applied sciences

MDPI

Article

Designing Innovative Digital Solutions in the Cultural Heritage and Tourism Industry: Best Practices for an Immersive User Experience

Vito Del Vecchio [1], Mariangela Lazoi [1,*], Claudio Marche [2], Christos Mettouris [3], Mario Montagud [4,5], Giorgia Specchia [1] and Mostafa Z. Ali [6]

[1] Department of Innovation Engineering, University of Salento, 73100 Lecce, Italy; vito.delvecchio@unisalento.it (V.D.V.); giorgia.specchia@unisalento.it (G.S.)
[2] Department of Electrical and Electronic Engineering, Università degli Studi di Cagliari, 09124 Cagliari, Italy; claudio.marche@unica.it
[3] Department of Computer Science, University of Cyprus, Nicosia 1010, Cyprus; mettouris.g.christos@ucy.ac.cy
[4] Instituto Tecnològico de la Energia, University of Valencia, 46010 Valencia, Spain; mario.montagut@uv.es
[5] i2CAT Foundation, 08001 Barcelona, Spain; mario.montagud@i2cat.net
[6] Department of Computer Information Systems, Jordan University of Science & Technology, Irbid 21110, Jordan; mzali.pn@gmail.com
* Correspondence: mariangela.lazoi@unisalento.it

Abstract: Digital transformation is reshaping business strategies and driving innovation across various industries including Cultural Heritage (CH) and tourism. Digital technologies, such as eXtended Reality (XR) and the Internet of Things (IoT), are increasingly being adopted to enhance visitors' experiences, foster interactive engagement, and promote cultural knowledge. Despite the growing number of digital solutions proposed in the CH sector, several challenges remain in differentiating digital products and services, including matching industry needs and user expectations. This aspect is of particular interest when dealing with small and medium enterprises (SMEs), which often suffer from limited resources. Therefore, to design an effective digital solution, like a cloud-based platform for tourism and heritage applications, it is essential to first identify the key requirements, expectations, and preferences of SMEs and customers. This study presents the findings of a survey-based analysis conducted among 122 CH and tourism professionals, focusing on the most relevant features, services, and functionalities that such platforms should integrate. Results indicate a strong demand for cloud-based solutions that incorporate XR, IoT, sensors, and smart devices to collect context data and deliver personalized, immersive, and context-aware experiences. These insights suggest valuable practices for the development of digital tools that effectively support cultural organizations in engaging visitors.

Keywords: cultural heritage; tourism; industry; visitor experience; user experience; immersive technology; cloud; extended reality; design; survey

Academic Editor: João Marcelo Teixeira

Received: 4 March 2025
Revised: 23 April 2025
Accepted: 25 April 2025
Published: 29 April 2025

Citation: Del Vecchio, V.; Lazoi, M.; Marche, C.; Mettouris, C.; Montagud, M.; Specchia, G.; Ali, M.Z. Designing Innovative Digital Solutions in the Cultural Heritage and Tourism Industry: Best Practices for an Immersive User Experience. *Appl. Sci.* **2025**, *15*, 4935. https://doi.org/10.3390/app15094935

1. Introduction

The Cultural and Creative Industry (CCI), which encompasses the cultural heritage (CH) and tourism sectors, is nowadays significantly influenced by digital solutions, like digital products and services, due to the increasing adoption of digital technologies. Indeed, the digital transformation process is reshaping business development strategies, driving innovation, and creating new opportunities in different industries, including CCI [1]. Digital solutions are redefining how cultural and tourism experiences are designed, delivered, and

consumed [2]. Emerging technologies such as eXtended Reality (XR), the Internet of Things (IoT), and cloud computing are playing a pivotal role in enhancing visitor engagement, enabling interactive and immersive experiences, and optimizing the management of cultural assets. These advancements facilitate data-driven decision-making, visitor journeys customization, and the integration of smart services, which, in turn, contribute to the sustainability and competitiveness of cultural and tourism enterprises [3]. This aspect is particularly critical for small and medium enterprises (SMEs) which, compared with big organizations, may suffer from limited resources, and face significant challenges, such as financial constraints and organizational boundaries [4].

The exploration and exploitation of digital technologies in the CH and tourism domains allow for enhancing local attractions, promoting cultural sites, and commercializing products and services [5]. Technologies have been tested in different domains of CCI, such as theatre [6], cinema [7], dance [8], music [9], and gaming [10], and for several purposes, from live streaming and distribution of the performing arts [11], to digital promotion and dissemination [12], advanced contents demonstration of events [13], human–computer interaction [14], and immersive user experiences [15]. In addition, digital platforms for the tourism sector play a key role not only in the provision and commercialization of a comprehensive experience to visitors, but also in networking service providers (e.g., transport, accommodation, restaurants), tourism stakeholders (e.g., tour organizers, tour operators, travel agencies), and consumer goods seller (e.g., local markets, companies and other small and medium enterprises (SMEs)) [16].

Despite these advancements, many organizations within CCI still face challenges in effectively adopting and leveraging digital solutions. This aspect is also critical considering the various cloud platforms and digital applications that have been designed, developed, and delivered on the market. Issues such as technological fragmentation, lack of interoperability, real-time technical efficiency, consistent contents tracking, friendly user interfaces, registration techniques, and the need for tailored solutions that align with the specific needs of cultural institutions and tourism operators remain critical [17]. Addressing these challenges is key to ensuring that digital transformation fosters inclusive, sustainable, and value-driven growth in the sector, by also satisfying the need of intuitive user interactions and successful visitor engagement [18]. Additionally, considering the plentiful literature, there is a need for differentiation of commercial offers in the reference market [19]. Differentiation is essential to address the challenges and opportunities presented in rural and central markets. This involves balancing the preservation of cultural values with market demands and ensuring that heritage products remain authentic and valuable [20].

Therefore, before designing and developing a novel digital solution for the CH domain, such as a cloud-based platform for tourists, it is of interest to comprehensively understand the key needs and expectations of SMEs operating in the CH and tourism industry, as well as of customers and visitors, and to address them through innovative products and services.

Considering these issues, technologies like IoT and XR are rapidly advancing, not only in fields like manufacturing [21] and healthcare [22,23], but also in the field of virtual heritage for enhancing user experiences, by leveraging perceptions, emotions, and interactions, and promoting cultural knowledge [12]. Indeed, the digitalization of heritage sites and archaeological locations is fundamental for the worldwide and more effective sharing of local culture and rural places. Also, enabling technologies allow for transversal access of cultural values with the provision of inclusive solutions that go beyond critical issues such as distances or disabilities [24].

Compared to traditional experiences, Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) enhance visitors' engagement by stimulating their senses, emotions, and cognitive processes [25,26]. XR technologies empower users to enrich their cultural site

experiences by overlaying the physical environment with various forms of virtual content, including textual information, 3D models, animations, and audio [25]. Basically, this is possible with the use of virtual information integrated in the real environment through the implementation of enabling devices, such as smart viewers, displays, mobile devices, handheld device, and software applications and platforms [27,28].

At the same time, mobile devices such as smartphones and tablets provide instant access to relevant information, facilitate navigation to Points of Interest (POIs), and allow users to explore digital content, share recommendations, leave feedback, and receive detailed insights on specific attractions. Additionally, digital platforms play a crucial role in managing and integrating both real and virtual elements, ensuring seamless interaction between the physical and digital realms [29]. In this context, the incorporation of beacon sensors, smart devices, and IoT is essential for collecting real-time data and transforming conventional heritage sites into intelligent, adaptive environments. By leveraging digital technologies, cultural institutions and tourism operators can offer more interactive, personalized, and immersive experiences, thereby enhancing visitor engagement and promoting deeper cultural understanding.

On top of this overview, the paper aims to investigate what are the key innovative elements that need to be considered by SMEs operating in the CH and tourism sector when dealing with the design and development of digital solutions, such as cloud-based platforms and applications for tourists, to satisfy user interests and expectations. Therefore, the study addresses the following research question: What are the most important needs of tourism SMEs with respect to the use of digital platforms aiming to enhance the customer offer?

Through an empirical investigation based on quantitative data, the study includes the design and development of a survey-based questionnaire, and its administration to CH and tourism professionals. The study, therefore, highlights the most important needs and expectations of SMEs in the tourism sector linked with customers' preferences. The results indicate a strong demand for cloud-based solutions that incorporate XR, IoT, sensors, and smart devices to collect site data and deliver personalized, immersive, and context-aware experiences. Therefore, while rooted in a specific regional context, the findings of this study provide transferable insights that may benefit other areas of the world, especially those with distributed heritage assets, growing tourism sectors, and the need for accessible, scalable, and user-centered digital platforms.

