



# ICT and Digital Technologies. The New European Competence Centre for the Preservation and Conservation of Cultural Heritage

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**Abstract.** Europe’s cultural heritage sites are in danger, due to the increasing occurrence of disasters such as floods, earthquakes, and also because of man-made damage or the effects of climate change. In this framework, digital technology can help preserve the knowledge of threatened heritage artefacts, museums, monuments, documents and sites and make them accessible for citizens across Europe and for future generations.

In this direction, the European Commission has launched a call for the creation of a “Competence Centre” aimed at preserving cultural heritage through ICT technologies, as a transnational and interdisciplinary reference point. The project 4CH—*Competence Centre for the Conservation of Cultural Heritage* aims to design and define the overall architecture of a European Competence Centre on Cultural Heritage, which will operate proactively for the conservation and safeguarding of heritage. The project aims to initiate the implementation of the structure, organisation and services of the Competence Centre, which will operate as an infrastructure aimed at providing cultural, scientific, technological, financial, strategic and policy expertise and advice able to exploit the most advanced ICT, 3D and digital technologies.

**Keywords:** Cultural Heritage · Conservation · Digital technologies · 3D Documentation

## 1 Introduction

Europe’s Cultural Heritage (CH) sites and historical documents, monuments and historic buildings across the Member States are increasingly under threat [1]. The increasing occurrence of disasters such as floods, earthquakes, fires, and pollution can sometimes cause irreversible damage to CH sites and historical assets or destroy entire areas together with the documents and monuments therein [2].

Apart from losing our heritage, the culture and creative sectors, and related industries such as tourism and hospitality [3] rely heavily on the appeal and conservation of cultural heritage sites, documents, and monuments.

To address this scenario and following successful initiatives previously launched, the European Commission, under the H2020 Call-H2020-SC6-TRANSFORMATIONS-2020, proposed to set up a European Competence Centre (CC) aiming at the preservation and conservation of European CH using new state-of-the-art ICT technologies [4]. The term Competence Centre is used in different contexts to describe an infrastructure dedicated to knowledge organization and transfer, and may have different meanings according to focus area, scope, domain, and socio-economic framework, with different objectives, organisation, and operational mode.

In order to answer to the European Commission's challenge, a consortium composed by nineteen partners has proposed a new research program called: "4CH—Competence Centre for the Conservation of Cultural Heritage" which has been funded under Grant Agreement n.101004468-4CH. The research project started on January 1, 2021 and will end on December 31, 2023.

The 4CH consortium is led by three main partners: *Istituto Nazionale di Fisica Nucleare* (Coordinator); INCEPTION Srl (Scientific coordinator); PIN Srl—*Servizi Didattici e Scientifici per l'Università di Firenze* (Technical Coordinator) and also includes leading institutions from academia, industry, Small Medium Enterprises (SMEs) and research centers with complementary expertise and broad geographical coverage of Europe.

## 2 Competence Centre Aims

The main aim of the 4CH project is to design and set up a CC on the Conservation of CH.

