SHIFT

MetamorphoSis of cultural Heritage
Into augmented hypermedia assets
For enhanced accessibiliTy
and inclusion

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Abstract:	One of the main goals of the SHIFT project is to develop a sustainability strategy for adopting advanced digital tools and technologies across cultural heritage (CH) institutions. To this end, Deliverable 1.2 provides a deployment lifespan roadmap to ensure that the deployment works efficiently and effectively in the long term and maximises value for cultural heritage (CH) stakeholders, their particular audiences and the associated creative industries. The document describes the specific challenges associated with the introduction and long-term usage of new media technologies in European cultural institutions in general and in the associated use case studies of the project in particular. At the end, procedures are outlined to ensure the long-term use of the SHIFT tools beyond the project's time frame.
Keywords	Cultural Heritage, deployment lifespan, digital tools, sustainability, ICT investment

Authors

Name	Organisation	Role
Klaudia Tvergyák	SOM	Deliverable lead
Ioana Crihana	ANBPR	Contributor
Milena Milosevic Micic	BMN	Contributor
Andreas Bienert	SPK-SMB	Contributor
George Margetis	FORTH	Contributor

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Krishna Chandramouli	QMUL	Contributor
Katja Hesch	SPK-SMB	Contributor

REVIEWERS

Name	**Organisation**	**Role**
Martin Zamorano	ERC	Reviewer
Rob Davies	HERITAGE	Reviewer

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EXECUTIVE SUMMARY

The aim of Task 1.2 is to develop a sustainable roadmap for adopting advanced digital tools and technologies for broader access and inclusive participation across CH institutions. The roadmap will form an integral part of the technical development in WP2-WP5. Corresponding suitable deployment solutions will be developed in the project to achieve the longest lifespan of individual system components.

To this end, Deliverable 1.2 provides solutions to the question of 'sustainability of digital innovations', that is, how to achieve the optimised deployment lifespan of SHIFT components across the infrastructure of European Cultural Heritage institutions in general, and across the stakeholders of the project in particular. The deliverable identifies the crucial factors that affect the deployment lifespan under the specific application conditions of the GLAM (Galleries, Libraries, Archives and Museums) organisations and propagates suitable deployment solutions to improve sustainability and optimised lifespan of system components.

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Abbreviations and Acronyms

Abbreviation / Acronym	Description
AI	Artificial Intelligence
ALM	Application Lifecycle Management
ANBPR	The National Association of Public Librarians and Libraries in Romania
BITV	Barrierefreie-Informationstechnik-Verordnung (Barrier-free Information Technology Ordinance)
BMN	The Balkan Museum Network
CH	Cultural Heritage
CI	Corporate Identity
CIDOC	International Committee on Documentation
CMS	Content-Management-System
CRM	Conceptual Reference Model
ERC	Eticas Research and Consulting
FORTH	Idryma Technologias Kai Erevnas
GLAM	Galleries, Libraries, Archives, Museums
ICOM	International Council of Museums
ICT	Information and Communication Technology
IoT	Internet of Things
LIDO	Lightweight Information Describing Objects
ML	Machine Learning
MPEG	Moving Picture Experts Group
OAI-PMH	Open Archives Initiative Protocol for Metadata Harvesting
PLY	Polygon File Format
QMUL	Queen Mary University of London
SAFe	Scaled Agile Framework
SIMAVI	Software Imagination & Vision
SOM	Magyar Nemzeti Múzeum – Semmelweis Orvostörténeti Múzeum
SPK-SMB	Staatliche Museen zu Berlin - Preußischer Kulturbesitz

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TIF	Tagged Image File
USAID	United States Agency for International Development
VIP	Vision Impaired Person
VR	Virtual Reality
W3C	World Wide Web Consortium
WAV	Waveform Audio File Format
XML	Extensible Markup Language

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1. INTRODUCTION

1.1 SCOPE AND OBJECTIVES

GLAM institutions - that is, Galleries, Libraries, Archives and Museums - are committed to collecting, preserving, researching and making accessible the cultural heritage of their respective estates.[1] In order to carry out these tasks, they have always used contemporary media and the technological tools of their time. One of the earliest cultural institutions, the "Musaeum Ioviani"of Paolo Giovio on Lake Como, owed its success not to visits to the museum, but to a broad dissemination of its literal and visual description (1577) in the comparatively new medium of letterpress printing.

Fig. 1 Veduta della villa di Paolo Giovio nel Borgo Vico di Como, 1619, Como, Musei Civici. Palazzo Volpi

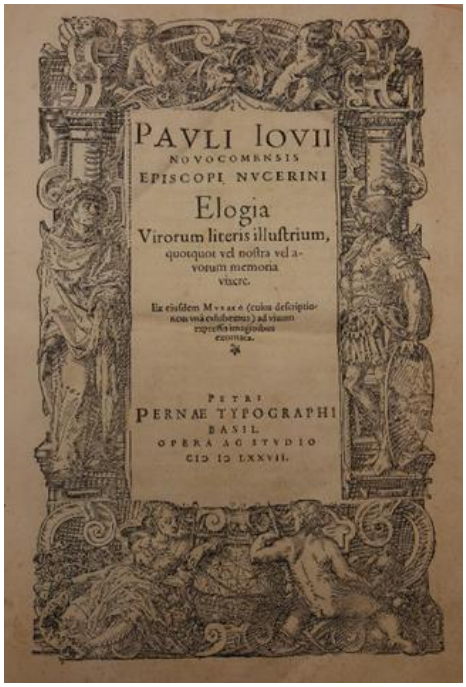

Fig. 2 Frontispiece, Paolo Giovio, Elogia virorum literis illustrium, Basel, 1577. Villa I Tatti

In today's world, digital transformation is taking the lead. Many, if not all sectors of CH institutions, are affected by digital media, virtualisation, social media,

[1] https://icom.museum/wp-content/uploads/2018/07/2017_ICOM_Statutes_EN.pdf

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gaming and techniques of Internet of Things (IoT), Artificial Intelligence (AI) and Machine Learning (ML). Access, outreach, and education - as addressed in the SHIFT project - benefit most from this. Innovative digital tools reach for multimodal access, inclusive mediation and may enable multisensory perception and experiences to a diverse and manifold audience.

However, the introduction and sustainable use of new technologies in the public GLAM environments follow a fundamentally different pattern to that in the business and industrial production sectors. Over centuries of their existence, museums, archives and libraries have developed a significant insistence on technical procedures and methods that have proven themselves through long use. The distinctive character of museum ethics regularly leads to reservations and reasonable scepticism about the adoption of new technologies which are not confirmed by years of practice. Thus, the deployment of new technological tools, methods and processes can take considerably more time than is to be expected in commercial ventures. In some well-known cases, applications and software components are already obsolete by the time they are regularly implemented in CH institutions. A depressing example is the many CD-ROM publications of the international museum community, which can no longer be read today due to proprietary formats, nor can they easily be migrated to other formats.

Therefore, this roadmap for sustainable and long-lasting deployment lifespan of SHIFT components considers, as the first step, precisely the basic institutional assumptions when introducing new technologies in GLAM institutions. New strategies of agile deployment prove to be better suited to meet these particularities. As the second step, factors that can impair or diminish life and availability of SHIFT tools and/or their components in the CH institutions are identified. Finally, the third step suggests necessary measures to improve the deployment lifespan of the applications and to ensure sustainable availability.

2. DEPLOYMENT LIFESPAN IN CULTURAL ENVIRONMENTS

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2.1 A general challenge: new techniques and technologies in the CH sector

The adaptation and introduction of new techniques in the field of GLAM institutions regularly takes long periods of time, and it often takes years to establish a new concept, a method or a technique in continuous everyday use as well as in economically justifiable budgets. Until the 1990s, European museums preferred black and white photography to the more modern colour photography with the argument of more stable usability over many years. Digital reproduction techniques were initially rejected in both the archives and museums sector because of valid concerns about permanence and availability of the digital documents. In addition, public cultural institutions have much smaller budgets than those for commercial productions. New, usually prohibitively expensive technologies, such as 3D scanning, are therefore adopted with a long-time lag, often only when they are already available in the low-priced consumer market. However, this opens up a questionable financial vicious circle in which the money saved and - even worse - the eminently important design potential of the early adopter is offset by radically shortened lifespan and a much too short availability of IT components.

The typical lifespan for consumer products today is 18-24 months and cca. 5-7 years is considered sufficient for the embedded components.[2] This is simply not sufficient for public institutions and especially not for cultural heritage institutions. Preparation and processing of the collections and the sources, ranging from scientific documentation to digital reproduction, are usually expensive and resource-consuming processes that do not justify, either in economic or in terms of public outreach, a limited technology lifespan of only two years. Even less so because most institutions cannot afford to spend significant portions of their budgets on continuous upgrading and maintenance of their products and tools. Many examples of media productions in the cultural heritage sector have unfortunately quickly disappeared into digital nirvana for this reason.

Regarding the use of new techniques and technologies, museums in the Balkan region are often facing problems that are directly connected with financial

[2] https://www.lantronix.com/blog/component-lifespan-considerations-for-industrial-iot-oems/

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conditions, such as limited budget, or financial support from the national or local governments, but also with a lack of suppliers on the market, expensive licences and few specialised staff in museums.

