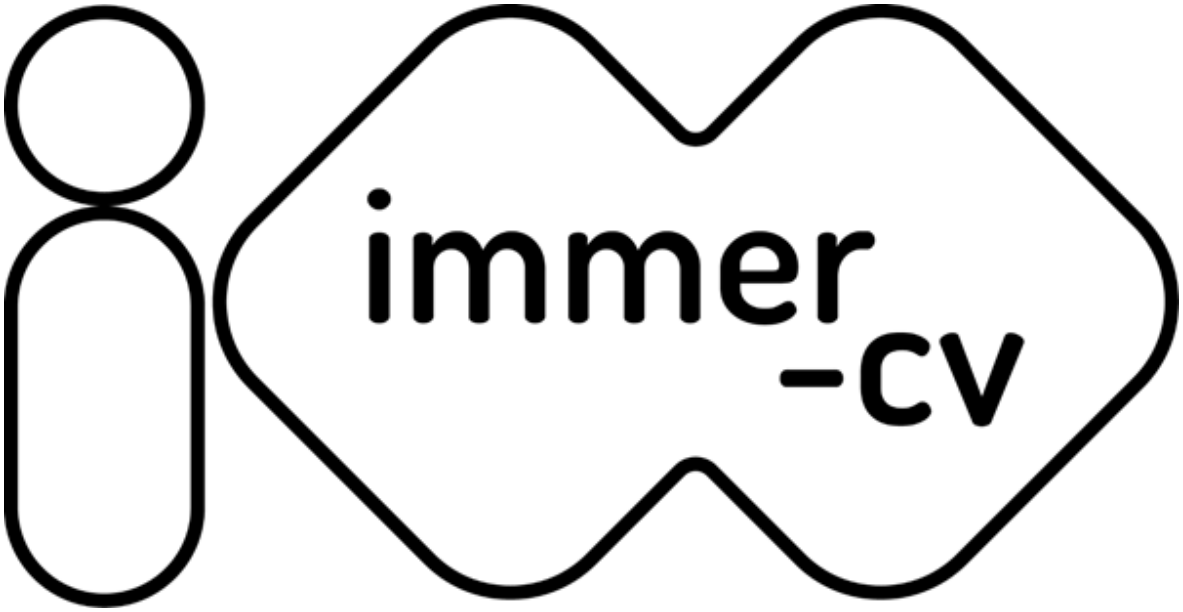

IMMER-CV: Curriculum development for Management of Immersive technologies by Professionals in Cultural and Creative Sectors

Title: D1.1 The Use of Immersive Technologies in Cultural and Creative Sectors. A Report of Exemplary Practices

Delivery date: 10/01/2025

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EXECUTIVE SUMMARY

D1.1 titled "*The Use of Immersive Technologies in Cultural and Creative Sectors. A report of exemplary practices*" aims to gather representative examples, concerning successful use of immersive technologies in the CCS, with the special attention to the potential, dynamics, and challenges of adopting immersive technologies in the cultural and creative sectors (CCS). Immersive technologies have emerged as transformative tools for enhancing cultural heritage preservation, reshaping audience engagement, and advancing the educational and entertainment goals of cultural organizations.

Key Findings

Immersive Technologies in the CCS

Immersive projects have significantly evolved over the past decade, taking two primary forms: immersive exhibitions and immersive applications. These projects aim to create dynamic, interactive environments that transform traditional cultural participation, foster engagement, and fulfill educational goals.

- **Immersive Exhibitions:** Focus on 360° environments using VR, AR, and projection technologies to enhance visitor experiences.
- **Immersive Applications:** Enable users to engage with cultural content virtually, blending digital and physical realms.

Key Players and Collaborative Dynamics

Immersive production thrives on interdisciplinary collaboration between three core domains:

- **Artistic/Cultural:** Focuses on creative vision, storytelling, and sensory engagement, ensuring that the immersive experience delivers meaningful, educational, or culturally rich content.
- **Technical:** Responsible for the implementation and maintenance of immersive technologies.
- **Managerial:** Oversees project coordination, resource allocation, and strategic planning.

Effective collaboration across these domains is vital for synergizing artistic creativity, technological functionality, and project management.

Challenges Identified

The report highlights four main challenges to the adoption of immersive technologies in CCS:

- **Technological Challenges:** Barriers include limited scalability, lack of standardization, and lagging software development, which increase costs and complexity.
- **Business Challenges:** The lack of a robust business ecosystem and the high cost of immersive technologies hinder accessibility for small and medium-sized organizations, particularly in remote regions.

- **Organizational Challenges:** A gap in technological and cultural literacy among professionals limits effective collaboration. Departmental silos in large organizations exacerbate inefficiencies.
- **Legal Challenges:** Data security concerns, particularly regarding real-time experiences, raise regulatory compliance issues with frameworks like the General Data Protection Regulation (GDPR).

Among them, the biggest challenge goes to the difficulty involved in communication between people from different backgrounds, which result from the general lack of technological and cultural literacy in the society.

1. INTRODUCTION

Technology has been considered for a long time to be a vital engine of innovation and growth in our society. Among diverse new age technologies, immersive technologies are increasingly acknowledged as a new source of innovation in many sectors. Immersive technologies serve as an umbrella term encompassing Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR), as a whole (Suh & Prophet, 2018; Tang et al., 2022). In a recent policy document titled European Union´s (EU) strategy for Web 4.0 and virtual worlds presented on July 11, 2023, the European Commission stressed the importance of immersive technologies in transforming efficient citizen participation, improving urban planning, and developing the European workforce[1]. While immersion and immersive technologies have become a hot topic among scholars and practitioners today, the use of immersive technology in these sectors is not new. As a matter of fact, as early as the end of the 1980s, VR has been introduced into the cultural heritage domain and Paul Reilly was the first researcher who proposed the term "Virtual Archaeology" in 1990 (Ferdani et al., 2020). Some immersive technologies like VR and AR have been greatly advanced in the cultural heritage fields over the last two decades (Hammady et al., 2021).

Accordingly, there has been a common understanding that the utilization of immersive technologies will benefit the cultural heritage sectors and organizations in different ways. First, immersive experiences are always a key selling point to attract more attention and attendance of museum goers (Burgard et al., 1999). Second, immersive technologies will enhance the visitor experience by extending and reshaping the traditional physical borders of cultural participation like museum visit (Hammady et al., 2021; Traboulsi et al., 2018). Third, they can improve information communication flow by facilitating a close interaction between visitors and artifacts (Flavián et al., 2019). Fourth, they help to strengthen edutainment and educational purposes of cultural heritage organizations by better connecting users with history and archeology both virtually and narratively (Anderson et al., 2010). Last but not least, immersive technologies provide powerful digital solutions to heritage preservation and conservation in the cultural domains (Husheng et al., 2023; Y. Li et al., 2023).

Despite that the role and benefits of immersive technologies are well informed in the cultural domain, the capacity of cultural and creative organizations, particularly of small and medium-sized ones, to leverage these technologies for digital transformation remains limited. Cultural and creative organizations are not traditionally technology-intensive/fluent, and their digital technologies and relevant transformation depend heavily on the organization's adoption of external technologies through cross-sectoral collaboration (C. Li, 2024). Many small and medium-scaled cultural and creative institutions are frequently excluded from inter-organizational and cross-sectoral cooperation due to the lack of sufficient knowledge and resources (e.g. human, capital, symbolic and technical resources) needed for such collaborative arrangement. This is why the most successful

[1] See: https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3718

application of immersive technologies in this field has concentrated primarily on large cultural organizations and high-tech companies specializing in immersive exhibitions.