The remainder of the paper is structured as follows: Section 2 highlights the main scientific contributions related to the design of digital solutions and the application of digital technologies in the CH and tourism industry; Section 3 introduces the methodological approach adopted in this study, which relies on the development and administration of a survey-based questionnaire for collecting and analyzing empirical data; Section 4 describes the results of the analysis; Section 5 critically presents the main findings of the study by also proposing a set of best practices for guiding the development of digital solutions in CH; Section 6 concludes the paper.

2. Theoretical Background

2.1. Immersive Technology Applications for Advanced Cultural Experience

The adoption of digital technologies in the CH and tourism sectors has significantly transformed the way heritage sites are managed, presented, and experienced. These advancements are not only improving accessibility and preservation but also redefining visitor engagement by offering more interactive and personalized experiences [30,31]. Digital tools enable cultural institutions to bridge the gap between tradition and innovation,

ensuring that historical and artistic assets remain relevant in the modern era while reaching wider and more diverse audiences.

A key area of focus is the integration of the IoT, beacon sensors, and smart devices, which facilitate real-time data collection and monitoring from real cultural and archeological sites. Particular attention is also addressed to user data, including users' behavior on-site and off-site [32]. These technologies provide valuable insights into visitors' habits, preferences, and movement patterns, allowing institutions and SMEs to optimize site management, improve crowd control, and enhance security. Additionally, the implementation of data analytics tools enables the processing and interpretation of vast amounts of information, leading to more informed decision-making, and the ability to offer personalized recommendations tailored to individual visitor interests [32].

XR technologies play a crucial role in creating more engaging and memorable experiences. XR enhances the sense of presence and interaction within cultural sites by merging the physical and digital worlds, allowing visitors to explore historical narratives, interact with virtual reconstructions, and engage in gamified learning experiences [12]. These innovations not only improve knowledge transfer but also foster a deeper emotional connection between visitors and heritage, ultimately transforming cultural tourism into a more dynamic and meaningful journey.

The tourism industry encompasses a variety of CH sites, ranging from indoor locations like museums to open-air spaces such as historic city centers and archaeological sites. A vast body of research has explored the application of different technologies, including XR, for a range of purposes aimed at enhancing visitor experiences [3].

For example, Bekele [33] developed a cloud-based MR application for the HoloLens, designed to enhance museum visits through multi-user collaborative interactions. This system utilizes a walkable MR map as an interactive tool, allowing users to manipulate 3D models of artifacts in a virtual space, fostering both engagement and educational benefits. Likewise, Debandi et al. [34] adapted MR technology for outdoor heritage environments by creating an intelligent guide application. This solution streams images from an immersive device to a remote visual search engine. Utilizing the Vuforia system, the application matches captured images with a database, recognizes objects, and then delivers augmented virtual content, enriching visitors' exploration of cultural landmarks. Additionally, Litvak and Kuflik [35] developed an outdoor navigation system that leverages localization and orientation technology to identify sites and objects. By storing the coordinates of POIs, the system provides visitors with digital information when they approach specific locations, offering a more interactive and informative exploration.

Balbi and Marasco [36] showcased how digital applications can enhance access to CH content for individuals with disabilities. Their study focused on the development of a VR scenario aimed at fostering cultural engagement while ensuring inclusivity for users with motor difficulties. By involving individuals with disabilities from the early stages of development, the researchers adhered to the principles of User-Centered Design (UCD), tailoring the experience to their specific needs. Creating accessible design for both disabled and non-disabled users can highlight challenges and tensions, influencing SMEs' attitudes in accessible design [37]. Another compelling example is a VR application designed to facilitate virtual visits to the Cancho Roano archaeological site in Spain [38]. This immersive solution was specifically developed to accommodate wheelchair users, allowing them to explore the site without the physical constraints typically present in such environments. The system integrates a VR headset with a motion simulator and a haptic interface, enabling users to experience tactile sensations, such as variations in ground texture and surface inclinations beneath their wheelchair. This combination enhances realism, providing a more

engaging and authentic experience that replicates the physical sensations of navigating the site in person.

Additionally, immersive technologies have also been increasingly adopted for the long-term management and preservation of CH sites. These advancements allow experts to digitize, monitor, and analyze heritage structures more efficiently, ensuring their conservation while improving accessibility to critical data. Masciotta et al. [39] introduced an MR-based methodology for heritage inspection and digital documentation. Through the use of specific devices, inspectors can access a virtual representation of a CH site, enabling them to retrieve or update technical details, such as previous assessment reports, structural measurements, or newly collected data. This system integrates standardized protocols for documentation, classification, and risk assessment, offering an objective and data-driven approach to evaluating the condition of heritage assets. Such a method not only enhances conservation efforts but also enables more effective intervention planning by streamlining the information retrieval process. Similarly, Teruggi et al. [40] developed a framework for handling large-scale 3D point cloud data, applying it to significant historical structures, such as the Temple of Neptune in Paestum, Milan Cathedral, and Bologna's porticoes. Using a head-mounted display, users can explore high-resolution digital models of entire buildings or zoom in on intricate architectural details. This capability serves multiple purposes: it enhances the visitor experience by allowing virtual exploration with information hotspots and interactive content while also supporting conservation efforts by facilitating close-up inspections without physical intervention.

The integration of these digital tools not only modernizes the management of CH sites but also contributes to their sustainable preservation. By reducing the need for direct human contact with fragile structures and enabling remote analysis, MR and 3D visualization technologies offer invaluable solutions for maintaining heritage sites while simultaneously enriching public engagement and educational opportunities. These studies demonstrate the versatility of XR technologies in both indoor and outdoor CH sites, underlining their potential to create immersive, educational, and engaging cultural experiences through real-time interaction, enhanced digital content delivery, providing an alternative way to enjoy cultural value, such as through gamification, storytelling, and immersion [12,41].

2.2. Tips and Attributes for Designing Cloud-Based Solutions for CH

Beyond traditional cloud-based platforms, more advanced digital solutions are emerging that integrate multiple cutting-edge technologies to enhance tourism experiences. These next-generation platforms leverage immersive tools, real-time data processing, and interactive features to create more engaging, informative, and sustainable experiences for visitors. A well-structured cloud system can enhance visitor experiences, facilitate real-time information access, and optimize resource management while ensuring scalability and security [42]. By analyzing significant applications and case studies available in the existing scientific literature, key insights can be gathered to guide the conceptualization and design of an integrated, cutting-edge cloud-based solution for the CH and tourism industries.

A compelling example is presented in [43], where a cloud-based mobile application for cultural tourism in Malaysia was developed using Amazon Web Services (AWS). The application architecture follows a three-layer model: front-end, middleware, and back-end. The front-end, designed for Apple devices, offers an interactive map that displays cultural attractions, calculates distances, and provides detailed information. It is built using Xcode and integrates SQLite for offline data management, ensuring usability even in areas with limited connectivity. The middleware functions as a web service, converting relational database content into XML output to communicate with the mobile application. This layer, developed with PHP, processes HTTP requests efficiently, enabling seamless data exchange

between the front-end and back-end. The back-end leverages AWS infrastructure, utilizing Amazon EC2 for hosting the web server, Amazon RDS for managing the MySQL database, and Amazon S3 for secure data storage. These cloud components ensure scalability, security, and performance optimization, allowing the application to handle fluctuating traffic demands while maintaining efficient resource allocation. This case study highlights the advantages of cloud technology in cultural platforms, demonstrating their ability to deliver real-time content, ensure data security, and support dynamic scalability.

Similarly, the ECOPACAYA 4.0 platform [44], developed as part of the Tourism 4.0 initiative, was designed to enrich ecotourism in the Peruvian Amazon by integrating a combination of AR, geo-localization, cloud computing, and gamification. The platform aims to provide visitors with an interactive and educational journey through the jungle while promoting responsible and sustainable tourism practices. One of the key strengths of ECOPACAYA 4.0 lies in its real-time geo-localization capabilities, which allow users to receive contextualized information about their surroundings, access interactive AR content, and navigate through the dense rainforest with enhanced safety and guidance. The AR features enable users to visualize digital overlays, such as historical reconstructions, ecological insights, and wildlife identification, directly on their mobile devices. Additionally, gamification elements, such as challenges, rewards, and storytelling-driven exploration, increase visitor engagement and encourage participation in conservation efforts. The platform was rigorously tested and validated, receiving positive feedback from users, who appreciated its innovativeness, usability, and commitment to sustainability. By leveraging cloud computing, ECOPACAYA 4.0 ensures seamless data synchronization and scalability, making it a model for future tourism applications.

