CROSS CULT

D2.1

Pilot Specifications

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Catherine Jones, Andreas Vlachidis, Antonis Bikakis, Ioanna Lykourentzou, Louis Deladienne, Yannick Naudet, Alberto Gil-Solla, Kalliopi Kontiza, Angeliki Antoniou, Joseph Padfield, Antonios Liapis, Evgenia Vasilakaki, Daphne Manessi, Susana Reboreda, Manolis Wallace, Ioannis Bourlakos, Silvia González Soutelo, Laurie de Zwart

The deliverable presents a collaborative effort of the four pilots, which took place in the first six months (M1-M6) of the project and focused on: 1) refining the original scenarios, 2) capturing the requirements, 3) defining the evaluation framework, 4) identifying the contributing technologies, 5) specifying the core gameplay for the four pilots and 6) outlining the ethical guidelines for experts.

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Authors	Catherine Jones, Laurie de Zwart (UL) Andreas Vlachidis, Antonis Bikakis (UCL) Ioanna Lykourentzou, Louis Deladienne, Yannick Naudet (LIST) Alberto Gil-Solla, Susana Reboreda, Silvia González Soutelo (UVIGO) Kalliopi Kontiza, Joseph Padfield (NG) Angeliki Antoniou, Manolis Wallace; Ioannis Bourlakos (UOP) Antonios Liapis (UOM) Evgenia Vasilakaki, Daphne Manessi (TEI-A)
Reviewers	Martín López Nores (UVIGO), Kalliopi Kontiza* (NG) (*except own contribution)
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1. Introduction

1.1. CrossCult Overview

CrossCult (www.crosscult.eu) is a three-year H2020 research project, which started in March 2016. It consists of 11 European institutions and 14 associated partners, from Computer Science, History and Cultural Heritage.

The goal of CrossCult is to spur a change in the way European citizens appraise History, fostering the re-interpretation of what they may have learnt in the light of cross-border interconnections among pieces of cultural heritage, other citizens' viewpoints and physical venues. The project aims at enabling a unified, IT-facilitated history approach, which goes beyond the conventional silo presentation of historical data, in order to trigger a substantial reflection on history as we know it. Thus, it focuses on aspects that are cross-cultural, cross-border, cross-gender and cross-ethic, as well as on grant societal challenges, such as population movements, access to health services, women's place in society, power structures and others.

To demonstrate its findings and potential impact, CrossCult uses four flagship pilots, each of which takes place in different venues of historical interest, triggers different elements of history reflection and uses different (but often overlapping) sets of technologies:

- **Pilot 1: Large multi-thematic venue**. This pilot takes place in the National Gallery, London in the United Kingdom (UK). It aims at using the broad collection of a single, larger institution to illustrate the connections among people, places and events across European history, through Art.

- **Pilot 2: Many small venues**. This pilot connects 4 small venues, i.e. the Roman healing spa of Lugo in Spain, the Roman healing spa of Chaves in Portugal, the Archaeological site of Montegrotto Terme in Italy and the ancient theatre of Epidaurus in Greece. The pilot highlights the inherently cross-border nature of History by engaging people of multiple nationalities, in the discovery of connections between their respective bodies of cultural heritage.

- **Pilot 3: One venue, non-typical transversal connections**. This pilot takes place in the Archaeological museum of Tripolis in Greece. The pilot aims at offering non-typical, crosscutting and transversal viewings of the museum items, in order to allow the visitors to go beyond the typical level of history presentation (e.g. type of a statue, or its construction date), into deeper levels of reflection, over social aspects of life in antiquity, power structures etc.

- **Pilot 4: Multiple cities, "Past & Present" interplay**. This pilot takes place outdoors, in two cities: Luxembourg City, Luxembourg and Valletta, Malta. The pilot aims at connecting contemporary and past history, with focus on migration and its impact.

Through a unique combination of digital cultural historical objects alongside contemporary objects (like statistical data), this pilot challenges the visitors' current perceptions on migration as a contemporary emotive topic and engages people in exploring the past to understand the present.

Each pilot is developed as standalone within the project, but their underlying principles, evaluation framework and supporting technologies are developed in a modular way: they are connected through a common platform front-end interface and back-end technologies.

1.2. Context of the Deliverable

The deliverable presents a collaborative effort of the four pilots, which took place in the first six months (M1-M6) of the project and focused on (1) refining the original scenarios, (2) capturing the requirements, (3) defining the evaluation framework, (4) identifying the contributing technologies, and (5) specifying the game design for the four pilots.

The original scenarios were refined and validated in collaboration with the historians that participate in CrossCult and the venues of the four pilots. The goals of the refinement were: (1) to provide a more detailed and realistic description of the scenarios from the user's point of view; (2) to highlight the reflection and history re-interpretation objectives of each pilot and how these can be achieved through the interaction of the users with the CrossCult platform and applications; (3) to identify the data, technology and game design requirements for each pilot.

To achieve the first two goals (*create detailed and realistic scenarios*, *highlight reflection objectives*), historians participating in CrossCult and/or working for the pilots' venues enriched the scenarios with concrete information about historical objects, events, people and the venues themselves, and associated it with the reflection objectives of each pilot.

For reaching the third goal (*identify pilots' requirements*) we followed a software engineering methodology. We transformed the high-level scenarios into use cases that describe the user interaction with the CrossCult platform and applications using activity diagrams. At the same time, the technology, data and game design experts that participate in CrossCult designed appropriate templates for the description of the pilots' requirements. Based on the description of the scenarios and the use cases, the templates were then populated with the requirements of each pilot. The pilots' requirements will guide the specification of the data model and the technologies that will be integrated in the CrossCult platform and the design of the CrossCult applications, which are the next tasks of the project.

For assessing the extent to which the reflection and history interpretation achievements of CrossCult will be achieved, we defined a general evaluation framework and four different instantiations, one for each pilot. The general framework describes the different axes of the evaluation, the indicators to be evaluated and possible evaluation methods for each

indicator, while each instantiation describes the evaluation metrics that each pilot will use. The evaluation framework will guide the evaluation of the four pilots, which is planned for months M20-M35 of the project.

1.3. Structure of the Deliverable

The deliverable is organised in such a way as to provide a coherent description of each of the pilots. It begins in section 2 with the rationale for the descriptive template that was used for defining each of the pilots according to five components. Section 3 then provides a description for each of the pilots based on the template presented in Section 2. It describes the pilots' contribution to the reflective history context in terms of cognitive phenomena, together with the activity diagrams and their short description. It also includes a concise overview of the suggested types of datasets/resources for pilots and a framework for evaluating the reflection requirements of the four pilots. Following the description of each pilot, Section 4 presents the technology framework that will underpin the development of the different Apps, and section 5 provides a description of the core gameplay design of the mini-games. Finally the document is drawn to a conclusion with a short discussion on a guideline towards ethical practices (section 6) for the experts and lastly provides a concise summary of the deliverable in the concluding section.

2. Descriptive template for pilot requirements

2.1. Introduction

To ensure consistency in the definition of each pilot, a standardised template has been defined and completed. In this framework each pilot is described using a set of five components. These feed into both the technology framework and game design as described in later sections of the document.

- Reflective history context
- High-level scenario
- Activity diagrams and their descriptions
- Description of suggested datasets
- Evaluation framework

A short description of each of the template components is given below.

2.1.1. Reflective history context

CrossCult will build a framework dedicated to reflective history in the European cultural context, especially targeting the understanding and (re)interpretation of history from multiple points of view. Within this framework a mobile App for each of the pilots will be developed in order to elicit these user reflections. As such each pilot has been given a short introductory paragraph to describe its main aims. This is then followed by a concise description, within the context of the App, of how the pilots are expected to realise the cognitive phenomena associated with reflective history practices: reflection, (re)interpretation, relation and comparison. The section is concluded with an overview of the strategic value and contribution that the pilot will make to overall CrossCult framework.

2.1.2. High-level scenario

Each pilot has been given a high-level user task scenario. The purpose of this scenario is to define user stories to describe the key steps and context. The steps reveal the tasks and the sequence in which they would be undertaken in order to help the user accomplish his or her goals (usability.gov, 2016; Courage et.al, 2005). Each user scenario provides details of how the user is expected to interact with people, places, venues, digital objects and physical objects in order to reflect on historical narratives, themes and events. They provide details from the perspective of the user rather than the perspective of the technology, and include the high-level steps outlining how and more importantly why the user(s) will interact will the pilot apps. For some pilots two stories have been developed to elaborate on different narratives and their associated steps. The stories originally included in the CrossCult proposal have been revisited and refined based on discussions within pilots and among users and/or stakeholders. They are not designed to be exhaustive but have the primary purpose of detailing in non-technical terms how the high-level app will work for the user(s)

and why. The scenarios are then subsequently translated into the main requirements that form the evaluation framework of each pilot App.

2.1.3. Activity diagrams and their description

2.1.3.1. Background and definitions

The activity diagrams are graphical representations of the system's operations presenting the flow of the computational process for each pilot application. They are designed using standard Unified Modelling Language (UML) version 2 and describe the overall flow of control using activities and actions which can be sequential, branched or concurrent. The resulting diagrams abstract the key computational elements of each pilot App as they are described in the high-level scenarios (section 3). Thus, the diagrams constitute the first stage in the process of converting the narrative functionality of the different pilot Apps into standard formal abstractions. The modelling approach has been kept to a high-level so that the diagrams are clear and concise whilst maintaining an appropriate degree of detail that ensures the expression of the range of key computational elements.

The template of the activity diagrams is divided into three interlinked compartments (tiers), namely *User Interface*, *Application* and *CrossCult Infrastructure*. The tiers contain activities that share common computational behaviour in terms of their engagement with the flow of actions. The *User Interface* is the closest tier to the user interactions; it contains activities that are triggered explicitly by the user or those which are implicitly handled by the graphical user interface (GUI). The *Application* tier contains actions and flows that handle the logic of the system. It can be understood as the layer that contains "behind-the-scenes" actions beyond the user interface. It handles the user's input and executes the system's logic. The *CrossCult Infrastructure* tier is at the deeper end of the application that controls the data flow, invokes services and provides access to storage components. It can be understood as the layer that supports the application with action that can be remote or beyond the strict boundaries of the system's logic.

The flow between actions is a fundamental notion of the activity diagrams, which can also be regarded as a type of flowchart. Each activity diagram has an initial state (beginning) shown as a white circle and a final state (end) shown as a black circle. There are cases where a particular branch of the flow may come to an end but without being the final state of the diagram. Such cases are shown as white circles with an X. The diagrams are read from top to bottom and left to right, whereas actions are connected with arrows denoting the direction of the flow. The actions are shown as rounded rectangles that contain a concise description of the action. The direction of a flow can be controlled by decision points that can precede or succeed actions. Such decision points are shown as white diamonds with a label underneath containing a brief description. Two branches from the side edges of a decision diamond start separate flows that comply in a true-false manner with the decision statement. Decision points do not necessarily constitute a user interaction with the system

but can be programmable decisions that are handled by the system's logic. Separate flows can merge as nodes shown as black diamonds. Such nodes differ from union merges that are used for synchronising flows and shown as orange bars that have two or more input flows and a single output flow. Similarly, concurrent flows can split through forks that are shown as orange bars and have a single input flow and two or more output flows.

The activity diagrams contained in the deliverable were homogenised across all pilots from two perspectives: standardised representations and level of granularity. All four pilots used the same set of notations in terms of sizes, colour and shapes for the design of diagrams. In addition, the level of abstraction and detail has been kept mostly at the same scale across pilots. However, each pilot was given a level of flexibility to be broken down into greater detail and to emphasise parts of the diagram that contain core and important actions in the overall scheme. The homogenised activity diagrams constitute the first step in the translation of the high-level scenarios to standardised notations. Further decomposition of the existing diagrams into more detailed activity diagrams and their projection to other types of UML formalisms, such as sequence diagrams, class diagrams, component diagrams, etc., will be required during implementation (WP3 and 4).

2.1.3.2. Common flows and actions

The homogenisation process has revealed particular flows and actions among the activity diagrams of the pilots that share a common purpose. In particular all pilots apart from pilot 4 have a very similar flow with respect to the Sign Up (User Registration) and Log In process. This particular flow has been homogenised to address the requirements of pilots 1, 2 and 3. Pilot 4 is designed to allow users to engage with the application without the requirement of user registration. This is a particular design choice that favours rapid engagement with the core of the Application with the least number of prerequisite actions. The homogenised sign up / log in activity has been decoupled from the main flow of the diagrams and is represented as a separate activity that constitutes the very first step in the user's engagement with the Application. The sign up / log in activity is an integral part of the diagrams' flow, despite being decoupled from the main flow. It is kept as a separate activity for economy of presentation and to avoid duplication.

User preferences and profiling is another activity flow which shares some common functionality across the pilots. However, each pilot engages to some degree a separate set of components and processes for building a user profile. It was therefore decided that the user profiling activity should remain coupled with the main flow and each pilot should maintain a form of variation in the process of capturing user preferences and profiling data. The pilots also share several common actions, particularly in terms of retrieving content, storing data and interacting with social media and the web. Whenever possible such actions have been described with common labels across the pilots to denote similarity and to assist identification of common components that can later be used by the implementation process.

2.1.4. High-level description of suggested datasets

In this section, each pilot provides an overview of the suggested data resources that are likely to form content. It provides information and details of the disparate datasets that will be linked in order to contribute to the CrossCult application. The information contained in this section is in addition to that documented in deliverable D1.2 (the Data Management Plan), which is concerned with data that is created as a result of the overall project activity. This component of the pilot descriptions is also concerned with secondary/ proprietary data that are not accounted for in deliverable D1.2.

The data template contains detail on the following categories and will be provided by pilots as a series of tables, each of which documents an individual dataset.

Dataset Name and Description: A brief description of the dataset including an indicative type (e.g. “data of paintings”, “glossary of materials”, “list of place names”) and a short description about how it will be used by the App.

Size and Format: Where known, the size of the dataset in terms of a rough number of tables, records or any other indication of the dataset’s size should be included. This section also provides details about the format of the dataset, e.g. Spreadsheet, Relational Database (eg MySQL), XML, OWL etc.

Openness: Pilots are expected to identify if the dataset is open / closed together with the conditions under which it can be accessed. Are the data open, are they governed by any embargo period, or are they closed and can be only used by the App under certain conditions?

Availability and Retrieval: Where the dataset exists, its availability and details about how it can be retrieved and accessed, e.g. a web link, should be included. Who is responsible for the dataset, who owns it and who can be contacted to get hold of the data.

2.1.5. Evaluation framework for the pilot

2.1.5.1. General framework

The purpose of the evaluation framework is to outline how the intended goals and objectives of the CrossCult pilots will be realised and evaluated according to set requirements. The evaluation framework will be used to inform the test protocols which will be written in detail for each pilot as part of WP5. The framework will provide a basis for assessing the usefulness of the CrossCult pilot apps for the respective venues and historical narratives, topics, themes, threads and events. The framework will aid the evaluation of the added value of the Apps, helping identify how they enhance the visitor experience and enable users to build connections between information and reflect on and (re)interpret a multifaceted history.

The actual evaluation of the pilots will be in two phases, with the first phase being conducted during pilot testing (WP5 task, beginning month 16). It will use a process of formative feedback to ascertain user acceptance of the Apps and detect improvements that can be made to both the design and functionality of the individual pilot Apps. The first phase will involve a formative approach in order to evaluate the Apps of each pilot.

Testing will be conducted with the barebones version of each pilot user scenario and will facilitate the following: (1) The assessment of the usefulness of the individual Apps from the perspective of usability and user experience, ensuring recommendations for improvements are identified and clarified; (2) The evaluation of the effectiveness of the Apps to elicit historical reflections; (3) Contribution towards the final evaluation methodology for the second phase of evaluation for the resulting Apps.

Of particular interest to the CrossCult platform and its evaluation will be the concepts of usefulness, usability and desirability of the Apps from the perspective of the users. We will take into account, for example, notions of ease of use and levels of learnability. These concepts will be measured together with the appraisal of the modes and contributions of the different types of historical reflections and (re)interpretations evoked during the user interaction. The collection and analysis of qualitative data associated with these Reflective Evaluation Axes (

Table 1) will enable us to evaluate the visitor experience and ascertain how effectively the Apps stimulate users' reflection and (re)interpretation.

The success of the CrossCult pilot Apps will be evaluated according to specific technical criteria as well as the evaluation metrics that are inspired by general principles and frameworks of user acceptance towards new technology, with an emphasis on evaluation from the perspective of user experience and user contributions. The CrossCult evaluation framework will utilise indicator categories derived, in part, from the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003). The framework will also include feedback associated with the Apps and perceptions of trustworthiness and credibility of the Apps and their content, as well as insights related to customary user behaviour and game-playing habits and a consideration of the impact of the Apps for critical reflection. A further departure from the standard UTAUT, one which is particularly important to CrossCult, is a blended evaluation approach that adopts mixed-method practices (qualitative and quantitative measurement methods). This will ensure that we are able to appraise, in detail, how effectively we meet each pilot's requirements.

With this in mind, a set of conceptual domains for evaluation has been defined (Table 2). They are based on the following: (1) system (2) user and (3) content. The domains are subdivided into indicator categories relevant to how we will ultimately measure the success of the CrossCult platform. In total, we have defined 11 indicator categories (these are

described in detail in Table 2). For each category a (non-exhaustive) list of possible measurement methods has been identified. These are used to indicate the types of method that can be used for each category in the development of the final evaluation test protocol, at which time individual metrics, survey elements and interview protocols will be written (WP5). Data for analysis of the formative evaluation of the barebones pilots are expected to be derived from a combination of the following complementary analytical methods:

- Analysis of system log files
- Pre / post-test user surveys (using a combination of Likert-scale single-item questions and open-ended qualitative questions)
- Pre / post-test user interviews (semi-structured interviews to ascertain perceptions
- Think-aloud transcripts
- User observations
- Analysis of the user-generated data (content), e.g. responses to reflective questions, tagging, etc.
- User profile data (both App-generated and/or harvested with permission from external social media accounts)
- Definition of consistency rules

2.1.5.2. Steps taken to define the evaluation method for each pilot

For each pilot the following steps have been undertaken to define the respective evaluation framework: For each pilot, the requirements for the relevant Reflective Evaluation Axes (see

Table 1,), of which there are six, have been defined. These axes were derived from the pilot categorisation in the original proposal.

1. Each pilot requirement is associated with a unique ID, comprising three elements:

    i) A unique code starting with the pilot number (1-4)
    ii) The acronym of the Reflective Evaluation Axis (see table 1)
    iii) An auto-incremental unique number

    E.g. 4.GEN.2 is the second requirement in the general requirement axis for pilot 4.

2. A set of evaluation criteria based on the indicator categories in Table 2, are then proposed for each of the axes. A selection of measurement methods for these criteria has been identified alongside the associated requirement(s).

2.1.5.3. Reflective evaluation axes

Table 1. Evaluation framework – reflective evaluation axes

Reflective evaluation axis	Acronym	Description
General Requirements	GEN	General requirements.
Content type	CON	Describes requirements related to: • What kind of content (text, multimedia etc.)? • Source (predefined, or user-generated). • Presentation mode (e.g. does the App show the sources? Does it includes contextual information or not?). • Structure (is it linked with other items or not? How (by location, theme etc.)?).
Content delivery	CDM	Describes requirements regarding the way the user can access the content: • Do we use a content browsing mechanism? • Do we allow direct querying of the Knowledge Base? • Do we use µAugmentation?
Individual reflection	RFN	Describes requirements regarding the means through which the pilot allows/facilitates/triggers reflection for *a particular user.*
Social reflection & interactions	SR	Describes the means by which a *community/group of users* may interact and co-create reflections.
Connection types and situatedness	CTS	Describes requirements regarding the connections between different venues. This axis is specific to multi-venue pilots.

2.1.5.4. Evaluation indicators to be considered for each pilot

Table 2. Definitions of measurement constructs for the CrossCult evaluation model

Acronym	Indicator category	Short description	Suggested measurement methods	Example metric variable (for information only)	Conceptual domain
SQ	System quality and performance	Measures ease of system functioning and ease of access.	Log files Survey	The system is stable	System
EE	Effort expectancy: perceived ease of use and usability	The degree to which users perceive the App to be easy to use, easy to learn and easy to remember how to use.	Survey / observation and transcripts	The app is easy to learn to use	System
FC	Facilitating conditions for functionality	The degree to which the constraints to the use of the Apps are perceived. Does the App work as the user expects it to and does the functionality enable them to complete their goals e.g. share story or play game?	Log files / survey Predefined consistency rules	e.g. My mobile loads the data quickly	System
AT	Attitude to using the technology (user experience and satisfaction)	This corresponds to the overall user experience. It measures the response a user has to the App: is it fun to use and is it engaging or confusing and frustrating?	Survey / interview / observation and transcripts (think aloud)	e.g. Playing the game is fun	User
PE	Performance expectancy / usefulness	This can be considered as usefulness. Do users perceive the app to be useful for their personal goals? It encompasses notions of the degree to which an individual believes that using the system will help him or her to achieve gains, e.g. the extent to which users believe the process of reflective history is valuable and useful to them.	Survey / interview / analysis of user inputs	e.g. The app is useful as I can contribute my historical reflections	User
HB	Habit	The degree to which Apps are used in certain situations. This will provide an understanding of	Survey	e.g. Every day I play games on my phone	User

Acronym	Indicator category	Short description	Suggested measurement methods	Example metric variable (for information only)	Conceptual domain
		the behaviour of the user.			
REF	Reflections on knowledge	The degree to which users develop new understanding that leads to knowledge discovery and reinterpretation of history, which leads to (new) understanding (s) of these experiences.	Interview / observation / analysis of reflections	e.g. Users provided critical reflections on multi-faceted topics whilst using the App	User
SD	Socio-demographics	A person's gender / age / language abilities / cultural background.	Survey	e.g. Please select your age group	User
REQ	Relevance and quality of content	The degree to which the user perceives the overall quality, relevance and usefulness of the content.	Survey / interview / observation and transcripts (think aloud)	e.g. The content is relevant	Content
COP	General comprehension and clarity of the content	The degree to which a user understands the content of the App. The extent to which a user considers the content is fit for purpose and easy to understand and engage with.	Survey / Interview / observation and transcripts (think aloud)	e.g. The content is clear and understandable	Content
TC	Trustworthiness/credibility of the app	The degree to which users trust in the content. Is the content credible and to what extent? How suitable are the different types of content?	Survey / interview	e.g. The data in the app is credible	Content

3. Pilot Requirements

3.1. Pilot 1

3.1.1. Reflective history context

This pilot takes place in the National Gallery (NG) in London, UK, a large multi-thematic venue. It aims to use the broad collection of a single large institution to illustrate the connections between paintings, painters, places and events across European history, through art. The processes and technologies included in this pilot aim to demonstrate new approaches to improve the accessibility and experience of European cultural heritage. This will be achieved through increasing the visibility and exploitation of the complex and diverse connections that exist between works of art. The pilot will facilitate user reflections and interpretation associated with, for example, the relationships between painters, schools, periods, materials and places. Furthermore, with the App, users will be able to search and explore the entire NG art collection to select their preferred artworks. This serves two purposes: (1) the development of personalised gallery experiences based on user preferences, and (2) self-discovery of the collection through three main reflection topics: Materials, Historical Events and Social Connections, which will reveal the interconnections at play.

The App developed in pilot 1 will provide multiple interconnected methods to enable new experiences in exploring and searching gallery collections. Pilot 1 will allow users with differing levels of experience and knowledge to interact with the NG collection. Users are able to engage and reflect on the information presented and the diverse works of art in the collection based on their own knowledge, choices and experience rather than being forced along a more traditional single choreographed route through the Gallery.

In terms of cognitive phenomena, pilot 1 serves the purposes of promoting reflection on and (re)interpretation of topics through the use of dynamic interactions. It also aims to stimulate interpretative thinking by exploring relationships and making comparisons. By interacting with the Gallery's room plan and with content enhanced by exploiting relevant linked data, users will be able to reflect on the diverse and complex connections between paintings and express this through a memory game which involves redesigning virtual exhibitions based on the gallery rooms. By directly connecting the NG collection to diverse digital resources, CrossCult will demonstrate how the NG collection fits within European and world history, thus making it easier for users to examine and reflect on what may have shaped the development of European painting. Reflections will be expressed by users through the creation of personalised favourites (i.e. their personal collections), tags and descriptions. Thereby enabling re-interpretation based on their experiences and knowledge constructions.

Additionally, by capturing user preferences, the recommendation system will learn what users enjoy, are intrigued by or simply spend more time on. By recommending short tours or individual paintings based on users' own preferences, the App will allow users to build up their own opinions of what they perceive as most interesting and contribute their own interpretation. Comparison will be possible with other users and alongside more traditional painting descriptions provided by the NG.

The strategic value of pilot 1 in the CrossCult framework is that it uses a multi-thematic venue to explore new innovative ways of exploiting technology with a view to enhancing the visitor experience, allowing visitors to move between themes. The CrossCult app will provide mechanisms for adding value to a visit, such as a personalised tour (which would be impractical on a one-to-one basis with visitors) and the use of linked data to enhance understanding for inquisitive visitors.

3.1.2. High-level scenario

Introduction to the scenario

The aim of the scenario is to provide NG visitors with the ability to reflect on different topics associated with its collection. Three main topics have been selected: Materials used in paintings, Historical Events and Social Connections. The scenario below starts with a visitor discovering the museum and wanting to view paintings that interest her. The CrossCult mobile App allows her to discover the Gallery's collection and to learn about specific paintings and painters and their place in European history.

Pauline, on the bus towards the National Gallery

Pauline is a young French woman who is interested in art and European culture. She is on a business trip to London and decides to visit the NG following her meetings. Though quite familiar with various French institutions, such as the Louvre, she knows less about the NG. She does a quick search on her phone as she heads towards the NG by bus. The website provides information about the building, its history and collection and indicates that there is free Wi-Fi and a new mobile App aimed at personalising her itinerary through the Gallery. She likes the idea!

Standing in the entrance hall of the National Gallery – discovering the App

Once at the NG, Pauline connects to the Wi-Fi and installs the App. Upon installation, Pauline sees that she can sign up using her social media account or by creating a specific App account. She signs in with her Facebook credentials. She is then asked to provide some simple details so the App can build her profile. She provides her gender and age and answers some questions about her preferences for art. As Pauline knows a bit about art, she provides some additional information by selecting her top 10 list of preferred painters from the NG and flags the Impressionist school. In order to complete her profile, the App asks her

to choose from a set of paintings from different styles and periods presented in a carousel – a snapshot of the whole NG's collection. Pauline flicks through and likes or dislikes different paintings. Pauline can also come back to the carousel later on during her visit to review and enhance her preferences.

Next, she is provided with information about the App's profiling and location tracking abilities and is asked to give her consent. She accepts and agrees to let her smartphone connect with Bluetooth iBeacons deployed in the NG, understanding that this is necessary to get useful personalised recommendation for her visit. Pauline then quickly reads the "getting started" text. It tells her what she can do with the App. She chooses to explore the gallery's building and room layout, using the plan to discover which paintings are where. She decides to head to the Central Hall, following the map.

With the location tracking activated, she is guided to the Central Hall of the Gallery. She looks at the 2D presentation of the room and discovers that she can see which painters are located where. As she stands in the middle of the hall she looks around the room and then at the screen. From the App she learns that the collection in the room is part of the 16th-century period and that the NG collection has been organised based on historical periods. After some minutes inspecting the paintings in the room, she notices the smallest in size and walks towards it. She uses the App to find out who painted it, when it was painted and which period it is from. She then reads a short description about the subject matter of the painting. She also explores the other paintings in the Central Hall and is impressed. Going back to the 2D presentation of the room, Pauline uses the App to create her own view: by rearranging the order of the paintings on the virtual wall, she reflects on how she would exhibit the paintings and she favourites the view.

