ISSN: 2623 - 4629

Journal
of Integrated Information
& Management

e-Journal

ΠΑΝΕΠΙΣΤΗΜΙΟ ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ · UNIVERSITY OF WEST ATTICA

Volume 9 - Number 1: Special Issue / Jan - Jun 2024
https://ejournals.epublishing.ekt.gr/index.php/jiim

Digital Cultural Heritage Management for Local Heritage

Mariana Ziku, Alexandros Teneketzis, Georgios Alexandridis, Yannis Christodoulou, Markos Konstantakis, Athanasios Drosopoulos, Elias Dritsas, Georgios Siolas, Konstantinos Paximadis, Fevronia Rousaki, George Caridakis

To cite this article:

Digital Cultural Heritage Management for Local Heritage: Overcoming Barriers to Accessibility with Regional Digital Infrastructures

Mariana Ziku, Alexandros Teneketzis, Georgios Alexandridis, Yannis Christodoulou, Markos Konstantakis, Athanasios Drosopoulos, Elias Dritsas, Georgios Siolas, Konstantinos Paximadis, Fevronia Rousaki, George Caridakis

University of the Aegean, Department of Cultural Technology and Communication, Greece

mziku@aegean.gr [**ORCID**: 0000-0001-9139-6722], ateneketzis@aegean.gr [**ORCID**: 0000-0002-9550-5858], gealexandri@aegean.gr [**ORCID**: 0000-0002-3611-8292], yannischris@aegean.gr [**ORCID**: 0000-0002-1627-6760], mkonstadakis@aegean.gr [**ORCID**: 0000-0003-0656-693X], ndroso@image.ntua.gr, edritsas@ceid.upatras.gr [**ORCID**: 0000-0001-5647-2929], gsiolas@mail.ntua.gr [**ORCID**: 0000-0002-4839-7831], kpaximadis@gmail.com, f.rousaki@aegean.gr, gcari@aegean.gr [**ORCID**: 0000-0001-9884-935X]

Abstract:

Purpose - *Digital transformation is often hindered for cultural heritage institutions operating in rural areas, due to factors including lack of digital literacy and/or digital readiness, limited capacity, underfunding and remoteness. The typology of these institutions varies, involving e.g. community-run folklore museums, cultural sites maintained by local associations, permanent thematic collections founded by collectors in their place of origin and enterprise initiatives showcasing historical information of local goods production within gallery settings. Due to their special traits and underlying factors, cultural heritage institutions operating in the periphery may remain outside the reach of central heritage infrastructures, such as aggregators of digital heritage content, and may fail to benefit from digital strategies and services.*

The paper describes the development of the "AegeanA" digital infrastructure for cultural heritage management in the region of the North Aegean, Greece, with the objective of overcoming those barriers by connecting with cultural heritage institutions across the region and supporting the wider sharing of their collections in open-access and semantically enriched ways. AegeanA is a digital repository and collection system for cultural heritage operating at the regional level, offering a single point of access for larger volumes of digital cultural heritage content previously dispersed in remote, offline or outdated databases.

The paper discusses key concepts related to the project on digitisation, innovation and sustainability in the cultural heritage field, highlighting the impact of regional development. Next, the framework and methodology of the digital infrastructure development is presented, and results are discussed in the context of user analysis, protocols of collaboration and technical infrastructure development. It particularly focuses on the backend development for achieving interoperability between the open-source system of AegeanA and the aggregator of digital heritage content of the National Documentation Centre in Greece. The paper further discusses the challenges and benefits of the project, in the context of digital heritage management and regional development

Design/methodology/approach - *Design and implementation of an open-source collection management system in the context of regional development. Focus is given on the components of user analysis and the development of the technological framework, especially in achieving interoperability with larger national and European digital heritage infrastructures. In addition, protocols of collaboration are established between the regionally operating institutions and the University of the Aegean.*

Findings - *i) Challenges in reaching out to the majority of the targeted institutions: Registration of 54 cultural institutions operating currently in the Region of the North Aegean, out of which 17 at least with digital heritage collections/artefacts, interested to take part in the project. A survey targeting regional institutions yielded 6 replies, containing insights on qualitative and quantitative data, including needs and challenges.*

ii) Specific user needs identification and technical development attuned to interoperability: A range of requirements related to access, functionality, usability, and support were identified, reflecting the diverse needs of regional institutions. Technical components include the configuration and customisation of the open-source collection management system selected for developing the digital infrastructure, especially in achieving interoperability with the national cultural aggregator with the implementation of the OAI-PMH and resolution of technical issues.

Originality/value - *The research addresses a significant gap in the digital transformation of cultural heritage institutions at the regional development level. The implementation of the digital infrastructure serves as a pragmatic solution for collecting, documenting and connecting otherwise non-accessible cultural collections and artefacts. The paper provides also insights for achieving interoperability between the open-source collection management system and the national aggregator of digital heritage content of the National Documentation Centre in Greece.*

Index Terms — digital cultural heritage management, regional development, digital infrastructures, barriers.

I. INTRODUCTION

Cultural heritage collections remain inaccessible by digital means to a substantial extent, despite the efforts for digital

transformation. While significant progress has been made, it is estimated that the vast majority of cultural heritage, estimated over 80%, hasn't been digitised yet **[1]**, **[2]**, **[3]**.