The main aim of the Erasmus + project *IMMER-CV* is to empower professionals, trainers and students in the cultural and creative sectors (CCS) by enhancing their understanding and preparation for the growing adoption of immersive technology in cultural production and experience through education. The project is based on the key assumption that, beyond the necessary knowledge and resources for technical transition, the technological literacy and capacity of cultural managers and artists are crucial in utilizing immersive technologies within cultural and creative organizations. This is particularly true for small and medium-sized cultural organizations where technical staff may be absent. While artists and cultural managers are often aware of immersive technologies, they frequently lack necessary knowledge and skills in immersive production, leading to reluctance or difficulty in engaging in cross-sectoral collaboration with immersive technicians or engineers – such a partnership is often considered vital for successful immersive production in these organizations.

As the initial effort of the project, this report aims to compile representative examples concerning successful use of immersive technologies in the CCS, with the special attention to heritage organizations and performance art. The main objective of this study is to understand the dynamics of immersive production within CCS and to identify the opportunities and challenges involved in this process. This report is structured as follows: after the introductory section, Section 2 provides an overview of immersive projects in the CCS, based on a selection of 30 samples collected from the field; Section 3 focuses on the immersive production process by identifying key players and their interaction; the final section summarizes the main challenges and opportunities of adopting immersive technologies in CCS as identified by experts in the sector.

2. IMMERSIVE PROJECT IN THE CULTURAL AND CREATIVE SECTORS

The successful commercialization and large-scale exploitation of immersive technology within the CCS have emerged as significant developments in the past decade. Like other digitized activities, immersive projects emphasize integrating emerging technologies into the creation, production, and exhibition of artistic and creative content. What sets them apart is their strong user orientation. In other words, they strive to create immersive environments that transform the traditional one-way relationship between visitors and artifacts into a dynamic, multidirectional interaction between visitors and artifacts, as well as among the visitors themselves. This approach enhances the visitor experience, facilitates information exchange, deepens audience understanding of culture, and ultimately fulfills the edutainment and educational goals of cultural organizations.

Currently, immersive projects are typically implemented in two main forms: ***immersive exhibitions*** and ***immersive applications***. Immersive exhibitions digitize physical artifacts and artistic content to create a 360° immersive environment, where visitors are surrounded by digital content and experience a sense of immersion during their visit. Examples are *Dalí. Cybernectics.* (https://immersive-dali.com) and *Van Gogh. The Immersive Experience* (https://vangoghexpo.com). In these cases, the immersive experience is the final product delivered through the exhibition, with the immersive format taking precedence over the artistic content, especially concerning cultural authenticity. Immersive applications are advanced tools that digitize physical artifacts and artistic content using immersive technologies such as VR and AR, enabling users to engage with exhibits in virtual and interactive ways. Examples include *Guardianes de Segorbe* (https://turismo.segorbe.es/guardianes-de-segorbe), a project that offers a novel cultural tourism experience using AR and VR technologies, and *Arte Conectado* (https://imascono.com/proyecto/arte-conectado-ayuntamiento-de-zaragoza/), a mobile application that combines immersive technology with popular culture in Zaragoza, providing a new way to explore this Spanish city. In these cases, the immersive experience serves as a means to enhance cultural participation, with cultural content taking precedence over the immersive format.

Case study 1. Immersive exhibition: Dalí Cybernetics

Dalí Cybernetics is a groundbreaking immersive exhibition that offers an in-depth exploration of Salvador Dalí's life and artistic legacy. Known for his critical, ambitious, and scientific approach to art, Dalí's surrealist vision is brought to life through state-of-the-art immersive technologies. Hosted at various cities across Europe, as for example IDEAL Barcelona in Barcelona, Spain, Bombas Gens Centre d'Art in Valencia, Spain and Foundation of the Hellenic World "Hellenic Cosmos", Athens, Greece, the exhibition targets art enthusiasts, historians, tourists, and students alike.

Immersive Technology and User Interaction: The exhibition incorporates a diverse range of immersive technologies, including AR, VR, 360º projections, and interactive installations. These elements collectively create a dynamic and engaging environment that allows visitors to connect with Dalí's works in innovative ways, including the following aspects:

- **360º Projections**: Panoramic projections envelop visitors in vivid displays of Dalí's most iconic works. These projections transform physical spaces into surreal landscapes, emphasizing the intricate and dreamlike quality of Dalí's art.
- **Virtual Reality**: Through VR headsets, attendees can step into Dalí's creative world, experiencing his works and artistic processes in an immersive 3D format. This feature provides a unique perspective on Dalí's inspirations and techniques.
- **Augmented Reality**: AR enhances physical exhibits by overlaying digital content, offering additional layers of information and interaction. Visitors can use their devices or AR glasses to uncover scientific and conceptual insights behind Dalí's works.
- **Interactive Installations**: Digital recreations of Dalí's art invite visitors to engage actively, whether by exploring the scientific principles behind his techniques or creating their own Dalí-inspired digital artworks.

Educational and Sensory Engagement: The exhibition includes a wealth of educational resources such as guided tours, multimedia presentations, and workshops tailored to different age groups. Sensory engagement is further amplified through curated soundscapes and sensory elements, enriching the immersive experience and creating a holistic environment that aligns with Dalí's multifaceted artistic approach.

Production and Funding: Dalí Cybernetics Is a collaborative production created by Layers of Reality with the permission of Fundacio Gala - Salvador Dali and collaborated with various cultural entities such as Bombas Gens Centre d'Art in Valencia and Video Theatre in Athens. The project is funded through ticket sales, private investments, cultural grants, and sponsorships, ensuring the development and sustainability of its cutting-edge immersive content.

Development Team: The multidisciplinary development team includes experts in VR, AR, 360º projections, interactive design, and art curation. Working closely with art historians and scientists, the team ensures that the exhibition remains both accurate and engaging, honoring Dalí's legacy through a blend of innovation and artistry.

By combining immersive technology with rich educational content, Dalí Cybernetics offers a unique opportunity to experience Salvador Dalí's works and ideas. This innovative exhibition not only deepens appreciation for Dalí's art but also provides interactive and accessible pathways for audiences to explore his visionary approach to creativity.

Case study 2: Immersive applications: Guardianes de Segorbe

Guardianes de Segorbe is a novel cultural tourism experience that leverages AR and geolocation technologies to bring Segorbe – a Spanish historical town in the Valencia community – and its cultural heritage to life. Designed for cultural tourists and gamers, this immersive application guides users and visitors through key historical sites in Segorbe, seamlessly blending digital elements with the real-world environment. Immersive technology and user interaction are characterized by the following aspects:

- **Augmented reality**: The AR component overlays interactive digital elements onto historical sites, enriching the cultural experience. Users can view these elements via their mobile devices, which offer additional historical and contextual information.
- **Geolocation Integration**: Players navigate real-world locations, solving puzzles and completing challenges directly tied to the surroundings. This feature enhances user engagement and encourages active exploration of Segorbe's landmarks.
- **Educational Gameplay**: The challenges and puzzles are designed to educate players about Segorbe's history and cultural significance, providing an entertaining and informative journey

Production and Funding: The project is produced by the Universitat Jaume I (UJI) in Castellón, Spain, in collaboration with the Segorbe City Council. Funding is provided by the Segorbe City Council, highlighting a commitment to innovative cultural tourism and local engagement.

