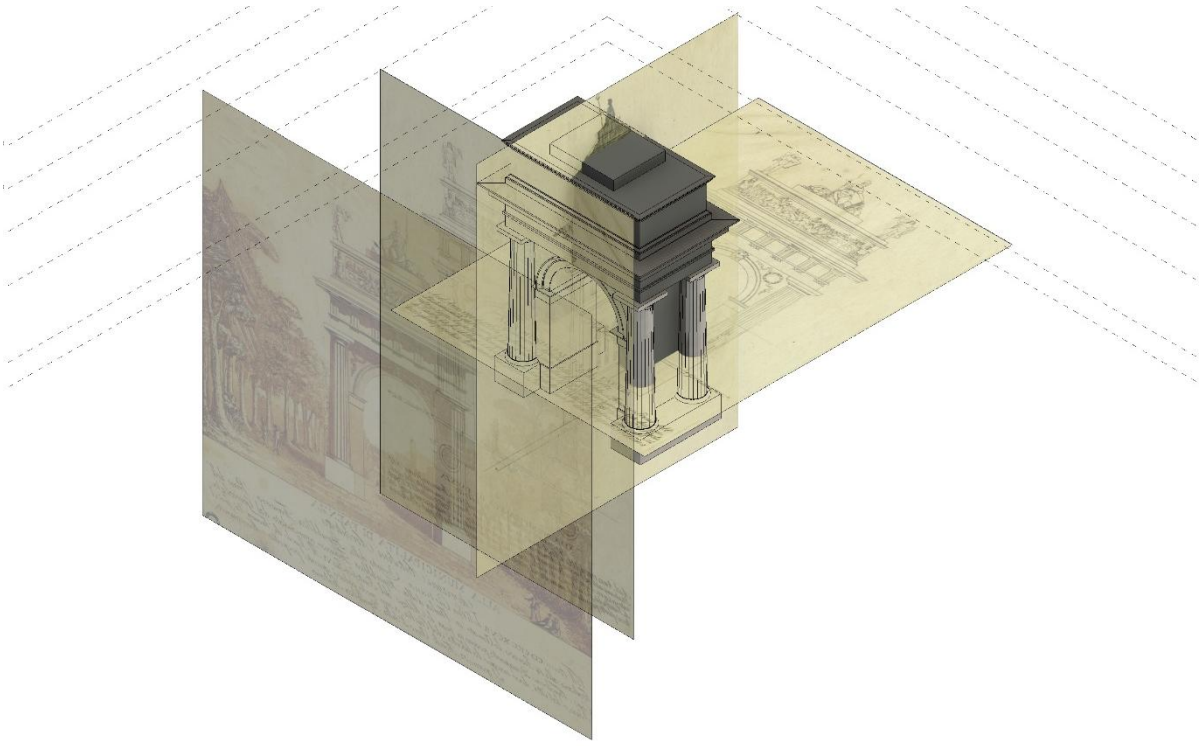


Fig. 1. 3D FAIR HBIM model with reference sources implemented through surfaces modelled as "adaptive families" with parametric width and height. The sources are displayed thanks to ad-hoc generated materials, named according to the IDOVIR Taxonomy (Grellert et al., 2026).