However, critical dimensions regarding the type of measurements on digital heritage are currently debated. The central question, as to whether the total percentage of digitised collections reflect the actual impact of digital heritage, is prompting for new directions. The need for more holistic indicators of impact and digital transformation has been recently stated **[4]**. Future impact measurements may thus bring forward more mindful digitisation processes based less on acquiring quantity and more on achieving sustainability, reuse, ethics and participation. The European Digital Cultural Policy, established in 2012 as a European Commission recommendation and benchmark on the digitisation, online accessibility, and digital preservation of cultural material, aims to enhance the availability of digital cultural heritage content. Among its goals are optimising the use of digitisation capacity and achieving economies of scale. **[5]**.

Based on a Consolidated Progress Report on the implementation of the 2011 Commission Recommendation **[6]**, the high-level overview of the planning and monitoring of digitisation progress among the member states, is provided through digitisation schemes at the national, regional and sectoral level. Reports from the regional level are thus contributing at large to the assessment of digital policies and strategies and their level of implementation. However, digitisation plans at the national level in the vast majority of the member states are not complemented by specifically tailored ones at the regional level, except in the cases of Belgium, Germany and Spain. A tailored digitisation plan addressing specific needs in regions, may be more useful in these countries due to their national structure (e.g., the federal states in Germany "Länder" with significant autonomy in areas such as culture).

In the European and national policy contexts, innovation is consistently addressed as a fundamental driver of economic growth and social progress. However, the focus on innovation in national policies without supporting organisational change or skill development may lead to slower growth of digital collection publications **[7]**. On the one hand, the capacity for innovation in cultural heritage institutions and other collection management organisations can be assessed from baseline indicators such as the digitisation and online publication of their heritage collections **[8]**. This can be seen as an initial sign of an organization's capacity to innovate in developing fresh heritage information services, broadening audience engagement, or generating added value for their collections. On the other hand, as innovation in this context often depends on technical expertise, i.e., technical innovation, this comes at a high cost, high risk and larger, established and sustainable funded institutions are recognised to have a higher ability to innovate. The New European Agenda for Culture published in 2018, reinforced the direction for digital

heritage as one of the major areas of cultural policy at the European level **[9]**. In doing so, the Commission particularly addresses the European Committee of the Regions, an advisory body representing locally and regionally interests. Furthermore, the New Agenda prompts a threefold focus on three ecosystems, one of which are cities and regions. Regional support and strategies are especially highlighted in the cultural heritage field, underlining their capacity for culture-led development, social and economic innovation.

Moreover, sustainability is considered a critical indicator for assessing development in digital cultural heritage management, while the use of ICT in cultural heritage has been noted as a driver of sustainable development **[10]**. The need for reliable IT infrastructures and additional funding is highlighted, In order to promote sustainability in the cultural field **[11]**. In international initiatives such as the United Cities and Local Governments (UCLG), culture is placed as the fourth pillar of sustainable development, prompting regional governments to develop a solid cultural policy **[12]**. However, in the 2030 Agenda for Sustainable Development of the United Nations, culture and heritage has not succeeded to enter as a pillar. Nevertheless, under the Sustainable Development Goal No.11 "sustainable cities and communities", the Target 11.4 states: "Strengthen efforts to protect and safeguard the world's cultural and natural heritage". Cultural heritage is thus addressed as part of national and particularly local authority level for achieving global sustainability goals. In addition, sustainable development is increasingly being discussed in the context of Intangible Cultural Heritage (ICH). ICH is emerging as a driver and enabler of innovation and sustainable development. In particular, practical guidance for the implementation of sustainable development has been provided in the form of Operational Directives in the context of the UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage **[13]**. The chapter added in 2016 in the operational directives titled "Safeguarding Intangible Cultural Heritage and Sustainable Development at the National Level", spurs state parties to acknowledge safeguarding efforts in both urban and rural contexts, facilitating cooperation with relevant experts, culture brokers and mediators through a participatory approach **[14]**.

In the wider European landscape, several initiatives at national level are implemented for the management and preservation of cultural heritage documentation. Existing literature points out how digital cultural heritage management is being put forward at national level, focusing on diverse aspects and objectives. The necessity for standardisation and interoperability has been stressed in Serbia, towards the development of a national information system **[15]**. In Italy digitisation techniques and web infrastructures **[16]** have been analysed, towards the enhancement of universal access to cultural heritage with a focus on public historic archives, noting that fragmentation of available resources and missing of ICT undermine the

efforts. In addition, Guccio et al. note the importance of relevant data collection that provide metrics over the field, which is critical for developing effective policies and programmes based on pragmatic conditions. A study in Romania stresses the cultural strategies at national level, which align with the European digital agendas, however noting Romania as part of the cluster of low performing countries, based on the Digital Economy and Society Index (DESI) 2017. In addition, several issues are pinpointed, such as the risk of an excess of quantity over quality [17] and the hazards of underfunding that hinder capacity and cultural heritage sustainability, for which digitisation is an important driving force.