Development Team: Developed by a multidisciplinary team from UJI and local authorities, the application combines expertise in technology, history, and tourism. This collaboration ensures that the experience is both engaging and educational, offering a unique way to discover Segorbe's rich heritage.

By integrating augmented reality and geolocation technologies, Guardianes de Segorbe redefines cultural tourism, making Segorbe's historical sites more accessible and engaging for modern audiences.

2.1 A snapshot of immersive project cases

To deepen our understanding of immersive projects and their production, we gathered 30 exemplary cases (see fact sheets in the Annex) through online

searches, literature reviews, and expert recommendations. [2] These cases include both immersive exhibitions and applications, organized by a diverse range of sub-sectors within the CCS. Although the developers of these projects are primarily based in Spain and Greece, where the IMMER_CV participating organizations are located, their reach extends to numerous European cities, including Rome, Milan, Budapest, and Copenhagen, among others (see Figure 1). Besides, two cases came from non-EU countries including Singapore and Japan.

As shown in Figure 2, the sub-sectors “cultural heritage” and “cultural and creative tourism” are the most active within the CCS in implementing immersive projects, representing 32% and 29% of the selected cases, respectively. Together, they account for over 60% of all immersive projects in the field. The “visual arts and crafts” (16%) and “performance and celebration” (13%) sub-sectors also hold significant shares, collectively representing an additional 30% of the cases. The remaining 10% is divided between “media arts” (7%) and “design and creative services” (3%). Notably, other cultural domains such as 'books and press' and 'sports and recreation' are absent from this field.

Figure 3 illustrates that the majority of immersive projects within the CCS are developed by cultural organizations (37%) and private business enterprises (40%). In contrast, only about one-fifth of the projects are developed by research centers (13%) and studios or individual creators (10%). Projects led by cultural organizations are typically non-profit and educational in nature. In comparison, projects by private companies serve more complex purposes. Some have a strong commercial focus, such as large-scale touring exhibitions like 'Dalí Cybernetics – The Immersive Experience' and high-profile immersive shows and events like The Sphere in Las Vegas. Others are commissioned by public entities or cultural institutions and thus non-profitable orientation. Meanwhile, projects developed by research centers and individual studios are often prototypes or experimental in nature.

[2] The exemplary cases were selected in terms of the criteria including credibility, innovativeness, timeliness, and sectoral coverage. Geographically, most cases are located in Spain and Greece, where the project partners come from; sectorally, they are concentrated primarily in heritage institutions and performing arts - two focuses of the project.

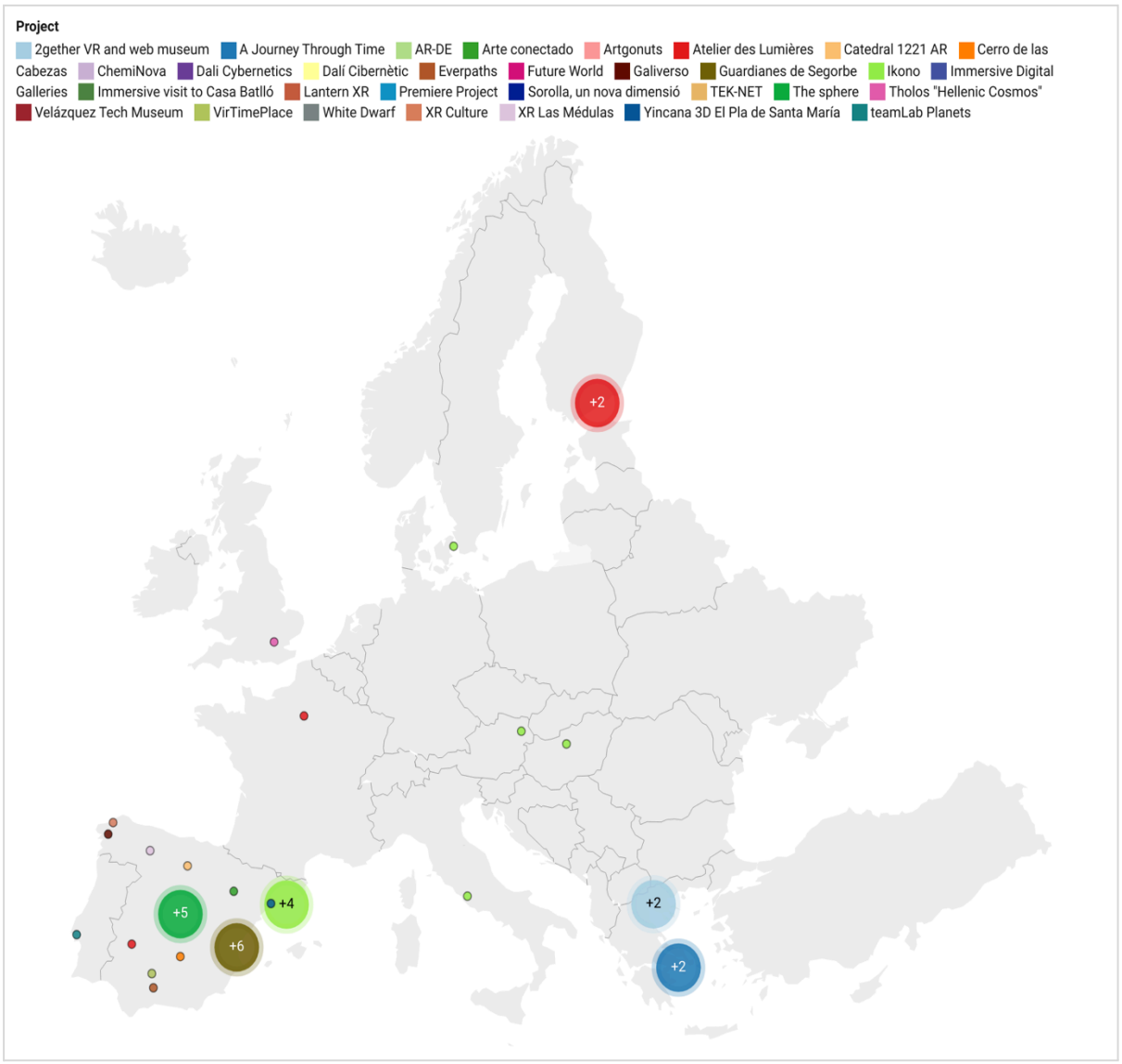

Figure 1. *Geographical Distribution of Immersive Projects in Europe*

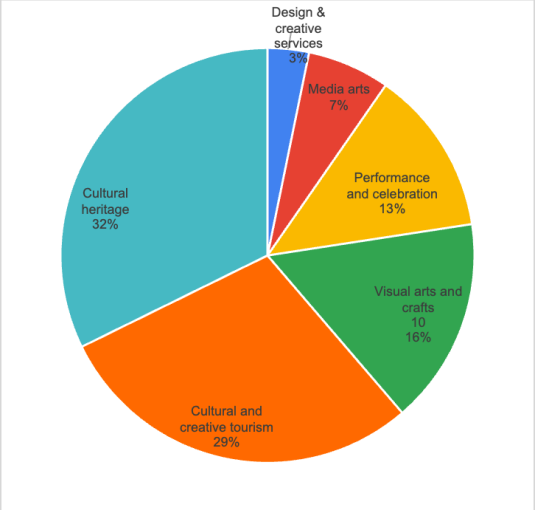

Figure 2. *Proportion of Immersive Projects across Different Sub-sectors within the CCS*