There are many examples where GLAM institutions are struggling to implement new materials in the process of collection preservation, but also to use new technologies in the process of digitization. The price of strong systems used for data storage is usually very high, and they are sometimes not entirely compatible with the existing old systems, or with new equipment for digital data processing. New, expensive software solutions and licences dictate equipment upgrades accompanied by a need for continuous education of already insufficient staffing.

A significant part of the problem is present in the need for GLAM institutions to fulfil the needs of contemporary visitors, democratise knowledge, and make CH accessible for all, but also to create an inclusive environment and content. This requires GLAM institutions to acquire compatible IT and technical equipment and to make data, available online or in the institutional environment, accessible for the front-end users. This important aspect requires significant financial investments but also technical staff that can maintain system functioning.

The increasingly intense propagation of digital, the dynamics of costs regarding technological devices and the ever-increasing prices of licences, connected with the rapid diversification of the supports on which information is stored and distributed, lead, in the case of real public libraries, to adaptation problems, primarily in terms of adequacy of procurement budgets.

Although suffering from almost chronic under-funding, public libraries make consistent efforts to align with the trends of cultural and creative institutions with greater financial possibilities. In the absence of investment opportunities in high-performance technology, public libraries in Romania have resorted to investments in the professionalisation and specialisation of staff, the hiring of visionary managers and the reconfiguration of library spaces to make room for new technology-based services.

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The adaptation of public libraries to modern IT technologies and advanced software solutions is essential for maintaining relevance and fulfilling the documentary and cultural heritage conservation mission for which they were created.

The main directions in which public libraries in Romania operate in order to prepare the ground for the import of modern technological devices and solutions such as those proposed by SHIFT mainly refer, but are not limited to:

- Digitization of content: Public libraries in Romania have joined the race of digitization of collections in order to reach a wider audience and meet the needs of modern users who prefer digital resources.
- Internet access and devices: As a result of the implementation of the national program Biblionet - World in My Library, most of the public libraries in Romania offer free access to the Internet and provide users with devices, such as computers, laptops or tablets, to enable information research and online study.
- Courses and training programs: Libraries organise courses and training programs for the use of new technologies, including the use of computers, surfing the Internet, digital skills, programming, etc.
- Online library services: Development of online catalogues, e-book lending services and e-learning resources
- Collaboration and Innovation Hubs: The most active public libraries have created, equipped and enabled workspaces and innovation to encourage collaboration and collaborative content creation
- Data security policies: Public libraries work on a unified data security policy in order to protect user information and to ensure that the technologies used are secure.
- Data analysis and user feedback: Public libraries in Romania evaluate statistical data collected from employees and users to better understand the needs of employees/users and to adapt services accordingly.

Currently, GLAM institutions in Hungary face several challenges in their pursuit of digitization and effective utilisation of AI technologies. Digitization remains a significant obstacle due to limited financial resources, outdated infrastructure, and a shortage of skilled professionals as many GLAM institutions in Hungary struggle with funding constraints, hindering their ability to invest in state-of-the-art

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digitization equipment and AI technologies. This financial gap limits their capacity to undertake large-scale digitization projects or implement advanced AI-driven solutions to enhance accessibility, preservation, and interpretation of their vast collections.

Furthermore, the lack of a standardised approach and guidelines for digitization and AI implementation poses a hurdle. Different GLAM institutions may have varying levels of expertise and understanding regarding digitization processes and AI technologies, leading to inconsistent outcomes and interoperability challenges across the sector.

Incorporating AI technologies into GLAM operations also requires overcoming barriers related to data privacy and intellectual property rights. The proper handling of sensitive historical, cultural, and personal data is essential to ensure compliance with legal and ethical standards, adding a layer of complexity to the integration of AI systems.

In addition to the aforementioned hurdles, Hungarian GLAM institutions grapple with the absence of established protocols and standard description rules for metadata in the digitization process. The lack of consistent guidelines results in varied metadata quality and limited interoperability across different collections and institutions, impeding efficient access, searchability, and retrieval of digitised materials.

Moreover, digitization itself is a time-consuming endeavour, demanding significant investments in terms of both time and manpower. The meticulous process of scanning, documenting, and curating each item to maintain its integrity and historical context requires substantial dedication and expertise. Unfortunately, the lack of competent staff with specialised digitization skills further exacerbates this challenge.

Another significant challenge faced by Hungarian GLAM institutions is the dilemma of prioritising who publishes the data first. This issue arises particularly in the research domain, where researchers and institutions grapple with concerns over ownership, recognition, and proper attribution. The struggle to establish

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precedence and recognition can inadvertently delay the public access to crucial digitised data and findings.

Collaborative efforts involving government support, industry partnerships, and academic involvement are crucial to address these challenges. Establishing a national strategy for digitization and AI integration, fostering skill development through training programs, encouraging public-private partnerships, and advocating for funding initiatives are potential solutions to propel Hungarian GLAM institutions toward a more advanced and sustainable future in the digital realm. Establishing frameworks for shared credit and attribution, as well as advocating for open-access platforms and policies, can help overcome this hurdle and accelerate the dissemination of digitised data and research findings, ultimately enriching academic discourse and public knowledge.

In general, a paradigm shift is essential. This transformation entails advocating for the development of standardised protocols for digitization and metadata, fostering a conducive environment for skill development and training, and encouraging a change of perspectives regarding the value and urgency of digitising cultural heritage.

2.2 Agile Deployment and Design Thinking Practices

Against this background, it is advisable to think about how the deployment lifespan of the SHIFT components can be extended and how the planning and development stage can be accelerated. Instead of linear, step-by-step development stages, in which each stage is completed before the next one is taken (waterfall principle), the SHIFT project pursues agile methods (agile deployment) to increase the deployment lifespan. Collaboration and iteration between developers on the side of the technical project partners and the stakeholders of the cultural heritage sector on the other side are therefore of basic importance for project-planning right from the start. Continuous feedback on acceptance, usability, cost-effectiveness and longevity of the SHIFT tools can guarantee their success between an extremely change-accelerated market and an increasingly short-lived attention-economy towards the public audiences of the GLAM institutions.

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2.3 SAFe Scaled Agile Framework

The implementation of the method of agile deployment follows loosely the concept derived from the Scaled Agile Framework[3]. The SAFe (Scaled Agile Framework) is originally a framework for scaling agile methods in large organisations and enterprises. It was developed to improve collaboration in large teams or organisations, especially in sustainable software development. Although it is not directly tailored to museums or cultural institutions, some of its principles and practices have proved valuable for streamlining the development of long-term operational components in museum outreach efforts.

An iteration cycle unfolds between the four stages of the process: deployment, verification, monitoring, and responding.

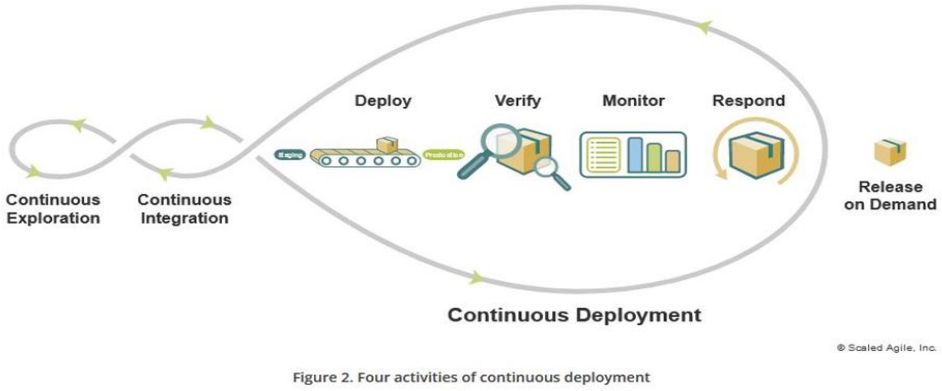

Figure 2. Four activities of continuous deployment

Fig. 3 Four activities of continuous deployment, © Scaled Agile, Inc.

1. Deployment: SAFe places great emphasis on customer orientation and promoting experimentation. Museums can adopt this idea by becoming more responsive to the needs and expectations of their visitors. This can be achieved through surveys, feedback loops, and analysis of visitor data to create personalised outreach offerings.

[3] © Scaled Agile, Inc.; https://scaledagileframework.com

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2. Verification: Agile deployment means to verify the achieved status at each stage of the development, through product testing, testing of data requirements and test of system attributes like IPR, reliability, security, or performance.

3. Monitoring: Problems across the entire stack that the system covers should be monitored by incremental program planning. Museums can use similar planning cycles to define their outreach strategies, such as for the duration of temporary exhibitions.

4. Responding: SAFe emphasises continuous improvement of products and applications by responding to unforeseen phenomena and identifying potential problems or situations before they occur. Museums implement retrospective workshops and feedback mechanisms and use confirmed visitor survey methods to evaluate applications such as k:eva[4].

