



# Master thesis

Master's Programme in Digital Service  
Innovation, 120 credits

## Immersive technology applications in the museum environment

Challenges and opportunities

Master Thesis in Informatics, 30 credits

Halmstad, 2022-05-20

Nadina Husidic



# Immersive technology applications in the museum environment

## Challenges and opportunities

*Nadina Husidic*

*nadhus20@student.hh.se*

Master thesis in informatics

Master's Programme in Digital Service Innovation

Halmstad University, Sweden

**Abstract.** Due to digitalization and digital transformation, service-based organizations are looking into how to apply innovative digital technology in their models and processes. In the cultural heritage sector, immersive technology is often adopted to enable the digitalization of the museum experience. Applying immersive technology comes with new challenges and opportunities for museums, and it is, therefore, a strategic decision. Current literature focuses on the impact of immersive museum experiences on visitors, leaving a knowledge gap concerning the internal and external strategic stakeholders' perspectives. The present work presents an explorative qualitative study of the perceived challenges and opportunities by strategic stakeholders of the Swedish cultural heritage sector. The main outcome of this study is a thematization of the challenges and opportunities. The findings on the challenges of immersive technology application are thematized based on innovation management, design value, and organizational model. The identified themes related to the opportunities regard operational efficiency, social sustainability, and experience design. The outcomes of this study can inform the work of researchers and industry professionals with epistemic, experiential, economic, social, and cultural implications.

*Keywords:* immersive technology, museums, cultural heritage, stakeholder approach

## 1 Introduction

In “Art as experience” (2006), Dewey describes the need for a shift in the role of art within society. The claim is based on the author’s observation that the essence of art transcends its physical manifestation, which Dewey defines as “the cultural object” (Dewey, 2006).

Society has traditionally separated works of art from the daily experience of their observers, for instance by positioning art inside museums. Museums preserve cultural heritage artifacts, and educate the public through exhibits, helping visitors obtain and understand information about a subject (Nisiotis et al., 2020). The process of preserving and handing on socially valuable content has traditionally resulted in the isolation of cultural artifacts into a “sterile, aesthetic dimension” (Gilmore & Ii, 2007). However, this confinement diminishes its impact on the observers' experience (Dudley, 2009).

In the past thirty years, first digitalization and then digital transformation have created both challenges and opportunities for all organizations and industries (Sjödin et al., 2020). Digital transformation is defined as the transformation related to the changes digital technology can deliver in an organization's business model, products or services, and organizational structure (Sjödin, Parida, Jovanovic, et al., 2020; Salvi et al., 2021). The application of digital technology has profoundly changed the nature of products and services alike (Norman, 2009; Resmini & Rosati, 2009). The 2020-2021 COVID-19 pandemic has hastened the digital transformation of all service-based sectors, including cultural heritage (Manser Payne et al., 2021). Cultural heritage professionals and policymakers have recognized a need for high-level organizational and process-related changes to support digital innovation (Matzner et al., 2018, Raimo et al., 2021). These changes transcend the digitalization of resources, and should rather reflect an all-encompassing, socio-technical transformation of the various components of the cultural heritage system (NEMO, 2013, 2020).

The growing pervasiveness of digital technology in the cultural heritage sector recalls the idea of an indispensable transformation of the role of museums and art in society as described by Dewey (2006). In the cultural heritage sector, digital transformation has firstly involved museums, starting with the introduction of websites, to the application of emerging new technologies to enhance the visitor experience with new interaction dynamics between the different museum stakeholders (Teece, 2018; Raimo et al., 2021). Museums contribute to improving and sharing knowledge about cultural heritage, within the cultural heritage system (Romanelli, 2018). The novel interaction models determined by the introduction of digital technology have been one of the drivers of the shift in the role of museums, extending the experience beyond mere knowledge sharing (Salvi et al. 2020, Raimo et al., 2021). The traditional model of museums, where experience relies on three-dimensional exhibitions of physical cultural artifacts, is redesigned when new technologies are integrated into the museum system (Raimo et al., 2021). New physical and digital spaces for interaction are designed to reconstruct the museum service experience, in a collaboration between the different system stakeholders (Romanelli, 2018).

Immersive technology is an example of promising innovation applicable to the museum sector (Ciolfi & Bannon, 2007; Pop & Bonca, 2016). The application of immersive technology in museums has supported the development of the “virtual museum” concept, a “digital spatial environment, located in the WWW or the physical exhibition, which reconstructs a real place and/or acts as knowledge of a metaphor, and in which visitors can communicate, explore and modify spaces and digital or digitalized objects” (Pujol & Lorente, 2014). This definition could be further elaborated to include those immersive technology applications that do not solely replicate a copy of an existing physical place, such as the Museum of Other Realities concept (MOR). The MOR is presented as an “immersive multiplayer art showcase”, with the aim of “supporting artists who are challenging and redefining what is possible” (*Home | Museum of Other Realities*, n.d.). Therefore, the content of this digital exhibition does not reproduce anything physically existent, but rather displays artistic interpretations of alternative realities.

The resulting narrative output of immersive technology is a unique experience, as it is formed iteratively and collaboratively by each user (Yi & Kim, 2021). Experience itself can be defined as the byproduct of continuous and cumulative interaction of the visitor with the world (Dewey, 2007). Whereas the traditional experience of a museum often resulted in static and largely passive relationships between the audience and exhibited objects (Dudley, 2009), recent developments have placed their emphasis on interactivity as a way to increase interest and engagement (Ciolfi & Bannon, 2007, Katifori et al., 2018, Ch'ng et al., 2019). Throughout the past two decades, digital technology has been increasingly used to shape novel museum experiences that center on visitor agency within the museum space, and on providing a narrative through which the fruition of cultural objects acquires depth and weight (Waern et al., 2022; Ciolfi & Bannon, 2007).

Innovations in the information and communication technology (ICT) field have profoundly changed the way of producing and communicating content and the way users access information. Digital technology refers to all the tools and new languages introduced in our cognitive, perceptual, cultural, social, and productive processes from the application of ICT in media and everyday life (Lughi & Suppini, 2015). Digital technology is developing to such an extent that it is now able to construct entirely new realities, within which novel relationships between actors are established. Immersive technology is a rapidly emerging digital technology enhancing digital transformation in several different contexts, including museums (Katifori et al., 2018).

The term immersive technology encompasses various technological innovations, including virtual reality (VR), augmented reality (AR), and mixed reality (MR) (Handa et al., 2012). Immersive technology blurs the barriers between the physical and the virtual world, enabling users to experience a new sense of immersion (Lee et al., 2013; Suh & Prophet, 2018).

Therefore, museums have been actively impacted by digital transformation, but are struggling to grasp and apply the potential of digital technologies (NEMO, 2013, 2020). Research has mainly produced specific studies on user satisfaction with exhibits based on immersive technology (Romanelli, 2018; Ch'ng et al., 2019). Museum visitors are no longer satisfied with passively enjoying exhibitions but look to be the protagonist of a valuable cultural experience.

Moreover, the co-creation and collaboration of different stakeholders within the museum system affect the streamlined adoption of new technologies and processes (Raimo et al., 2021; Salvi et al., 2021).

The introduction of immersive technology creates novel opportunities for interactions between different stakeholders in the museum system (Teece, 2018, Raimo et al. 2021). While research has identified a need for a cross-methodological and cross-disciplinary investigation of the usefulness and impact of digital technology in the cultural heritage sector (Pagano et al., 2021), the different components of the museum experience have been traditionally analyzed as separate entities. Researchers have identified a lack of knowledge about the factors that influence strategic digitalization choices in museum settings (Raimo et al., 2021).

This study intends to complement the current understanding of digitalized museum experience in the research field of information systems (IS) by specifically approaching the application of immersive technology in the museum sector from a stakeholder perspective (Pagano et al., 2021). Thus, the following research question (RQ) was formulated:

*What are the key challenges and key opportunities related to the application of immersive technology in museums?*

Following a stakeholder approach (Freeman, 1984), this study identifies several internal stakeholders representing different strategic roles in the museum system, internally (e.g., museum

directors, curators, technical operators), and externally (e.g., representatives of municipalities and other institutional actors).

The paper is structured accordingly: it presents a literature review of immersive technology and its applications in the museum environment, followed by a description of the concepts of narratology, storytelling, and extended narrative interfaces in relation to the digitalized museum experience. Next, the paper continues with the research methodology, research approach, methods for data collection in the form of a literature review and interview methods, and data analysis. Following is a depiction of the empirical findings and their thematization. The findings are divided based on the RQ in challenges and opportunities related to the application of immersive technology in museum settings. The identified challenges regard innovation management, interpreting the design value, and adapting the museum organizational model to immersive technologies. The main opportunities related to the application of immersive technology in museums resulted being the optimization of operational efficiency, and the enhancement of social sustainability and experience design. Next, the discussion elaborates on the findings by comparing them to the results of the literature review and outlining the findings' possible implications on the knowledge base. Finally, the paper ends with the conclusion and comments on research limitations and the implications for further research.

## **2 Literature review**

This study anchors its fundamentals in a literature review, as an instrument of direction to understand the research area and establish a conceptual base for the research problem. Existing knowledge is presented in the following paragraphs and has been utilized to design and develop essential elements of this study. The literature review describes firstly immersive technology and its application in museums. Following, it describes narratology and storytelling as the foundation for immersive experiences, and it ends by addressing the concepts of extended narrative interfaces and spatial computing.

### **2.1 Immersive technology: a definition**

Immersive technology blurs the barriers between the physical and the virtual world, enabling users to experience a novel sense of immersion (Lee et al., 2013; Suh & Prophet, 2018). The term immersive technology entails various types of digital technology, including virtual reality (VR), augmented reality (AR), and mixed reality (MR) (Handa et al., 2012).