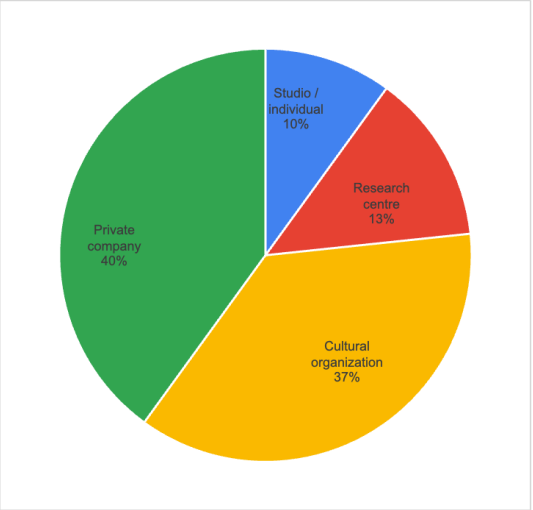

Figure 3. *Different Profiles of Developers in Immersive Projects within the CCS*

The high participation rate of private companies indicates that immersive projects are highly commercialized and have significant scalability potential. This is further evidenced by the fact that only two of the cases are still in the prototype stage, while 28 have reached the market as final products. Among these, 19 projects are permanent installations displayed at various sites, and 9 are temporary exhibitions with a defined lifecycle (see figure 4). The dominant involvement of cultural organizations and private companies has shaped the primary purposes of immersive projects, with promotion, education, and entertainment emerging as the top three functions, as shown in Figure 5. In contrast, research, dissemination, and training purposes are relatively underrepresented, reflecting the lower participation rates of research centers and individual studios.

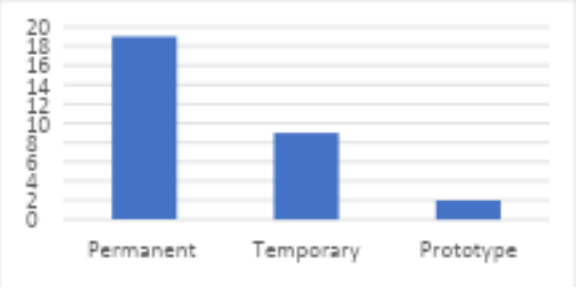

Figure 4. *Most Immersive Projects are Market-Ready Products with Permanent or Temporary Installations*

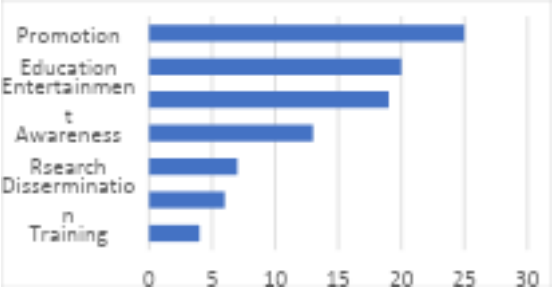

Figure 5. *Various Purposes of Immersive Projects Implemented within the CCS*
Note: The sample size is 30, and each project may serve multiple purposes.

2.2 Technical characteristics of immersive projects

Immersive projects utilize a range of immersive technologies, and the choice of specific technologies or combinations thereof can vary significantly depending on the project and its objectives. In the cultural and creative sectors, the primary immersive technologies used include virtual reality, projection, augmented reality, and light and audio systems, among others. As indicated in Figure 6, our study reveals that 21 of the examined cases prominently utilize virtual reality, making it the most adopted technology. In addition, half of the cases used projection and augmented reality and over one third of them adopted light and audio systems in their projects. In contrast, vibro-tactile systems, body-tracking systems, and video mapping are among the least frequently used technologies.

Besides, many projects require additional external devices and equipment to enhance the immersive experience of the users. Our study shows that touch screens are the most frequently used equipment in immersive projects, closely followed by smartphones, projectors, and computers. As illustrated in Figure 7, approximately half of the examined cases incorporate these devices. Tablets, headsets, visors, and multiscreen are also commonly utilized by cultural organizations. On the contrary, audio recording, rotating seats, and video recording devices are least frequently adopted by these projects.

From a technology-focused perspective, immersion is a physical process in which human bodies and senses are tricked into responding as though the virtual environment is genuinely real (Kitson et al., 2018). Immersive projects leverage various technologies and devices to engage multiple senses, enabling users to interact with artificial stimuli (Rubio-Tamayo et al., 2017). In other words, the less the user perceives the real world around them, the more immersive the system becomes (Beck et al., 2019).

From this perspective and considering the prevalent technologies and devices used in current projects, it is clear that most immersive projects within the CCS focus on constructing immersive environments primarily by isolating users from the physical world through visual, tactile, and auditory means. This is further evidenced by our study, which shows that sight, hearing, and touch are the top three senses engaged in exemplary immersive cases, whereas smell and taste are rarely involved, as illustrated in Figure 8.

Figure 6. *Primary Immersive Technologies Used in the Immersive Projects in the CCS*
Note: The sample size is 30, and each project may utilize multiple technologies

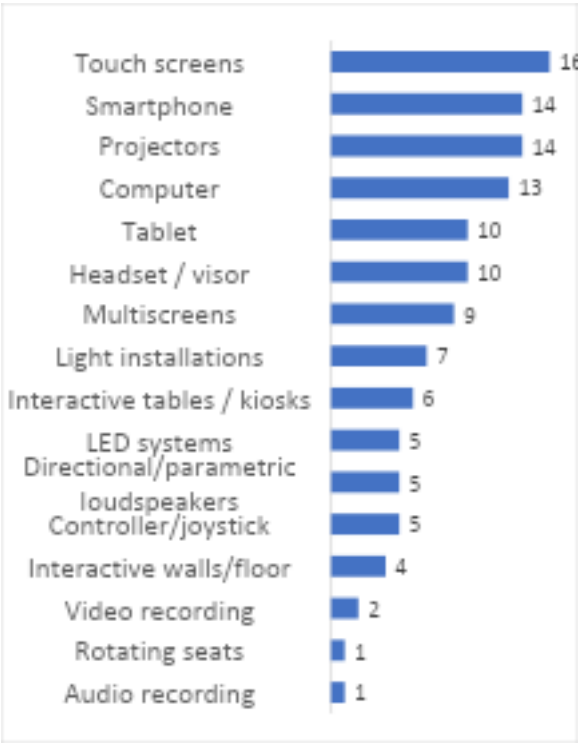

Figure 7. *Additional External Devices Required for Enhancing Immersive Experiences*
Note: The sample size is 30, and each project may engage multiple devices for immersive experience

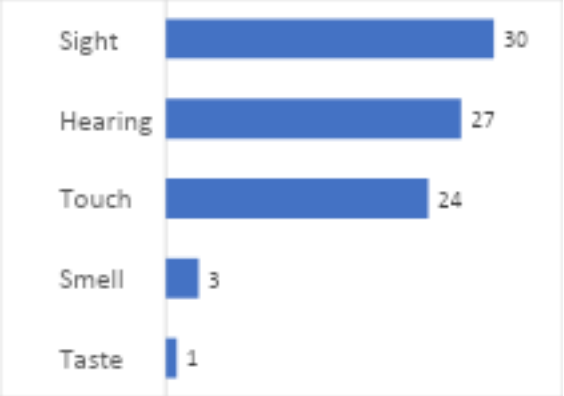

Figure 8. *Different Senses Highlighted in Current Immersive Experience*
Note: the sample size is 30, and each case may involve multiple senses

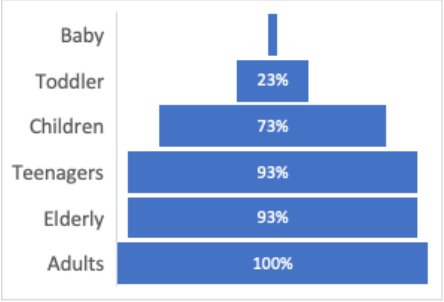

Figure 9. *Target Audience of Immersive Projects*

2.3. Audience and interactive experience

In the cultural and creative sectors, most immersive projects target the adults, the elderly, and the teenagers. Children are also frequently included as a key audience, particularly in immersive exhibitions or applications within the cultural heritage and visual arts sectors. However, toddlers and babies are rarely considered primary targets; their involvement is usually limited to immersive installations with an exploratory nature. The presence of each group of audience is reported in Figure 9.