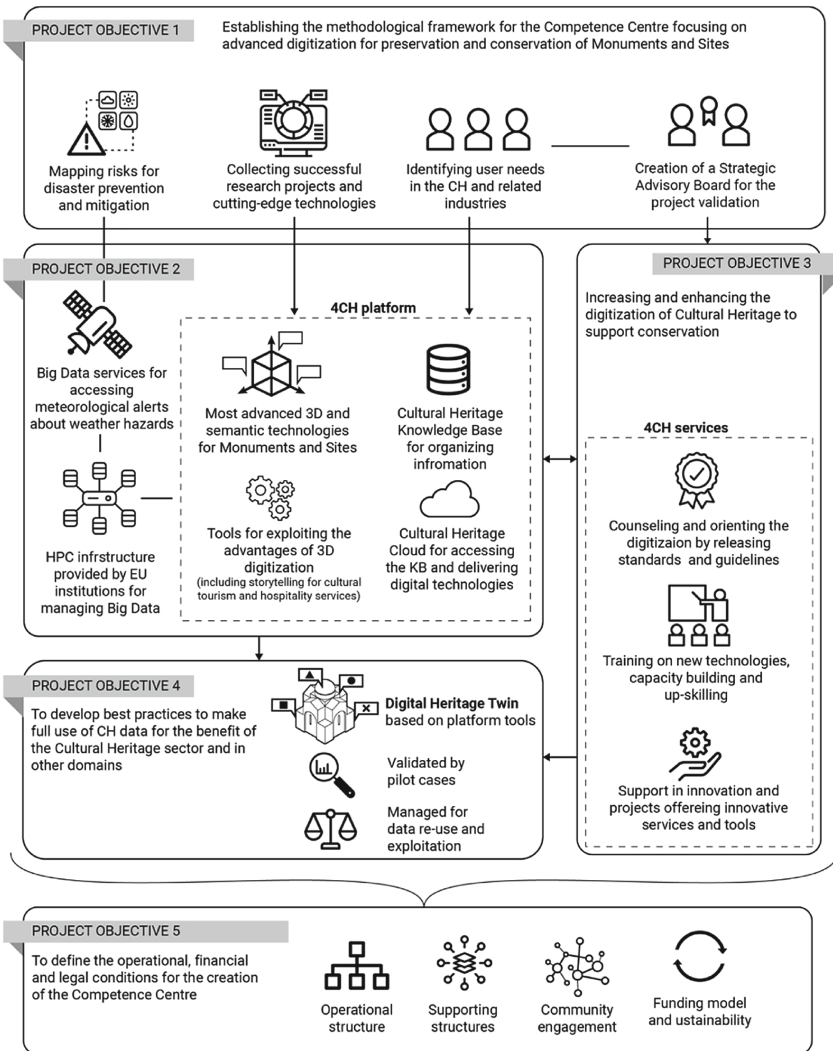
The Centre will offer knowledge (advice and support activities) and services to national and regional heritage agencies, CH institutions, professionals and citizens.

The main research actions of the 4CH project are:

- To promote state-of-the-art ICT solutions including 3D digitization, which have great potential for documenting, monitoring, mitigating, and preventing damage caused by natural degradation, human-related developments and disasters.
- To pave the way for the future work of the Centre by raising awareness among institutions and professionals about innovative ICT solutions, the positive benefits of high-quality digitization of heritage assets and sustainable exploitation of the cultural, social, and economic potential of the cultural heritage.
- To define the organizational framework and plan the activities of the future CC, designing and testing the infrastructure, tools, and services which the CC will provide.

To achieve the main goal, required by the European Commission, 4CH will pursue a sub-set of five related objectives (see Fig. 1):

1. "Establishing the methodological framework for the CC focusing on advanced digitization for preservation and conservation of Monuments and Sites". The objective is to design the methodological framework for the CC and the knowledge base needed to support work with the network of national, regional, and local cultural institutions. The framework will collect and relate experiences, skills and best practices,



**Fig. 1.** Outline of the main objectives of the 4CH project in relation to the actions planned to achieve them.

innovative approaches, policies, and strategies for preservation and conservation of monuments and sites.

2. “To design and implement a Platform for the CC to support the collaboration among European CH Institutions”. The objective is to create a CC Platform through which European CH institutions will be able to interact, access an interdisciplinary network of knowledge, providing advice and support. To enhance this task, an Advisory Board (AB) has been established including experts on CH, advanced technologies, and relevant industries.

3. “Increasing and enhancing the digitization of CH to support conservation”. The overall objective is to increase digitisation of CH assets at a quality which supports conservation and preservation. This involves supporting Cultural Institutions and SMEs carrying out digitisation projects in identifying and implementing key standards, guidelines, benchmarks, and methodologies that match their needs and the solution required.
4. “To develop best practices to make full use of CH data for the benefit of the CH sector and in other domains”. The objective is to develop best practices that maximize the impact of digital transformation in the CH sector. Increasing the volume and quality of digitized content for conservation purposes opens up to new possibilities for creating and re-using data—from co-creation and co-curation to storytelling, visualization, gamification, virtual and augmented reality applications.
5. “To define the operational, financial and legal conditions for the creation of the CC”. This objective is to define the operational framework of the future CC assessing several conditions ranging from its organizational structure, governance, funding, and business plan with the aim of establishing the conditions for its sustainability.

