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Executive Summary

D5 provides a general presentation of the case studies that will be developed within the Spoke, distinguished between core and research cases. In the following sections, the various cases are reviewed from the perspective of the technologies used and their ethical implications; the debate concerning the visitor's experience of museums using such technologies; issues relating to cultural heritage jurisprudence and reflections prompted by the debate on the decolonisation of Western cultural institutions.

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1. Presentation of case studies

1.1 Pilot studies

From an institutional point of view, the entities involved in the nine pilot cases are a State museum (Royal Palace of Caserta), a museum foundation with special autonomy (Egyptian Museum, Turin), two literary parks ("Grazia Deledda", Galtelli, and "Carlo Levi", Aliano), the University Museums Systems (from now: SMA) of the Universities of Bologna, Ferrara and Turin, the museum system of the Suor Orsola Benincasa Institute (from now: UNISOB) and a university research centre, the Centre for Communication and Archives of the University of Parma (from now: CSAC). Distributed homogeneously throughout Italy (four pilot cases in the South and Islands, three in the Centre, two in the North), they are very different in terms of size, public attendance, organisational structure and type of collections.

Identified by analysing ISTAT data, the entities involved in the pilot studies are as follows:

- Type A – high-density and innovative museum (Egyptian Museum);
- Type B – natural history and scientific museum (SMA Bologna; SMA Ferrara);
- Type C – widespread art gallery (CSAC; SMA UNISOB);
- Type D – sites museums with tangible and intangible heritage and landscapes, among those that have either low or no virtual and digital implementations with a particular focus in southern Italy ("Grazia Deledda" and "Carlo Levi" literary parks);
- Type E – historical palaces, labeled as museums, among the most important in the Italian heritage context, including UNESCO sites (Royal Palace of Caserta);
- Type F – demo-ethnic-anthropological museums, including rural culture museums (with less than 20,000 visitors per year), anthropological museums and museums of art and popular traditions (SMA Torino).

In detail, the nine institutions involved will develop projects using eight different models, listed below:

1. A digital platform for the enhancement of diffuse museality, applied to the SMA UNISOB art collections, as a prototype for the identification of scalable and flexible technological solutions suitable for cultural heritage in the inland areas of Southern Italy;
2. an innovative application of artificial intelligence to the CSAC's collections of art, photographs, architectural drawings, design, fashion and graphics, through which the user can interact with the online digital content, immediately benefit from the updated content and interact with the exhibits using mobile devices;
3. The digitalisation and enhancement of museum environments and collections through three-dimensional models of the Ferrara SMA, mainly the collection of the "Piero Leonardi" Museum of Prehistory and Palaeontology and the Exhibition Hall (Hohenstein et al., 2021; Bertolini et al., 2019);
4. The virtual reconstruction in 3D of the Queen's flats at the Royal Palace of Caserta in the original design by Luigi Vanvitelli and the creation of an application that will also provide storytelling content on the original use of the spaces and the historical figures who inhabited them;
5. The design and implementation of containers and digital environments and literary representation of the landscape/territory for the "Grazia Deledda" and "Carlo Levi" literary parks. The prototypes, based on environmental recreation and immersive experience, will be designed with a view to their possible application to other literary parks;
6. The creation of a software that helps during the production of stories and the management of interactive storytelling experiences of the Egyptian Museum,

including research and study processes related to it (Greco, C., Rossi, C., Della Torre, S., 2020) and the study and research processes involving it;

7. The experimentation of three-dimensional exhibition experiences, immersive virtual reality and interactive web on the collections of the SMA Turin: Museum of Anthropology and Ethnography (from now: MAET; Cilli et al, 2019; Pennacini, 2020); Museum of Criminal Anthropology "Cesare Lombroso" (from now: MCACL; Montaldo, 2015). The project will consist in the realisation of prototypes in an open-source environment for the digital enhancement of cultural heritage exhibited in the museum (the Art Brut collection), in storage (the pre-Columbian Zemi: Ostapkowic, Pennacini 2022) and in the archive (the tattoo collection);
8. The reorganisation and enhancement of the Capellini Museum - SMA Bologna. The project includes the reorganisation of the Capellini Museum archive; the creation of a room on the ground floor of the museum, that serves to visitors as introduction to the digital use of the narrative elements present during the visit and workshops; the reorganisation of part of the collection on the first floor, with the digital narration of some highlights.

1.2 Research cases

These are the research cases not included in the pilot cases financed by the cascade calls, which the Spoke members are nevertheless working on and which are intended to be completed within the project. The first example is the creation of a digital twin of the exhibition *"L'altro Rinascimento. Ulisse Aldovrandi e le meraviglie della terra"* (*"Ulisse Aldovrandi and the Wonders of the World"*) (Balzani et al. 2023). A second example is the virtual environments as open archives to explore the cultural biographies of ethnographic artefacts at the Museo delle Civiltà (Rome). The recent activities of the project included the performance of non-destructive analyses (X tomography, imaging and point spectroscopy)

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and the creation of a 3D model by means of structured light scanner and photogrammetry. The analyses were coordinated by CNR's Institute of Cultural Heritage Science and were funded by [E-RIHS.it](https://www.e-rihs.it) (European Research Infrastructure for Heritage Sciences). The project has recently been funded as part of the PRIN 2022 project "Knowledge of Things: Reassessing the Indigenous American Heritage in Italy (KNOT)". A third example is digital strategies for enhancing cultural heritage: the Villa del Casale of Piazza Armerina, from the late Antique building site to the Museum Collection. This research case-study focuses on Palazzo Trigona Museum of Piazza Armerina, EN (Type D Museum), in its interlinked relationship with the archaeological context of Villa del Casale. The project aims at expanding the users' current perception of Piazza Armerina cultural heritage with the creation of a web-based digital environment for enhancing both findings on display in the Museum and a wide-range of artefacts stored in the Villa del Casale storerooms. The project envisages producing a variety of digital resources to retrace and enrich the thread of memory both in relation to the monument history and the multifaceted circumstances that led to its discovery. To this end, the virtual environment will entail different sections related to archive resources and archaeological heritage: (i) a digital collection of archive photographs and excavation diaries related to the first excavations seasons; (ii) the virtual reconstruction of the Villa and galleries of 3D models of artefacts with a curated set of descriptive metadata; (iii) virtual exhibitions focused on thematic sections, such as the key figures of the discovery, the building site of the Villa, the architectural heritage, the decorative program. Providing free access to a wide range of digital resources, the project pursues the final goal of improving users' involvement both remotely and in situ.