Nearly all exemplary cases allow multiple users to participate simultaneously, as contemporary immersive projects often utilize public spaces and require a high degree of user interaction. Freedom of movement for the users is a key feature of the immersive experience, as it allows participants to explore the environment more naturally and engage deeply with the content. Figure 10 indicates that 97% of immersive projects allow visitors to move freely or with a certain degree of mobility, while only 3% of the experiences are stationary.

This interaction is diverse and includes not only interaction between humans and artifacts but also interaction among people. Our study reveals that 66% of projects allow visitors to interact with physical or digital objects during the experience and 43% of projects provide dynamic experience that permits multiple users to work together or interact in a shared virtual environment.

Many interactive experiences are facilitated through external portable or wearable devices. As shown in Figure 11, smartphones and tablets are the most used devices, particularly in immersive applications, representing 45% of all use cases. AR glasses and VR headsets account for 23% and 19% of external device use, primarily within immersive exhibitions. Haptic feedback devices, such as game controllers, joysticks, and steering wheels, are frequently used in immersive installations in museum exhibitions, making up 10% of the cases. Finally, motion tracking systems (3%) are used exclusively in certain performing arts contexts, such as the Tek-Net exhibition.

In addition to physical isolation achieved through external portable and wearable devices, over 70% of immersive projects employ storytelling techniques to craft narrative content, enhancing subjective immersive effects and allowing for personalized experiences.

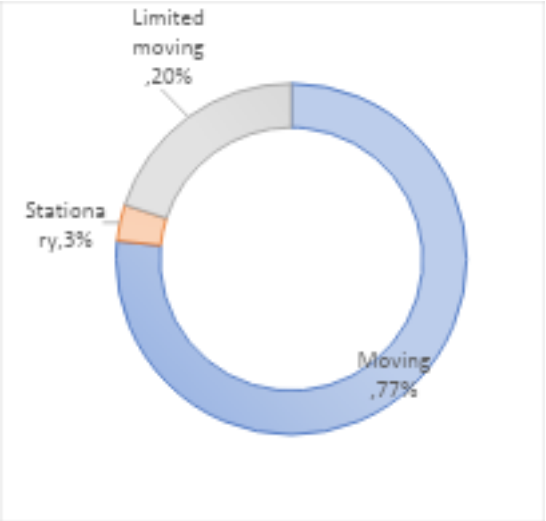

Figure 10. *Most people can freely move in immersive projects*

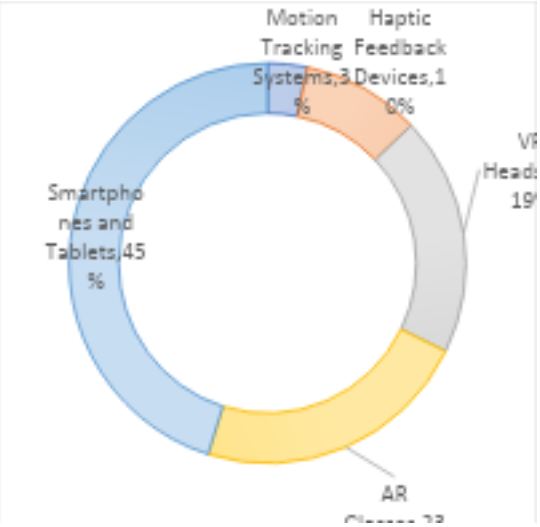

Figure 11. *The Percentage of Portable and Wearable Devices Utilized in the Immersive Projects*

3. KEY ACTORS AND INTERACTION IN THE IMMERSIVE PRODUCTION

The cultural and creative sectors are not traditionally known for being technology-intensive/fluent; therefore, technological innovation and digital transitions in these sectors are often reliant on organizational adoption of external technologies and innovation, wherein cross-sectoral collaboration between culture and technology play a vital role (C. Li, 2024).

In the cultural and creative sectors, the integration of arts, creativity, and technology is indispensable for immersive production. This integration is usually achieved through interdisciplinary collaboration at both organizational and individual levels. Organizational collaboration is typically structured through formal contracts or agreements between organizations, whereas interpersonal collaboration tends to be more flexible, which either arises from formal agreements within organizational boundaries and routine workflows or emerge spontaneously, such as through informal dialogues and conversations outside work hours.

At the organizational level, most immersive projects within the CCS are results of cross-sectoral and inter-organizational cooperation between cultural and IT sectors. As mentioned above, some of the immersive projects are commissioned by cultural heritage organizations and produced by high-tech companies specializing in immersive technologies; some are led by immersion exhibition companies with creative contents licensed by art agencies; and some are developed by research centers for experimental use in partnership with cultural and creative institutions.

At individual level, this interdisciplinary collaboration is often hidden but is widely embedded in the complex process of immersive production. By adopting the immersive project design framework proposed by the Design Department of Politecnico di Milano, we can map a series of players and their interaction in different stages of immersive production.

3.1 Multiple and iterative phases of immersive production

One of the foundational theoretical frameworks on immersive technologies developed by the Horizon Europe project *Artcast4D: Unleashing Creativity* (https://www.artcast4d.eu) is the design framework for immersive production by Italian researcher Elena Spadoni. Spadoni (2024) emphasizes that the development of immersive projects is a complex, multi-stage process that often involves iterative cycles. While the number and function of these stages may vary depending on the specifics of each project, a general framework can be established to outline the overall workflow of immersive production.