Personalised guide through a selection of the Gallery's paintings.

Pauline likes the App and thinks it would be fun to explore the Gallery using a guided tour based on the styles of paintings she likes. She uses the "search and explore collection" option. She observes that there are two possibilities to personalise her tour: (1) search by NG painting, artist, period or subject matter, or (2) follow a route suggested by the App (based on her profiling). Pauline is curious to see which Impressionist paintings are in the Gallery.

She can choose between a personalised group of paintings without sequence or a route with a sequence in which the paintings are indicated in the rooms. Pauline selects the first option, as she wants to see *The Chair*. She looks for the shortest route to room 45, the location of this painting, and asks for a route that avoids stairs and crowds since she has a painful knee and walks slowly.

Exploring The Chair *and its digital enrichment*

Pauline enters room 45. She finds the painting and takes a while to look at it. She wants to know more. She looks at her screen and sees a picture of *The Chair* with some icons that lead her to find out more. She taps one and reads about the interpretation of the empty chair as a symbol of an absent person. She learns about the painter, the school and the date of production. All this information is in text format and some of the text is clickable, leading to other internal and external sources of information. The App provides access to external resource material and she reads about the life of the painter Van Gogh. She also listens to a spoken poem by poet Niall O'Sullivan that was inspired by the painting. Once again she looks at the painting hanging on the wall and then the digital version in the App. She notices that she can choose to find out even more information by selecting from a list of topics: Materials, Historical Events and Social Connections. She is interested in learning about other related paintings. She clicks on another icon and notices that there are two ways to explore the connections: (1) using a map view, and (2) uncovering historical influences in Europe via a timeline. Pauline selects the map view. She sees a world map with all the locations that played a role in Van Gogh's career – it highlights connections between the painting and certain countries and cities. Pauline clicks on the city of Arles in France and reads that while Van Gogh lived there with Paul Gauguin he painted two chairs: one for him and a companion armchair for Gauguin. Pauline also reads that the contrast between the two chairs expresses the different personalities of the painters. Going back to the map, Pauline clicks on the city of Amsterdam and discovers that Gauguin's *Armchair* is located in the Van Gogh Museum.

Switching tour paths and exploring relationships using a timeline

Curiosity sparked, she wants to discover more. Pauline remembers that she can filter the collection by topic and decides to select "Social Connections". The information on the screen can be filtered according to the following criteria: Painter's Relations, Provenance, Portraits, Schools, Women in History, Caricatures and Iconic Depictions. She chooses to filter the Impressionist paintings by selecting "Painter's Relations". The App then displays an updated group of paintings. Pauline checks the time and sees that the Gallery will close in an hour, so she switches options to explore the paintings in sequence using the recommended route.

Pauline follows the new route to room 41 and then discovers that two paintings she really likes are in the room: Monet's *The Thames below Westminster* and Pissarro's *Fox Hill, Upper Norwood*. She approaches Monet's painting and admires the misty atmosphere of London on a spring day, with the Houses of Parliament and Westminster Bridge in the background. Pauline wonders what the connection is between the two paintings and so decides to view the "Social Connections" option again, this time via a timeline that explores the paintings' connections to historical influences in Europe. She is presented with a timeline which

highlights the dates of the paintings, the artists, objects depicted on the painting and external historical information. In the timeline, apart from Monet and Pissarro, Pauline reads information about another painter Daubigny, a precursor of Impressionism, who fled France during the Franco-Prussian War and Paris Commune of 1870-1 to settle in London. Pauline looks again at Monet's painting and then on her screen, following one of the links that provide historical information about the Houses of Parliament and Westminster Bridge.

She is then guided across the room to look at Pissarro's *Fox Hill, Upper Norwood*. While looking at the painting she reflects on events that led those three artists to London. She reads a text quoting Pissarro's words: "Monet and I were very enthusiastic over the London landscapes. Monet worked in the parks while I, living in Lower Norwood, at that time a charming suburb, studied the effects of fog, snow and springtime." Pauline thinks that it is particularly fitting that the Gallery now houses some of their finest London paintings of that period. Pauline wants to save the three paintings and create a new group in her favourites. She tags her mini Impressionist collection with a title: "The Three Exiles". But where is Daubigny's painting? Pauline cannot find it. In the App she notices an option "additional paintings" and sees a list of paintings currently not on display, in temporary exhibitions or on loan to other museums.

Daubigny's *St Paul's from the Surrey Side* is in the additional list. Pauline reads that this painting is on loan at the moment. In the additional list Pauline also notices Gauguin's *Vase of Flowers*. The App tells her that this painting is temporarily on display in a thematic exhibition in another part of the gallery. She decides to save this painting to her favourites so she can go and look at it. Impressed by the painting's intense colours, she remembers a painting with a lot of red in it, but she cannot remember its name.

Searching for paintings with similar colours or style

Maybe the App can help her to remember. Pauline pauses the personalised tour and uses the search option to filter topics according to specific painting materials. She can choose to narrow down the list of paintings, by selecting colour and even choosing a specific pigment – such as gold, ultramarine blue or vermilion. If she could only see the picture she would immediately recognise it. She loved its intense colour and how it depicts the motif of intimacy. *Et voilà*!!! The App's list of results includes the painting she was trying to remember, Degas' *La Coiffure* or *Combing the Hair*. Pauline notices that the painting is on display in the Sainsbury Wing as part of a temporary exhibition. She favourites this painting for later and decides to visit this exhibition at the end of her current tour.

She unpauses the tour and heads to room 30 to see the final painting on her recommended route. She stops and looks at the painting, Velasquez' *The Toilet of Venus*. Using the App she reads that *The Toilet of Venus* and Degas' *Combing the Hair* have been connected through the topic of colour. Pauline looks more closely at the painting. She notices the red drapery.

She reads on her screen again how the red lake pigment was used to depict rich fabrics and draperies but as a material is vulnerable to fading. Dating from the 1640s, this painting provides a notable example of colour change and material degradation. She reads how the Scientific Department of the NG constructed an image of how the picture might have looked based on extending tiny areas of relatively well-preserved colour. Pauline places the reconstructed image next to the painting and focuses on the slate-grey colour of the bed cover. The digital reconstruction of *The Toilet of Venus* reveals to Pauline an element of the painting that she would not have been able to see otherwise. Pauline selects the map view and learns about important centres for the pigment trade. Pauline creates a new favourites group for red paintings. She has finished her tour and makes her way to the Sainsbury Wing with the help of the building plan.

Serendipitous discovery and sharing discoveries

As she makes her way to the Sainsbury Wing, Pauline notices a portrait of a woman in a room off to one side, room 25. She enters the room and looks at it, Vermeer's *A Young Woman standing at a Virginal*, and the App flags up the painting. She filters once again using Social Connections and this time by the theme of Female Portraits. This will definitely be of interest to her friend Maria, who studies historical costumes. She saves the painting to her sharable favourites. She adds keywords and a title to this personal group. She also sees an information box that when selected informs her that "Women in History" is also explored in another part of the App which is linked to another museum, this time in Greece, in the city of Tripolis. Pauline makes a note of it and shares this favourite group with Maria via email, inviting her to download the App.

Creating personal metadata and playing the memory game "Recreate a gallery room"

Happy with her discovery and after visiting the temporary exhibition, she sits in the National Gallery's café. She reflects on her personal art discoveries made with the assistance of the CrossCult App and reviews the gallery map. Pauline is able now to make connections between the development of Impressionism, one of her favourite artistic schools, and the important locations in Europe that influenced it. She selects an icon called "Recreate a gallery room". She selects a virtual wall from the Impressionist rooms, and her job is to virtually replicate the room with its artworks. Pauline starts choosing available paintings. She moves the paintings around the walls and the App gives her clues on how to rearrange the location of the paintings to achieve the best score. She has now virtually curated her own exhibition! The next level gives her "curatorial status". Her next task is to review the three main reflection topics – Materials, Historical Events and Social Connections – to think about the paintings she has seen and add any further relevant paintings to these topics.

The Gallery café will close soon. The Gallery has two more main periods that Pauline was not able to visit, but Pauline's time was limited. "Next time, London," she thinks, "we will stay in touch!"

3.1.3. Activity diagram and descriptions

3.1.3.1. Sign-Up and Log-In Activity

Please note the activity described in this section is applicable to Pilots 1, 2 and 3.

The first interaction with the CrossCult application after installing the App on a mobile device prompts the user to log-in[1] using a set of credentials. Logging in with either their CrossCult credentials or a Social Media account is allowed (Figure 1). The application imposes an initial check against the user's status. If the log-in is requested by an existing user then a straight forward process is invoked. In the case of a user not previously registered, the system requires the creation of a new account. The activity diagram contains core actions of the log-in and sign-up processes to highlight how request and validation actions are handled by the tiers of the application. Actions such as "Forgot Password" are omitted from the diagram for simplicity purposes, since retrieval of credentials is considered a standard functionality of a log-in module.

Sign-up and log-in with CrossCult credentials

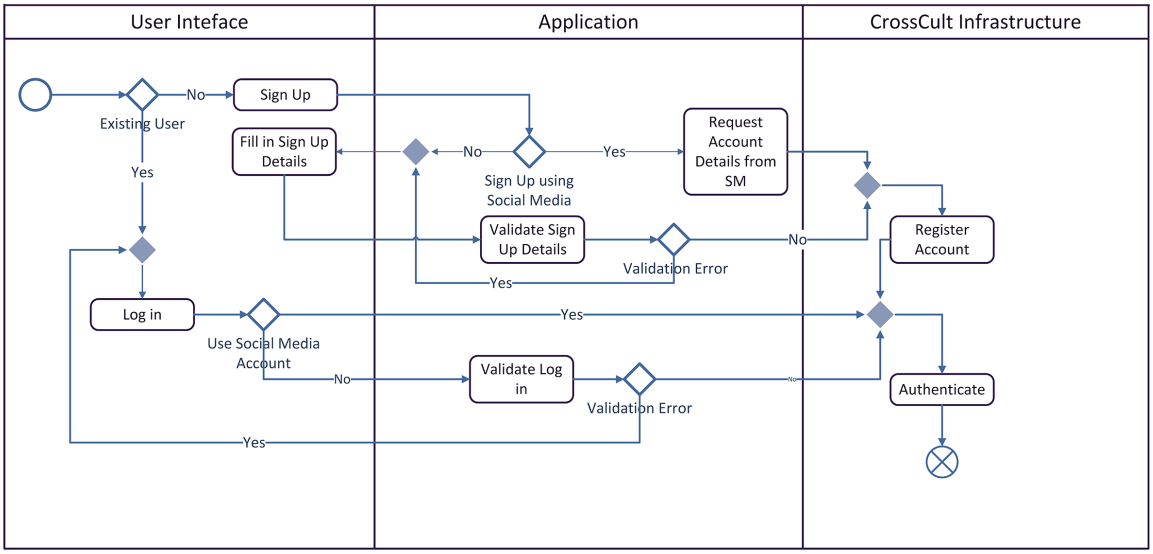
The log-in action permits users to use either their CrossCult credentials or a Social Media account. Logging in with the App's own registration system requires entry of user credentials which are validated via the user database. First time users are registered using a sign-up form in which they enter details such as username, password and email account. The application validates the user input and an error free submission is registered in the user database. The application validates the user input and the credentials are authenticated against the user database. Users are prompted to repeat the process in case of erroneous entry of log-in details.

Log-in with a social media account

In the case of signing-up using a Social Media account, the application retrieves the user details from social media through an Application Programming Interface (API) and registers the user account. A successful log-in authenticates the user account and automatically provides access to the CrossCult application. When someone logs in with his or her Social Media account, the system authenticates the user input against this social media account.

[1] The activity is part of the Pilot 1,2 and 3 applications. Pilot 4 does not require users to Log-in and allows a rapid engagement with the App.

Figure 1. Sign-up and log-in activity



3.1.3.2. Activity diagram description

The user installs the application and obtains access through the log-in/sign-up flow as described in the previous section. The first step in the engagement of a new user with the App is to build a user profile. This step may be skipped for users who have already completed their profile. The option to edit an existing profile is also available to users. The profiling process involves answering questions and liking/disliking images on a carousel display so the App can provide a personalised experience to the user. Profiling questions are used to capture general user preferences and their background interests including: favourite painters, age, gender etc. The carousel captures more specialised preferences with respect to favourite painting styles, medium, period etc.

With the profile ready, a user can retrieve a personalised experience and engage with the National Gallery (NG) collection through a range of interactive options. The notion of user engagement with a group of paintings is central to overall experience. The user can retrieve a group of paintings through a variety of interactive options and can engage and reflect with the group as a whole or with individual paintings. A group of paintings can be retrieved *automatically* or *manually*. The first option implies that the user interaction in the group selection process is kept to a minimum. The system suggests to the user a group of paintings based on their profile and current location. The *manual* group selection option enables the user to search and filter through the entire National Gallery collection. Search and filtering

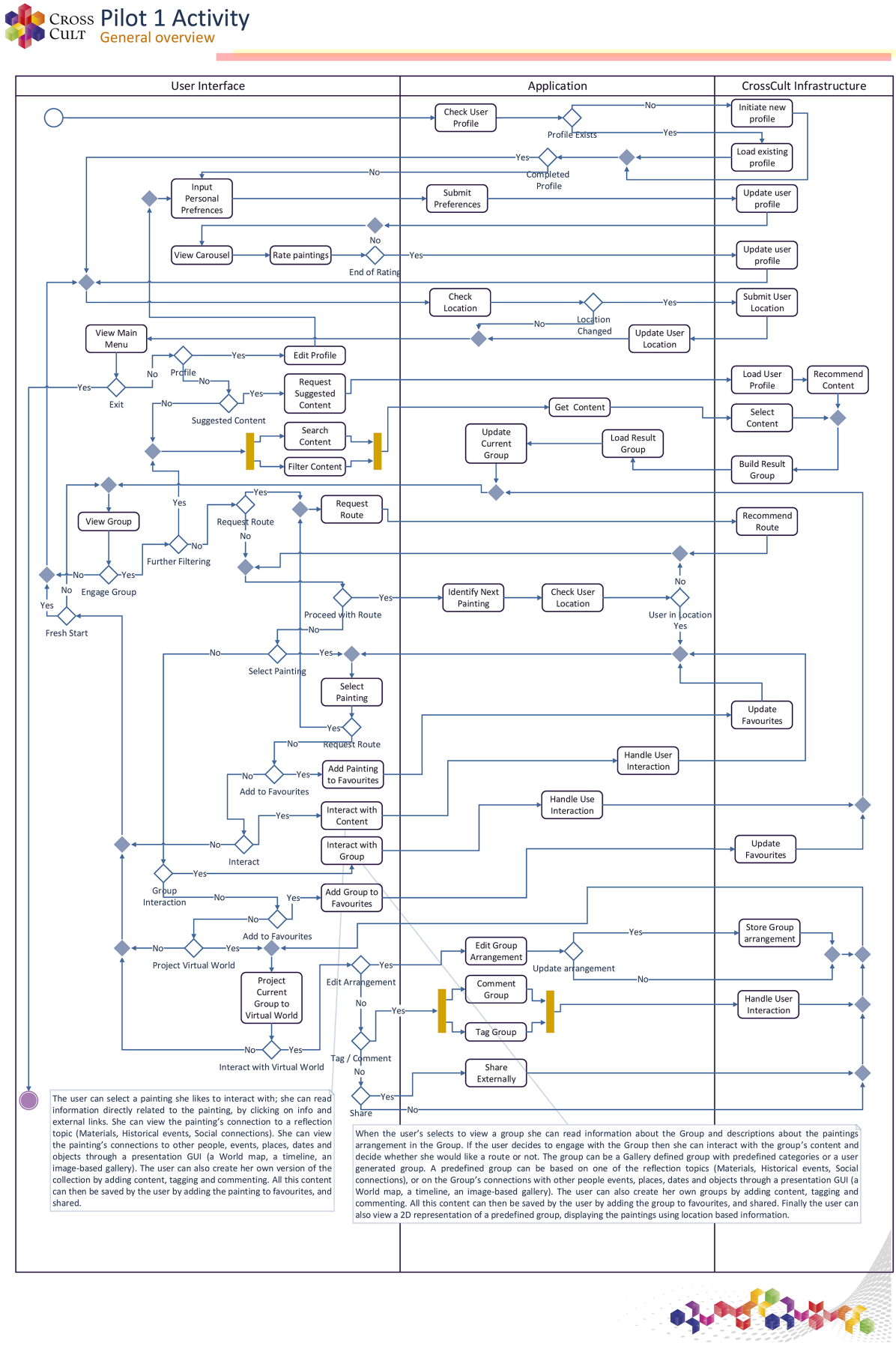
of results can be performed in an iterative manner so the user can search and filter to small group of paintings of personal interest.

The user can engage with the group in the following ways: 1 request to view the group of paintings in a suggested sequence and retrieve a route to be followed; 2) view the paintings of the group in any order they wants and obtain directions on how to reach to each painting individually; 3) view information about the group, add the group to favourites and tag/comment the group with user generated content and 4) view the group as part of a virtual world view where it is possible to engage further with the group and the arrangement of paintings in the virtual space.

Beyond engaging with a group of paintings, the user can also interact with an individual painting in a variety of ways. The activity diagram encapsulates the variety of user interactions with a painting under the action labelled *Interact with Content*. The user when interacting with a painting will be able; 1) to read information directly related to the painting and access external Web resources for further information; 2) view the painting's connection to a reflection topic (Materials, Historical events, Social connections); 3) view the painting's connections to other people, events, places, dates and objects through a GUI (a World map, a timeline, an image-based gallery) and 4) tag, comment and add a painting to favourites.

The virtual world provides a space to the user for experimenting with the arrangement of paintings and to freely move paintings to new locations. This way the user creates and curates new views that would not be possible to achieve in the physical world. The user can tag and comment the views, save them to favourites and make them available (share) with other users.

Figure 2. Activity diagram for Pilot 1



3.1.4. Suggested datasets

In the tables below we describe a non-exhaustive suggested set of data resource associated with the pilot. These dataset resources are summaries of that documented in deliverable D2.1 (Data management plan). Please note where possible datasets will be stored in the CrossCult Zenodo repository.

Table 3. Suggested datasets / Pilot 1

CROSSCULT-DS-pilot1_NG_Collection_Ontology_Extensions and CROSSCULT-DS-pilot1_NG_Collection_Literals	
Description	The CROSSCULT-DS-pilot1_NG_Collection_Ontology_ Extensions dataset will be used to model the paintings of the National Gallery (NG) Collection. The core (Tombstone) data will be retrieved from National Gallery collection information held in the National Gallery Collection Management System (CMS) TMS (The Museum System™) and will be presented to the CrossCult App via a new API. This dataset will be composed of upper-level ontology classes and a set of specialisation (extensions) required for describing the types and relationships of the National Gallery Collection and the actual literal data related to the collection, such as Painting Inventory number, Painting Date, Title, Medium and Support, Dimensions, Description etc. and Artist Details such as Name, Dates and Biography (where available). The dataset also contains an in-house classification and keywords about General type and grouping classification terms, along with more general subject matter related keywords. This is the core of the paintings dataset that will be used to define the collection and its inter-relationships. The dataset will be further enriched with appropriate internal NG resources of contextual information. Further information about this dataset can be found in deliverable D2.1 (Data Management Plan: Table 6.)
Size - Format	Size: the dataset will contain data related to approximately 2300 paintings. Format: the dataset will be expressed in a standard semantic web serialisation.
Openness	All data belonging to this dataset and the related fields in TMS are already public on the NG website and are in common use. The core data will be made available in accordance to the agreement signed by the Consortium. Access to any augmentation of the core dataset created outside the CrossCult app will be as open as possible but specific agreements may well be required (see Consortium Agreement).
Availability-Retrieval	The core of the dataset is based on information extracted from the NG Collection Management System (CMS) TMS (The Museum System™). Created data that augments the core of the dataset will be folded into the NG ongoing Information System. When appropriate, this data would also be integrated into the Collection and Information Repositories and continue to be used within future projects of the NG. The CROSSCULT-DS-pilot1_NG_Collection_Ontology_Extensions dataset will be added to the recommended project repository. The 'literals', CROSSCULT-DS-pilot1_NG_Collection_Literals, will encompass dynamically updated information, that will be

	presented through a documented API, hosted at the National Gallery. A description of the API including the documentation will be added to the recommended project repository. Joseph Padfield will be the contact person for the CROSSCULT-DS-pilot1_NG_Collection_Literals dataset, for the duration of the project.

CROSSCULT-DS-pilot1_User_Profiles	
Description	This dataset will include anonymised information entered by the users that will participate in the experiments of pilot 1, and user related data that describe and categorise users and their interests, activities, preferences and interaction with the collection and CrossCult App. Further information about this dataset can be found in deliverable D2.1 (Data Management Plan: Table 7).
Size - Format	Size: depends on number of users participating in the experiments Format: the dataset will be expressed in a standard semantic web serialisation, in an appropriate format such as XML, OWL, which will allow reuse and further data enrichment.
Openness	The anonymised data and user profile metadata as well as other curated data and metadata that may be required for validation purposes and has longer-term value for re use, will be made fully accessible.
Availability-Retrieval	All the information files belonging to this dataset will be deposited in the recommended project appropriate data repository to facilitate re-use.

CROSSCULT-DS-pilot1_User_Generated_Content	
Description	This dataset will include anonymised contributions of content created from the users participating in the experiments using the CrossCult App. Its structure will be very similar to the CROSSCULT-DS-pilot1_NG_Collection_Literals dataset.Further information about this dataset can be found in deliverable D2.1 (Data Management Plan: Table 8).
Size - Format	Size: depends on number of users participating in the experiments. Format: the dataset will contain structured data expressed in an appropriate format, such as XML or JSON, which will allow reuse and further data enrichment.
Openness	User anonymised generated data and metadata as well as other curated data and metadata that may be required for validation purposes and has longer-term value for reuse, will be made fully accessible.
Availability-Retrieval	All the information files belonging to this dataset will be deposited in the recommended project appropriate data repository to facilitate re-use.

CROSSCULT-DS-pilot1_NG_Routes_Tours	
Description	This dataset will include the data collected from the location of paintings in combination with records of location tracking of users participating in the experiments using the CrossCult App. It will begin with a small set of predefined, suggested, NG tours, based on the available data and the defined CrossCult pilot 1 reflection points. The dataset will then be augmented by user's recommended tours created during the profiling and recommendation processes, records of user visits, and the creation of new user defined tours. Further information about this dataset can be found in the D2.1 (Data Management Plan: Table 9).
Size - Format	Size: the dataset will be structured as a collection of files. Format: the dataset will contain structured data expressed in an appropriate format, such as XML or JSON which will allow reuse and further data enrichment.
Openness	Since full use of this dataset will be in combination with the CROSSCULT-DS-Venue_Infrastructure_Collections dataset, there may be some security restrictions on its use that will need to be taken into account. Where possible, anonymised generated data and metadata as well as other curated data and metadata that may be required for validation purposes and has longer-term value for reuse, will be made fully accessible.
Availability-Retrieval	All the information files belonging to this dataset will be deposited in the recommended project appropriate data repository to facilitate reuse.

CROSSCULT-DS-pilot1_Multimedia_Images	
Description	This dataset will contain the multimedia resources, images provided by the NG that will be used to create stories to be presented to the users. The dataset will consist of: • A full set of 800 pixel collection images of National Gallery acquisitioned paintings (~2300). • Possible selective inclusion of technical images, details, samples (that need to be related to interpreted details) Further information about this dataset can be found in deliverable D2.1 (Data Management Plan: Table 10).
Size - Format	Size: The full set of 800 pixel collection images is around 1150 Mbytes. Format: The data will use the most well-known formats regarding multimedia resources.
Openness	The data of this dataset have different access levels at the time of writing. The full set of 800 pixel collection images is under a Creative Commons (CC) BY-NC-ND 4.0 licence. Specific agreement/Licence would need to be defined for the high-resolution images presented on the NG website. Additional image resources could be created if necessary for the project by direct capture or recordings of the venue's assets. Additional video and alternative surface texture based multimedia may also become available, but these will be subject to specific additional agreements that would be organised by the NG. Access to any augmentation of

	the dataset created outside the CrossCult App will be as open as possible but specific agreements will be required (see Consortium Agreement).
Availability-Retrieval	The images will be available via an IIIF image server, hosted at the National Gallery. Joseph Padfield will be the contact person for the CROSSCULT-DS-pilot1_Multimedia_Images dataset, for the duration of the project. The dataset will also be part of the NG internal multimedia archive and will continue to be archived and made available, where appropriate for re-use within future projects related to the NG. Further generated data and metadata belonging to this dataset will be deposited in the recommended project appropriate data repository to facilitate reuse.

CROSSCULT-DS-pilot1_User_Tracking_Observation	
Description	This dataset will contain anonymised data collected from observation and location tracking of the users participating in the experiments using the CrossCult App. It will include information about the users' interaction with the NG collection information. The data will be directly related to the actual user route information included in the CROSSCULT-DS-pilot1_NG_Routes_Tours dataset. Additionally, for users who give their permission, location information can be automatically extracted/ retrieved from their devices. User agreement must be obtained before tracking and processing data about the user. Further information about this dataset can be found in deliverable D2.1 (Data Management Plan: Table 11).
Size - Format	Size: depends on number of users participating in the experiments. Format: The dataset will contain structured data expressed in an appropriate format (such as XML or JSON) which will allow reuse and further data enrichment.
Openness	User anonymised generated data and metadata as well as other curated data and metadata that may be required for validation purposes and has longer-term value for reuse, will be made fully accessible.
Availability-Retrieval	All the information files belonging to this dataset will be deposited in the recommended project appropriate data repository to facilitate re-use.

CROSSCULT-DS-pilot1_Game_Scenarios	
Description	This dataset will contain information about the content available in the game scenarios for the users participating in the experiments of pilot 1 using the CrossCult App. It will have a generic structure for a memory game (Remember the painting setup) and a 'creativity' game (Make your own gallery), with default core gaming mechanisms (populating paintings, moving them around, following clues, describing arrangements, receiving rewards).

	The data will be directly related to the information included in the CROSSCULT-DS-pilot1_NG_Collection_Literals, CROSSCULT-DS-pilot1_User_Profiles and CROSSCULT-DS-pilot1_User_Tracking_Observation dataset. Further information about this dataset can be found in deliverable D2.1 (Data Management Plan: Table 12).
Size - Format	Size: depends on number of users participating in the experiments. Format: The dataset will contain structured data expressed in an appropriate format, such as XML or JSON which will allow reuse and further data enrichment.
Openness	User anonymised generated data and metadata as well as other curated data and metadata that may be required for validation purposes and has longer-term value for reuse, will be made fully accessible.
Availability-Retrieval	All the information files belonging to this dataset will be deposited in the recommended project appropriate data repository to facilitate reuse.

3.1.5. Requirements and associated evaluation metrics

3.1.5.1. General requirements and evaluation

This section describes the more general high-level requirements that the pilot 1 App is expected to deliver.

Table 4. General requirements / Pilot 1

#	General requirements
1.GEN.1	The pilot 1 App is a cross-platform mobile application (e.g. Android and/or iOS).
1.GEN.2	The App will be made public on the application market of the targeted platforms, designed to be installed on users' personal devices.
1.GEN.3	The main device target for the app is smartphones.
1.GEN.4	The user's explicit consent must be obtained before gathering personal information in order to build a user profile and track people.
1.GEN.5	Users must be able to use the App with minimal training (ease of learning, efficiency of use, memorability).
1.GEN.6	The App should enable users to reflect on the content they have viewed and experienced during a visit to the NG.
1.GEN.7	User registration can be authenticated using an existing social network account.
1. GEN.8	The App should trigger user interactions, conforming to basic usability standards.