### 3 Competence Centre Organizational Framework

The new CC for the conservation and preservation of CH set up by 4CH project will be implemented starting from the lessons-learned from the analysis of existing European Commission CCs. Up to now, existing and operational European CCs are: Competence Centre on Composite Indicators and Scoreboards—COIN (2016); Competence Centre on Microeconomic Evaluation—ME (2016); Competence Centre on Text Mining and Analysis—TMA (2017); Competence Centre on Modelling—MOD (2017); Competence Centre on Foresight (2018); Competence Centre on Technology Transfer—TT (2018).

It will be based on a purpose-built European cooperation model made of digital and physical infrastructure and trans-national networks, aiming to go beyond the sphere of research and development and to support the market/policy deployment of CH conservation processes, services and products.

The CC will support the European CH industry (CH agencies, institutions, companies, professionals, etc.) and other related industries (creative industry, tourism, hospitality etc.) in exploiting the added-value of CH digitization for preservation and conservation, overcoming existing hindrances by developing and acquiring new advanced skills.

Scope of the CC is also to bridge the gap between research and business, policy-making and finance, providing:

- “Counseling and orientation”:
  - analyzing experiences, skills and best practices, past and ongoing research implemented so far in the European Countries;
  - mapping risks which can damage CH and technology that can help in avoiding them;

- creating and promoting of interdisciplinary networks and mapping user needs;
  - releasing standards and guidelines for digitizing CH and managing preservation and conservation activities.
- “Training and capacity building”:
- creation and maintenance of training material for up-skilling using different modalities, both for distance learning and proximate learning;
  - sharing best-practices and promoting the use of released standards, guidelines and tools.
- “Supporting innovation and projects”:
- promoting innovative services and tools for the 3D digitization of Monuments and Sites;
  - facilitating access to finance, sharing knowledge about EU funds and national projects for innovation;
  - support innovative use and re-use by SMEs of data in edutainment and cultural tourism
  - working directly with the EU Commission policy Directorates-General, paving the way for new research.

The new CC will also collaborate with the existing European Centers, enriching the system of existing European CCs. It will be also integrated in the European Commission’s Knowledge policy platform, and it will make use of the services provided by the Cybersecurity Industrial, Technology and Research one—as soon as it will be operative—regarding the protection of sensitive data.

Based on what has been introduced, the 4CH project is working to develop the organizational structure of the CC specifically with the drafting of the charter, in which roles, tasks, duties, reports, voting powers will be defined and designed.

The schema below is the conceptual map of the main governing bodies and the central and local units, operating inside and outside the CC, on which the 4CH will develop the CC organizational structure considering three main level (see Fig. 2).

The “first level”, concerning a “governing board” with a decision-making and strategic role, would be in charge of compliance and consistency of objectives, financial matters, conflicts resolution. It would be composed by:

- “Founders”: some partners from the 4CH Consortium and a few super-experts, one for each Thematic Department. Thematic Departments will be identified in the 4CH project;
- “Members”: made of one delegate for each National Coordination Centre. The Governing Board would be supported by a Strategic Advisory Board (SAB), which would have the task of assisting and advising the CC in general. As main aim, the SAB would provide the Governing Board with matchmaking among mega-trend (socio-economic/global mission) and challenges linked to CC, contributing to define political and strategic orientations. SAB will include global recognized structures such as

UNESCO, ICOMOS, DOCOMOMO, and national consolidated institutions, such as Ministries, National Clusters, governmental institutions, heritage agencies, etc.

The decisions of the Governing Board are made operative thanks to the Executive Committee and its relevant Thematic Departments:

- The “Executive Committee” is composed by a group of selected members who run the CC, with operative duties. It includes a directorate and a management structure, in direct liaison with the Thematic Departments.
- The “Thematic Departments” will be identified within the project, based on most relevant topics for the CH preservation and conservation, including, among others, Sciences and Technologies, ICTs and 3D Technology, Training and Education, Policies and Strategies, Financial Department. Their role will be to provide support within their thematic axis, and to transfer the instances of the national task forces, guiding the research agenda. Their target will be stakeholders from the research and industrial communities and Member States, public administrations, management and conservation entities, academic actors, business players. The Departments will report to the Executive Committee and advocate with the National CH Coordination Centers.