It is important to note that museums are cultural and artistic institutions, and not all aspects of SAFe can be seamlessly transferred. Therefore, any adaptation should be carefully thought through and tailored to the specific needs and goals of the museum.

3. FACTORS AFFECTING THE DEPLOYMENT LIFESPAN OF THE SHIFT TOOLS IN CULTURAL HERITAGE INSTITUTIONS

In the realm of cultural heritage institutions, the seamless integration and sustained functionality of innovative digital tools, including the SHIFT applications, are critical for enhancing visitor experiences and preserving cultural artefacts. This chapter focuses on understanding the diverse factors that influence the lifespan and efficiency of the SHIFT tools within CH establishments.

3.1. Hardware Factor - Front ends/User-clients

The frontend hardware must be adapted to as many spatial, climatic, network related, energetic, design and maintenance conditions of the museum as possible.

[4] https://www.museum4punkt0.de/ergebnis/keva-kultur-evaluierungstool-fuer-digitale-angebote-von-museen

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Environmental control is important to ensure the integrity of the exhibits and the hardware in use. It must be vandalism-proof, hygienically flawless and guarantee performance and intuitive operation in line with the expectations of the public audiences. Museum staff should be familiar with operating modes, have the necessary training and documentation to operate, maintain, and troubleshoot simple problems. In the best case, the hardware should be reusable in different exhibitions or in other museum contexts. Any changes in design and functionality should be easily adaptable and economically feasible.

There are different groups of devices, each with its special functional requirements. It is necessary in all cases to consider the aspect of accessibility. Front ends of SHIFT components are barrier-free and allow access for people with different abilities. This is not only an ethical obligation, but also important for long-term usability and legal requirements.

Fig. 4 Nationalgalerie Berlin, Visitor with VR glasses in front of C.D. Friedrich, »Mönch am Meer« Staatliche Museen zu Berlin, 2019

Fig.5 Antikensammlung Berlin, Visitor with tactile model

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3.1.1. Mobile Devices to hand out to visitors in the museum

Audio guides and headphones, VR glasses, tablets, etc. are often held at the ticket counter in the museum and issued to visitors for the duration of the visit. For these devices, the expected useful lifespan depends mainly on mechanical stability, ease of maintenance, charging efficiency, and compliance with the museums' IT infrastructure as well as the specific technical and legal framework to be respected. With regard to an optimised deployment lifespan, special attention needs to be paid to the following questions: Is the operating system designed in a way that new functionalities, programs or media formats can easily be adapted? Can upgrades be introduced, and maintenance provided in the long term?

3.1.2. Mobile Devices provided by the visitors

Smartphones and tablets are brought along by most of the visitors of our museums. In these cases, the useful life of a SHIFT app will depend on attractive download and use even beyond the museum visit. Versioning and upgrading have to be possible in an easy and especially secure manner. Cross-platform UX is essential to assure the audience that they can seamlessly continue their journey without confusion.

3.1.3. Local installations and information-systems in the museum or at the site of an exhibition

Kiosk systems, touch-tables, sound-showers, scent installations, etc. accompany many exhibitions in the CH sector and often stage an educational program. The deployment lifespan of these frontends is greatly affected by spatial and climatic circumstances in the bricks-and-mortar of the museum’s building. On the one hand, the components of an application must be adapted to the local spatial situation, on the other hand, the design should be flexible enough to be easily adapted in various contexts. Projection systems, to give an example, should ensure the most flexible installation possible, hanging and standing, close or far from the object, and should be able to operate regularly with reduced or low noise generation and without endangering the stocks by heat emission.

3.1.4 Online-Interface - virtual museums, blogs and social media

The deployment lifespan of websites of museums, social media channels, virtual museums, digital concert halls, etc. depends mainly on the use of common

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protocols and open formats. The long-term use of inclusive and barrier-free information and virtualization offers can be ensured with a generic orientation towards the recommendations of the W3C (World Wide web Consortium, www.w3.org), and other associations and organisations.

3.2. Hardware Factor - Backend-Layer

The backend layers of the SHIFT applications can ideally be installed as virtual servers within the IT infrastructure of the museums themselves. Stand-alone solutions or remote servers might be preferred for several reasons. For all three platforms different requirements have to be respected to ensure an adequate deployment lifespan of the backend. In any case, the hardware should be designed so that it can be expanded or upgraded as needed to support new technologies and content. This helps to extend the service life. Maintenance contracts with the manufacturers or service providers have to be considered to ensure that the hardware is regularly maintained and repaired when necessary. To ensure smooth and long-term use of the hardware selected, the choice has always to respect the museum's specific requirements and budget.

3.2.1. Server Infrastructure of local GLAM institutions

Each installation on an application server requires explicit coordination with the IT infrastructure disposable at the GLAM institutions. They should provide the standards for all areas of service and set out the guidelines that the corresponding programmes and protocols must comply with. This is the only way to ensure cost-effective maintenance and long-term operation. The coordination must often start several months in advance in order to be implemented in a timely manner.

3.2.2. Stand-alone Solutions for SHIFT components

Stand-alone solutions for the back-end layers of the SHIFT components offer a higher independence of restrictive specifications or poor performance that might occur within the IT infrastructures in the CH sector. At the same time, the useful life of the application is limited then to the foreseeable period of the project. Cultural institutions regularly have no financial or budgetary resources available for further maintenance, backup or upgrading of the technology. This harbours the danger of a stand-alone solution that can only be used in the very short term, regardless of the components installed or embedded.

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3.2.3. Remote Web Server

By using a remote application server system the deployment lifespan of the server-side connections of a SHIFT component can be contractually agreed with the provider, even with long-term contractual conditions. However, the flexibility gained this way requires a high-performance network connection on site at the local museums. Further restrictions may jeopardise the long-term use of commercial cloud storage and server providers. In many cases, the use of commercial data-storage has to be checked against the legislation of individual European countries and authorities.

3.3. Software Factor

The use of software programs is especially associated with considerable risks for the longevity of the SHIFT components. At the beginning and over the entire time of development, it must be checked whether suitable application lifecycle management (ALM) procedures can be applied to the software. Is there a forecast over how long updating and bug fixing can be guaranteed? An example from recent years reflects the eminent risks for the lifespan deployment. When support for Adobe Flash Player ended its support in 2020, the readability of many and more interactive productions programmed in Flash, including many of them from the CH-sector, was lost.

3.3.1. Custom Software - Market-Led Software - ALM

With regard to deployment lifespan it needs to be carefully considered whether to use customised or branded software with the SHIFT components. Ultimately, the best choice depends on the museum's specific needs and resources. It may be helpful to perform a cost-benefit analysis and consider different options before making a decision. Custom software can better be tailored to the museum's needs and the project’s efficiency, though it can be time-consuming and expensive to develop and to ensure the application lifecycle management (ALM). Often you may need special skills or resources may be needed to maintain and update it in future time. Standardised, market-led software products are usually less expensive and easier to implement than custom software, since they are. It is supported by a larger user community, which can lead to more resources for help and support.

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3.3.2. Data Security

One of the biggest influencing factors on the longevity of SHIFT Components in archives and museums is data security, reliability of applications and the overall trustworthiness of information. Inasmuch as the CH sector is facing challenges from AI and ML in these areas, the project's attention is focused on software and data security. This is crucial for the sector, especially when it comes to protecting relevant scientific and historical data. Outdated software tends to be easier to hack and to be compromised by cyberattacks. Continuously maintaining the software is of primary concern to building security into the deployment lifespan.

3.3.3. Attractive Design and Winning Handling

A design that is also attractive in the long term with convincing handling for digital applications in museums requires careful planning and consideration of the needs and expectations of museum visitors. To ensure a long deployment lifespan and to prevent premature "ageing", short-lived design trends must be avoided and general ergonomic requirements have to be implemented.

A clear and intuitive menu structure enables users to quickly access information and to experience comfortable reactions when interacting with the program, even in the long term.

Graphics, images and colour palettes must fit the overall branding of the museum or collection or be able to adapt its corporate design. The application design should meet the needs of people with different abilities. This includes the use of alternative audio or text for images, easy-to-read fonts, or clear contrasts. Care should be taken to establish mobile responsiveness so that applications can be driven on different types of devices (smartphones, tablets, desktops) without further effort.

3.4. Factor Data and Information

The SPK-SMB's use-case pilots (see Section 4.1) include all kinds of data, 2D reproductions as well as 3D models, textual information and textual database contents, video files and sound files. For the deployment lifespan of the proposed multimodal and multisensory applications within the SHIFT project it is imperative to organise the interfaces and transmedial translation services dynamically and to

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rely on interoperability of the formats of the data repositories. Furthermore, the lynchpin of the museum system should not be underestimated with regard to the deployment lifespan. Visitors of the museums do not want to hear about data, they want to hear about stories! Against this background, every application will only be used as long as it serves the Triple A of Attractiveness, Actuality and Authenticity of the stories (see below), as a basic prerequisite for an optimal deployment lifespan.

With regard to data formats, museums are guided by the recommendations of the national science organisations, which prescribe open and lossless compression formats such as TIF, PLY, WAV, etc. Data-exchange is based on standardised harvesting protocols such as OAI-PMH and XML-LiDO data format.