In Greece, the management and growth of digitisation efforts have been carried out through two main schemes in the past years, the Operational Programme "Digital Convergence" 2013-2017 National Programme for Digital Convergence 2012-2015 and the new Operational Programme Competitiveness, Entrepreneurship and Innovation 2014-2020 (EPAnEK) (European Commission, 2018). Notably, two Member States, Greece and Cyprus reported that no measures were adopted to allow preservation of web content, as of 2018. Currently, the vision of a digital transformation plan in Greece has been analyzed in the Digital Transformation Bible 2020-2025 (Ministry of Digital Governance, 2021), which includes the cultural sector as one of the 17 pillars of digital transformation in the Greek economy. Among the six general objectives of digital transformation for culture are the improvement of quality, interoperability, and access to data, the utilization of digital cultural content as open data, as well as the reinforcement of digitization of cultural entities for consistent implementation of generally accepted international standards and best practices for digitisation and documentation of content. (ibid., 297-305). At regional level, strategic planning for the Cultural and Sports Sector focuses on Priority Axis 1: the development of technologies and methods for conserving artworks from archives and collections of artistic and cultural heritage.

II.   AEGEANA DIGITAL INFRASTRUCTURE

A.   Framework

The paper presents the development of a digital heritage infrastructure and project with educational components for the management of cultural heritage and for capacity building in the field, in the Region of the North Aegean, Greece. The project is part of the programme "Interregional Digital Transformation of the Aegean Archipelago in Culture and Tourism (e-Aegean CulTour)", supporting the Regional Excellence of the Operational Program "Competitiveness, Entrepreneurship and Innovation" of ESPA 2014-2020, funded by the European Regional Development Fund (ERDF) and national resources. Within this context, 10 research teams with the participation and collaboration of 14 laboratories from 9 different Departments of the University of the Aegean on the islands of Lesvos, Chios, and Syros,

worked on more than 10 large-scale projects.

The programme with a three-year implementation horizon (2020-2023) presented multiple benefits for the North Aegean Region, for institutions and industries active in the field of culture, as well as for citizens or visitors, through the collection, documentation, intelligent management and promotion of digitised cultural content. The programme was included in the list of "Good Practices - Success Stories in the Exploitation of Operational Program Resources". It actively contributed to achieving specific goals of the Smart Specialization Strategies of the Aegean Regions, which include: a) the protection and promotion of cultural heritage and identity through innovative applications, b) the development of skills to support the tourism and cultural products of the regions, c) sustainable development through the integration of academic research with the needs of local communities. The e-Aegean CulTour aimed at supporting authorities in fulfilling their strategic objectives for regional innovation, entrepreneurship, employment, and human resource skills acquisition in all priority areas of the Smart Specialization Strategies for 2014-2020, as well as through solid planning within the framework of 2021-2027: through Entrepreneurial Discovery Actions in the fields of Tourism, Culture, and Creative Industries, of the two regions of the Aegean Archipelago and their direct connection with the research laboratories of the University of the Aegean for collaborative efforts.

The actions of the project were articulated around the axis of services, structures, and networks of cultural communication and interculturality, as well as the creation of a digital mechanism for collecting cultural content. The action "AegeanA-Digital Heritage Management Centre", within the "e-Aegean CulTour", has been developed by the Intelligent Interaction Research Group, Dept. of Cultural Technology and Communication, University of the Aegean. The action aims to develop a digital infrastructure for the collection, harmonisation, documentation, and disposal of the tangible and intangible cultural heritage of the North Aegean Region, operating in connection with SearchCulture.gr, and the Greek national aggregator for digital cultural content of the National Documentation Centre and with Europeana, the European web portal for digitised cultural heritage. AegeanA aimed to support the collection of cultural resources that are scattered in remote, offline or non-interconnected databases, with the objective to offer interoperability services for digitised cultural resources and "smart" management through semantic web technologies to collaborating institutions of the North Aegean related to the cultural, environmental or tourism promotion of the region. The action also provides expertise and training for the development of ICT skills to participating local cultural institutions and individual users through the release of Open Educational Resources (OER) in the field of digital heritage management. The action aims to cover the life cycle of digital cultural data management, from collection, validation and semantic enrichment to primary

disposal and preservation of digital cultural resources.

B. Methodology

The project is based on a research and development framework, including a twofold approach, a technical development and a policy-supportive approach.

First, a user analysis report was conducted for the identification of relevant user groups and target audience. This followed a classification of how to design for and evaluate Cultural User Experience (CUX), on the basis of UX evaluation methods in cultural technology **[18]**. The requirements specification methodology formed included the steps for user needs identification, further breaking down prioritisation of user requirements. Focus group findings were recorded through usage scenarios with the digital infrastructure. Lastly, identification of evaluation indicators was performed.

Next, the methodology included the formulation and agreement of collaboration protocols, between the higher education institution (i.e., University of the Aegean) and the collaborating cultural institutions in the Region of the North Aegean. First, a survey for data collection was designed and published, aimed at regional institutions interested to participate. A draft template of collaboration agreement in the form of a Memorandum of Understanding was set, addressing key passages of the agreement such as on intellectual property rights and on protection of personal data. Communication with the National Documentation Centre was established in this phase stipulating the field of action and the signing of the agreements with stakeholders.

Next step included the technical infrastructure development, with backend components and the development of interoperability between the digital infrastructure and the national aggregator of digital heritage content of the National Documentation Centre in Greece. The objective was to develop a data collection and storing mechanism so that its functionality aligns with similar content collection mechanisms, enabling the coverage of the entire content aggregation lifecycle, from harvesting, validation, and semantic enrichment, to central distribution and secure preservation of digital resources.

C. Results

C1. User Analysis

The user groups of the system were presented, followed by the methodology employed to determine the system requirements, addressing both its theoretical background and its application within the project framework. Furthermore, the analysis findings were presented, including descriptions of existing workflows targeted for enhancement by the system, responses to the analysis queries, and specific usage scenarios for the system's core functionalities. Finally, the system evaluation metrics were introduced.