Janet Murray (1997) defines three main characteristics of digital technology, as applicable to immersive technology: agency, immersion, and transformation. Agency refers to the user experience of imposing a change onto the digital artifact, and immersion represents the ability of a digital artifact to hold the interest of users (Koenitz et al., 2017). The transformative nature of these characteristics of digital and immersive technology results in an always different experience (Yi & Kim, 2021).

The use of immersive technologies in designing interaction within real-and-virtual combined environments serves as the fundament for human-machine interactions in the context of extended reality (XR) (Waern et al., 2022). The term extended reality (XR) includes various technologies incorporated within the virtuality continuum, a spectrum connecting the “complete real” to the

“complete virtual” (Milgram & Kishino, 1994), comprising different levels of virtuality: AR, MR, and VR.



**Figure 1.** Reality-Virtuality continuum (Milgram & Kishino, 1994)

As shown in Figure 1, the relationship between real and virtual environments can be described by means of a continuum, where the real environment and the virtual environment represent the two extremes of an MR space in which AR sits closer to the former and VR coincides with the latter (Milgram & Kishino, 1994; Suh & Prophet, 2018).

Augmented reality integrates virtuality in the real environment and enhances user experience by superimposing digital information on the real world (Azuma, 1997; R. Azuma et al., 2001; Suh & Prophet, 2018). Virtual reality enables the user to experience a realistic virtual environment (H. G. Lee et al., 2012). Mixed reality technology provides novel instruments for the design of enhanced experiences (Yi & Kim, 2021).

Table 1 below defines the main investigated concepts, as per the analyzed literature.

Concept	Definition	References
Immersive technology	Technology that blurs the boundaries between real and virtual environments, enabling users to experience a feeling of immersion.	Lee et al., 2013; Suh & Prophet, 2018
Augmented reality (AR)	Technology that offers a reality enriched with computer-generated information, which is superimposed on the real environment.	Azuma, 1997; R. Azuma et al., 2001
Virtual reality (VR)	Technology that immerses the user in a virtual environment, often designed to recreate the physical world, with no visibility of the real environment.	H. G. Lee et al., 2012
Mixed reality (MR)	The space where physical and virtual worlds coexist with different degrees of admixture on the reality-virtuality continuum.	Milgram & Kishino, 1994
Extended reality (XR)	Term that refers to all real, virtual, and mixed environments. It includes AR, VR, MR, and all future technologies.	Okanovic et al., 2022

**Table 1.** Definitions of main concepts

The present study utilizes the nomenclature immersive technology as a general term to identify all diverse applications of extended reality technology (Handa et al., 2012; Y. N. Lee et al., 2013, Suh

& Prophet, 2018). The term immersive technology is often inside the cultural heritage sector to refer to extended reality, while XR is preferred in technical settings (Guastalegmanne, 2021).

Furthermore, systems based on immersive technology comprise two elements: the technological component, which is far from the users' perception of the service, and a psychological experience, incepted within the users' perception (Coelho et al., 2006).

As per Okanovic et al. (2022), the use of immersive technology in the museum sector serves mainly three purposes: (1) enhancing exhibitions by expanding user experience; (2) interactively reconstructing sites or objects; (3) supporting the exploration of the space and the exhibits.

Depending on the different levels of digitalization and the integration of immersive technology, the major changes within the cultural heritage ecosystem regard either the audience's perception of the cultural object or the way the cultural experience is conveyed (Raimo et al., 2021).

## 2.2 Narratology and storytelling

Narratology is defined as the theory that studies narratives and narrative structures (Urbaneja, 2019). The term narrative describes the recounting of events between two sides: narrator and audience (Koenitz et al., 2017). A narrative is designed and produced through the use of storytelling to organize its content (Pujol et al., 2012).

Traditional storytelling refers to oral forms of unilateral communication (del Carmen Villaseñor Ferrer, 2007), but has evolved into interaction-based communication with the advent of digitalization and the introduction of digital technology (Pujol et al., 2012; Koenitz et al., 2017; Okanovic et al., 2022). This newly-established interactive digital storytelling refers to the use of digital technology for narrative design (Koenitz et al., 2017). The agency and immersion characteristics of digital technology described by Murray (1997), participate in the transformative process of individual user experience and are reflected in interactive digital storytelling. Thus, digital storytelling relies on user interaction as a paradigm for story narration (Pujol et al., 2012).

Museums are places where visitors are given access to cultural objects, to learn and live remarkable and unforgettable experiences (Kamariotou et al., 2021). Pekarik et al. (1999) developed a taxonomy of user experiences in museum applications: (1) objective experiences, which focus on the cultural object; (2) cognitive experiences, developed around the learning and intellectual aspect of the experience; (3) introspective experiences, within the intimate, personal sphere of the visitor; and finally, (4) social experiences, with museums as social gathering places.

Therefore, "museums are storytellers" (Bedford, 2001), as they use stories to animate their collections (Lohman, 2006). Museums offer an interpretation of the meaning of cultural objects, which could otherwise be not immediately discernible to the general public. They do so by using different media and mediators sequentially positioned through the space of the museum or gallery (Pujol et al., 2012).

With the advent of digital technology, museums are participating in extended, more frequent interactions with their visitors and they have recently been pursuing a more visitor-oriented perspective (Pujol et al., 2012; Ch'ng et al., 2019). As a direct consequence of the increasing interactions with visitors, the once authoritative voice of museums as monolithic custodians of culture has turned into a multifaceted experience that encourages dialogue with the visitor (Wyman et al., 2011).

Furthermore, Okanovic et al. (2022) describe digital storytelling and narratology as evolving methodologies focusing on digital media environments, adding to conventional storytelling a novel dimension: interaction. The interactive museum experiences fall within the cross-media contexts described by Resmini and Lacerda (2016). In cross-media contexts, several service ecosystems come together to create a loose, personal narrative ecosystem centered on the goals and desired

future state of a specific person (Resmini & Lacerda, 2016). Users are now active participants in these ecosystems and directly produce novel content or transform the existing one (Resmini & Rosati, 2009).

Due to this novel and enhanced level of user interaction, the application of immersive technology is still lacking standardization of patterns and dynamics (Okanovic et al., 2022), which often compromises user satisfaction with the immersive experience itself (Roussou & Katifori, 2018; Katifori et al., 2018).

## **2.3 Extended narrative interfaces and spatial computing**

Myron Krueger, among the leading exponents of first-generation VR and AR research, describes immersive technologies as mainly based on the notion of immersion, which consists of involving the body in physical or digital spaces (Krueger, 1983).

In museum settings, the architectural environment in which exhibitions are positioned has a purposeful influence on the placement of the curated story in the physical space (Pujol & Lorente, 2014). As per space, the essence of architecture can be described as the positioning of spatial episodes to design sequences (DER SPIEGEL, 2006).

In the domain of information architecture, the notion of space has been reflected in concepts such as spatial computing: the virtualization of interactions between actors, machines, objects, and the environment in which they take place (Waern et al., 2022; Falk & Dierking, 1995). Spatial computing defines human-machine interactions in which “the machine retains and manipulates referents to real objects and spaces” (Greenwold, 2003). Spatial computing describes the situation when users, machines, and the physical space are integrated to the point that users do not adapt to the complexity of computing, but rather machines conform to their users and space ubiquitously (Low, 2020; Guedez, 2021).

Systems based on immersive technology applications can fall within the definition of ubiquitous ecologies by Resmini and Rosati (2009), as “emergent systems where old and new media, as well as physical and digital environments, are designed, delivered, and experienced as a seamless whole”. These new architectures embrace different domains (physical, digital, and hybrid), different types of entities (data, physical items, and people), and different media. When every single artifact, be it content, product, or service, is a part of a larger ecosystem, the focus shifts from how to design single items to how to design the experiences themselves (Resmini & Rosati, 2009). The immersive technology experience of walking through real space while being involved in the mixture of reality and virtuality processes differs at its core from the user experience derived from desktop or mobile digital applications (Yi & Kim, 2021). While desktop and mobile devices convey the experience through touching and handling physical, technological mediums equipped with screens, with immersive technology the medium transcends the physical object and is replaced by the users’ perception (Greenwold, 2003). In the context of museums, it is important to take into account the relation of interaction and experience with the space of the exhibition. Thus, researchers focus on understanding and integrating the spatial properties of the physical world in digital and virtual design (Ciolfi & Bannon, 2007).

## **3 Research methodology**

The present study follows an explorative research approach based on qualitative interviews of specific stakeholders in the museum service system. More specifically, this study aims at uncovering challenges and opportunities related to the application of immersive technology in the



museum environment. The outcomes result from qualitative research conducted with key stakeholders part of the museum experience, in the form of semi-structured interviews, the subsequent analysis of said interviews, and reflections based on literature. A qualitative approach was preferred due to its predisposition for the elaboration of themes, to be developed in implications, based on the analysis of the collected data (Wilson & Creswell, 1996). Qualitative research methods have been proven useful to iteratively investigate and inform emerging and developing processes (Maxwell, 2022; Kaplan & Maxwell, 2005). Thus, they were considered in line with the dynamic evolution of immersive technology and its applications. The nature itself of explorative and qualitative studies is circular and recursive (McCartan & Robson, 2016), while common design research methods are often sequential, and establish preemptively the essential steps of a study (Maxwell & Loomis, 2003).

The objective of this study is to provide a stakeholder perspective of the point of view of the internal and external, strategic stakeholders that shape the museum experience, and the current context in which they operate. Qualitative research is particularly useful when examining the influence of social, organizational, and cultural context on the study subject (Kaplan & Maxwell, 2005).