3.4.1. Transmedial Interfaces and Open Data Formats

In order to achieve a long lifetime of SHIFT applications, it is necessary to provide interfaces between different data repositories, to use open formats and to ensure the long-term referencing of the data. The aim of multimodal enrichment of the applications will work stably over time only by use of standardised data exchange formats and protocols as well as machine-readable classifications and thesauri.

3.4.2. Triple A - Attractiveness, Actuality and Authenticity

The Triple A concept - Attractiveness, Actuality and Authenticity - is an important basis for the successful mediation of collections in museums. In order to remain attractive in the long term, it is necessary to attract the attention of visitors by design and use of contemporary technology. It is imperative to ensure regular updating of data, because nothing is more frustrating than the sentence 'last updated 10 years ago'! Digital content promises to reveal current data by allowing continuous aggregation of new insights, research or contemporary perspectives. The authentic credibility of an application or a story is the most important factor at the intersection of material and digital presence. The same care that the museum takes about its exhibits must be given to the long-term integrity of the data describing these objects. The combination of attractiveness, actuality and authenticity helps to ensure that visitors have an enriching and meaningful experience in the museum. This guarantees long-term interest in art and culture and communicates the importance of the collections to their visitors.

3.4.3. Deployment Lifespan of Digital Presentations

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In design and appearance any digital publication or application has to follow the CI of the museum to ensure an optimal deployment lifespan. Websites represent their museums on the global internet. Attractive layout, navigation concept and information relevance correlate with user popularity. All three factors have continuously to be adapted to the pressure of change from technology, user demands and communicative trends.

Many museums and libraries promote their social web platforms by continuous editorial work. Features of personalisation and interaction are essential to comply with target group-specific information formats. The technical and content-related implementation of the Barrier-Free Internet Guideline[5], to give a German example, is an unconditional requirement for any internet communication. It is binding for all public internet offers in German public institutions.

3.4.4. Long-lasting and future-oriented user services in public libraries

The lifespan of speech synthesis software tools, automatic summarization, emotion analysis as used, to give an example, in the ANBPR use-case (see Section 4.4), can have a significant impact on the activity of public libraries and the long-term services they can offer their audiences.

Advanced speech editing and synthesis technologies have the potential to substantially revolutionise the way libraries serve heterogeneous categories of users, providing a wide range of benefits. By integrating these types of techniques and technologies, public libraries can both retain their current users and attract new categories of users, such as visually impaired people, who thanks to these new techniques and technologies can become full beneficiaries of accessible cultural content.

3.4.5. Adapting modern library services to the current cultural consumption needs of users

The use of high-quality voice synthesis technologies and emotion analysis based on NLP algorithms can improve the user experience of library users in the long

[5] Barrierefreie Internet-Verordnung, BITV, https://www.barrierefreiheit-dienstekonsolidierung.bund.de/Webs/PB/DE/gesetze-und-richtlinien/bitv2-0/bitv2-0-node.html

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term. Today's users expect rich and diverse content that is available in different formats, including audio summaries and spoken content. To achieve long-term customer commitment, it is helpful to extrapolate how natural language processing algorithms can be used to synthesise and summarise the content of books or of audio-video materials available in library collections.

3.4.6. Consolidation of the use of advanced technologies by integrating the processes into the libraries course of business

To consolidate automatic summarization and text-to-speech conversion services, public library staff can help users identify and access key information of interest to different audiences, including visually impaired people, who would otherwise be excluded from this type of cultural consumption.

The technologies and tools of voice synthesis, automatic summarization, text-to-speech or emotion analysis proposed by the SHIFT consortium have the ability to consistently reform the way modern library services are received under the aspect of new functionalities. By integrating these new derivations of the way of delivery of audio-video constructs from the libraries' collections, it is possible to generate an increased interest on the part of audience categories not included in the libraries' current audiences.

For a correct implementation of new technological procedures, as proposed by SHIFT, the right balance between ethical responsibility and confidence in the benefits of the use of advanced technologies is a key requirement. A detailed analysis of the long-term costs and benefits of the implementation of these technologies in public libraries must correlate with the identification of future developments in the field of advanced technologies and respect rigorously the rights and claims of personal data and copyrights. Only in this way can the positive aspects of the new technologies successfully find their way into everyday library life with an increase of accessibility, expansion of collaborative learning and co-creation for the benefit of the users and the communities as a whole.

3.5. Knowledge Transfer and Knowledge Drain in Cultural Heritage Institutions

New technological challenges, international collaborations and, increasingly, economic considerations have greatly changed the organisation of work and

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budgeting of European GLAM institutions in recent decades. In order to achieve greater flexibility in the allocation of resources and greater freedom for the creative and interdisciplinary processes, many museums and libraries have significantly increased the share of project-oriented work, which is often limited in time, as opposed to tasks that are oriented towards the institutional long term and reflected in mid-term financial planning. Today, only a flexible work organisation tailored to specific project work seems to enable traditional public institutions to efficiently and quickly use the resources that are often acquired at very short notice through third-party funding and subsidies. Budgets, staff and working time can be allocated to specific projects in this way instead of making continuous, long-term commitments. New ideas and innovative approaches in research, conservation and outreach can be tested in a future-oriented way, and often only temporary projects offer the appropriate playing field or test bed of better audience involvement in the creative process or enabling participation and co-creation by implementing innovative technological tools.

In the context where citizens' information needs have grown and become more sophisticated, libraries have gone beyond the status of book repositories and acquired new values, becoming learning centres focused on the creativity of the participants and the stimulation of innovation. According to IFLA-UNESCO Public Library Manifesto 2022, "The public library, the local gateway to knowledge, provides a basic condition for lifelong learning, independent decision-making and cultural development of the individual and social groups"[6]. Keeping their basic function as knowledge repositories, libraries have varied their methods of delivering information through the major contribution of the digital. As a result of the challenges generated by technology, the librarian becomes the mediator and trainer of the reader who facilitates the more efficient use of the library's informational resources. The librarian's professional training itself requires an appreciable level of knowledge that will allow him to access, structure and disseminate the information stored online.

[6] IFLA-UNESCO Public Library Manifesto 2022: https://repository.ifla.org/bitstream/123456789/2006/1/IFLA-UNESCO%20Public%20Library%20Manifesto%202022.pdf

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On this basis and with the aim of creating a well-informed community and increasing loyalty to library services, the communication between the librarian and the user for accessing and using information in cyberspace is intensified. And this aspect generates the evolution of managerial techniques, as well as in terms of information resources management, human resources and information technology management.

Technology supports the approach of libraries to stimulate reading and information-research-documentation in increasingly different and sophisticated forms that favour their transformation into true centres of culture with varied services centred on the needs of users. According to IFLA "An important role of the public library is providing a focus for cultural and artistic development in the community and helping to shape and support the cultural identity of the community. This can be achieved by working in partnership with appropriate local and regional organisations, by providing space for cultural activity, organising cultural programmes and by ensuring that cultural interests are represented in the library's materials. The library's contribution should reflect the variety of cultures represented in the community. It should provide materials in the languages spoken and read in the local community, and support cultural traditions "[7].

This elucidates the rationale behind the endeavours associated with Use Case 3: "Romanian History and Customs Explained to Digital Natives" within the SHIFT project. The project partners aspire to establish a foundation for reinterpreting heritage assets by leveraging technology, with a distinct focus on cultural identity and fostering cultural reconciliation between the present and the future. This is to be achieved through the development of technologically enriched and readily accessible digital narratives.

In the last 20 years, libraries have carried out constant projects to digitise collections with the aim of developing integrated library systems that manage large

[7]https://www.ifla.org/wp-content/uploads/2019/05/assets/hq/publications/archive/the-public-library-service/publ97.pdf

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volumes of information, and at the current stage we are witnessing a hybrid version of traditional and modern services that coexist.

In order to ensure the continuity, traceability, preservation and perpetuation of the results and the securing of investments in technology (also applicable in the case of SHIFT), regardless of whether these investments were made through projects with financing or from their own resources, public libraries in Romania are concerned with maintaining a discipline rigorous regarding the up-to-date records of project managers, the inventory of technological resources, the infrastructure of IT devices and tools, the base of manuals and user guides, the suite of procedures that regulate the commissioning of modern technological components.

Potential risks regarding the durability of SHIFT solutions and technologies:

Risk 1: Loss of relevance of tools/solutions after completion of implementation: If libraries will not keep up with the maintenance and updating of SHIFT technologies after completion of implementation, there is a risk that part of the project results will become inoperable for their public, a fact that could ultimately lead to the termination of the service.

In the absence of rigorous procedures for monitoring the technological infrastructure and the inventory of SHIFT technological solutions, as well as the managers and the internal procedures for managing the project's assets, the libraries risk being unable to maintain the already established results.

Risk 2: The wear and tear of SHIFT solutions and the impossibility of replacing them with other similar or comparable solutions.

Therefore, in order to ensure the longest possible lifespan of SHIFT solutions, technologies and results and to better face the challenges specific to the technological era we are going through, public libraries should develop a coherent policy of inserting SHIFT technologies into the flows working currents and adequacy of own IT infrastructure to be compatible with them.