In the realm of CH management, the SACHER project [45] has also been highly effective in supporting the restoration and maintenance of CH sites. The platform offers several key cloud services aimed at enhancing the management, preservation, and accessibility of CH data. One of them focuses on the lifecycle management of CH data, facilitating the collection and management of data throughout the restoration process, and providing a powerful tool for visualizing these data in 3D. This capability allows for detailed, interactive views of heritage sites or objects, improving the accuracy and effectiveness of restoration efforts. Another crucial service delivers an advanced search function for CH data that originate from a variety of diverse sources. The platform employs ETL (Extract, Transform, Load) workflows, which are used to gather data from multiple CH providers in different formats, transforming and centralizing it into a unified data repository. This centralized approach not only streamlines data access but also ensures that the information is consistent, easily searchable, and ready for analysis. Furthermore, user-friendly applications are incorporated to increase citizens' and tourists' understanding of CH, making it more accessible to a wider audience. By improving the way data are handled and visualized, the SACHER platform enhances both the preservation of heritage sites and the educational experience for visitors.

In summary, the growing adoption of XR technologies in the CH sector is delivering numerous advantages. One of the most notable benefits is the enhanced learning experience that immersive and customizable technologies offer, allowing users to engage more deeply with cultural content [3]. Additionally, devices like Head-Mounted Displays (HMDs) and CAVE systems significantly increase the level of interaction and immersion, providing a more engaging experience. The Bring Your Own Device (BYOD) concept further adds value by allowing visitors to use their own devices to personalize their tours, making the experience more tailored and accessible [46]. Several options also stand out in terms of preferred features and services for enhancing the visitor experience. These include the following [12]: content profiling which leverages user data and preferences to deliver tailored suggestions,

thus offering a more personalized experience, decision-making systems to recommend specific content based on individual interests, 3D object and artifact recognition allowing users to interact with heritage objects in a more engaging and informative way, and gamification and storytelling elements to enrich the experience by adding an interactive, narrative-driven dimension that encourages deeper engagement with the cultural context.

3. Materials and Methods

This study has been promoted by a robust collaboration among various academic and industrial stakeholders from Italy, Jordan, Spain, Turkey, and Cyprus. The driving force was the intention to explore how Mediterranean tourism and CH can be supported and enhanced through the use of digital technologies, with a particular focus on XR and cloud-based platforms [47]. Such technologies represent a valuable means for providing customers with digital services for enhancing and extending the visiting experience of cultural sites, both physically and digitally. This effort aims to investigate the competitiveness and sustainability of the Mediterranean by fostering the knowledge and expertise of SMEs and people belonging to different regions adjoining the same sea. Beyond the countries from which the authors come, the Mediterranean region offers a unique and valuable context for this investigation. It is historically the home of a concentration of tangible and intangible cultural heritage, including ancient archaeological sites, historical cities, cultures and traditions that span multiple civilizations. These assets are distributed across diverse countries that, despite having different economic maturity, share a strong dependence on tourism as a driver of cultural and economic sustainability.

Ensuring that digital CH solutions meet the specific needs of the tourism market and understanding the requirements and preferences of SMEs and customers is essential. As a result, a survey-based questionnaire was developed and implemented across the five countries. Surveys have proven to be an efficient and valuable tool for quantitative research and data collection [48], particularly in explorative studies. According to [49], surveys offer a quantitative snapshot of trends, opinions, and attitudes within a population, and can also test associations between variables within that population. Furthermore, online surveys offer significant advantages over other methods by reaching large, geographically dispersed populations while reducing costs and time. In line with the methodological suggestions provided by [50,51], a survey-based questionnaire was first defined and designed, and then implemented for collecting data from the reference market of each country.

3.1. Definition of the Survey-Based Questionnaire

The survey-based questionnaire was designed with the aim of providing an answer to the research question.

Surveys allow for fast and easy gathering of data from responders. Specifically, a close-ended questionnaire was developed [52] for obtaining quantitative data and to facilitate the following analysis. The contents and elements of investigation were derived starting from the scientific literature and adding further details and concepts based on the knowledge and experience of practitioners and authors, as in [53].

The questionnaire was structured with a five-point Likert scale, which enables respondents to answer questions by scaling responses from the lowest level (1) to the highest (5), including the possibility of a neutral response (3), as suggested by [48]. Also, in some cases, where required by the question, the answers were designed with a Boolean structure (“yes” or “not”) or a multiple-choice structure. Moreover, several open-ended questions were included to better contextualize responses and gather more qualitative information on SMEs and customers’ needs and expectations. Therefore, open-ended questions were not included in the quantitative analysis of responses.

The questionnaire includes a first section of 5 questions aiming to gather information on the responding SMEs. After that, a second section of 32 questions investigates the topic of analysis, SMEs needs, preferences, and expectations. The questionnaire is therefore composed of 37 questions in total, and the expected time for its completion is estimated to be about 20 min. All the items of the questionnaire were designed collaboratively such that they could provide a market analysis in different countries. Indeed, starting from interesting tips and attributes suggested in the literature, through focus group sessions, the authors shared their ideas with respect to the contents of the items as well as considering the potential interpretations and different interests related to each different country. The questionnaire was developed in English, through an iterative and collaborative approach among the authors. This allowed for a cyclical process of proposal of questions, refinement, and validation [48]. Personal information of respondents was not requested or collected to ensure protection of privacy. The content of the questionnaire is presented below in Table 1.

Table 1. Questionnaire structure.

ID	Questions	Response
	Section 1: information on responding SMEs	
1	Country	Italy, Jordan, Spain, Turkey, Cyprus
2	SME size	Micro, Small, Medium, Large
3	What is your reference cultural heritage site?	Open-ended question
4	What is your core business type?	Service provider, product developer, both
5	If you are a service provider, what type of services do you provide?	Tourism operator, hospitality, IT and digital services, restaurant, food, not providing services, other
	Section 2: information on SMEs' needs, preferences, expectations	
6	Do you believe that technology, such as mobile applications and cloud-based platforms, can provide benefits for enhancing cultural heritage experiences?	Yes/No
7	How familiar are you with the concept of using technology to enhance cultural heritage experiences?	1–5
8	In your opinion, how important is it for SMEs to invest in digital solutions for enhancing cultural heritage experiences?	1–5
9	How interested are you in leveraging digital tools to enhance visitor experiences at cultural heritage sites?	1–5
10	Would your SME benefit from having access to a cloud-based platform for managing and delivering cultural heritage content?	Yes/No
11	How likely would you be to use a platform that offers services such as content profiling, manipulation, and downloading of various media types related to cultural heritage?	1–5
12	Do you see value in incorporating features like object recognition and 3D reconstruction to provide immersive experiences at cultural heritage sites?	Yes/No
13	How important do you consider features like a recommender system, Points of Interest (POIs), and dynamic content enhancement based on visitor preferences?	1–5

Table 1. *Cont.*

ID	Questions	Response
14	How likely are you to utilize data obtained from sensors within the cultural heritage site to enhance visitor experiences?	1–5
15	Are you concerned about the costs associated with developing and maintaining such a digital solution?	Yes/No
16	Would you be willing to allocate resources (time, budget, etc.) towards the development and maintenance of such a cultural heritage application?	Yes/No
17	Do you have any reservations regarding data privacy and security when utilizing cloud-based services for cultural heritage applications?	Yes/No
18	Would you consider investing in or partnering with developers to create a digital solution for enhancing cultural heritage experiences in the future?	Yes/No
19	How likely are you to recommend adopting digital tools for cultural heritage to other SMEs in your industry?	1–5
20	Overall, how beneficial would it be for your SME to invest in an application connected to a cloud-based platform that offers these features for cultural heritage?	1–5
21	Is there any specific feature or functionality that you believe would be crucial for the success of a cultural heritage application connected to a cloud-based platform?	Multiple choice
22	Do you have any other suggestions or insights regarding the integration of technology into cultural heritage preservation and visitor engagement efforts?	Open-ended question
23	What knowledge or resources do you feel are lacking in your current operations?	Open-ended question
24	What specific skills or expertise would you seek in a potential strategic alliance partner?	Open-ended question
25	Are you currently exploring international markets or considering expanding internationally?	Closed-ended question
26	What barriers do you perceive in entering or expanding into international markets?	Open-ended question
27	Are there any complementary products or services that could enhance your offerings or address current gaps in your business?	Open-ended question
28	What types of partnerships or collaborations do you envision would be most beneficial for your business growth?	Open-ended question
29	How much are you interested in forming collaborations with other SMEs?	1–5
30	How hard is it to form a collaboration starting from an independent initiative?	1–5
31	What is the usefulness of using incubators for knowledge transfer?	1–5
32	How useful is it to have a specific training for innovative technologies in cultural heritage?	1–5

Table 1. *Cont.*

ID	Questions	Response
33	What factors would influence your decision to enter into a strategic alliance?	Open-ended question
34	Percentage of your revenues from local market?	Closed-ended question
35	Percentage of your revenues from international markets?	Closed-ended question
36	What are your long-term goals and objectives for your business?	Open-ended question
37	How do you envision strategic alliances contributing to the achievement of these goals?	Open-ended question

3.2. Administration of the Survey

In line with the aforementioned objective, the target of the survey was set as SMEs operating in the tourism sector in different forms (e.g., tourism operators, digital and IT service providers, hospitality, restaurant, food) [17]. Indeed, they all contribute in different ways to providing a comprehensive experience to visitors and, therefore, to a better understanding of customer needs and how to enhance their cultural experience.