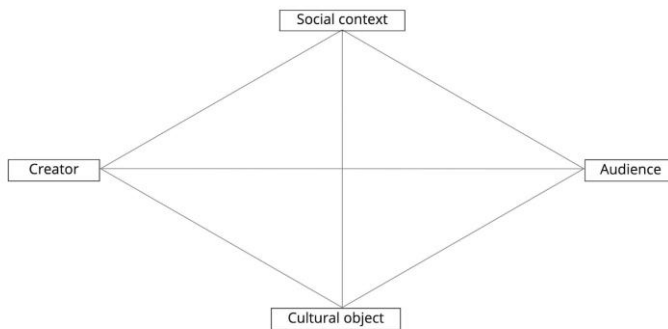
The scope of this study is limited to the museum context, as the place in which the experience unfolds (Benyon & Resmini, 2017). The study follows a stakeholder approach (Freeman, 1984), specifically targeting internal and external strategic stakeholders.

### 3.1 Stakeholder approach: the stakeholders in the museum system

The present study is grounded in the stakeholder theory developed by Freeman (1984). Stakeholders (SHs) can be defined as those individuals, groups, communities, or organizations who are either capable to affect or are instead affected by a specific endeavor (Friis Dam & Yu Siang, 2020). The stakeholder approach suggests that any organization is defined by the relationship and dynamics it holds with different actors (Freeman, 1984).

Researchers agree that choosing to use a stakeholder approach when analyzing the involvement of innovative technology in any organization, provides a systemically cohesive picture of a problem (Tipping et al., 1995; Hall & Martin, 2005; Kamal et al., 2011).

Regarding the topic of this study, Griswold and Hongladarom (1999) identify the main stakeholders in any generic cultural process, as follows: (1) cultural object, which is physical, abstract, textual, or performed; (2) creators, who have worked on the cultural object as its creator, performer, or interpreter; (3) audience, those who actually or potentially experience the cultural object; (4) social context, the spatial and temporal context in which the previous are situated, and the cultural object is experienced.

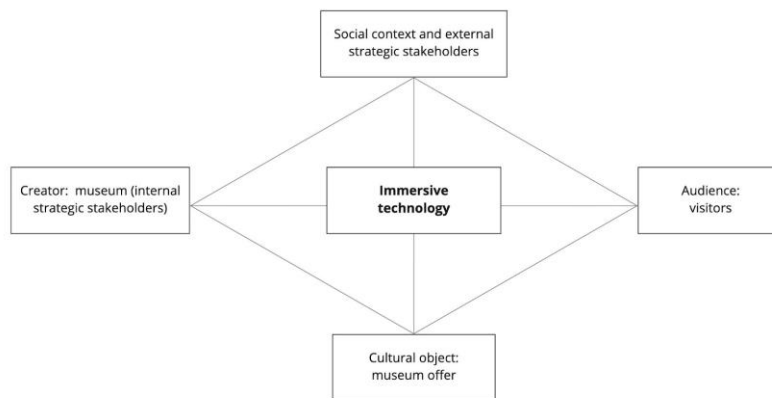


**Figure 2.** Cultural diagram (Griswold and Hongladarom, 1999)

The four different actors in the ecosystem interact with each other following the connection lines of a rhomboidal structure, with perpendicular intersections.

With the advent of new technologies and digitalization, the cultural diagram fails to depict a complete picture of the active stakeholders in the cultural process. Digital technology assumes a novel position in the ecosystem, as they represent a tool that enables the development of new dynamics between all the formerly identified actors (Teece, 2018, Raimo et al. 2021).

Therefore, immersive technology occupies the center of the revised cultural diamond developed for this study (see Fig. 3). This pivotal position determines the function of immersive technology and its possible relationships with the other elements of the system.



**Figure 3.** Cultural diamond and immersive technology (adapted from Griswold and Hongladarom, 1999)

The introduction of immersive technology and its position defines specific classes of stakeholders within the ones outlined by Griswold and Hongladarom (1999). As per the presented RQ, this study focuses on exploring what are the possible challenges and opportunities related to the introduction of immersive technology in the museum system. While all stakeholders interact with the new actor in the framework, the scope of this study is limited to exploring the challenges and opportunities related to the application of immersive technology within the museum setting. Within organizations, possible challenges and opportunities are assessed by strategic level stakeholders in light of technological application (Freeman, 1984; Romanelli, 2018). Strategy involves setting goals, determining the processes to achieve them, and mobilizing the resources to execute them (Freedman, 2013). Moreover, Freeman (1984) classifies stakeholders into two categories: internal stakeholders, such as employees and managers of a company; and external stakeholders, for instance, the government, society, shareholders, customers, and users.

Therefore, the scope of this study focuses on targeting the perspective of internal and external strategic stakeholders. In the adapted cultural diamond framework (Fig. 3), they are represented by the classes of:

- Creators, as the internal strategic stakeholders in the museum environment. Namely, museum directors, curators, and technical operators.
- Social context, in terms of the external strategic stakeholders involved in the museum industry, such as representatives of municipalities and other institutional stakeholders.

## 3.2 Methods for data collection and analysis

Data was collected in the form of a literature review of scientific and industry-specific articles and documentation, and interviews. Interviews were conducted from March 2022 to May 2022. The secondary data was used to inform and design the interview guide and materials. The primary data derived from said interviews represented the base for developing insights, and iterative observations.

To assess the current state of knowledge on immersive technology in cultural heritage and museum applications, the present study includes a search of relevant academic literature (Watson & Webster, 2020). The literature review was also the foundation to uncover potential gaps in the knowledge base.

A preliminary Google Scholar search was conducted to ensure the best keyword combinations referring to immersive technology in the cultural heritage and museum sector. The search mainly showcased the multifaceted nature of the subject matter, and resulted in the identification of a series of keyword strings: “museums” and “cultural heritage”, “immersive technology”, “extended reality” (and “XR”), “augmented reality” (and “AR”), “spatiality”, “narratology” and “storytelling”. Therefore, to provide an accurate depiction of the state-of-the-art research and develop a multidisciplinary, systemic analysis, searches from multiple databases (Google Scholar, Scopus) were composed. While Google Scholar was used as a base to easily identify recurrent themes, Scopus was the primary choice due to its reputation as a leading database of peer-reviewed literature. The search query for the initial set of articles was based on various combinations of the previously listed keywords. At this point, exclusion and inclusion criteria were applied. The results were filtered to only include works published between 2012 and 2022, to ensure their relevance. The search only focused on papers written in English. Moreover, to account for the intrinsic cross-disciplinarity of the topic, the articles were filtered per subject area, including only the following fields: computer science, arts, business, and sociology.

The filtered search resulted in a total of 2,287 articles. Duplicate papers were excluded, and papers related to the technical aspects of immersive technology application were deemed as out of scope. At this exclusion level, the search offered 79 remaining papers. The titles and abstracts of the remaining papers were scanned with regard to their relevance to the present study. The inclusion criteria used during this analysis were mainly focused on the type of stakeholders involved in the research.

In conformity to this study’s research question, the inclusion comprehended all strategic, internal, and external stakeholders, and excluded papers focusing on users, artists, and specific immersive installations. Finally, the literature search resulted in 18 relevant articles. Additionally, 12 more articles were included after reviewing the cited references of the former 18 papers. Thus, the final set of papers included 30 scientific articles. The articles were thoroughly read, analyzed, and summarized to define the main concepts and the most relevant themes related to immersive technology in museum applications, as previously described in the *Literature overview* section.

Semi-structured interviews were used to gather primary data. Interviews were chosen as they represent a common tool in qualitative research settings (Bell & Bryman, 2007). Moreover, conducting semi-structured interviews offered the opportunity to collect data on the perception, experience, and perspectives of the selected museum stakeholders on the topic of immersive technology.

The interviews were structured to gather insights from different actors in the museum experience. Aiming to develop a collectively exhaustive frame of reference and perspective regarding the topic, the selection of participants for the interview data gathering was based on a cross-functional and

cross-disciplinary principle. Thus, the selection criteria for the stakeholders were based primarily on their functional position within their respective organizations. Based on the scope of the stakeholder approach, the target stakeholder categories were internal and external strategic stakeholders.

Table 2 provides an overview of the information about the respondents to the interview sessions.

ID	Position	Organization	SH category	Location	Date	Duration
R1	Researcher Developer	Research institution	External	Sweden	2022/04/06	60 min
R2	System Manager	Public museum	Internal	Sweden	2022/04/07	60 min
R3	Culture Project Manager	Municipality	External	Sweden	2022/04/07	60 min
R4	3D Developer	Municipality	External	Sweden	2022/04/12	60 min
R5	Business Developer	Public institution	External	Sweden	2022/04/14	60 min
R6	VR Creative Strategist	Private organization	Internal	Denmark	2022/04/14	60 min
R7	Museum Director	Public museum	Internal	Sweden	2022/04/20	45 min
R8	Exhibition Curator	Public museum	Internal	Sweden	2022/04/22	60 min

**Table 2.** Interview respondents

To guarantee anonymity, the interviewees' names have been omitted from the interview respondents list. Instead, the interviewees have been referenced using an identifier (ID): the letter R, for respondent, and a number.

The selection of participants comprehended eight unique stakeholders of the museum system. The main inclusion criteria for the selection of interviewees was to cover a strategic position within the museum system. To ensure a fair representation of the parts, out of the eight involved stakeholders, four were internal strategic stakeholders, and four were external strategic stakeholders. A secondary prerequisite was to be comfortable being interviewed in English. All the interviewees were scouted and contacted directly by the author of this study, after research of main Scandinavian museum institutions and organizations. The interviews followed an interview guide (see Appendix 1), to ensure the scientific rigor and trustworthiness of the qualitative study (Lincoln et al., 1985; Kallio et al., 2016).