The classification of user groups within the AegeanA system is based on distinct categories. In total, six user groups were analysed within the AegeanA system. These include administrators, who have full access and editing rights, as well as internal end-users, who also possess comprehensive access and editing capabilities. Additionally, there are users with restricted access and editing permissions, catering to specific roles or functionalities within the system. External end-users constitute another group, comprising individuals who access the system's services from outside the organisation. Furthermore, there are non-registered users who interact with the system without creating an account, as well as registered users who have created accounts to access personalised features.

In the process of determining system requirements, two main categories are identified: functional and non-functional requirements. Functional requirements delineate the system's interaction with its environment in detail, while non-functional requirements specify the system's specifications, essentially framing the functional requirements. These non-functional requirements are crucial as they impose constraints on the choices available to designers during the design and implementation stages. Non-functional requirements are further analyzed into specific categories, with key areas including security, performance, reliability, usability, and support. The foundation for applying different user requirement analysis methods lies in a straightforward process encompassing four fundamental stages: information gathering, user needs identification, envisioning and evaluation, and requirements specification. Key methods for determining final requirements include task/function mapping, requirements categorization, prioritization of user requirements, and criteria setting. These methodologies provide a structured approach to comprehensively identify and prioritize user needs, ensuring the successful development and implementation of the system.

For identifying user needs, the methodology of Focus Groups and questionnaires was considered an efficient approach for this particular case. Within this framework, necessary data regarding the different user types identified were collected, and subsequently, user needs were recognised.

The focus groups served as a method for collecting opinions and experiences. Each group typically consisted of five to twelve participants, while the discussion was guided and facilitated by a moderator. In addition, questionnaires were used which consisted of predefined questions provided to the participants, who then recorded their answers or marked a subjective satisfaction rating for certain system parameters. Based on the discussions held during the focus group and the information provided in the questionnaire, the fundamental user requirements were identified for both the collection of cultural assets and the presentation of content through the AegeanA system.

Detailed use-case scenarios of the AegeanA digital repository were recorded based on the major functionalities of the system as identified during the focus group meetings.

Performance metrics of the system were categorized into three categories i) performance metrics measuring the performance (response time, availability, etc.) of the AegeanA system, ii) support metrics measuring how effectively the workflow of collecting cultural assets is supported by the AegeanA system, and iii) engagement metrics measuring the level of user engagement.

C2. Protocols of Collaboration

The collaboration with cultural institutions in the Region of the North Aegean was one of the main objectives of the research project. The development of digital infrastructures for the digital management of local cultural heritage was pursued, acknowledging the prominent role of regional institutions in maintaining and preserving historical evidence, technological knowledge, resources, practices, and communities. The protocols of collaboration aimed to establish a reliable foundation for cooperation between academic institutions (e.g., research laboratories, working groups) and cultural, tourism, or environmental organisations involved in the study and promotion within the region.

A desktop-based survey was conducted to identify cultural institutions in the North Aegean Region. The selection criteria for these institutions in the region were based on their cultural, touristic, or environmental involvement in the promotion of the region, encompassing from museums and art galleries to cultural centres and multipurpose venues. The survey yielded 54 cultural institutions operating in the region. The typology of these institutions encompasses a variety of categories, including archaeological museums, municipal museums, digital museums, cultural centers, ethnographic museums, visitable monuments, art galleries, Byzantine museums, exhibition centers, and natural history museums. The most prominent categories with the most occurrence are arhaeological museums, ethnographic museums and municipal museums.

To approach these institutions, a web questionnaire with 31 fields was created to record the institutions and their characteristics, in order to capture a better picture of the potential participation of the institutions. A series of telephone calls were made for initial briefing of the institutions and to clarify if they have digital/digitised collections, in order to establish a general understanding of their potential participation. Some institutions did not possess digitised collections, and communication with certain institutions was not feasible as their contact information could not be found or there was no response. The majority of the institutions responded positively regarding participation and integration of their collections in the digital infrastructure, and expressed interest in the educational materials. Subsequently, emails containing relevant information and credible links for the programme were sent out. The questionnaire remained open for three months and was filled in by only six institutions. Based on the information gathered, 5 out of 6 organisations don't operate

a collection management system and none is interconnnected with the national cultural aggregator or Europeana. 4 out of 6 didn't have professional digitisation of their collections but still have photographs of average quality of many artefacts. 2 out of 6 institutions don't have any personnel and rely on volunteering and support from other institutions, including schools and municipal personnel. Others have personnel on an irregular and short-term basis, depending on national employment programmes.

A document in the form of a Memorandum of Understanding (MoU) was sent to institutions that expressed interest and possess digital/digitised assets. The collaboration protocols aimed to establish a reliable basis for cooperation between academic infrastructures (e.g., research laboratories, working groups) and cultural institutions within the region. The purpose of establishing collaboration protocols between the University of the Aegean and local cultural institutions within the framework of the AegeanA project was to formalise a cooperative agreement for the benefit of the local stakeholders, in connection with broader national and European cultural infrastructures, to make local cultural content more accessible. The collaboration protocols aimed to establish new networks among the regional institutions and the university that can remain active even after the conclusion of the initiative.