A final research case concerns the Lombroso Museum and involves the realisation of podcasts and interactive tools on the autobiographical documents of the inmates. This prototype, which will be placed around the installation on tattoos (the subject of the pilot

case), will provide a new point of view in the museum setting, aimed at recovering the subjectivity of incarcerated people.

2. Technologies and ethics

2.1 Technologies

The technologies on which the projects are based can be divided into four main categories. It should be noted that these macro-categories, useful for the organization of the discussion, are not intended to be exhaustive and are not to be understood as separate areas, given their intrinsic interrelationships.

Digitization

Digitization involves obtaining a digital version of works of art through acquisition operations. The technologies employed are various and include 3D photogrammetry, 3D laser scanning, X-ray computed tomography, and the use of projectors (Structured Light Scanning).

Digitization is highly relevant for several reasons:

- **Conservation and Preservation:** Artworks can be preserved in the long term. The materials of paintings, sculptures, objects, drawings, and prints are subject to natural deterioration or exposure to external agents. Through the digitization process, virtual copies can be archived and protected more effectively.
- **Accessibility:** By using the Internet and other digital platforms, digitized works can be shared and experienced from anywhere in the world.

- Ease of Search and Archiving: Digital files can be further enriched with metadata that allow for effective searching and archiving.
- Enhancement of Cultural Heritage: Digitization enables the preservation and sharing of cultural and historical heritage on a broader scale, contributing to the understanding and appreciation of the history and culture of various communities.

Digitization is useful not only for the public but also for historians (and experts in various disciplines in general) who can study artefacts in detail without having to handle them. Furthermore, despite the known and specific preservation issues of digital objects, it contributes to the conservation of assets, especially when there is a possibility that they may be destroyed or damaged by unforeseen events (Atzori et al., 2023).

In the Spoke 4 projects, multiple uses of digitization techniques are proposed, ranging from 3D scanning of small objects (SMA Bologna, SMA Ferrara, SMA Turin, SMA UNISOB) to the digitization of places, rooms, or buildings (Egyptian Museum, Royal Palace of Caserta, "Grazia Deledda" and "Carlo Levi" literary parks).

Digital/Immersive Experiences

As mentioned, the process of digitization allows for the creation of digital/immersive experiences. There are multiple approaches that can be adopted, including:

- Immersive Experiences: digital technologies like Virtual Reality (VR) and Augmented Reality (AR) enable immersive experiences that take the visitor into a virtual environment replicating the physical museum visit or enhance the visit by integrating virtual elements into the real environment through the use of mobile devices or installations (Royal Palace of Caserta, SMA Ferrara, SMA Turin, "Grazia Deledda" and "Carlo Levi" literary parks).
- Virtual Tours: they allow visitors to explore museums and their collections online, providing detailed views, information about artworks, historical and cultural details,

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without needing to be physically present in the museum (Royal Palace of Caserta, SMA Ferrara, SMA UNISOB, "Grazia Deledda" and "Carlo Levi" literary parks).

- Apps and Interactive Platforms: They enable visitors to personalize their experience, making guided tours and gamification elements possible, such as interactive games and quizzes, following the edutainment paradigm (CSAC, Egyptian Museum).

Digital experiences can take place through various devices. The most immersive experiences are typically implemented using AR/VR headsets (provided by the entity offering the experience or installed on the end user's computer or device). It is good practice to also offer an alternative version of the experience—less immersive but equally informative—that can be accessed directly on the user's monitor through a browser or specific app. The widespread use of mobile devices (tablets and smartphones) also allows for the design and implementation of experiences that can fully leverage the portability of the devices. For instance, a smartphone camera, when framing an artefact, can be used as a "lens" that allows for zooming in, providing a more detailed view, or consulting an alternative version of the artefact (e.g., restored or placed in its natural/original context).

The use of such technologies also naturally encourages active engagement of the public through comments, reviews, social media sharing, and creative contributions (Egyptian Museum).

Ontologies and Semantic Representation

Digital representations can be leveraged to obtain archival representations that go beyond collecting information. They can be naturally enriched using the paradigm of semantic technologies applied to the description of cultural heritage. By using specific vocabularies for the cultural heritage domain, it's possible to translate expert annotations, results of analyses conducted on assets, and other relevant information for the study, preservation, and use of assets into a format directly interpretable by machines. Through semantic

enrichment, data becomes interoperable and opens up to the creation of innovative methods of access, study, and reuse.

This methodology, based on the use of international standards and frameworks (e.g., CIDOC-CRM, Dublin Core, PROV-O), applies to various types of media, ranging from text to images, including 3D and 4D (space-time) models (Egyptian Museum, SMA Ferrara).

Artificial Intelligence

Lastly, in the realm of generating textual and visual content, a significantly relevant technology is that of deep neural networks. In the case of the Egyptian Museum, for example, there is a proposal to leverage technologies such as Stable Diffusion for image generation and Large Language Models (GPT) to generate text that can be used to supplement interactive narratives. The use of these tools must always be supervised due to the ethical issues highlighted in the following paragraph.

2.2 Ethical concerns

The technologies mentioned in the previous paragraph, despite their aim to expand knowledge and enhance the enjoyment of cultural heritage, present some potentially risky ethical implications. On one hand, virtual technologies widen the potential audience, reaching those unable to visit cultural locations and enabling the enjoyment of assets by a larger number of people through multichannel access. On the other hand, they may cause potential discomfort in usage, as highlighted in literature.