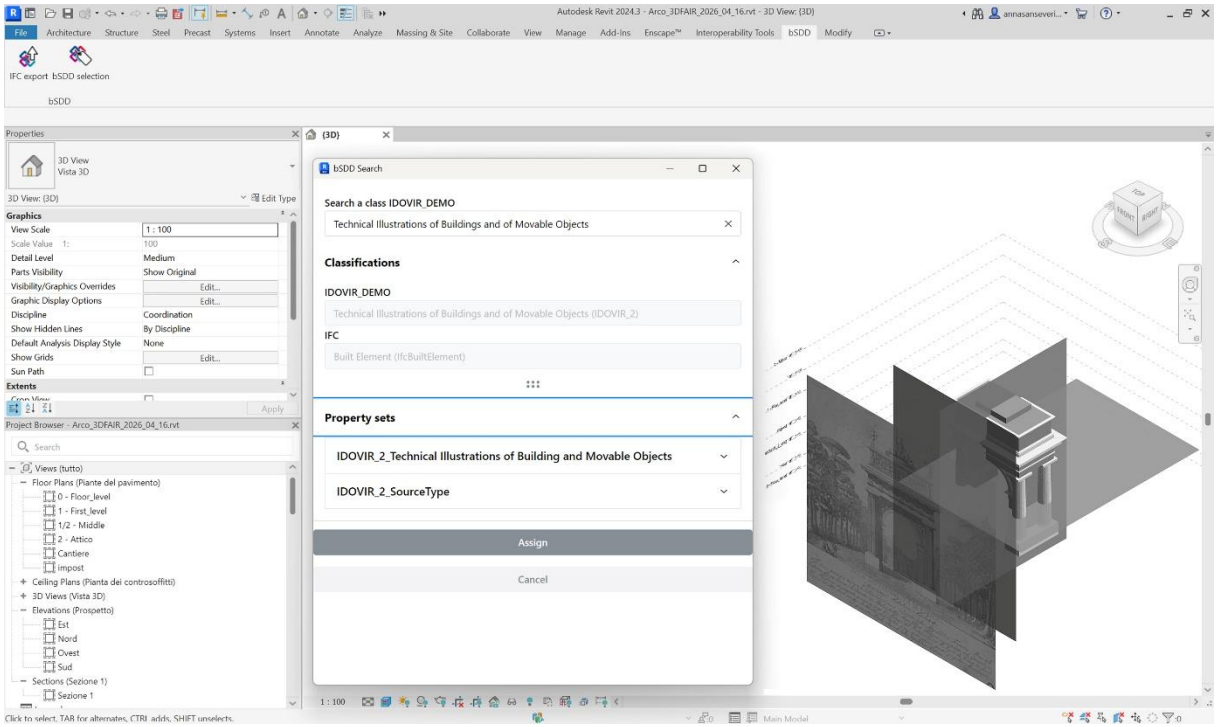


Fig. 2. The demo IDOVIR bsDD (Sanseverino & Giovannini, 2026c) has been structured into seven classes based on the seven primary categories (Grellert et al., 2026). Specifically, the second class –"Technical Illustrations of Buildings and of Movable Objects"– was further populated via two groups of properties: "IDOVIR_2_SourceType" –containing all the possible source types for the category– and "IDOVIR_2_Technical Illustrations of Building and Movable Objects" –containing the attributes and a URL to the source–.