C3. Technical Infrastructure Development

The AegeanA platform is developed as a repository for digital cultural heritage based on a system for collecting, documenting, and publishing collections from multiple institutions. The selection of suitable software was evaluated against 20 criteria from among 70 different software options. Positive responses were noted in areas of open-source nature and overall openness, support for public access through a web portal, availability of APIs, IIIF compatibility, and user-assigned tasks. Data analysis partially relied on Ashley Blewer's "Management System Collection" spreadsheet. With reference to this spreadsheet, the Omeka software received positive evaluation, leading to the decision to install Omeka-S, the latest version supporting linked data and enhanced usability.

By analysing the user requirements for the software of the infrastructure, the development and configuration of the collection management system began as part of the AegeanA's Backend system deliverable. Omeka software was positively evaluated based on the table and selected for installation, specifically the new version Omeka-S, which supports linked data and offers enhanced usability. User roles (global administrator, supervisor) were added for the software's operation. Subsequently, a metadata template was created based on the specifications of the National Documentation Centre (EKT), validated by EKT for field accuracy, and a digital resource template was developed with selected metadata fields, successfully applied as a template. Additionally, structured vocabularies were

installed and utilized to enrich metadata fields, allowing terms from the lexicon to appear in a drop-down menu during data entry. Successful testing was conducted for displaying structured vocabulary terms during data entry. Functionality was further enhanced through the installation of add-ons, and integration with EKT was achieved through the installation of the additional module for initiating the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). The protocol allowed the automated system of EKT to access and collect Aegeana's metadata records from its repository in a standardized format, facilitating interoperability between the systems and services.

The Omeka S software was selected for its features, capabilities, and performance in the context of managing digital cultural heritage for the development of the AegeanA digital infrastructure. Specifically, Omeka S supports the aforementioned evaluation criteria with additional support for Semantic Web and RDF triple-store standards and vocabularies. The Omeka S database is developed in MySql, and the programming language used is PHP. Furthermore, for small to medium-sized institutions with limited technical expertise, characteristics related to potential collaborating institutions, Omeka S is a good choice due to its user-friendliness compared to more specialized systems requiring greater technical knowledge, such as Arches.

Omeka S provides an application programming interface (API) that allows CRUD operations (create, read, update, and delete). The integration of the backend of the AegeanA digital repository with SearchCulture.gr was achieved through collaboration with the Department of Electronic Infrastructure and Information Systems of the National Documentation Center (EKT). The integration involved resolving technical issues and adapting system compatibility in two directions: i) Dynamic retrieval of EKT vocabulary (in JSON-LD format via a corresponding endpoint), and ii) Provision of metadata via OAI-PMH (supporting Dublin Core and EDM schema). Tests with the query of the "ekt-item-types" vocabulary in Omeka-S initially did not work as expected. The issue was identified in Omeka-S's capability to search only key values and not nested ones, while EKT has a nested structure and not a flat one. Following the communication between the research team and EKT, a new notation of json-ld generated by the library was defined by the Electronic Services Unit, which aligns with the capabilities of Omeka S. The use of the vocabulary became feasible, and the search now returns results in a drop-down menu format within the metadata field utilized, specifically applied to the "Type" field of the template.

The Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) is a mechanism for collecting documents containing metadata from content dissemination infrastructures (e.g., repositories, digital libraries). OAI-PMH enables data providers to make metadata available to harvesters based on open standards such as HTTP and XML. To disseminate AegeanA's metadata to the EKT, the OAI-PMH Harvester module (plugin) was installed with the OAI-PMH URL. The retrieval of metadata was successful, with the only requirement being the adaptation of the Dublin Core "identifier" field.

After the EKT retrieves metadata from AegeanA via OAI-PMH, the API call of Omeka S for items presents an issue with the first URI of the dc:identifier field. Instead of leading to the document presentation page, it directs to an API call of Omeka S for that specific item. To ensure the correct retrieval of metadata from the EKT, the URI of the dc:identifier needs to redirect users of searchculture to the document pages. For resolving this issue, an additional field dc:identifier was added, returning the document presentation page.

III. DISCUSSION

In the context of managing local cultural heritage, particularly within regional settings, institutions often face significant challenges in responding to innovation and sustainability planning. These obstacles are compounded by limited resources and expertise, making it difficult for regional institutions to effectively preserve and promote cultural heritage. However, the study aimed to provide a paradigm of digital infrastructure implementation that functions as a crucial mediator in overcoming these barriers. By providing the digital components for collecting, storage, and dissemination of digital cultural artefacts and resources, the digital infrastructure enabled regional institutions to enhance accessibility and visibility of local heritage. Despite the potential benefits, communication and collaboration with these institutions proved to be challenging. Many lack the necessary personnel and expertise to fully leverage digital tools and platforms. Moreover, some institutions are driven by passionate individuals dedicated to supporting local cultural heritage, yet they often grapple with a lack of knowledge and skills in digital heritage management. Overcoming these barriers requires concerted efforts to provide training, technical assistance, and capacity-building initiatives tailored to the needs of regional institutions. In this context, provided services of the digital repository and related tools were accompanied by training and digital skills development activities. After all, the goal was not solely the development of infrastructure but primarily raising the awareness of the possibilities they offer, their implementation, and their future, continuous utilisation by the community for which they are intended. A fundamental component of the project involves developing digital educational materials in the form of Open Educational Resources (OER) and organising training workshops. These workshops aimed to enhance users' proficiency in utilising the digital infrastructure, for tasks like data search, retrieval, documentation and presentation. The objective is to familiarize participants with these tools and facilitate discussions on their practical applications. Additionally, webinars were conducted to provide insights into the evolving technologies and methodologies employed in the programme. These webinars served to disseminate

knowledge and foster a deeper understanding of the project's advancements.