First, starting from the developed questionnaire, an online version was implemented and administered using the Google Modules tool. It offers responding SMEs a direct and easily used tool for questionnaire completion, as well as a user-friendly way for authors to collect and analyze data. Second, the questionnaire was translated from English to the specific languages of the authors' countries in order to facilitate the understanding and completion by local SMEs and rural cultural sites managers. Third, the survey was shared by the authors in each associated country by relying on their institutional and personal channels (e.g., LinkedIn), and on their network of partners and contacts operating in the reference context. Fourth, the authors collected the responses and translated them into English in order to have a common base for the analysis. Fifth, the authors proceeded to analyze the collected information to provide useful insights to answer the research question. To ensure comparability across countries, relative percentages were calculated: the frequency of each response was divided by the total number of responses from each country, yielding the percentages reported in the subsequent sections.

A total of 122 responses were collected (25.41% from Jordan, 21.31% from Turkey, 21.31% from Spain, 19.67% from Italy, 12.30% from Cyprus), which represented the sample analysis.

All the collected responses were eligible for analysis since the completion of the questionnaire was restricted to those organizations providing value in different forms for cultural visitors and travelers. Before completing the questionnaire, the basic premise was introduced to ensure the right sample of respondents.

Respondents were representative of organizations operating in the tourism sector in Italy (24), Jordan (31), Spain (26), Cyprus (15), and Turkey (26). Most of the countries were mostly represented by small and micro companies. Only the Jordanian responses were composed of an almost equal distribution among micro, small and medium enterprises.

With respect to the typology of core business of the involved organizations, in each country, most of the responses came from SMEs providing services in the tourism sector. Specifically, it is interesting to observe how each group of responses in each country was distributed with respect to the type of services provided, e.g., tourism operators, hospitality, food, and IT services. Figure 1 shows that while Cyprus is mainly represented by IT companies, Italy and Spain are mainly represented by tourism operators. On the other hand, Jordan and Turkey present a quite homogeneous distribution of CH and tourism

stakeholders, with a small presence of cultural IT companies. In some cases, respondents were not classified as tourism operators, hospitality, food or IT companies. This means that they operate in the CH and tourism sectors but in other forms.

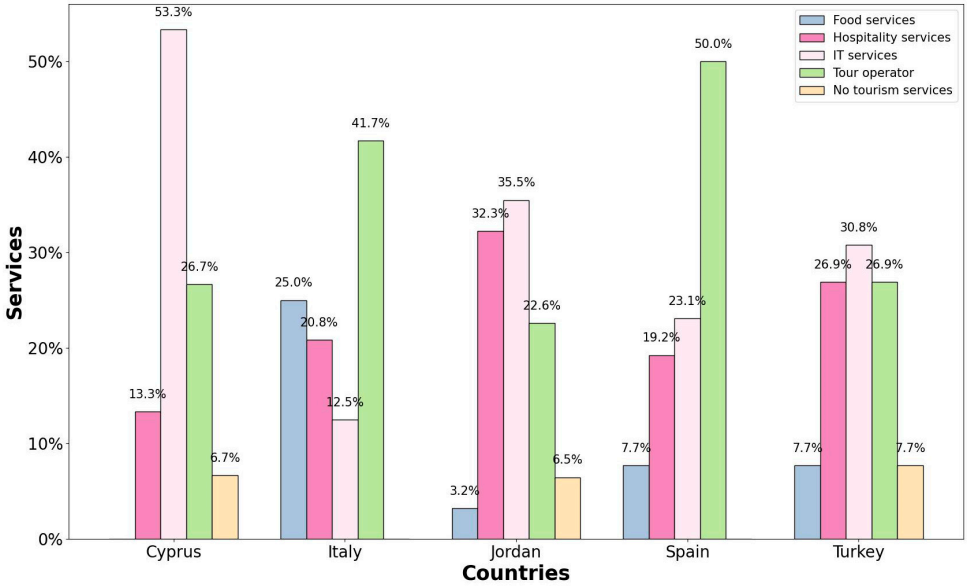

Figure 1. Type of tourism services provided in each country.

4. Results

Considering the second section of the survey-based questionnaire, the quantitative data collected were accurately analyzed to capture the most important needs, preferences, and expectations of SMEs operating in the CH and tourism sector. Starting from such information, valuable best practices can be derived in terms of key attributes and tips for supporting the design of innovative and useful digital solutions for the reference market.

Responses and insights were derived from SMEs potentially interested in the use of technological and digital solutions (e.g., digital platforms) for enhancing customers' experiences, to provide innovative products and services, and to facilitate and foster business collaborations and competitiveness.

First, according to the data collected, all the respondents fully agreed with the potential benefits of the use of technology, such as use of mobile applications and cloud-based platforms for enhancing cultural experiences. They were fully aware of the importance of investing in the digitalization of the CH and tourism sectors. This represented an essential insight for the authors because it testifies to the will and awareness of CH stakeholders to invest in digitalization in these markets for enhancing the user experience. Therefore, the response provided positive feedback with respect to the authors' collaboration and intentions. Moreover, in each country, the SME respondents indicated that they were less familiar with the use of platform technology in CH, thus creating the opportunity for input to SMEs of potential business opportunities associated with the design of innovative digital and cloud solutions.

Of particular interest was the identification of the needs of SME respondents with respect to incorporating specific features within CH and tourism platforms. As illustrated in Figure 2, features such as contents profiling, manipulation and downloading of media (in orange), recommendation systems, POIs, and dynamic content enhancement based on visitors' preferences (in blue) are considered highly important by respondents. The figure highlights the percentage of respondents who rated each of these features. It shows that the responses reflect very positive attitudes (Likert classes 4 and 5, represented by the darker sections of each bar, are the most prevalent). This indicates that these features are

regarded as relevant drivers to enhance visitors' experiences and better inform them along their journey to cultural sites. In this context, moreover, respondents stated that they were very interested in incorporating enabling features for providing visitors with immersive experiences, such as through the recognition and 3D reconstruction of objects with the use of enabling devices.

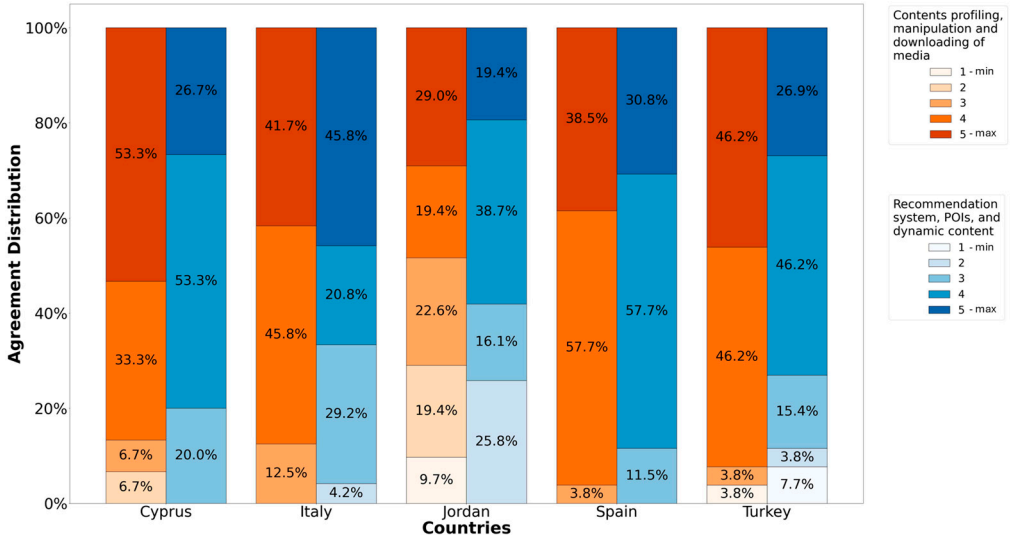

Figure 2. Preferences of attributes and features of a digital platform in CH.

