European Commission

ReInHerit

Redefining the Future of Cultural Heritage, through a disruptive model of sustainability

ReInHerit
Redefining the Future of Cultural Heritage

www.reinherit.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004545

Project Number	101004545
Project Acronym	Reinherit
Project Title	Redefining the future of cultural heritage, through a disruptive model of sustainability
Starting Date	01/03/2021
Duration in Months	36
Funding Scheme	Coordination and Support Action
Call (part) Identifier	H2020-SC6-TRANSFORMATIONS-2020
Topic	TRANSFORMATIONS-19-2020 *Culture beyond borders – Facilitating innovation and research cooperation between European museums and heritage sites*
Website	www.reinherit.eu

Deliverable

Work Package	WP3 ReInHerit Toolkit
Task	T3.1 National Surveys on current state-of-art tools
Deliverable	D3.1 National Surveys Report
Dissemination Level	Public
Type of Deliverable	Report
Leader	BOCCF
Due Date	30 June 2022
Submission Date	27 July 2022
Keywords	National surveys, digital innovation, ICT tools, CH Management, data

Version History

Version	Date	Author	Notes
V1.0	10/5/2022	Andreas Anastasiou Paolo Mazzanti Marco Bertini Dimitris Bourpoulas Polina Nikolaou	First version created and updated by the authors
V1.1	18/07/2022	Andreas Anastasiou Paolo Mazzanti Marco Bertini Dimitris Bourpoulas Polina Nikolaou	Second version sent to the reviewers: Paolo Montemurro (Matera Hub) and Sibylle Dienesch (Graz Museum). On 22/07/2022 minor corrections were received, and relevant actions were taken.
V1.2	27/07/2022	Andreas Anastasiou Paolo Mazzanti Marco Bertini Dimitris Bourpoulas Polina Nikolaou	Submission to EC

Acronyms and abbreviations

Consortium Agreement	CA
Cultural Heritage	CH
Description of Action	DoA
Grant Agreement	GA
Research Executive Agency	REA
Project Coordinator	PC
Project Management Team	PMT
Steering Committee	SC
Work Package	WP

Disclaimer

This document reflects only the author's view and the Research Executive Agency is not responsible for any use that may be made of the information it contains.

Contents

Contents

Executive Summary

The overall objective of the "Redefining the future of cultural heritage, through a disruptive model of sustainability (ReInherit)" project is to create a model of sustainable cultural heritage management that will foster a digital dynamic European cultural heritage network. Our model is based on the idea of a digital cultural heritage ecosystem in which all the stakeholders (museums, heritage sites, policy makers, heritage professionals, and communities) will be provided with the tools and resources to communicate, experiment, innovate and disseminate European cultural heritage in an egalitarian manner. To achieve this, the ReInherit Digital Hub will be created: its technological solutions will address specific needs of the sector in the context of digital innovation and, as such, they will facilitate the development of a European cultural heritage network, open to all stakeholders, enabling collaboration and sustainability. The pooling of resources within the Digital Hub will enhance the innovation potentials of small- and medium-size organizations.

This deliverable (D3.1 National Surveys Report) examines the digital capacities of heritage organizations across Europe, by analysing the data collected through national surveys (conducted between October-December 2021), with the aim to create a map of digital innovation in the heritage sector. Specifically, this report examines:

a) The current use of the technological tools (types and extend) by the sector, across Europe. This will provide insightful indications as to whether organizations have made important steps towards digital transformation and innovation.
b) The current human resources available in the heritage sector. This will give a clear picture whether organizations can implement digital innovation in the long-term.

This deliverable will also report on the availability of open-source frameworks and tools, as well as to commercial tools that have been proved to be commercially and technologically viable, with the aim to select tools that allow to create personalized visits, allow user interaction and learning-by-doing or by gamification. The overall aim of this report is to provide recommendations to the ReInHerit project for ensuring the implementation of digital innovation during and beyond the project's lifecycle.

1. Introduction

This deliverable reports on the data collected from the national surveys conducted by the ReInHerit project between October 2021 and December 2021 with the aim to provide recommendations for ensuring the implementation of digital innovation. The national surveys were filled by **506 participants across Europe** on the current ICT tools they use in their cultural heritage institutions. This is a necessary stage in the development of the ReInHerit Digital Hub, which will be structured to serve two user segments, cultural heritage professionals and visitors of museums and heritage sites. The segment for the professionals will consist of the ReInHerit Toolkit, webinars and resources on cultural heritage management. The ReInHerit Toolkit will provide guidelines and prototypes for developing technology-assisted immersive performances, digital exhibitions, and educational and smart tourism applications. With respect to the section for the visitors, there will be information on and links to the ReInherit activities, digital applications and exhibitions including an e-shop, where items will be available. These tools will be developed having as their principal goal to create a digital ecosystem that will address specific needs of the sector, as identified by the ReInHerit primary and secondary research, and, thus, enable communication and sustainability of museums and heritage sites. The ReInHerit project situates the development of its digital ecosystem, in the form of the Digital Hub, within the context of Industry 4.0 and, as such, considers digital innovation as a core component of sustainable heritage management.

In accordance with the European Commission, innovation is the introduction within a firm or market of a new or significantly improved:

- product (good or service)
- process
- marketing method
- organisational method (business practices, workplace organisation or external relations)

For more information see:
https://ec.europa.eu/growth/industry/strategy/innovation_en

The minimum requirement of innovation is for the newly developed product, process, marketing method or organisational method to be new (or significantly improved) to the firm**.** The Oslo Manual defines innovation as 'a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)'.[1] Importantly, UNCTAD defines innovation as "a process of discovery of better ways to arrange productive resources in order to address individual or social needs'.[2] This can include research and experimental development (R&D) activities, engineering, design and other creative work activities, marketing and brand equity activities, intellectual property (IP) related activities, employee training activities, software development and database activities, activities related to the

[1] OECD/Eurostat 2018, p. 20
[2] UNCTAD 2019, p.5

acquisition or lease of tangible assets and innovation management activities'.[3]

The concept of digital innovation has become pervasive across different sectors, albeit it is still a highly complex one; it requires a certain level of transformation in each organization which depends on the contingent challenges of adopting and using digital technologies. The concepts of "innovation as a process" and "innovation as an outcome" have been used as a research framework for examining how digital innovation can be implemented in a sustainable manner in the heritage sector in Europe that has the potential to effectively address its needs.[4] In this context of 4.0 Industry, digital technologies have demonstrated unprecedented opportunities for a sustainable heritage management. Indeed, aligned with the inclusive and democratic approach to heritage, digital technologies have been incorporated in heritage management to enhance the experience of audiences. However, due to the constraints of the sector many organizations still lag behind in the adoption of innovative digital technologies. This poses a risk for the heritage sector's relevance to contemporary societies, ability to respond to various crises (such as climate change or pandemics) and its competitiveness. During the pandemic of COVID-19, surveys were conducted (Nemo 2021, ICOM 2021, Museum Innovation Barometer 2021) to show how heritage organizations responded and what digital resources they had (mostly they used social media, livestreaming, online exhibitions, virtual tours, videogames and podcasts). These surveys depicted the need of the sector for an outward-looking digitalization and for upskilling the professionals showing that achieving digital transformation and innovation is among the key challenges we face today.[5]

Adopting the concept of innovation described above and having in mind that the minimum requirement for an innovation is that it must be new or significantly improved, further collection of data was needed (in the post-pandemic period) to create a map of digital innovation in heritage organizations.

Specifically, the **national surveys examine**:

a) The **current use of the technological tools** (types and extend) by the sector, across Europe. This will provide insightful indications as to whether organizations have made important steps towards digital transformation and innovation.
b) The **current human resources available in the heritage sector**. This will give a clear picture whether organizations can implement digital innovation in the long-term.

[3] OECD/Eurostat 2018, p. 20
[4] For more information on this research framework and how it aligns primary research conducted in WP2 with the ReInHerit outputs in WP3, WP4 and WP5 see D2.4 Focus Groups Phase II Report.
[5] To support this European policy actions targeting successful digital transformation and accelerate diffusion of digital technologies by 2030 have been launched. For example, building upon the European Commission's Digitising European Industry (DEI) strategy, the Digital Europe Programme (DIGITAL), launched late 2020, inaugurates the current financial period 2021-2027.

Fig. 1 Digital Transformation and Innovation Process in ReInHerit

The ReInHerit national survey data has been collected by 4 questions, which were added as the final section of the questionnaires targeted to heritage professionals and disseminated 6.10.2021- 15.12.2021 from 37 countries in Europe[1]. The national survey questions were answered by **506** heritage professionals working with digital technologies in their respective organizations. This deliverable reports the results of the national survey providing quantitative and aggregate data.

1.1. Summary of the National Survey findings

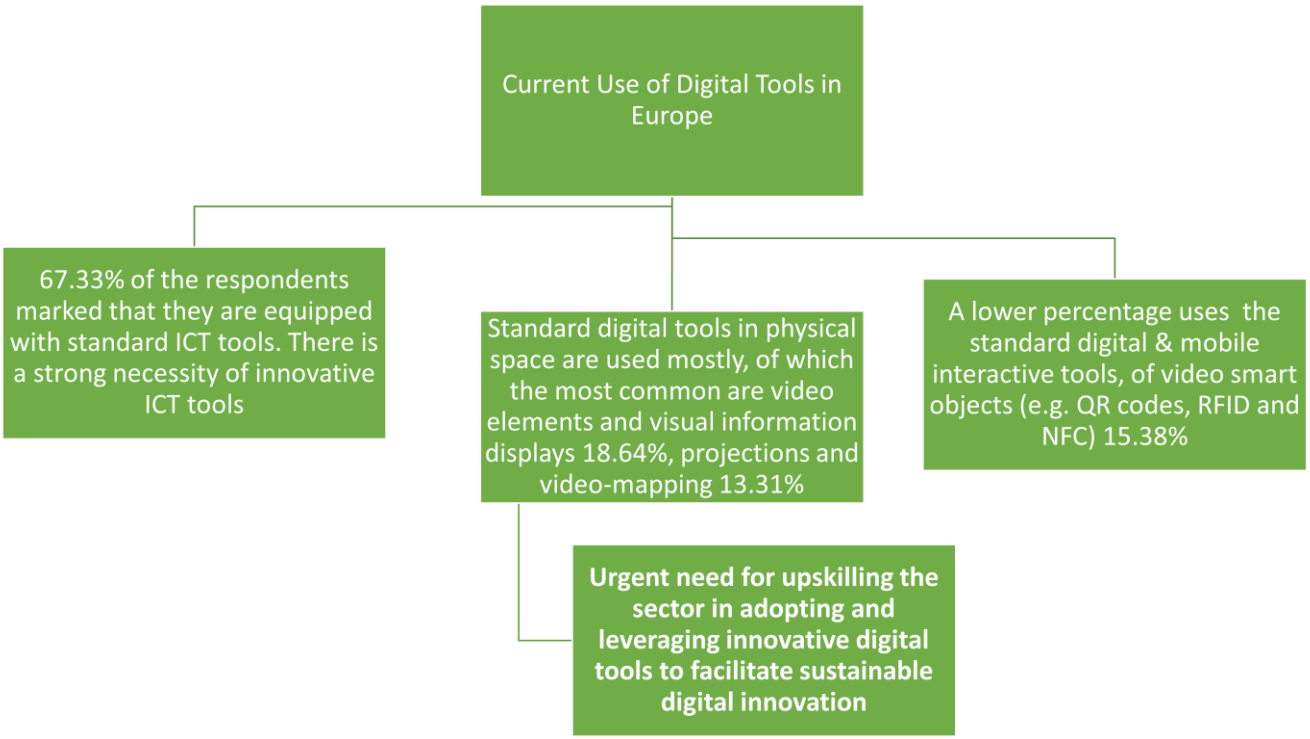
The National surveys findings are used in two ways in the implementation of the project. First, the results produce a map on the current use of technological tools in the heritage sector and on the available human resources for using these tools; secondly, this report will inform the strategy of the ReInherit Toolkit, on how to develop the specialized digital tools, resources, and training courses for cultural heritage professionals, that will ensure the implementation and sustainability of digital innovation.