Specific guidelines for experimenting with virtual reality applications have been proposed by Madary and Metzinger (2016), who thoroughly discussed the ethical aspects that can arise from the research and personal use of virtual reality devices, providing a set of recommendations. These recommendations range from the need to conduct experiments

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transparently, without malicious intent, to the necessity of informing the subjects (or users) about the characteristics and possible risks associated with the virtual experience. These risks, which have implications for physical and mental health, are specifically addressed by the authors, who emphasize both the possibility of causing physical discomfort (dizziness, loss of balance, etc.) and the potential psychological impact resulting from exposure to emotionally traumatic experiences, even as mere spectators ("Torture in a virtual environment is still torture"). To mitigate ethical risks, adherence to the codes of conduct indicated by Madary and Metzinger is recommended, along with the use of clear and detailed information in conducting experiments and creating user experiences, which should be interrupted and abandoned at the discretion of the experimental subject and the user. Barbara, Koenitz, and Bakk (2021) have examined the aforementioned issues in the context of cultural storytelling. Their reflection serves as a basis for creating applications that consider ethical aspects from the design phase. Moreover, they highlight the risks that could arise from creating narratives that contradict the scientific, historical, and cultural assumptions of the cultural heritage assets involved (see also Do et al. 2023).

A problematic aspect of conducting experiments and creating applications that involve interaction between the public and installations and/or devices is the collection and use of data generated as a collateral product of the interaction itself. This aspect is crucial in the context of virtual, augmented, and extended reality, where the naturalness of interaction is maximal—compared to traditional digital environments—and potentially encompasses the entire sensory sphere and ability to act of subjects and users. Regarding this issue, an examination of the aforementioned ethical aspects is essential, as well as adherence to national and community regulations for data processing. Even if the data is collected in an anonymous form, preventing the identification of individuals is crucial, moreover, users must be informed of the types of data related to their behavior that will be collected and the scientific purposes for which the collection occurs. The collected data should not be used

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for secondary purposes, especially when such purposes may entail future disadvantages for certain categories of people. The publication of data according to the Open Science paradigm must take these aspects into account, conditionally sharing the data based on the scope of use and the experimental purposes declared by third parties making requests. Finally, the examination of ethical aspects arising from technology cannot ignore the risks associated with Generative Artificial Intelligence tools. These tools, trained on large amounts of textual and other format data, do not currently possess transparency features that allow for unsupervised use. Despite their undisputed ability to imitate and support human creative processes, the processes through which this ability is realized are not inspectable, and the systems lack the ability to explain how the results were generated in response to a human prompt or stimulus. Furthermore, the data on which the tools are trained are partially unknown, making it impossible to verify their truthfulness and representativeness to ensure they are free from any biases. Lastly, as recently highlighted by Tam et al. (2023), the lack of tools to measure the ability of these systems to produce reliable information makes them unsuitable for unsupervised use within project activities, to prevent experimental subjects and the public from being exposed to untrue content and/or content that violates shared ethical principles (including content that could cause cultural discomfort). For this aspect, reference is made to the publication by the European Commission "On Artificial Intelligence - A European approach to excellence and trust"¹ in 2020.

¹ https://commission.europa.eu/system/files/2020-02/commission-white-paper-artificial-intelligence-feb2020_en.pdf

3. Customer experience in museums

3.1 Customer experience and technologies

One of the main objectives of all pilot studies is to improve the customer experience of potential and actual visitors using technologies. From this point of view, pilot studies decide to use different types of technologies to enhance their culturally-based service experience: from the classical interactive websites and social networks – used to better communicate with actual and potential visitors – to the newest ones such as virtual and augmented realities – helpful to create a better interaction and a fully immersion both online and onsite for visitors.

Customer experience is relevant to organizations because it refers to 'the customer's cognitive, affective, emotional, social, and physical responses' to specific stimuli (Verhoef et al., 2009, p. 32) and, from the company's perspective, customer experience can be seen as the journey that includes different phases of the purchase process: search, purchase, consumption, and after-sales, encompassing multiple touchpoints able to influence the choices of customers at each phase. Within this journey, customer engagement has become essential thanks to the interactive and co-creative experience generated (Lemon & Verhoef, 2016) between customers and a focal agent/object (e.g., a brand) (Brodie et al., 2011); moreover, it serves to measure the number of customers' actions directed at the firm (Pansari & Kumar, 2017). These aspects have also been analysed looking at cultural heritage organisations with an emphasis on visitors' co-creation (Antón et al., 2018; Minkiewicz et al., 2014)

To enhance the customer experience, museums try to create a greater number of interactions with visitors, drive people into a full immersion inside the museum, and generate active participation of the visitors (Trunfio et al., 2020; Civita, 2021; Leoni & Cristofaro, 2021; Fernandez-Lores et al., 2022; Trunfio et al., 2022). More specifically, museums use interactive

websites (Capriotti et al., 2016; Padilla-Meléndez & del Águila-Obra, 2013; Pallud & Straub, 2014), social networks (Amitrano et al., 2018; Bertoldi et al., 2018; Padilla-Meléndez & del Águila-Obra, 2013), digital platforms, virtual and augmented realities (Fernandez-Lores et al., 2022) and, more recently, they started to explore the potential use of the metaverse.

Looking at the aspects related to the visiting experience, among the nine pilot studies described by general categories in the first chapter, we have identified two macro-categories that can show how visitors can interact with the technological solutions (described in D4) to enhance their experience. Each pilot study presents features within both the following two macro-categories:

1. Digital visiting experience
2. Integrated visiting experience.

3.2 The digital visiting experience

The digital visiting experience is mainly based on the use of websites and social networks: those instruments are relevant to share information, allow people to consult databases and have an online preview of the artworks.

Almost all the pilot studies and the research cases adopted the digitalisation approach with the objective to engage and involve both potential visitors (in their pre-visit phase) and who already visited the museum. In the first case, potential visitors can have a preview of the artworks, artefacts, archaeological and historical findings, rooms, and spaces; first approach with the museum and its offer can influence the intention to visit on site the museum.

Furthermore, the digital visiting experience can be analysed from the perspective of who already visited the museum and its collection: these visitors can evaluate and share their experience online, give hints about activities to do for future visitors, and make suggestions to improve the experience of cultural organisations (Suess & Barton, 2022). In addition, the

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digital experience is also connected to research activities: all the digital materials offered by pilot studies represent a great resource for scholars, experts, and students.

All pilot studies aim to create digital platforms that operate as dynamic and interrogable online spaces integrating 3D reconstructions, digitalised objects, and web applications.