In addition, by partnering with the Aegeana infrastructure and project, the National Documentation Centre facilitated the establishment of interoperability and a robust backend system for the open-access digital repository. This collaboration ensured seamless integration of the regional digital infrastructure with broader national and international networks, enhancing the visibility and accessibility of local cultural heritage resources. The National Documentation Centre's expertise and resources bolstered the technical capabilities of the project, enabling the implementation of standardized protocols and best practices in digital heritage management. Overall, the collaborative efforts between the project and the National Documentation Centre underscored the significance of cross-institutional partnerships in advancing digital cultural heritage management initiatives and overcoming technological barriers for the benefit of regional communities and broader audiences alike.

AegeanA collected cultural content in the Region of North Aegean, operating in full compliance with the national cultural aggregator SearchCulture.gr of the National Documentation Centre and through it with the European portal of cultural content Europeana. The project will develop a digital repository for the collection, organization and promotion of cultural heritage artefacts, by providing relevant services to the cultural institutions in North Aegean, as well as to other institutions of the Region related to the cultural, environmental, pedagogical development and touristic visibility of the area.

The AegeanA project aimed to offer a technological infrastructure to cultural institutions, supporting regional development in fulfilling their strategic objectives for regional innovation in the field of cultural heritage. The strengthening of the outreach of cultural institutions and enterprises operating in the field of culture, extended to the national and European levels, as the services provided by the digital infrastructure allowed interconnection with platforms. Although the majority of the cultural institutions expressed an interest in integrating their collections into the digital infrastructure, the process of formalising the Memorandum of Understanding (MoU) and commencing collaborative efforts is progressing at a slower pace than anticipated. Numerous regional cultural institutions rely on the voluntary contributions of individuals or associations dedicated to advancing local heritage, albeit often possessing limited digital literacy.

In addition, AegeanA was also envisioned as an online point of open access to the general public with enriched cultural content focusing on the geographical area of the Aegean. The project aimed to provide know-how to cultural professionals and museum personnel, related to digital cultural heritage management, as well as to make available upgraded resources and information of open cultural content to the general public.

The project supported a series of actions with four main directions: i) networking, by developing a credible and sustainable network of communication and cooperation of the involved bodies, ii) training, conducting workshops, seminars and webinars in the field of digital cultural heritage management and for the practical presentation of the Aegeana digital infrastructure, iii) technical development, of the digital infrastructure hosting and documenting regional collections that were previously inaccessible and iv) Policies and guidelines: Implementing good practices and policies for the management of cultural heritage data. Towards these directions, recommendations for future work may include actions for sustaining and broadening the collaboration network between the university and local institutions, finding efficient ways to mitigate the barriers of the under-functioning institutions and the digital literacy gaps among its associates. Improving the openness of the participating agencies, thereby fostering broader accessibility to local cultural heritage.

In addition, provision to release the OERs developed within the project and maintaining updates for the open-source software to ensure the current, long-term and optimal functionality of the digital infrastructure.

In terms of innovation and impact, the development of a regional digital infrastructure for collecting, documenting, and enhancing the interoperability of fragmented or previously inaccessible local heritage collections was executed as a pragmatic solution toward fostering regional development in the field of digital transformation. In addition, the technical development of the interoperability framework between the AegeanA digital infrastructure and the National Documentation Centre (and through it with Europeana), provided the first testing and implementation of the OAI-PMH between the open-source Omeka S software and the national aggregator of digital cultural content searchculture.gr.

IV.   REFERENCES

[1] **European Commission**, Directorate-General for Research and Innovation, Brunet, P., De Luca, L., Hyvönen, E. et al., Report on a European collaborative cloud for cultural heritage – Ex – ante impact assessment, Publications Office of the European Union, 2022. https://data.europa.eu/doi/10.2777/64014

[2] **G.J. Nauta, W. van den Heuvel, and S. Teunisse**, "D4.4 report on ENUMERATE core survey 4. Europeana DSI 2 – Access to Digital Resources of European Heritage," Europeana, 2017. https://pro.europeana.eu/files/Europeana_Professional/Projects/Project_list/ENUMERATE/deliverables/DSI-2_Deliverable%20D4.4_Europeana_Report%20on%20ENUMERATE%20Core%20Survey%204.pdf

[3] **Toma Tasovac, Sally Chambers, Erzsébet Tóth-Czifra**. Cultural Heritage Data from a Humanities Research Perspective: A DARIAH Position Paper. 2020. https://hal.science/hal-02961317

[4] **F. Mowat and N. McNeilly**, "Report from the Czech Presidency Europeana conference," Europeana, March 15, 2023. [Online]. Available: https://pro.europeana.eu/post/report-from-the-czech-presidency-europeana-conference

[5] Commission Recommendation on the digitisation and online accessibility of cultural material and digital preservation. 2011. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32011H0711

[6] Implementation of Commission Recommendation on the Digitisation and Online Accessibility of Cultural Material and Digital Preservation Consolidated Progress Report 2015-2017. 2018. https://www.digitalmeetsculture.net/wp-content/uploads/2019/06/ReportonCulturalHeritageDigitisationOnlineAccessibilityandDigitalPreservation.pdf

[7] **Trilce Navarrete**. Becoming Digital: A Dutch Heritage Perspective. Journal of Arts and Management, volume 44, issue 3 , p. 153 - 168. 2014.