The interviews were all conducted separately and remotely, using video conference platforms (Zoom and Teams). By opting for remote interviews, it was possible to reach a broader base of stakeholders. Before the interview sessions, the stakeholders were firstly invited via email to participate in the study and informed about its setting (Master's thesis research for Halmstad University), the topic, and the duration of the interview. The same interview process was replicated throughout all the interviews. At the beginning of each interview, the participants were greeted and informed about the interview process, and consent to record the interview was requested. To establish a common ground and understanding of the subject matter, the interviews opened with a description of the topic of immersive technology and the definition of the general concepts within the realm of extended reality.

As the study follows a stakeholder approach, all interviewees were asked to thoroughly describe their position within their organization, their title, specialization, and prior experiences in the cultural heritage and museum sector, as well as previous encounters with immersive technology in

other environments. The discussion was then conducted as per the interview guide (Appendix 1), giving the respondents the open opportunity to elaborate on topics of their interest. The flexible, semi-structured nature of the interviews allowed for a deeper understanding of each stakeholder's perspective (Bell & Bryman, 2007).

The interviews ended by thanking the respondents and asking for any impromptu comments on the experience. All the respondents expressed their interest in the final results of the research and independently requested access to the final materials.

Interview recordings were then accurately transcribed, read, and analyzed as follows.

To answer the RQ, the interview assessment methodology was developed by taking into consideration variances in the respondents, the referenced technology adaptations and installations, and content diversity. The identified themes were based on the diversified angles given by the different stakeholders, covering technology aspects (e.g., hardware), business aspects (e.g., organizational impacts), and social aspects (e.g., user perception, sustainability).

Data collected from different sources were then analyzed following a reflexive thematic analysis (RTA) approach, recommended for qualitative studies due to its flexibility (Braun & Clarke, 2020). RTA is theoretically flexible (Braun & Clarke, n.d.), and it facilitates the identification and analysis of patterns or themes within a specific data set. Using a reflexive approach, the development of themes happens in the later stage of the analysis process. Therefore, RTA represents a valuable approach when exploring realities and themes produced within a set of qualitative data (Braun & Clarke, 2020).

The reflexive thematic analysis consists of the following phases:

1. familiarization with the data, during which the data is transcribed, read, and initial ideas are noted down;
2. systematically coding the transcriptions, with preliminary codes based on interesting features of the data;
3. generating themes by collecting the coded data in sets;
4. reviewing themes based on connections about the previous codes;
5. establishing a thematic map by refining the themes outlined in the previous step;
6. producing conclusions, through the final analysis of the themes then reported in the present paper.

The collected data was iteratively analyzed throughout the six different phases, to establish research rigor (Hevner, 2007).

## 4 Empirical findings

The following paragraph proposes a breakdown of the empirical findings resulting from the data analysis of the qualitative study conducted to answer the RQ: *What are the key challenges and key opportunities related to the application of immersive technology in museums?* Following the RQ, the analysis has focused on identifying and classifying the challenges and opportunities related to immersive technology application in the museum environment (see Tables 3 and 4). In the Tables, an example of data extract is included as the empirical reference for the respective codes.

## 4.1 Challenges related to immersive technology application in museum settings

As previously discussed, digitalization and digital transformation have affected most industries (Manser Payne et al., 2021), requiring organizations to operate crucial, socio-technical changes (Matzner et al., 2018, Raimo et al., 2021). Table 3 provides a structured depiction of the codification and thematization of the three observed themes pertaining to the challenges related to the application of immersive technology solutions for museums, relating to the *Innovation Management* aspect, the *Design Methods*, and the *Organizational Model*.

Data extract example	Code	Theme
“Immersive technology is still quite new and not completely developed, so it still has some bugs that have to be worked out for it to be easily implemented in museums.” (R8)	Novelty	Innovation Management
“VR equipment is expensive.” (R1)	Cost	
“The technological tools are still bulky and sometimes non-intuitive to use in a museum setting.” (R1)	Complexity of configuration	
” (...) We are still using the physically standardized way of being a museum and putting that into a digital context.” (R5)	Technology valorization	Design Value
“Museums possess what is the best knowledge of something that we have, and visitors expect to find the truth, in an experienceable way.” (R1)	Truth-value	
“Immersive media are disruptive by definition and the museum sector is very traditional.” (R5)	Digitalization and organizational change	Organizational Model
“An important problem with immersive media is that it takes a lot of competencies and resources, and it is troublesome to find the right resources.” (R1)	Lack of specialized resources	
“It is mainly an organizational issue: people do not talk and we have a total lack of knowledge sharing between departments.” (R3)	Lack of internal communication	

**Table 3.** Thematization of challenges based on empirical findings

### 4.1.1 Innovation Management

The established theme of Innovation Management encompasses a set of codes that describe the identified key barriers to the application of immersive technology in museums, referring to the innovative nature of this technology.

The first code refers to the notion of novelty, which is often completely assimilated into the one of innovation (Kraus, 2015). Innovation has its most important impact on society through the diffusion of new technical knowledge (Knell & Srholec, 2009), yet the novelty of technology can also represent an obstacle to its successful application. For instance, R8 points out that:

“Immersive technology is still quite new and not completely developed, so it still has some bugs that have to be worked out for it to be easily implemented in museums.”

The respondent highlights the maturity level of immersive technology, explaining that a reason for the difficulty in integrating it in the museum setting is represented by the uncertainties and lack of reliability of the technology. Moreover, R5 specifies that:

“We still do not see VR in every home: I am not entirely sure youth is the target audience for it.”

R5 perceives the missing adoption of VR solutions among the masses as a blocker to the acceptance of immersive technology solutions in the museum sector. Moreover, the respondent singles out a specific user group, youths, and describes the lack of widespread adoption of these technologies among them as a negative indicator.

Several interviewees have also reported that one of the major barriers to the application of immersive technology in museum settings is the cost of this technology.

“VR equipment is expensive.” (R1)

*“Immersive technology is still expensive.”* (R8)

“We often don't implement these technologies because of financial reasons.” (R2)

The interviews highlighted how the cost variable represents a significant impediment to adopting solutions based on immersive technology.

Furthermore, the complexity of configuration was particularly emphasized among respondents as a key challenge to immersive technology employment in museum spaces. Interaction researcher and developer R1 explained how:

“The technological tools are still bulky and sometimes unintuitive to use in a museum setting.”

The current state of development of immersive technology tools does not satisfy the necessities of museum stakeholders, from a logistics and safety point of view. R1 also adds “It is a problem to organize the visitor journey and ensure safety.”

The equipment for immersive experiences can occupy large spaces in the exhibition areas, and it is often limited and bound to cables, both for functional reasons and to ensure it will not be misappropriated. The cabling and the volumes occupied by the equipment need to be considered when designing exhibitions, therefore challenging curators.

#### **4.1.2 Design Value**

The theme describing the Design Value of immersive technology revolves around the possible solutions offered by immersive tools. All respondents appeared to be aware, at different levels, of the opportunities arising from the development of immersive technology. However, several of the correspondents mentioned the difficulty of putting into practice the enhancement of cultural artifacts and technology themselves. For instance, R5 states the following:

“The pandemic showed us we are still using the physically standardized way of being a museum and putting that into a digital context.”

The statement describes the common tendency of organizations operating in an intrinsically traditional sector, to treat digital transformation as a mere digitization process (Raimo et al., 2021). Moreover, R7, a museum director, underlines that:

“You must make something more of an artifact with technology.”

Thus, it appears from the data collection, that a challenging aspect of the introduction of immersive technology in the museum field is represented by the failure to envision how it could contribute to valorizing the cultural object.

Furthermore, several of the interviewees also provided examples of how sometimes the use of this technology can affect some of the values of the cultural objects. Most of them referenced authenticity, the truth-value commonly associated with any cultural artifact (Gilmore & Ii, 2007). On the topic, R1 declares:

“Museums possess what is the best knowledge of something that we have, and visitors expect to find the truth, in an experienceable way.”

Archeologist and exhibition curator, R8, offers a direct description of the relationship between authenticity and digital technology:

“‘Authentic’ is what is there, in place, not the copies or the digital copy, but that is my point of view.”

These difficulties in valorizing both the artifacts and the immersive tools often derive from the complexity of the configuration, as previously described, as mentioned by R7:

“Immersive solutions are too often overly complicated: sometimes it must be simple to be useful.”

### **4.1.3 Organizational Model**

The Organizational Model theme revolves around all the structure and dynamics of museum organizations, in terms of rules, processes, and roles, and their interrelation with respect to digitalization.

To even consider the adoption of immersive technology in museums, it is necessary to take note of the challenges represented by human prerequisites in terms of resources and company organization. Museums and cultural heritage institutions – public ones in particular – often follow traditional organizational and operational models, whose dynamics contrast with the innovation of new technology. As R5 states:

“Immersive media are disruptive by definition and the museum sector is very traditional.”

It is often the technical operators who declare that a change in the museum organization system, historically rooted in the business models of the past, is necessary. Any digital transformation requires effective change management (Bellantuono et al., 2021). R4 describes this problem as follows:



“If you are used to working in a certain way, changing to a more modern way is hard: people do not want to do it because they do not really have to.”

Moreover, to add to the traditionalism of these organizations, there is a lack of technical competence and knowledge. As a representative of a research institution, R1 has been involved in several projects regarding extended reality solutions for museums and claims that:

“The main challenge with museums is that are not tech-savvy, therefore we need to be able to do these cooperations so that you can actually meet halfway.”