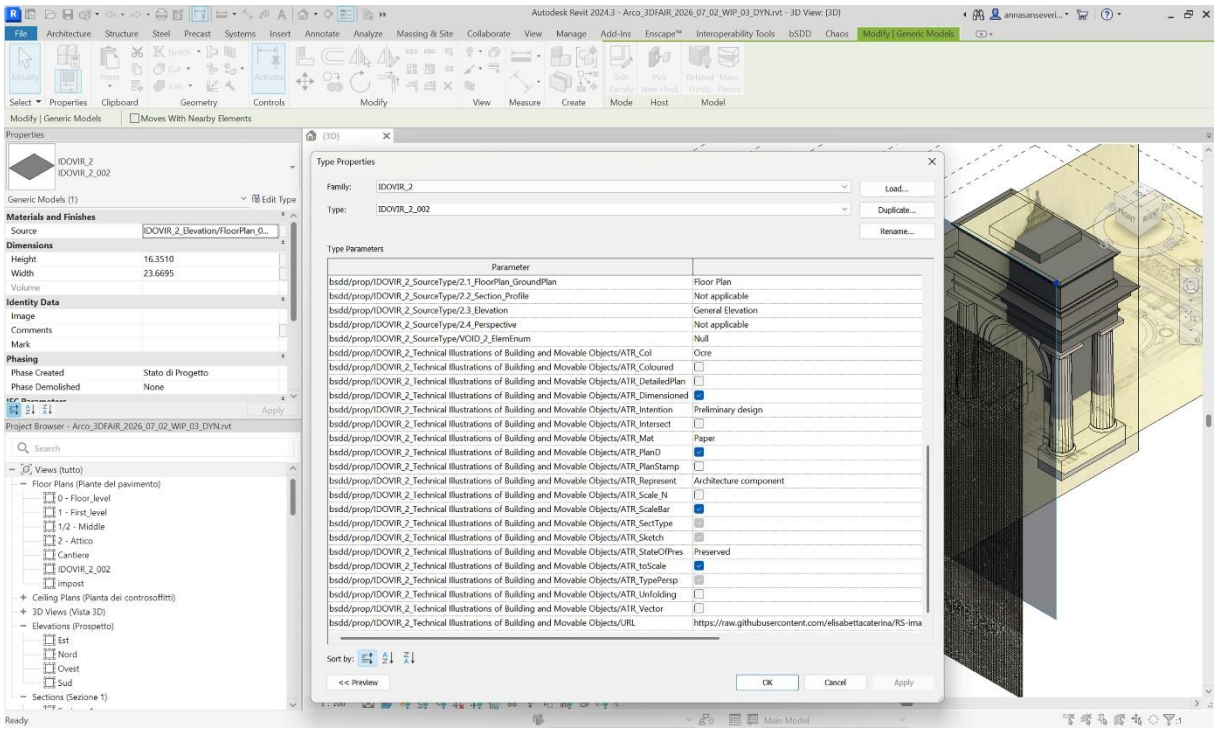


Fig. 3 To link the testing IDOVIR bsDD to the "modelled sources", we employed the "bSDD Revit plugin" (available for up to Autodesk Revit 2024) (buildingSMART Community Projects, 2024). Namely, a total of twenty-seven properties – four under the group "IDOVIR_2_SourceType" and twenty-three under "IDOVIR_2_Technical Illustrations of Building and Movable Objects"– were added as "type parameters", either as "boolean" or "string" values according to the IDOVIR taxonomy.