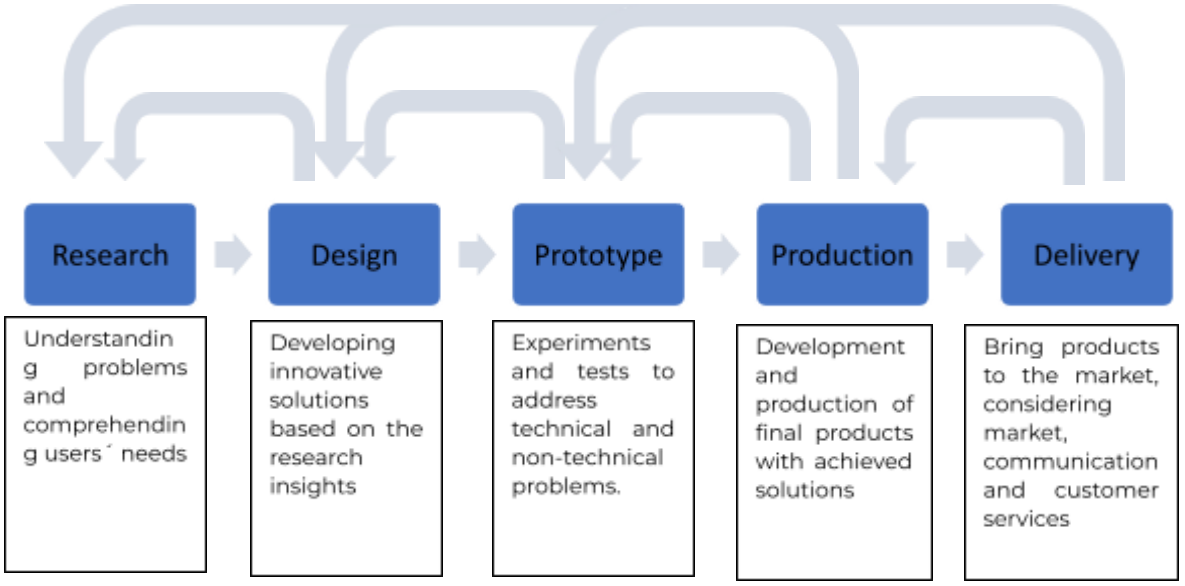

***Figure 12**. Five Iterative Stages of Immersive Technology*

As illustrated in figure 12, this general framework includes five stages as follows:

- **Research.** It is the initial stage of immersive production, aiming to adopt an empathic understanding of the problem and to deeply comprehend the users´ needs. In this stage, final users are directly involved for the research purpose.
- **Design**. It aims to synthesize insights from preliminary research to frame the design problem. At this stage, innovative solutions are presented to respond to the problem statement as previously defined in Stage 1.

- **Prototype and test**. It is an experimental phase of immersive technology projects, which addresses both technical and non-technical aspects of products and leads to a highly iterative process.
- **Development and production**. Based on the results of the prototype and test, this stage focuses on the improvements and production of final projects while reinforcing the perceived complexity of dealing with immersive technologies and tools.
- **Delivery**. This is the stage of bringing a product to market and involves communications, marketing, and consumer services.

Certainly, it is important to emphasize that this classification does not suggest that immersive production follows a strictly linear progression from research to delivery. Rather, the process is inherently dynamic, with various feedback loops occurring between stages such as design, R&D, and prototyping. These iterative cycles allow for continual refinement and adaptation, ensuring a more flexible and responsive development process.

Case study 3. 2gether: agile strategy for mapping design journey

2gether is a hybrid digital-physical museum experience developed by *MOMus – The Metropolitan Organization of Museums of Visual Arts of Thessaloniki*, in collaboration with *HyperTech* – a digital solution company specializing in cultural heritage sector as well as the IMMER-CV partner – and *CERTH/ITI* – a public research center of information technologies under the auspices of the General Secretarial of Research and Technology of Greece. The project was launched in 2022, serving as a participatory art platform and virtual museum space to connect users with modern art through interactive 3D experiences and crowdsourced content. More ambitiously, 2gether managed to redefine audience participation in the museum experience by turning passive visitors into active co-creators.

As a key partner responsible for project design and production, HyperTech highlights the importance of *trust* and *client engagement* to identify and satisfy the true needs of clients of 2gether, i.e., MOMus and its visitors. For this reason, HyperTech adopted an *agile philosophy* and strategy to carry out a design and production journey, including (1) discovery and analysis, (2) ideation and design, (3) development, (4) deployment and staff training, and (5) after-sells support. The main function of each stage is described as follows:

1. **Discovery and analysis stage**: producers tried to hear from clients straightly what they want and what they need from IT producers through thorough interviews and workshops between key members of production team and clients.
2. **Ideation and design stage**: sharing general ideas and doing mock-ups through internal brainstorm sessions; it is a conceptual prototyping process prior to the actual design.
3. **Development stage**: it involved many iterative testing and design process to align with clients´ evolving opinions and continuous feedback, in order to ensure everything is proper and goes towards a right direction.
4. **Deployment and staff training stage**: training and coaching museum staff to understand what have been created, as well as every step and action created that they can take advantage of in the new experience involved in museum visit.
5. **After-sells support stage**: there´s a specific duration when production team provided technical assistance and helped the museum run it properly and alive. But after this stage, the museum had to take over the maintenance and to keep the technology running.

To ensure the core place of clients in the design and production process, iterative testing and check with clients are treated as a transversal process spanning from the beginning to the end of this journey. This

means that producers had to collaborate with their clients close and correspond to changing ideas of clients in time.

3.2 Key actors in the immersive production

Immersive production depends heavily on a division of labor and collaboration, drawing from diverse knowledge bases and areas of specialization. At least three key knowledge bases are integral to the process: the **creative**, **technical**, and **managerial** knowledge bases (Li & Coll-Serrano, 2019).

The creative knowledge base encompasses the creative vision, content creation, and aesthetic aspects of the project, bringing together artists, designers, storytellers, choreographers, artistic curators, and archeologists, who shape the narrative, educational and sentimental experiences to captivate and engage the audience. This domain is responsible for crafting the emotional, informative/educational and sensory elements that make the immersive experience memorable, ensuring the content resonates with the audience on both an intellectual and emotional level.

The technical knowledge base focuses on the development, calibration, implementation, and maintenance of the essential technologies, involving experts in areas such as software development, audio-visual engineering, VR and AR application, and hardware integration. These specialists ensure the seamless functionality and stability of the immersive environment, translating creative concepts into interactive, responsive, and technically sound experiences. Their role is critical in optimizing performance, ensuring compatibility across platforms, and delivering a fluid user experience that aligns with the project's artistic and narrative goals.

The managerial knowledge base supports the coordination and overseeing of the overall production process, ensuring efficient project planning, resource allocation, and team collaboration. This domain includes project managers, production coordinators, communication specialists, event planners, curators, and education coordinators etc., who oversee timelines, budgets, and ensure that both artistic and technical objectives are aligned. They play a crucial role in balancing creativity with practicality, facilitating communication across different teams, mitigating risks, and maintaining the project's momentum from conception to delivery.

Table 1. *Key players in the immersive production*

Knowledge base	Actor	Main role
Creative	Artistic Director	Oversees the creative vision and direction of the project.

	Researcher	Develop innovative concepts and ensure the artistic integrity of the project.
	Storyteller	Craft interactive narratives, build worlds, and develop characters to engage audiences dynamically.
	Visual Designer	Create visual elements, including set design, props, and digital art.
	Sound Designer	Develop soundscapes and audio elements to enhance the environment.
Technical	Technical Director	Oversee the technical aspects of the production, ensuring everything runs smoothly.
	Light Engineer	Design and implement lighting setups to create the desired atmosphere.
	Sound Engineer	Manage audio equipment and ensure high-quality sound production.
	Software Developer	Develop software and interactive elements for the experience.
	VR/AR Specialist	Create virtual and augmented reality components.
Managerial	Project Manager	Coordinate all aspects of the project, ensuring timelines and budgets are met.
	Curator	Select and organize content for exhibitions and performances.
	Communication Staff	Handle public relations, marketing, and communication with stakeholders.
	Event Planner	Organize events and manage audience engagement.
	Education Coordinator	Develop educational programs and materials related to the immersive experience.