Table 5. General requirements evaluation method / Pilot 1

Indicator domain	Code	Indicator category	Suggested measurement mode (s)	Requirement
System	SQ	System quality and performance	Selection from: Log files / Test plan compliance / Survey	1.GEN.1 to 1.GEN.8
System	EE	Perceptions of general effort expectancy: perceived ease of use and usability of the App in general	Selection from: Survey / transcripts (think aloud)	1.GEN.5 1.GEN.6 1.GEN.8
System	FC	Perceptions of facilitating conditions to interact with the NG collection	Surveys	1.GEN.5 1.GEN.6 1.GEN.8
User	AT	Perceptions of users' attitudes more generally to the technology	Selection from: Survey / interview / observation / transcripts (think aloud)	1.GEN.5 1.GEN.6 1.GEN.8
User	PE	Perceptions of general performance expectancy: overall usefulness of the App for NG visitors	Survey	1.GEN.5 1.GEN.6 1.GEN.8
User	PE	Perceptions that the App's features motivate users	Selection from: Survey / interview	1.GEN.5 1.GEN.6 1.GEN.8
User	REF	Users' perceptions of how users' engagement and experiences with the App lead to an understanding and appreciation of art history	Selection from: Interview / analysis of reflections	1.GEN.6

3.1.5.2. Content

In the first pilot, the content of the App consists of digital resources of several types. In the first instance the content and metadata of the artworks in the National Gallery (NG) themselves are integrated. In addition to the images and metadata of paintings, information related to the painters and some of the historical backgrounds will also be provided, textually and visualised via maps and timelines. There is the possibility of linking different objects to one another, which should facilitate user reflection. The paintings are also connected to the building plan of the NG itself and content will also include details about floors, floorplans, stairs and elevators.

Within the App, in addition to the textual information provided by the Gallery, where available, there will be links between the Gallery's objects and digital audio and/or video content and external Linked Open Data. Lastly, there is room for user-generated content as well, such as feedback (likes), tags, personal notes, favourite paintings and organisation of the paintings in the App's virtual rooms.

Table 6. Content requirements / Pilot 1

#	Requirements – Content
1.CON.1	The App must provide access to digital resources curated from one or more repositories.
1. CON.2	The App must display information about the objects (e.g. paintings, artists) and their connections with other objects (e.g. artist(s), group(s) of paintings, schools (i.e. groups of artists), art periods/movements, events, places.
1. CON.3	The App should enable resources to be viewed in the form of text, images, audio or video, where available.
1. CON.4	All the paintings are associated with a certain location (such as in the museum or not on display).
1. CON.5	Objects should be associated with the reflection topics so as to enable reflection.
1. CON.6	The App will gather data about the user that will be used for further profiling and personalisation.
1. CON.7	The App must provide an interactive digital map of the NG.
1. CON.8	The App must provide a virtual representation of the NG's rooms.
1. CON.9	The App must collect metadata (such as when, where, what, how) associated with user contributions.
1. CON.10	The App needs to be able to conform to basic usability standards (e.g. textual descriptions, fonts, character sets, typography & layout, identified clickable links).

Table 7. Content evaluation metrics / Pilot 1

Indicator Type	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	Facilitating conditions: objects will be connected to a reflection topic	Consistency rules	1.CON.4 1.CON.5
System	FC	Facilitating conditions for functionality	Selection from: Survey / interview / observation and transcripts	1.CON.4 1.CON.10
System	EE	Perceptions of ease of use in accessing and interacting with content (digital resources – objects and text)	Survey	1.CON.2 to 1.CON.5 1.CON.7 1.CON.8 1.CON.10

Indicator Type	Code	Indicator category	Suggested measurement mode(s)	Requirement
Content	REQ	Perceptions of general relevance and level of content quality relative to the user – do users find the NG content useful	Selection from: Survey / interviews	1.CON.2 to 1.CON.9
User	PE	Measures of perceptions of general performance expectancy: overall usefulness of the app	Selection from: Survey / Interview	1.CON.2 to 1.CON.9
User	AT	Attitudes of user to using the technology to discover museum content	Selection from: Survey / interview / observation and transcripts	1.CON.1 to 1.CON.4 1.CON.7 1.CON.8 1.CON.10
User	REF	Reflections on knowledge	Selection from: Survey / interview / observation and transcripts	1.CON.2 to 1.CON.4 1.CON.7 1.CON.8

In this pilot, the user will be able to explore the available content on their own, receive recommendations from the app, or just walk in the museum's rooms and be proposed information related to near-by paintings.

Table 8. Content delivery requirements / Pilot 1

#	Requirement – historical content delivery mode
1.CDM.1	The App will trigger content delivery in a carousel of paintings to capture user preferences.
1.CDM.2	The App will provide a digital map that can reveal distances to the different paintings' locations in the museum based on the user's location.
1.CDM.3	The App will present routes that will guide the user through the museum. The App will be able to trigger content delivery based on user preferences, activities and information such as available time, potential congestion points, distances and accessibility options (staircase, lift).
1.CDM.4	The App will automatically display a representation of rooms where the user is currently.
1.CDM.5	The App features a search engine that enables users to search for paintings manually using criteria & facets.
1.CDM.6	The user can use filters to refine search results.
1.CDM.7	The App will use a recommending engine to suggest paintings based on user preferences, profiling, user location and reflection topics.

#	Requirement – historical content delivery mode
1.CDM.8	In the group option of the virtual presentation, the user can select a specific painting to access more details about it.
1.CDM.9	The App allows content to be linked to other content via links and touchable icons.
1. CDM.10	The App will display user contributions (commenting / tagging), user visit history and saved content.

Table 9. Content delivery evaluation metrics / Pilot 1

Indicator type	Indicator code	Target category	Specific measurement mode(s)	Requirement
System	FC	Facilitating conditions of content delivery (including the carousel and digital maps)	Consistency rules & test plans	1.CDM.2 to 1.CDM.4
System	FC	Perception of conditions enabling interaction with content delivery interfaces (including the carousel and digital maps)	Selection from: Survey / interview	1.CDM.2 to 1.CDM.10
System	EE	User perceptions of ease of use of content delivery modes and interfaces	Selection from: Survey / interview / observation	1.CDM.2 to 1.CDM.10
System	EE	Navigational cues for personal itineraries are easy to use	Selection from: Survey / observation	1.CDM.3 to 1.CDM.10
Content	REQ	Perceptions of general relevance of content delivery	Selection from: Survey / interview	1.CDM.2 to 1.CDM.9
User	AT	Effectiveness of serendipitous discovery	Selection from: Survey / interview / or observation	1.CDM.8 1.CON.10
User	AT	Attitude to using the technology (user experience and satisfaction at the content delivery interactions)	Selection from: Survey / interview / observation and transcripts / log files	1.CDM.3 to 1. CDM.10 (except 5, 6)

3.1.5.3. Individual reflection

Pilot 1 must facilitate reflection and interpretation in relation to the information a user is exploring as they walk around and experience the National Gallery collection in London. Reflection will be based upon the information displayed about the objects (e.g. paintings, artists) and their connections with other objects (e.g. artist(s), group of painting(s), schools (i.e. groups of artists), art periods/movements, (historical) events, places). The selected reflection topics are: Social Connections (provenance, people in portraits, artistic schools, women in history, caricatures and iconic depictions), Materials & Techniques (medium (e.g.

oil, egg tempera), pigments (e.g. ultramarine, gold, vermilion), and other materials) and Historical Events (the connection between works of art and events in history).

There will be several modes of interaction to capture reflection and interpretation:

(1) Review & edit prior art preferences
(2) Create /save/ tag and describe thematic groups of paintings as favourites
(3) Move existing paintings around in a virtual space and create another presentation of the collection
(4) View how objects are connected to other objects (e.g. artist(s), group(s) of paintings, schools (i.e. groups of artists), art periods/movements, events and places, using a visualisation method (e.g. a map or a timeline)

Table 10. Individual reflection requirements / Pilot 1

#	Requirements – Individual reflection
1.RFN.1	The App allows users to review their prior art preferences.
1.RFN.2	The App allows users to edit their profile and reflect on their visit and which painting(s)/subjects they feel are the most important.
1.RFN.3	Data visualisations should facilitate the user's reflection.
1.RFN.4	The App will allow the user to create and save personal thematic groups of paintings as favourites and tag and comment on their groups in order to provide reflections on their experience.
1.RFN.5	The App will facilitate reflection by showing a painting's location in a room and allowing the user to virtually move existing paintings around to create their own presentation and reinterpret the collection.
1.RFN.6	The App will suggest groups of paintings related to a particular topic which will allow the user to discover new paintings related to that topic.

Table 11. Reflection evaluation methods / Pilot 1

Indicator type	Code	Indicator category	Suggested measurement mode(s)	Require-ment
System	FC	Perceptions of conditions enabling interaction – recorded changes of user preferences and view/edit of user profile	Analysis of logs	1.RFN.1 to 1.RFN.3
System	FC	Conditions enabling interaction – Number of ways user viewed content	Analysis of logs	1.RFN.3 to 1.RFN.6
System	EE	Perception of effort required to contribute reflections	Selection from: Survey/ interview / think aloud	1.RFN.2 1.RFN.4 to

Indicator type	Code	Indicator category	Suggested measurement mode(s)	Require-ment
				1.RFN.6
User	PE	Perceptions of the usefulness of the user reflection process	Selection from: Survey / interview / think aloud	1.RFN.1 to 1.RFN.5
User	REF	Reflections on prior and newly acquired knowledge	Qualitative analysis of user responses to the evaluation process	1.RNF.1 to 1. RFN.6
Content	REQ	Perceptions of connections between objects – how connections are relevant to reflection topics and categorisation	Selection from: Survey / interview / think aloud	1.RFN.3 to 1. RFN.6
User	AT	Attitude to the use of digital means to explore and reflect on the exhibitions in the Gallery	Selection from: Survey / interview / observation and transcripts	1.RFN.1 To 1.RFN.6

3.1.5.4. Social reflections & interaction

The App facilitates user contributions and reflections on the views of other gallery visitors. Moreover, it allows visitors to share content during their visit with friends using existing social networks/communication systems.

Table 12. Social reflections & interaction requirements / Pilot 1

#	Requirements – Social reflections & interaction
1.SR.1	The App allows the user to share content with friends using third-party communication channels and social media.
1.SR.2	The App allows the user to view and reflect on content added by other users, when this is public.
1.SR.3	The App allows users to generate content to describe their experiences with the App to capture their reflection and reinterpretation experience and share it (micro-blogging).

Table 13. Social reflections & interaction evaluation methods / Pilot 1

Indicator Type	Code	Indicator domain	Suggested measurement mode(s)	Requirement
User	PE	Number of interactions with shared content (all types) per user via third-party communication channels and social media	Analysis of user-generated data	1.SR.1
User	PE	Number of views made by a user on their interaction and feedback	Analysis of log files	1.SR.2 1.SR.3
System	FC	Perceptions of social interaction	Selection from: Survey / interview	1.SR.2 1.SR.3
Content	COP	Perceptions of comprehension –	Selection from: Survey /	1.SR.2

Indicator Type	Code	Indicator domain	Suggested measurement mode(s)	Requirement
		clarity of user-generated content	interview	1.SR.3
System	SQ	Measure of system quality and performance – number of discussions	Selection from: Log files / survey	1.SR.2 1.SR.3
User	AT	Attitude to using the technology to interact with others – user experience and satisfaction of contributing reflections	Selection from: Survey / interview / observation and transcripts / log files	1.SR.1 to 1.SR.3
User	REF	Reflections on knowledge through contributions and replies	Selection from: Interview / observation / analysis of user-provided data	1.SR.1 to 1.SR.3
System	EE	Effort expectancy: perceived ease of use and usability of interfaces for social interactions	Selection from: Survey / observation and transcripts	1.SR.1 to 1.SR.3
Content	TC	Trustworthiness of user contributions	Selection from: Survey / interview / observation and transcripts	1.SR.2 1.SR.3
User	SD	Socio-demographics: analysis of App users	Profiling data	1.SR.1 to 1.SR.3

3.1.5.5. Connection types and situation awareness

Pilot 1 focuses on the vast collection of the National Gallery, providing connections between paintings and the possibility to expand to external venues in the future. It links paintings that are not connected by locality, time or temporary exhibition, instead focusing on the personal preferences of the user. New connections can also be made with external Linked Open Data.

Table 14. Connection types requirements / Pilot 1

#	Requirements – Inter-venue connections
1.CTS.1	Paintings or POIs located in other European venues can be linked to the NG knowledge base and can be explored where available as Linked Open Data.
1.CTS.2	The App will help visualise connections between appropriate objects and topics from different venues.
1.CTS.3	The App will allow users to add new connections between appropriate objects and topics

Table 15. Connection types evaluation methods / Pilot 1

Indicator Type	Code	Indicator domain	Suggested measurement mode(s)	Requirement
Content	COP	Perceptions of comprehension /	Selection from:	1.CTS.1

Indicator Type	Code	Indicator domain	Suggested measurement mode(s)	Requirement
		understanding of the connections	Survey / interview	to 1.CTS.3
User	AT	Perceptions of user experience	Selection from: Survey / interview / observation	1.CTS.1 To 1.CTS.3
System	SQ	Measure of system quality and performance – all digital surrogates of physical objects will be connected to locations in the App	Log files	1.CTS.2
System	FC	Facilitating conditions for functionality associated with creating connections	Selection from: Survey / interview	1.CTS.1 to 1.CTS.3
User	PE	Performance expectancy / usefulness of the connection creation interfaces	Selection from: Survey / interview	1.CTS.1 to 1.CTS.3
Content	REQ	Perceptions of relevance and quality of the connections created	Selection from: Survey / interview /	1.CTS.2
User	REF	Reflections on knowledge associated with the creation of connections	Selection from: Interview / observation / analysis of user-generated reflections	1.CTS.2 1.CTS.3
System	EE	Effort expectancy: perceived ease of use and usability of connection interfaces	Selection from: Survey / interview	1.CTS.1 to 1.CTS.3

3.2. Pilot 2

3.2.1. Reflective history context

Pilot 2 connects four small venues, namely the Roman healing spa of Lugo (Spain), the Roman healing spa of Chaves (Portugal), the archaeological site of Montegrotto Terme (Italy) and the ancient theatre of Epidaurus (Greece). It aims to highlight the connections among the respective bodies of history and culture, as well as many traits of human behaviour, captured in the archaeology of the sites, that are still recognisable in our current society. This will be achieved by engaging visitors in a mobile game based on the exploration and completion of graphs of relevant concepts and interconnections, extracted from the CrossCult knowledge base. Some concepts in the graph will appear blank, and the players will have to fill them in by selecting the correct answer from a set of five choices. The sets of choices will be adapted to the (individual or collective) profiles of the players, based on age and level of knowledge. The game will consist of several rounds, each focusing on the connections related to a broad topic (e.g. “health”, “religion and pilgrimage” or “daily life”). It may be played individually or in groups, with or without live competition against other teams (from the same venue or different venues).

In terms of cognitive phenomena, pilot 2 aims to promote reflection (inspired by the choices offered in the game and the possibility of playing in teams), interpretative thinking (aided by experts from the venues, who may explain connections and tell stories in between two consecutive rounds or at the end of the game) and retrospective interpretation (due to opportunities to relate present and past).

The researchers have identified a large number of reflection topics, derived from general facts associated with chronology or archaeological evidence (e.g. ancient civilisations that lived in the areas of the four venues, the work of an archaeologist, the importance of context to interpret archaeological remains, etc.) to more specific facts related to the aforementioned topics (e.g. medical treatments related to mineral water and religion, health rituals, ancient forms of entertainment, places and activities of leisure, civil architecture, etc.). From these points, a number of stories will be written which will weave together the remnants of the ancient societies and narrate human behaviour patterns, actions and deeds that are drawn together by a common natural element such as water. Physical items from the different venues have been selected as a trigger to stimulate the process of learning and thinking, as they represent the relics of societies long ago, as an instance in the history of a particular place. Digital resources, in turn, will act as a complementary tool to the scenario and provide valuable information linked to the concepts explored in the game, enhancing user experience and instigating reflection. Finally, the pilot will empower crowdsourcing by asking the players to provide additional

connections between the concepts explored in the game and any items of tangible[2] or intangible[3] heritage they may know.

Pilot 2 has strategic value within the CrossCult project because there are many small and medium-sized museums around Europe but they have reduced visibility, failing to engage the people from the region (who may not see the point of returning after their first visit) and tourists (who prioritise larger venues because they do not know what they might find in small museums, what interest they might have in the artefacts they contain or how long a visit would take). The CrossCult platform offers the promise of greater visibility for these venues, and this may give them the incentive to develop good, fine-grained descriptions of their archaeological items and surroundings in relation to those of other venues (from large to small) around Europe.

3.2.2. High-level scenario

Introduction to the scenario

The aim of this scenario is to describe the process by which a typical user will discover and interact with pilot 2. It enables individual players or teams of players to compete to win a place in the Hall of Fame. They earn their place by answering questions that correspond to missing information and knowledge in the "mesh of nodes". The questions, which are in the form of an engaging quiz, are in a variety of formats, as are the answers. These formats will primarily be derived from one of the following interactions: (1) interacting with a map by selecting the correct location; (2) interacting with a timeline by picking the start and end point of a historical period/event; (3) interacting with a picture and choosing from a set of possible answers in text form and (4) interacting with text and selecting the correct picture response from a set. As they answer questions correctly the missing information in the "mesh of nodes" is filled in. The users are able to reflect on the mesh and the multiplicity of its connections and, in so doing, to enhance their own knowledge.

The Duvals in Padua: "families – non-experts"

The Duvals, a French family, are visiting Padua on holiday. It is very warm but Blandine (the mum) would really like to take the family on an excursion to an archaeology site in Montegrotto Terme. Her children Zoé (age 16) and Aimee (age 14) struggle with the heat and she can see that even her husband Florian is not keen on the idea. She persuades them by saying that the earlier they leave, the sooner they will be back in the swimming pool.

Committing to the game and downloading the App

[2] Tangible cultural heritage are materials and can be movable objects such as paintings or artefacts and immovable objects such as monuments and archaeological sites

[3] Intangible cultural heritage is what cannot be touched but which can be felt through other sensory organs, for example can be seen as in the case of a dance or performance or a play.

Zoé and Aimee fall quiet when they see the archaeological site. Upon entering, they notice an information panel about a game they can play during their visit. They can discover the historical site and learn about its connections to other European venues. Blandine asks whether the family would like to play and points at a sign saying "Enter the international Hall of Fame and win a 10% discount in our souvenir shop or café!" It sounds like fun! She promises the family they will earn an ice cream if they reach the Hall of Fame. This gives Zoé and Aimee the final push they need to try it out.

To play the game, they need to download the CrossCult App. They use their parents' smartphones and a tablet (3 devices in all). The devices can scan the QR code to get the link to download the App; they install it. When the devices are ready, Blandine creates a virtual playroom for the four people to play. Soon the devices have logged in and Florian indicates that his smartphone will be used by two people.

Once in the "*gamezone*", the four people enter their nicknames and take a selfie picture. Florian dislikes having his picture in the App and chooses an avatar instead. Then it is time for each player to take a quick test based on an image carousel and simple multiple-choice questions. The App uses this information to recommend who should be in which team on the basis of their personalities and levels of history knowledge. After three minutes, they have all completed the test. They learn that they can play as a single group or in teams. They decide to play against each other in two teams, to see who knows more.

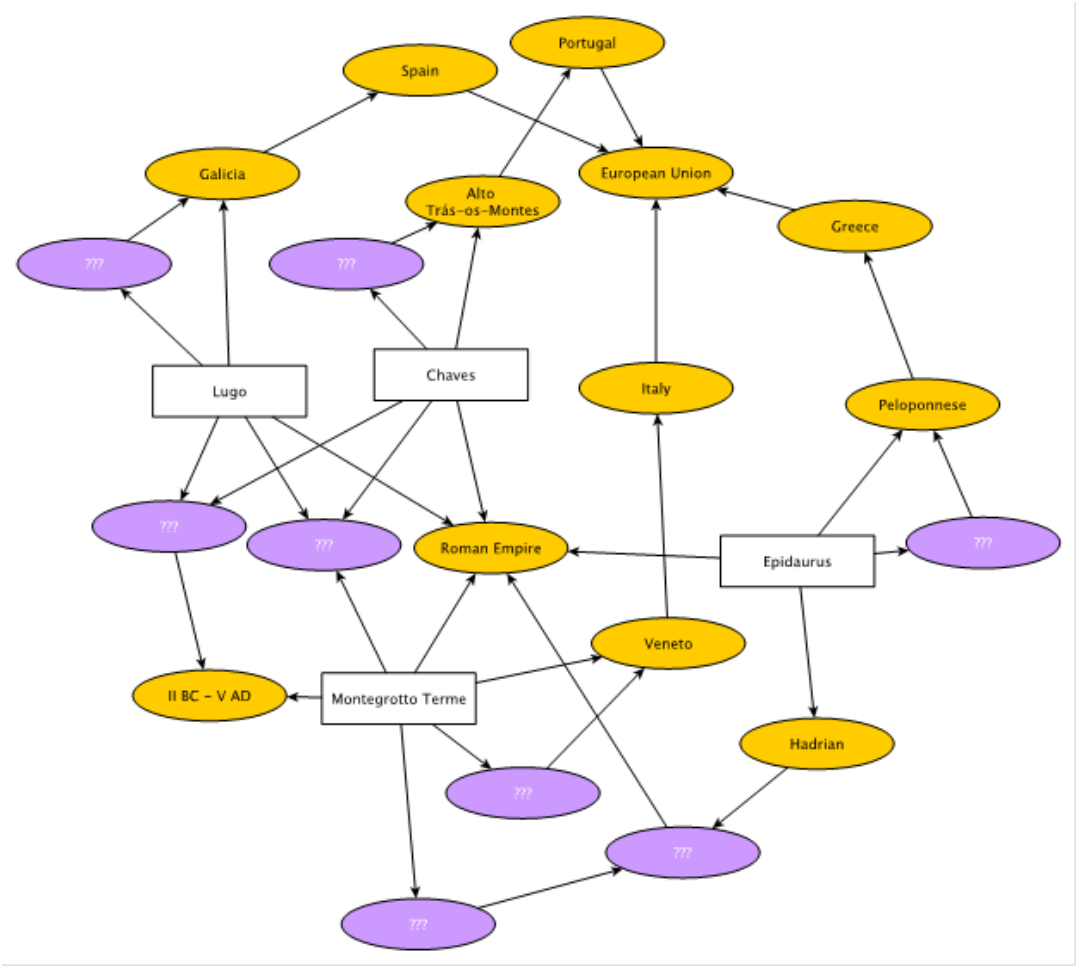
Organising teams

The App suggests that the most balanced teams would be Florian + Zoé versus Blandine + Aimee. They are profiled as "families – non-experts". The family accepts the profile, but they swap the teams to play as they do all games at home: Florian + Aimee versus Blandine + Zoé. Next, they assign devices to teams/players: Florian and Aimee will use his smartphone, whereas Blandine will use hers and Zoé will use the tablet. The game can start!

Exploring the "mesh of nodes"

After clicking the "Ready!" button, the devices display a splash screen with the text "Round 1: Discover other sites", and a "mesh of nodes" containing text and/or pictures appears on the screen, see Figure 3. The nodes are connected by labelled arrows (the labels are not shown in the picture below). There are four nodes corresponding to four cities: their current location of "Montegrotto Terme", and three new ones called "Lugo", "Chaves" and "Epidaurus". A few labels and images only show a question mark; these indicate gaps to be completed.

Figure 3. An example of a "mesh of nodes" of Pilot 2



Interacting with map and text questions

Zoé and Blandine dive into the questions immediately by clicking the *Lugo* node and the label "*is located in*". A map with four pinned locations is displayed and they must identify the location of Lugo, see Figure 4.

Figure 4. Example type of interaction with a map

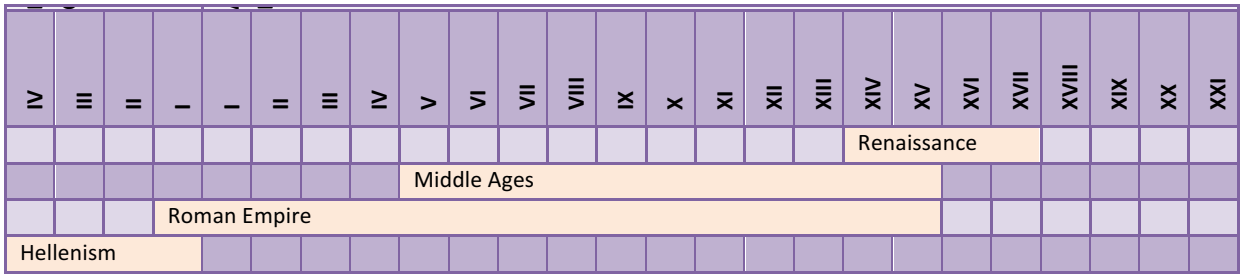
Where is the correct location of Lugo?

In the next question, Montegrotto Terme, Lugo and Chaves are linked to a *blinking* node through an arrow labelled "*has this type of archaeological site:*". Tapping on the node displays a menu of four possible choices as follows: (1) prehistoric caves (2) healing spa (3) cemetery (4) football stadium. These questions are easy to resolve by thinking logically.

Interacting with a timeline-type question

The sites of Lugo and Chaves have in common the existence of archaeological remains dating back to the same period, which the players have to place on a scrollable timeline. They can place two cursors (beginning and end) in any century from 10th century BC to 21st century AD. Some historical periods are shown to provide a few hints. Another hint is given in the "mesh of nodes", since Montegrotto Terme appears to be linked through an arrow labelled "has archaeological remains from …" to a node indicating "II BC – V AD", which is shown as containing the era of Lugo and Chaves, see Figure 5.

Figure 5. Example type of interaction with a timeline



Answering a picture question

The next question is a tough one. They are asked to identify a famous visitor to the site. They look at picture of a statue depicting the visitor. They have to select from 4 possible names: Aristotle, Tiberius, Zinedine Zidane or King Arthur.

Making connections with reflection

After a couple of minutes going through the questions, the players begin to make sense of the connections among the four sites: the archaeological sites of Montegrotto Terme, Lugo and Chaves are Roman healing spas, all the places were part of the Roman Empire at some time and Montegrotto Terme and Epidaurus received Roman emperors as visitors.

Revising responses and submitting answers

Florian and Aimee submit their responses one minute before the final countdown, whereas Blandine and Zoé run out of time. But they score more points because they answered more

questions correctly and their chronology placement was more accurate. With these scores, the two teams get ready for a new round.

Meeting the expert

The family plays three more rounds, sad to see that neither of the teams can make it into the Hall of Fame. Still, they are given the chance of scoring additional points with assistance from the museum staff. Having the offer from Blandine in mind and her eye set on a strawberry ice cream, Aimee quickly clicks the button to ask to meet the expert. They are told to go to the reception, and soon a French-speaking lady appears and invites them to take a seat nearby. The expert looks through the responses of the two teams and guides Blandine towards finding two further connections between the information in the "mesh of nodes". By contributing responses for these extra connections, they improve their score. Wow! They have made it into the Hall of Fame. They choose to publish their player names and photos/avatars. They certainly deserve that ice cream now!

Tamás and Zitá visit Epidaurus – "semi-experts"

Tamás and Zitá met each other during their archaeology course at university. Tamás is a Master's student in history, Zitá a second-year art historian. Their first holiday together is to the historic sites of Athens. They allocate one day to visit the theatre of Epidaurus, well known for its acoustics and importance in Roman history. At the entrance to the museum they see a poster describing the App and learn how they can explore the museum and its objects through digital gameplay. They find the App on Google Play and decide to download it. They will play as a team and after taking the test their profile is set as "young adults – semi-experts".