a) The national survey overall results show **that the majority (67.33%) of the museums or cultural heritage sites are equipped with standard ICT tools; it seems that there is a strong necessity for the introduction of innovative ICT tools**. Only around 33% of museums and cultural heritage sites use innovative ICT tools. This can be correlated with the results of the questionnaires which show that larger organizations have experience of organizing technology assisted immersive experiences and offering digital games. All organizations had an interest in both the digital game and the immersive experience. However, smaller organizations need technical assistance, either guidance or a ready-made package, to implement these digital tools (for educational games, immersive performances, and exhibitions); since, this work is usually outsourced. This indicates that small and medium size organisations are less likely to adopt these tools unless they are provided with support and guidance. Although there is a growing number of museums adopting a formal digital strategy and digital engagement has become standard practice in the heritage sector, as the ReInHerit survey has shown, smaller museums still lack the capacity to incorporate digital tools in their everyday activities.

b) Another trend shown by the national survey results is that **the respondents marked the standard digital tools used in physical space (video elements and visual information displays 18.64%, projections and video-mapping 13.31 %) as mostly used; followed by standard digital & mobile interactive tools (smart objects e.g QR codes, RFID and NFC 15.38%) as common digital activity.** This supports the responses in the first questions where the necessity of innovative tools has been shown that will allow museums and heritage sites to address their challenges.

c) Apart from becoming members of a European cultural heritage community, actively involved in enhancing the sustainable development of the cultural heritage sector, the survey participants, as shown in the current report, have also highlighted **the urgent need for upskilling and training in the use of innovative technological tools for heritage management due to the organizational structures (high percentage of outsourcing digital activities 50%) and the use of mostly standard tools, which create a crucial knowledge gap on digital innovation**. The results gave us invaluable insights on **how to produce relevant sources for the required skills and knowledge development**.

Map on the current use of digital tools in heritage organizations



2. Survey Design

2.1. Survey Framework I: Cultural Heritage Management in 4.0 Industry

The following key outcomes from the ReInHerit primary research have been identified as useful in the development of a set of digital tools (prototypes, apps and training on tools) for museum professionals and museum visitors using sustainable design and management in line with the ReInherit goals (see D2.2 Literature Review Report). The extensive secondary and primary research conducted by the ReInHerit project in WP2 produced a rich database on heritage management in the context of 4.0 Industry. The role of the museums has changed in the last years: relevance has become a central goal for heritage institutions. With the aim of democratizing heritage, inclusive and a human centered approach that emphasizes "multi-stakeholding" has become a core aspect of heritage management. This research has shown that the use of digital technologies for enhancing visitor experiences in the museums has been aligned with this democratic and inclusive approach. Nowadays, museums and heritage sites are turning towards the "user-centered" approach focusing on the 'multi-tasking visitor', immersed simultaneously in the physical and digital dimension. The new human-centered approach considers museums and cultural heritage sites as a collaborative and inclusive cultural hub, an interdisciplinary space in which to co-create tools for different visitors. New trends are related to multisensorial and multimedia spaces (sensors, touchscreen, digital tools...) with a convergence of experiences and a continuous flow, through a dialogue between exhibits and visitors, during and after the museum visit (see Fig.2).

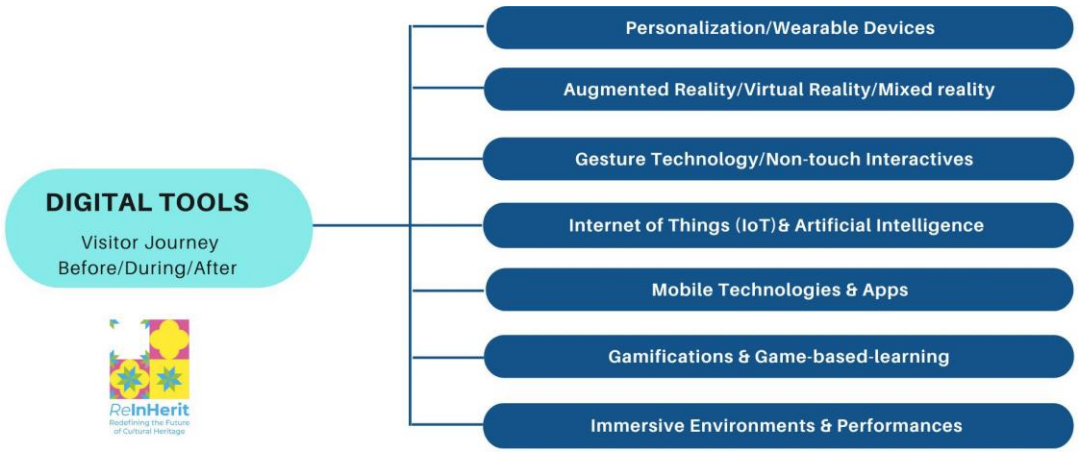


Fig 2- Developing different types of digital tools for all the visitor journey

2.1.1 Digital Technologies and “user-centered” approach to heritage management

Digital technologies are useful to detect the interests of visitors during the visit and particularly mobile and wearable devices, sensor networks, artificial intelligence (AI), and multimedia augmented realities, few examples of innovative technologies follow:

- Developing tools for a phygital interaction, promoting immersivity and interactive experiences, give the users the possibility to create narrative contents via participative storytelling and engaging them using gamification and playful solutions. This contributes towards an enhanced and integrated visitor experience as multisensory engagement becomes possible and triggers emotions, before, during and after the visit.
- AI and Computer Vision can understand the user's movement and what they are looking at, recognize the artwork, measure the interaction time and infer the degree of interest, and finally, as a result, provide appropriate information. Together with AI software for Visual Query and Answer digital tools can interpret questions and answer appropriately, satisfying interests.
- Sensors installed in museum rooms or added to artworks are essential to enable a system to understand context and to provide personalised experiences to visitors with higher engagement. Processing such sensory data by AI permits museums to build time-varying visitor profiles, interpret the momentary affective status of the visitor, understand and anticipate their needs, and provide adequate responses. The visitor experience has been improved with smart apps, wearable devices and augmented reality. For an expanded user experience, digital tools can make the museum part of a wider journey of the visitor through everyday devices and can be means for attentional guidance of the visitors during their visit.
- Most importantly, Artificial Intelligence can be used to adapt information to the needs of the visitors while through virtual tours, museums can also connect with remote areas. AI/CV tools help to develop dynamic exhibits that make visitors feel part of what is happening on site, providing them meaningful experiences through cultural offer (enjoy). Offering them a visitor’s experience of leaving (departure) and ensuring the experience to continue after the visit (memories and social media sharing).

Overall, digital technologies have offered the opportunity to extend museum visits into sessions of experiential education by expanding the modes of visitor engagements. A well-founded question arises on whether, in doing this, digital technologies might also contribute to establishing a stronger relationship between the artwork and the visitor: whether they are able to create emotions" [Del Bimbo 2021]. The use of digital tools, as described above, will enable heritage professionals to effectively address the challenges they currently face in engaging different types of audiences. This emerging vision involves an interactive and participatory approach to cultural heritage for different audiences (with various ages, many interests, and diverse visiting styles). Visitors are familiar with using new languages and digital tools to interact with the museum's collections, creating and sharing new stories, during, after and before the visit. Especially younger audiences, who are considered digital natives and who use digital tools, social networking services and text messaging as their main means of communication and learning. If these audiences are emotionally involved, the contents become unforgettable and memorable. Digital technology -combined with effective scenography- offers the great opportunity to expand the modes of visitor engagements, creating an emotional relationship between collections, museum and visitors.

2.1.2 Key challenge for heritage professionals: engaging audiences using technologies

For the professionals that participated in the ReInHerit focus groups, the key challenge is for museums and heritage sites to redefine their relevancy to today's society. It was noted that people want to see cultural heritage preserved but they do not support the sector practically. The ReInHerit research identified local communities, young people, tourists, global audiences and policy makers as key categories of audiences. Contemporary literature emphasizes the importance of engaging diverse audiences in dynamic experiences, developing solutions in which the visitor's essential motivation is to learn, discover, experience and consume the tangible and intangible heritage. It is important to use different digital tools that can motivate diverse audiences to experience, enjoy, and participate. Tools based on participatory storytelling, user personalization and headset devices, mobile technologies, and smart applications for game-based learning in immersive environments

The Focus Groups results indicate that a primary need is using digital tools to **diversify the cultural offerings**, engaging people in more enriching and meaningful experiences that cover the needs of all audiences. Especially the **younger audience** who are considered digital natives and who use digital tools, social networking services and text messaging as their main means of communication and learning. Young museum visitors are more likely to use digital tools in a museum environment and therefore would be more positively inclined towards the digital engagement activities and the solutions offered by the ReInHerit Digital Hub. They use digital tools to interact with the museum's collections, creating and sharing new stories, during, after and before the visit. Social media sharing and new technologies can also play an important role in attracting younger audiences, promoting social inclusion, creating more narratives via participative storytelling. Cultural Heritage institutions need to expand their target audience and attract younger visitors, making museums and CH sites as more appealing and emotional places.

As the results from the ReInHerit questionnaires show, younger people in general have a strong

tendency towards technology related experiences and in gamification approaches. Younger respondents are more likely to use digital tools, including games, exhibitions and immersive experiences, and the use of QR codes in a museum or cultural heritage sites. Although young audiences seems to be one of the most desirable target groups for CH professionals, it is equally important to maintain and increase the visitor base of CH organisations across all age groups (e.g., 65+). As such engaging existing or new audience of all ages should be the starting point in the process of audience development. As evidenced by the visitors' survey conducted by the ReInHerit project, young audiences are the most likely to be interested in using digital tools, however it is equally significant to ponder how we can market these tools to all age groups. It is important to develop solutions for audience development and engagement of different types of audiences, with a focus on **local communities** and through different digital tools and instruments capable of involving and motivating diverse audiences in experiencing.

According to the focus groups conducted with professionals and experts it is important to develop the tools that enable the dialogue between heritage professionals and audiences. Hackathons and design-thinking workshops need to be organized, inviting communities into the creation process and understanding their needs, defining the problem, devising solutions, and testing prototypes. The goal is to provide not just a tool, but a development process, inviting communities into the creation process and understanding their needs, defining the problem, devising solutions, and testing prototypes. In addition, visitors and professionals can interact with the digital platform, sharing a set of useful practices for museum professionals and in connection with national and international networks, in order to explore new trends on people-centered museums and sustainability with an interdisciplinary perspective.

Digital technology makes cultural tourism more competitive and professionals see digital technology for audience development as very important. It is important to diversify cultural tourism products. Create new experiences, services and cultural products with the application of new information and communication technologies (ICT) for the development of intelligent tourism. Synergies with other CH organisations and sites to create cultural routes, creative tourism experience, etc. Heritage professionals noted in the focus groups that it is important for museums and heritage sits to remain relevant on a European and global level, as nowadays each organization has a potential global audience through digital means. It is crucial to promote dialogue between different audiences and the heritage sector in order to determine their specific needs as well as to better understand how they define CH, how they experience it, how they want to engage with it, and what is important to them. This can help to renew the current view of CH and to establish a new relationship based on collaborative and strong interaction, fostering innovation.