Among the interviewees, several cited the scarcity of specialized resources within their organizational fabric as one of the obstacles to the application of immersive technology. As reported by R1, researcher and extended reality expert:

“An important problem with immersive media is that it takes a lot of competencies and resources, and it is troublesome to find the right resources.”

Often the ability to use immersive technology depends on the casual presence of personnel within the museum organization, that not only understand their potential but are also able to implement them. This common situation has been described, for example, by R7, who states that:

“Implementing immersive technology in our museum follows a proactive bottom-up kind of approach, where you need to find someone or you happen to have someone that knows how to do it, which is often very difficult.”

When asked about the different figures necessary for the complete success of projects with immersive technology applications, the interviewees mostly agreed on drawing up the following list: “curators”, “interaction designers”, “content developers”, “museum representatives”, “programmers”, and “3D modelers”.

In particular, the attention focused on the figure of the curator, as:

“The curators have the main role: they ensure that experiences are understandable and there is reliable storytelling.” (R1)

Additionally, regarding the previously mentioned difficulties with valorization, the lack of technical know-how in terms of resource competencies is also cited by R7 as an inhibitor for immersive technology utilization:

“When you have the technology, you must also have the knowledge and resources, and know how to use that technology in a good way in order to enhance it (the technology) and enhance the artifact.”

One of the most frequent results of the data collection phase was the reference by the various stakeholders to an evident lack of internal communication within their organizations. R3, a cultural project manager, highlights that:

“It is mainly an organizational issue: people do not talk, and we have a total lack of knowledge sharing between departments.”

R4 further develops the argument by providing another point of view:

“It is much easier to communicate with people from different municipalities between similar departments than to communicate with people in the same municipality but in different departments.”

Thus, the communication problem only increases the distance between immersive technology and the museum environment, as it hinders the learning of those who are unrelated to these tools and knowledge sharing by those who know and understand their potential. R4 explains the consequences of the lack of internal communication:

“Immersive technology is not a problem, it is doable, but for some people, it looks complicated, expensive, and not so easy to do. They know about the possibility, but it seems like it is out of reach.”

## 4.2 Opportunities related to immersive technology application in museum settings

Parallely to the obstacles, a set of themes related to the key opportunities related to immersive technology application were uncovered.

Table 4 offers a schematized description of the three observed themes pertaining to opportunities for immersive technology solutions for museums, The main opportunity areas are *Operational Efficiency*, *Social Sustainability*, and *Experience Design*.

Data extract example	Codes	Themes
“There is a connection between the digital experience and the artifact and my role is to understand how to do the museums job: spread knowledge.” (R5)	Knowledge sharing	Operational Efficiency
“To find a way to share art outside of the walls of the museum.” (R3)	Increase the reach	
“We always think about how can we make cultural places accessible for people with disabilities.” (R4)	Accessibility	Design Value
“We always think about how can we make cultural places accessible for people with cognitive disabilities.” (R4)	Integration	
My opinion as an exhibition curator I think it is great that we can let the visitors steer their experience thanks to immersive technology. (R8)	Visitor centric approach	Experience Design
“Suddenly, with immersive technology, you can narrate the story of a cultural object when it is found, researched, conserved, and exposed and each step is possible to be shown to the audience.” (R5)	Storytelling and narratology	
“The key with immersive technology is to start with data and make the chain process digitalized.” (R2)	Use of data	

**Table 4.** Thematization of opportunities based on empirical findings

### 4.2.1 Operational Optimization

Operational Optimization was soon identified as a common theme in the respondents' answers. The theme refers to the positive impact of immersive technology on the operational activities of the museum industry. R2, Information System responsible and Archivist, states that when discussing the use of immersive technology “We are looking for efficiency.”

The main task of a museum is to preserve but above all to communicate culture to the public (Nisiotis et al., 2020). In the modern era, it is important to understand how these activities can be supported by new technology (Raimo et al., 2021). Based on the data collected, the stakeholders of the museum industry do not solely consider the obstacles, but also comment on the opportunities represented by the introduction of immersive technology.

In the words of R5:

“There is a connection between the digital experience and the artifact and my role is to understand how to do the museum’s job: spread knowledge.”

Although the main activity of a museum equates to distributing information, most museums keep a large part of their collections in archives, due to space and safety limitations. Regarding this, R2 describes how:

“Objects are in storage units and we are always thinking of how to show them to the public.”

Leaving aside the archived works, most of the interviewees expressed particular concern about the impossibility of showing even those exhibited within the walls of the museums. Museum director R7 explains what the initial plans for the use of immersive technology have been, specifically extended reality solutions, in their facility:

“The idea initially with that was that we wanted to be able to show art, to present art when we were closed.”

The same argument was brought up by several of the interviewees, therefore substantiating the idea of immersive technology as an aid and support to museums and cultural heritage institutions to increase their reach.

“To find a way to share art outside of the walls of the museum.” (R3)

“We can reach other (visitor) groups, which is very interesting.” (R2)

The content of any museum belongs to the public: it is there for visitors to experience. This is especially true of course for publicly funded or state-owned structures. In this respect, R4 comments that “Public art is not public for all: it is not public for those who cannot get there.” elaborating on the argument in favor of immersive technology as a design tool to support the main activity of museums, to share knowledge.

### 4.2.2 Social Sustainability

The attention to sharing knowledge and to the ability to reach the widest possible audience reflects the inclusive consideration for the part of the public that might necessitate special requirements and solutions. With respect to accessibility, R4 states that:

“We always think about how we can make cultural places accessible for people with cognitive disabilities.”

Several respondents agree on the meaningful opportunities offered by immersive technology when it comes to increasing accessibility and addressing social sustainability needs. Immersive solutions can offer different services to account for the special requirements of people with various disabilities, from cognitive to physical ones. An example was provided by R8, who strongly advocates for the use of immersive technology to cater to all people indiscriminately:

“It is good for some of them to learn how a place looks in VR before they visit it, so they are not overwhelmed.”

The attention to inclusivity is declined by the respondents, not only as accessibility but also as integration. R3 testifies with his personal experience as an immigrant:

“My personal experience of the museum is that I did not want to enter when I moved to Sweden, especially being an immigrant.”

In his current role as a curator focusing on innovation, R3 describes several projects in which, using immersive technology, it was possible to work on communication and bridging the gap between the local cultural heritage and the different cultural backgrounds of immigrant residents of the area.

Therefore, one of the main identified opportunities derived from immersive technology is represented by the possibility to encourage access to culture through immersive solutions, as R4 concludes:

“We can promote art through technology in a smart way, supporting society.”

### **4.2.3 Experience Design**

As society develops into integrating digital services and emergent technologies into our regular routines, we are given the chance to design more impactful and meaningful experiences. Immersive technology represents one of the central tools for the experience design of novel exhibitions that follow a user-centered approach (Burford & Resmini, 2017). As stated by R5:

“There is a need to make the experience inside the walls of the museum more contemporary because the audience is far more digitalized.”

Immersive technology offers curators the prospect to design exhibitions where visitors can play a central role in the experience setting itself:

“My opinion as an exhibition curator I think it is great that we can let the visitors steer their experience thanks to immersive technology.” (R8)

Moreover, R5 builds on the topic by expressing the necessity for museums to approach the public in a more digitalized manner, from the point of view of storytelling, as their fundamental activity for knowledge sharing, acknowledging the potential of immersive technology as an enabler:

“Museums need to get better to tell their stories online: immersive technology is a tool for that.”

Storytelling and narratology have been cited by the interviewees as crucial activities for the successful delivery of museum experiences. Furthermore, R1 describes these aspects as crucial strengths of museum experts:

“It is important to understand that museums are experts in narratives and in converting artifacts into a story.”

Immersive technology opens new possibilities in terms of expanding the capabilities of curators regarding storytelling and worldbuilding:

“So what we can do is we can open up other worlds around the object and we can have new tools for storytelling.” (R8)

“Suddenly, with immersive technology, you can narrate the story of a cultural object when it is found, researched, conserved, and exposed and each step is possible to be shown to the audience.” (R5)

R2 emphasizes the importance of data for the execution of immersive technology applications:

“The key is to start with data and make the chain process digitalized.”

In conclusion, “An experience where the data that is produced by the user as they travel through space and it is integrated into the spatial digital components” is the desired result of the application of immersive technology in the museum environment, as described by R6. With a former background in architecture, R6 sees the physical space and the interactions between space, users, and objects in the space:

“The space is already a computer. It computes human functions and object interactions, no matter if it's a dumb object or a smart object. And so that could be a principle. For that, you could lay out and say the museum needs to compute a story into the human and into the space as they discover it.” (R6)

The respondent also outlined the connection between the data, the architectural space, and the narrative, as “a gesture of worldbuilding, and sort of an interesting crossover between storytelling, architecture, and design.”

## 5 Discussion

This study aimed to investigate the obstacles and the opportunities of immersive technology in the museum context. The research was based on the following RQ: *What are the key challenges and key opportunities related to the application of immersive technology in museum settings?*

When it comes to the challenges regarding the application of immersive technology, the results identify obstacles related to innovation management, the design value, and the organizational model of museums. Within the theme of innovation management, this study outlines three main adverse aspects of immersive technology: novelty, cost, and complexity of configuration.

Schumpeter (1974) alluded to the idea that novelty is a component of innovation. Novelty as originality in innovation has an ambivalent nature. Novelty can represent both a perk as well as a reason for increased risks and uncertainties, as described by the respondents. The complexity of the

technical configuration adds to the novelty of immersive technologies as an obstacle to application. The findings identify that the technical configuration of immersive tools interferes with the curatorial process of exhibit design. As previously stated by Okanovic et al. (2022), the outcome of the interviews suggests that immersive technology in digital museum applications “needs to be simple and intuitive”.