Answering a text question with picture responses and hints

Tamás and Zitá start playing together on Tamás' phone. Their first question is easy: Epidaurus is linked to an empty question node containing the text "Hadrian" through an arrow labelled "*was visited by…*". Tapping on the node they see a gallery of four pictures: they must choose the one that is Hadrian. From time to time, when they select an incorrect option, a flash screen appears on the mobile device displaying some funny or informative information that acts as a clue to discovering the correct answer.

Discovering connections through gameplay

During the game, Tamás and Zitá discover a lot of new connections among the four sites, related to the purposes of the buildings and to ancient societies: rituals related to health and fortune; therapeutic uses of water; gods and goddesses; theatre in southern Europe; symbols of animals, etc. They are happy with their new discoveries.

Building personal connections

After four rounds, their game is over, and they also call in the help of an expert. The expert reminds Tamás and Zitá that they can play again any time they feel like it. Indeed, they can see the scores of Blandine and Zoé and Florian and Aimee, who have just beaten their own scores with their knowledge. Blandine has linked a venue in Nancy (a French city) to others in Poland and Hungary. The couple decides to give the game another try later on while having a snack in the café, this time competing against each other. This time Tamás earns enough points to enter the Hall of Fame and win his reward, a discount in the museum shop.

Zitá takes the opportunity to use the option to share their experience on Twitter, tweeting "*Staged history; the real deal in Epidaurus! #Euripides*". In the meantime, Tamás decides to use his 10% discount on a book on Euripides from the shop, which he gives to Zitá.

3.2.3. Activity diagram and description

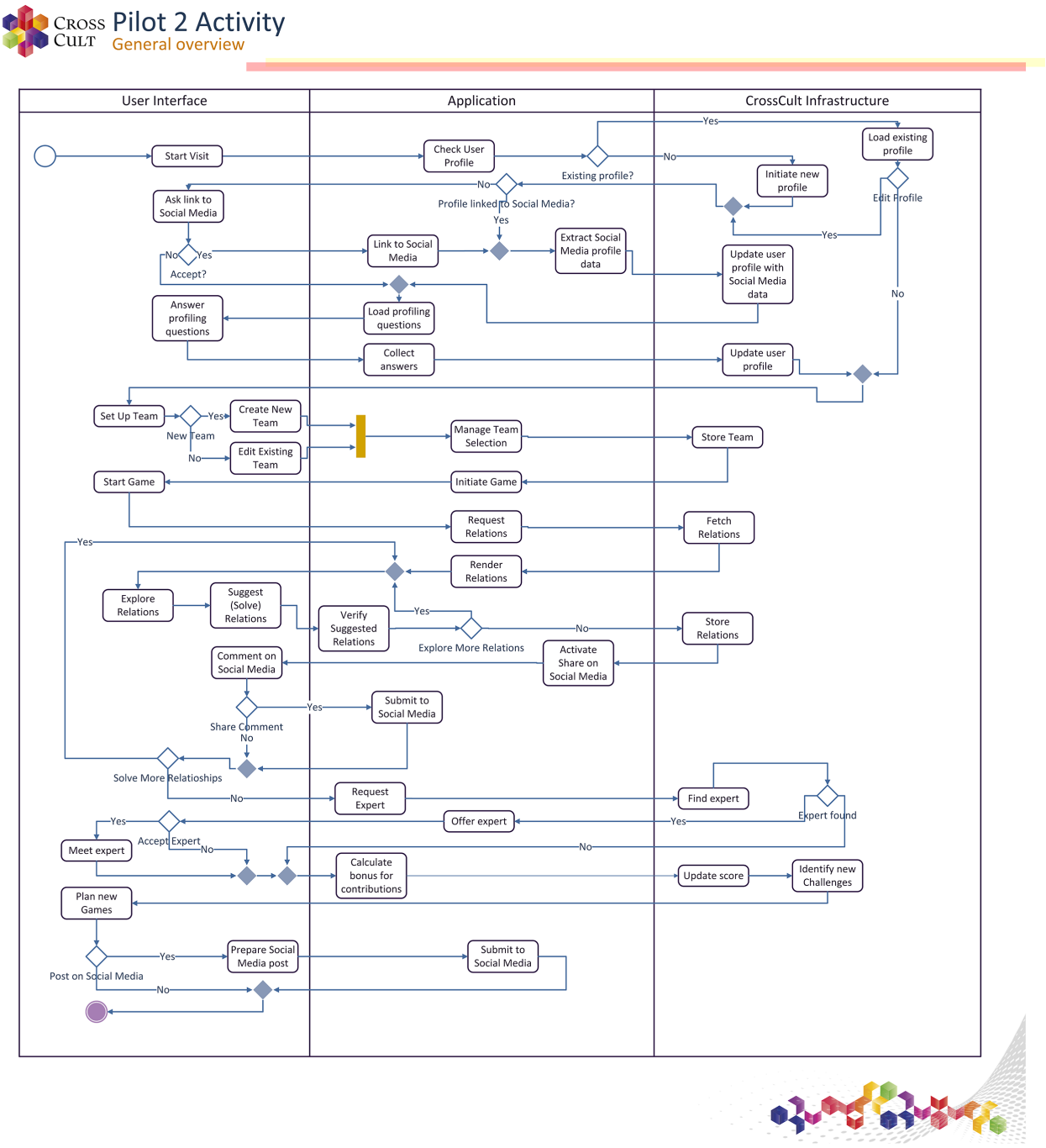
With the application installed on a mobile phone or a tablet the user registers with the application and obtains access using the login process as described above in section 3.1.3.1. After successful login, the user is offered the option to build a profile, which is then used by the App to identify the level of knowledge he/she has related to European history. This information is then used to provide a personalised experience. The process involves answering profiling questions and an optional flow of harvesting user preferences through social media.

When the profiling process is completed the user is ready to engage with core of the App - which is about winning a place in the hall of fame through resolving historical connections between people, places, events, time etc. The user starts the game and selects to compete against other users as a single player or as a member of team. The App initiates the game and makes available to the user a 'mesh of nodes' containing text and/or pictures of relations to be solved. The user reflects on the historical dimensions of the nodes engaging with a range of interactive elements while trying to resolve the relations. The user can solve the relations through: (1) interacting with a map by selecting the correct location of a place; (2) interacting with a timeline by picking the start and end point of a historical period/event; (3) interacting with a picture and choosing from a set of possible answers in text form and (4) interacting with text and selecting the correct picture response from one of a set. The user submits an answer and receives a score and continues to engage with App and to explore more relations until the game comes to an end. The user receives an overall final score based on the number and complexity of the relations resolved.

The user has the option to share via social media the experience and reflections attained while playing the game. The App enables the user to post comments on social media and to share the score. Additionally, the App provides the user with the option to ask for help from

an *Expert* to resolve more challenging relations. The user searches for an expert and the App suggests an available expert in the venue where the visit takes place. The user can accept help from the *Expert* to improve the score and enter the hall of fame and post further comments on social media. The user reaches to a final point where she can initiate a new game or exit the application.

Figure 6. Activity diagram for Pilot 2



3.2.4. Suggested datasets

In the tables below we describe a non-exhaustive suggested set of data resource associated with the pilot. These dataset resources are summaries of that documented in deliverable

D2.1 (Data management plan). Please note where possible datasets will be stored in the CrossCult Zenodo repository.

Table 16. Suggested datasets / Pilot 2

CrossCult-DS-pilot_2_visitor_profiles	
Description	This dataset includes all the information used to create the profiles of the visitors participating in the experiments of pilot 2. It will comprise anonymised information about the visitors who participate in the games, including socio-demographic data, cognitive style, and interests mined from social networks. Some information will be gathered through questionnaires and tests before the experiences.
Size - Format	Size: it is expected that the dataset will contain up to a few hundred profiles, with up to a few Kbytes for each participant. Format: the information will be stored in the form of XML or JSON files containing the answers to the questionnaires and the findings obtained through social mining.
Openness	This dataset may be used by researchers worldwide to run experiments with similar or different profiles in order to replicate the published research results and appraise differences according to whichever parameters: local culture, previous background, relationship to the historical contents of the venues, etc.
Availability-Retrieval	The actual information posted in the social network accounts will never be stored to prevent any identity guessing. The rest of the information files will be stored and made available to worldwide researchers through the project repositories, with no restrictions. Martín López-Nores will be responsible for the dataset and the person to contact for getting hold of the data.

CrossCult-DS-pilot_2_ontology_extensions CrossCult-DS-pilot_2_literals	
Description	This dataset will be used to model the knowledge about the items from the four venues participating in pilot 2. This dataset will be composed of upper-level ontology classes and a set of specialisation (extensions) required for describing the types and relationships required and the actual literal data related to the collection. The basic data will be augmented using related concepts such as geographical data and related vocabulary terms and connected to external sources of information (Wikidata, Wikipedia) and other museums APIs (BM, Europeana).
Size - Format	Size: The dataset will be structured as a collection of files one per venue. Format: the dataset will be expressed in a standard semantic web serialisation.
Openness	The ontology extensions will be shared with any interested researcher through the project's general repository. The literals may be subject to access restrictions, derived from the venue's Intellectual Property policies. Open, unrestricted access will be granted wherever possible.

Availability-Retrieval	The data will be made available through the project repositories. Martín López-Nores will be responsible for these datasets and the person to contact for getting hold of the data.

CrossCult-DS-pilot_2_venue_profiles	
Description	This dataset includes the description of the venues participating in pilot 2, their infrastructure and exhibition characteristics. Initially, it will contain data of the four venues identified in the proposal: the Roman healing spa of Lugo (Spain), the Roman healing spa and the city of Chaves (Portugal), the thermomineral site of Montegrotto Terme (Italy) and the archaeological site of Epidaurus (Greece). Later on, data about venues involved through the CrossCult Living Lab will be added, too. The information will cover the description of the facilities, including area, number of rooms, maximum capacity, opening hours and dates, availability of toilets, cafeteria, bookshop and souvenir shop. In addition, venue profiles will include keywords or tags to drive the identification of relevant dates or topics to link several venues. The latter will be a dynamic set, as the project members or external researchers may add new tags and keywords at any time (e.g. due to new inputs or even extensions in the exhibition collections).
Size - Format	Size: the dataset will be structured as a collection of files, one per venue, up to several Kbytes each. Format: the dataset will contain structured data expressed in an appropriate format, such as XML or JSON. No special tools are deemed necessary beyond general-purpose editors.
Openness	This dataset may be used by researchers worldwide to run experiments with similar or different profiles in order to replicate the published research results and appraise differences according to whichever parameters: local culture, previous background, relationship to the historical contents of the venues, etc.
Availability-Retrieval	All the information files will be stored and made available to worldwide researchers through the Zenodo repository, with no restrictions. Martín López-Nores will be responsible for the dataset and the person to contact.

CrossCult-DS-pilot_2_multimedia_contents	
Description	This dataset will include the multimedia resources provided by the venues involved in pilot 2, which may be used to create stories to be told to the participants in the experiments. The intended resources include text, images, video and audio clips, animations, 3D shapes, AR contents, external links, and any other formats. Descriptive metadata will contain semantic characterisations for every resource. Additional material will be linked from open online sites like Wikipedia. It is foreseen to include short clips (up to 30 seconds long) extracted from classical European movies, too.
Size - Format	Size: the information volume will be strongly dependent on the final scripts of the

	experimental pilots and the resources selected from the venues repositories and other sources. The forecast is around several Gbytes. Format: the multimedia resources will use the common and standard multimedia formats. Transcoding may be used wherever necessary. The descriptive metadata will rely on MPEG-7 standard vocabularies as far as possible, describing relevant details of the files, their technical characteristics and semantic annotations. In addition, a global metadata file will be created that will declare all the items contained in the dataset, their structure, ordering scheme and access terms.
Openness	The data will be shared with any interested researcher through the project's general repository in Zenodo. Both the multimedia contents and the descriptive metadata may be subject to access restrictions, derived from the venues' Intellectual Property policies. Open, unrestricted access will be granted wherever possible to allow worldwide researchers to arrange experiments with the same or different combinations of materials in order to check the learning differences according to whichever parameters: local culture, previous background, relationship to the historical contents of the venues, etc.
Availability-Retrieval	Access to the dataset will be possible through the global asset declaration provided in the root of the repository that will announce all the items of the dataset, their name, classification, associated metadata and access rights.

CrossCult-DS-pilot_2_game_scenarios	
Description	This dataset will contain information about the content available in the game scenarios for the users participating in the experiments of pilot 2. It will contain predefined graphs of concepts and relationships to explore, attached sets of choices for the concepts that will be left blank (including different sets for different individual/team profiles and locations) and attached multimedia contents. The scenarios will be developed by CrossCult humanities experts.
Size:	Size: dependent upon number of users participating in the quizzes Format: the dataset will contain structured data expressed in an appropriate format, such as XML or JSON
Openness	All the information files belonging to this dataset will be freely available. They may be used by worldwide researchers, e.g. as a reference to evaluate the operation of algorithms trying to automate any part of the experts' design work.
Availability-Retrieval	All the information files will be stored and made available to worldwide researchers through the project repositories, with no restrictions. Martín López-Nores will be responsible for the dataset and the person to contact.

CROSSCULT-DS-pilot_2_Interview_ Transcripts	
Description	This dataset provides the user responses to the interviews that will be performed during the evaluation phase of the project and will be designed around the unified theory of users acceptance of technology. Data will be collected during pilot 2 evaluations, consisting of anonymised transcripts of interviews. The dataset could be used by any interested researchers. It is expected that the dataset can contribute to an understanding of the users' acceptance of the CROSSCULT technology and to an article based on this study. It will also inform the evaluation framework.
Size - Format	Size: dependant on the number of participants and what they have to say. The volume of information that will be stored is likely to be small Format: It will be made available as a set of .docx documents for each transcription.
Openness	The dataset will be made available on the general project repository made available with a Creative Commons with attribution license.
Availability-Retrieval	The files will be available to worldwide researchers through the project repositories. No costs are foreseen for long-term storage.

CrossCult-DS-pilot_2_visitor_interactions_and_staff_observations	
Description	This dataset comprises records of individual/collective interactions during the pilot 2 experiences, including visitors' interactions (tweets, posts, replies to questionnaires, votes, …) linked to the corresponding profiles from the *CrossCult-DS-pilot_2_visitor_profiles* dataset, as well as observations from the guiding staff of the venues (e.g. about the mood of the team discussions, amounts of idle time, etc). The data items yield indicators and measurements of the quality of the experience.
Size - Format	Size: there will be one file per game played, grouping the different contributions of every participant. They will be differentiated by their role: visitor, expert and staff. The volume of information that will be stored is small, expecting several Kbytes for each participant at the most (up to a few Mbytes per experimentation session). Format: the stored information will consist of XML or JSON files structuring all their contributions and interactions.
Openness	This dataset may be used by worldwide researchers to run experiments with similar or different profiles in order to replicate the published research results and appraise differences according to whichever parameters: local culture, previous background, relationship to the historical contents of the venues, etc.
Availability-Retrieval	All the information files will be stored and made available to worldwide researchers through the project repositories, with no restrictions. Martín López-Nores will be responsible for the dataset and the person to contact for getting hold of the data.

3.2.5. Requirements and associated evaluation metrics

3.2.5.1. General requirements

This section describes the more general, high-level requirements that the App for pilot 2 is expected to deliver.

Table 17. General requirements / Pilot 2

#	General requirements
2.GEN.1	The pilot 2 App is a cross-platform mobile application (e.g. Android and/or iOS).
2.GEN.2	The App will be made public on the application market of the targeted platforms. The App will be designed to be installed on users' personal devices.
2.GEN.3	The main devices targeted for the App are smartphones. A tablet version can be developed in a second phase.
2.GEN.4	The App must allow the game to be played individually or in teams, in isolation or in live competition against other individuals or teams (in the same venue or different venues).
2.GEN.5	The App must allow several members of a team to play using the same device.
2.GEN.6	The App must be multilingual (i18n-compliant).
2.GEN.7	The user's explicit consent must be obtained to build a profile and gain access to posted comments introduced by him / herself on social networks.
2.GEN.8	The App must enable users to reflect on items of tangible and intangible heritage, fostering a cross-border perspective.
2.GEN.9	The App must engage and motivate users to discover cross-border relationships.
2.GEN.10	The App must attract new users and allow dissemination through social media.
2.GEN.11	The App must help increase the visibility of the venues.

Table 18. General requirements evaluation method / Pilot 2

Indicator domain	Type of user	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	Visitor	SQ	Measure of system quality and performance	Selection from: Log files / survey	2.GEN.1 to 2.GEN.6
User	Visitor	AT	Attitude to using the technology (user experience and satisfaction)	Selection from: Survey / interview / observation and transcripts	2.GEN.8 to 2.GEN.10

System	Visitor	FC	Facilitating conditions for functionality that enable reflection on historical and societal themes across venues	Selection from: Log files / survey	2.GEN.8 to 2.GEN.10
User	Visitor	PE	Performance expectancy / usefulness	Selection from: Survey / interviews	2.GEN.8 to 2.GEN.10
	Venue staff	PE	Performance expectancy / usefulness	Selection from: Survey / interviews	2.GEN.11
Content	Visitor	REQ	Perceptions of relevance and content quality	Selection from: Survey / interview / observation and transcripts	2.GEN.8 to 2.GEN.11
Content	Visitor	TC	Perceptions of trustworthiness / credibility of the data	Selection from: Survey / interviews	2.GEN.8 to 2.GEN.10
User	Visitor	SD	Socio-demographics	Survey	2.GEN.8 to 2.GEN.10
User	Visitor	REF	Reflections on knowledge	Selection from: Interview / observation / analysis of reflections	2.GEN.8 to 2.GEN.10
System	Visitor	EE	Effort expectancy: Perceived ease of use and usability	Selection from: Survey / observation and transcripts	2.GEN.8 to 2.GEN.10
User	Visitor	HB	Habit	Survey	2.GEN.8 to 2.GEN.10
	Venue staff	HB	Habit	Survey	2.GEN.11
Content	Visitor	COP	General comprehension and clarity of the content	Selection from: Survey / interview / observation and transcripts	2.GEN.8 2.GEN.9

3.2.5.2. Content

In Pilot 2, digital resources have to coexist and create a mesh of interrelated weaves between the physical objects that the user has in front of him/her during visits to any of the four venues – the cities of Lugo (Spain), Chaves (Portugal), Montegrotto Terme (Italy) and

Epidaurus (Greece), the digital resources that will appear on the screen (smartphone/ tablet) and the concept provided by the scenario he/she is following. The mingling of these three elements should lead him/her to reflect on the connections. Physical objects exhibited at the venue(s) will act as a means to encourage the process of learning and thinking as they observe the relics of a society long gone, an instance in the history of a particular place. These objects act as a glimpse in time and place of what people of past ages have left behind. Semantic metadata related to each venue will therefore trigger reflection points, and multimedia content in the form of text, pictures, videos or collages will be shown to underpin player retention.

The digital content will be predominantly owned by the venues, but there will be linked data resources derived from many disparate web-based information resources (e.g. Wikipedia, Wikimedia, Youtube or Europeana). For more information about the datasets see section 3.2.4.

Table 19. Content requirements / Pilot 2

#	Requirements – Content
2.CON.1	The App must provide access to selected digital resources from one or more online data resources.
2.CON.2	The App must display interactive graphs of concepts and relationships (a "mesh of nodes"), involving items from different venues.
2.CON.3	The App must display relevant data and information (descriptive metadata, sources, references and linked multimedia content, if available) following the user's interactions with the graphs.
2.CON.4	The App must display information tailored to the visitor profiles (multiple choices tailored to age and level of knowledge).
2.CON.5	The App must allow the post and exchange of comments relevant to specific venue artefacts (objects) and topics in social networks.
2.CON.6	The App must allow visitors to enter new connections in the form of text and URL links.

Table 20. Content evaluation method / Pilot 2

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	System quality and performance: Number of solved questions and completed graphs	Log files	2.CON.2 to 2.CON.4
	SQ	System quality and performance:	Log files	2.CON.1

		Number of multimedia objects		to 2.CON.4
	SQ	System quality and performance: Number of comments per user	Log files	2.CON.5
	SQ	System quality and performance: Number of user-provided connections	Log files	2.CON.6
User	AT	Attitudes of user to using the technology, user experience and satisfaction of interactions and discovery of content	Selection from: Survey / interview / observation and transcripts	2.CON.1 to 2.CON.6
System	FC	Facilitating conditions for functionality	Selection from: Log files / survey	2.CON.1 to 2.CON.6
User	PE	Performance expectancy: usefulness of the interactions with content	Selection from: Survey / interviews	2.CON.1 to 2.CON.6
Content	REQ	Perceptions of relevance and content quality	Selection from: Survey / interview / observation	2.CON.1 to 2.CON.5
Content	TC	Perceptions of trustworthiness / credibility of the linked data	Selection from: Survey / interviews / log files	2.CON.1 to 2.CON.5
User	REF	Reflections on knowledge	Interview / observation/ analysis of reflections	2.CON.2 to 2.CON.6
Content	COP	General comprehension and clarity of the content	Selection from: Survey / interview / observation and transcripts	2.CON.1 to 2.CON.6

3.2.5.3. Content delivery mode

Pilot 2 poses a puzzle/quiz hybrid game whereby users are required to fill in the blanks of a graph of concepts (the "mesh of nodes") and define the relationships between related items from different venues. The activity of going through the blanks and replying to questions is the main driver of content presentation. The selection of right and wrong choices may trigger micro-augmentations[4] about topics more or less directly related to the core messages of the graph. Micro-augmentations showing indirect relations are useful to foster aspects of retention and serendipity.

[4] A micro-augmentation in pilot 2 is defined a blend of stimuli intended to draw the users' attention for a very short time

Table 21. Content delivery requirements / Pilot 2

#	Requirement – historical content delivery mode
2.CDM.1	The App will trigger content based on the users' interactions with the graph of concepts and relationships (clicking on any node with attached content, clicking on a blank node).
2.CDM.2	The sets of choices offered to fill in a blank will be tailored to the age and level of knowledge of the individuals and teams.
2.CDM.3	The App will trigger content delivery using micro-augmentations linked to certain right/wrong choices in the game.
2.CDM.4	The App will support multiple modes of content delivery through the use of multimedia material (e.g audio, text, video, etc.).
2.CDM.5	In live competition between individuals or teams, the sequencing of different graphs will be synchronised.

Table 22. Content delivery evaluation metrics / Pilot 2

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	Measure of system quality and performance of content delivery	Selection from: Survey / interview / observation	2.CDM.1 to 2.CDM.5
User	AT	Attitude to using the technology (user experience and satisfaction at the content delivery interactions)	Selection from: Survey / interview / observation and transcripts	2.CDM.1 to 2.CDM.5
System	FC	Facilitating conditions for functionality for the delivery of multimedia content and graph sequencing	Selection from: Survey / interviews	2.CDM.1 to 2.CDM.5
User	PE	Performance expectancy / usefulness of content delivery interactions and interface	Selection from: Survey / interviews / questionnaire	2.CDM.1 to 2.CDM.5
Content	REQ	Perceptions of relevance and content delivery quality for the "mesh of nodes"	Selection from: Survey / interview / observation and transcripts	2.CDM.1 to 2.CDM.5
System	EE	Effort expectancy: perceived ease of use and usability of content delivery interactions	Selection from: Survey / observation / transcripts / questionnaire	2.CDM.1 to 2.CDM.5

Content	COP	General comprehension and clarity of the content of the "mesh of nodes"	Selection from: Survey / interview / observation and transcripts	2.CDM.1 to 2.CDM.5

3.2.5.4. Individual reflection

The development of pilot 2 must facilitate reflection according to the specified topics that connect the venues of Lugo, Chaves, Montegrotto Terme and Epidaurus. Digital resources should present points and key elements for reflection on healing practices, medical treatments and religion through time, place, cultural context, technology, knowledge and understanding of nature, and can be enhanced using the venue's objects and the diversity of the Semantic Web. Reflection will essentially be driven by the consideration of the multiple choices which motivate users to complete the blanks (missing information) in the game, with brief deviations in the form of micro-augmentations, possibilities to interact with museum staff after the game finishes, and means for users to enter additional links to enrich the knowledge bases.

Table 23. Reflection requirements / Pilot 2

#	Requirements – Individual reflection
2.RFN.1	The App must enable users to browse the graph of connections among different concepts and venues (dragging and re-arranging nodes, zooming in and out, displaying contents attached to nodes, etc.).
2.RFN.2	The App must display different types of multiple-choice sets and reward users for right or wrong choices.
2.RFN.3	The App must be able to deliver micro-augmentations involving concepts related to right and wrong choices in the game.
2.RFN.4	The App must offer means to enter new links in relation to the concepts explored in the game.
2.RFN.5	The App must make it easy for users to contact museum staff to encourage reflection.

Table 24. Reflection evaluation methods / Pilot 2

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Associated requirement
User	AT	Attitude to using the technology: user experience and satisfaction at reflection modes and interfaces	Selection from: Survey / interview / observation and transcripts	2.RFN.1 to 2.RFN.5
User	PE	Visitor performance expectancy / usefulness of methods and interactions for gathering reflections	Selection from: Survey / interviews	2.RFN.1 to 2.RFN.5

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Associated requirement
	PE	Museum staff performance expectancy / usefulness of process for reviewing players' reflections	Selection from: Survey / interviews	2.RFN.5
Content	REQ	Perceptions of relevance and content quality of user-generated reflections	Selection from: Survey / interview / observation and transcripts	2.RFN.1 to 2.RFN.4
User	REF	Reflections on knowledge: understanding of individual reflections contributed	Selection from: Interview / observation/ analysis of reflections	2.RFN.1 to 2.RFN.5
System	EE	Effort expectancy: perceived ease of use for contributing reflections	Selection from: Survey / observation and transcripts	2.RFN.1 to 2.RFN.5
System	FC	Facilitating conditions for micro-augmentations of game hints	Consistency rules	2.RFN.3

3.2.5.5. Social reflections & interaction

Describes the means by which a community/group of users interact and co-create reflection

Pilot 2 will enable social interaction between players by allowing visitors to play the exploratory game in teams so they have the opportunity to discuss the correct response (and potentially even vote on the correct answer). When players decide to fill in the blanks of the graph of concepts (the "mesh of nodes" and relationships), they are presented with multiple-choice questions. The members of a team may discuss face to face as they observe the physical object and examine the mesh of nodes, or via the chat facility integrated into the App. If players are competing in real time against other individuals or teams, there will also be a chat feature to exchange messages. Player will also have the option of posting messages to social networks to foster additional collective reflections (depending on whether the users grant the relevant permissions), even with people who have not played with the CrossCult Apps before. This will help raise awareness of both the App and the museum.

