Chapter 1
Dhekalos Lab to Metaverse:
Exploring XR Strategies for Digital Cultural Heritage

Alessandra Frontini
Università Politecnica delle Marche, Italy

Ramona Quattrini
Università Politecnica delle Marche, Italy

Romina Nespeca
Università Politecnica delle Marche, Italy

Paolo Clini
Università Politecnica delle Marche, Italy

Mirco D'Alessio
https://orcid.org/0009-0004-3268-4491
Università Politecnica delle Marche, Italy

Renato Angeloni
https://orcid.org/0000-0001-8869-506X
Università Politecnica delle Marche, Italy

Irene Galli
Università Politecnica delle Marche, Italy

Umberto Ferretti
L'Università degli Studi di Roma La Sapienza, Italy

Mirco Tangherlini
Independent Researcher, Italy

ABSTRACT

This chapter presents the design and implementation of Meta-Dhekalos, a digital twin of the Dhekalos Laboratory at the Università Politecnica delle Marche, developed within the Spatial platform. The project aims to transpose the physical lab into

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the Metaverse, enabling remote access, immersive interaction, and participatory dissemination of cultural heritage research. A curated selection of six XR-based digital experiences, spanning AR, VR, MR, and AI-enhanced environments, is also presented and integrated into the new Meta-space to reflect the lab's evolving methodological and technological approaches. Each case was chosen for its ability to represent different stages and paradigms of immersive cultural storytelling. The chapter documents the criteria used in this selection and the design strategies adopted to translate them into a shared 3D environment. Finally, it presents the preliminary results of an evaluation test conducted with educators, offering early insights into presence, usability, and educational impact across the different experiences.

1. INTRODUCTION

The enhancement of cultural heritage increasingly relies on digital twins, developed and adapted to engage users through extended reality (XR) experiences. Defining shared workflows for XR applications, whether device-based or web-based, remains a crucial research challenge. Equally important is usability testing, which improves accessibility by considering diverse user groups in terms of age, education, and geographic background.

Although the Metaverse experienced an initial surge a few years ago and a revival during the COVID-19 pandemic, it has since become less central for cultural institutions. Nonetheless, its potential should not be underestimated. The possibility of remotely accessing and sharing models, even in entirely virtual environments, fosters real-time collaboration among users located around the world.

This chapter aims to analyze the process through which the digital heritage laboratory, Dhekalos (Digital Heritage + Kalos), has established a presence in virtual space. The objective was to transpose the physical spaces of the laboratory into the Spatial platform and to replicate online the same immersive experiences offered at the Università Politecnica delle Marche. By sharing this experience, we aim to highlight both procedures and challenges, while also encouraging other laboratories to innovate within the Digital Cultural Heritage (DCH) field and make their work accessible through immersive environments.

Dhekalos is a transdisciplinary laboratory on Digital Cultural Heritage (DCH) within the Department of Construction, Civil Engineering and Architecture (DICEA-Univpm). Recognized as a Department of Excellence by ANVUR for both 2018–2023 and 2024–2027, DICEA includes Dhekalos as one of the four main axes of the 2E Lab, a federated structure supported by MIUR funding. Dhekalos also serves as a training hub for new professionals in the field of Digital Cultural Heritage. In line with Europe's ongoing digital transformations, the laboratory faces the challenge of