Also, most SMEs seemed to be very interested in installing beacon sensors and smart devices within cultural sites to help assess the benefits of digitalization. However, with the exception of Spanish SMEs, the other countries indicated that they lacked expertise in being able to exploit and capitalize on data collected from sensors (about 50% of respondents selected a score from 1 to 3 on the 5-point Likert scale). An important issue also emerged about the management of customer data from a privacy perspective. The survey revealed that while Cypriot, Spanish, and Turkish SMEs take considerable care with respect to data privacy and security, only about 50% of Italian and Jordanian respondents did so. Therefore, this suggests the need to invest in security and privacy awareness and to enhance this aspect not only from a technical perspective but also for alignment of corporate knowledge.

Furthermore, most of the SME respondents in each country declared they were substantially aware of the costs (with the exception of Italy, with 50% of responses) and resources required for the digitalization, development, and maintenance of CH applications and platforms, as well as their intention to consider or invest in digital heritage in the future. This is because they believed that such investments could be highly beneficial for improving their business. However, Jordanian SMEs seemed to be less aware of the capitalization of digital investments in CH. In line with this, most SMEs declared also stated they were very interested in forming collaborations with other SMEs in order to improve competitiveness in the Mediterranean, in order to design and develop innovative solutions and to better satisfy customer needs. However, most of them also declared that the establishment of an international collaboration and formation of an independent initiative is not something that can be immediately realized or would be straightforward in terms of policy and bureaucracy, and that the passage of time may weaken the potential value of business opportunities. This insight is crucial for SMEs that intend to liaise internationally and cooperate with other partners and form cross-business alliances.

Based on the SME respondents' replies, Table 2 shows the most important services and functionalities they would like to integrate within a cloud-based platform for enhancing tourists and visitors' experiences. In particular, the column "total" presents the percentage

of respondents selecting each specific service. The other columns present the percentage of respondents' interested, considering the specific country.

Table 2. Distribution of service and functionalities interest of the entire dataset and per country.

Service	Description	Total	Cyprus	Italy	Jordan	Spain	Turkey
i	Third-party services integration	41.80%	8.62%	13.76%	0.00%	10.32%	12.20%
ii	Platform services support	2.46%	0.00%	0.00%	0.00%	1.94%	0.00%
iii	Social community	31.15%	6.90%	7.34%	0.00%	8.39%	10.57%
iv	Story generator	9.02%	0.00%	0.00%	7.28%	0.00%	0.00%
v	Setup walkthrough for beacons to the IoT established network	41.80%	5.17%	2.75%	9.93%	12.26%	8.94%
vi	Recommendations based on accumulated knowledge from data	59.02%	13.79%	16.51%	7.28%	10.32%	15.45%
vii	Recognition of 3D objects for MR apps	57.38%	17.24%	12.84%	6.62%	12.26%	13.82%
viii	Gaming contents to the platform of choice	13.11%	0.00%	0.00%	9.93%	0.65%	0.00%
ix	Profiling and personalized manager	60.66%	5.17%	15.60%	8.61%	10.97%	19.51%
x	Privacy and security management	0.82%	0.00%	0.00%	0.66%	0.00%	0.00%
xi	Point-cloud to model (to support MR)	8.20%	0.00%	0.00%	6.62%	0.00%	0.00%
xii	IoT network establishment walkthrough	33.61%	10.34%	6.42%	7.28%	10.97%	0.00%
xiii	Expert system-based itinerary planner	30.33%	8.62%	7.34%	4.64%	8.39%	3.25%
xiv	Data analysis and knowledge building	9.02%	0.00%	1.83%	5.96%	0.00%	0.00%
xv	Content access	73.77%	24.14%	15.60%	11.92%	13.55%	16.26%
xvi	Cloud-based recognition of target images (MR apps)	9.02%	0.00%	0.00%	7.28%	0.00%	0.00%
xvii	Advanced visualization	7.38%	0.00%	0.00%	5.96%	0.00%	0.00%

From the first to the seventeenth point, the investigated services and functionalities were: (i) third-party services integration (e.g., weather, localization), (ii) platform services support, (iii) social community, (iv) story generator, (v) setup walkthrough for beacons to the IoT established network, (vi) recommendations based on accumulated knowledge from data, (vii) recognition of 3D objects for MR apps, (viii) gaming contents to the platform of choice, (ix) profiling and personalized manager, (x) privacy and security management, (xi) point-cloud to model (to support MR), (xii) IoT network establishment walkthrough, (xiii) expert system-based itinerary planner, (xiv) data analysis and knowledge building, (xv) content access, (xvi) cloud-based recognition of target images (MR apps), (xvii) advanced visualization.

As can be seen in Table 2, with respect to the seventeen services considered, most of the SME respondents across the countries agreed on the particular need to integrate within a tourism digital platform specific services, such as the possibility to facilitate content access and manipulation from users (xv), to enable a recommendation service able to suggest custom information and profiled contents based on user preferences data (vi and ix), and to enable the 3D recognition of objects and provide an immersive experience (vii). Additionally, about one-third of the respondents highlighted the importance of integrating an IoT network, including the implementation of smart devices and beacons, to gather data useful to personalize and augment user experiences along their journey within smart and connected sites (v, xii, and xiii).

In addition, the analysis revealed that some features seem to be relevant only in some specific countries. For instance, the integration of third-party services (i) is highly requested by SMEs in Cyprus, Italy, Spain, and Turkey, but no Jordanian company seems to be interested in it. Nevertheless, it is fundamental to customize the visitors' journeys with respect, for example, to the weather conditions. And this aspect is highly relevant, especially in outdoor venues or in those places where the weather changes suddenly. Similarly, the integration of a social community (iii) in a tourism platform represents a place where users can share feedback, comments and reviews, and feel part of a community sharing personal perceptions and emotions. However, as previously indicated, this aspect seems to be not relevant for Jordanian SMEs. Conversely, with respect to the other SMEs, Jordanian companies highlighted the need to integrate story generators (iv), gamification (viii), privacy and security management (x), cloud models (xi and xvi), data analysis and knowledge builder (xiv), and advanced visualization (xvii), which is strongly in line with the use of XR technologies for providing an advanced and immersive experience.

Finally, with respect to other SMEs, only Turkish SMEs declared they were interested in the establishment of an IoT network in CH sites (xii), despite indicating support for the implementation of smart devices and beacons (v). Spanish SMEs also suggested the need to underpin the development and release of a tourism platform with support services that could assist SMEs during the use of the digital solution, thus assisting customers along their journeys.

To explore the economic relevance of local and international tourism for SMEs operating in the Mediterranean area, the survey also collected information on the average share of revenues generated from both local and international markets (questions 34 and 35). Respondents were asked to indicate a revenue range for both the local and international market. For the purpose of analysis, each range was approximated by its midpoint, and the overall average was calculated across all responses to estimate the potential revenue distribution.

As shown in Table 3, most revenues for the surveyed SMEs come from the local tourism market, with an overall average of 57.65%, while 31.41% of revenues come from the international market. Disaggregating by country, some interesting variations emerge. For instance, Spanish SMEs report the lowest international revenue share (21.92%), whereas Jordanian SMEs show the highest (38.68%). These differences reflect the diverse positioning of local tourism ecosystems and their levels of international attractiveness. Nevertheless, the data confirm that both markets—local and international—represent significant and complementary revenue sources for SMEs, reinforcing the importance of designing digital solutions based on XR and IoT serving multiple tourist profile types.

Table 3. Mean revenue from the local and international market for each country.

Country	Local Market	International Market
Average	57.65%	31.41%
Cyprus	47.87%	38.57%
Italy	57.00%	29.00%
Jordan	56.29%	34.68%
Spain	66.92%	21.92%
Turkey	55.77%	35.00%

5. Discussion

The survey results from SMEs across different Mediterranean countries provide critical insights into the role of digitalization, platform features, and business collaboration in improving visitor experiences in CH sites. From this analysis, a set of best practices can be

derived to assist SMEs dealing with the design and development of novel digital solutions for the CH and tourism industries.