Table 25. Social reflections & interaction requirements / Pilot 2

#	Requirements – Social reflections and interactions
2.SR.1	The App must enable players to form teams, whose members, in sync, will go through the questions posed by the game.
2.SR.2	The App must let the members of a team discuss the choices before filling in a blank in the "mesh of nodes" via a chat feature.
2.SR.3	In cases of live competition between several individuals or teams, the App will enable

#	Requirements – Social reflections and interactions
	messages to be exchanged through chat.
2.SR.4	The App will allow users to share items and comments on social networks.
2.SR.5	The App must enable teams to vote for a multiple choice answer and then select the answer from the most voted-for choice.
2.SR.6	The App should provide a feedback system to notify users of reactions and/or other users' contributions related to their input

Table 26. Social reflections & interaction evaluation methods / Pilot 2

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Associated requirement
System	SQ	Measure of system quality and performance – Number of discussions	Selection from: Log files / survey	2.SR.1 to 2.SR.6
User	AT	Attitude to using the technology: user experience and satisfaction of game play in teams	Selection from: Survey / interview / observation and transcripts	2.SR.1 to 2.SR.6
System	FC	Facilitating conditions for functionality for social interactions and team playing	Selection from: Log files / survey	2.SR.1 to 2.SR.6
User	PE	Performance expectancy: usefulness of game play in teams	Selection from: Survey / interviews	2.SR.1 to 2.SR.5
User	REF	Reflections on knowledge through discussions and voting	Selection from: Interview / observation / analysis of reflections / qualitative analysis of user interactions	2.SR.1 to 2.SR.5
System	EE	Effort expectancy: Perceived ease of use and usability: discussions and exchanges	Selection from: Survey / observation and transcripts	2.SR.1 to 2.SR.4
Content	COP	General comprehension and clarity of the team interactions and discussions	Selection from: Survey / interview / observation and transcripts	2.SR.1 to 2.SR.6
Content	TC	Trustworthiness of the interactions and exchanges between players	Selection from: Survey / interview / observation and transcripts	2.SR2 to 2.SR.6

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Associated requirement
User	SD	Socio-demographics: analysis of the museum visitors through user profiles of contributors	Profiling data	2.SR.1 to 2.SR.5

3.2.5.6. Connection types and situation awareness

Pilot 2 focuses on exploring connections among items and topics from different venues, previously curated by experts assisted by the CrossCult platform. For the venues of Lugo, Chaves, Montegrotto Terme and Epidaurus, the humanities researchers have chosen to develop the connections around the topics of healing through the use of water, thereby introducing the diversity of art objects, social traits, religious manifestations, nature and technology linked to these healing rituals. The game will be arranged into successive stages: the first looks at general venue connections related to the features of time, space and key historic events, and subsequent stages will develop the concepts of "*Health*", "*Leisure & daily life*", "*Waters*", "*Trips & communication routes*" and "*Religion & pilgrimage*". Digital resources will underpin the multifaceted perspective of healing by using the venues' objects and their surroundings as a proof of situation awareness.

Additionally, the visitors will be able to enter new connections about any items of tangible or intangible cultural heritage they are familiar with and their relation to concepts explored in the game. Such contributions may be validated by experts and will subsequently be rewarded with extra points in addition to the scores already attained.

Table 27. Connection types requirements / Pilot 2

#	Requirement – Intra-venue connections
2.CTS.1	The App will help visualise connections among items (historic objects) and topics from different venues.
2.CTS.2	The graphs of successive rounds of the game will focus on connections linked to different topics.
2.CTS.3	The concepts included in the graphs may be connected to digital data resources selected in relation to the reflection topics.
2.CTS.4	The App will enable new connections to be entered involving any items (historic objects) of cultural heritage that the visitors may know in relation to the concepts explored in the game.

Table 28. Connection types evaluation methods / Pilot 2

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Associated requirement
System	SQ	Measure of system quality and performance: all items (objects) are connected to the graph.	Log files	2.CTS.1 2.CTS.3 2.CTS.4
System	SQ	Measure of system quality and performance: connections between items linked to different venues.	Log files	2.CTS.2
User	AT	Attitude to using the technology (user experience and satisfaction) associated with interactions to define connections.	Selection from: Survey / interviews / questionnaire	2.CTS.1 to 2.CTS.4
System	FC	Facilitating conditions for functionality associated with creating connections.	Selection from: Survey / interviews / questionnaire	2.CTS.1 to 2.CTS.4
User	PE	Performance expectancy / usefulness of the connection creation interfaces.	Selection from: Survey / interviews	2.CTS.1 to 2.CTS.4
Content	REQ	Perceptions of relevance and quality of connections created.	Selection from: Survey / interviews/ questionnaire	2.CTS.1 to 2.CTS.4
User	REF	Reflections on knowledge associated with connection creation.	Selection from: Interview / observation / analysis of reflections	2.CTS.1 to 2.CTS.4
System	EE	Effort expectancy: perceived ease of use and usability of interactions that connect content.	Selection from: Survey / interviews / questionnaire	2.CTS.1 to 2.CTS.4
Content	COP	General comprehension and clarity of the connections.	Selection from: Survey / interviews / questionnaire	2.CTS.1 to 2.CTS.4

3.3. Pilot 3

3.3.1. Reflective history context

Pilot 3 will be implemented at the Archaeological Museum of Tripolis, Greece. This is a small museum with low visitor numbers although there are some very interesting items housed here. Pilot 3 will aim to present Greek ancient history from a different angle than that of other archaeological museums. It aims to engage visitors in exploring and understanding the unexpected connections between objects in the museum. Relevant additional information will be provided to encourage further exploration. The pilot will focus on the topic of women in ancient Greece, which functions as a cross-cutting topic that links many of the artefacts in the museum.

This topic differs from the usual approach to history, which focuses on major events and great characters (most often male). The topic of women can reveal stories about different aspects of ancient societies. The history of women in general is a subject that has only begun to be researched recently but the conclusions remain in the hands of experts. The aim of pilot 3 is to increase awareness and understanding among the public of the important aspects of women's role in society. Starting with women in ancient Greece, the goal is not only to increase visitor knowledge but also to stimulate reflection and interpretation using a unique combination of physical objects and digital resources.

Pilot 3 will use open historical resources linked together to facilitate comparisons with the situation of women across ancient and modern societies. Narratives will be created and personalised in various ways, seeking to raise empathy: the itineraries that each individual will follow, the contents he/she will browse, the text he/she will read or hear, etc. The mobile App plays an important role in profiling the visitors even before they start their visit. The virtual visitor's book offered by the App is a place to gather new, subjective interpretations of history. The purpose is twofold: (1) to provide new user evidence that the venue experts can study later on to acquire knowledge about the visitor experience, and (2) to enrich the CrossCult knowledge system through user-generated content via the App's sharing and reflection mechanism.

Traditionally, archaeological museums provide information in the form of label descriptions, usually explaining what the object is and where and when it is from. In pilot 3, the App will enrich and enhance the physical exhibits of the museum with different digital objects from museums and sites around the world and other digital resources (such as videos, audio material and images). This will provide a more holistic view of the available evidence associated with the different topics and will lead to more in-depth understanding. After extensive observations at the museum and in close cooperation with the museum director and staff, thematic areas relevant to women in antiquity have been identified. For example, women will be studied and presented from the perspective of education, daily and domestic life, religion, appearance, etc. For each thematic area, physical objects, digital objects and

topics for reflection will be combined to allow users to engage with history interpretation and reflection. Users will be able to share their reflections and views on the themes using both social interaction technology integrated into the App or via more commonplace methods such as Facebook.

Pilot 3 has strategic importance to the CrossCult project due to the significant number of small local museums that house fascinating objects of public interest but have difficulty competing against larger museums and galleries that draw considerable visitor numbers. The CrossCult platform therefore highlights the need for new imaginative methods that harness technology, digital resources and the physical discovery of museum objects together with visitors' desire for personalised visits. The result should motivate visitors, stimulate reflection and enhance the museum experience. In addition, pilot 3 will use 5 mini games to promote the App, create personalised digital souvenirs, attract new users and facilitate broader dissemination of information about the museum and its games by harnessing players' social networks. The benefits of the mini games are manifold: personalisation, dissemination and post-visit reminders will be used in CrossCult to show how mini games can enhance the cultural experience. It should be noted that these games will be designed in a way that could be reused for the purposes of other museums (generic design).

3.3.2. High-level scenario

Introduction to the scenario

This scenario is composed of two user stories, both based in the museum. The first story outlines using the App to interact with different personalised narrative routes through the museum, exploring both physical and digital objects on the way. As users uncover engaging video images or points of reflection they can interact with each other and share interesting object discoveries via the CrossCult framework. In the second user story, users interact with a Facebook game to spark their interest in the museum and to contribute profile information which is used to provide personalised routes through the museum.

Jane, Susie and April interrailing through Europe to discover its cultural heritage

Discovering the App

Jane, Susie and April use their last summer holiday before university to interrail around Europe, discovering different cultures and visiting cultural heritage sites and venues. In their high school senior year in Helsinki, Finland, they studied the beginnings of modern society, and decided they wanted to see the remains for themselves, so they headed to Greece. Having visited other more famous museums across Europe, including the National Gallery in London, where they learnt about the CrossCult App and received a recommendation to visit the Archaeological Museum of Tripolis, they think the museum sounds interesting and worth a visit once they arrive in Greece.

On their arrival at the museum, Jane and her friends are intrigued by the possibility of following a personalised tour through the small museum and its objects rather than following a more traditional linear route. Jane, who has used the App before, invites Susie and April to install the App as well. Susie and April register with a username and password and provide their gender and age.

Getting started: choosing a tour theme

At the museum entrance, they each receive headphones to plug into their mobiles. Upon entering, the App displays a list of possible topics (Appearance, Mortality, Nudity, Religion & Rituals, Social Status, Education, Healing Practices, Daily Life, etc.) that the girls can choose from. The App uses their age and gender to suggest different museum topics that they might be more interested in. Since April is younger than the other girls, a different profile is created for her. Jane selects the topic "Appearance", while Susie chooses the second option "Daily Life". April picks "Education". These selections will take them separately through different parts of the museum, but they will be able to exchange messages (in the form of typed text or audio messages) and pictures through the App.

Following a theme: connecting to different objects

The girls head off in different directions, each following a route personally suggested to them. They listen to the audio direction to discover where to go. Simultaneously, the girls follow a map of the museum.

Multimedia enhancement and enrichment of objects

Jane is first taken to a relief of a woman, child and man. Jane scans the QR code next to the statue. She listens to a historical overview of the way women dressed in antiquity and the significance of the dress code they used (e.g. different clothes for women and girls). Some artefacts from other European museums showing women's and girls' dresses appear on her screen. She is asked to observe the differences in the appearance of men, women, mortals, immortals, old and young in the different museum items to learn more about the dress code and is then given the option of viewing a video. This is a short social psychology experiment showing bystander intervention studies and how people react to victims wearing different clothing. She learns that clothing is not only an aesthetic choice but that it can signify and reflect many diverse social dimensions.

Sharing content among friends

Jane is guided to another room where she can observe differences in women's hair and jewellery. She has the option of watching another short video showing modern practices in jewellery making. Jane is asked to reflect on the issue of ancient jewellery making (what tools did they use? How easy was it to find gold and precious stones? How accessible was

jewellery for women?). At the end of the video, an image is presented to Jane: a modern Greek orthodox nun next to Roman women in bikinis (a 4th-century AD mosaic). She shares the image via the App with her friends and adds a short comment: "Religious clothing, traditional clothing and ancient clothing seem to reflect societal values". She can explore the issue later, when she goes back to the hotel. She sees that the App provides her with access to other resources and a game to explore fashion in antiquity and in the present day.

Reflecting on thematic areas

Meanwhile, the App guides Susie to another room. She has chosen to follow the narrative of daily life and is therefore given information about the life of women at home in ancient Greece. Susie scans a QR code of an object and listens to a traditional Greek song about the importance of dowries. In ancient Greece, mothers and daughters would weave together to prepare the daughter's dowry. Relevant images of women weaving in ancient Greece are presented to her. She compares two images that are presented, see Figure 9.

Figure 7. Example of two images presented side by side in Pilot 3

Image source:
a) http://www.metmuseum.org/toah/works-of-art/31.11.10/
b) http://www.metmuseum.org/toah/works-of-art/75.2.11/

She is impressed by the second one. She wonders how it was to be a woman in ancient Greece. Could a woman marry without dowry? An image of St Nicholas giving dowries to poor girls appears, implying that it was very difficult for women to marry without a dowry. She wonders what the practice is in modern Greece and in other places. Susie chooses to watch a few short documentaries about dowry practices.

Viewing objects on a map and seeing a 360° view of the location

Meanwhile, in another part of the museum, April discovers a relief from Luku with Apollo and the muses. She scans the QR code and reads about who the muses were, what they did and how they are related to education and knowledge. While walking she also listens to a description about women's access to education. She learns how access to education changed for women in ancient times and finds out about the differences between Archaic, Classical and Hellenistic times. She wonders if there are still gender issues in education today. The story continues and she is taken to another room with the statues of women

benefactors of Mantineia. The QR codes of these statues allow April to see the location of Mantineia in Google Maps and also to see a 360° view of the archaeological site as it is today.

Collaborative reflection on thematic areas

April is moved to see that her right to education has come so far and wants to share her viewpoint. She uses the App to communicate with all available App users by attaching her comment to a relevant hashtag. She posts a comment about how she feels about gender-based access to education (*#girls#education*). In this public space, she sees that someone else has posted different images from schools around the world showing girls being taught. She comments on that too, since the differences seem enormous. The App asks her to imagine herself in ancient Mantineia... Could she manage her fortune and properties? Could she influence politics? She finds these issues interesting since she had not ever realised how lucky she is to be in school. With the App, she asks Jane's opinion, too.

Reflecting on stories

When the three girls have finished, they arrange to meet at a nearby café. There, they talk about their different experiences and find that they have many points in common with the lives of women in ancient Greece, despite the fact that there have been major developments over the years. While they talk, their mobiles display a virtual visitor's book where they can share their opinions, upload pictures from the items they have seen and post comments about them. They can see that other people are writing in the book at the same time, and they spend some time reading and considering other people's reflections.

Curiosity triggered with game play

Stathis and his partner Alex are walking around their home city Tripolis, and they decide to visit the Archaeological Museum. At the entrance to the museum, they find out about a museum App. They download and install it. They log in with their Facebook accounts and see that they can choose a game to play ("Which goddess is your guardian?", "Your face in a statue", "Mixing fashion styles", "Anthroponymy" and "Find your social status"). While waiting in the queue for their tickets, Stathis plays "Anthroponymy" and Alex plays "Find your social status". As Alex turns out to have belonged to aristocracy in ancient times, their curiosity is sparked. They decide to use the app during their visit.

Matching themes and players

As visitors enter the museum, the App displays a list of topics to create each user's itinerary through the exhibits. The lists are ordered differently for each user according to their profile, which is determined by their Facebook profile and Facebook games. The first item on the list is the one deemed most suitable for the user. So Stathis selects "Religion &

Rituals" and Alex chooses "Mortality". These selections will take them through different places in the museum, but they will be able to communicate through the App or through Facebook.

Sharing information via social media

Stathis is first taken to prehistoric female figurines from the Sfakovouni people that used to live in Greek mountainous areas. Stathis scans the object's QR code. Augmented reality is employed to show the figurines in the Sfakovouni excavation. The audio information available to Stathis explains how these figurines are unique since they depict female figures using poppies to heal malaria. Stathis finds this interesting and shares this information on Facebook. Stathis continues with his visit and discovers more items related to ancient healing practices. He watches a short video about healing herbs from the wider area. He also finds out about other museums and sites exploring the issue of health in antiquity.

Triggering reflection via social media

Alex is led in a different direction. She scans the QR in front of her. Suddenly, an old Greek song is played. This type of song is called Miroloi (lament), and it is used to represent separations (either death or other permanent separations such as migration). Pictures of different funeral practices are presented, finishing with a series of images from ancient burials in Greece. Alex is asked to observe the differences between rich and poor burials through time and in different areas. Alex expresses an opinion via Facebook and uses the App to share the links to her Facebook account, together with a check-in of their current location. Alex writes: "at the Tripolis Archaeological Museum with Stathis finding out about ancient burial practices… not much has changed". The Miroloi song is included in the post.

Options for further exploration

When Stathis and Alex have finished their tour, they arrange to meet at the reception of the museum. There, they talk about their experiences. While they talk, their mobiles display two options: (1) explore and contribute to virtual visitor's book or (2) download a personalised map with suggested discovery tours of the wider Tripolis area, to visit some of the places they have learned about whilst at the museum. They think this is a nice way to connect the museum with sites around it. They download the map and plan a short excursion next weekend. They post a picture of them posing in front of the archaeological objects on Facebook, including the maps and suggestions for other excursions, and ask their friends to join them next weekend. They also realise that some of their friends have already responded to some of their museum uploads. Alex's post on ancient cemeteries in particular has received a lot of comments that they will respond to later that day, giving them a chance to engage in further discussion.

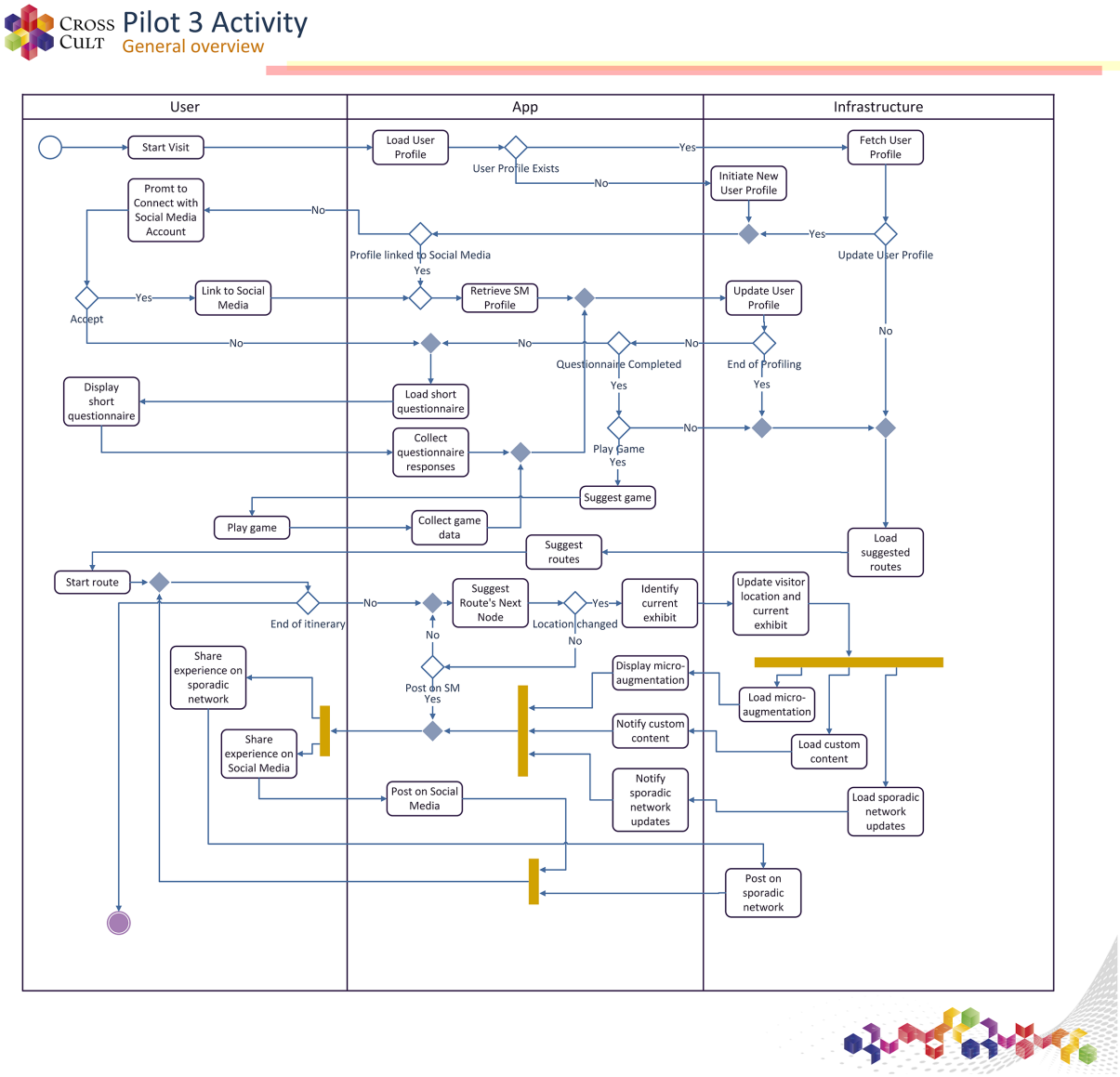
3.3.3. Activity diagrams and descriptions

The visitor initially installs the museum App on her mobile device, registers as a user with the CrossCult platform (see *Sign-up and Log-in Activity* in the beginning of this chapter, section 3.1.3.1) and, while at the entrance of the venue, is asked if they want to play game apps (e.g. a quiz). If used, these Apps help initialise or enhance the visitor's profile in the CrossCult platform.

According to the visitor's profile, the CrossCult platform feeds the museum App with recommended topics for the itinerary. The user chooses one topic in the App and is taken through the venue according to this scenario. The visitor is guided across several artworks within the current exhibition, during this time the visitor can view the path on a digital map of the gallery, while studying an exhibited object. Moreover, the App offers an enriched view of related digital content (e.g. a YouTube video). The CrossCult platform also pushes audio notifications (and possibly other micro-augmentations) to the visitor's mobile App, triggering and directing the visitor towards exhibits that could be interesting to explore.

Additionally, the CrossCult platform automatically joins them to a proprietary network. In the network her travel companions (if any), and other visitors that currently visit this or one of the related venues and are interested in the topic of choice are integrated. Via the network, the visitor can share experiences about each exhibited items (objects) by sending direct messages (e.g. text, image and audio) to companions in the venue or other visitors. The user can also choose to share updates with friends outside of the venue by means of the social network of her preference (e.g. Facebook) via the different information dissemination activities supported by the CrossCult platform. After the tour, the visitor(s) may comment on the whole experience with the aforementioned networks. Moreover, they are offered extra material connected to the scenario to reflect on and are invited to play other CrossCult apps and games.

Figure 8. Activity diagram for Pilot 3



3.3.4. Suggested datasets

In the tables below we describe a non-exhaustive suggested set of data resource associated with the pilot. These data resources are to be considered in addition to those documented in deliverable D2.1 (Data management plan). Please note where possible datasets will be stored in the CrossCult Zenodo repository.

Table 29. Suggested datasets / Pilot 3

CrossCult-DS-pilot_3_visitor_profiles	
Description	This dataset includes all the information used to create the profiles of the visitors participating in the experiments of pilot 3. It will comprise anonymised information about the visitors who participate in the games, including psycho-demographic data, cognitive style, and interests mined from social networks. Some information will be gathered through

	questionnaires and tests before the experiences.
Size - Format	Size: It is expected that the dataset will contain up to a few hundred profiles, with up to a few Kbytes for each participant. Format: the information will be stored in the form of XML or JSON or other appropriate formats of files containing the answers to the questionnaires and the findings obtained through social mining.
Openness	This dataset may be used by researchers worldwide to run experiments with similar or different profiles in order to replicate the published research results and appraise differences according to whichever parameters: local culture, previous background, relationship to the historical contents of the venue, etc.
Availability-Retrieval	All the information files will be stored and made available to worldwide researchers through the Zenodo repository and a mirror TEI-A repository, with no restrictions. Angeliki Antoniou will be responsible for the dataset and the person to contact for getting hold of the data.

CrossCult-DS-pilot_3_ontology_extensions CrossCult-DS-pilot_3_literals	
Description	These dataset will be used to model the knowledge about the museum items participating in pilot 3. This dataset will be composed of upper-level ontology classes and a set of specialisation (extensions) required for describing the types and relationships required and the actual literal data related to the collection.
Size - Format	Size: The dataset will be structured as a collection of files one per venue. Format: the dataset will be expressed in a standard semantic web serialisation.
Openness	The ontology extensions will be shared with any interested researcher through the project's general repository. The literals may be subject to access restrictions. Open, unrestricted access will be granted wherever possible.
Availability-Retrieval	Angeliki Antoniou will be responsible for the dataset and the person to contact.

CrossCult-DS-pilot_3_museum objects_multimedia_contents	
Description	This dataset will include the multimedia resources provided by the Archaeological Museum of Tripolis, which may be used to create stories to be told to the participants during the experiments. In particular, pilot 3 will use descriptions of the physical objects presented at the museum, museum maps, different visitor itineraries based on the different profiles, etc. Descriptive metadata will contain semantic characterisations for every resource. The intended resources include text, images, video and audio clips, animations, 3D shapes, AR

	contents, external links, and any other formats. For example, it is foreseen to include short clips (up to 30 seconds long) extracted from Greek songs. Additional material will be linked from open online sites like Wikipedia, Europeana, Wikimedia, etc.
Size - Format	Size: the information volume will be strongly dependent on the final scripts of the experimental pilots and the resources selected from the venues repositories and other sources. The forecast is around several Gbytes. Format: the multimedia resources will use the common and standard multimedia formats. Transcoding may be used wherever necessary. The descriptive metadata will rely on MPEG-7 standard vocabularies as far as possible, describing relevant details of the files, their technical characteristics and semantic annotations. In addition, a global metadata file will be created that will declare all the items contained in the dataset, their structure, ordering scheme and access terms
Openness	The data will be shared with any interested researcher through the project's general repository in Zenodo and in a mirror TEI-A repository. Both the multimedia contents and the descriptive metadata may be subject to access restrictions, derived from the venue's Intellectual Property policies. Open, unrestricted access will be granted wherever possible to allow worldwide researchers to arrange experiments with the same or different combinations of materials in order to check the learning differences according to whichever parameters: local culture, previous background, relationship to the historical contents of the venue, etc.
Availability-Retrieval	Access to the dataset will be possible through the global asset declaration provided in the root of the repository that will announce all the items of the dataset, their name, classification, associated metadata and access rights.

CrossCult-DS-pilot_3_visitor_interactions_and_observations	
Description	This dataset comprises records of individual/collective interactions during the pilot 3 experiences, including visitors' interactions (posts, replies to questionnaires, personal visiting itineraries, etc.) linked to the corresponding profiles from the *CrossCult-DS-pilot_3_visitor_profiles* dataset. The data items yield indicators and measurements of the quality of the experience.
Size - Format	Size: there will be one file per game played, grouping the different contributions of every participant. They will be differentiated by their role: visitor, expert and staff. The volume of information that will be stored is small, expecting several Kbytes for each participant at the most (up to a few Mbytes per experimentation session). Format: the stored information will consist of XML, JSON or other appropriate formats of files structuring all their contributions and interactions.
Openness	This dataset may be used by researchers worldwide to run experiments with similar or different profiles in order to replicate the published research results and appraise differences

	according to whichever parameters: local culture, previous background, relationship to the historical contents of the venues, etc.
Availability-Retrieval	All the information files will be stored and made available to worldwide researchers through the Zenodo repository and a mirror TEI-A repository, with no restrictions. Angeliki Antoniou will be responsible for the dataset and the person to contact.

3.3.5. Requirements and associated evaluation metrics

3.3.5.1. General requirements

This section describes the more general high-level requirements that the App for pilot 3 is expected to deliver.

Table 30. General requirements / Pilot 3

#	General requirements
3.GEN.1	The pilot 3 App is a cross-platform mobile application (e.g. Android and/or iOS).
3.GEN.2	The App will be made public on the application market of the targeted platforms. The App will be designed to be installed on users' personal devices.
3.GEN.3	The main devices targeted for the App are smartphones. A tablet version can be developed in a second phase.
3.GEN.4	The App must be multilingual (i18n-compliant).
3.GEN.5	The user's explicit consent must be obtained before gathering basic personal information in order to build a user profile.
3.GEN.6	The App must engage and motivate users to contribute reflections.
3.GEN.7	The App must enable reflection on museum items and historical topics and (re)interpretion in light of players' own experiences and interaction with App users.
3.GEN.8	The games must tap into an additional audience of the Tripolis museum.
3.GEN.9	The games must enable user profiling.