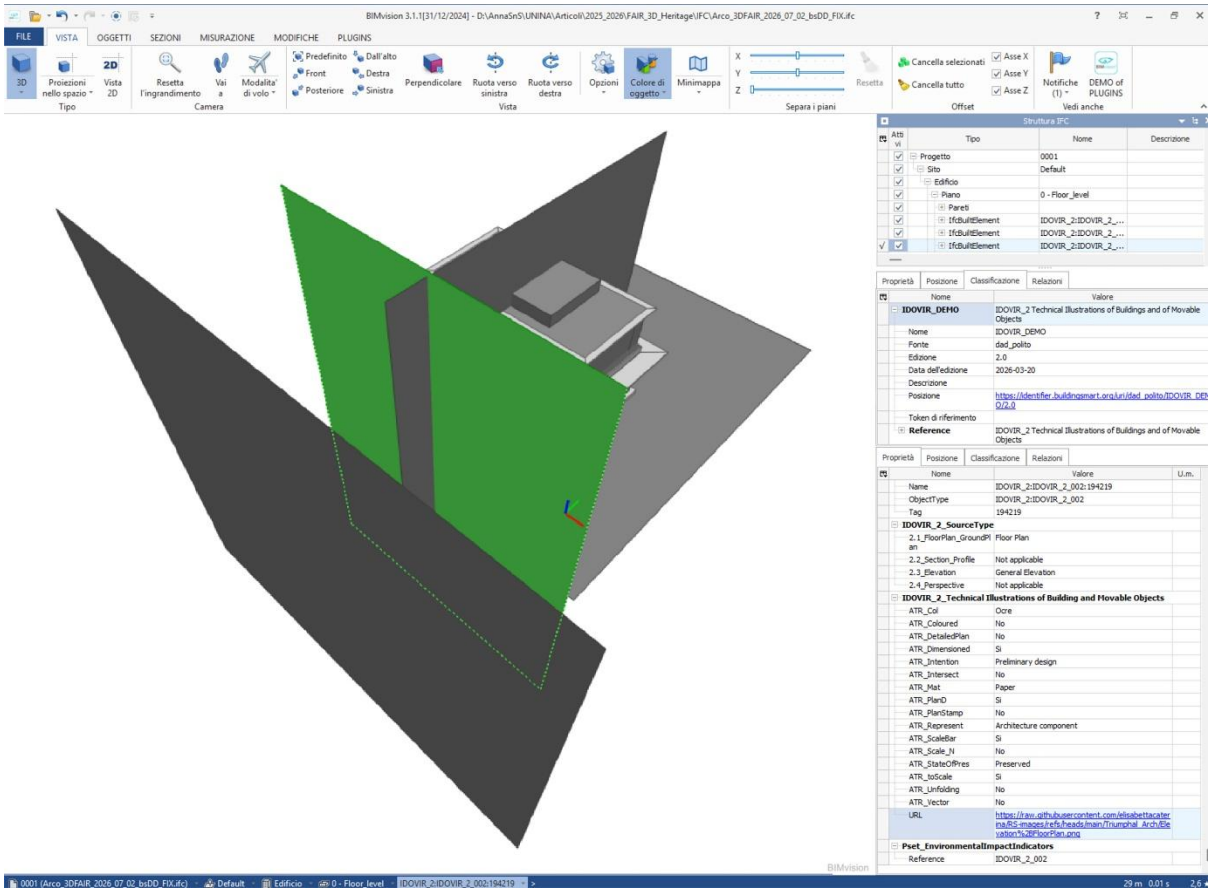


Fig. 4. Using the IFC exporter embedded in the "bSDD Revit plugin" (buildingSMART Community Projects, 2024), the added parameters are grouped into "IfcPropertySets" (pset) according to the "Groups of Properties" identified within the bsDD, which is also properly entered as "Classification".

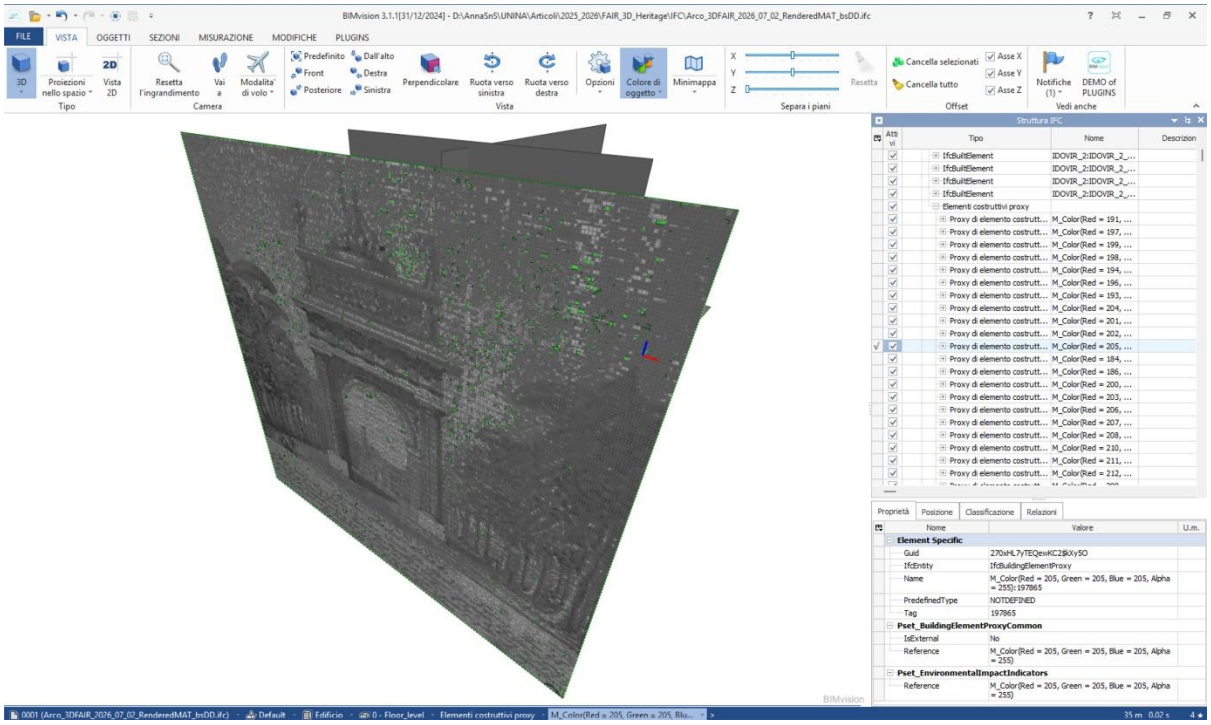


Fig. 5. Upon exporting the "reference sources" to IFC, the texture is usually not transferred. Therefore, we are currently testing some algorithmic approaches (Sanseverino & Giovannini, 2026a) to sample the image colours and render them as materials, in order to preserve their visualisation upon export into OpenBIM formats.

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