The findings showcase how a need for simplicity is also reflected in the respondents’ perception of the design value of immersive technology. In particular, the stakeholders agree on the challenges of curating museum digitalized museum experiences with a satisfactory valorization of the applied technology. Moreover, the outcomes emphasize the impact of designing through immersive technology and incorporate a level of truth-value in the museum experience. In relation to the museum sector, the concept of value assumes various interpretations: ethical and moral, pedagogical, recreational, and aesthetic, and culture also withholds intrinsic economic value (Gilmore & Ii, 2007). The respondents expressed concerns regarding the inhibiting effect that immersive technology can have on the user perception of the truth-value in museum experiences.

To even consider the common adoption of immersive technology in museums, it is necessary to take note of the important challenges represented by human prerequisites. This study categorizes these needs in terms of requirements on the museums’ organization model. Digital transformation requires effective change (Manser Payne et al., 2021; Raimo et al., 2021; Salvi et al., 2021). Organizational change can overcome the gap between experiencing, comprehending, and accepting the disruptive novelty of immersive technology. The findings point out that digitalization and organizational change appear to be some of the most challenging aspects in the matter of immersive technology application (Raimo et al., 2021). Moreover, the lack of specialized internal resources represents an obstacle to the introduction of immersive technology in museum settings. The research also offers a perspective that was not highlighted in the reviewed academic literature. The results of the semi-structured interviews show the particular concern of stakeholders towards the lack of internal communication on the general topic of digitalization, but more specifically the use of novel technologies such as immersive technology. The findings suggest a need for the enhancement of internal knowledge-sharing practices. The results showcase a need to consolidate the common understanding of the available technological and digital solutions for museum curation. Respondents agree that this goal can only be achieved by unifying the human and technical resources already available within the walls of any museum organization.

In addition, when it comes to the opportunities related to immersive technology introduction, the findings indicated several beneficial elements of immersive technology. Within the context of the present study, the identified factors representing opportunities for the application of immersive technology in museum settings were the optimization of operational efficiency and the improvements in social sustainability and experience design.

Across the interviewed stakeholders, there was a determined common agreement on the importance of knowledge sharing and increased audience reach as examples of optimized operational efficiency. This study defines knowledge sharing as the main activity and end goal of the museum service (Bedford, 2001; Lohman, 2006). Moreover, the study highlights the perceived positive impact of immersive technologies on this activity, in accordance with Romanelli (2008).

The findings on the operational efficiency theme also support previous studies by Raimo et al. (2021), which describe how regarding “the reasons behind the digitalization choices of museum organizations, the results show a strong prevalence of the desire to attract a greater number of visitors”. On the topic of opportunities enabled by the use of immersive technology, another result regards social sustainability. The interested stakeholders described their predisposition to the use of immersive technology as valuable support for better accessibility of the museum context to a more

inclusive audience (NEMO, 2013). Notably, this research highlights the potential of immersive technology as a tool to improve cultural integration.

Furthermore, the area of experience design was pointed out as a major sphere of interest for the introduction of immersive technology. The experience design theme supports existing literature on the willingness of museums to enhance the visitor experience as the main enabler for the use of immersive technology (Pujol et al., 2012; Pop & Bonca, 2016; Benyon & Resmini, 2017; Raimo et al., 2021). Following the “visitor centric” vision described by Pujol et al. (2012), the findings define the ability of immersive technology to steer visitor experience and cater to a highly digitalized audience. Therefore, immersive technology enables the curation of visitor-centered experiences (Pujol et al., 2012; Ch’ng et al., 2019; Benyon & Resmini, 2017; Raimo et al., 2021).

Several of the interviewed stakeholders expressed the valuable opportunities provided by immersive technology as a tool for enhanced storytelling. The role of storytelling in the curation of museum experiences was also highlighted throughout the interview sessions as a crucial activity within the museum economy (del Carmen Villaseñor Ferrer, 2007). Curators appreciate that immersive technology disrupts and redesigns the paradigms of narrative and storytelling, by merging reality and its representation (Wyman et al., 2011).

The apposition of multimedia and technological layers in the museum environment allows for the redesign of new information structures that are only perceived through specific interfaces and tools, yet fully integrated into the fabric of physical reality. The research underlines the value of immersive technology as a tool for the optimal utilization of all the data and information available to museums.

Due to the cross-disciplinary approach of this study, the implications range across different aspects of the challenges and opportunities of immersive technology use in the museum environment. The implications of this study address these aspects and can be described as follows. Firstly, the present study contributes to the field of information systems, highlighting the challenges and opportunities represented by immersive technology as a tool for the digital transformation of experiences in museum settings. Next, the study contributes to the literature by providing an adapted framework for the stakeholder relations in the museum sector, based on the cultural diamond by Griswold and Hongladarom (1999). The adapted framework showcases the changes in the relations between the different museum stakeholders with the integration of immersive technology. Moreover, academic literature presents a lack of exploratory studies approaching the problems from the perspective of stakeholders outside of the visitor stakeholder group (Raimo et al., 2021; Pagano et al., 2021). The study addresses this gap in the knowledge base by considering the adapted cultural diamond, focusing on the perspective of strategic, internal and external stakeholders. The attention to this category of stakeholders provides empirical illustrations of the challenges and opportunities museum directors, curators, system architects, and operators face when using immersive tools.

The study describes a lack of internal resources and communication within the museum sector when it comes to technological issues. A practical implication of the findings is represented by the possible inclusion of professional figures such as innovation strategists and service designers in the cultural heritage system that could address the challenges related to integrating the human, technological and economic aspects of digital transformation processes initiated through immersive technology. Furthermore, implications regarding challenges of immersive technology can inform the industry, as design and manufacturing, to support the development of solutions that address the stakeholders’ needs.

In terms of opportunities, crucial finding discerned from the literature review showcases the need to apply a visitor centric approach to experience design in museums (Pujol et al., 2012). Furthermore, this study contributes to the IS literature by providing a thematization of key

challenges and opportunities for the design of museum experience aided by immersive technology. The empirical findings of this study can be used by both researchers and industry specialists to inform the development of novel artifacts and processes with a visitor centric approach. Moreover, the storytelling approach based on immersive technology for exhibition design brings culture closer to a vaster audience (Pujol et al., 2012). This knowledge can inform the work of different museum stakeholders. For instance, by providing base insights for museum executives to consider when assessing the introduction of immersive technology in their facilities. Moreover, the findings can inform the work of curators, who can explore storytelling techniques when using immersive technology for exhibition design. These findings should be also analyzed from the perspective of ethics and sustainability. The cultural nature of the museum institution requires specific attention to such aspects. The themes of inclusivity, accessibility, and integration were discussed as opportunity areas for the application of immersive tools. This can support all museum stakeholders and reinforce the need to account for social sustainability within the entirety of the museum system. Increasing the audience and the reach of museums through technology can bring overall benefits to society with improvements in cultural heritage knowledge sharing.

The outcomes of the present study need to be acknowledged considering its potential limitations. The study was conducted over a limited timeframe of 20 weeks of full-time work, partially limiting its scope. Moreover, the empirical findings of this study were based on interviews conducted with stakeholders resident or related to the country of Sweden. Arguably, the results of this study might differ if the respondents' base included stakeholders from different countries. To address this limitation, the study provides a clear description of the research process, to ensure the transferability of its findings, and the possible reproduction in other geographical contexts.

## 6 Conclusions and further research

The present study intended to answer the research question: *What are the key challenges and key opportunities related to the application of immersive technology in museum settings?* To address the RQ, an explorative qualitative study was conducted by the means of eight semi-structured interviews. The collected data were then analyzed using a reflexive thematic analysis. As the research question, the findings are categorized as challenges and opportunities to the application of immersive technology in museum settings.

The outlined challenges regard innovation management, interpreting the design value, and adapting the museum organizational model to immersive technologies. Within the innovation management theme, the empirical findings pay attention to the challenges represented by the aspects of novelty, cost, and complexity of the configuration of immersive technology solutions. The identified opportunities related to the introduction of immersive technology in museums resulted being the optimization of operational efficiency, enhancement of social sustainability, and experience design. Therefore, the results of this study contribute to the research field of information systems. Moreover, their implications can inform the work of researchers and industry strategic stakeholders with epistemic, experiential, economic, social, and cultural insights.

The use of immersive technology is expanding across different industries (Sjödín et al., 2020). The scientific quality measures were adopted to ensure the generalization of the findings of this study. Therefore, further research could replicate the process of this study to analyze challenges and opportunities related to immersive technology applications in different industries. Regarding sustainability, the outcomes identify the opportunities for enhancement of social sustainability in



the museum sector, in terms of inclusivity and accessibility. However, the findings did not highlight any relevant environmental sustainability implications. Future research on the topic could provide insights into the environmental impact of immersive technology applications in museums.

## Acknowledgment

The present work represents the end of a journey: quite literally, the journey of moving abroad, but also the long journey of pursuing my education and career and finding my place.

This journey would not have been possible without the support of several fundamental figures.

In true Italian fashion, the acknowledgments are presented as follows.

I would like to start by thanking the supervisor of this work, *il professore* Andrea Resmini, for his guidance during the past months, for sharing his knowledge, and for encouraging me to choose the topic of this thesis based on my passions.

I am grateful for the great support provided by my dear family. First, my parents, Resid Husidic and Nadejda Nikolova Andreeva, for their sacrifices and all the opportunities they gave me. I am thankful for all of my big, Balkan family. An honorable mention to Valeria Nikolova Andreeva, for all the discussions, and to my dearest grandfather, Nikola Ivanov Andreev, my role model. At the end of this journey, my thoughts go to the memory of my beloved grandmother, Jordanka Nikolaeva Andreeva.