2.1.3 Digital Implementation

In accordance with the ReInHerit Questionnaires results, all types and sizes of organizations are interested in digital tools and digital games or technology-assisted experiences offered by the ReInHerit Digital Hub.[6] Smaller and medium sized organizations need more support and external talent to implement and maintain the technological services and systems currently used. This indicates that small and medium size museums and CH sites are less likely to adopt these tools unless they are provided with support and guidance. The sustainability of the digital tools has been identified by the primary and secondary research as a crucial issue that needs to be considered in the design phase of the digital tools. The key aspects of digital sustainability that have been identified are cost, skills, development and maintenance, IPR and collaboration (see fig. 3).[7]

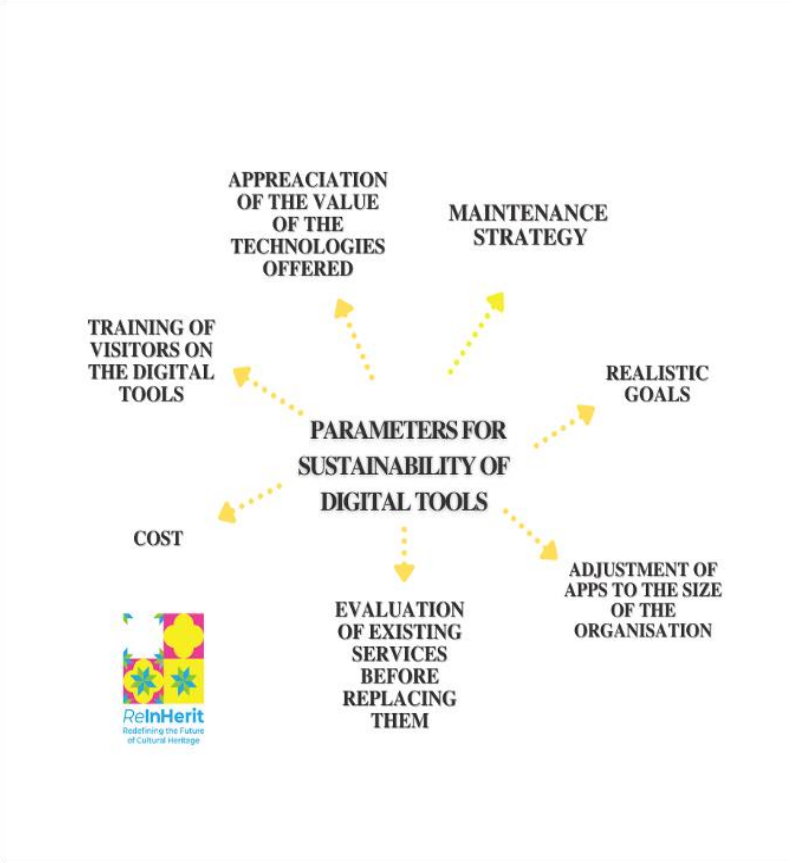


Fig. 3 Parameters of digital tools sustainability

[6] For more information see D2.3 Questionnaires Report
[7] For more information see D2.4 Focus Groups Phase II Report

2.2. Survey Framework II: State of the Art of ICT Tools

In this section we briefly review different types of digital technologies and a selection of relevant open source and commercial solutions related to the tools considered in the national surveys that were initially planned with the aim to correspond to the parameters set by the primary and secondary research conducted in WP2. The innovative technologies described below are associated with the categories used in the following chapter reporting the analysis of the results of the national surveys. This review is related to the types of applications that are expected to be delivered within ReInHerit: examples of gamification, smart tourism/smart guide apps, tools for exhibitions and collection, management, immersive experiences. It must be noted that innovative digital tools, falling within the categories reported below and exploiting the most recent advances of AI and its applications (like CV), are experimental works and typically not deployed in small-medium museums and organizations. The apps developed in ReInHerit and distributed through the Digital Hub aim to reduce this technological gap.[8]

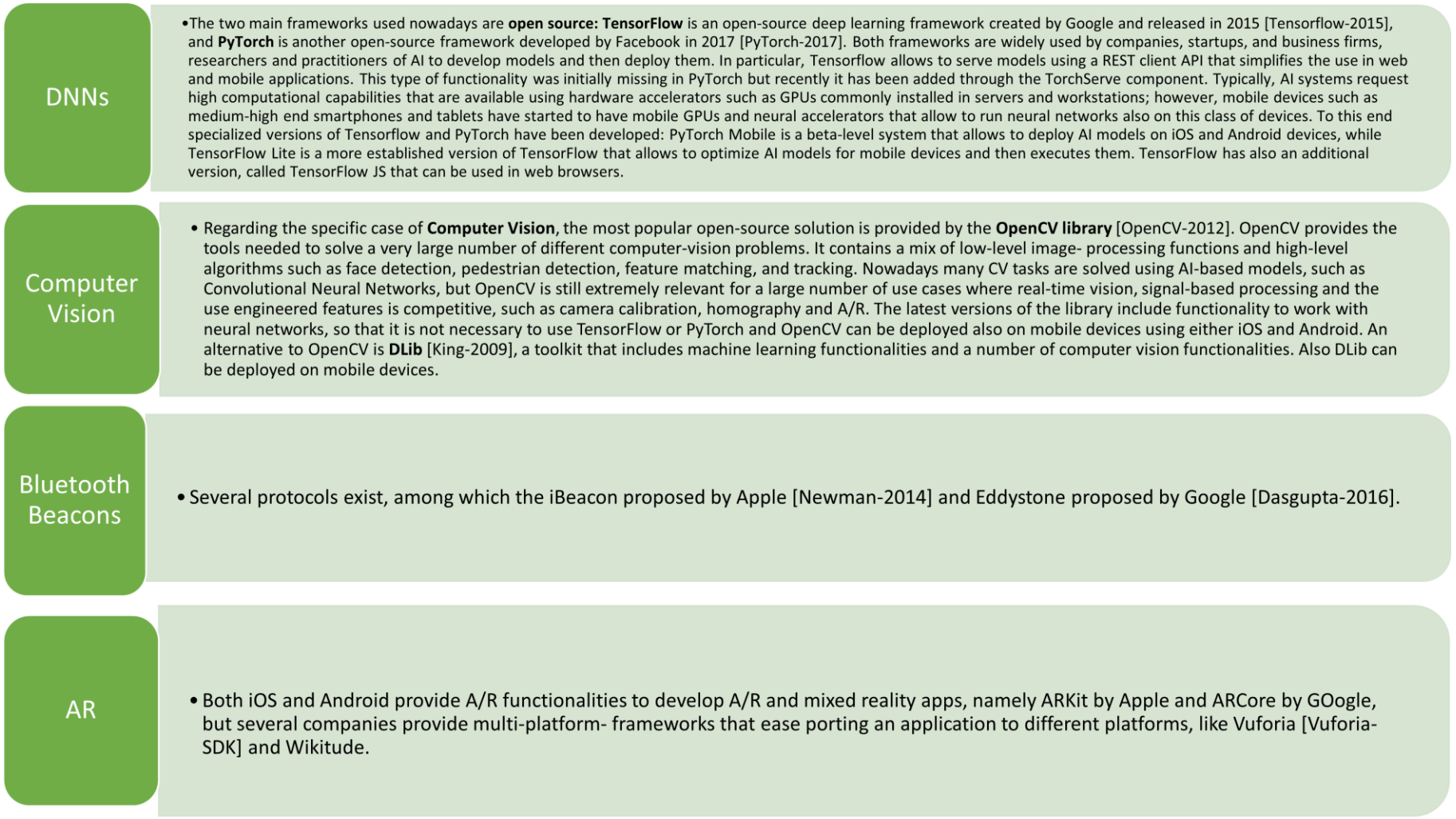
The innovative technologies described here can be utilized to address key needs of the sector such as exhibitions and audience development. For example, AI and Computer Vision can help to improve the planning of an exhibition, evaluating how **visitors interact** with it; this technology can be applied also to cultural sites. The main computer vision problems that must be solved in this context are those of retrieval, i.e. searching for the most similar image of a known location in case it is needed to localize a visitor using a view taken from a wearable device, or person **detection** and **re-identification** if there is need to track the movements of the visitors within a specified area using environment cameras. Understanding how visitors move and interact can be used to deliver personalized content and targeted recommendations. AI and Machine Learning techniques can be used as marketing tools, e.g. providing personalised recommendations to visitors, either as a way to provide a better experience and education to the users and as a way to improve a tourist experience. A thorough review of recommenders in CH domain is provided in [Pavlidis-2019]. Computer Vision can be used to analyze in an unobtrusive way the engagement and satisfaction of visitors through analysis of their behaviors and emotions.

[8] For detailed review of such examples see D3.4 Consolidated Report on ICT Tools

Fig. 4 Overview of technological tools[9]

[9] Artificial Intelligence and Computer Vision: Services we use every day, from video and music streaming to buying products online, all use Artificial Intelligence (AI). When it comes to museums AI can be incorporated across the spectrum, from visitor experience to behind the scenes, and the technology can and has come in many forms.

Fig. 5 Open-Source Systems



Conclusions

This selection of applications and technologies was used in the design of the national surveys comprise the types of applications initially planned in the ReInHerit proposal with the aim to correspond to the parameters set by the primary and secondary research conducted in WP2. The advances in AI allow the creation of new versions of many of these applications that can run on mobile devices, instead of fixed installations or on servers that require a client-server paradigm for their implementation, thus democratizing the access to such tools. All these issues were examined by the consortium through primary and secondary research and the comparative analysis of the research results will guide the development of the ReInHerit Toolkit. A key issue, as noted in the focus groups, is the lack of open-source solutions, which leads to maintenance problems and to the failure of reusing applications by the same or different organizations. Developing these new apps following an open-source approach along with documentation on the digital hub of ReInHerit, allows small organizations with limited resources to re-implement them; forming, thus, as sustainable digital management.

2.1 National Surveys Collection of Data

The national surveys were added as the final part of the questionnaires distributed to professionals under Work Package 2 (for more information see D2.4 Questionnaires Report).[10] It consisted of 4 distinct questions and was addressed to professionals related to/and or responsible for the digital capacity of their organizations. The key aims of the national surveys are to examine:

A. The current use of the technological tools (types and extend) by the sector, across Europe. This will provide insightful indications as to whether organizations have made important steps towards digital transformation and innovation.
B. The current human resources available in the heritage sector. This will give a clear picture whether organizations can implement digital innovation in the long-term.

The following **4 questions were set to collect quantitative data** for the above key aims:

1. What types of technological services and systems do you have in the organisation where you work?

2. What other types of tools are commonly used for running digital components in your museum or cultural heritage site?

3. What human resources are available for implementing the technological services and systems currently used where you work (museum, heritage site)?

4. What methods do you use to develop and maintain digital skills among the staff?

[10] See D2.4 Focus Group Report Phase II on the qualitative research conducted by the ReInHerit project on digital innovation and heritage professionals.

The **questions were developed through a process of co-creation with all the partners** from the ReInHerit consortium through workshops and meetings.[11] A random sampling process was used as the national surveys were made available, through different media (mailing lists, social media etc) to professional of any educational background, of any age and location in Europe that were responsible for the digital components of the museum/heritage site they worked in. The online questionnaires were active for a 9-week period (6.10-15.12.2021). The language of the national surveys was English so that they could be disseminated widely, Italian and German were added in the last two weeks to increase response rates from Austria and Italy (two partner countries), after a relevant decision from the project's Steering Committee.[12]

The national surveys complied strictly to GDPR and did not ask for details of the participant (name, contact details, or legal entity they work for), so the data were rendered fully and irreversibly anonymous. As such, the questionnaires and national surveys produced an anonymized database of aggregated and statistical data. Participants were asked to tick a box on the introductory page of the surveys to confirm that they were 18 years of age and that they had a sufficient knowledge of English to be able to understand the content of the surveys. This box had to be ticked before they could proceed with the survey. On the introductory page of the surveys respondents were informed of the aim of the project and the specific aim of the surveys, as well as how the data gathered would be used within the project. The survey data will be transferred to the BOCFF server as per the above and will be deleted after 5 years per the retention policy.