That policy should include clear objectives related to staff training, maintenance and updating of solutions and data security, and, above all, measures regarding the education of users to understand the benefits of using technology and in

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particular the solutions, devices and technologies proposed by SHIFT. Also, public libraries will have to identify opportunities for collaboration with suppliers and integrators of software solutions, as well as with other cultural and creative organisations in Europe to connect their audiences and thus maximise the impact of SHIFT technologies on the largest possible scale.

Risk 3: It remains important, though, for public cultural institutions to be aware of the risks as well as the opportunities of project-based work. Uncertainties for permanent staff are definitely among them if employment depends on the availability of projects. This may lead often to instability in terms of job security or income. Project-oriented work also makes it difficult to maintain successful long-term strategies or long-running programmes. If there is a lack of coherence in the multitude of projects within the individual cultural institution, the impression of arbitrariness is quickly given. In the long run, this diminishes the external impact of a clear mission and a trustworthy identity.

However, two of the greatest risks associated with project-oriented work in large organisations are the economic and scientific consequences of insufficient 'knowledge transfer' during the life of the project and an uncontrolled 'knowledge drain' at the end of the project phase. The question of how the necessary knowledge, skills and budgets for the long-term operation of a new application can be transferred from the project to a respective organisation, museum or library must be given the utmost attention. This involves the risk of losing the crucial resources, skills and also the financial investments that have contributed to the success when the project comes to an end and the staff associated with it will have to leave.

Equally consequential in the long term are the effects of "knowledge drain" within an organisation, in the event that essential information for innovative processes or tools cannot be adequately documented in a user-friendly manner. Additionally, ensuring adherence to application practices and maintenance requisites specific to the respective museum or library is imperative to mitigate such repercussions.

It is of paramount importance for the deployment lifespan of SHIFT tools to identify the risk of an expected knowledge drain already during the implementation phase of the project-tools and to propose appropriate measures to ensure the relevant knowhow in the long term.

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4. FACTORS AFFECTING THE DEPLOYMENT LIFESPAN IN SPECIFIC SHIFT PILOTS AND OVERVIEW OF USE-CASE STUDIES

4.1. SPK-SMB use-case

The proposed use-case exhibition projects of SPK-SMB develop innovative techniques of multimodal access and multi-sensorial experience to the collection objects. Thereby, the consideration of barrier-free and inclusive access for VIPs is in the foreground. The tools that are developed are also considered from the point of view of economic efficiency and sustainable reusability in other contexts:

(1) One or two 3D tactile models on a scale of 1:25 (or approx.) from large-scale objects will be printed or casted from existing digital 3D models in the collection's repository.

(2) The tactile model is used as a tactile interface. It also links via touchable hotspots to written articles and/or audible narration of the scenes depicted from ancient mythology.

(3) If technically feasible, the same tactile model can serve a "seeing" audience interacting with the frieze by Remote Eye-Tracking systems.

(4) > 25 landscape/cityscape-paintings will be transformed into soundscape-echoes and enriched with sonic atmospheres. Digital storytelling and emotional visitor's journey.

(5) > 25 paintings of the Gallery of Old Masters will be deciphered and described automatically by complementary information from ICONCLASS and online sources. Image to text to speech to make them more accessible for VIPs, visitors and curators.

(6) A tool for evaluating the effectiveness and success/failure within the use case exhibitions.

(7) > 3 reference events to promote and popularise the SHIFT tools to the various communities in engineering, administration, curation, and outreach

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4.2. SOM use-case

4.2.1 Basic information about the use-case

The Semmelweis Museum, Library and Archive of the History of Medicine (SOM) is a small museum that has limited immersive content and no modern, engaging tools (e.g., AR/VR, haptics). The SOM has cca. 200 paintings covering scenes from the history of medicine, healing, sickness, epidemics, hospitals in past eras, and 150 portraits of physicians and pharmacists. It also has more than 55 sculptures and reliefs of physicians, scientists, or other persons related to medicine and various medical objects. Additionally, the institution counts more than 140.000 books on the history of medicine and pharmacy, together with photos and videos and a coin collection of cca. 12000 pieces. The museum does not use any digital devices at the moment in its permanent exhibition. Since physical space is also limited in theMuseum, the institution opted for a technology that does not take a lot of space and can make use of the high number of artefacts already present there.

4.2.2. SOM's Pilot

The use-case aims to immerse the visitors in the history of medicine and let them "feel" how different illnesses have been treated before modern times. This will be achieved using several tools within the project. In particular, this pilot exhibition will test the following tools:

(1) Tool to enhance photos/paintings to short videos
(2) Tool that translates physical objects to digital objects
(3) Tool that translates historical meaning into more contemporary language and for auto-tagging/ auto-categorization of cultural heritage resources
(4) Tool that by AI technology presents ancient, mediaeval and early modern medical practices as used to cure illnesses of various symptoms.

The SOM decided to mainly rely on its collection of coins to be used on this use-case. By digitising a curated selection of coins and turning them into objects with a higher resolution to be more visible and enjoyable by the visitors, the museum will be able to showcase a collection of objects that has not been enjoyed earlier. By changing their characteristics, these artefacts will be able to tell a story to a wider audience: using animation, enhancement and added audio, the coins can

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finally be able to come alive by "showing" their stories via symbols, inscriptions, sounds and voices.

4.3.3. Deployment lifespan of the existing technical environment and integration of the SHIFT solutions

Similarly to the other use-cases, the main consideration revolves around the lifespan of existing technical hardware meant for front-end users, including touch-screens, PCs, tablets, and peripheral devices like headphones, and their compatibility with the outcomes of SHIFT's technical solutions. In a very tight physical space that the SOM has, even placing these devices can be difficult. The technical solution offered by SHIFT should pay a special attention to this aspect.

Implementing educational and training programs for museum staff to enhance their proficiency in using new technologies and troubleshooting common issues related to SHIFT technologies is also of vital importance. Additionally, procurement decisions concerning IT infrastructure should prioritise circular economy criteria, focusing on components that are repairable and replaceable.

4.3. BNM use-case

4.3.1 Basic information about the use-case starting point

The Homeland Museum of Knjaževac, as a member of the Balkan Museum Network and one of the use case museums in the SHIFT project, has offered a set of digitised content regarding its artistic collections, for testing in the process of development of various sensory effects integrated into the SHIFT's digital solutions.
This content is in the form of audio-visual material, short video clips explaining and presenting selected objects from the museum collections by curator-narrator, supported by subtitles in both Serbian and English language, and in some cases 3D or replicas of artefacts.

Those videos are available online on the museum's YouTube channel, but also in some cases via QR codes in the exhibition spaces. Some of them have been integrated into the museum's applications, available on mobile devices such as tablets or/and touch screen PCs in the museum, or on the museum's websites.

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This provides an opportunity for the museum to use this kind of digital content as a digital resource available for all users, both individuals online from home, but also on personal mobile devices outside of the museum and in the museum during personal or group visits as audio-video "guides'', especially during (but not exclusively) the workshops with people with disabilities.

Those materials, in this phase of the SHIFT project, are used as a testing element for the development of different sensory digital tools that should enhance and enrich the final experience of people with disabilities and museum visitors, in general.

Also, a significant part of the proposed material for testing new technologies through the SHIFT project is represented by digital images of paintings, such as masterpieces of the local, but nationally recognized artist Dragoslav Živković and artefacts that can be used in combination with different technologies for audio descriptions, emotion transfer, haptic experience supported by novel IT equipment, in order to make CH more accessible, especially for, but not exclusively for blind, partially sighted and people with vision impairments. Some of the digital images of paintings are supported by textual descriptions in Serbian and English language and audio-visual materials with bilingual subtitles and sign-language interpretation.

All technical solutions initiated by technical partners of the SHIFT consortium are presenting steps toward the improvement of accessible and inclusive museum collections, and cultural heritage in general, but also modernise and improve ways of presentation and interpretation of cultural heritage in general.

The Homeland Museum of Knjaževac is, at the moment, using touch-screen PCs and tablets with headphones for providing content to museum visitors on designated, accessible info points. It has nine Android/iOS applications, interactive with interpretative boards and books, websites, virtual 360-degree tours, etc.

All above mentioned present the tendency of the Homeland Museum of Knjaževac, as a member of the Balkan Museum Network, to be current with new trends and technologies and to provide a satisfactory, if possible multi-sensory inclusive experience for all, evoke an emotion, disseminate knowledge, create accessible and socially engaged contents and programs.

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4.3.2. BMN's & The Homeland Museum of Knjaževac Pilot

Case study of the BMN (Balkan Museum Network /The Homeland Museum of Knjaževac), is directed toward creating an augmented experience for visitors in the Homeland Museum of Knjaževac. This experience will be based on the exhibition focused on the art collection (20th-century paintings, 19th-century icons, and contemporary Serbian paintings). The exhibition will be using innovative digital tools, audio-visual materials, tactile elements for people with sensory impairments, and a wide audience. The above technologies seek to address specific physical and contextual barriers to accessibility.