An explicit attention to the website and social networks re-design is given by the pilot study CSAC. CSAC is a widespread art gallery located in a non-touristic position and far from traditional cultural and tourism routes: increasing the number of onsite visitors is a hard task but they believe that investing resources in a well-designed and attractive website with dedicated profiles on social networks could help the diffusion of their cultural offer and initiatives among people.

During the Covid-19 pandemic an increasing attention of museums and heritage sites toward immersive technologies and digital storytelling was recorded (Bonacini, 2020; Jiang et al., 2022; Tsai, 2020). In particular, the use of VR and the integration of digitalised artworks in virtual reconstructed museums allowed visitors to look for new experiences directly at home (Bonel et al., 2023; Giachino, 2022). In this case, a lot of museums started to follow the pioneering example of the Google Arts and Culture project (<https://artsandculture.google.com/>) but also implemented in their social networks challenge-based gamification, real-time tours and events, and live streaming of performances or interviews to artists (Agostino et al., 2020; Giachino, 2022).

The use of digital twins, 3D reconstructions, and VR tools are proposed by all the pilot studies. Some examples are NAVIGA UNISOB whose objective is to develop a scalable platform of interactive 3D multimedia digital twins of museum spaces to allow virtual online visits, and the creation of a digital twin of the exhibition "*L'altro Rinascimento. Ulisse Aldovrandi e le meraviglie della terra*", a digital experience starting from the creation of a digital twin of an entire temporary exhibition.

These technologies can generate positive effects on customer experience: customers can gain enjoyable and immersive information, reducing the barrier of distance, and they can experience a virtual environment in which they can be fully immersed (Jung et al., 2016; Lee et al., 2020). On the other hand, websites designed in VR style (as opposed to traditional websites) can discourage users from future visit onsite: the perceived similarity acts as a mediator between virtual and physical visits and only a strong individual interest or intrinsic satisfaction (so called enduring involvement) can moderate the negative effects of the virtual experiences on intentions to visit onsite (Deng et al., 2019).

3.3 The integrated visiting experience

The integrated visiting experience has been identified as an onsite experience that integrates a traditional visit with the potential of digital technologies, starting from the 3D reconstructions and digital twins, virtual reality solutions but also augmented reality technologies, etc.

All pilot studies aim to use VR technologies to reconstruct artefacts or recreate spaces - that do not exist anymore or are closed to the public for different reasons - to make them accessible. This is true for all the demo ethnoanthropological (MAET-SMA Turin) and natural history-scientific museums (SMA Ferrara, SMA Bologna) that are not regularly open and sometimes have few digital contents (as highlighted also in D4) but also for historical palaces (Royal Palace of Caserta).

However, pilot studies should pay attention to another challenge of VR: isolation. In fact, visitors are unable to interact with their relatives or friends, with other visitors, or with the museum staff. It has been demonstrated (Jung et al., 2016; tom Dieck et al., 2018) that social presence has a positive impact on the overall experience of visitors, particularly improving the enjoyment factor that consequently influences visitors' intention to return or to give

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positive feedback online. The isolation issue can partially be overcome by integrating augmented reality solutions as they can offer a stronger connection with the real world: AR allows to give information overlaid on reality and it can be easily used thanks to the diffusion of personal mobile devices such as smartphone or wearable devices (Han et al., 2018; tom Dieck et al., 2018; Fan & Luo, 2022; Maubisson et al., 2022; Khalil et al., 2023). The combination of location-based mobile applications, along with AR, is considered a more effective means to provide 'content in context' (Parise et al., 2016) to present-day visitors who constantly seek valuable and personalised real-time information and suggestions for visit patterns.

Among the pilot studies, the Royal Palace of Caserta aims to develop a mobile app starting from the 3D reconstructions that could allow visitors to compare the actual rooms and spaces with the original conditions and to learn its story thanks to digital storytelling content. Another use of mobile applications during the visit experience that extends the possibilities offered especially to involve young generations is the use of gamification (Skinner et al., 2018; Garcia et al., 2019) and the CSAC pilot study is one of those that aims to use this solution to attract potential visitors.

However, using mobile application can even be another trigger to isolation as while visitors use their devices and their interaction, both with the museum context and other visitors, could decrease together with their interest of using the application along all the visiting experience. The Egyptian Museum pilot study aims to overcome these issues proposing an immersive experience without mobile devices but exploiting interactive storytelling.

Even if not explicitly cited, all pilot studies aim to integrate AR and VR technologies following the trend of actual museums around the world for mixed reality (MR) experiences – sometimes eXtended reality (XR) (Silva & Teixeira, 2022) – experiences. The newest research on this topic is looking for new ways to measure the impacts on visiting experience (Trunfio

et al., 2020; Trunfio & Campana, 2020) highlighting how MR enhances heritage valorisation, education, and entertainment but also post-experience behaviour (Trunfio et al., 2022).

The integrated visiting experience through MR has been delineated as a combination of education, valorisation, entertainment, socialisation, and escape due to the integration of functional elements of the technological MR devices, namely format, museum information, customisation, usability, interaction, and saving information (Trunfio et al., 2022).

Education on the inherent topics of the museum's artefacts, but also actual topics like resource scarcity, environmental changes, and the impacts of research activities on both artefact conservation and historical and historiographical reading by researchers are the objectives of the mixed reality solutions that the Egyptian Museum would like to develop and implement in a new exhibition area to open during 2024.

In addition, positive behavioural effects have been identified in visitors' intention to revisit the museum and use of digital technologies. These results respond to the criticisms concerning how sometimes the adoption of immersive technologies seems to happen following an imitative attitude more than looking at the integration of technological tools into the physical experience of a visit, thus leading to risky investments (Maubisson et al., 2022).

A peculiar type of integrated visiting experience is the one proposed by the two literary parks "Grazia Deledda" and "Carlo Levi" for a walk-through experience that mixes traditional and digital technologies with onsite and en-plein air activities by visitors who explore different places tied by a story. Participatory processes will be conceived and conducted, thus involving students and other local subjects with the aim of creating cultural digital contents (audio guides). Furthermore, content co-creation works will be conducted through e-books and sensorial books, to benefit subjects with special needs.

3.4 Open issues and future research perspectives

As highlighted above, all pilot cases should pay attention to some potential risks: the discouragement of future visit onsite when museums use websites designed in VR style, and the isolation of visitors when using VR solutions during the visit.