3. Results and Analysis conducted for the National Survey

3.1 Descriptive Statistics

We start this section with an overview of the survey results for the professionals. This is achieved through descriptive statistics, which is a branch of Statistics aiming at summarizing, describing, and presenting a series of values in a dataset; they are often the first step and an important part in any statistical analysis of either categorical or continuous data. It gives various important insights into the data and allows to assess the quality of the data by detecting potential outlier or missing values. All in all, a careful look at descriptive statistics is always a good starting point for further statistical analysis.

The total number of participants is 506. Of course, this does not mean that we had 506 responses for each one of the questions in the survey because a small proportion of participants have skipped parts of the questionnaire. We now provide contingency tables on the frequency and the percentages of the different levels in five categorical variables in the data set. Concerning the participants, we concentrate on their age and educational level, whereas as far as characteristics of the organizations are concerned, we present results for their type, size, and location.

[11] For more information see D2.4 Focus Groups Phase 2 Report
[12] For more information see D2.3 Questionnaires Report

3.2 Socio-demographic data

Table 1: Descriptive Statistics for the age of the participants

Age category	Counts	Percentages
18-29	38	7.55%
30-44	203	40.36%
45-64	242	48.11%
65+	20	3.98%

Table 2: Descriptive Statistics for the educational level of the participants

Level of Education	Counts	Percentages
Secondary Education	8	1.59%
Bachelor's degree	70	13.95%
Master's degree	280	55.78%
Ph.D.	133	26.49%
Other	11	2.19%

We notice from Table 1 that around 90% of the respondents are within the age group of 30-64 years old, while Table 2 makes it clear that majority of the participants (around 82%) have at least a postgraduate degree. Concerning the category ``Other'', the responses mainly include national diplomas from various countries; among others, examples include ``*specializzazione post laurea'',* `` Licenciatura Portugal'', and ``Grado Superior GIAT''.

Table 3: Descriptive Statistics for the type of the organization

Type of organization	Counts	Percentages
Creative industries	47	9.75%
Non-governmental organization (NGO)	44	9.13%
Private museum/cultural heritage site	69	14.32%
Public authority	39	8.09%
Public museum/cultural heritage site	174	36.10%
University/Research Institute	79	16.39%
Other	30	6.22%

Table 3 indicates that around half of the professionals that took part in the survey, work in museums (either public or private) or cultural heritage sites. The category ``Other'' mainly includes responses related to the tourism industry, such as ``Travel agency'', ``Tourism hospitality'', and ``Tourism Board''.

Table 4: Descriptive Statistics for the size of the organization in terms of employees

Size of organization	Counts	Percentages
1-10 employees	174	37.50%
11-50 employees	134	28.88%
51-250 employees	88	18.97%
Over 250 employees	68	14.66%

From Table 4, we observe that most of the participants (about 67%) work in small- and medium-sized organizations (fewer than 50 employees), while organizations with over 250 employees take only about 15% of the total number of responses. Table 5 provides an overview of the responses concerning the location of the organization where each participant is employed. At this stage of the initial analysis, we provide the frequencies (counts) and the percentages for all the possible options in the questionnaire. The majority of the professionals (more than half) work in an organization based in either Spain or Italy. The option ``Other'' includes

``Luxembourg'', ``International'', and ``Currently not working''.

Table 5: Descriptive Statistics for the location of the organization

Location of organization	Counts	Percentages
Albania	1	0.20%
Austria	13	2.65%
Azerbaijan	2	0.41%
Belgium	12	2.44%
Bosnia and Herzegovina	3	0.61%
Bulgaria	13	2.65%
Croatia	9	1.83%
Cyprus	18	3.67%
Denmark	2	0.41%
Estonia	1	0.20%
Finland	36	7.33%
Georgia	2	0.41%
Germany	5	1.02%
Greece	58	11.81%
Hungary	1	0.20%
Ireland	2	0.41%
Italy	123	25.05%
Latvia	9	1.83%
Netherlands	2	0.41%
North Macedonia	1	0.20%
Portugal	9	1.83%
Romania	32	6.52%
Russia	1	0.20%
Spain	123	25.05%
Switzerland	1	0.20%
Turkey	1	0.20%
Ukraine	2	0.41%
United Kingdom	5	1.02%
Other	3	0.61%

In Tables 1-5, our initial exploratory data analysis based on descriptive statistics has indicated, among others, that there are many categories with a small number of responses, leading to extremely low percentages. Therefore, for the rest of the analysis, we have decided to merge responses from different categories, under a common umbrella. To be more precise,

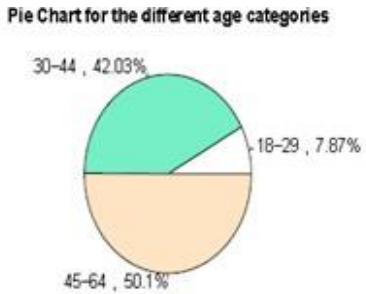
· The category ``65+'' has been removed from the variable ``Age''.

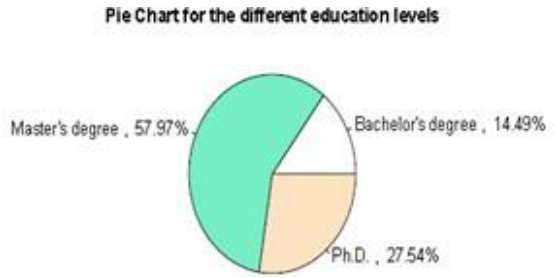
· The categories ``Secondary Education'' and ``Other'' have been removed from the ``Level of Education'' variable.

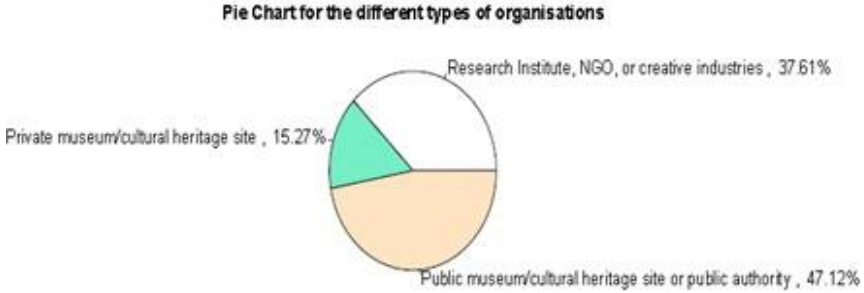
· For the ``Type of organization'' variable, we have removed the option ``Other'' and we have created three new categories by merging the already existing ones. The new categories are `` Public Museums/Cultural Heritage and Public Authority'', `` Research Institutes, NGOs, and Creative Industries'', and `` Private Museums/Cultural Heritage sites''.

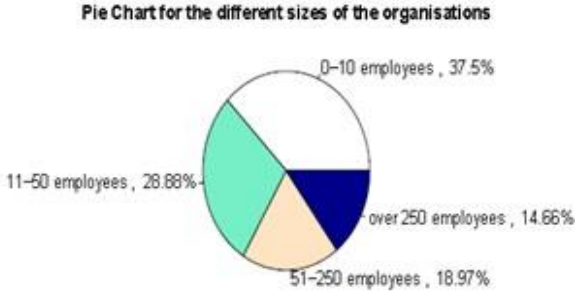
· With respect to the location of the organizations, for the rest of the analysis, we have kept only the top 6 countries in terms of their percentage. It can be seen from Table 5 that these are Italy, Spain, Greece, Finland, Romania, and Cyprus.

In Figure 6, we provide a graphical representation of the results after the new categorization described above has been applied to our data. Similar conclusions, as those already made due to the results in Tables 1-5, hold here as well.









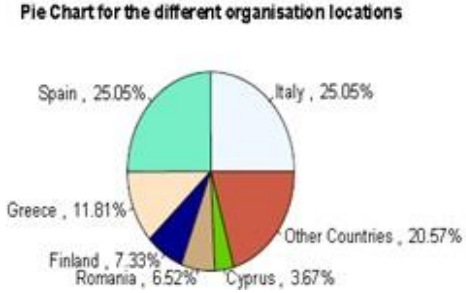


Fig.6: Graphical representation of the percentages after the new categorization of the variables has taken place

3.3. Heritage Professionals and Technological Tools: Analysis of Results

Question 1 What types of technological services and systems do you have in the organisation where you work?

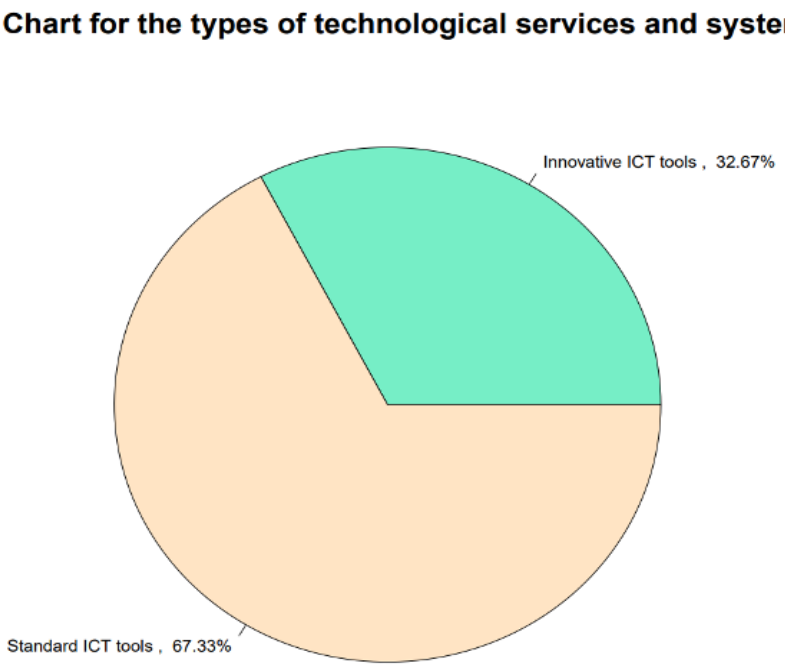
Heritage professionals were required to choose the technological services and systems that are currently available in the organization they work. Their responses were analyzed based on the correlations and patterns related to the following two categories of the technological services and systems (that were given as options) :

Innovative ICT tools
Artificial Intelligence applications | Chatbots | Games and/or gamification | Digital storytelling tools | Digital tools for exhibition planning

Standard ICT tools
Video and audio recording equipment | Web applications | Mobile applications | Online exhibitions | Digitalization systems | Analytics and Feedback tools | Social Media Management tools | Ticketing systems | E-shop

From the pie chart in Figure 7, we observe that **the majority (67.33%) of the museums or cultural heritage sites are equipped with standard ICT tools**; it seems that there is a **strong necessity for the introduction of innovative ICT tools**. Only around 33% of museums and cultural heritage sites use innovative ICT tools.

Figure 7 Pie chart on the types of technological services available in museums or cultural heritage sites.