The expected results of the SHIFT pilot will provide and validate the following tools:

- Tool to enhance **Photos/Paintings** to Short Videos describing images and providing different sensory experiences with the support of IT tools capable of transferring visual stimuli into tactile experience;
- **Audio tool** – "Video to Speech" capable of interpreting visual stimuli (e.g., actions explained in visual sequences);
- Tool to **"Text to Speech"** that automatically can provide complementary information regarding the cultural heritage assets (paintings, icons, photos);
- A tool that translates historical meaning into more contemporary language and for **auto-tagging/auto-categorization** of cultural heritage resources.
- 3D tactile models will be used as a tactile interface for the presentation of different layers and interpretations of elements of cultural heritage.

4.3.3. Deployment lifespan of the existing technical environment and integration of the SHIFT solutions

As the BMN's pilot is going to be implemented in the Museum and tested in the previously described environment, the same or similar principles and main points regarding deployment lifespan can be observed as in the case of the SPK-SMB pilot.

Here we are providing a visual scheme of the Homeland Museum of Knjazevac Network Map with the list of PC with characteristics:

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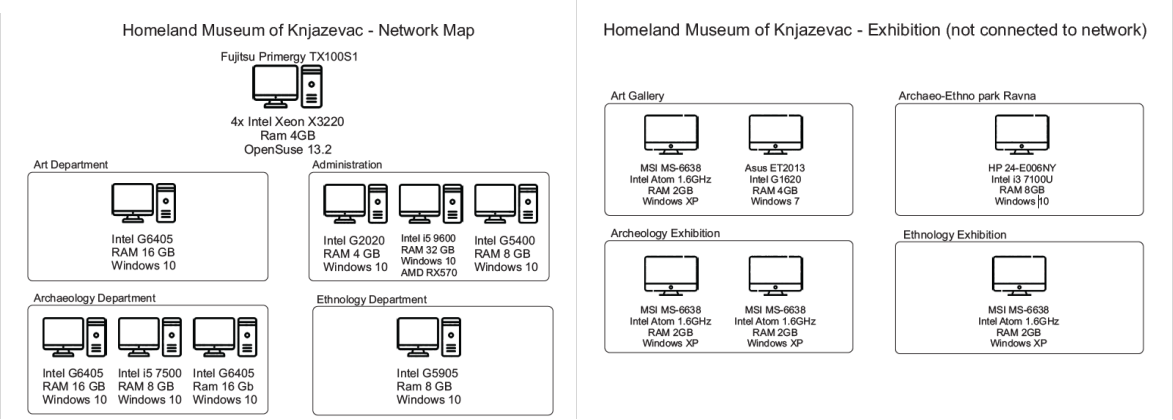

In addition, we have five Windows 10" tablets, two 10" Android tablets and one 12" Android tablet with headphones used as audio-video guide but also for presenting the museum's Android application, one interactive board and three projectors used for other interactive programs in the museum.

One of the main issues is in connection with the current capacity of data storage and data distribution systems, servers, and the existing internal network, but also its safety, and efficiency. There are also existing national platforms and software solutions in use for the digitization of the CH and its presentation, research, and interpretation online, that have to be taken into consideration.

The other important issue should be referring to the lifespan of the existing technical equipment designated to front-end users such as touch-screens, PCs, tablets, and peripheral equipment (headphones), and its compatibility with the results and outcomes of the SHIFT's technical solutions. Current websites and other online available content can be easily outdated or even endangered by insufficient funding for updating, security systems, and maintenance…

In this regard, there has to be a plan for investing in data collection software, or compatible free-to-use open source, supporting back-end systems like servers and internal networks, back-up cloud options, but also in equipment for implementation of the program elements, presentation, and use of content. Sustainable, accessible, and inclusive use of cultural heritage is one of the main goals of the SHIFT project, but sustainable use of energy, space, time, money,

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equipment, and human resources should be the main pillars of the SHIFT project and therefore the main principles for further work.

To ensure the longest lifespan, at least three preconditions will be taken into account contributing to sustainable usage of SHIFT technologies. These are:

(1) Installed equipment will be maintained according to prescribed terms of usage provided by technology suppliers. Each CH partner should receive guidelines about proper management of installed equipment.

(2) Appointing responsible persons within CH institutions, both technical and programmatic, that will be responsible for the new technologies.

(3) Educational and training programs for museum staff on the usage of new technologies and troubleshooting for the most typical problems are needed for the CH institutions that will receive SHIFT technologies.

(4) Procurement procedures and decisions on the IT infrastructure based on the criteria of circular economy, utilising the components, which can be repaired and replaced.

(5) Signing maintenance contracts with hardware and software producers covering the period after the project completion.

4.4. ANBPR Pilot

4.4.1. Contextualization

In the context of a society in full transformation, the public library has the imperative mission of ensuring fair access to information, as a fundamental element of knowledge. Unlike in the past decades, this role takes on increased importance in today's society, marked by the supremacy of digital, the public library becoming a key actor in the process of facilitating access to published information, especially in electronic formats, increasingly widely distributed. The primary purpose of the public library is to assist and guide users to responsibly navigate the vast, ever-expanding streams of information, ensuring that they can do so efficiently and effectively.

To approach the SHIFT Deployment Lifespan Roadmap from the perspective of ANBPR Romania and public libraries, it is necessary to first understand the context

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of the evolution of libraries and the modelling of the role of the public library in accordance with the new requirements of users and the galloping pace of integration of advanced technologies in everyday life by day.

From this perspective, we can identify three main directions:

Economic Activation Area: This direction revolves around the strategic significance of knowledge development. The ever-evolving economic landscape requires new approaches to the workforce, businesses, public administration and education. The current trajectory of information generation emphasises that knowledge acquisition is the primary social factor for individuals, competitive companies, and public institutions alike. Consequently, libraries must continuously innovate their information and documentation services in accordance with the needs of users and cultural and creative institutions engaged in the process of managing knowledge assets.

Area regarding access: This direction refers to the imperative to provide democratic access to information, published online or offline, regardless of support/medium/format, etc. This extends beyond the principles of direct and fair access to information for citizens and also includes the promotion of active civic participation in a constantly changing society.

Social Engagement Direction: This direction refers to a critical concern within society, namely the information divide or the widening gulf between the information rich and the information poor. From this perspective, the public library can anticipate and prevent the deepening of these gaps, by approaching culturalization programs aimed at those on the periphery of knowledge in order to think and implement remedial measures, which will transform libraries into safe and stimulating outposts for the disadvantaged, to be encouraged in this way to increase their knowledge base, in a free and accessible way, and to benefit more and more personalised from the advantages of technology.

Based on the three dimensions identified, it is necessary to develop tools that facilitate solving potential problems (economic, access or social) and mitigate these threats as much as possible. A promising path is the revitalization and substantial reformation of public libraries, as institutions of information and documentation and heritage preservation with a long tradition and granting a strategic role in stimulating and cultivating knowledge for all. Public libraries, as

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vital pillars of knowledge dissemination, must constantly adapt and reinvent to meet the increasingly complex demands of a society that relies more and more on the input given by technology.

4.4.2. ANBPR Romania's Pilot

In the context of the objective of the SHIFT project to bring to fruition technological innovation to make European cultural heritage accessible, the pilot exhibition in Romania aims to make Romanian history and customs more accessible and captivating for the modern public.

"Romanian history and customs explained to digital natives" envisages the artistic exhibition of representative rare books, photos, audio, video related to the Romanian cultural heritage circumscribed by the theme of the exhibition (holidays, customs and rituals and musical folklore, artistic crafts, different forms of the word art, choreographic folklore, games for children and young people from the geographical space of Romania, etc.), respectively:

- 70 short videos featuring paintings and photos from libraries or shared by citizens

- 50 books compiling complementary information from online sources. These resources will be accessible through multiple digital platforms, including mobile devices, tablets and MP3s

- 100 books of historical significance will be translated into a more contemporary language, allowing visitors to make correlations and associations between archaic and modern language and deepen the information stored in the historical archives

- 5 reference events from the history of Romania, presented through pre-existing and newly generated digital content, to give visitors a perspective on the cultural significance of these events and their relationship with human experiences and societal values observed by communities.

4.4.3. Integration of SHIFT components in the Romanian public libraries

The general context and the current situation of libraries in Romania

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Romanian libraries have not benefited from a national computerization strategy. In the absence of a systemic action orchestrated at the decision-making level, public libraries in Romania have tried through their own efforts or with attracted sources to computerise their activity by implementing specialised library systems and importing modern technologies on a small scale. This happened, however, with great budgetary restrictions, considering the chronic under-funding of libraries at the national level. With few exceptions, each library independently decided to optimise its own IT architecture, each according to possibilities, without synchronising with the rest of the libraries and without resorting to a mutually beneficial sharing of human and material capital with other similar libraries.

Public libraries in Romania - critical nodal centres in the context of digital transformation

Public libraries in Romania have a dual role in the contemporary information landscape. They function both as primary gateways to accessible published information, regardless of their support, and as nodal centres for the promotion of digital literacy and information technology skills. Therefore, the public library must provide access to a diverse range of resources and services. These resources generally refer to comprehensive collections of records, covering fact and fiction in various storage formats, as well as extensive collections of loanable documents available in both traditional print and multimedia formats.