Further, only a few pilot studies cite the importance of implementing technologies to improve the accessibility of visitors with special needs (e.g., visually impaired visitors in CSAC); however, the analysis of the impacts of immersive technologies on individuals with disabilities in visiting museums would be an interesting perspective to explore (Falk & Dierking, 2000; Camic & Chatterjee, 2013; Zbranca et al., 2022) that aligns with the overarching objective suggested by the EU to devise strategies for making museums more accessible (European Commission, 2021).

Another point that pilot studies do not mention is the metaverse, which represents one of the latest and debated technological advances defined as 'a network of digitally mediated spaces that immerses users in shared, real-time experiences' (Hadi et al., 2023). The main developments in this digital space are related to gaming, retail and hospitality, with new challenges pertaining to a wide range of topics from customer motivations, memory, learning, well-being, and inclusion to communication and branding. Museums with their collection represent one of the possible spaces that can become digital spaces to be experienced in the metaverse; however, the pilot studies have not pointed out this aspect and they have not mentioned it among the technologies that could be implemented to enhance the visiting experience.

Finally, it would be interesting to understand how the use of emerging technologies, including the metaverse, can change with respect to different generations (Hadi et al., 2023; Khalil et al., 2023): this is an issue that could be more considered by the pilot studies.

4. Legal analysis

Today, the experimentation of different types of digitization and the virtualization of their collections by museums, art galleries, museums of sites with (in)tangible heritage and landscapes, historic palaces, demo-ethno-anthropological museums, impose (also through the identification of some case studies involving cultural institutions representative of various museum contexts in Italy) the need to analyze and then identify methodologies and solutions that are functional for defining, within the existing regulatory framework, common standards and best practices that can be further adapted and reused in institutions and contexts with similar characteristics.

The digitization of cultural goods, understood as "all immovable and movable things that have artistic, historical, archaeological, ethno-anthropological, archival, and bibliographic interest, and other things identified by law or under the law as testimonies of civilization" (Art. 2, paragraph 2, of Legislative Decree no. 42 of 2004, the Italian Cultural Heritage Code), began systematically in Italy in the 1990s, both at central and regional levels. This digitalization has been carried out over the years and based on a rich system of methodological tools, primarily developed by the central institutes of the Ministry, which have gradually covered practically every aspect of cultural heritage. This has allowed for the emergence of the concept of 'digital heritage,' defined as the "set of irreplaceable resources of knowledge and human expression. It includes cultural, educational, scientific, and administrative resources, as well as technical, legal, medical, and other information created digitally or converted into digital form from existing analog resources" (Art. 1, Charter on the Preservation of Digital Heritage, adopted by the General Conference of UNESCO on October 17, 2003). Digital resources can encompass a wide range of cultural content, including texts (books, manuscripts, historical documents, newspapers, poems, novels, essays, and other written texts that have been digitized and made available online), images

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(photographs, paintings, illustrations, postcards, maps, and other visual representations of art objects, historical places, and more), audio (audio recordings of music, speeches, interviews, environmental sounds, and more), video (films, documentaries, video recordings of historical events, theatrical performances), three-dimensional objects (3D models of historical objects, artworks, or archaeological artefacts that can be explored virtually), websites, and interactive applications (digital platforms dedicated to the promotion and exploration of cultural heritage, which may include virtual museum tours, digital archives, educational games, and more).

At the beginning of 2020, the European Commission, through the Horizon Europe programs, clarified that the requirements underlying the digitization of cultural heritage must:

- Restore the "visual" appearance of individual objects, collections, or cultural sites.
- Construct stories, experiences, and cultural contexts.
- Produce interconnected digital resources that are searchable across different domains or languages.

In this sense, cultural institutions must be able to assimilate technological changes that will evolve over time, and the level of digital maturity of a cultural institution will be defined by the gap between the adoption of individual technologies with specific operational purposes and the use of digital technologies in transforming internal processes to achieve these objectives.

It is for these reasons that the concept of digital transformation is dynamic and constantly needs to be reexamined and adapted to the changing needs of cultural heritage, institutions, and users, who play a dual role as co-narrators and consumers. (See Guidelines for the Digitization of Cultural Heritage and Guidelines for the Classification of Digital Products and Services, Processes, and Management Models).

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In this framework, the legal perspective serves to identify the strengths and weaknesses of this "transformation" of cultural heritage, considering both constitutional principles (especially Article 9 of the Italian Constitution) and national and European legislation regarding the protection of cultural goods. It is clear that this digitization process enriches the possibilities for the public to access cultural heritage, which until recently were limited to "analog approaches" (comprising physical visits, direct interaction, and immersive experiences). Digital access makes cultural heritage potentially more accessible, allowing people from around the world to explore and appreciate a country's cultural heritage without having to travel physically (Constitutional Court no. 9 of 2004). Digital access offers various presentation modes, including high-resolution images, virtual tours, videos, audio guides, and digital texts, which can enhance the learning and enjoyment experience and contribute to the long-term preservation of such types of assets, reducing the risk of physical deterioration and enabling sharing and research by scholars and enthusiasts.

However, at the same time, these aspects need to be examined in balance with the legal nature, of a public nature, of the assets being digitized (Mikhaliova, 2023). In this legal perspective, specific analysis appears to be required for:

1. Digital Reproduction and the Protection of the Image of Cultural Heritage
2. Digital Twins and the Potential Use of NFT

4.1 Digital Reproduction and the Protection of the Image of Cultural Heritage

The digital reproduction of cultural heritage and the right to the image are intertwined with the Italian Cultural Heritage Code (Legislative Decree no. 42 of 2004), as it recognizes the fundamental role played by images (and, therefore, reproductions) of cultural heritage. It requires protection that is equal in importance to the protection afforded to the cultural goods in its uniqueness. The right to the image of cultural heritage includes a general

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prohibition on reproducing the asset without authorization. This allows the Administration to express (following a discretionary evaluation) its consent regarding the compatibility of the requested use with the cultural purpose of the asset itself. The possibility of economically exploiting the reproduction of the asset is merely incidental, while what matters is avoiding harm to the public image of the public work and, therefore, intangible harm to the cultural asset due to its collective value. The legal framework for this can be found in the Second Part (Cultural Heritage), Title II (Use and Enhancement), Chapter I (Use of Cultural Heritage), Section II (Use of Cultural Heritage) of the Code, specifically in Articles 107 and 108. These articles regulate the ways in which the Ministry, regions, and other territorial public entities can authorize the reproduction of cultural heritage under their care. The combined provisions of these two articles require both seeking authorization from the competent institution regarding the possibility of reproducing a cultural asset (Article 107 of the Cultural Heritage Code) and, in general, the obligation to pay a concession fee (according to Article 108 of the Cultural Heritage Code), unless "the reproductions are requested or made by individuals for personal use or for study purposes, or by public or private entities for enhancement purposes, provided they are carried out without profit."