Table 31. General requirements evaluation method / Pilot 3

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	Perceptions of ease of system functioning and ease of access to the App.	Selection from: Test plan compliance / survey / log file	3.GEN.1 to 3.GEN.6
System	EE	Perceptions of general effort expectancy – it is easy to use the app to reflect on history and historical events.	Selection from: Survey / transcripts (think aloud)	3.GEN.6 to 3.GEN.9

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	FC	Perceptions of facilitating conditions: the App enables users to reflect on history and historical events.	Survey	3.GEN.6 3.GEN.7 3.GEN.8
Content	REQ	Perception of the quality of enhanced content provided by the App	Selection from: Survey / interviews	3.GEN.6 to 3.GEN.9
Content	TC	Perceptions of trustworthiness / credibility of content in pilot 3.	Selection from: Survey, interview / transcripts (think aloud)	3.GEN.5 3.GEN.6 3.GEN.7 3.GEN.8
Content	COP	General perceptions of comprehension and clarity of content or pilot 3.	Survey	3.GEN.4 3.GEN.6 3.GEN.7 3.GEN.8
User	AT	Perceptions of the use of enhanced objects in a museum environment.	Selection from: Survey / interview / transcripts (think aloud)	3.GEN.6 3.GEN.7 3.GEN.8
User	PE	Measures of perceptions of general performance expectancy – usefulness of pilot 3 App.	Selection from: Survey / interviews	3.GEN.6 3.GEN.7 3.GEN.8
User	SD	Social demographic of users.	Survey	3.GEN.6 to 3.GEN.9
User	REF	Reflections on knowledge: perceptions of how App contributed to users' understanding of historical events and history.	Selection from: Interviews / observation / analysis of reflections	3.GEN.6 3.GEN.8
User	HB	Evaluation of users' habitual behaviour with mobile technology.	Survey	3.GEN.1 to 3.GEN.9

3.3.5.2. Content

In pilot 3, content refers to the descriptions of the museum items (historical objects) that will be used, the accompanying metadata as well as external data resources relevant either to the museum item itself or to the broad concept that the museum item represents. Data resources will be used as a way to enhance user experience in the Archaeological Museum of Tripolis as well as to provoke personal reflection. There are three types of content relevant to pilot 3:

1. Historical objects from the museum and their metadata
2. Linked data from external sources on the web
3. User data: user-generated content from reflections and personal data collected for feeding the user scenario

The historical content comprises images of the objects selected from the Archaeological Museum of Tripolis together with museum-curated descriptions of the museum objects and their metadata. This will be enriched and enhanced with resources derived from the CrossCult knowledge base together with different linked data resources available on the web (e.g. Wikipedia Wikimedia (DBpedia), YouTube, National Gallery collection, Europeana, etc).

User-generated content (UGC) is likely to take the following forms: (1) Like/agree/rate; (2) Tags; (3) Responses to reflective questions; (4) User-contributed comments; (5) Share multimedia content; (6) Created images (through the games).

Table 32. Content requirements / Pilot 3

#	Requirements – Content
3.CON.1	The App must provide access to digital resources curated from one or multiple data resources.
3. CON.2	The App must display contextual information about the museum object the user is looking at (e.g. sources, references, link to historical thread, etc.).
3.CON.3	The App must enable users to contribute and share their personal viewpoints and reflections.
3.CON.4	The App must collect metadata associated with user contributions.
3.CON.5	The App should be flexible so that it can be used to integrate content from selected appropriate data resources.
3.CON.6	The App should enable resources to be viewed in the form of images, text, sound, video objects and virtual and augmented content.
3.CON.7	The App should allow the post and exchange of comments relevant to specific museum objects and topics.
3.CON.8	The games should allow exploration of material relevant to the historical topics in the museum.
3.CON.9	The games should save content created by the players.
3.CON.10	The games provide content regarding user profiles for the App.
3.CON.11	Virtual objects should be connected to physical objects in the museum.
3.CON.12	All objects should be related to a museum topic.

Table 33. Content Evaluation method / Pilot 3

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	Measure of system quality and	Log files	3.CON.1

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
		performance: Number of data resources curated.		3.CON.2 3.CON.5 3.CON.6 3.CON.8 3.CON.11 3.CON.12
System	SQ	System quality and performance: Number of exchanges between users.	Log files	3.CON.1 3.CON.2 3.CON.3 3.CON.6 3.CON.7 3.CON.9
System	SQ	System quality and performance: Number of comments per user.	Log files	3.CON.1 3.CON.2 3.CON.3 3.CON.4 3.CON.5 3.CON.7
User	AT	Perceptions of museum visitors and their experience and satisfaction in using the App to reflect on history and historical events.	Selection from: Survey / interview / observation and transcripts	3.CON.1 to 3.CON.10
User	AT	Perceptions of museum web-based game players and their experience and satisfaction in using the App to reflect on history and historical events.	Survey	3.CON.8 3.CON.9 3.CON.10 3.CON.11
System	FC	Facilitating conditions for the museum visitors & web-based games players.	Selection from: Log files / survey	3.CON.1 to 3.CON.13
User	PE	Perceptions of performance expectancy: usefulness of app for museum visitors.	Selection from: Survey/interviews	3.CON.1 3.CON.2 3.CON.3 3.CON.6 to 3.CON.12
User	PE	Web-based game player performance expectancy: usefulness of online game.	Selection from: Survey	3.CON.8 3.CON.9 3.CON.10

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
Content	REQ	Museum visitors' perceptions of relevance and content quality.	Selection from: Survey / interview / observation and transcripts	3.CON.1 to 3.CON.9 3.CON.11
Content	REQ	Web-based game players' perceptions of relevance and content quality in games.	Selection from: Survey	3.CON.8 3.CON.9
Content	TC	Museum visitors' perceptions of trustworthiness / credibility of the content.	Selection from: Survey / interviews / log files	3.CON.1 3.CON.2 3.CON.3 3.CON.5 to 3.CON.12
Content	TC	Web-based game players' perceptions of trustworthiness / credibility of the data in games.	Survey	3.CON.8 3.CON.9 3.CON.10
User	REF	Reflections on knowledge: perceptions from museum visitors on how content triggers reflection.	Selection from: Interview / observation	3.CON.1 to 3.CON.8
Content	COP	Perceptions from museum visitors on comprehension and clarity of the content.	Selection from: Survey / interview / observation and transcripts	3.CON.1 3.CON.2 3.CON.5 to 3.CON.8
Content	COP	Web-based game players' comprehension and clarity of the content in games.	Survey	3.CON.8

3.3.5.3. Content delivery mode

In this pilot, users will walk through the museum following specific scenarios and discover content that is in some way connected to the objects that they are observing. The museum building plan and interrelated topics that objects in the museum are associated with are also embedded within the scenario. Users will be able to discover the content by choosing personal itineraries based on their individual profile. Content will also be delivered by micro-augmentations.

Table 34. Content delivery requirements / Pilot 3

#	Requirements – content delivery mode
3.CDM.1	The App will trigger content delivery based on user scenarios.
3.CDM.2	The App will trigger content delivery using micro-augmentations for certain objects.
3.CDM.3	Objects associated with historical topics are revealed according to personalised itineraries.
3.CDM.4	The App will support multiple modes of content delivery (e.g audio, text, video, augmented reality, virtual reality, etc.).
3. CDM.5	Web-based games can be used as a content delivery mode.
3.CDM.6	The App should create personalised museum itineraries.

Table 35. Content delivery evaluation metrics / Pilot 3

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	Measure of system quality and performance: delivery mechanisms for content are stable and reliable.	Log file	3.CDM.1 to 3.CDM.6
User	AT	Perceptions of museum visitors' attitude to using the technology: user experience and satisfaction at content delivery using games.	Selection from: Survey / interview / observation / transcripts /	3.CDM.1 to 3.CDM.6
User	AT	Web-based game player attitude to using the technology: user experience and satisfaction at content delivery.	Selection from: Survey / interview / observation	3.CDM.5
System	FC	Facilitating conditions for micro-augmentations.	Consistency rules	3.CDM.1 3.CDM.2
System	FC	Facilitating conditions for functionality of web-based game.	Consistency rules	3.CDM.5
User	PE	Museum visitor performance expectancy: perceptions of usefulness of content delivery interfaces.	Selection from: Survey / interviews	3.CDM.2 to 3.CDM.5
User	PE	Performance expectancy of web-based game players: perceptions of usefulness of content delivery interfaces.	Survey	3.CDM.5

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	EE	Effort expectancy of museum visitors: perceived ease of use and usability of content delivery interfaces and modes.	Selection from: Survey / observation / transcripts	3.CDM.1 to 3.CDM.5
System	EE	Effort expectancy of web-based game players: perceived ease of use and usability of online games.	Survey	3.CDM.5
Content	COP	Museum visitors' general comprehension and clarity of the content delivery modes.	Selection from: Survey/interview/observation and transcripts	3.CDM.1 to 3.CDM.4; 3.CDM.6
Content	COP	Museum visitors' general comprehension and clarity of the content delivery modes of online games.	Survey	3.CDM.5
System	SQ	System quality and performance: number of ways to lead to selected personalised itineraries.	Log files	3.CON.11 3.CDM.6

3.3.5.4. Individual reflection

The development of pilot 3 must facilitate reflections and prospective interpretations according to the specified topics as developed from the collection of the Archaeological Museum of Tripolis. Reflections will be based upon the museum objects, the user scenario and the data resources associated with the specific museum artefact. They should provide users with the ability to engage in the process of making meaning, not only for the consumption of facts but also to increase visitor empathy and enable visitors to imagine themselves as members of ancient societies. There will be four modes of interaction to capture different modes of reflection and (re)interpretation:

1. Tagging
2. Free text responses to reflective questions
3. Comments on digital museum guest book
4. Comments during and after game playing with other visitors in the museum

Table 36. Reflection requirements / Pilot 3

#	Requirements – Individual reflection
3.RFN.1	The App should enable the user to contribute reflections (free text) related to specific topics

#	Requirements – Individual reflection
	and museum objects.
3.RFN.2	The App should enable the user to contribute reflections in the form of tags based on physical historical objects, digital objects or museum topics.
3.RFN.3	The App should provide users with predefined questions based on a historical object or museum topic.
3.RFN.4	The App should incorporate user-generated content (e.g. free text reflective tags).

Table 37. Reflection evaluation methods / Pilot 3

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Associated requirement
User	SQ	System quality: tags	Log file	3.RFN.1 to 3.RFN.4
User	PE	Museum visitors' perceptions of performance expectancy: usefulness of modes and interfaces for creating user content	Selection from: Survey / interviews	3.RFN.1 to 3.RFN.4
Content	REQ	Perceptions of enhanced content provided by museum visitors	Selection from: Survey / interview / observation and transcripts	3.RFN.1 to 3.RFN.4
User	REF	Reflections on knowledge: understanding of reflections contributed by museum visitors	Selection from: Interview / observation / analysis of reflections	3.RFN.1 to 3.RFN.4
System	EE	Perceived ease of use by museum visitors to contribute reflections	Selection from: Survey / observation and transcripts	3.RFN.1 to 3.RFN.3
System	PE	Number of times multimedia object is accessed by a user of the App	Analysis of logs	3.RFN.1

3.3.5.5. Social reflections & interaction

Pilot 3 will enable social interaction through direct messaging between visitors and groups of museum visitors in order to facilitate reflection on the topics and the associated artefacts

in the museum. Any user of the App will be able to read and reflect on all other users' contributions.

Table 38. Social reflections & interaction requirements / Pilot 3

#	Requirements – Social reflections and interactions
3.SR.1	The App must enable the user to quickly reflect on and respond to others' contributions (agree/disagree).
3.SR.2	The App must enable collaborative contributions and discussion.
3.SR.3	The App contains a feedback system to notify users of other users' reactions and / or contributions related to their input.
3.SR.4	The App should allow users to share items and comments with other users and / or social network users.

Table 39. Social reflections & interaction evaluation methods / Pilot 3

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	Measure of system quality and performance –number of social interactions between museum visitors	Log files	3.SR.1 to 3.SR.4
User	AT	Attitude to using the technology: perceptions of user experience and satisfaction, towards discussion	Selection from: Survey / interview / observation and transcripts	3.SR.1 to 3.SR.4
System	FC	Facilitating conditions: new comments and reflections load quickly for museum visitors	Selection from: Log files / survey	3.SR.1 to 3.SR.4
User	PE	Perceptions of usefulness of user contributions (reflections)	Selection from: Survey / interview	3.SR.1 to 3.SR.4
User	PE	Measure of usefulness of contributions for museum visitors: count of reflections with more than one response	Selection from: Analysis of user-generated content	3.SR.1 3.SR.2 3.SR.4
Content	PE	Measure of usefulness of contributions for museum visitors: count of likes / agrees	Selection from: Analysis of user-generated content	3.SR.1 to 3.SR.4

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
		as response		
User	SD	Socio-demographics: analysis of the museum visitors through user profiles of contributors	Profiling data	3.SR.1 to 3.SR.4
User	REF	Reflections on knowledge through discussions between museum visitors	Interview / analysis of reflections	3.SR.1 to 3.SR.4
System	EE	Effort expectancy: perceptions of effort required for museum visitors to contribute reflections	Survey / interview	3.SR.1 to 3.SR.4
Content	COP	Perceived comprehension and clarity of reflections in relation to objects and in relation with museum and topic	Survey / interview	3.SR.1 to 3.SR.4

3.3.5.6. Connection types and situation awareness

In this pilot, users will be able to walk around the Archaeological Museum of Tripolis and discover the artefacts in its collection. The users' actions, connections and reflections happen within a specific venue. Pilot 3 connects digital resources (objects) based on their relation to the topic.

Table 40. Connection types requirements / Pilot 3

#	Requirements – Intra-venue connections
3.CTS.1	Museum objects will be connected to each other through identified reflection topics and museum themes.
3.CTS.2	Users will be able to discover museum objects through different user scenarios.
3. CTS.3	Museum objects will be connected to digital data resources through identified reflection topics and museum themes.

Table 41. Connection types evaluation methods / Pilot 3

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	Measure of system quality and performance: number	Log files	3.CTS.1 to 3.CTS.3

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
		of connections within the App		
User	AT	Perceptions of museum visitors' user experience interacting with the data connections	Selection from: Survey / interviews	3.CTS.1 to 3.CTS.3
System	FC	Perception of modes of interaction of connections between digital and physical objects (do they work as expected?)	Selection from: Survey / interviews	3.CTS.1 3.CTS.2 3.CTS.3
User	PE	Museum visitors' perception of usefulness of the connection with digital objects	Selection from: Survey / interviews	3.CTS.1 to 3.CTS.3
Content	REQ	Perceptions of relevance of connections with digital enrichment	Selection from: Survey / interviews /	3.CTS.1 to 3.CTS.3
User	REF	Perceptions of usefulness of enriched knowledge	Selection from: Interview / observation /	3.CTS.1 To 3.CTS.3
System	FC	Connections do not disrupt experience of museum	Selection from: Survey / interviews	3.CTS.1 to 3.CTS.3
System	EE	Perceived ease of use of scenarios and connections	Selection from: Survey / interviews	3.CTS.1 to 3.CTS.3
Content	COP	General comprehension and clarity of the connections	Selection from: Survey / interviews	3.CTS.1 to 3.CTS.3

3.4. Pilot 4

3.4.1. Reflective history context

Pilot 4 is a multicity scenario situated in Valletta, Malta, and Luxembourg City, Luxembourg. This pilot is also the only one that will take place outdoors, in the open air. It is akin to a personalised outdoor exhibition. Its purpose is to enable users to explore, reflect and reinterpret historic *threads* (topics) as they (re)discover the city; in doing so, they are able to uncover the variety of connections that coexist between both cities. The result is a richer and deeper understanding of how historical phenomena and European cultural heritage are manifested not just locally but also across borders. This will be achieved through the use of a personalised location-based game-playing App. The App will encourage users, through playful interactions, to evaluate both their surroundings and the historical objects (as well their descriptions) that they encounter hidden in the city.

The resulting App developed in pilot 4 will foster new, in-place experiences for its users. It will lead players to discover meaningful coexistent connections between two cities that may not be immediately obvious. In doing so, they will be able to explore enriched perspectives and interpretations associated with topics in European history while reflecting on their own narrative understanding of these thread topics and, by corollary, unravelling the perspectives, learning and experience that have helped shape them. Their user-generated reflections and interpretation will contribute to a shared collective memory.

In terms of cognitive phenomena, and through the use of playful interactions, pilot 4 aims to promote reflection and (re)interpretation of historic threads. It will engage users in this process in a number of ways. Using the format of a treasure hunt, pilot 4 will stimulate interpretative thinking and reflective practices through the players' discovery of hidden historical objects that spark curiosity. As they read more and delve into the short contextual descriptions that situate the object within the context of its historical thread and its location, players are able to absorb the meanings and the underlying symbolism of the objects. Players can then use various methods to express their own interpretations. Players will be able to provide reflections as they tag objects that other players can review and either reach consensus or not.

Furthermore, the players will also be challenged to provide a short textual reflection based on an open-ended question associated with the object, its description and its thread. For example, a player discovering a balcony in Luxembourg City with an inscription that comes from a national song will be asked: "*Why, at this time, do you think the Luxembourg people wished to remain as they are?*" As players find more and more hidden objects attributed to one or more thread(s) they will be able to critically appraise and contemplate the connections between the objects, content and their threads. Additionally, players will be able to follow the aggregate anonymised traces of other players' routes taken through the

city, which will provide them with an alternative view of the city and enhance their ability to discover more reflections and objects.

The strategic value of pilot 4 to the CrossCult framework is through the provision of a unique combination of technology, gameplay and curated digital objects and their contextual descriptions that weave together historic threads to connect cities through space and time. The result is a set of new imaginative practices for exploring the physical cit(y)(ies) in combination with reflective methods and modes for enriching understanding and contributing personal perspectives, interpretations and narratives that ensure a public contribution to collective memory. The results of the user-generated contents of this scenario will be of interest to the general public as well as to public historians, social scientists and cultural heritage experts. More broadly the framework trialled during pilot 4 should provide valuable information to cultural heritage institutions, the city council, local authorities, etc. where it is important to develop cross-cutting exhibitions and improve public understanding, removing the constraints of geopolitical and often arbitrary administrative boundaries.

3.4.2. High-level scenario

Sophie in Luxembourg

Arriving in Luxembourg by train

At the railway station in Luxembourg City, Sophie waits in line to purchase a bus ticket that will to take her to the youth hostel, when a postcard with an old picture of the construction of the station (1859) catches her eye. On the back, she finds information about the "CrossCult" App and sees a QR code. She discovers that the App is a treasure hunt game which she can use to explore the city and its historical and present character through different historical lenses including discovering how migration has and continues to shape the city.

The postcard summarises the history of the railway station, beginning with its foundation and subsequent rebuilding between 1907 and 1913 at the height of the steel industry that brought many migrants to the country, up to the present day and its function as a national and international transport hub.

At the beginning – following a thread

On arriving at the hostel (where there is a Wi-Fi connection), Sophie downloads the "CrossCult" App on her phone by scanning the postcard's QR code. She notices that she has unlocked the first object (treasure) located near to her current location. She can see the historic threads connecting it to the steel industry and expats. She wins a badge indicating that she's still an apprentice – and she has to find one more object in order to reach the next level and unlock more treasure. She reflects on the topic by adding a tag to the object. She connects this part of history to the tag *industrialisation* and with this contribution she

wins points and discovers she can earn even more points when she answers a reflective question based on the object.

Having settled in, she starts walking to the city centre. On her way she looks at the App and discovers another treasure connected to the steel industry at Rue de la Loge. She reads the navigational cue "*Look at the balcony*" and manages to find the correct place, winning points once she reached it. She then looks up and sees the national motto *Mir wëlle bleiwen wat mir sinn* ("We want to remain what we are") written on the balcony. The App introduces her to the 1859 song by Michel Lentz (including a clip) and provides a short description that reiterates the desire for autonomy of the Luxembourg people following the country's independence from the Netherlands and then Belgium. She is asked to reflect on what this motto might mean and the importance it might have today. By doing so, she wins points and her answer becomes part of the discovered object alongside all other players' responses. With those extra points she moves up a level to "*Crew Member*" and unlocks a new thread on the treasure map.

Choosing a thread

This object does not only relate to the thread of the *steel industry*, but also to the thread on "*Cross-border workers – a very special phenomenon for Luxembourg"*. Every day, many people residing outside Luxembourg in Germany, France and Belgium cross the borders to go to work. Sophie is unfamiliar with this idea and decides she would like to learn more about it. She decides to filter all objects related to this special phenomenon. Among the selected objects, using the radar on the treasure map and the navigational cue "*Look at this street name*" on her screen, she heads towards Rue de la Monnaie, where she is introduced to the growth of the banking/financial industry within the country in the 1960s and the related migration flows. With help of the background information on the early days of the Luxembourg banking sector, she reflects on what the presence of the banking industry means for the country.

Responding to other users

Sophie now follows the treasure map and clues ("*Find the seat of national learning*") to the National Library, where she finds an object that explains more about the Luxembourgish language. She has noticed everybody speaking to her in different languages and she herself is fluent in English, French and Romanian. She does not yet know about the existence of *Lëtzebuergesch*. Studying in a country where different languages are spoken as part of everyday life, she can relate to the topic. Curiosity leads her to read what other players discussed when answering a question. She reads a response that resonates with her and she adds a tag. Between the comments she also reads about an American who does not understand why Europeans have all these different languages and why they do not all learn English. She replies passionately, explaining why speaking Romanian is so important to her sense of being. She reaches the "*Traveller*" level.

Max in Kirchberg

The German cross-border worker Max downloaded the CrossCult App after a tip from one of his European colleagues at the European Parliament in Luxembourg. He unlocks the nearest object to his position and reaches the "*Apprentice*" level.

Receiving a quest: expats and cross-border workers in Kirchberg

He receives a special message on his screen: to reach the "*Crew Member*" level he has to find and unlock one more object related to the cross-border workers thread. He accepts the quest and so objects related to cross-border workers are highlighted on the screen.

On the map, he can see the area he works in is apparently filled with treasure objects to find. Kirchberg is a very young but thriving district, with many banks, financial companies and European institutions. Suddenly, a notification on his mobile phone draws his attention to the Tall Banker, an artwork he always drives past in the morning but has never paid attention to. He is asked to reflect on himself and his colleagues. He looks down at his shiny shoes, suit and neatly knotted tie. What does this uniform represent? Past users have added tags such as *Europe, economy* and *identity* to the object. *Economy* is an obvious one, he thinks, but *Europe* triggers more reflection. As a German working abroad in the banking sector of the continent, Europe for him is an area that is a Union in a geographical and economic sense with *free movement* of people. He also decides to tag the object with *free movement* and *neighbours*, thereby validating the observations of the previous user and creating a new tag for others to reflect on. He earns enough points to unlock other types of treasure and complete his first quest.

Post from Valletta

During his lunchtime walk, Max passes the University campus in Kirchberg and his phone buzzes and tells him a flying object is within reach (this type of object is not pinned to a location such as a "flying postcard"). Curious, he opens the envelope that appears on the screen and reads about another city on the other side of Europe. International students, it states, make up almost half of the student population in Luxembourg, whereas that percentage is only 0.1% in the Maltese city of Valletta. Using his own education and travels towards the financial hotspot of Europe as an example, he thinks about the way universities and knowledge can connect people and encourage migration. He adds his reflection and earns more points. He observes that the next level is the "*Traveller*" level, which allows people to leave their observations in the CrossCult collective travel diary.

During his lunchtime break the next day he opens the App and in his profile he states that he has half an hour to discover things around him. The App leads him back over the impressive boulevard in Kirchberg with the navigation cue "*Locate the rusty statue*", where he finds *Kopf,* the artwork in the centre of the district. Once the object is unlocked, he reaches the "*Traveller*" level. The question in the App makes him more curious about the many works of art in the area, and he decides to tag some of them. Passing the MUDAM art gallery, he snaps a picture of the *European Pentagon, Safe and Sorry Pavilion* by Bert Theis,

tagging it with *modern* and *Europe.* He reaches the "*Experienced Traveller*" level and learns can comment on other travellers' findings.

Before he heads back to the office he takes in the view of the old city from the Grand Duchesse Charlotte Bridge. He receives another "flying postcard" from Valletta. He learns about the Breakwater Bridge in the grand harbour of the city, which has historic, socio-economic and intercultural relevance. The old bridge was built under the English rule in 1903, but was destroyed during the Second World War. The rebuilding of the bridge took several years, and helped the economy as it provided many jobs in difficult financial times. Not only the Maltese participated in its reconstruction, skilled workers from Sicily, Italy and Spain were engaged in the project as well. He tags the postcard with Cross Border workers and economic migration. He then goes back to work.

Replying to others

When he drives home and passes by Theis' work of art, he receives a notification that somebody has responded to the picture he took of the *Safe and Sorry Pavilion*. The original purpose of the *Pavilion* was as part of the Centre for Fine Arts in Brussels, but it was moved. He looks at the MUDAM once more and is suddenly hit by the architectural paradox of the building, combining old ruins with the modern use of glass. Later at home he adds a like tag to the comment made on his picture.

Connecting and making collective memories

After having completed the quest, Sophie and her backpack are back at the train station. Meanwhile, Max saves his contributions to the database. They are able to write a message in the "Diary of Collective Memories": they both unlock a story card, the buzzing phone informs them. They are invited to choose two symbols in order to tell their personal story of migration.

Sophie chooses a bag of money and an open border and relates her experience at the Belgian border when first arriving from Romania, heading to a new country to study and needing to use different money, and the wonderful feeling of not even having to show her passport when travelling to Luxembourg. She attaches her story to the collective travel diary, a digital "*lieu de mémoire*" or place of collective memory that highlights all the stories contributed by all the players. Sophie pins her story to the University campus in Kirchberg, since she thinks her experiences are relevant to other students.

Max on the other hand writes about his grandfather fleeing Germany in the Second World War and returning some years later. Since Max's story is not linked to a specific location in the city but to a memory, a personal story, his contribution is added to the collective travel diary as a "story object" that floats above the real city waiting to be caught by other players.

When they upload the stories, the App shows their personal map of their Luxembourg adventure, highlighting the places they have visited, the treasure they have found, the

stories they have written and the reflections they have made. They have their own reflective history diary of their experiences.

3.4.3. Activity diagram and description

The user downloads the App on their mobile device, potentially incentivised by beacons, advertisements, QR codes or other stimuli distributed throughout the city. On the first interaction with the App, the user can choose to set up a personalised profile, which includes playing a few mini games to inform a persistent user profile on the CrossCult back-end (on the cloud). The personalised profile is then stored on the mobile device for subsequent use such as for personalising the user interface (e.g. user's chosen player name). Pilot 4 is designed to allow users to engage with the application without the requirement of user registration.