Libraries - vital agents in promoting access to knowledge

Public libraries in Romania offer services for the provision of documents for loan and have a decent network infrastructure, but unfortunately with unbalanced distribution compensated by the support of qualified staff, able to help customers in navigation and information retrieval. In addition, public libraries provide an environment conducive to open education and training, characterised by multifunctional spaces that enable thematic presentations aimed at creating knowledge. s They also extend their reach through remote access to a range of information services, including community information and specialised databases. This multifaceted role, based on the hybrid library concept (both traditional and digital-centric), positions public libraries as vital agents in promoting access to information, digital literacy and the dissemination of knowledge to heterogeneous categories of the population, including disadvantaged groups .

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In the context of county libraries in Romania, an uneven integration of modern functionalities is observed, especially when we refer to the management of electronic resources and the development of digital libraries. For example, the National Library of Romania has implemented extensive computerization, adopting modern systems for managing both traditional documents (such as ALEPH), as well as electronic and digital ones. These implemented technological platforms have the ability to coordinate libraries in the network, including those that use different systems, but with the strict observance of the relevant standards in the field.

The need for massive investments in IT infrastructure, standardisation and compatibility

With regard to public libraries, especially county ones, the widespread use of the TinLIB system or its variant TinREAD, which facilitates online access via the Internet to electronic catalogues, is noteworthy. However, the document digitization process is still far from being as consistent as would be desirable and necessary, since many of the digitised documents are not yet integrated into proper digital libraries, but are listed in the form of lists with links to those resources. These lists are generally available on library websites, also raising concerns about the future management of these digital resources and the much-needed ongoing updating. To be able to function really effectively, libraries in Romania need consistent investments in IT infrastructure and, perhaps more importantly, they need to be part of a wider network of libraries, which requires standardisation on as many levels as possible and compatibility.

Biblionet – the main capital infusion in the introduction of technology in public libraries in Romania

An essential role in the modernization of public libraries in Romania was played by the Biblionet program, the largest private investment in Romania regarding the introduction of technology in public libraries financed by the Bill & Melinda Gates Foundation, with a value of 26.9 million dollars at the national level. The Biblionet program, launched in 2009, aimed to revitalise and equip public libraries in Romania with modern computing and communications infrastructure. In doing so, it sought to improve library services and facilitate access to digital resources, while promoting information literacy and community engagement.

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Before Biblionet, several initiatives aimed to promote the use of ICT in society, such as the "Access to ICT in rural areas through telecentres" project supported by USAID and the "Knowledge Economy Project" supported by the World Bank. These efforts aimed to improve access to telecommunications and IT services in local communities.

However, a truly transformative change occurred with the Biblionet program (2008-2014), a six-year effort funded by the Bill & Melinda Gates Foundation within the Global Libraries Initiative, implemented in collaboration with the International Research & Exchanges Board (IREX), ANBPR, the Ministry of Culture, Microsoft Romania, EOS Romania, local authorities and public libraries. This initiative provided hardware, software and IT support for 2,280 public libraries, consisting of an investment of 26.9 million dollars consisting of library technology, operational expenses and training.

The implementation of the Biblionet program led to the equipping of over 80% of Romanian libraries with mini-technology laboratories. It successfully introduced over 600,000 people to the Internet and trained 4,200 librarians to use technology effectively in improving library services and interaction with their communities. The Biblionet program equipped the libraries with computers, software and IT support, while the local administrations in turn invested approximately $25 million consisting of Internet connection costs, library renovations, and maintenance costs. In addition, the Biblionet program provided financial support and technical assistance to ANBPR, thus putting libraries on the agenda of decision-makers at both national and EU level. After the exit of the Biblionet program, based on the developed infrastructure and the permanent efforts of ANBPR, as the main guarantor of the conservation of the results of the program at the national level, it continues to provide public access to the Internet, training in the field of digital literacy and other basic ICT services, contributing thus to the continued growth of digital access and literacy for users of library services from all walks of life.

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5. SOLUTIONS TO IMPROVE SUSTAINABILITY AND ACHIEVE THE LONGEST LIFESPAN OF INDIVIDUAL SHIFT COMPONENTS

Sustainability of IT components and hardware in museums requires careful planning, high-quality selection, continuous monitoring and maintenance, and a willingness to respond to technological developments as well as to changing requirements. A comprehensive hardware sustainability strategy is crucial to maximising the lifespan of hardware and making museum services efficient and effective. The selection and development of specific hardware and software solutions for SHIFT components must therefore take into account some general specifications to ensure an optimal deployment lifespan in the ecosystems of cultural heritage institutions.

5.1. Hardware Factor - Front ends/User-clients

5.1.1. Mechanical stability, robustness and maintenance-friendly design

Stationary systems and mobile devices used in museums and libraries must be designed for high frequency of use by visitors and groups of visitors of all ages. This results in considerable demands on mechanical stability and a robust, preferably vandalism-proof design of the mechanical components. Impact-resistant cases and display protection devices may hinder the hardware from accidental damage. If permanent use is to be ensured during the museums' regular opening hours, which can usually be assumed, hygienically flawless maintenance in changing use must be ensured in addition to efficient energy supply. This includes easy access to batteries or accumulators, exchangeable components and the possibility of short-term replacement in the event of a defect.

5.1.2. Energy efficiency

In terms of energy efficiency, it is recommended to use only hardware that minimises energy consumption. This may include, for example, the use of

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rechargeable batteries instead of disposable batteries or the implementation of standby modes.

5.1.3. Adaptation to local spatial and climatic conditions

An optimised deployment lifespan of frontends like kiosk systems, touch-tables, sound-showers or scent installations has to respect the spatial and climatic conditions in the bricks-and-mortar museums building. The components of an application must be adapted to the local spatial situation, though the design should be flexible enough to serve in various contexts. Projection systems, to give an example, should ensure the most flexible installation possible, hanging and standing, close or far from the object, and should be able to operate regularly with reduced or low noise generation and without endangering the stocks by heat emission.

5.1.4. Enduring and widespread operating systems and software

It must be ensured that the operating systems and the application programmes of the devices are supported in the long term or at least over the planned deployment lifecycle. Modularisation options must be planned for in order to update the hardware components, extend the life cycle and integrate new technologies.

5.1.5. Maintenance, monitoring and remote access

The current operational status and readiness of the equipment in the visitor zones of museums or libraries requires continuous monitoring. This plays a crucial role in preventing or minimising embarrassing downtime. Evaluation and analysis tools can help to track hardware usage and collect information on performance and usage. It should be considered to repair potential accidents or failures remotely.

5.1.6 Security precautions

Unfortunately, appropriate precautions must be taken in the museum or library to protect the equipment from theft or tampering. On the hardware side, security measures like locks or surveillance cameras may be used; on the software side, interfaces can be blocked to prevent unauthorised access to the administration programmes or contents of the devices.

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5.1.7 Recycling and disposal

The disposal of hardware that will eventually become obsolete must be taken into account right from the start. It has to be ensured that an environmentally friendly waste management at the end of the useful life of the equipment leads to proper recycling or disposal.

5.1.8 Staff training

Finally, the sustainable and long-lasting use of all SHIFT components in the CH institutions can only be successful if museum staff have the necessary training and motivation to supervise the hardware properly and to troubleshoot simple problems.

5.2. Hardware Factor - Backend-Layer

The architecture of backend layers and suitable server solutions has an important impact on sustainability and long-term deployment of any media application in the GLAM institutions. Whether an application runs on local or remotely hosted servers, on stand-alone PCs or in a networked WLAN or Ethernet environment depends to a decisive extent on the local circumstances. Ultimately, the decision depends on the specific requirements and goals of the museum, as well as the resources available. Therefore, it is important to perform a comprehensive cost-benefit analysis to assess the impact on sustainability, operational efficiency, and financial performance. However, some critical factors with regard to deployment lifespan can be generalised.

5.2.1. Cost-effective maintenance

The sustainability of IT applications depends largely on reliable and cost-effective maintenance. Local servers usually require a lot of internal effort and updating, while remotely hosted servers can be maintained by an external service provider. As they are often offered on a subscription basis and do not require a high initial investment, this can reduce the burden on museum staff and possibly free up resources. On the other hand, however, larger museum institutions already have a developed and fail-safe server infrastructure that can take over reliable

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maintenance and care in line with the institution's goals and security guidelines. In individual cases, it is necessary to check which solution is suitable for which of the SHIFT use cases.

5.2.2. Energy efficiency

Attention must be paid to the energy consumption and efficiency of the server solution. Local servers tend to consume more energy than remotely hosted or individual stand-alone servers. Energy efficiency is rapidly becoming important to minimise the environmental footprint of the IT infrastructure.

5.2.3. Scalability

Any server solution must be assessed against scalability. Requirements for IT applications in museums can change over time and adjustments should be possible without expanding the cost-intensive physical server infrastructure. Virtualized services are state of the art.

5.2.4. Security

The security of IT applications is of critical importance, especially in museums that store valuable cultural and historical information. In many institutions, legislative regulations have to be respected. The use of remote server solutions can, therefore, be restricted to national or particularly certified providers. Many institutions have set up their own IT security policies and require them to be taken into account.