Recent jurisprudence (most recently, Florence Court, January 31, 2022, but previously Florence Court, judgment no. 15147/2018) extends the concept of the protection of cultural heritage to include the protection of its image, even when digitized. It is established that the protection of the digitized image also contributes to the public enjoyment of the asset, which is a prerequisite for its legal status, and it contributes to the development of culture and the promotion of knowledge of the historical and artistic heritage of the nation (Article 9 of the Italian Constitution). Considering the placement of the relevant provisions within the regulatory structure of the Cultural Heritage and Landscape Code, the reproduction and dissemination of images of cultural assets are considered a form of use of the asset.

Therefore, it requires both the protection of its physical integrity and control over the dissemination of the images (Franceschelli, 2018, 291).

The purpose of the legal framework is to protect the "functional destination of cultural assets to be culturally qualified for use by the community, in ways that contribute to the development of culture and the promotion of public knowledge of the historical and artistic heritage of the nation. The pursuit of the ultimate goals identified by the legal framework for the protection of cultural assets cannot be separated from the protection of their image" and must be related to the specific cases of study within the project (Serra, 2010, 223 ss.; Tumicelli, 2014; Casini, 2018; Mikhailiova, 2023).

4.2 Digital Twins and the Potential Use of NFTs

The term "Digital Twin," as defined by Grieves in 2016, refers to the digital duplication, often (but not exclusively) based on a blockchain system, of a real-world physical system. When it comes to creating digital models of cultural heritage assets, it becomes essential to balance the use of this technology with the need for accessibility to these assets. This ensures that the use of Digital Twins aligns with the public nature of cultural heritage.

Digital Twin techniques, if not coordinated with regulations concerning the protection and enhancement of cultural heritage, can potentially lead to proprietary claims or exclusive access rights to cultural assets. Such claims would be incompatible with the regulations governing their use. The use of cultural heritage cannot be divorced from its historical, artistic, archaeological, and landscape significance, nor from its character as a collective resource. Therefore, it is essential to develop alternative forms of valorization for cultural heritage while simultaneously maintaining the connection between the assets themselves, the relevant communities, and public ownership through a management approach that is "not negotiable or voluntary but legal and necessary" (Giannini, 1963, 54).

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4.3 (Intelligent) Data Protection

Data protection is a fundamental concern when it comes to digitization. Cultural institutions, particularly museums, because of these processes, can collect and store a vast amount of data, including personal information of visitors, information about artworks, and other details. Furthermore, the use of such technologies requires a large amount of data, which can lead to issues related to storage, management, and sustainability. Long-term preservation of large digital data sets can also be costly and complex. It is, therefore, essential to ensure the security and privacy of this data through the adoption of appropriate cybersecurity measures and ethical data management, in compliance with the General Data Protection Regulation (GDPR).

At the same time, in order to avoid the risk of underutilization of data and the informational heritage generated by them, data protection regulations should be applied "intelligently," taking into account other protected interests and compatible uses. Among these, the primary considerations include data processing for archival purposes in the public interest, which also encompasses the function of public service in managing cultural heritage, scientific or historical research (GDPR, Article 5).

4.4 Interconnection of the Three Analytical Profiles with Reference to the Core Cases

The identified legal analysis profiles appear to be relevant in each of the 9 core cases within the project. Indeed, issues related to the (intelligent) protection of data, in accordance with the GDPR, constitute the basis of examination when discussing digitalization, in order to constantly consider the protection of all involved interests. At the same time, digital reproduction and the protection of the image of cultural assets affect every aspect of the digital enjoyment of all those narrative elements that are functional to the visit and the

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access to the collections hosted in various museums (considering different types of museum offerings).

More specifically, the theme of creating so-called Digital Twins is particularly relevant today, in one core case and in one research case. The last one involves the creation of a digital twin of the exhibition "*L'altro Rinascimento: Ulisse Aldrovandi e le meraviglie del mondo*" which took place in 2022-23. The same aspects are involved in the digital reconstruction of the surface and inner structure of the cotton Zemi (housed at the MAET - SMA Turin), which will be integrated into an interactive virtual display.

These are, therefore, closely interconnected investigation profiles, the analysis and development of which need to be implemented together.

4.5 The regulatory framework of the Egyptian Museum and its extendibility to other museum contexts. An in-depth study

The elements that characterize the uniqueness of the Egyptian Museum in Turin have been subjected to initial analysis, aiming to assess whether the authorization framework it is subjected to, considering the digitalization of cultural assets, could be extended to other museum contexts.

The Egyptian Museum of Turin is a Foundation (Foundation Museum of Ancient Egyptian Artifacts in Turin) established on October 6, 2004, with a duration of thirty years. The founders of the Egyptian Museum are the Ministry for Cultural Heritage and Tourism, the Piedmont Region, the City of Turin, as well as the Compagnia di San Paolo and the CRT Foundation (Article 3 of the Statute).

The heritage consists of the current usage rights on movable and immovable assets conferred by the Ministry, contributions from other founders, bequests, donations, and grants of any kind, and the assets (movable and immovable) owned by the Fondazione CHANGES - Cultural Heritage Active Innovation for Sustainable Society

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(Transfer of the Museum of Egyptian Antiquities to the Foundation Museum of Ancient Egyptian Artifacts in Turin and Article 4 of the Conventional Act).

The Foundation aims to enhance, promote, manage, and structurally, functionally, and exhibitively adapt the Museum, cultural assets received or acquired in any capacity, and the promotion and enhancement of museum activities (Article 4 of the Deed of Incorporation).