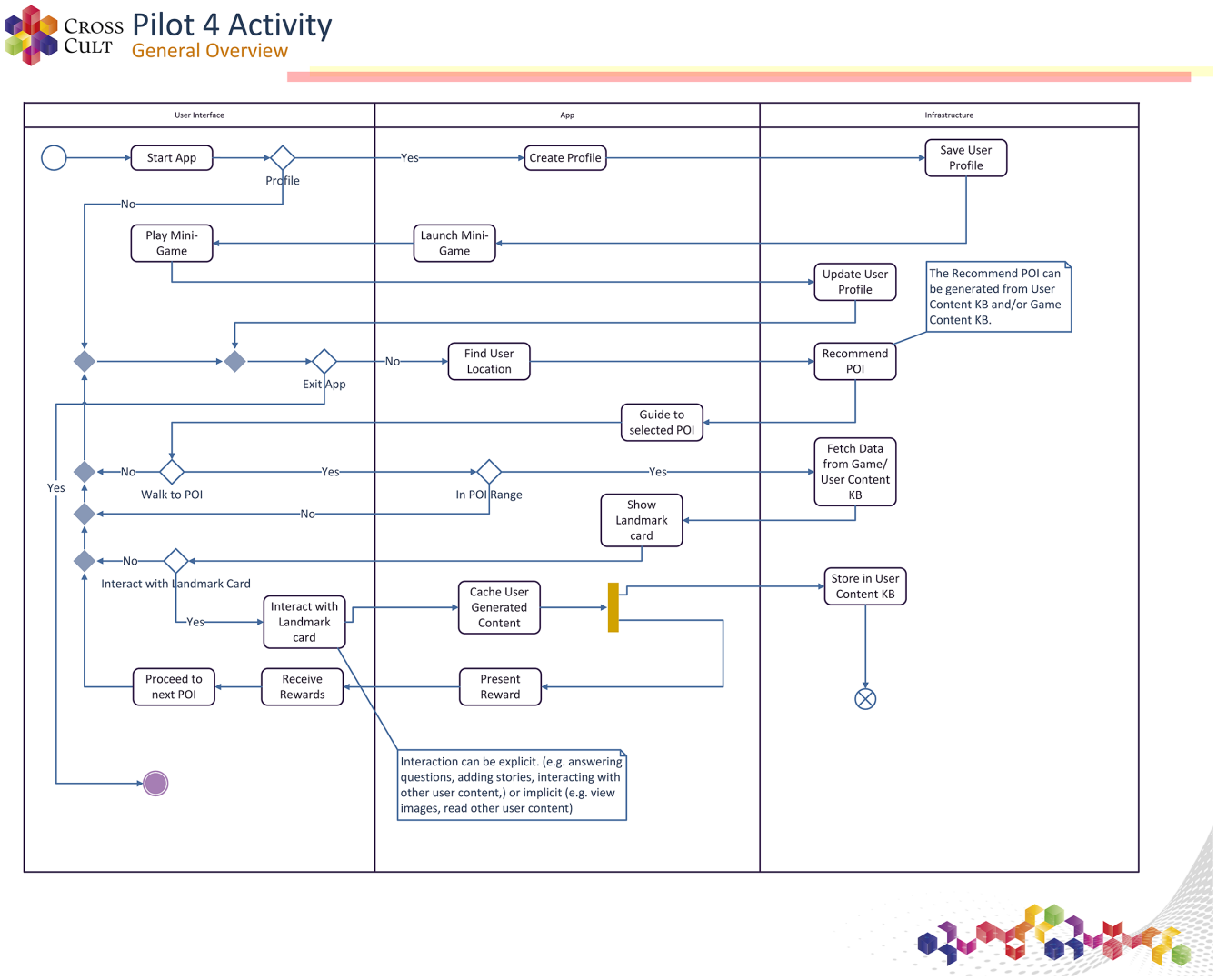
The core gameplay loop consists of the App detecting the user's location and showing relevant or nearby points of interest (POIs). The user can then walk to the POI, and when inside its range and then interact with game content appearing on the mobile device. After the interaction, the user receives appropriate rewards and can decide to move towards other POIs.

POIs are drawn from a database created by experts (content database), where the data associated with it are stored, including: name, geolocation, audio-visual assets (objects), metadata, interaction options (e.g. questions for reflection) and ontological information (e.g. threads it is related to) are stored. Based on several heuristics, which will be developed under WP3 (including proximity to user, their profile, game, and other users' contributions), the CrossCult backend returns several POIs to the app. These are shown to the visitor through a navigational interface (e.g. map or compass). If the user walks to a POI and gets within its radius, the App springs to life to incentivise user interaction.

The user can choose to then interact with the POI, reading/viewing static content obtained from the content database, adding their own contributions (e.g. tags, free text) or viewing and contributing to other users' past interactions with the POI (drawn from a user content database). The interaction data of this specific user is cached locally, in order to inform the locations the user has already visited and to provide the appropriate game rewards (e.g. a reward popup) for completion of multiple objectives. Moreover, the same data is transferred to a general database on the CrossCult framework (user content database). Here is stored all the past data interactions contributed by users, and can be used to add new POIs, inform the appeal of existing POIs as well as enrich questions on specific POIs with other users' answers or stories.

Additional elements, such as the multi-city connection in the form of a post-card from another city and the opportunity for users to contribute their own stories and POI locations (with the appropriate creative prompt from the app), complement this core gameplay loop but for diagram simplicity are considered as a landmark card in the activity diagram.

Figure 9. Activity diagram for Pilot 4



3.4.4. Suggested Datasets

In the tables below we describe a non-exhaustive suggested set of data resources associated with historical content that Pilot 4 expects to make use of. These data resources are to be considered in addition to those documented in the data management plan which focuses on the data that will be produced by the interactions of users.

Table 42. Suggested datasets / Pilot 4

CrossCult-DS-pilot_4_ontology_extensions CrossCult-DS-pilot_4_literals	
Description	These dataset will be used to model the knowledge about the multimedia items used in pilot 4. This dataset will be composed of upper-level ontology classes and a set of specialisation (extensions) required for describing the types and relationships required and the actual literal data related to the collection.
Size - Format	Size: these datasets will be composed of the ontologies used to describe the types and relationships between multimedia resources used in Pilot 4.

	Format: the dataset will be expressed in a standard semantic web serialisation.
Openness	The ontology extensions will be shared with any interested researcher through the project's general repository. The literals may be subject to access restrictions. Open, unrestricted access will be granted wherever possible.
Availability-Retrieval	Ioanna Lykourentzou will be responsible for the dataset and the person to contact.

CrossCult-DS-pilot_4_visitor_profiles	
Description	This dataset includes all the information used to create the profiles of the visitors involved in the experiments of pilot 4. It will contain anonymised information about the visitors who participate in the games.
Size - Format	Size: It is expected that the dataset will contain up to a few hundred profiles, with up to a few Kbytes for each participant. Format: the information will be stored in the form of XML or JSON or other appropriate formats of files containing the profiling data.
Openness	This dataset may be used by worldwide researchers to run experiments with similar or different profiles in order to replicate the published research results and appraise differences according to whichever parameters: local culture, previous background, relationship to the historical contents of the venue, etc.
Availability-Retrieval	All the information files will be stored and made available to worldwide researchers through the Zenodo repository and a mirror TEI-A repository, with no restrictions. Ioanna Lykourentzou will be responsible for the dataset and the person to contact.

CrossCult-DS-pilot_4_eLuxemburgensia	
Description	This dataset will include selected text snippets and their metadata identified from relevant articles contained with the Bibliothèque nationale de Luxembourg (BnL) (BNL) newspaper archive relevant to the Pilot 4 texts. Snippets will be less than 10% of total length of an article to ensure compliance with copyright restrictions. The dataset will be enriched with relevant metadata using text analysis techniques.
Size - Format	Size: the volume of information that will be stored in this dataset is difficult to foresee at this stage. The forecast is around several Mbytes since this dataset will be preselected according to individual article appropriateness for the different P4 threads. Format: it is expected that the dataset will contain less than a hundred articles. The information will be translated from the BNL provided specific XML format and stored in the JSON format or in another interoperable format .

Openness	The data is used with permission of the BNL and will be available for use within the CrossCult framework.
Availability-Retrieval	The dataset will require the permission of BNL for research and reuse outside the CrossCult framework

CrossCult-DS-pilot_4_VDL_mulimedia objects	
Description	This dataset will include a set of multimedia objects and text snippets that are selected and curated from the archives of the Ville de Luxembourg (VDL). We expect this file to contain (1) images stored in the photo-archive of the City (2) text snippets and metadata manually extracted from the monthly city magazine “Ons Stadt”. Snippets will be less than 10% of total length of an article to ensure compliance with copyright restrictions.
Size - Format	Size: the volume of information that will be stored in this dataset is difficult to foresee at this stage. The forecast is around several Megabytes. Format: the multimedia resources will use the common and standard multimedia formats. Transcoding may be used wherever necessary. The descriptive metadata will rely on MPEG-7 standard vocabularies as far as possible, describing relevant details of the files, and their technical characteristics.
Openness	The data is used with permission of the VDL and will be available for use within the CrossCult framework. The dataset will require the permission of BNL for research and reuse outside the CrossCult framework
Availability-Retrieval	Access to the dataset will be possible through the global asset declaration provided in the root of the repository that will announce all the items of the dataset, their name, classification, associated metadata and access rights.

CrossCult-DS-pilot_4_CNA_mulimedia objects	
Description	This dataset will include a set of multimedia objects selected and curated from the archives Centre National de l'Audiovisuel (CNA). We expect this file to contain video segments with metadata manually created by researchers that conform to Dublin Core standards.
Size - Format	Size: the volume of information that will be stored in this dataset is difficult to foresee at this stage. The forecast is around several Megabytes. Format: the multimedia resources will use the common and standard multimedia formats. Transcoding may be used wherever necessary. The descriptive metadata will rely on MPEG-7 standard vocabularies as far as possible, describing relevant details of the files, and their technical characteristics.
Openness	The data is used with permission of the CNA and will be available for use within the CrossCult framework.

Availability-Retrieval	The dataset will require the permission of CNA for research and reuse outside the CrossCult framework

CrossCult-DS-pilot_4_multimedia_contents	
Description	This dataset will include the multimedia resources which may be associated to different threads and contextual captions as part of the POI landmark cards and used for micro-augmentations. The intended resources include text, images, video and audio clips. These data will be derived from open sources with liberal reuse licenses such as Wikimedia commons.
Size - Format	Size: the information volume will be strongly dependent on the final number of objects used for the pilots and the resources selected from the venues repositories and other sources. The forecast is a maximum of around several Gbytes Format: the multimedia resources will use the common and standard multimedia formats. Transcoding may be used wherever necessary. The descriptive metadata will rely on MPEG-7 standard vocabularies as far as possible, describing relevant details of the files, and their technical characteristics.
Openness	The data will be shared with any interested researcher through the project's general repository in Zenodo. Both the multimedia contents and the descriptive metadata may be subject to access restrictions. Open, unrestricted access will be granted wherever possible.
Availability-Retrieval	Access to the dataset will be possible through the global asset declaration provided in the root of the repository that will announce all the items of the dataset, their name, classification, associated metadata and access rights.

3.4.5. Requirements and associated evaluation metrics

3.4.5.1. General Consideration

This section describes the more general high-level requirements that pilot App 4 is expected to deliver.

Table 43. General requirements / Pilot 4

#	General requirements
4.GEN.1	The pilot 4 App is a cross-platform mobile application (e.g. Android and/or iOS).
4.GEN.2	The App will be made public on the application market of the targeted platforms. The App will be designed to be installed on users' personal devices.
4.GEN.3	The main devices targeted for the App are smartphones. A tablet version may be developed in a second phase.
4.GEN.4	The App must be multilingual (i18n-compliant).

#	General requirements
4.GEN.5	The user's explicit consent must be obtained before gathering personal information in order to build a user profile.
4.GEN.6	The game must engage and motivate users to contribute reflections.
4.GEN.7	The App must facilitate the collection and curation of personal user stories associated with historic threads.
4.GEN.8	The App must enable users to reflect on historical topics and (re)interpret them in light of their own experiences.

Table 44. General requirements evaluation method / Pilot 4

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
System	SQ	System quality and performance – measures to determine whether the App is stable / easy to access	Selection from: test plan compliance and survey	4.GEN.1 to 4.GEN.6
System	EE	Perceptions of general effort expectancy – perceived ease of use and usability of the App	Selection from: Survey / transcripts (think aloud)	4.GEN.1 to 4.GEN.8
System	FC	Perceptions of facilitating conditions that lead to reflection	Survey	4.GEN.6 to 4.GEN.8
User	AT	Perceptions of user attitudes: experience and satisfaction more generally to the app	Selection from: Survey / interview / transcripts (think aloud)	4.GEN.6 to 4.GEN.8
User	PE	Measures of perceptions of general performance expectancy – overall usefulness of the App	Selection from: Survey / interviews	4.GEN.6 to 4.GEN.8
Content	REQ	Perceptions of general relevance and content quality	Selection from: Survey / interviews	4.GEN.8
Content	TC	Perceptions of general trustworthiness / credibility of app	Survey	4.GEN.6
Content	COP	General perceptions of comprehension and clarity of content	Survey	4.GEN.4 4.GEN.6 to 4.GEN.8
User	SD	Social demographics of users	Survey	4.GEN.6 4.GEN.8
User	REF	Understanding how the users' engagement in the App and their experiences lead to	Selection from: Interviews / user generated data	4.GEN.8

Indicator domain	Code	Indicator category	Suggested measurement mode(s)	Requirement
		understanding and appreciation of historical threads		
User	HB	Evaluation of users' habitual behaviour with mobile technology	Survey	4.GEN 1 to 8

3.4.5.2. Content

In pilot 4 we will handle historical content and its constituent objects as well as the use of story cards to provoke the collection and curation of personal reflections and storytelling to form a collective memory. There are three types of content relevant to pilot 4:

(1) Historical content and its metadata
(2) Historical threads
(3) User-generated content in the form of players' personal stories (story cards)

The historical content comprises objects (images, text snippets, video or sound files) derived from different open archives or proprietary archives (e.g. Ville de Luxembourg) with corresponding metadata including a CrossCult caption. The caption describes the historical object in the context of (1) the overarching historical topic it is situated in (e.g. migration) and (2) the thread it is associated with (e.g. Europe, expats, cross-border workers), as well as providing evidence to be interpreted when answering the associated reflective questions. In this pilot historical threads are considered as a specific form of content because they provide a curated narrative between the objects and represent a way in which the content is structured.

User-generated content (UGC) takes four forms: (1) Like/agree/rate; (2) Tags; (3) Responses to reflective questions; (4) User-contributed stories. The first three forms are outlined in the section relating to the previous section on requirements for capturing user reflections. The user-contributed stories form part of the content requirements. The user-contributed stories (personal story treasures) will lead to the development of a collective memory based on the players' personal experiences; this will take the form of a virtual memorial known as a collective travel diary, akin to a virtual *lieu de mémoire*[5].

Table 45. Content requirement / Pilot 4

#	Requirements – Content
4.CON.1	The App must provide access to digital resources curated from one or more repositories or data sources

[5] A virtual memorial that represents collective memory that has symbolic meaning to the group of players of pilot 4

#	Requirements – Content
4.CON.2	The App must display contextual information about the content (e.g. sources, references, link to historical thread, etc.)
4.CON.3	The App must enable users to contribute and share their personal stories
4.CON.4	The App must collect metadata associated with user contributions
4.CON.5	All digital objects should have an associated POI
4.CON.6	All objects should be associated with historical threads
4.CON.7	The App should be flexible so that it can be used to integrate content from any domain in history
4.CON.8	The App should enable historical resources to be viewed in the form of images, text, sound or video objects
4.CON.9	The App will save personal stories as geolocated POIs or as a *lieu de mémoire*

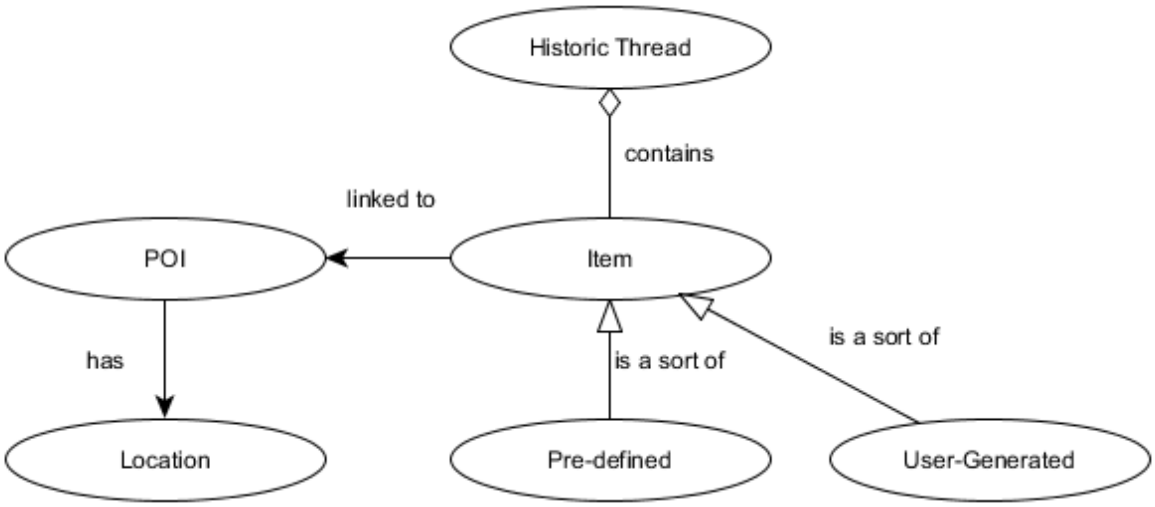
Table 46. Content evaluation metrics / Pilot 4

Indicator domain	Code	Category	Suggested measurement mode(s)	Requirement
System	FC	Facilitating conditions: objects must be connected to at least one thread	Consistency rules	4.CON.6
System	FC	Facilitating conditions: objects must be connected to at least one POI per object	Consistency rules	4.CON.5 4.CON.9
User	REQ	Perceptions of usefulness of objects and captions (contextual descriptions)	Selection from: Survey / interview	4.CON.1 4.CON.2 4.CON.8
Content	COP	Perceptions of comprehension of objects and content (clarity and appropriateness of contents and threads)	Selection from: Survey	4.CON.1 4.CON.2 4.CON.5 4.CON.7 to 4.CON.9
User	EE	Perceptions of ease of use in accessing and interacting with content (historical resources – objects and text)	Survey	4.CON.1 to 4. CON.9
Content	TC	Perceptions of trust and reliability of the content and the threads	Selection from: Survey / interview	4.CON.1 to 4. CON.9
User	PE	Perceptions of usefulness of content made available	Survey	4.CON.1 to 4. CON.9

Indicator domain	Code	Category	Suggested measurement mode(s)	Requirement
User	AT	Perceptions of experience and satisfaction in using the app to reflect content	Selection from: Survey / interview	4.CON.1 to 4. CON.9

The data structure used for the app content will be as follows:

Figure 10. General data structure of Pilot 4



3.4.5.3. Content delivery mode

In this pilot users will walk around the city and discover content in the form of objects pinned to locations (POIs) that are in some way connected to historical threads. Users will be able to navigate towards the POIs using navigation cues that provide directional hints to the correct location. Micro-augmentations, which are typically any type of stimuli provoked by the players' mobile device with the purpose of drawing their attention, will be used to encourage serendipitous discovery of the content. Micro-augmentations may be in the form of images, text messages or sound bites.

Table 47. Content delivery requirements / Pilot 4

#	Requirements – historical content delivery mode
4.CDM.1	The App will trigger content delivery based on user location
4.CDM.2	The App will trigger content delivery using micro-augmentations for certain POIs
4.CDM.3	(Paths through) objects in threads are revealed according to personal preferences (building of personalisation algorithms)
4.CDM.4	Users are provided with navigational cues to discover the locations of treasure objects

Table 48. Content delivery evaluation metrics / Pilot 4

Indicator domain	Category code	Target category	Suggested measurement mode(s)	Associated requirement
System	FC	Facilitating conditions: ensure moderate to high triggering accuracy of micro-stimulations	Consistency rules	4.CDM1
User	AT	Perceptions of usefulness of content delivery modes	Selection from: Survey / interview / observation	4.CDM.1 to 4.CDM.4
User	PE	User perceptions that App features and content delivery mechanisms motivate users	Survey	4.CDM.2 to 4.CDM.4
System	EE	User perceptions of ease of use of content delivery modes	Selection from: Survey / interview/ observation	4.CDM.1 to 4.CDM.4
System	EE	Navigational cues are easy to use	Selection from: Survey / observation	4.CDM.4 4.CDM.3
Content	COP	Perceptions of comprehension of content delivery processes	Selection from: Survey / interview	4.CDM.1 to 4.CDM.4
User	AT	Effectiveness of serendipitous discovery of content	Selection from: Survey / interview / observation	4.CDM.2
System	SQ	Measure of system quality and performance: delivery mechanisms for content are stable and reliable	Selection from: Survey / interview/ observation	4.CDM.1 to 4.CDM.4

3.4.5.4. Individual reflection

The development of pilot 4 must facilitate reflections and retrospective interpretation according to the historical threads (topics) a user is exploring. Reflections will be based upon the historical object a user discovers and its associated contextual caption. They should provide users with the ability to engage in the process of making meaning, not only consuming facts. There will be three modes of interaction to capture reflection and interpretation:

1. Tagging (both predefined and free text)
2. Free text responses to reflective questions
3. Adding a personal story to a location or the topic

Table 49. Reflection requirements / Pilot 4

#	Requirements – reflection
4.RFN.1	The App should enable the user to contribute reflections (free text) on historical threads
4.RFN.2	The App should enable the user to contribute reflections in the form of predefined tags based on a historical object and its contextual caption

#	Requirements – reflection
4.RFN.3	The App should enable the user to contribute reflections in the form of free-text tags based on a historical object and its contextual caption
4.RFN.4	The App should provide users with predefined questions based on a historical object and its contextual caption.
4.RFN.5	The App should incorporate user-generated content (e.g. free text reflective tags) once there is user consensus regarding its use.

Table 50. Reflection evaluation methods / Pilot 4

Indicator domain	Code	Category	Suggested measurement mode(s)	Requirement
User	PE	Perceptions of the usefulness of user reflections	Selection from Survey / interview / observations / think aloud	4. RFN.1 to 4. RFN.5
User	REQ	Perceptions of relevance to topic	Selection from: Survey / interview	4. RFN.4
System	EE	Perceptions of effort required to contribute reflections	Selection from: Survey / interview/ think aloud	4. RFN.1 to 4. RFN.4
System	AT	Number of interactions per object	Selection from: Analysis of log files and database files	4. RFN.1 to 4. RFN.4
User	REF	Reflections on knowledge: understanding of individual reflections	Selection from: Qualitative analysis of user generated responses	4. RFN.1 to 4. RFN.5
User	AT	Perceptions of the experience of adding reflective content	Selection from: Survey / interview	4. RFN.1 to 4. RFN.5

3.4.5.5. Social Reflections & Interaction

Pilot 4 will enable two main modes of social interaction based on groups. Any user of the App will be able to read and reflect on all other user contributions. Users will also be able to see collective routes that other players have taken through the city.

Table 51. Social reflections & interaction requirements / Pilot 4

#	Requirements – participation mode
4.SR.1	The App must enable the user to quickly reflect on (curate) others' contributions (agree/disagree, rank, etc.)
4.SR.2	The App must enable collaborative contributions
4.SR.3	The App must enable users to see the collective traces of other people (i.e. show paths where people have walked in the city)

#	Requirements – participation mode
4.SR.4.	The App must allow a feedback system to notify users of reactions and/or other users' contributions related to their stories

Table 52. Social reflections & interaction evaluation methods / Pilot 4

Indicator domain	Code	Category	Suggested measurement mode(s)	Requirement
User	PE	Number of reflections (all types) between users	Analysis of user-generated data	4.SR.1
User	PE	Count of reflections (all types) with more than one response	Analysis of user-generated data input	4.SR.2
User	AT	User can easily follow other aggregate paths (collective traces) of others users' paths	Analysis of log files	4.SR.3
User	AT	Attitude to using the technology: perceptions of user experience and satisfaction at collaborative contributions	Selection from: Survey / interview / observation and transcripts	4.SR.1 to 4.SR.4
User	PE	Perceptions of the usefulness of collaborative user reflections / stories / traces	Selection from: Survey / interview / observations / think aloud	4.SR.1 to 4.SR.4
User	EE	Perceptions of effort required to contribute reflections	Selection from: Survey / interview / think aloud	4.SR.1
System	EE	Perceptions of effort required to contribute to other stories	Selection from: Survey / interview	4.SR.1
System	EE	Number of interactions per object	Analysis of log files	4.SR.1
User	REF	Reflections on knowledge derived from collaborative contributions	Qualitative analysis of user generated reflections	4.SR.1
Content	PE	Perceptions of content usefulness	Selection from: Survey / interview	4.SR4
User	SD	Socio-demographics: analysis of the museum visitor user profiles of contributors	Profiling date	4.SR.1 to 4.SR.4
Content	COP	Perceived comprehension and clarity of reflections in relation to objects and threads	Selection from: Survey / interview	4.SR.1 to 4.SR.4

3.4.5.6. Connection types and situation-awareness

Table 53. Connection types requirements / Pilot 4

#	Requirements – Inter-venue connections
4.CTS.1	Objects located in different cities will be connected to each other through content connections
4.CTS.2	Users will be able to discover content in one city whilst in the other city

Table 54. Connection types evaluation methods / Pilot 4

Indicator domain	Code	Category	Suggested measurement mode(s)	Requirement
Content	COP	Perceptions of understanding of connections	Selection from: Survey / interview	4.CTS.1 4. CTS.2
User	AT	Perceptions of user experience of connections between cities	Selection from: Survey / interview / observation	4. CTS.1 4. CTS.2
User	EE	Connections work as expected with minimal effort	Selection from: Survey (Likert scale) / observation	4. CTS.1 4. CTS.2
User	PE	Perceptions of usefulness	Selection from: Survey / observation	4. CTS.1 4. CTS.2
Content	REQ	Perceptions of relevance of connections	Selection from: Survey / interviews	4. CTS.1 4. CTS.2
Content	TC	Perceptions of trustworthiness and relevance of the connections between the cities	Selection from: Survey / interview	4. CTS.1 4. CTS.2
User	REF	Perceptions of understanding and appreciation of knowledge created by connections	Qualitative analysis of user input	4. CTS.1 4. CTS.2
System	FC	Facilitating conditions: perceptions that connections work as expected	Survey / predefined consistency rules	4.CTS.1 to 4.CTS.4

4. Technologies

In the previous sections of this document using a story-telling narrative we have described the definitive user scenario for each pilot. This next section considers how the different Apps are expected to improve the visitor experience and at the same time demonstrate how the CrossCult framework can leverage diverse technologies to trigger reflections, dialogues and (re)interpretation of historical topics, narratives or events. Thus we have identified that each pilot will build an App, and all pilot Apps will be joined under what we call the CrossCult Framework. The numerous high-level ways in which each App interacts with this framework were formalised as activity diagrams. These diagrams presented a broad description of the general workflows that underpin each pilot, which consequently helps us to identify both the requirements and the technologies that each App will harness.

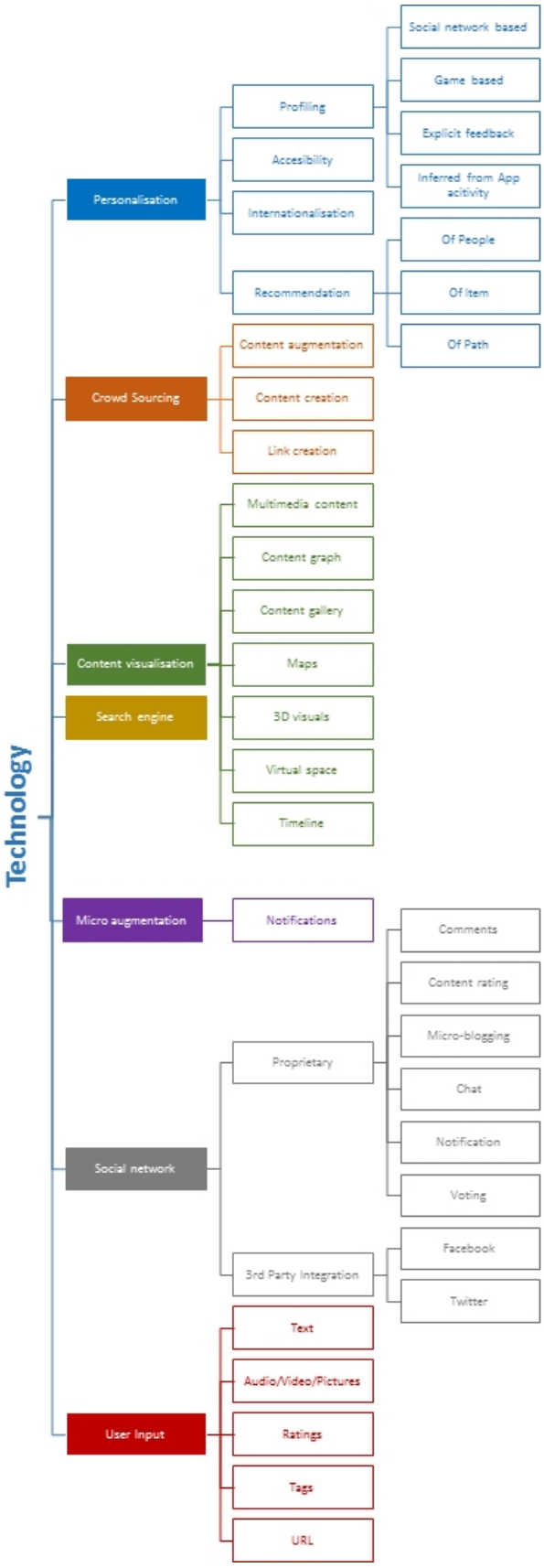
Finally, a list of requirements is expressed for each pilot as part of the project's evaluation framework. These requirements are derived from the user scenarios. For each pilot, the requirements concisely describe the features that will be developed as part of a pilot App. In each pilot's evaluation framework we also identified the most suitable indictor categories that will be defined and measured in order to appraise how successfully the requirements are delivered within the technology framework. The list of requirements helps us to understand which technologies are necessary to incorporate into the CrossCult framework. In this section, we map the set of technologies that will support the delivery of the key features of pilot Apps.