I want to share my immense gratitude to Filip Huseni, for the incessant support he offered, unconditionally.

I will always be thankful for my friends back home, in Italy and Bulgaria. To Elisa Cocco, for staying by my side from so far. Last but not least, to the friends I made during the journey. To Victoria Friebe and Philipp Forstenhausler, that shared this journey with me. To all of my colleagues, to Emmanuel Chatel-Roux, for enduring my presence at the office and giving me all the possible support. To Carl Henrikson, source of great inspiration. To Sara West and Carolin Roske, for always believing so strongly in me.

This thesis focuses on museums, that cherish the memory of culture. This journey has been memorable itself. *To more memories to come.*

## References

- American Historical Association. (n.d.). *Historians in Historic Preservation / AHA*. Historian, American Historical Association. Retrieved March 26, 2022, from <https://www.historians.org/jobs-and-professional-development/career-resources/careers-for-students-of-history/historians-in-historic-preservation>
- Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *IEEE Computer Graphics and Applications*, 21(6), 34–47. <https://doi.org/10.1109/38.963459>
- Azuma, R. T. (1997). A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments*, 6(4), 355–385. <https://doi.org/10.1162/pres.1997.6.4.355>
- Bedford, L. (2001). Storytelling: The Real Work of Museums. *Curator: The Museum Journal*, 44(1), 27–34. <https://doi.org/10.1111/j.2151-6952.2001.tb00027.x>

- Bell, E., & Bryman, A. (2007). The Ethics of Management Research: An Exploratory Content Analysis. *British Journal of Management*, 18(1), 63–77. <https://doi.org/10.1111/j.1467-8551.2006.00487.x>
- Bellantuono, N., Nuzzi, A., Pontrandolfo, P., & Scozzi, B. (2021). Digital Transformation Models for the I4.0 Transition: Lessons from the Change Management Literature. *Sustainability*, 13(23), 12941. <https://doi.org/10.3390/su132312941>
- Benyon, S., & Resmini, A. (2017). Cross-channel information architecture for a world exposition. *International Journal of Information Management*, 37(6), 547–552. <https://doi.org/10.1016/j.ijinfomgt.2017.05.010>
- Braun, V., & Clarke, V. (n.d.). *Understanding TA / Thematic Analysis*. Thematic Analysis. Retrieved May 16, 2022, from <https://www.thematicanalysis.net/understanding-ta/>
- Braun, V., & Clarke, V. (2020). Can I use TA? Should I use TA? Should I not use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches. *Counselling and Psychotherapy Research*, 21(1), 37–47. <https://doi.org/10.1002/capr.12360>
- Ch’ng, E., Cai, S., Leow, F. T., & Zhang, T. E. (2019). Adoption and use of emerging cultural technologies in China’s museums. *Journal of Cultural Heritage*, 37, 170–180. <https://doi.org/10.1016/j.culher.2018.11.016>
- Ciolfi, L., & Bannon, L. J. (2007). Designing hybrid places: merging interaction design, ubiquitous technologies and geographies of the museum space. *CoDesign*, 3(3), 159–180. <https://doi.org/10.1080/15710880701524559>
- Coelho, C., Tichon, J., Hine, T. J., Wallis, G., & Riva, G. (2006). Media Presence and Inner Presence: The Sense of Presence in Virtual Reality Technologies. In G. Riva, M. T. Anguera, & A. W. B. K. F. Mantovani (Eds.), *From Communication to Presence: Cognition, Emotions and Culture Towards the Ultimate Communicative Experience, Volume 9 Emerging Communication: Studies . . . Technologies and Practices in Communication* (pp. 25–46). IOS Press.
- del Carmen Villaseñor Ferrer, M. (2007). *Building Echoes. The Role of Storytelling in Museums and Galleries*. n.d.
- DER SPIEGEL. (2006, March 27). “*Evil Can also Be Beautiful.*” DER SPIEGEL, Hamburg, Germany. Retrieved March 10, 2022, from <https://www.spiegel.de/international/spiegel/spiegel-interview-with-dutch-architect-rem-koolhaas-evil-can-also-be-beautiful-a-408748.html>
- Dewey, J. (2005). *Art as Experience* (1st ed.). TarcherPerigee.
- Dudley, S. (2009). *Museum Materialities: Objects, Engagements, Interpretations* (1st ed.). Routledge.
- Falk, J. H., & Dierking, L. D. (1995). Recalling the Museum Experience. *Journal of Museum Education*, 20(2), 10–13. <https://doi.org/10.1080/10598650.1995.11510292>
- Freedman, L. (2013). *Strategy: A History* (1st ed.). Oxford University Press.
- Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Pitman.
- Friis Dam, R., & Yu Siang, T. (2020, June 30). *Map the Stakeholders*. The Interaction Design Foundation. <https://www.interaction-design.org/literature/article/map-the-stakeholders>
- Gilmore, J. H., & Ii, J. P. B. (2007). *Authenticity: What Consumers Really Want* (Illustrated ed.). Harvard Business Review Press.
- Greenwold, S. (2003, June). *Spatial computing* (Master’s Thesis). Massachusetts Institute of Technology. <https://acg.media.mit.edu/people/simong/thesis/SpatialComputing.pdf>
- Griswold, W., & Hongladarom, S. (1999). Cultures and Societies in a changing world. *AI & Society*, 13(4), 446–449. <https://doi.org/10.1007/bf01205989>

- Guastalegmanne, M. (2021, September 29). *What is XR and How Does it Relate to Immersive Technology?* Cornwall Museums Partnership. Retrieved May 14, 2022, from <https://www.cornwallmuseumpartnership.org.uk/what-is-xr-and-how-does-it-relate-to-immersive-technology/>
- Guedez, A. (2021, June 8). *How Spatial Computing Can Change Life And Work*. Forbes. <https://www.forbes.com/sites/forbestechcouncil/2021/06/08/how-spatial-computing-can-change-life-and-work/?sh=5fef8fcb4f8b>
- Hall, J. K., & Martin, M. J. C. (2005). Disruptive technologies, stakeholders and the innovation value-added chain: a framework for evaluating radical technology development. *R and D Management*, 35(3), 273–284. <https://doi.org/10.1111/j.1467-9310.2005.00389.x>
- Handa, M., Aul, G., & Bajaj, S. (2012). Immersive technology—uses, challenges and opportunities. *International Journal of Computing & Business Research*, 6(2), 1–11.
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, 28(1), 75–105. <https://www.jstor.org/stable/25148625?seq=1>
- Home | Museum of Other Realities*. (n.d.). Museum of Other Realities. Retrieved May 14, 2022, from <https://www.museumor.com/>
- Kamal, M., Weerakkody, V., & Irani, Z. (2011). Analyzing the role of stakeholders in the adoption of technology integration solutions in UK local government: An exploratory study. *Government Information Quarterly*, 28(2), 200–210. <https://doi.org/10.1016/j.giq.2010.08.003>
- Kamariotou, V., Kamariotou, M., & Kitsios, F. (2021). Digital Transformation Strategy Initiative in Cultural Heritage: The Case of Tate Museum. *Digital Heritage. Progress in Cultural Heritage: Documentation, Preservation, and Protection*, 300–310. [https://doi.org/10.1007/978-3-030-73043-7\\_25](https://doi.org/10.1007/978-3-030-73043-7_25)
- Kaplan, B., & Maxwell, J. A. (2005). Qualitative research methods for evaluating computer information systems. In *Evaluating the organizational impact of healthcare information systems* (pp. 30–55). Springer Publishing.
- Katifori, A., Karvounis, M., Kourtis, V., Perry, S., Roussou, M., & Ioanidis, Y. (2018). Applying Interactive Storytelling in Cultural Heritage: Opportunities, Challenges and Lessons Learned. *Interactive Storytelling*, 603–612. [https://doi.org/10.1007/978-3-030-04028-4\\_70](https://doi.org/10.1007/978-3-030-04028-4_70)
- Knell, M., & Srholec, M. (2009, October). *The novelty of innovation and the level of development*. GLOBELICS 7th International Conference, Dakar, Senegal.
- Koenitz, H., Ferri, G., Haahr, M., Sezen, D., & Sezen, T. İ. (2017). *Interactive Digital Narrative: History, Theory and Practice (Routledge Studies in European Communication Research and Education)* (1st ed.). Routledge.
- Korstjens, I., & Moser, A. (2017). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, 24(1), 120–124. <https://doi.org/10.1080/13814788.2017.1375092>
- Kraus, N. M. (2015). Categorical difference of notions “novation”, “novelty” and “innovation” as tools of innovative economy: institutional context. *Institutional Framework for the Functioning of the Economy in the Context of Transformation*, 4, 53–57.
- Krueger, M. (1983). *Artificial Reality*. Addison-Wesley.
- Lee, H. G., Chung, S., & Lee, W. H. (2012). Presence in virtual golf simulators: The effects of presence on perceived enjoyment, perceived value, and behavioral intention. *New Media & Society*, 15(6), 930–946. <https://doi.org/10.1177/1461444812464033>
- Lee, Y. N., Shan, L., & Chen, C. (2013). System development of immersive technology theatre in museum. *Proceedings of International Conference on Virtual, Augmented and Mixed Reality*, 400–408.