The analysis revealed evident diversity amongst SMEs belonging to the five different countries. This information is critical to ensure that the design of digital solutions reflects different variables, such as the geographical distribution, cultural context, ethical considerations, knowledge gaps, investment readiness, standards and regulations compliance, digital priorities, social preferences and behaviors, technology maturity, lack of infrastructure, financial resources, and public and private sector alignment, recognizing the complexity of how digital solutions vary based on local needs and resources [4]. It is essential to carefully address all these issues to carefully ensure international marketing agility driven by enabling technologies [54].

Moreover, despite the evident differences among the surveyed countries in terms of economic maturity, digital readiness, and infrastructural conditions, SMEs consistently recognized XR as a powerful enabler for both local and international tourism enhancement. Indeed, this is supported by the SMEs' revenue-related data, as shown in Table 3. These results suggest that XR is not only a technological trend in the CH and tourism contexts but is also a strategic asset capable of bridging markets, improving visibility, and delivering added value regardless of the target segment. It also confirms the importance of including immersive functionalities in digital platforms for enhancing tourists' engagement.

Also, due to the interactions of SMEs belonging to different countries, several technical challenges may arise which need to be carefully managed to ensure the successful implementation of digital solutions [55]. These challenges include system interoperability, where digital platforms must seamlessly exchange data across different technological ecosystems; scalability, to accommodate varying levels of adoption and infrastructure capabilities; data governance, ensuring proper data management policies in compliance with regional and international regulations; and data security and privacy, which remains a significant concern given the differing approaches to cybersecurity regulations across countries. Data management and security is a critical issue when dealing with user data and mobile applications [56]. Moreover, networking and infrastructure limitations can hinder the real-time accessibility and efficiency of digital applications, particularly in regions with weaker levels of technological infrastructure. Another key challenge is represented by the integration with existing applications and platforms. Many SMEs already operate within established digital ecosystems, requiring new solutions to be compatible with legacy systems to avoid disruptions [57]. Furthermore, user adoption remains a major concern, as the success of digital solutions is largely dependent on the willingness of SMEs and end-users to embrace new technologies. This adoption is influenced by factors such as the digital knowledge, ease of use, support services, and the perceived value of digital tools [58] that help businesses transition smoothly into digital transformation initiatives.

Digital technologies such as cloud computing, XR, IoT, and artificial intelligence can facilitate international collaboration by providing flexible, scalable, and customizable digital solutions that cater to diverse market conditions. Furthermore, SMEs should not only focus on technological advancements but also integrate strategic business models that support cross-border interactions and sustainable growth in the digital tourism and CH sectors.

Based on theory and empirical evidence, a set of best practices (Table 4) can be suggested for supporting SMEs operating in the CH and tourism industries in considering different perspectives of digital solutions in the design and development of cloud-based platforms for an advanced and immersive user experience.

Table 4. Best practices for assisting SMEs in digital solutions for the CH and tourism industry.

ID	Best Practices
1	For extended and immersive user experience, digital contents, mobile applications, cloud-based platforms, and XR tools need to be combined
2	CH platforms should be supported by IoT technology, smart devices, beacon sensors, and 3D models to enable real-time and context-aware interactions
3	User data should be collected and elaborated for providing customers with tailored services and customized experience based on their interests and preferences
4	Gamification and storytelling elements make cultural exploration more engaging and educational
5	SMEs should focus on developing analytics and data-driven capabilities to extract valuable insights from IoT data, which can help optimize visitor journeys and operational efficiency
6	Data privacy and security frameworks need to be implemented to establish a trustworthy relationship between users and technologies
7	Digital content should be created, managed and provided according to regional preferences, customization needs, and cultural diversity
8	Visitors need to be supported, both physically and digitally, in all the phases of their experience, from journey planning, to site visiting, and after their experience
9	Digital applications and services should be designed to ensure a valuable customer experience both in the physical site and remotely
10	Digital solutions should engage customers beyond their experience in terms of time, space, and provided value
11	CH platforms should be integrated with third-party services in order to provide the customer with complementary and additional services
12	Social community enhances the sense of belonging to a group of people with common interests and preferences with whom they share emotions and perceptions
13	Digital user data should be accurately stored and analyzed for elaborating insights and foresights based on historical data
14	Digital platforms should be associated with the use of multimodal interaction interfaces to ensure inclusivity
15	Open standards and tools should be used to facilitate interoperability and scalability of digital solutions with third parties
16	AI predictive models should be integrated for improving visitors flow management
17	Adaptive learning and educational models could be customized for different user segments
18	Platforms should be designed to provide value for customers and SMEs in terms of site visiting, management, and maintenance
19	Ethical concerns should be considered for a sustainable use of cultural heritage
20	CH platforms should have robust backup and disaster recovery mechanisms to protect digital cultural assets from cyber threats or system failures

In response to the stated research question, the findings clearly indicate that SMEs across different Mediterranean countries prioritize functionalities that enhance user engagement, profiling, and satisfaction. These include the ability to access and manipulate content, the integration of recommendation systems based on user preferences, and the provision of immersive experiences through XR and 3D technologies. Additionally, SMEs express the need for interoperable, scalable, and secure platforms that can support international collaboration and adapt to local infrastructural constraints. These insights offer valuable guidance for the development of digital platforms tailored to the evolving needs of CH and tourism SMEs.

6. Conclusions

Through a survey-based questionnaire, the paper investigated the most important needs, preferences, and expectations of SMEs and people operating in the digital tourism and cultural heritage sector. In particular, the paper explored how companies can be supported in considering the right features and functionalities when dealing with the

design and development of a novel digital platform for an immersive and enhanced user experience. The analysis was conducted in five countries adjoining the Mediterranean Sea: Italy, Jordan, Spain, Cyprus, and Turkey. The intention of the authors was to explore how SMEs belonging to different cultures and regions can cooperate for sustainable competition of their business, by leveraging a common thread, i.e., enhancing customers' experiences through digital products and services.

Based on the empirical evidence, the findings supported the identification of a set of 20 best practices that could be considered by SMEs in designing and developing a CH digital platform for enhancing user experience. Such practices can be considered by practitioners to understand how best to foster their competitiveness in cooperation with international stakeholders.

A summary of the most relevant insights is provided below:

- SMEs are fully aware of the potential value coming from digital technologies in CH, and most of them intend to invest in such initiatives;
- A cloud-based platform for tourism is seen as a useful digital solution to more effectively and resiliently satisfy visitors' expectations;
- Among the most important technologies to integrate in such platforms, SMEs focus on XR technologies, IoT, sensors, and data-driven services, in order to provide immersive and customized CH journeys;
- XR technology is essential for virtual heritage, offering users an immersive experience, even though it requires advanced visualization techniques and tools to fully use contents;
- SMEs need to integrate a recommendation system for suggesting sites, products, and services based on user preference data.

The study has also extended the scientific literature through an empirical investigation supported by the analysis of quantitative data. It highlights practical implications for SMEs. However, despite its relevance, this study has some limitations that may inform potential future research. Considering the limited sample of responding SMEs, the findings cannot be generalized. Also, this issue is more evident given the selection of only five countries from all those in the Mediterranean area. It would be interesting to compare the findings with those from an extended sample in terms of countries and SMEs.

Finally, although the study is grounded in the Mediterranean region, both the methodological approach and findings offer scalable and generalizable insights. The challenges and opportunities identified in this context mirror those faced by SMEs and cultural institutions in other parts of the world, particularly in regions with distributed heritage resources, limited technological readiness, and growing tourism sectors. Therefore, the best practices and functional priorities highlighted in this work can serve as a reference framework for designing user-centered, inclusive, and digitally advanced solutions for cultural heritage beyond the Mediterranean area.