[8] **K. Borowiecki and T. Navarrete**, "Digitization of heritage collections as indicator of innovation", SSRN Electronic Journal, 2015. https://doi.org/10.2139/ssrn.2654167

[9] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. 2018. https://www.cultureinexternalrelations.eu/wp-content/uploads/2018/06/commission_communication_-_a_new_european_agenda_for_culture_2018.pdf

[10] **E. Macrì and C. L. Cristofaro**, "The Digitalisation of Cultural Heritage for Sustainable Development: The Impact of Europeana," in Cultural Initiatives for Sustainable Development, P. Demartini, L. Marchegiani, M. Marchiori, and G. Schiuma, Eds. Springer, Cham, 2021. https://doi.org/10.1007/978-3-030-65687-4_17

[11] **U. Preuß**, "Sustainable digitalization of cultural heritage—report on initiatives and projects in brandenburg, germany", Sustainability, vol. 8, no. 9, p. 891, 2016. https://doi.org/10.3390/su8090891

[12] **United Cities and Local Governments**. Culture: Fourth Pillar of Sustainable Development. 2010. Available online: http://www.agenda21culture.net/sites/default/files/files/documents/en/zz_culture4pillarsd_eng.pdf

[13] **UNESCO**, "Convention for the Safeguarding of Intangible Cultural Heritage," Paris, France, 2003. https://ich.unesco.org/doc/src/2003_Convention_Basic_Texts-_2022_version-EN_.pdf

[14] **UNESCO**, "Operational Directives for the Implementation of the Convention for the Safeguarding of the Intangible Cultural Heritage," Chapter VI, 170. 2016. https://ich.unesco.org/doc/src/ICH-Operational_Directives-6.GA-PDF-EN.pdf

[15] **Z. Ognjanović, B. Marinković, M. Šegan-Radonjić, & D. Masliković**, "Cultural heritage digitization in serbia: standards, policies, and case studies", Sustainability, vol. 11, no. 14, p. 3788, 2019. https://doi.org/10.3390/su11143788

[16] **C. Guccio, M. Martorana, I. Mazza, & I. Rizzo**, "Technology and public access to cultural heritage: the italian experience on ict for public historical archives", Cultural Heritage in a Changing World, p. 55-75, 2016. https://doi.org/10.1007/978-3-319-29544-2_4

[17] **Fanea-Ivanovici, M.**, "Culture as a Prerequisite for Sustainable Development. An Investigation into the Process of Cultural Content Digitisation in Romania," Sustainability, vol. 10, no. 6, p. 1859, 2018. Available: https://doi.org/10.3390/su10061859

[18] **Markos Konstantakis and George Caridakis**, "Adding Culture to UX: UX Research Methodologies and Applications in Cultural Heritage," *J. Comput. Cult. Herit.*, vol. 13, no. 1, Article 4, pp. 17, February 2020. Available: https://doi.org/10.1145/3354002

V. AUTHORS

Mariana Ziku, Researcher in the e-Aegean CulTour project, is a PhD candidate at the Intelligent Interaction Research Group, Dept. of Cultural Technology and Communication, University of the Aegean. She is also staff member of the Master's Programme Folk/Popular Culture and Modern Cultural Heritage at the Hellenic Open University. Her research is in Digital Cultural Heritage/Cultural Informatics, particularly in the field of Intangible Cultural Heritage (ICH) and Traditional Cultural Expressions (TCE). She holds a BA in Art Sciences, an MA in Theory/History of Art and Curation (University of Ioannina, Greece), and an MSc in Digital Humanities (KU Leuven, Belgium).

Alexandros Teneketzis, Researcher on the project, is Assistant Professor of Art History at the Department of History and Archaeology, University of Patras, Greece. He also teaches Public History at the Hellenic Open University as an Adjunct Lecturer. He has published widely on public art and memory, the history of digital art and the history of museums.

Georgios Alexandridis received the M.S.E.E. degree from the Department of Electrical and Computer Engineering, University of Patras, Greece, in 2005 and the Ph.D. degree from the School of Electrical and Computer Engineering (ECE), National Technical University of Athens (NTUA), Greece, in 2015. From 2018 to 2023, he was Laboratory Teaching Staff at the Artificial Intelligence & Learning Systems Laboratory of ECE, NTUA. Since 2023, he has been an Assistant Professor with the Department of Digital Industry Technologies, School of Science, National & Kapodistrian University of Athens, Greece. He is the author of one book chapter, more than 20 journal articles and more than 35 conference articles. His research interests include natural language processing, the development of large language models for tasks such as sentiment analysis, as well as the application of deep learning techniques on a wide range of domains, such as video and image processing.

Dr. Yannis Christodoulou holds a PhD from the National Technical University of Athens (School of Electrical & Computer Engineering) in Knowledge Representation and Web Ontologies, an M.Sc. in Advanced Computing – Global Computing & Multimedia from the University of Bristol, and a B.Sc. in Informatics from Athens University of Economics & Business. His research interests and experience lie within the fields of Knowledge Representation, Web Ontologies and Conceptual Modeling. Furthermore, he has studied and proposed methods of visual knowledge representation (semantic visualization, visual languages, interactive visualization, geo-visualization), as well as knowledge acquisition methods. In the context of his research he has followed a deeply interdisciplinary Digital Humanities approach by studying various knowledge domains, all falling into the Humanities and Social Sciences, such as Filmmaking, Dance, Cultural Heritage and Human Geography. He has worked as a researcher in several funded research projects –among them three European (FP7, H2020) and one British (ESRC)– where he has conducted deep interdisciplinary research focusing on conceptual analysis and modeling, ontology engineering and semantic visualization.