To this end, it promotes, among other things, research, acquisition, inventorying, cataloguing, conservation, organization, exhibition, study, and publication of the preserved heritage; the development of research, documentation, and information on the Museum's heritage; the promotion and dissemination of knowledge for the better enjoyment by the public of its cultural heritage and museum activities, also through experimentation and innovation; innovation and experimentation in its areas of activity (Article 2 of the Statute).

The affiliation of governmental and territorial entities to this legal entity makes the activities of the Egyptian Museum (although it is believed to be persistently subject to the discipline of the Code of Cultural Heritage and the protection of dependent assets) susceptible to a different development and realization, including digital, compared to other museum realities.

An analysis will therefore be conducted to assess the possibility of interpretatively extending the regulations specific to the Egyptian Museum to other museum entities, while acknowledging from now on that this appears challenging. It is difficult, as it seems, to exempt objects held by different museums and susceptible to digital reproduction from the legislation protecting cultural heritage.

5. Digital restitution and museum decolonization

5.1 The museum decolonization debate

Today museums owning artworks and items from the international arena face relevant postcolonial issues, with the set of ethical, geopolitical, juridical and patrimonial implications they inevitably raise. A vibrant debate invested the most important world museums devoted to the conservation and valorization of the universal heritage, like the British Museum and the Victoria and Albert Museum in London, the Musée du Quai Branly in Paris, the Royal Museum for Central Africa in Tervuren (Bruxelles, recently renamed "Africa Museum"), the Humboldt Forum in Berlin, the Smithsonian Institution in the US, just to mention few of them. A vast bibliography addresses topics connected with the study of the biographies and the provenance of objects arrived in the Western world from extra-European countries, considering decolonial and repatriation practices (among others see Appadurai 1986, Aria M., Paini A., 2014, Harris C., O'Hanlon M., 2013, Sarr F., Savoy B., 2018, Thomas N., 1991, Von Oswald M. and Tinius J., 2020). Provenance research is more and more encouraged in order to enlighten circumstances of acquisition of the massive importation of objects from different regions into Western museums, so that illegal or violent acquisitions could be identified and appropriately addressed. More generally, in the globalized world the awareness of the ethical implications connected with cultural heritage and intellectual property is growing, and the need to involve communities of origin of the objects in international cooperation projects is widely perceived. In this perspective, digitization of collections, web dissemination of information and virtual reproductions of the objects are seen as fundamental steps in the process of museum decolonization, allowing a virtual returning of cultural heritage to scholars and international audiences.

Italian demo-ethno-anthropological museums begin to be involved in this international debate. Italy preserves many important collections of non-European origin, which have

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arrived since the 15th century by virtue of an ancient cosmopolitanism linked to the political, economic and religious interests of the pre-unitary states. A long tradition of explorers, travelers, missionaries, and traders fostered the formation of important museum collections. A chapter unto itself is that of the heritage of the Italian colonies (Somalia, Eritrea, Libya and Ethiopia), to which must be added the many testimonies of Italian official participation in the administration of the Independent Congo State and of Belgian Congo. Most of this heritage remain in storages that are not accessible, while what is on display is often presented with obsolete narrations based on primitivist and cultural evolutionary schemes (Lattanzi 2021). But in recent years, some important Italian museums (among others Museo delle Civiltà in Rome, Museo delle Culture in Milan, Museo di Antropologia ed Etnografia of the University of Turin) began to experiment decolonial practices partly based on innovative technological displays and digital communication.

5.2 Digital catalogues, web platforms, virtual restitution

Research on objects' provenance and biographies is necessary to contrast the wide scarcity of data and of in-depth knowledge of artefacts and on their trajectories. The Italian Code of Cultural Heritage states the fundamental need of studying and cataloging cultural properties for the purposes of heritage knowledge, protection, preservation and conservation (Codice dei Beni Culturali, Art. 17). The Ministry of Culture, together with the Central Institute of Catalogue and Documentation (ICCD), oversees this fundamental activity through its regional offices (Soprintendenze). To unify and optimize the processes related to cataloging the cultural heritage, ICCD developed since 2004 the general information system SIGEC-WEB. The system uses different types of records for each category of material and immaterial cultural goods belonging to the archaeological heritage, the architecture and landscape heritage, the demo-ethno-anthropological heritage, and the historical and artistic one. It manages alphanumeric, multimedia and geographic information to optimizes the

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process of cataloguing, guaranteeing data quality and homogeneity (Fiorino e Loddo, 2015). The Italian General Heritage Catalogue is fully accessible on the web through browsers and is not influenced by hardware or software configurations. The homogeneity of information is in fact the prerequisite for its immediate availability, interoperability and sharing.

The study and dissemination of the trajectories of objects guaranteed by the web platform is in accordance with the ethical principles that progressively international museums are trying to promote. Publishing the information on objects is not only a legal obligation, but also a tool of fundamental transparency that can be adopted for cultural heritage. In this perspective, the SIGEC platform can be seen as a powerful instrument of digital restitution of the cultural heritage preserved in Italian museums, even if it could be implemented to envision a bilingual Italian/English version (at least for the core data) so to reach also the communities of origin of exotic objects. However, the platform is a professional tool suitable for use mainly by officials and researchers. More broadly usable communication systems for digital data sharing should therefore be experimented.

Paul Basu's carried out an interesting project focused on the digital restitution of a traditional African heritage (2015), showing the potentialities of web-based information systems in international heritage management. The project consists of a database of about 3500 digitized images of ethnographic objects from Sierra Leone, accompanied by information and short films that "reanimate" the items, showing them in action in their contexts of use. The aim of the project is the sharing of information and practices among different actors and communities, involved in a multi-sited production of knowledge.

Another sample of digital restitution is provided by the "Digital Benin project" led by Italian ethnologist Barbara Plankensteiner, director of the Museum of Rothenbaum in Hamburg (MARKK). The website consists in a digital catalogue collecting data, images and linked research for 5.246 objects from Benin, dispersed in 131 institutions in twenty countries, freely available on the Web (<https://digitalbenin.org/>). Many of the items present in the website

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are connected to the British colonial military campaign on Benin City, a 'punitive expedition' led by British Navy forces and members of the Niger Coast Protectorate in 1897, which caused the wide-scale looting of the royal palace and the city. One section of the system provides detailed information on the provenance and the biographical history of the objects, while other sections present video-interviews to scholars, local historians, testimonies, artists, and oral documents (see also Plankensteiner 2018).