Covariation is defined as the tendency for the values of two (or more) variables to vary together in a related way. Covariation plots help us visualize the relationship between the variables under consideration. Figure 8 presents a covariation graph between the variables ``Types of technological services and systems available in the organization'' and ``Type of Organization''. We conclude that the type of the organization where professionals work and the type of the technological services and systems available in the respective organization seem to be uncorrelated, meaning that there is a uniform and heavy use of only standard ICT tools in the different organizations. This indicates the necessity for the introduction of innovative ICT tools (along with the required training on their use) to all three categories regarding the types of organizations

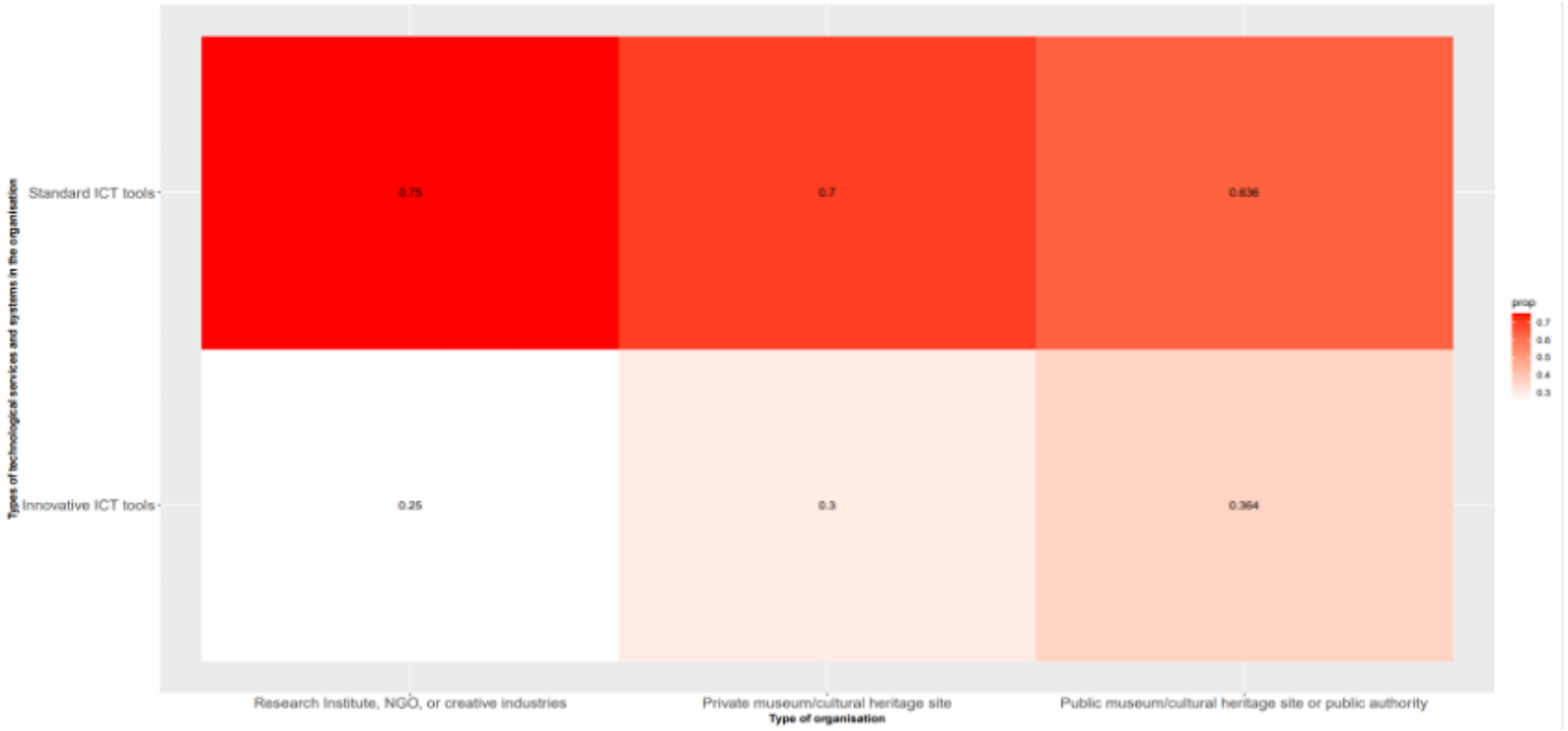
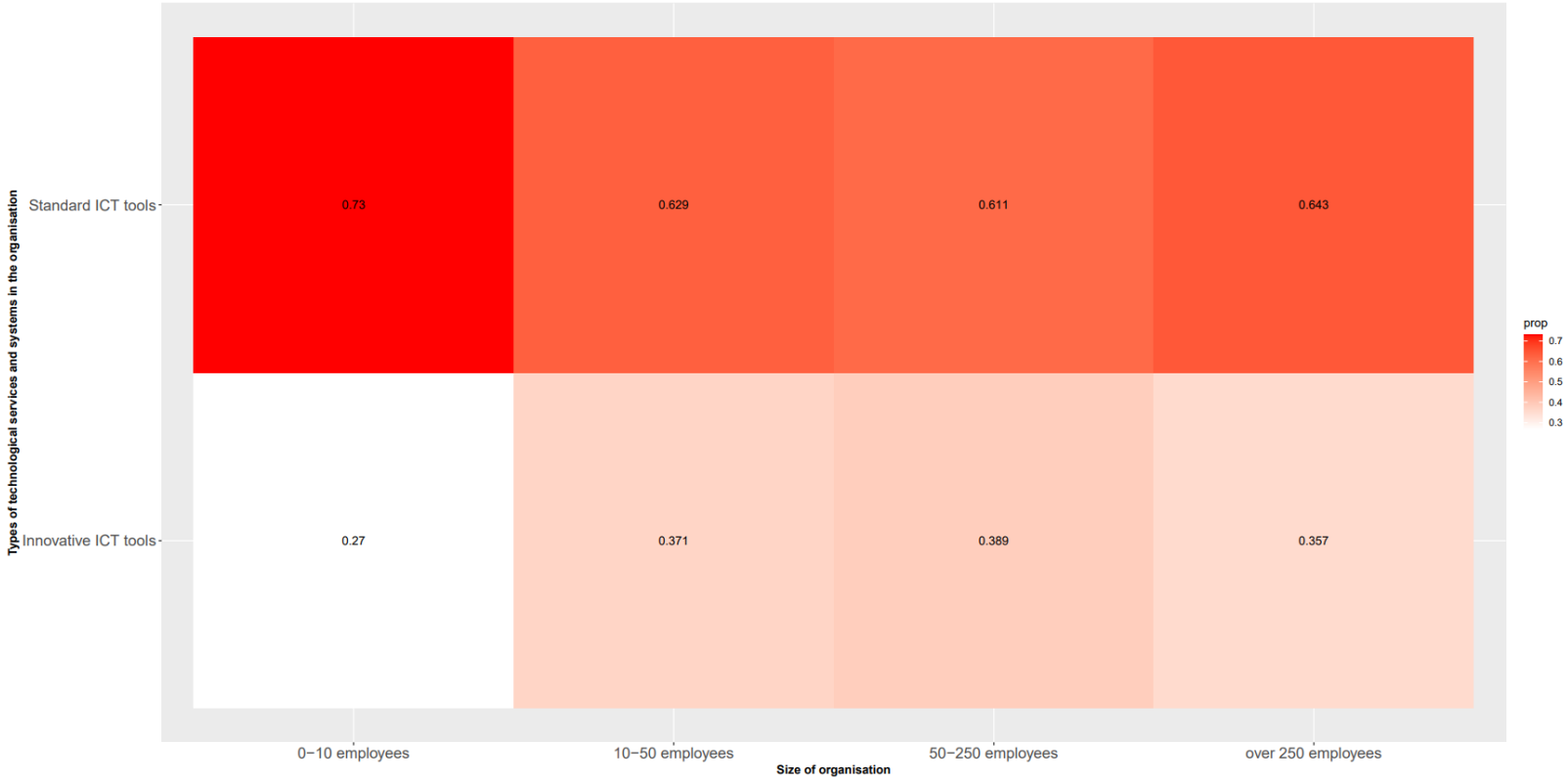


Figure 8: Covariation plot between the variables ``Types of technological services and systems used in the organization'' and ``Type of the organization''

In Figure 9, we provide the relevant graph for the covariation analysis between the variables ``Types of technological services and systems available in the organization'' and ``Size of Organization''. We observe that irrespectively of the size, the organizations mainly rely on standard ICT tools for their day-to-day functioning. This makes apparent the necessity for the development of a digital hub to be used in different types of organizations of any size and that can address the different challenges identified by the first stages of the primary and secondary research conducted by ReInHerit. We need to highlight here that this difference in the use of standard versus innovative ICT tools is more prominent in organizations with a size of 1-10 employees, making the digital hub development more urgent for such small organizations.

Figure 9 Covariation plot between the variables ``Types of technological services and systems used in the organization'' and ``Size of the organization"



The percentages of the innovative tools of gamification (4.76%), digital tools for exhibition planning (4.3%), digital story telling tools (3.69%), artificial intelligence applications (1.23%) and chatbots (0.31) are very low (see fig 10 below), whereas more standard technology that has already been developed has higher percentages (such as social media management and online exhibitions). These innovative tools have been identified by heritage professionals as necessary tools for reaching out and engaging different audiences with different levels of interaction (see D2.1 Focus Groups Phase I Report and D2.4 Focus Groups Phase II Report). As such, there is an urgent need for museums and heritage sites to have access to this type of technology.

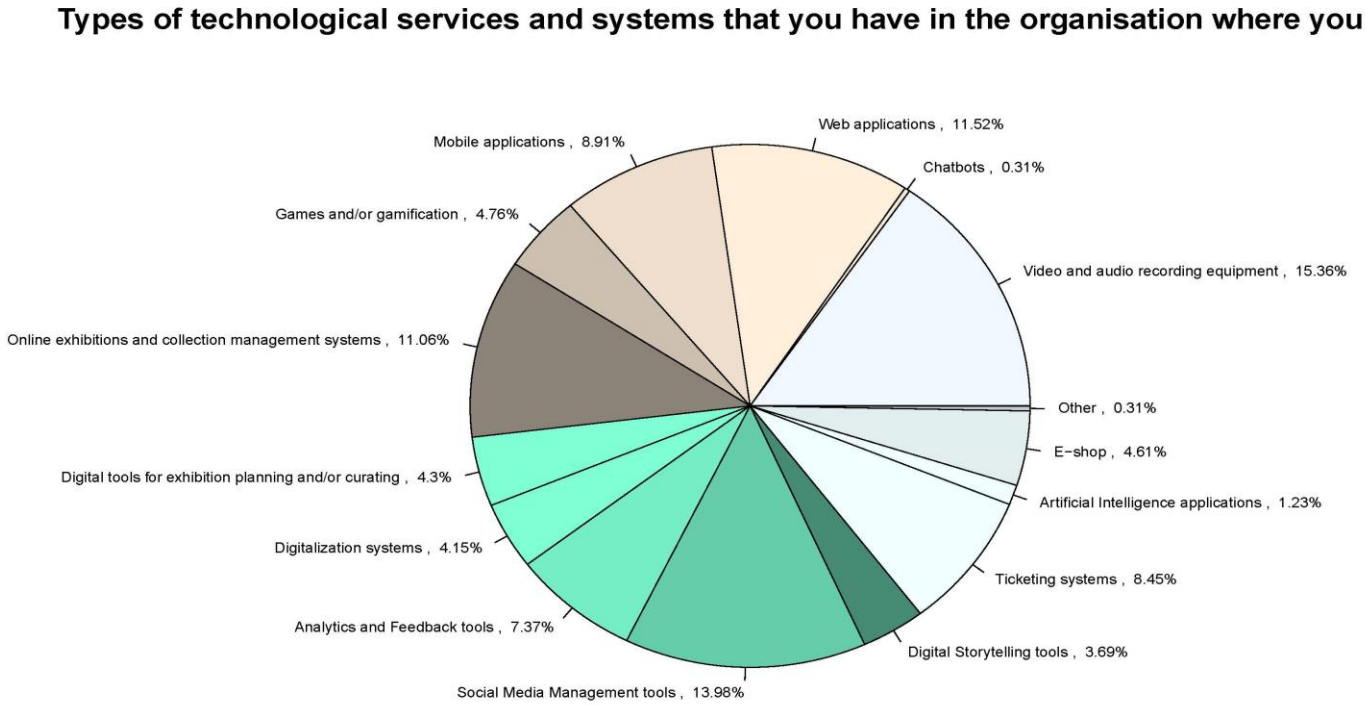


Fig. 10 Types of technological services and systems in heritage organizations

Question 2: What other types of tools are commonly used for running digital components in your museum or cultural heritage site?