- Lincoln, Y. S., Guba, E. G., & Pilotta, J. J. (1985). Naturalistic inquiry. *International Journal of Intercultural Relations*, 9(4), 438–439. [https://doi.org/10.1016/0147-1767\(85\)90062-8](https://doi.org/10.1016/0147-1767(85)90062-8)
- Lohman, J. (2006). Introduction. In E. Johnsson (Ed.), *Telling tales. A guide to developing effective storytelling programmes for museums*. (p. 2). Renaissance London.
- Low, J. J. (2020, April 30). *How spatial computing can change the way we interact with technology*. Tech Wire Asia. [https://techwireasia.com/2020/05/how-spatial-computing-can-change-the-way-we-interact-with-technology/#:%7E:text=The%20concept%20is%20called%20'spatial,mixed%20reality%20\(XR\)%20tools.](https://techwireasia.com/2020/05/how-spatial-computing-can-change-the-way-we-interact-with-technology/#:%7E:text=The%20concept%20is%20called%20'spatial,mixed%20reality%20(XR)%20tools.)
- Manser Payne, E. H., Dahl, A. J., & Peltier, J. (2021). Digital servitization value co-creation framework for AI services: a research agenda for digital transformation in financial service ecosystems. *Journal of Research in Interactive Marketing*, 15(2), 200–222. <https://doi.org/10.1108/jrim-12-2020-0252>
- Matzner, M., Büttgen, M., Demirkan, H., Spohrer, J., Alter, S., Fritzsche, A., Ng, I. C. L., Jonas, J. M., Martinez, V., Möslin, K. M., & Neely, A. (2018). Digital Transformation in Service Management. *Journal of Service Management Research*, 2(2), 3–21. <https://doi.org/10.15358/2511-8676-2018-2-3>
- Maxwell, J., & Loomis, D. (2003). Mixed Methods Design: An Alternative Approach. In A. M. Tashakkori & C. B. Teddlie (Eds.), *Handbook of Mixed Methods in Social & Behavioral Research* (Second ed., pp. 241–271). SAGE Publications, Inc.
- Milgram, P., & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *EICE TRANSACTIONS on Information and Systems*, 77(12), 1321–1329.
- Myers, M. D., & Venable, J. R. (2014). A set of ethical principles for design science research in information systems. *Information & Management*, 51(6), 801–809. <https://doi.org/10.1016/j.im.2014.01.002>
- NEMO. (2013). *Museums in the Digital Age, Museums and the Development of Active Citizenship*. Network of European Museum Organisations 21st Annual Conference, Bucharest, Romania.
- NEMO. (2020, July). *Digitalisation and IPR in European Museums*. <https://www.digitalmeetsculture.net/article/the-challenges-that-eu-museums-face-to-digitise-their-collections/>
- Nisiotis, L., Alboul, L., & Beer, M. (2020). A Prototype that Fuses Virtual Reality, Robots, and Social Networks to Create a New Cyber–Physical–Social Eco-Society System for Cultural Heritage. *MDPI Sustainability*, 12(2), 645. <https://doi.org/10.3390/su12020645>
- Norman, D. (2018, December 3). *Systems Thinking: A Product Is More Than the Product*. Jnd.Org. [https://jnd.org/systems\\_thinking\\_a\\_product\\_is\\_more\\_than\\_the\\_product/](https://jnd.org/systems_thinking_a_product_is_more_than_the_product/)
- Okanovic, V., Ivkovic-Kihic, I., Boskovic, D., Mijatovic, B., Prazina, I., Skaljo, E., & Rizvic, S. (2022). Interaction in eXtended Reality Applications for Cultural Heritage. *Applied Sciences*, 12(3), 1241. <https://doi.org/10.3390/app12031241>
- Pop, I., & Bonca, A. (2016). TECHNOLOGICAL INNOVATIONS IN MUSEUMS AS A SOURCE OF COMPETITIVE ADVANTAGE. *Proceeding of the 2nd International Scientific Conference*. International Scientific Conference "News, challenges and trends in management of knowledge-based organizations", Păltiniș, Romania.
- Pujol, L., & Lorente, A. (2014). The Virtual Museum: a Quest for the Standard Definition. *Archaeology in the Digital Era*, 40–48. <https://doi.org/10.1515/9789048519590-005>
- Pujol, L., Roussou, M., Poulou, S., Balet, O., Vayanou, M., & Ioannidis, Y. (2012, March). *Personalizing Interactive Digital Storytelling in Archaeological Museums: the CHES Project*. 77–90.

- Raimo, N., de Turi, I., Ricciardelli, A., & Vitolla, F. (2021). Digitalization in the cultural industry: evidence from Italian museums. *International Journal of Entrepreneurial Behavior & Research*. <https://doi.org/10.1108/ijebr-01-2021-0082>
- Resmini, A., & Rosati, L. (2009). Information architecture for ubiquitous ecologies. *Proceedings of the International Conference on Management of Emergent Digital EcoSystems - MEDES '09*. <https://doi.org/10.1145/1643823.1643859>
- Romanelli, M. (2018). Museums creating value and developing intellectual capital by technology. *Meditari Accountancy Research*, 26(3), 483–498. <https://doi.org/10.1108/medar-10-2017-0225>
- Roussou, M., & Katifori, A. (2018). Flow, Staging, Wayfinding, Personalization: Evaluating User Experience with Mobile Museum Narratives. *Multimodal Technologies and Interaction*, 2(2), 32. <https://doi.org/10.3390/mti2020032>
- Salvi, A., Vitolla, F., Rubino, M., Giakoumelou, A., & Raimo, N. (2021). Online information on digitalisation processes and its impact on firm value. *Journal of Business Research*, 124, 437–444. <https://doi.org/10.1016/j.jbusres.2020.10.025>
- Schumpeter, J. A. (1974). *Theory of Economic Development*. Oxford University Press, New York.
- Sjödin, D., Parida, V., Jovanovic, M., & Visnjic, I. (2020). Value Creation and Value Capture Alignment in Business Model Innovation: A Process View on Outcome-Based Business Models. *Journal of Product Innovation Management*, 37(2), 158–183. <https://doi.org/10.1111/jpim.12516>
- Sjödin, D., Parida, V., Kohtamäki, M., & Wincent, J. (2020). An agile co-creation process for digital servitization: A micro-service innovation approach. *Journal of Business Research*, 112, 478–491. <https://doi.org/10.1016/j.jbusres.2020.01.009>
- Suh, A., & Prophet, J. (2018). The state of immersive technology research: A literature analysis. *Computers in Human Behavior*, 86, 77–90. <https://doi.org/10.1016/j.chb.2018.04.019>
- Teece, D. J. (2018). Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world. *Research Policy*, 47(8), 1367–1387. <https://doi.org/10.1016/j.respol.2017.01.015>
- Tipping, J. W., Zeffren, E., & Fusfeld, A. R. (1995). Assessing the Value of Your Technology. *Research-Technology Management*, 38(5), 22–39. <https://doi.org/10.1080/08956308.1995.11674292>
- Urbaneja, M. H. (2019). Narrative Interfaces: Temporality and spatiality in art museums' online resources. *Electronic Workshops in Computing*. <https://doi.org/10.14236/ewic/eva2019.5>
- Waern, A., Løvlie, A., Eklund, L., Spence, J., Rajkowska, P., & Benford, S. (2022). Hybrid Museum Experiences. In *Hybrid Museum Experiences* (pp. 31–48). Amsterdam University Press.
- Watson, R. T., & Webster, J. (2020). Analysing the past to prepare for the future: Writing a literature review a roadmap for release 2.0. *Journal of Decision Systems*, 29(3), 129–147. <https://doi.org/10.1080/12460125.2020.1798591>
- Wilson, R. D., & Creswell, J. W. (1996). Research Design: Qualitative and Quantitative Approaches. *Journal of Marketing Research*, 33(2), 252. <https://doi.org/10.2307/3152153>
- Wyman, B., Smith, S., Meyers, D., & Godfrey, M. (2011). Digital Storytelling in Museums: Observations and Best Practices. *Curator: The Museum Journal*, 54(4), 461–468. <https://doi.org/10.1111/j.2151-6952.2011.00110.x>

# Appendix 1: Interview guide

## Presentation

Brief presentation of myself.

Description of the interview setting: Master thesis study for the Digital Service Innovation program at Halmstad University.

Description of the topic: challenges and opportunities related to immersive technology application in the museum setting.

Description of the themes: definition of immersive technology.

Confidentiality of disclosure and permission to record.

- To start, could you give me a brief description of yourself? (name, position, company/organization, place of residence, background)
- What is your experience with immersive technology, both within the museum environment and outside?

## The challenges

- What do you think is poorly understood about immersive technology for museum applications? Why? Could you share an example?
- What frustrates you about immersive technology in cultural heritage applications?
- Which aspects of immersive technology application are closely related to your role in the museum system?
- What aspects of immersive technology influence negatively your decisions regarding its application?
- Who are the figures within your organization that deal or possibly could deal with immersive technology?
- What aspects of immersive technology do you see as challenges for their work?
- What would you improve about immersive technology in relation to museum application?
- Could you describe the worst application of immersive technology that you have experienced in a museum environment?

## The opportunities

- Could you describe the best application of immersive technology that you have experienced in a museum environment?
  - Which key qualities of immersive technology did you observe in this case?
- What about immersive technology inspires or could inspire your decision to implement them in cultural heritage applications?
- From your perspective: what are the best aspects of immersive technology applications in museums?
- How would implementing immersive technology positively affect your work? How does it or could it help your tasks?

- What are the possible positive impacts of implementing immersive technology impact on others in your organization?

### **Themes**

- What is your opinion on the sustainability implications of immersive technology?
- What

### **Conclusion**

- Is there anything else you would like to recommend or add that hasn't been covered by the questions I have not already proposed?
- Would you suggest any contacts you think I should interview?
- Can I reach out to you at a later stage to get your feedback on my findings?