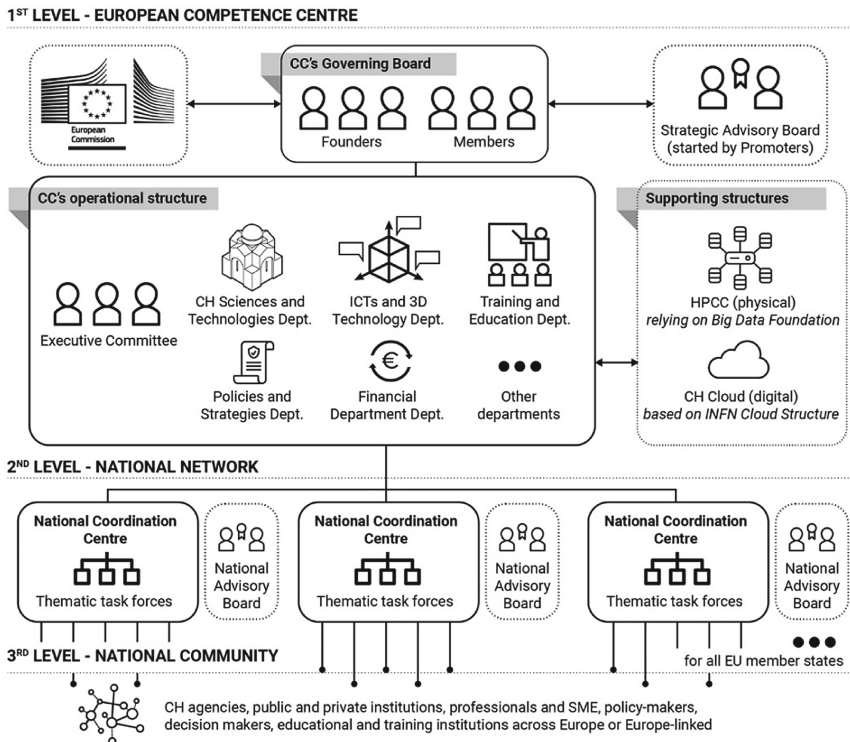
The constellation of the CC will be completed with two supporting structures:

- The CH Cloud (digital), relying on the existing cloud structure.
- The High-Performance Computing centre (physical), relying on the HPCC infrastructure provided by the “Foundation Big Data and Artificial Intelligence for Human Development” and exploiting the services developed by the 4CH project.

The “second level” concerns the National CH Coordination Centers that will be the national structure in charge of the provision of services linked to Thematic Departments, complementing their expertise, by widening the know-how on CH. Each National CH Coordination Centers will be equipped with a task-force responsible for adapting and aligning contents from the Thematic Departments to specific national rules, policies, and laws. Each Member State participating in the CC will have its National CH Coordination Centre that will receive tools, guidelines, and directions from the Executive Committee. It will be responsible for pooling and connecting efforts and implementing locally, guidelines and directions in an efficient manner. A National Advisory Boards (NAB) will support each National CH Coordination Centre. NABs could be composed, for instance, by national technological clusters. They will have strategic role in the definition of services in terms of feedbacks and input on current trend in CH, and in the updating at European/national policy level; they will collect market and enterprise need as well as public administration requirements; they will provide inputs on technological innovations on national and global scale and share national technological roadmaps.

The “third level” regard the Member Countries interested in joining 4CH will promote the activities of the CC locally in order to recruit new members for the National CH Competence Community (Community). This Community is meant as a reticular structure including both regional and metropolitan, as well as local entities. It will involve entities—public and private institutions, professionals and SME, agencies, policymakers,

decision makers and educational and training institutions—that are established within the EU or are linked with the EU matters, with CH expertise in the domains of research, development and/or training and education. The Community will contribute to collect both information and data about user needs, criticalities, frailty, and threats affecting the CH, and about local best practices, skills, and virtuous experiences. It can grow and up-scale according to the necessities of the CC and the relevance of the players involved.



**Fig. 2.** Conceptual map of the main governing bodies and the central and local units, operating inside and outside the CC.

## 4 Cultural Heritage Digitization Process

In consideration of the CC aims, one of the main pillars of 4CH project is to promote the use of ICT solutions and digital technologies for 3D digitization process.

ICT and digital technologies can help preserve the knowledge of threatened heritage artefacts, museums, monuments, documents, and sites and make them accessible for citizens across Europe and for future generations [5, 6]. Moreover, online access to high quality holistically documented digital replicas (including storytelling) of artefacts, sites, documents, and monuments [7] may increase the appeal and promotion of a place, city or Member State, thus supporting the local tourism and hospitality industries [8].