Author Contributions: Conceptualization, V.D.V., M.L., C.M. (Claudio Marche), C.M. (Christos Mettouris), M.M., G.S. and M.Z.A.; data curation, V.D.V., M.L., C.M. (Claudio Marche), C.M. (Christos Mettouris), M.M., G.S. and M.Z.A.; formal analysis, V.D.V. and G.S.; methodology, V.D.V., M.L., C.M. (Claudio Marche), C.M. (Christos Mettouris), M.M., G.S. and M.Z.A.; project administration, V.D.V.; supervision, V.D.V., M.L. and M.Z.A.; validation, V.D.V., M.L. and M.Z.A.; visualization, V.D.V. and G.S.; writing—original draft preparation, V.D.V., M.L. and G.S.; writing—review and editing, V.D.V. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Dataset available on request from the authors.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Del Vecchio, V.; Menegoli, M. Internet of Things and Industrial Business Models: Knowledge Boundaries and Practical Implications. In Proceedings of the 2023 5th Blockchain and Internet of Things Conference, Osaka, Japan, 21–23 July 2023; ACM: New York, NY, USA, 2023; pp. 80–86. [CrossRef]
2. van Nuenen, T.; Scarles, C. Advancements in technology and digital media in tourism. *Tour. Stud.* **2021**, *21*, 119–132. [CrossRef]
3. Kontopanagou, K.; Tsipis, A.; Komianos, V. Fostering Cultural Awareness in Museums and Monuments by Employing Extended Reality. *Glob. J. Archaeol. Anthr.* **2024**, *13*, 555870. [CrossRef]
4. Thomas, G.H.; Douglas, E.J. Resource reconfiguration by surviving SMEs in a disrupted industry. *J. Small Bus. Manag.* **2024**, *62*, 140–174. [CrossRef]
5. Pratisto, E.H.; Thompson, N.; Potdar, V. Immersive technologies for tourism: A systematic review. *Inf. Technol. Tour.* **2022**, *24*, 181–219. [CrossRef]
6. O'Dwyer, N. The scenographic turn: The pharmacology of the digitisation of scenography. *Theatr. Perform. Des.* **2015**, *1*, 48–63. [CrossRef]
7. Mueser, D.; Vlachos, P. Almost like being there? A conceptualisation of live-streaming theatre. *Int. J. Event Festiv. Manag.* **2018**, *9*, 183–203. [CrossRef]
8. Kim, J.; Kim, E.; Hong, A. OTT Streaming Distribution Strategies for Dance Performances in the Post-COVID-19 Age: A Modified Importance-Performance Analysis. *Int. J. Environ. Res. Public Health* **2021**, *19*, 327. [CrossRef]
9. Valbom, L.; Marcos, A. WAVE: Sound and music in an immersive environment. *Comput. Graph.* **2005**, *29*, 871–881. [CrossRef]
10. Kaytoue, M.; Silva, A.; Cerf, L.; Meira, W.; Raïssi, C. Watch me playing, I am a professional: A first study on video game live streaming. In Proceedings of the 21st International Conference on World Wide Web, Lyon, France, 16–20 April 2012; ACM: New York, NY, USA, 2012; pp. 1181–1188. [CrossRef]
11. Del Vecchio, V.; Lazoi, M.; Lezzi, M. An Overview on Technologies for the Distribution and Participation in Live Events. In *Extended Reality*; De Paolis, L.T., Arpaia, P., Sacco, M., Eds.; Lecture Notes in Computer Science; Springer International Publishing: Cham, Switzerland, 2022; Volume 13445, pp. 312–323. [CrossRef]
12. Innocente, C.; Ulrich, L.; Moos, S.; Vezzetti, E. A framework study on the use of immersive XR technologies in the cultural heritage domain. *J. Cult. Herit.* **2023**, *62*, 268–283. [CrossRef]
13. Maietti, F. Heritage Enhancement through Digital Tools for Sustainable Fruition—A Conceptual Framework. *Sustainability* **2023**, *15*, 11799. [CrossRef]
14. Okanovic, V.; Ivkovic-Kihic, I.; Boskovic, D.; Mijatovic, B.; Prazina, I.; Skaljo, E.; Rizvic, S. Interaction in eXtended Reality Applications for Cultural Heritage. *Appl. Sci.* **2022**, *12*, 1241. [CrossRef]
15. Pistola, T.; Diplaris, S.; Stentoumis, C.; Stathopoulos, E.A.; Loupas, G.; Mandilaras, T.; Kalantzis, G.; Kalisperakis, I.; Tellios, A.; Zavraka, D.; et al. Creating immersive experiences based on intangible cultural heritage. In Proceedings of the 2021 IEEE International Conference on Intelligent Reality (ICIR), Piscataway, NJ, USA, 12–13 May 2021; IEEE: Piscataway, NJ, USA, 2021; pp. 17–24. [CrossRef]
16. Marino, A.; Pariso, P.; Picariello, M. Digital platforms and entrepreneurship in tourism sector. *Entrep. Sustain. Issues* **2022**, *9*, 282–303. [CrossRef]
17. Schuhbauer, S.L.; Hausmann, A. Cooperation for the implementation of digital applications in rural cultural tourism marketing. *Int. J. Cult. Tour. Hosp. Res.* **2022**, *16*, 106–120. [CrossRef]
18. Puig, A.; Rodríguez, I.; Arcos, J.L.; Rodríguez-Aguilar, J.A.; Cebrián, S.; Bogdanovych, A.; Morera, N.; Palomo, A.; Piqué, R. Lessons learned from supplementing archaeological museum exhibitions with virtual reality. *Virtual Real.* **2020**, *24*, 343–358. [CrossRef]
19. Ercan, F. An examination on the use of immersive reality technologies in the travel and tourism industry. *Bus. Manag. Stud. Int. J.* **2020**, *8*, 2348–2383. [CrossRef]
20. Bortolotto, C. Commercialization without over-commercialization: Normative conundrums across heritage rationalities. *Int. J. Herit. Stud.* **2021**, *27*, 857–868. [CrossRef]
21. Del Vecchio, V.; Lazoi, M.; Lezzi, M. Digital Twin and Extended Reality in Industrial Contexts: A Bibliometric Review. In *Extended Reality*; De Paolis, L.T., Arpaia, P., Sacco, M., Eds.; Lecture Notes in Computer Science; Springer Nature: Cham, Switzerland, 2023; Volume 14218, pp. 269–283. [CrossRef]