People are the carriers of knowledge. Although professional development requires a combination of diverse knowledge bases, it is often dominated by a focus on specific areas of expertise. For example, artistic and cultural work is determined by the creative knowledge base, technical work is dominated by the technical knowledge base, while management is based primarily on the managerial knowledge base.

Accordingly, each knowledge domain involves different actors who are responsible for specific tasks within their respective areas of expertise, and together they form the core team in the immersive production. These key players may vary between projects; not all roles are always present, and some professionals may take on multiple responsibilities simultaneously. However, effective collaboration between individuals from the artistic, technical, and management domains is essential to the success of any immersive project. Establishing clear and cooperative workflows across these domains will ensure

that creativity, technology, and organization work in harmony to achieve the desired outcome. A tentative list of key actors and their role descriptions is provided in Table 1.

3.3 Actor involvement in the immersive production

These key actors participate in the immersive production in different ways. Some actors take on a more continuous, horizontal role throughout the immersive production, while others have more specific, focused roles at different stages of the process. Figure 13 maps the stages of involvement of different actors in the process of immersive production based on Spadoni's (2024) findings and our case studies.

In general, creative and managerial actors are involved throughout the entire lifecycle of immersive projects, while technical actors are typically absent during the initial research and ideation stage. This is because the early phase focuses on conceptual development, storytelling, and creative direction, which primarily requires artistic vision and content creation (from the creative domain) and strategic planning (from the managerial domain), and early technical involvement tends to set up a box for creativity, which is not conducive to artistic creativity and innovation. However, technical expertise becomes more crucial in later stages, such as design, prototyping, production, and delivery, where the creative concepts are translated into practical, immersive experiences.

In the creative domain, roles vary significantly. For example, the artistic director, visual, and audio designers play a horizontal role, engaging in all stages of the project. On the other hand, storytellers and researchers are more active during the early (research and design) and later (delivery) phases, with less direct involvement during prototyping and production stages.

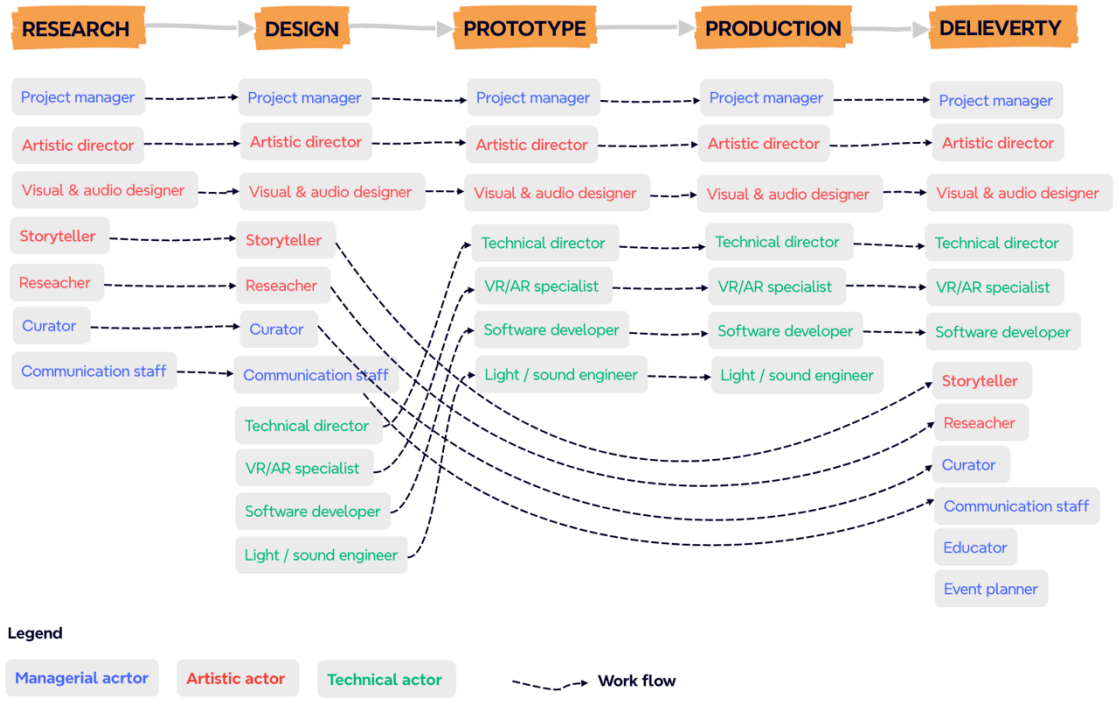

***Figure 13**. Mapping key actors in the immersive production*

Note: The roles of project manager and curator often overlap, particularly in small and medium-sized cultural organizations where it is uncommon to have both positions simultaneously. However, in large cultural institutions and technical R&D companies, these roles are more distinct and clearly defined. Generally, the project manager oversees the entire production process, ensuring smooth execution and delivery, while the curator focuses on design, research, and storytelling, emphasizing the conceptual and creative aspects of the project.

In the managerial domain, the project manager has a horizontal role, overseeing project implementation and strategic planning. Similarly, curators focus on content integration, mostly at the product level. Communication staff are involved in the early and later stages, handling market and branding concerns, while education coordinators and event planners primarily focus on the delivery phase, engaging end users through educational programs and public events.

In the technical domain, roles are more specialized. The technical director, VR/AR specialists, and software developers play crucial roles during the whole project (except for the research stage), ensuring the integration of hardware, software, and other technical elements essential for the project. Certainly, the technical field encompasses many niche, specialized tasks that go beyond the three positions above. Examples include light and sound engineers, electrician, mechanic, installer etc. whose involvements are generally supportive and concentrated primarily in the prototype and production process.

In summary, **immersive production can be defined as collaborative, project-based work that thrives on interdisciplinary teamwork and synergy**. Most successful immersive projects are built upon the close integration of artistic, technical, and managerial expertise, where diverse knowledge backgrounds intersect to create a cohesive and engaging working environment. This interdisciplinary cooperation is crucial to balancing creativity and technology throughout the production process.

4. MAIN CHALLENGES IDENTIFIED

According to both technical and cultural experts in immersion projects interviewed under the framework of Immer-CV, there are four main challenges identified for adopting immersive technologies in CCS, covering the technical, business, organizational and legal domains. Table 2 provides a detailed list of these challenges along with their assessed significance.

4.1 Technological challenges

Regarding technological challenges, three critical barriers hinder the promotion of immersive technologies: limitations in scalability, lack of standardization, and compatibility issues with hardware and software.

First, the scalability potential is frequently weakened by the complexity involved in the adoption of tailored technical solutions to meet specific requirements resulting from distinct physical spaces from different cultural institutions (e.g. museums and theaters) and art forms (performing arts and visual arts). In other words, there doesn't exist any one-fits-all solution, making it more difficult to make the immersive project scalable.

Second, as a cutting-edge technology, immersive technology is rapidly evolving and experimenting with various possibilities, resulting in a lack of standardized criteria. On the positive side, this environment fosters maximum innovation. However, it also significantly increases the time and financial costs for stakeholders because they have to search for and select reliable solutions to meet their specific needs and expectations.

Third, the widespread adoption of immersive technologies is heavily dependent on the availability of necessary software, which has often lagged behind the advancements in immersive technology and devices.