Markos Konstantakis serves as an Adjunct Lecturer and as a Postdoctoral Researcher at the Department of Cultural Technology and Communication, University of the Aegean, where he is a member of the Intelligent Interaction research group (ii.aegean.gr) and the I-Lab Intelligent Systems laboratory, active in the research fields of Intelligent Systems, Human Computer Interaction, and Digital Management of Cultural Heritage. He received a Ph.D. in the same department, entitled: "Augmented Cultural User Experience (ACUX)" and a master's degree in "Specialization in Information Systems, Networks, and Telecommunications" from the Faculty of Sciences and Technology of the Hellenic Open University (HOU). Markos completed a degree and a master's degree as a Marine Mechanical Engineer at the National Technical University of Athens (NTUA). His research on various aspects of intelligent human computer interaction and cultural informatics has been published in more than 25 journal articles and more than 20 papers in conferences and workshops and has been well recognized by the scientific community by being cited more than 380 times with an h-index of 13. He has participated in more than 10 research projects during the past 15 years at the Regional, National and European level as a Researcher and Academic Fellow.

Athanasios Drosopoulos received the degree in Computer Science from the University of Ioannina, Greece in 1998, and the PhD in the field of computer vision from the Elec. & Comp. Eng. school of the National Technical University of Athens (NTUA) in 2005. He has worked as a senior researcher, software engineer and project manager for NTUA, in more than 20 Greek and EC projects in the fields of neural networks & machine learning, emotion analysis & human-computer interaction, knowledge technologies and digital archives. He is currently involved in research activities and projects concerning metadata modelling and aggregation, interoperability and access to digital cultural heritage content and, semantic web technologies.

Elias Dritsas received his Diploma, M.Sc and PhD degrees in Computer Science and Informatics from the Department of Computer Engineering and Informatics, University of Patras, Greece. Also, he received his MBA from the University of Derby, United Kingdom. His research interests focus on AI and Machine Learning, Big Data, Databases, Data Mining, Human-Computer Interaction, Cloud Computing, Security and Trust. He is the author and co-author of publications in the area of Machine Learning and Data Analysis. He participated in many development projects funded by the EC and the Greek Secretariat of Research and Technology. He serves as a regular reviewer for several technical journals and conferences. He is a member of the Technical Chamber of Greece, Association for Computing Machinery, and IEEE.
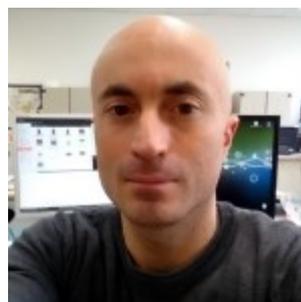
Georgios Siolas graduated from the School of Electrical and Computer Engineering of the National Technical University of Athens (NTUA) in 1998. In 1999 he obtained a Master's Degree in Cognitive Science at the Sorbonne Université Campus Pierre et Marie Curie in Paris, France. In 2003 he obtained his Ph.D. in Computer Science from the same university. Since 2007 Dr. Siolas has been a Senior Researcher at the Artificial Intelligence and Learning Systems Laboratory of the School of Electrical & Computer Engineering NTUA. He is the author

of one book, two book chapters, 18 journal articles and 40 conference articles. His research interests include: machine learning, text mining, information retrieval, recommender systems, social network analysis, semantic web technologies, computer vision, and design patterns.

Konstantinos Paximadis received the BSC from the Computer Engineering and Informatics Dept (CEID), University of Patras, Greece in 1989 and the PhD from the same department in 1998. He has served as a faculty adjunct member in University of Patras and Hellenic Open University for more than twenty years and has taughed more than twenty lessons and labs. He also directs a private company in Greece, specializing in computers and communications. His research interests include network planning and performance evaluation in optical networks and ML in computer networks. In his free time he likes to fly, he holds a JAR-PPL license and has over 350 hours on light single engine aircrafts.

Fevronia Rousaki is an experienced project manager specializing in e-learning and classroom-based educational programs. She is a Computer Science Teacher and has served as the Head of the Training Services Unit at the Institute of Entrepreneurship Development (iED). Fevronia holds an MSc in ICT Applications on Education and a Bachelor's Degree in Cultural Technology & Communication from the University of the Aegean, focusing on Educational Technology & Intercultural Communication.

George Caridakis is an Associate Professor at the University of the Aegean, coordinating the Intelligent Interaction research group, and affiliated with Athena RC and NTUA. His research spans Intelligent Systems and Human-Computer Interaction with applications in Creative and Cultural Heritage. He has over 130 publications and over 3,000 citations with an h-index of 27. He has taught and supervised students at various levels and served on numerous academic boards. Caridakis has participated in over 40 research projects and evaluated multiple European research frameworks, including Horizon 2020 and Horizon Europe. He is also the Chair of ACM SIGCHI Greek chapter and the National Council for Research, Technology, and Innovation in Tourism, Culture, and Creative Industries.