5.3. Software Factor

The long-term usability of SHIFT components at GLAM agencies is based significantly on a positive forecast of the updating procedures, maintenance, and bug-fixing of the software programs deployed or developed. The essential part of this prognostication assesses different factors such as application lifecycle management (ALM), application security, and design.

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5.3.1. Evaluation of development practices

The development of proprietary software programs or the use of branded or open source software products is an issue that is closely related to the deployment lifespan. It is important to ensure in advance that best practices in application lifecycle management (ALM) are applied in both cases. These include the use of version control systems, test automation and DevOps principles. A clear forecast is necessary right from the beginning, which resources in terms of personnel, budget and technical infrastructure are available for the continuous updating and bug fixing of the software and for which period of time.

In many cases, the use of ready-made brand software and relevant, widely published libraries of tools offers great advantages in terms of long-term useful life and sustainability. Branded software is also usually less expensive to purchase and to implement than developing museum-specific software 'from scratch'. Museums with limited budgets can benefit significantly from these cost savings in the long run.

In addition, the adaptation of branded software to the specific requirements of a task takes a much shorter period of time, so that the overall useful lifetime increases and a quick and maybe 'dirty' solution is at hand when the museum or the project needs it. The dissemination in much broader user communities leads to conformity with generic operating-experiences and towards broad-based support.

Sometimes the specific museum requirements or resources cannot be met by existing branded software. In this case the development of proprietary software can be beneficial to a project. Though, the question of longevity is very difficult to answer and depends on many factors. In most cases only the museum's planning horizon for the usage-period of the software can be taken as a basis for evaluation.

5.3.2. Data Security

Ensuring the general trustworthiness of information is decisive for the deployment lifespan of the SHIFT components. Artificial intelligence (AI) and machine learning (ML) algorithms are revoluting the work on inclusive and multisensory

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programmes of many museums. This is challenging and requires careful planning, a high degree of quality control and the implementation of initial authentication mechanisms, especially to prevent or distinguish between untrustworthy fake information and docu-fiction.

The trustworthiness of information has therefore to be checked with diligence and regularity. Users must be given the opportunity to learn about how the systems work, what kind of ground truths are used and which algorithms are modelling the results. Feedback mechanisms should be implemented to allow participatory feedback from users and experts on the AI and ML applications. The editorial, human support of such feedback mechanisms must be ensured at least over the scheduled runtime of the application.

Data security, on the other hand, can be ensured by usual practices of patch management, training in security practices, data backup and recovery, and access controls.

5.3.3. Attractive Design and Winning Handling

Attractive design and intuitive handling are crucial for the long-term and sustainable use of software in CH facilities. This attracts visitor's interests, and after all, if the software looks good and is easy to use, users are more likely to use it and engage with the issues. Software that is easy to learn is also likely to be used longer term and more efficiently than software whose challenge already lies in the technical hurdles of operation.

Attractive design and winning handling can be achieved by various approaches. Design should basically be user-centred from the outset. This means that user feedback must be included in the design process. Interviews, surveys, tests and continuous feedback help to keep the dialogue going.

The software must provide a clear and compliant ergonomic navigation. Users must be able to navigate effortlessly through the application to access all needed functions and content.

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The aesthetic appearance of the software has to reflect accurately the experiences of the users but also the corporate identity of the institution. This includes the use of appealing colour schemes, fonts and graphics.

Accessibility must be respected at all levels of the programme. Changing gamification elements such as rewards, badges and challenges can contribute to the long-term attractiveness of the programmes, as can multimedia libraries and interactive appeal.

5.4. Factor Data and Information

In order to increase the longevity of SHIFT programmes and components, user-centred, multi-perspective storytelling as well as increased accessibility through multimodal access and multisensory translation services are of utmost importance.

5.4.1 Transmedial Interfaces and Open Data Formats

To enable inclusive storytelling and multimodal presentations from heterogeneous data repositories, the interoperability of data and the standardisation of interfaces and protocols for the exchange and harvesting of data are imperative. At the same time, these are the prerequisites for future-oriented and long-lasting operation of the SHIFT applications.

Against this background, the SHIFT project is oriented towards established and open data formats recommended by national and international scientific organisations, e.g. TIFF/JPEG in the image domain, PLY/OBJ/3D-PDF in the 3D domain or WAV/MPEG in the audio domain. This facilitates interoperability and data exchange.

APIs and web services are used to facilitate access to data and functions and to enable integration into various applications, e.g. Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH).

The metadata standardisation follows the national characteristics that are specified in the European cultural sector by the CIDOC-CRM (Conceptual Reference Model) or its corresponding derivatives (e.g. LiDO "Lightweight information Describing Objects").

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5.4.2. Triple A - Attractiveness, Actuality and Authenticity

Nothing is more tiring than the sentence: 'last updated 10 years ago!'. Digital content promises to show up current data by allowing you to continuously aggregate new insights, research-results or contemporary perspectives. The authentic credibility of an application or a story is the most important factor at the intersection of materiality in the museum and its digital presence. The long-term integrity of data describing the material world has to be handled in this respect with the utmost care that the museum brings into its exhibits. This has to be ensured throughout the lifecycle and usage of the SHIFT components.

5.4.3 Deployment Lifespan of Digital Presentations

In order to ensure the longest possible deployment lifespan of digital publications and educational applications for museums, the corporate identity (CI) of the museum must be respected and the design must respond to technical developments, user requirements and digital media trends.

The regular updating and adaptation of the design must make the digital publication attractive and provide it with user-oriented arcs of attention.

The design should be kept responsive according to current trends and must work ergonomically well on different devices and screen sizes - from smartphones to large tailored screens.

Accessibility and compliance have to meet applicable standards to ensure broad accessibility. In Germany, to give an example, the Barrier-Free Information Technology Legislation (BITV) is binding. Careful targeting of applications to the needs of users are crucial to maximise the lifespan of digital publications and to ensure that they represent the museum and its CI in a sustainable way.

5.5. Knowledge Transfer and Knowledge Drain. How to!

The deployment lifespan of the SHIFT tools in the use-case pilots and in subsequent applications requires targeted measures to ensure knowledge transfer and prevent knowledge drain. Relevant knowledge must be documented in the contexts of usage, and it must be shared and kept accessible for future generations

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or technological upgrades. In the SHIFT project, general practices of knowledge management and documentation are applied for this purpose.

A central repository will be established in the course of the project to store and negotiate any relevant information, documentation, best practices and expert contacts. A simple content management system (CMS) or an online wiki engine will foster collaborative exchange of experience and updating project-relevant information over time. The online platform is set up by the technical project partners and the data is entered collectively. At the end of the project, a solution is found to ensure continued accessibility and/or operation.

Training and education of the user communities as well as the museum or library staff are further indispensable requirements to create lively knowledge transfers, to keep the knowledge up to date and to ensure the continuous operation of the SHIFT tools. Thus, training and education will be provided during the course of the project. For this purpose, the technical possibilities of the project's collaboration platform will be used, as well as the partners' internal social media or collaboration tools. All processes and procedures of the project will be documented in writing to ensure that important knowledge is not lost when staff leave.

Of great importance for the motivation of users and a culture of appreciation are reliable feedback mechanisms that make it possible to suggest improvements for knowledge management in the project and beyond. Knowledge transfer and knowledge drain require continuous attention when it comes to preserving the value of intellectual and financial capital.

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6. CONCLUSIONS

The D1.2 SHIFT deployment lifespan roadmap, content aggregation and distribution process analysed various facets of the deployment lifespan of SHIFT tools within Cultural Heritage (CH) institutions. The research began by outlining the scope, objectives, and structure of the report, emphasising the need for greater accessibility and inclusion in the CH sector.

The analysis delved into the general challenge of implementing new techniques and technologies in the CH sector, advocating for agile deployment and design thinking practices. The SAFe Scaled Agile Framework emerged as a viable approach to address the evolving landscape of CH deployment. Subsequently, factors affecting the deployment lifespan were categorised and thoroughly explored, including hardware considerations for both front-end user clients and backend layers, software implications, data management, and the critical aspect of knowledge transfer within CH institutions.

The report also provides an insightful overview of specific SHIFT pilots and use case studies, shedding light on the deployment lifespan of existing technical environments and the integration of SHIFT solutions in different contexts. The SPK-SMB, SOM, BNM, and ANBPR pilots were meticulously evaluated, providing valuable insights into the sustainability and longevity of SHIFT components within these unique frameworks.

The report then proposed comprehensive solutions to improve the sustainability and extend the lifespan of individual SHIFT components. These solutions included strategic considerations relating to hardware, back-end infrastructure, software, data management, and knowledge transfer practices. Emphasising mechanical stability, energy efficiency, security, and staff training, among other aspects, the suggested solutions aimed to optimise the operational efficiency and longevity of the SHIFT tools.

In essence, this report serves as a foundational guide for ensuring the lasting impact and effective deployment of SHIFT tools in the realm of Cultural Heritage institutions through strategic insights and actionable recommendations.

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