22. Pellegrino, G.; D'errico, G.; De Luca, V.; Barba, M.C.; De Paolis, L.T. Hand Tracking for XR-Based Apraxia Assessment: A Preliminary Study. In *Proceedings of the 19th Nordic-Baltic Conference on Biomedical Engineering and Medical Physics, Liepaja, Latvia, 12–14 June 2023*; Dekhtyar, Y., Saknite, I., Eds.; IFMBE Proceedings; Springer Nature: Cham, Switzerland, 2023; Volume 89, pp. 362–369. [CrossRef]
23. Pellegrino, G.; Barba, M.C.; D'errico, G.; Küçükkara, M.Y.; De Paolis, L.T. eXtended Reality & Artificial Intelligence-Based Surgical Training: A Review of Reviews. In *Extended Reality*; De Paolis, L.T., Arpaia, P., Sacco, M., Eds.; Lecture Notes in Computer Science; Springer Nature: Cham, Switzerland, 2023; Volume 14218, pp. 345–355. [CrossRef]
24. Museen der Stadt Wien-Stadtarchäologie. In *In Monumental Computations, Proceedings of the International Conference on Cultural Heritage and New Technologies, Vienna, Aus-tria, 4–6 November 2019*; Propylaeum: Heidelberg, Germany, 2021. [CrossRef]
25. Wang, C.; Zhu, Y. A Survey of Museum Applied Research Based on Mobile Augmented Reality. *Comput. Intell. Neurosci.* **2022**, *2022*, 2926241. [CrossRef]
26. Morciano, F.; Mondellini, M.; D'errico, G.; Gatto, C.; Pellegrino, G.; Antonietti, A.; Palesi, F.; De Paolis, L.T. Assessment of Neuroaesthetic Criteria to Select Hedonic Stimuli for Rehabilitation: A Preliminary Study. In *Extended Reality*; De Paolis, L.T., Arpaia, P., Sacco, M., Eds.; Lecture Notes in Computer Science; Springer Nature: Cham, Switzerland, 2024; Volume 15029, pp. 19–39. [CrossRef]
27. Carmigniani, J.; Furht, B.; Anisetti, M.; Ceravolo, P.; Damiani, E.; Ivkovic, M. Augmented reality technologies, systems and applications. *Multimed. Tools Appl.* **2011**, *51*, 341–377. [CrossRef]
28. Gao, X.; An, H.; Chen, W.; Pan, Z. A Survey on Mobile Augmented Reality Visualization. *J. Comput. Des. Comput. Graph.* **2018**, *30*, 1–8. [CrossRef]
29. Corallo, A.; Del Vecchio, V.; Lezzi, M.; Morciano, P. Shop Floor Digital Twin in Smart Manufacturing: A Systematic Literature Review. *Sustainability* **2021**, *13*, 12987. [CrossRef]
30. Skublewska-Paszkowska, M.; Milosz, M.; Powroznik, P.; Lukasik, E. 3D technologies for intangible cultural heritage preservation—Literature review for selected databases. *Herit. Sci.* **2022**, *10*, 3. [CrossRef] [PubMed]
31. Chong, H.T.; Lim, C.K.; Ahmed, M.F.; Tan, K.L.; Bin Mokhtar, M. Virtual Reality Usability and Accessibility for Cultural Heritage Practices: Challenges Mapping and Recommendations. *Electronics* **2021**, *10*, 1430. [CrossRef]
32. Chianese, A.; Piccialli, F. Designing a smart museum: When cultural heritage joins IoT. In Proceedings of the 2014 8th International Conference on Next Generation Mobile Applications, Services and Technologies, Oxford, UK, 10–12 September 2014; IEEE: Piscataway, NJ, USA, 2014. [CrossRef]
33. Bekele, M.K. Clouds-Based Collaborative and Multi-Modal Mixed Reality for Virtual Heritage. *Heritage* **2021**, *4*, 1447–1459. [CrossRef]
34. Debandi, F.; Iacoviello, R.; Messina, A.; Montagnuolo, M.; Manuri, F.; Sanna, A.; Zappia, D. Enhancing cultural tourism by a mixed reality application for outdoor navigation and information browsing using immersive devices. In Proceedings of the IOP Conference Series: Materials Science and Engineering, Florence, Italy, 16–18 May 2018; Volume 364, p. 012048. [CrossRef]
35. Litvak, E.; Kuflik, T. Enhancing cultural heritage outdoor experience with augmented-reality smart glasses. *Pers. Ubiquitous Comput.* **2020**, *24*, 873–886. [CrossRef]
36. Balbi, B.; Marasco, A. Co-designing Cultural Heritage Experiences for All with Virtual Reality: A Scenario-Based Design approach. *Um. Digit.* **2022**, *11*, 71–98. [CrossRef]
37. Shinohara, K.; Bennett, C.L.; Wobbrock, J.O. How Designing for People with and with Disabilities Shapes Student Design Thinking. In Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility, Reno, NV, USA, 23–26 October 2016; ACM: New York, NY, USA, 2016; pp. 229–237. [CrossRef]
38. Pérez, E.; Merchán, P.; Merchán, M.J.; Salamanca, S. Virtual Reality to Foster Social Integration by Allowing Wheelchair Users to Tour Complex Archaeological Sites Realistically. *Remote. Sens.* **2020**, *12*, 419. [CrossRef]
39. Masciotta, M.; Morais, M.; Ramos, L.; Oliveira, D.; Sánchez-Aparicio, L.J.; González-Aguilera, D. A Digital-based Integrated Methodology for the Preventive Conservation of Cultural Heritage: The Experience of HeritageCare Project. *Int. J. Arch. Herit.* **2021**, *15*, 844–863. [CrossRef]
40. Teruggi, S.; Grilli, E.; Fassi, F.; Remondino, F. 3D surveying, semantic enrichment and virtual access of large cultural heritage. *ISPRS Ann. Photogramm. Remote Sens. Spat. Inf. Sci.* **2021**, *VIII-M-1–2021*, 155–162. [CrossRef]
41. Corallo, A.; Esposito, M.; Marra, M.; Pascarelli, C. Transmedia Digital Storytelling for Cultural Heritage Visiting Enhanced Experience. In *Augmented Reality, Virtual Reality, and Computer Graphics*; De Paolis, L.T., Bourdot, P., Eds.; Lecture Notes in Computer Science; Springer International Publishing: Cham, Switzerland, 2019; Volume 11614, pp. 221–229. [CrossRef]
42. Mathioudakis, G.; Klironomos, I.; Partarakis, N.; Papadaki, E.; Anifantis, N.; Antona, M.; Stephanidis, C. Supporting Online and On-Site Digital Diverse Travels. *Heritage* **2021**, *4*, 4558–4577. [CrossRef]
43. Panahi, M.S.; Woods, P.; Thwaites, H. Designing and developing a location-based mobile tourism application by using cloud-based platform. In Proceedings of the 2013 International Conference on Technology, Informatics, Management, Engineering and Environment, Bandung, Indonesia, 23–26 June 2013; IEEE: Piscataway, NJ, USA, 2013; pp. 151–156. [CrossRef]

44. Baldeon, J.; Díaz, E.; Auccapuri, D.; Masuda, A.; Gálvez, R.; Arana, A.; Chávez, P.; Hernández, V.; Lau, M.E. ECOPACAYA 4.0: An Innovation Augmented Reality Based Application for Ecotourism and Scientific Tourism in the Pacaya Samiria Amazon Lodge Private Reserve in the Amazon Jungle of Loreto, Peru. In Proceedings of the International Conference on Industrial Engineering and Operations Management, Lima, Peru, 8–11 March 2023; IEOM Society International: Southfield, MI, USA, 2023. [CrossRef]
45. Bertacchi, S.; Al Jawarneh, I.M.; Apollonio, F.I.; Bertacchi, G.; Cancilla, M.; Foschini, L.; Grana, C.; Martuscelli, G.; Montanari, R. SACHER Project: A Cloud Platform and Integrated Services for Cultural Heritage and for Restoration. In Proceedings of the 4th EAI International Conference on Smart Objects and Technologies for Social Good, Bologna, Italy, 28–30 November 2018; ACM: New York, NY, USA, 2018; pp. 283–288. [CrossRef]
46. Clark, K.A.; Welsh, K.E.; Mauchline, A.L.; France, D.; Whalley, W.B.; Park, J. Do educators realise the value of Bring Your Own Device (BYOD) in fieldwork learning? *J. Geogr. High. Educ.* **2021**, *45*, 255–278. [CrossRef]
47. Del Vecchio, V.; Lazoi, M.; Marche, C.; Mettouris, C.; Montagud, M.; Specchia, G.; Ali, M.Z. Designing Digital Solutions in the Cultural Heritage and Tourism Industry for Advancing Visitors' Experiences: SMEs Needs, Preferences, and Expectations. In *Extended Reality*; De Paolis, L.T., Arpaia, P., Sacco, M., Eds.; Lecture Notes in Computer Science; Springer Nature: Cham, Switzerland, 2024; Volume 15029, pp. 301–309. [CrossRef]
48. Corallo, A.; Crespino, A.M.; Del Vecchio, V.; Gervasi, M.; Lazoi, M.; Marra, M. Evaluating maturity level of big data management and analytics in industrial companies. *Technol. Forecast. Soc. Chang.* **2023**, *196*, 122826. [CrossRef]
49. Creswell, J.W.; Creswell, J.D. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed.; SAGE: Los Angeles, CA, USA, 2018.
50. Lewis, B.R.; Templeton, G.F.; Byrd, T.A. A methodology for construct development in MIS research. *Eur. J. Inf. Syst.* **2005**, *14*, 388–400. [CrossRef]
51. MacKenzie, S.B.; Podsakoff, P.M.; Podsakoff, N.P. Construct Measurement and Validation Procedures in MIS and Behavioral Research: Integrating New and Existing Techniques. *MIS Q.* **2011**, *35*, 293–334. [CrossRef]
52. Reja, U.; Manfreda, K.; Hlebec, V.; Vehovar, V. Open-ended vs. Close-ended Questions in Web Questionnaires. *Dev. Appl. Stat.* **2003**, *19*, 159–177.
53. de Oliveira, A.C.; Kaminski, P.C. A reference model to determine the degree of maturity in the product development process of industrial SMEs. *Technovation* **2012**, *32*, 671–680. [CrossRef]
54. Thoumrungroje, A.; Racela, O.C. Linking SME international marketing agility to new technology adoption. *Int. Small Bus. J. Res. Entrep.* **2022**, *40*, 801–822. [CrossRef]
55. Ben Ali, M.; Rauch, E.; Matt, D.T. Exploring the Synergy of Digitalization and IoT: A Literature Review on Energy Monitoring for SMEs. In Proceedings of the 2024 10th International Conference on Control, Decision and Information Technologies (CoDIT), Vallette, Malta, 1–4 July 2024; IEEE: Piscataway, NJ, USA, 2024; pp. 61–66. [CrossRef]
56. Angelelli, M.; Catalano, C.; Hill, D.; Koshutanski, H.; Pascarelli, C.; Rafferty, J. A Reference Architecture Proposal for Secure Data Management in Mobile Health. In Proceedings of the 2022 7th International Conference on Smart and Sustainable Technologies (SpliTech), Split/Bol, Croatia, 5–8 July 2022; IEEE: Piscataway, NJ, USA, 2022; pp. 1–6. [CrossRef]
57. Alqoud, A.; Schaefer, D.; Milisavljevic-Syed, J. Industry 4.0: A systematic review of legacy manufacturing system digital retrofitting. *Manuf. Rev.* **2022**, *9*, 32. [CrossRef]
58. Angelelli, M.; Gervasi, M.; Ciavolino, E. Representations of epistemic uncertainty and awareness in data-driven strategies. *Soft Comput.* **2024**, *28*, 13763–13780. [CrossRef]