Table 2. *Key Challenges in Adopting Immersive Technologies in the Cultural and Creative Sectors*

Challenges	Description	Significance *
Technological challenges		
Replicability	Technological limits hinder from the scalability of immersive solutions and projects.	♦♦♦♦
Standardization	There´s no standardized criteria for immersive technologies.	♦
Compatibility	There´s a gap between software and hardware development in the field.	♦
Business challenge		
Price	Quality devices are expensive for small and medium-sized organizations.	♦♦♦♦
Ecosystem	Immersive business ecosystem is not established yet; it´s hard to find reliable equipment suppliers and installers.	♦♦
Service	Logistic, infrastructure and other services are expensive.	♦♦
Organizational challenge		
Technological legacy	Artists and cultural managers lack necessary knowledge of immersive technologies.	♦♦♦
Cultural legacy	Technical experts lack necessary artistic, historical and esthetical knowledge and contexts related to the project.	♦♦
Departmental segmentation	Departments within the cultural organizations do not share information and need requirements with each other.	♦
Awareness	Cultural managers are reluctant to use immersive technologies	♦
Legal challenge		
Data security	GDPR-related issues may arise due to the risk of compromising personal data in immersive experiences	♦

Note: The significance of each challenge was determined based on the frequency with which each challenge was mentioned by the interviewees.

4.2 Business challenges

Respect the business challenge, the most significant issue is the lack of a robust business ecosystem for immersive projects. In many regions, particularly remote and peripheral areas, it is challenging for immersive producers to find reliable equipment providers and installers, hindering the adoption of immersive technologies in these locations.

Furthermore, immersive technologies are still in their early stages of business development globally, leading to relatively high costs that small and medium-sized organizations often cannot afford. Compounding this problem is

the scarcity of relevant services and logistical support, which further drives up the cost of utilizing such technologies.

4.3 Organizational challenges

Concerning the organizational challenge, technological and cultural literacy need to be emphasized. Immersive production depends on inter-sectoral collaboration and cross-disciplinary integration, requiring close partnerships between technicians, artists, and cultural managers. Currently, however, many arts and cultural professionals have limited knowledge and experience with immersive technology and production. This gap prevents them either from clearly articulating their needs for specific functionalities and effects or from realistically imagining what existing technologies can achieve from the technical point of view in the collaborative process.

At the same time, many technicians lack the cultural literacy needed to fully understand and effectively convey the historical, cultural, and aesthetic significance of heritage objects and artworks. Addressing this issue requires technicians to take a more proactive approach in identifying the needs of both clients and end-users by developing smart strategies and methods, especially since artists and cultural managers often have difficulties in expressing their needs clearly for the lack of technological literacy. In this sense, technological and cultural literacy is essential for immersive production as it establishes a common language, fostering mutual understanding among partners from diverse professional disciplines.

Furthermore, departmental segmentation (silos) is also a notable issue within some (particularly large and bureaucratic) cultural organizations, leading to significant communication challenges in collaboration with technical partners. Specifically, different departments may present uncoordinated, trivial, repetitive, or even contradictory requirements. This creates inefficiencies, as technical partners must carefully sift through these inputs to distinguish valid needs from irrelevant or conflicting ones.

In addition, it is worth noting that awareness of immersive technologies remains limited in some cultural organizations. For example, certain museum managers perceive immersive technologies as "virtual games for kids," making them reluctant—or even outright resistant—to integrating these technologies into their daily operations.

Case study 4. TEK-NET: key challenges of integrating immersion and arts

TEK – NET is an immersion-enhanced contemporary dancing pilot created as a part of the ARTCAST4D project – an EU Horizon project aiming to promote immersive technology as a diver of creativity and innovation. Presented in May 2024 at Espai LaGranja in Valencia, Spain. TEK-NET was produced as a

free-form, physically expressive performance that integrates bodily movement with digital interactivity. The project was conceived and directed by choreographer Elton Luis, in collaboration with performers Sebastian Verde and Luisa Cerrada.

The project used interactive scenography, including light sensors, mirrored surfaces, metallic structures, and responsive digital projections. These elements were connected to a so-named AAASeed immersive technology framework provided by the ARTCAST4D project, whose core function was to design and create immersive environment by capturing audience engagement data in real-time.

As performance director, Elton highlights that "getting help from someone who knows how to integrate effectively the technology into dance (…) is very important". Although some digital artists are knowledgeable of programming and other IT skills, the advantage of collaborating with external specialists is to allow the artistic creation more effective, because a highly qualified technician can manage complicated technology easily and help to create some artistic effects expect in the project meanwhile saving learning costs for artists.

However, Elton also stressed three challenges preventing from such kind of collaboration from his own experience. First of all, **immersive arts are for everyone.** While futurist artists often embrace immersive technology, traditional and classic-oriented art forms generally prioritize artistic purity over technological innovation. In addition, prior experience in digital events is a significant advantage when participating in such programs

Second, **miscommunication between artists and technologists often hinders collaboration**. Artists need enough tech literacy to translate ideas into reality, while technologists require artistic awareness to avoid impractical design. For example, his tech collaborators designed an effect he found visually striking, but Elton and his team struggled to execute it or performed it in an uncomfortable manner.

Last but not least, **the high cost and outdated nature of the equipment** pose significant challenges, making it difficult for them to develop such programs

4.4 Legal challenges

Last but not the least, the legal challenge must be prioritized. In particular, personal data such as portraits, gender, and other sensitive information can be at the risk of exposure during real-time, live-streaming experiences. This raises regulatory concerns on data security, especially in relation to compliance with the General Data Protection Regulation (GDPR) in the European Union (EU).

In addition, organizations need to put in place robust safeguards to ensure not only compliance but also ethical handling of user data. Clear policies, transparency and regular audits are essential to mitigate risk and maintain user trust in an era of growing digital engagement.

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6. ANNEX: IMMER_CV Fact Sheets

1. **GUARDIANES DE SEGORBE**
2. CASA BATLLÓ IMMERSIVE EXPERIENCE
3. ARTE CONECTADO
4. VIRTIMEPLACE-VIRTUAL HISTORICAL EXPLORATION
5. IKONO - Immersive Art Experience
6. AR-DE - AUGMENTED REALITY ART AND DESIGN CIRCUIT
7. VELÁZQUEZ TECH - 360° SENSORIAL EXPERIENCE
8. GALIVERSO DE LOS MUSEOS - VIRTUAL MUSEUM EXPERIENCE
9. SOROLLA: A NEW DIMENSION - IMMERSIVE ARTISTIC EXPERIENCE
10. XR LAS MÉDULAS
11. REM EXPERIENCE - GAMIFIED TOURISM IN EL PLA DE SANTA MARIA
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17. **DALÍ CYBERNETICS SKG - IMMERSIVE EXPERIENCE**
18. THOLOS - IMMERSIVE VIRTUAL REALITY THEATRE
19. **2GETHER INITIATIVE - IMMERSIVE VIRTUAL MUSEUM EXPERIENCE**
20. THE SPHERE - IMMERSIVE ENTERTAINMENT VENUE
21. ARTSCIENCE MUSEUM - IMMERSIVE AND INTERACTIVE EXHIBITIONS
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25. DO NOT OPEN - VR HORROR ESCAPE ROOM GAME
26. INCLUTIC - IMMERSIVE VR AND SOCIAL ROBOTICS FOR AUTISM COMMUNICATION
27. PREMIERE - MODERNIZING THE PERFORMING ARTS
28. EVERPATHS - ADVANCED WAYFINDING AND IMMERSIVE MUSEUM EXPERIENCE
29. XR CULTURE - IMMERSIVE CULTURAL HERITAGE CONSERVATION AND EXPERIENCE
30. **TEK-NET**