Heritage professionals were required to choose other types of tools, specifically for user interaction with the exhibits, that are commonly used for running digital components available in the organization they work. The responses were analyzed based on the correlations and patterns related to the following main categories:

Digital Tools used in Physical Space

ICT tools for interaction are mostly used in the physical space to design interactive expositions creating multisensory and immersive experiences to engage the visitors with all senses in the exhibits

- Multisensory/Immersivity (Sound specialization and immersive audio | Projections and video−mapping |Video elements and visual information displays | 3D/4D elements | Digital and Mobile Interactive Tools)
- AR/VR (Oculus Rift | Holographic Imaginary Display | Augmented Reality | Virtual reality | Mixed reality)

Digital and Mobile Interactive Tools

ICT and Mobile Interactive Tools are used in many types of cultural institutions to create online, virtual and extended experiences, to increase user interaction of the visitors with the collections in different times and spaces, using:

- AI and CV (AI and Image recognition technology |Robots | Gesture and motion control)
- Smart Environments & IOT (Beacons | Smart objects | Li. Fi Technology)

The following chart (fig.11) shows that the respondents marked the standard digital tools used in physical space (video elements and visual information displays 18.64%, projections and video- mapping 13.31 %) and standard digital & mobile interactive tools (smart objects e.g QR codes, RFID and NFC 15.38%) are most used. This means that standard technologies in the physical space are mostly used, followed by standard mobile technologies. This supports the responses in the first questions where the necessity of innovative tools has been shown and the urgent need for the introduction of new tools that will enable the diversification of cultural offering that will engage different audiences locally and globally.

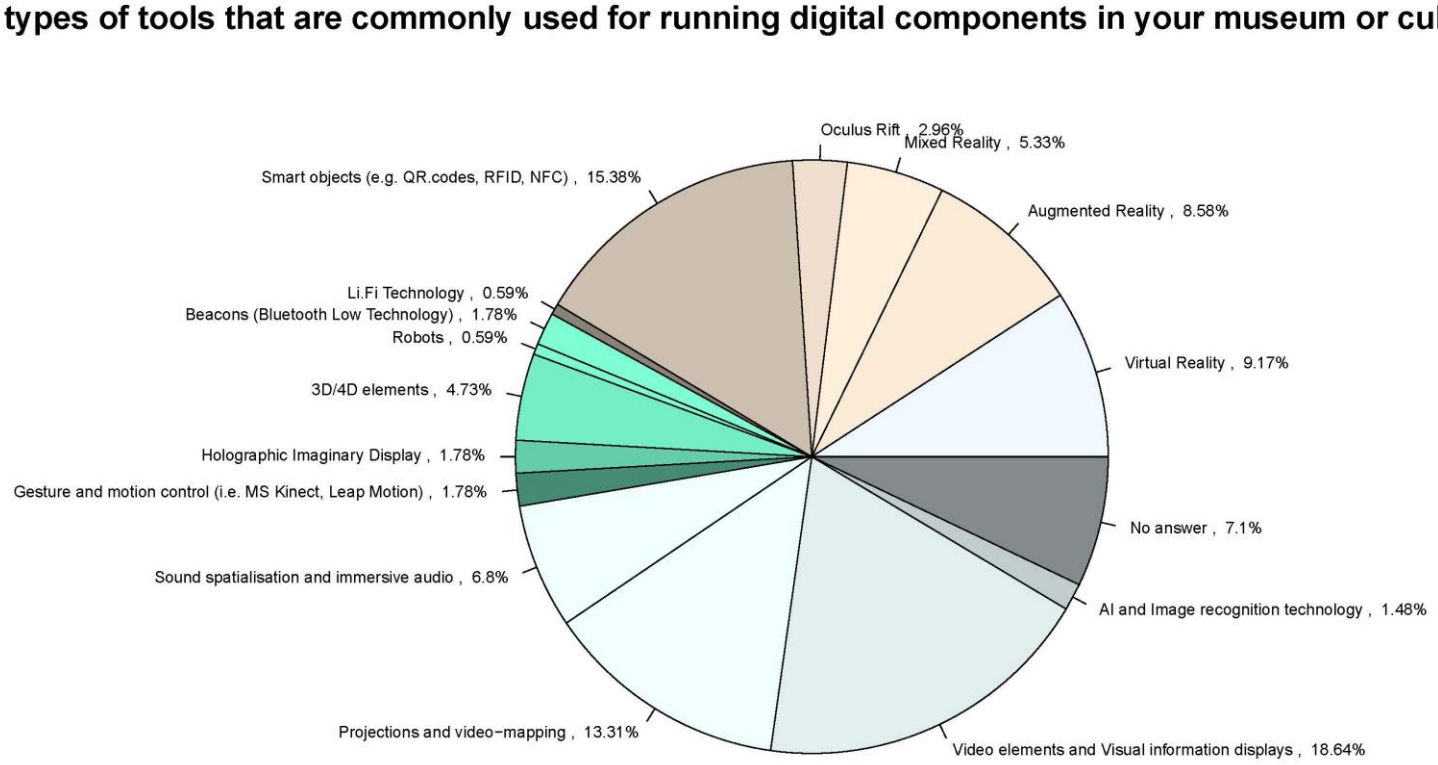


Fig. 11 Other types of tools commonly used for running digital components in heritage organizations

We now proceed with some relevant covariation graphs. Figure 12 below indicates that Multisensory/Immersivity tools are the most used ones across all different age categories. In addition, it seems that as the age level increases, then the proportion of the usability of Smart Environments and IOT tools increases as well; the opposite relation holds for the AR/VR tools. Regarding AI and CV tools, although not very well known, these are more relevant to more senior professionals.

Figure 12: Covariation plot between the variables ``Commonly used tools in companies'' and Age''.

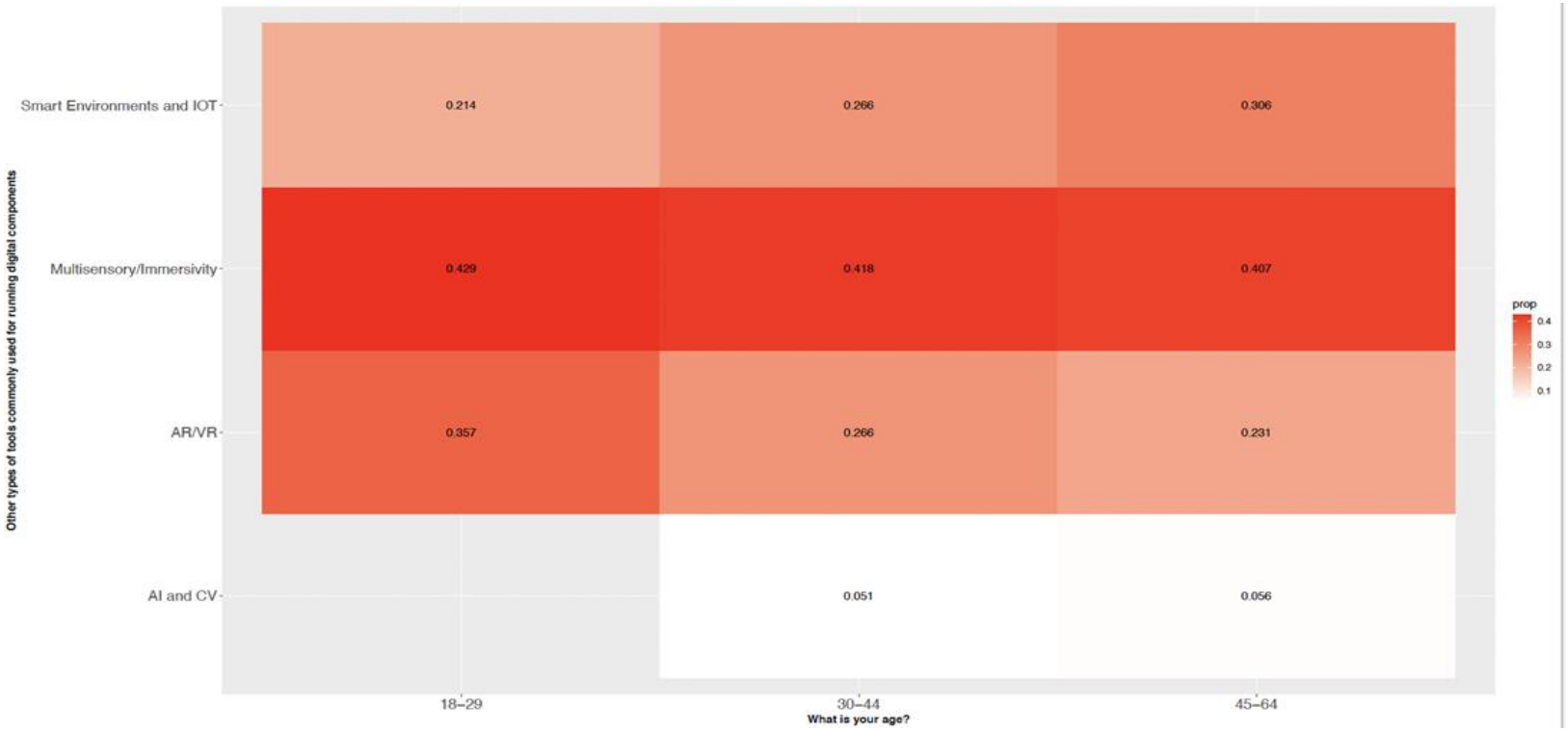


Figure 13 shows that public museums, cultural heritage sites, and public authorities employ mostly Multisensory/Immersivity tools. In addition, it seems that AI and CV tools are used more than twice the time in Research Institutes, NGOs, or creative industries compared to all the other types of organizations.