Digital restitution policies are adopted by a wide range of museum and heritage contexts, including archaeological sites that can be reconstructed through virtual technologies to recreate destroyed or looted buildings or works of art, even when physical repatriation cannot be legally pursued for a variety of reasons (Genovese & Russo, 2021; Atzori et al., 2023). Physical 3D replicas, realized through virtual technologies, along with digital twins are techniques often used as surrogates to compensate for cultural losses. More recently, NFTs (Non-Fungible Tokens) have been introduced into the debate to try to obviate or at least supplement the issue of cultural ownership. For example, digital images of looted artworks in Africa, transformed into unique NFTs, have been acquired by digital museums maintaining an economic value (Stec, Jagielska-Burduk, 2023).

5.3 Pilot studies

The pilot studies of the spoke "Virtual Technologies for Museum and Art collections" offer various insights to experiment forms of digital restitution in a wide perspective. As seen in the literature quoted before, demo-ethno-anthropological museums are among the institutions most affected by the post-colonial debate and for this reason they need to explore opportunity of carrying out cooperation projects involving the countries and the communities of origin of the heritage they host. Digital technologies can provide different interesting solution for this need.

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The MAET – SMA Turin is planning to carry out a project centered on one of its most important artefacts, the cotton zemi of the extinct taino people, dating back to the XV century. The object has raised an intense debate, following a restitution request made by the Dominican Republic to the Italian government, that has provided an important opportunity for reflection. The zemi is the only existing pre-Columbian cotton taino reliquary, containing the portion of a human skull. It was discovered in a cave in the Dominican Republic in 1882 and purchased by the Italian consul Giovanni Battista Cambiaso, who sent it to Italy before 1902. It was then donated in 1928, along with another wooden zemi, to the Museum of Antiquities in Turin and from there to MAET. Extensive research into the provenance and the biography of this extraordinary object proved the legitimacy of the acquisition (Ostakpowicz and Pennacini 2023). Nevertheless, the MAET wishes to collaborate with Dominican cultural institutions to pursue its shared valorisation.

In this perspective a project funded by E-RHIS (European Research Infrastructure for Heritage Sciences) has been carried out in 2022: MAETZE (The Maet Zemis new virtual life) aimed at producing detailed data on the manufacture of the object, useful for developing an interactive 3D model designed for the general public. MAET is planning to create a digital twin of the cotton zemi using this data, to be explored 360° externally and internally, with public-activated information hotspots that reconstruct the complex trajectory of the object, witness to crucial changes in global history. The software containing this information can be realized through virtual reality immersion with VR viewers, deepened through installations that reproduce a full-size digital twin to be consulted thematically at different levels of depth, and further explored through mobile devices. A cooperation project with Dominican cultural institutions could be developed so to make the zemi digital twin available both in a tangible display and on a web platform, accessible to scholars and the international public.

The MCACL - SMA Turin, will give another opportunity to experiment digital restitution of a sensitive heritage. The museum exhibits the collections gathered mainly by Cesare Fondazione CHANGES - Cultural Heritage Active Innovation for Sustainable Society

Lombroso in the second half of the 19th and early 20th centuries, consisting of anatomical preparations, drawings, photographs, bodies of crime, handicraft and artistic productions made by internees in asylums and prisons. Experimentations with digital technologies will be carried out to represent part of this heritage in a virtual form, re-elaborating it through graphic and multimedia supports that will facilitate its contemporary comprehension.

For instance, the tattoo drawings collection of the museum will be virtually displayed in a specific interface for in-museum use, that will be designed and textured through a 3D interactive station with touchscreen videos which will allow a 360 display of individuals and details of individual tattoos. The installation will virtually display the entire collection of tattoos stored in the museum archives using an interactive approach, that will be interrogated by visitors. A similar experience will be available through a web platform, where the museum collections will be reframed, historicizing old narratives and reading them in a new perspective.

Similar applications can be explored by the SMA Ferrara, dealing especially with anatomical, zoological and scientific *specimina* that can be represented in virtual displays reconstructing their historical trajectories. The SMA Bologna preserves diverse historical, ethnographic and naturalistic collections. If the Aldrovandi cabinet of curiosity used to reflect the Renaissance perception of the world, the Cappellini museum was conceived following the XIX century scientific museum paradigm. In both cases, the use of virtual technologies can offer the opportunity to share digital reproduction of specific objects to the international public, experimenting forms of restitutions of exotic samples to their countries of origin.

The Egyptian Museum of Turin has pursued a model of participatory museology since its renovation in 2015. The nature of its collection obviously requires a focus on postcolonial issues, which has been expressed in the effort to involve in museum life migrant communities in Turin from Egypt and the Middle East. Several projects have been carried out by the museum in this direction, such as the "Museum and Migrants" workshop held in 2018-19, Fondazione CHANGES - Cultural Heritage Active Innovation for Sustainable Society

and the initiatives organized for International Refugee Day. A digital experiment can expand this vision by giving to diversified publics the opportunity to create their own stories in an interactive mode. In this way, visitors will be enabled to create subjective museum narratives, virtually choosing objects and linking them together through a semantic structure. In contrast to the passive and undifferentiated fruition of the traditional museum, this experience can return agency to audiences by avoiding the imposition of a preordained exhibition organization.

Demo-ethno-anthropological, historical and scientific collections have crossed a multiplicity of meanings in their trajectories, attributed to them by the different actors with whom they came into contact. Successive interpretations have intertwined with the original ones in a dense and inextricable layering, so that displays are made by “entangled objects” (Thomas 1991). Reading their trajectories through the complex and multiple perspective of a globalized world is a fundamental challenge for contemporary museums. Objects are testimonies and ambassadors of the societies which produced them (Aria and Paini, 2014), and digital technologies can bring them out of stillness and muteness, so that they can tell their entangled stories for the benefit of generations, opening a view on the links between the past and the present.

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