The digitization potential is recognized also in the “Declaration of Cooperation on Advancing Digitization of Cultural Heritage” [9], signed by 27 EU Member States to join efforts in a European initiative on the 3D digitization of CH, re-use of digitized cultural resources to foster citizen engagement and innovative use in other sectors, and to enhance cross-sector, cross-border cooperation and capacity building.

If the 3D digitization defines a process for capturing reality, a complementary approach is represented by the use of modelling techniques and, in particular, the so-called Heritage Building Information Modelling (H-BIM).

The use of H-BIM [10, 11] has already proven to be an effective tool for technicians, offering a significant contribution to interpretive models for intervention. Innovations in the field should be aimed at the full-achievement of the Heritage Digital Twin [12], making the H-BIM model effective even for the continuous monitoring.

4CH recognizes the added value of using H-BIM and will include this as a pillar of the future CC, promoting a gradual transition from plain 3D scanning or photogrammetry, to sophisticated 3D solid models with rich contextual H-BIM information [13].

In detail, 4CH is working to implement a novel approach to 3D technologies integrated with an interdisciplinary knowledge base. It will propose an inclusive approach for time-dynamic 3D reconstructions of artefacts, buildings, and sites, achieving the Digital Heritage Twin.

3D digitization involves the use of equipment (e.g. 3D scanners, digital cameras) and proprietary software to convert the digital signals coming from the equipment into processable data [14, 15].

To improve the whole CH digitization process, the 4CH project is defining a dual approach to be adopted by the future CC:

- “Instrumental certification”—that means a test of the proprietary components by an independent authority and certify their compliance with quality requirements. In other words, the reliability of the digitization process needs the involvement of equipment manufacturers, contributing to an interdisciplinary certification procedure;
- “Procedural certification”—the 4CH will release guidelines for the data capturing procedures and a certification system for evaluating its compliance. Environmental conditions and the setup of the digitization campaign are also relevant for the quality of the outcome.

To these approaches are also added support tools such as:

- “Releasing guidelines” to improve the post-processing steps for the creation of 3D digitized model;
- “3D repository specification” to facilitate storing and accessing of 3D high quality scanned models that are usually much demanding in terms of size.

## 5 Conclusion

As introduced in this paper, the ambitions and expectations of the future CC are very high. At the conclusion of what has been described, it is relevant to summarize the expected



positive impacts on the management, conservation, preservation and valorization of the CH.

The CC will increase the quality of preservation initiatives and create the condition for more effective strategies and programmes by the following actions:

- providing standards, guidelines and state-of-the-art tools for the initiatives of CH institutions, contributing to the development of the Knowledge Base;
- establishing links and connections between the existing networks of public and private institutions working on CH conservation;
- becoming a point of reference for transnational and interdisciplinary networking focused on the preservation of historic buildings, urban areas, monuments, sites and landscapes;
- promoting and encouraging the exchange and sharing of experiences, knowledge and best practices in the preservation of CH;
- promoting and supporting education and training programmes organized and implemented by local institutions (conferences, summer schools, workshops, etc.) and supplying on-line initiatives (e-learning, webinars, etc.).

Achievable impacts from 4CH, during the project, include also the construction of a “4CH Community” of prospective users of the CC, creating links and exchanges between existing networks of public and private institutions working on CH as the seed of the CC Community; defining criteria and parameters about the quality assessment of digitised monuments, sites and documents; establishing a dynamic repository on available new digital technologies for preservation and promotion of cultural heritage, arising from EU research projects; supporting on-going pilot projects or implementing new ones aiming at defining the basis and the methodology that the digitisation standards and guidelines, developed by the CC.

Summarizing, the CC, organized according to the 4CH criteria introduced, “will increase both the quantity and the quality of digitized sites and monuments” by: enhancing and sharing knowledge on digitisation; defining and promoting standards and guidelines; promoting protocols and criteria to validate the existing digital assets for their adaptation and reuse; promoting education and training on digitisation procedures, technologies and tools. The CC “will extend and strengthen the coordination between the players in CH”: continuing to expand the Community started by 4CH to include all networks and players in the CH domain; involving the members of the CC community in existing networks and new networks in the CH and conservation domain; involving the AB, already set up during 4CH, formed by experts in all fields pertaining to CH preservation and exploitation.

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