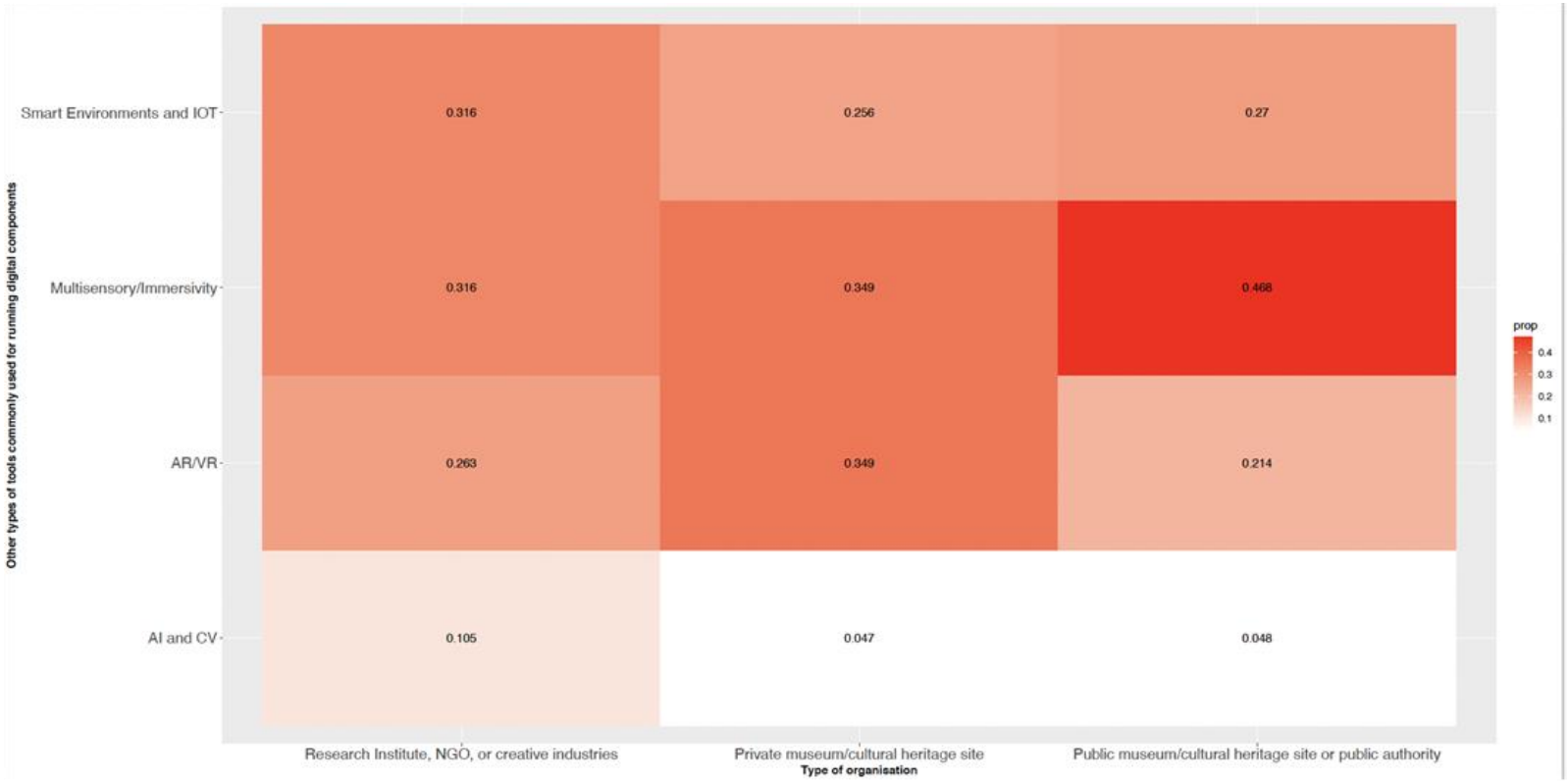
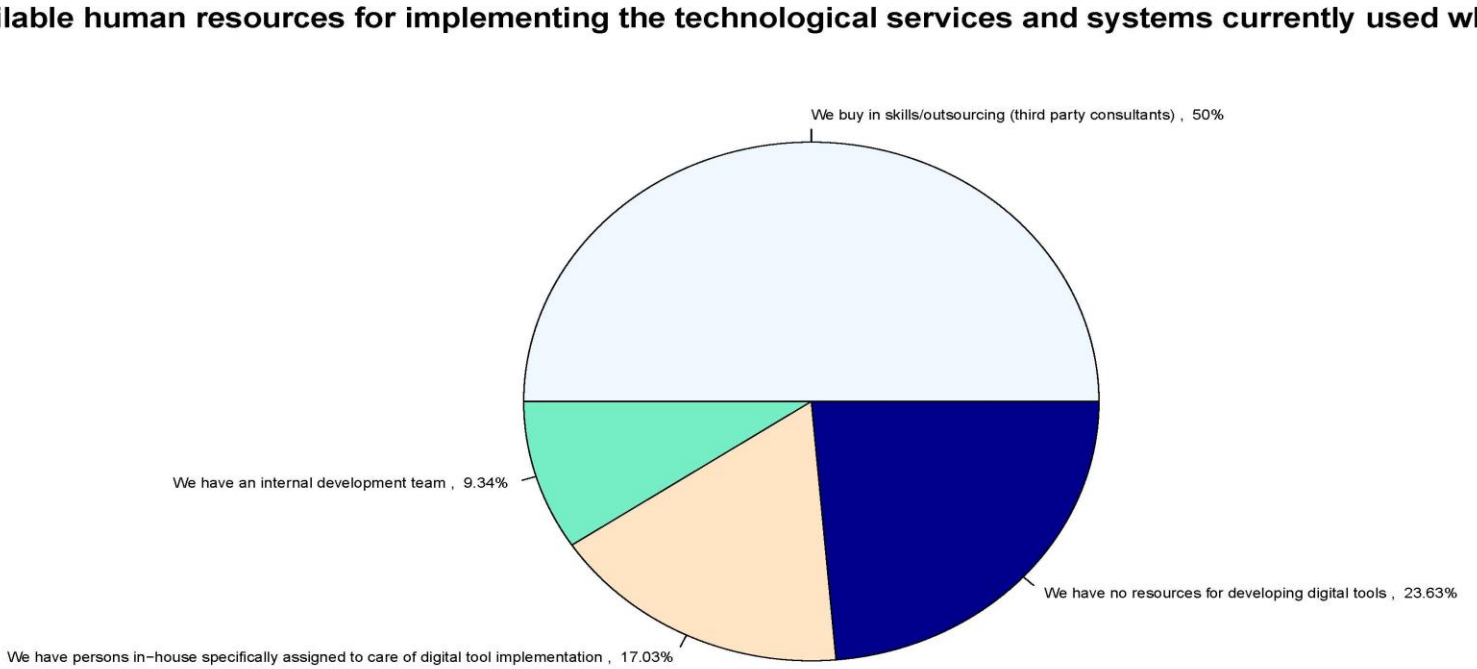


Figure 13: Covariation plot between the variables ``Commonly used tools in companies'' and ``Type of Organization''.

Question 3: What human resources are available for implementing the technological services and systems currently used where you work?

In this question, heritage professionals had to mark how the organizations they work in, in terms of human resources, implement the technological services/tool with the aim to ascertain whether the resources to be innovative exist. The graph (fig.14) shows that a small a percentage of the respondents marked that their organizations employ professionals specifically assigned for implementing technological services/tools. 50% of the respondents noted that third party consultants are employed and 23.63% have no resources for developing digital tools. These results show that necessity for upskilling heritage professionals so that they can be active agents in the digital transformation of the heritage sector by implementing and maintaining themselves technological tools.

Fig. 14 Available human resources for implementing technological services and systems in heritage organizations



Question 4: What methods do you use to develop and maintain digital skills among the staff?

Currently, organizations employ different methods for upskilling from formal training to informal peer learning, but our survey shows that these methods needs to be further developed or updated as outsourcing digital components (development and maintenance) is the most common method for the heritage sector and the use of innovative tools is minimal. This means that there still long way to go for the digital transformation and innovation of the sector. It is very important to correlate these results with the graph (fig. 15) below, extracted from the data collected in the ReInHerit questionnaires (from a sample of 886 responses). Fig. 16 shows the opinion of professionals on how their upskilling should be conducted. This is very useful when designing digital tools in order to accelerate the digital transformation of the sector. A high percentage of professionals (30.4 %) marked best practices and demo prototypes of the digital tools as what the ReInHerit platform should offer.

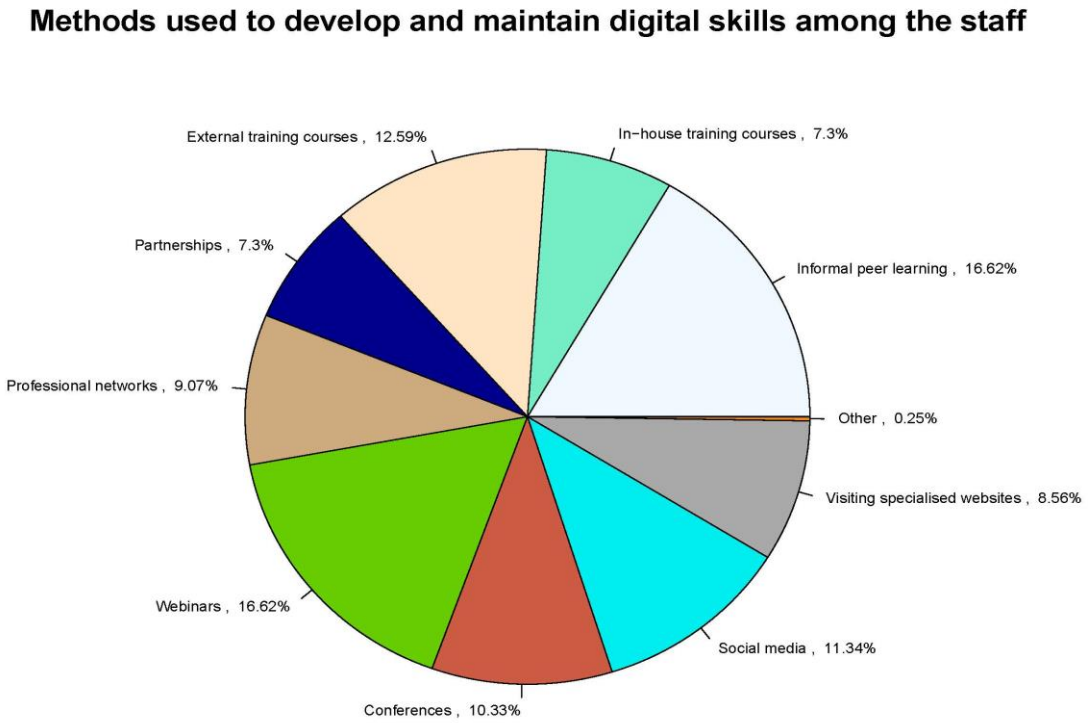


Fig. 15 Methods for developing and maintaining digital skills in heritage organizations

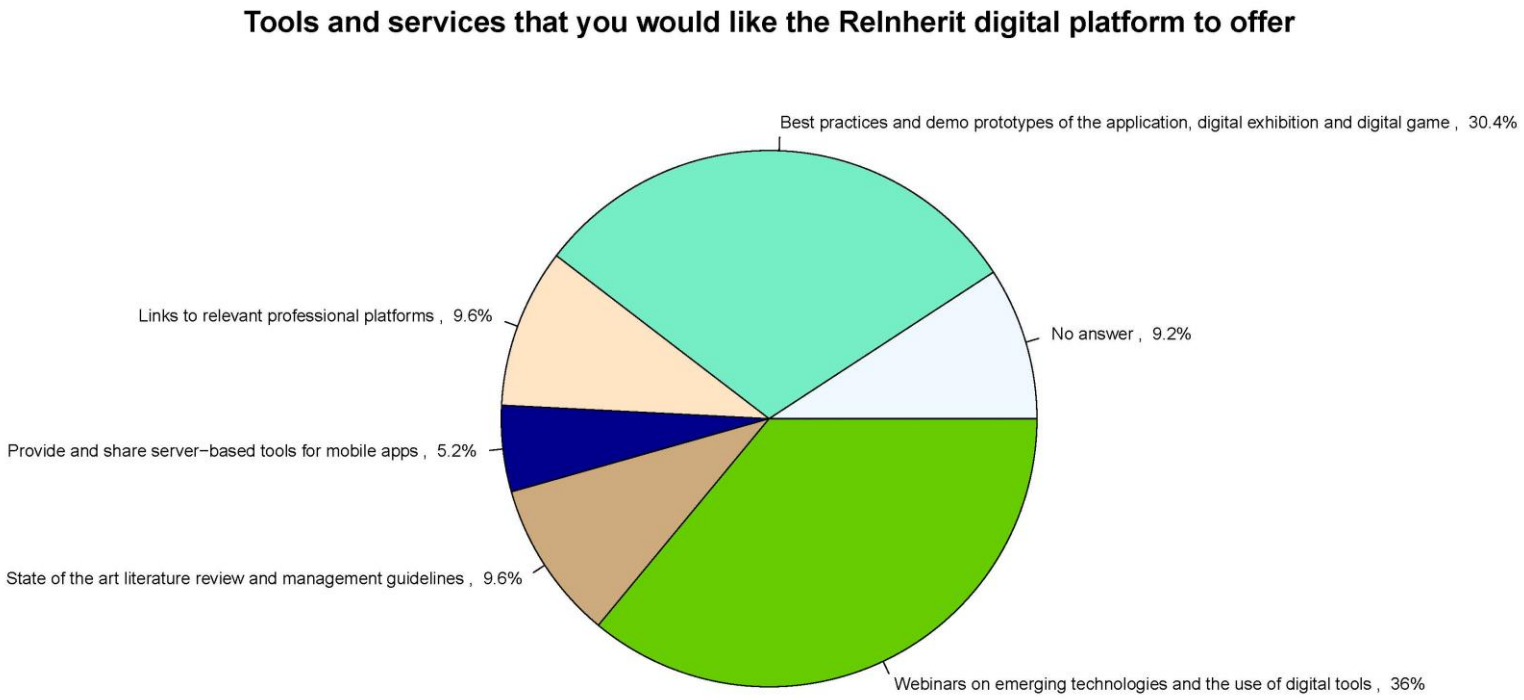


Fig. 16 Tools and services heritage professionals would like to use in the ReInHerit digital platform

4. Recommendations

This section outlines the recommendations produced from the analysis of the national surveys' results in conjunction with the primary and secondary research conducted in WP2. For the design of the national surveys, we selected a set of applications and technologies as set out in the grant agreement of the project. During the analysis of the results the consortium examined the various challenges and opportunities as trends of the sector that emerged from the focus groups and questionnaires conducted in WP2. The comparative analysis of the research results during the project and through different deliverables will guide development of the strategies in WP3 (ReInHerit Toolkit), WP4 (Digital Hub, WP6 (Digital and Travelling Exhibitions Pilot Phase). Technology Services and Tools are used by professionals working in public and private museums and Cultural Heritage sites, including also Public Authority, Research Institutes, NGOs, and Creative Industries. Museums and Cultural Heritage sites are interested in using more technology services related to tools and application for user interaction.

Most museums and cultural heritage sites (67.33%) that participated in the survey seem to be equipped with **standard ICT tools.**

Standard ICT Tools reported in the Survey

Only about 33% of museums and cultural heritage sites use **innovative ICT tools.** Therefore, new ICT tools to enhance the visitor-experience are an emerging need in all types of museums and cultural institutions.

Standard and innovative tools

Not all ICT technologies are capable of changing the traditional object-oriented approaches of museums. Tools like websites and social networks, with the associated analytics and management tools, or paperless ticketing systems are basically built upon standard technologies. More advanced technologies, like AI and its applications (e.g. Computer Vision), chatbots, gamification, etc. are much less common. As noted in [Leoni-2021] the most used technologies in small museums are websites and social media channels; this may be motivated by the fear of the risks and investments in terms of time, and human and financial resources [Damala-2019]. Both these facts have been observed in the national surveys (regarding the adoption of standard technologies) and in the focus groups phase 2 (regarding the maintenance cost, see D2.4 Focus Groups Phase 2 Report).

Innovative ICT Tools reported in the Survey

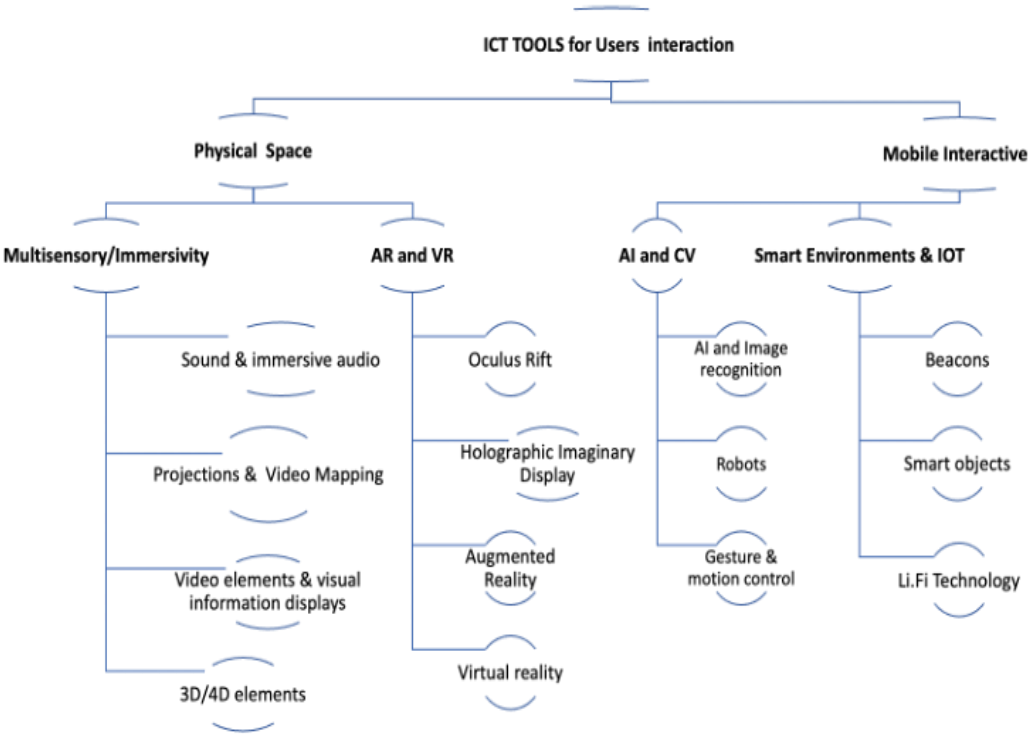
Innovative and Interactive ICT Tools

Survey results indicate that Cultural Institutions are interested in digital tools for visitor interaction in the physical space to design interactive expositions and create multisensory and immersive experiences to engage the visitors with all senses in the exhibits. Mobile Interactive Tools are also requested by many types of cultural institutions who use mostly standard technologies to create online, virtual and extended experiences, to increase user interaction of the visitors with the collections in different times and spaces. Innovative and emerging ICT tools are needed to create stronger emotional bonds between museums and CHS and visitors, enhancing the visitor experience triggering emotions, before, during and after the visit.

Museums and cultural heritage sites are widely interested in "**ICT tools for user interaction".**

Professionals surveyed prefer to use standard digital *tools in the physical space* to perform digital components and they use more multisensory/immersive tools than AR/VR tools. Multisensory/immersive are the most used tools across all different age categories and mostly in public museums, cultural heritage sites, and public authorities. The knowledge of AR/VR tools decreases with age of professionals. Training and courses in these innovative skills, could be attended and interest a target audience of young cultural professionals.

Digital and mobile interactive tools are less used by Professionals surveyed, and they are more familiar with the use of standard Smart Environments and IOT tools than AI and CV ones. The usability of Smart Environments and IOT tools increases with age. AI and CV tools, although not very well known, are more relevant to more senior professionals These types of tools are used more than twice the time in Research Institutes, NGOs, or creative industries compared to all the other types of organizations. The ReInHerit Toolkit will close this gap as it will develop a strategy (see D3.2 ReInHerit Toolkit Strategy and D3.4 Consolidated Report on ICT Tools) that will effectively address this issue and enable the heritage sector to employ innovative tools for the long term.



ICT Tools for User-Interaction (physical and mobile) reported in the Survey

According to the recommendations of the Focus Group Report Phase II on "Cost – Maintenance" and "Technical Barriers", innovative tools are expensive to develop for organizations of all sizes and they also become obsolete over the years. It is strategic to design a ReinHerit innovative digital toolkit based on **open-source**, **modular** and **re-usable architecture**, helping museum and CH institutions, especially the small one, to **increase, share** and, crucially, **sustain** their **digital activities**. In the meantime, to provide them up-to-date **guidelines, best practices, and selected training courses on the digital tools in the context of an interdisciplinary and collaborative Digital Platform. This strategy will enable heritage professionals to adopt and leverage innovative digital tools in the long-term, which will lead to sustainable digital innovation.**

References

1. ReInherit Literature Review (D2.2) | CH Management Guidelines (D2.5) | Focus Groups Phase I Report (D2.1) | Focus Groups Phase II Report (D2.4) | A sustainable model of CH management state of the art report (D2.6)
2. [Bekele-2018] M. K. Bekele et al., "A Survey of Augmented, Virtual, and Mixed Reality for Cultural Heritage", Journal on Computing and Cultural Heritage, Vol. 11, Issue 2, 2018
3. [Bubaris-2014] Bubaris, N. ("Sound in museums – museums in sound", Museum Management and Curatorship, 29:4,391-402.
4. Cesaria, F., Cucinelli, A. M., De Prezzo, G., & Spada, I. (2020). Gamification in cultural heritage: a tangible user interface game for learning about local heritage. In *Digital cultural heritage* (pp. 411-422). Springer
5. [Damala-2019] Damala, A., Ruthven, I., & Hornecker, E. "The MUSETECH model: A comprehensive evaluation framework for museum technology", Journal on Computing and Cultural Heritage, 12(1), 1– 22, 2019
1. [Dasgupta-2016] Dasgupta et al. "An internet of things platform with google eddystone beacons." Journal of Software Engineering and Applications 9.6 (2016): 291-295.
6. [Del Bimbo 2021] A. Del Bimbo "Emotions in Digital" 2021 in "Emotions and Learning in Museums" pp 24-30
7. [King-2009] D.E. King, "Dlib-ml: A machine learning toolkit", Journal of Machine Learning Research, n. 10, 2009
8. [Leoni-2021] L. Leoni and M. Cristofaro, "To adopt or not to adopt? A co-evolutionary framework and paradox of technology adoption by small museums", Current Issues in Tourism 2021
9. [Newman-2014] Newman, Nic. "Apple iBeacon technology briefing." Journal of Direct, Data and Digital Marketing Practice 15.3 (2014): 222-225.
10. [OpenCV-2012] Pulli et al. "Real-time computer vision with OpenCV", Communications of the ACM, vol. 55, Num. 6, 2012
11. [Pavlidis-2019] G.Pavlidis, "Recommender systems, cultural heritage applications, and the way forward.", Journal of Cultural Heritage, vol. 35, 2019
12. [PyTorch-2017] Paszke et al. "Automatic differentiation in PyTorch", Proc. of Neural Information Processing Systems, 2017
13. [Tensorflow-2015] Abadi et al. "TensorFlow: Large-Scale Machine Learning on Heterogeneous Distributed Systems", Proc. of USENIX conference on Operating Systems Design and Implementation, 2016

14. [Vuforia-SDK] Vuforia Engine, from: https://developer.vuforia.com/downloads/sdk

15. A FRAMEWORK for Science, Technology and Innovation Policy Reviews. United Nations Conference on Trade and Development (UNCTAD). 2019.

16. OECD/Eurostat (2018), Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg. https://doi.org/10.1787/9789264304604-en