4.1. Technology categories

Before we clarify the technologies of the CrossCult framework, we must first start by providing a definition of what constitutes 'a technology'. For the purposes of this document a technology is considered as: a black-boxed, low level functionality that can be compiled with other ones to provide a particular feature or set of features that contribute to the delivery of specific requirements. The listed technologies are not considered as ready-to-use components, but rather as technological processes, tools and algorithms that can be adapted and implemented in many ways to form components of the different technological feature sets. The framework will combine the range of technologies presented in Figure 11 according to each App's requirements, resulting in different types of services.

With this in mind, detailed categories of the technologies and their associated algorithms are not the focus of the discussion. For example, when a pilot needs to provide a recommended set of items (pictures, locations, objects, instructions etc.) to the user, the black-boxed "Recommendation of Items" service is clearly identified. We consider there is no need to discuss the underlying workflows, tools or algorithms, since they will be dealt with during work package 3. Thus, Table 55 deliberately ignores these detailed components and focuses instead on the high-level technologies required for the provision of services that will comprise the CrossCult framework.

Figure 11. Technology categories for CrossCult framework



The list of high-level technologies required for building the Apps is identified in Figure 11 and concisely described below.

Personalisation: set of technologies that allow the App(s) to tailor content and content delivery to individual users' characteristics and preferences

- **Location-tracking**: technology that facilitates access to the user's device location to help route making and object finding including: GPS, Wi-Fi, iBeacons
- **Profiling**: in order to understand preferences, this technology builds a user profile with data and information about the user.
    - **Social network based profiling**: importing and analysing data from commonly used social networks to build the users'-profile.
    - **Game-based profiles**: technologies/tools that allow the building of a user profile by analysing the user's interactions with a game.
    - **Explicit feedback:** profiles built using responses to a questionnaire or explicitly asking for likes/dislikes of objects or locations in the App.
    - **Inferred from App activity:** build a user profile by inferring user characteristics (e.g. habits, preferences) from the analysis the interaction with a particular App. (e.g. number of views of a particular item, or use of location logs).
- **Recommendation**: The ability of the App to recommend personalised content by analysing a user's profile:
    - **Of people**: user profiles and inter-activities that connect people to one another.
    - **Of item**: recommend an item that might be of interest to the user.
    - **Of path**: take into account the user preferences among other factors (e.g. congestion point or propose to the user a route to follow).
- **Accessibility:** technologies, techniques and tools that improve the user experience of the App making it friendly to persons with disabilities, such as text to speech.
- **Internationalisation**: technologies, techniques and tools that enable an App to adapt for example to a user specific language, time zone, currency.

Crowd-sourcing: crowd-sourcing technologies are specifically concerned with enabling users to contribute, enrich and enhance to the content of the App.

- **Content augmentation**: this category covers technology and tools to facilitate, via the Apps interfaces, the enrichment of existing content with user contributions (e.g. tag content, label content, add comments).
- **Content creation**: this category covers technologies, processes and tools that support the creation of new content by users (e.g. upload of pictures, create new objects).
    - **Link creation**: this category encompasses every technology that allows users to create links between different items presented within the App. (e.g. classification of content).

Social network: incorporate the option to involve a users' social network in the use of the App.

- **Proprietary**: CrossCult specific social network tools
    - **Comments** (reflections): allows the users to comment on content within the App.
    - **Rate content**: enables the users to rate the content of the App and other users' contributions.
    - **Micro-blogging**: tools that assist users to write short texts that can be shared with others in a blog style.
    - **Chat**: permits users to directly communicate with other users by means of the App.
    - **Notification:** facilitates a notification of activities the user might be interested in.
    - **Voting:** provides the ability to create voting polls
- **3rd Party integration**: integration of external social media Applications into the pilot App.
    - **Facebook:** integration of sharing/commenting via Facebook (if copyrights permit).
    - **Twitte**r: The possibility to integrate Twitter in the App for sharing purpose (if copyrights permit).

Content visualisation: Any form of UI component/information visualisation techniques and tools.

- **Multimedia content:** multimedia content can be text, images, video, audio, and any combination of them.
- **Content graph:** the possibility to integrate representations of relationships between objects using connections or links.
- **Content gallery**: the possibility of visualisation that renders a set of objects (e.g. images) in a "browseable" fashion. An example would be a carousel of images.
- **Timeline:** interactive display showing content and/or historical periods in chronological order.
- **Maps:** the possibility to render a map. This technology also covers all the functionalities/features that can be associated to a map. Such as navigation, zoom in, zoom out, route from a to b. For example locating objects within a city.
- **3D visuals:** the possibility of 3D rendering within the App.

User input: referred to here are the low level input methods and components that can be combined with other technology categories to imply a way of interacting.

- **Text**: allowing users to enter texts in the App.
- **Audio/Video/Pictures:** technologies that enable the user to upload multimedia content like a picture, soundbite or video in the App. This category covers both the capturing and the use of existing multimedia content.
- **Ratings:** allowing the user to add ratings to existing content in the App.

- **Tagging:** enabling the user to define or select from a list a keyword or term that provides information about an item (painting, picture, location)
- **URL**: permitting users to create links to web content.

Micro augmentation - notifications: technologies and tools that enable the production of different types of stimuli with the purpose to attract the user's attention to something. For example a vibration or a short sound to notify the user of an interesting object or, as in pilot 2, popups interrupting the user's attention to deliver a clear short message blending pictures, text and/or sound. This technology will be used to notify a user at a certain time, place or object.

Search engine: with this technology users can request content according to specific search terms and/or classification criteria (facets) e.g. paintings by Van Gogh.

Having described the technologies that underpin the CrossCult framework, the next step is to assume that a specific component(s) combining these technologies has to be built and integrated in the App. The details of which will be completed as part of WP3 and WP4. The technologies framework in Table 55 provides the starting point for these subsequent work packages and provides the building blocks to them. In this table, for each pilot the appropriate requirements are assigned to one or more technologies. The information in this table highlights the high-level assignment of the components that will be developed.

4.1.1. Pilot 1 technologies overview:

The technological pillars for Pilot 1 are location tracking and content recommendation. The App proposes a powerful profiling tool in the form of the carousel: a gallery of paintings. It permits the simple and quick gathering of the user's art preferences. The whole dynamic of the App relies on the user's location in the gallery. Using the user's current and previous locations, in regard to the user profile, the App will propose a personalised set of paintings and routes (itinerary) through the museum. The App also features many visuals and lets the user explore the whole collection of the NG either freely with its search engine or in a more supervised manner relying on the recommending engine. At any time, the user can check her/his position on a museum map/building plan. The location tracking system also encourages serendipitous discovery of content since the presented content varies depending on her/his current location. In addition, a virtual space facilitates reflection by enabling users to virtually organise their own collection(s) and share/discuss it with other visitors. The users also provide their reflections through *Favourites*, a utility that supports users in tasks such as tag, comment, describe and organise personalised collections of favourite paintings, group of favourite paintings and favourite views of the virtual world. For a concise definition of the technologies that will be utilised by Pilot 1, please see Table 55.

4.1.2. Pilot 2 technologies overview:

Pilot 2 focuses mainly on visualisation and interaction of/with graphs of concepts referred in this document as the "mesh of nodes". The App features gameplay where players are

organised in teams that compete against each other. Therefore, it also requires technologies that support communication between team members (e.g. chats, voting polls etc.). To support team creation on the fly, the App will provide a person recommendation tool that will try to predict propositions for homogeneous teams based on players profiles. To build these profiles, the App will rely only on explicit information provided by the user or gathered through questionnaire-like interfaces. Visualisation technologies will be used to present different question formats and micro augmentations will be used to foster retention and serendipitous discovery during gameplay.

Finally, the App acts as a crowd sourcing system allowing users to link the existing content to external Web resources creating links of the core content of each venue to the global knowledge available on the Web. For a concise definition of the technologies that will be utilised by Pilot 2, please see Table 55.

4.1.3. Pilot 3 technologies overview:

The pilot 3 App requires technologies that propose a personalised tour of a venue with the display of multimedia content related to the venue's artefacts. To achieve this personalisation, the App will build detailed profiles of its users. These profiles will mostly be built through the use of a set of mini-games before the actual visit and by mining the user's existing social network accounts. Using this profile a recommendation engine will be used to suggest items and/or routes that the user might like.

Social networks will also provide services for sharing amongst visitors in the museum. For viewing digital content, the visualisation technologies will facilitate use of multimedia objects and 3d visuals. The App will require crowd-sourcing technologies and user input (text, ratings, tags etc.) for requirements that encourage users to express themselves in relation to their visit experience, either in the form of text, tags, and ratings. These contributions can be shared using existing social networks but can also to make them public to other users. For a concise definition of the technologies that will be utilised by Pilot 3, please see Table 55.

4.1.4. Pilot 4 technologies overview:

In Pilot 4, the backbone of the pilot is its location tracking system. The user's location drives the entire user experience and gameplay. Content is only accessible when the user enters a certain physical area in the real world. Micro augmentations are extensively used to draw the user attention to location-specific content. This encourages (and rewards) exploratory behaviours – and enables users to explore the city without the constant need to look at the mobile device. The App is conceived as a crowd sourcing system to generate user content. Thus, any user contribution can enhance and enrich existing knowledge exploited by the App. So by its nature, the amount and quality of content provided by the App will be directly correlated to the number of users and their level of engagement. For a concise definition of the technologies that will be utilised by Pilot 4, please see Table 55.

Table 55. Technologies table for CrossCult Pilots

Technology			Pilot 1	Pilot 2	Pilot 3	Pilot 4
Personalisation	**Location tracking**		1.CDM.2 1.CDM.3 1.CDM.4 1.CDM.7 1.RFN.5			4. CON.9 4.CDM.1 4.SR.3
	Profiling	**Social network based**			3.GEN.9 3.CON.10	
		Game based			3.GEN.9 3.CON.10	
		Explicit feedback	1.CDM.1 1.RFN.1 1.RFN.2 1.RFN.5	2.CON.4 2.CDM.2 2.SR.1		
		Inferred from App activity	1.CON.6 1.RFN.4			
	Recommendation	**of People**		2.SR.1		
		of Item	1.CDM.3 1.CDM.7 1.RFN.6			4.CDM.3
		of Path	1.CDM.3			4.CDM.4
	Accessibility		1.CON.10	2.GEN.5 2.GEN.6		4.GEN.4
	Internationalisation			2.GEN.6	3.GEN.4	4.GEN.4
Crowd sourcing	**Content augmentation**					4.RFN.4 4.SR.2
	Content creation					4.RFN.4 4.SR.2
	Link creation		1.CTS.3	2.CON.6 2.RFN.4		

Technology			Pilot 1	Pilot 2	Pilot 3	Pilot 4
				2.CTS.4		
Social network	**Proprietary**	**Comments**	1.SR.1 1.SR.2	2.SR.2 2.SR.3	3.RFN.1 3.RFN.3 3.RFN.4 3.SR.2 3.SR.4	4.SR.2
		Content rating			3.RFN.4 3.SR.1 3.SR.2	4.SR.1 4.SR.2
		Micro-blogging	1.CDM.10 1.RFN.2 1.RFN.4 1.SR.2 1.SR.3		3.CON.3 3.RFN.1 3.RFN.3 3.RFN.4 3.SR.2 3.SR.4	4. CON.3 4.RFN.1 4.SR.2
		Chat		2.SR.2 2.SR.3	3.CON.3 3.RFN.1 3.RFN.3 3.RFN.4 3.SR.2 3.SR.4	4.SR.2
		Notification			3.RFN.2 3.RFN.3 3.RFN.4 3.SR.1 3.SR.3	4. SR.4
		Voting		2.SR.2		
	3rd party integration	**Facebook**	1.SR.1	2.CON.5 2.SR.4	3.RFN.1 3.RFN.2 3.RFN.4 3.SR.1 3.SR.2 3.SR.4	
		Twitter	1.SR.1	2.CON.5	3. CON.7	

Technology		Pilot 1	Pilot 2	Pilot 3	Pilot 4
			2.SR.4	3.SR.4	
Content visualisation	**Multimedia content**	1.CON.1 1.CON.2 1.CON.3 1.CDM.1 1.CDM.4 1.CDM.8 1.CDM.9 1.RFN.3	2.CON.1 2.CDM.1 2.CDM.4 2.RFN.2	3.CON.1 3.CON.2 3.CON.5 3.CON.6 3.CON.8 3.CDM.4 3.CDM.5 3.RFN.3 3.SR.3 3.CTS.1 3.CTS.3	4.CON.1 4.CON.2 4. CON.8 4.RFN.4 4.SR.3 4.CTS.2
	Content graph	1.CTS.2 1.CTS.3	2.CON.2 2.CON.3 2.CDM.1 2. CDM.5 2.RFN.1 2.CTS.1 2.CTS.2 2.CTS.3	3.CON.1 3.CON.2 3.CON.5 3.CON.6 3.CON.8 3.CDM.4 3.CDM.5 3.CTS.3	
	Content gallery	1.CDM.1 1.CDM.4 1.RFN.3 1.CTS.2	2.RFN.2	3.CON.1 3.CON.2 3.CON.5 3.CON.6 3.CON.7 3.CDM.4 3.CDM.5 3.CTS.1 3.CTS.3	
	Timelines	1.CON.1 1.CON.2 1.CDM.9	2.CON.3 2.CON.4 2.CDM.4		
	Maps	1.CON.7	2.RFN.2	3.CON.1	4. CON.5

Technology		Pilot 1	Pilot 2	Pilot 3	Pilot 4
		1.CDM.2 1.CDM.3 1.RFN.3 1.CTS.2		3.CON.2 3.CON.5 3.CON.6 3.CDM.4	4.CDM.4 4.SR.3
	Virtual space	1.CON.8 1.CDM.4 1.CDM.8 1.RFN.4 1.RFN.5			
	3D visuals			3.CON.1 3.CON.2 3.CON.5 3.CON.6 3.CDM.4 3.CTS.1 3.CTS.3	
User input	**Text**	1.RFN.4 1. CDM.10	2.CON.5 2.SR.2 2.SR.3 2.SR.4 2.SR.6	3.CON.3 3.CON.4 3.CON.7 3.CON.9 3.RFN.1 3.RFN.4 3.SR.2 3.SR.4	4. CON.3 4.RFN.1 4.RFN.3
	URL links		2.CON.6 2.RFN.4 2.CTS.4		
	Audio / Video / Pictures	1.RFN.4		3.CON.3 3.CON.4 3.CON.7 3.CON.9 3.RFN.1 3.RFN.4 3.SR.4	

Technology		Pilot 1	Pilot 2	Pilot 3	Pilot 4
	Ratings	1.RFN.4		3.CON.3 3.CON.4 3.RFN.1 3.CON.7 3.CON.9 3.RFN.4 3.SR.1 3.SR.4	
	Tags	1.RFN.4		3.CON.3 3.CON.4 3.CON.7 3.RFN.2 3.RFN.4 3.SR.4	4.RFN.2 4.RFN.3
Micro augmentation	**Notifications**		2.CDM.3 2.RFN.3	3.CON.6 3.CDM.2	4.CDM.2 4.CTS.2
Search engine		1.CDM.5 1.CDM.6			

5. Game design

Over the last twenty years, computer games have grown from a niche market targeting young adults to an important player in the global economy, engaging millions of people (Entertainment Software Association, 2015). Nowadays, games are being played on a multitude of devices, including personal computers, dedicated gaming consoles, mobile phones, tablets and virtual reality devices. The themes, aesthetics and types of gameplay in modern digital games vary greatly, from combat-oriented competitive games to social quiz games among friends, and from casual games requiring little daily involvement to massive online games with millions of interacting players. The diversity of target devices, the broad variety of game themes and a recent tendency towards free games (which draw revenue from optional in-game transactions) have resulted in a broad player base with a diverse range of ages, genders and cultural backgrounds. This expansive range represents a strategic opportunity for the CrossCult framework to maximise user engagement and enhancement of the cultural heritage experience through the development of different types of serious games.

The success of commercial digital games has motivated the integration of several patterns of gameplay into other tasks such as training (Rizzo et al., 2015), advertisement (Zichermann and Linder, 2010), rehabilitation (Holmgård et al., 2013) and learning (Liapis et al., 2015). *Gamification* and the idea of serious games have attracted substantial academic and commercial interest in recent years for their ability to involve users in solving problems and to increase their engagement (Deterding et al., 2011). Studies in gamification (Hamari and Koivisto, 2014) have identified play patterns such as autotelic experience[6], clear goals, immediate feedback, control and skill-level balance that are salient dimensions of flow in gamification. This leads to the conclusion that *goal-oriented features* provide a firmer basis for prolonging the user's interaction with software. It is hoped that these types of features, if implemented in the CrossCult pilots, will encourage more in-depth and sustained user engagement.

On the other hand, Nicholson (2012) argues against gamification which primarily only uses extrinsic reward motivators, relying on operant conditioning (rewards, points, limited meaning). In addition, studies in the field of human creativity suggest that extrinsic motivators lower the potential for fostering creativity (Amabile, 1998). Games and playful experiences in CrossCult must therefore be designed carefully in order to reap the benefits of gamification (prolonged interaction and self-motivation) while minimising the importance of elements such as extrinsic reward motivators. It is important to ensure that the games implemented in the pilots serve the main user requirement: to enable reflection and (re)interpretation of the historic themes, topics and threads central to the pilots' core.

[6] an experience without an ulterior goal.

Game design is paramount to the creation of any digital game. It defines the way in which players interact with the system, including the motivations and the conditions in which this interaction is brought to an end (e.g. win or loss conditions). A game's design is therefore comprised of the following elements: the narrative (e.g. themes or specific in-game text), the visuals (including the user interface), audio and possibly different levels. Game design relies on a formal vocabulary, which is useful for understanding the underlying structures of games (Sicart, 2015). This vocabulary is also essential for communicating in a game development team which includes, as in the case of CrossCult, interdisciplinary experts from diverse fields of research.

For the purposes of describing the games developed in the CrossCult pilots, the formal game design concepts of *goals*, *loops* and *rewards* are introduced in Table 56. Each game has a goal, which describes the intended *gameplay* experience: gameplay is formally defined as "*one or more causally linked series of challenges in a simulated environment*" (Rollins and Adams, 2003). The game's goal is accomplished through the game loop, which can be described as the primary set of actions that players must learn in order to become skilled (Momoda, 2013). All games have a (core) loop and often include nested, dependent loops (Cook, 2012) for sub-tasks: typical examples in commercial games range from *"shooting enemies while avoiding being shot, clearing dots in a maze while steering clear of ghosts chasing you, or collecting resources to build a strong offense and defence"* (Momoda, 2013). Loops enable the balance of "*interrelated actions [...], systems of crisply defined cause and effect [and] functional feedback that helps players understand causation*" (Cook, 2012).

The actions that players need to perform as part of a (core or supplementary) gameplay loop are known as *game mechanics*, formally defined as "*methods invoked by agents, designed for interaction with the game state*" (Sicart, 2008), where agents can be human players or computer-controlled opponents. Simply put, game mechanics are "*the verbs available to all agents in a game that can be used in order to engage with the game system*" (Sicart, 2015). Thus, the game mechanics in the game play loop for the player are described as verbs in Table 56. As noted above, the causal chain of the gameplay loop requires that players' actions are performed in a sequence (as listed in Table 56) which ends with a feedback mechanism (receive reward). For the CrossCult pilots the functional feedback loop mechanism is based upon receiving rewards (or even punishments), as the direct consequences of the player's choices (Fullerton, 2008). Table 56 includes planned rewards for players performing the action sequences of the gameplay loop correctly. Punishment (as a negative intrinsic reward) is not compulsory for the interactions in CrossCult as gameplay is motivated by their desire to contribute reflections.

Table 56 uses the formal language of game design elucidated above to describe a broad range of games and playful interactions designed explicitly for the four CrossCult pilots and specifically for their learning outcomes. Since game design traditionally follows an iterative process of play testing and refining of the game's rules and mechanics, these goals and core

gameplay loops are expected to be refined during the process of development and evaluation of pilots 1-4. Expected additions include nested, dependent loops which complement or enrich the core game loop, alternative reward systems which provide a better intrinsic (rather than the problematic extrinsic) motivation for reflection, and punishment systems for increasing the dramatic tension of player choices. Therefore for the first version of each pilot we have focused on defining the high-level goal of each game, its core gameplay loop and the intrinsic reward mechanisms that we will use to spark sustained gameplay and thus reflection and interaction with the relevant cultural heritage content and experience (see Table 56).

Table 56. Overview of CrossCult games with core gameplay loop

Pilot	Game type	Goal	Core gameplay loop	Reward mechanism
Pilot 1	Gallery Creation Game	Fill in an empty virtual room with paintings, based on cues, and reflection topics	Select virtual walls from NG rooms, move paintings to match NG arrangement or create a novel setup, receive reward	Score, peer evaluation
Pilot 2	Exploration of networks of concepts and relations: puzzle / quiz hybrid	Discover relationships among items of tangible/intangible heritage from different venues	Choose a new blank to fill in, discuss set of choices, choose one option, receive reward	Hall of Fame
Pilot 3	Social game - short quiz	Answer a quiz regarding ancient citizen's social status	Answer question, observe answer, receive reward	Score, information about ancient society
Pilot 3	Social game - short quiz	Answer a quiz regarding ancient religion and ancient gods	Answer question, observe answer, receive reward	Score, information about ancient gods
Pilot 3	Social game - maze game	Solve the maze and unlock paths by providing information (e.g. name, birthplace)	Move in the maze in all directions, input information, unlock path, receive reward	Score, reveal information about the origin/popularity of name, etc.
Pilot 3	Social game - face in hole game	Capture a self-portrait and present themselves with the body of an ancient statue	Take picture, view picture on statue, receive reward	Picture as a souvenir
Pilot 3	Social game - dress up game	Create new fashion styles and learn about fashion in different cultures	Select parts of clothes from different eras, combine parts, receive reward	Picture as a souvenir
Pilot 4	Location-based treasure hunt game	Explore the city and reflect on the topic of migration and more, linking with other cities, histories and eras	Receive guidelines to next location, walk to location, find hidden object, read about object at location, interact with and contribute to object, receive reward	Score, badges, quests, levels and collective travel diary

Pilot 1 will showcase the exhibits of the National Gallery, giving players the opportunity to create and curate their own virtual gallery. This game is primarily an autotelic creation game, where the reward is intrinsic in the aesthetically pleasing, personalised arrangement of paintings on a virtual wall. Less intrinsic rewards such as peer evaluation through social media or an accuracy score based on existing room setups in the National Gallery will complement and further motivate the player.

Pilot 2 will develop a game based on a type of puzzle/quiz hybrid game (a "mesh of nodes") which triggers reflection and interpretation of historical content, events and connections by asking users to contribute missing pieces of data information. The players' contributions are stimulated by various multiple choice multimedia questions. Players may be asked to interact with a map, a picture or a timeline, for example.

Similar to the quiz game of pilot 2, pilot 3 makes use of "social quizzes" to trigger reflection and comparative understanding. Each quiz will be based on a diverse range of questions and answer formats that make use of linked open multimedia content. In these quiz games players will be competing against each other in terms of score (accurate answers); play can be either synchronous or asynchronous but the primary focus will be on asynchronous playing.

Pilot 3 will also develop a "maze game", which triggers user reflection and understanding by navigating through a maze and unlocking paths that represent pieces of information that correspond to historic narratives about e.g. an historic figure. It has a similar core gameplay to that of the quizzes. Finally, pilot 3 will also make use of playful experiences that harness intrinsic rewards to provide personalised souvenirs. The games are based on the goal of creating a type of mashup of a digital object by either placing your head on an ancient Greek statue or creating a new fashion design by mashing up styles from different periods. For these games the reward is a digital souvenir that can be shared on your social network.

Finally, pilot 4 will develop a location-based game akin to that of a cultural heritage treasure hunt. The game will connect two cities (Valletta and Luxembourg) and will explore different historical topics known as threads (including phenomena associated to migration such as expats and cross border worker as well as the Knights of St John and cultural representations). Players will be able to interact with a map to explore the city and find the location of hidden objects (objects are digital multimedia data that are relevant to a thread). Users will be able to reflect on the thread and its object by selecting tags (predefined or free text), answering reflective questions and agreeing or disagreeing with other players' contributions. Users will be motivated to play by a combination of rewards based on scores, badges, quests and levels as well as the possibility of contributing to a collective travel diary.

A range of different games will be developed for the four pilots, which have been described in Table 56 and can be categorised as quiz games, hybrid puzzle-quiz games, creation games, location-based games and playful interactions that create personal souvenirs.

6. Ethics – expert guidelines

This section provides a list of guidelines developed for experts who will evaluate user interpretations during CrossCult activities in order to protect the diversity of user interpretations. The following guidelines have been developed in line with all European laws and regulations, such as Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions, as well as the Fundamental Rights of the European Union. The guidelines are intended to protect the fundamental rights and freedoms of all natural persons, particularly their privacy rights with respect to the handling and processing of personal data when using the Apps and / or participating in evaluation experiments. However, this will neither restrict nor prohibit the free flow of personal data subject to the national law of the Member States implementing European Directive 95/46/EC for data protection.

In particular, the Fundamental Rights of the European Union (2000/C 364/01, article 21) for non-discrimination policies, the Fundamental Rights of the European Union (2000/C 364/01, article 11) for the protection of the diversity of interpretations and the aforementioned European Directive 95/46/EC for data protection have been used to draw up the following guidelines for experts:

1. **Protection of vulnerable individuals.** CrossCult encourages respectful behaviour and fully protects vulnerable individuals who cannot give their legal consent, such as children or people with an intellectual disability. These individuals will be excluded from data collection/ or user observation studies. However, they may still use the CrossCult platform and Applications, which will be appropriate for all ages and visitors but any data collected will be excluded from analysis, if prior consent is not obtained. In the case that such interpretations end up in the data set (e.g. a mother writing her child's opinion), the data will ultimately be excluded. Only interpretations from people that have provided their consent can be used.
2. **Fair consideration of individuals' interpretations.** Interpretations from all participants that have provided their legal consent should be treated equally by the researchers and no opinion should be either excluded from the data set or altered in any way on the basis of the user's gender, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, birth, disability, age, sexual orientation or nationality. Additionally, there should not be any classification of the interpretation according to discriminating criteria like those cited previously.
3. **No tolerance for bad behaviour.** CrossCult has zero tolerance for any behaviour that promotes and advocates bullying of other people and disrespectful behavior. Every effort shall be made to remove from any gathered data disrespectful comments, foul language, incitation to hatred or discrimination, or totally irrelevant/off-topic

comments. For example, users may be given the option of a report button to enable them to flag inappropriate content, or experts could be used to screen samples of user comments on an ad hoc basis. Any comments identified as being problematic should be reviewed and may potentially be rejected following a decision by at least two experts, with provision of an appropriate justification in the database (e.g. "Comment X removed for foul language").

4. **Neutral position of experts.** Experts should maintain a neutral position and avoid using suggestive language. Their aim should be to help participants express their opinions freely. It should be noted that CrossCult experts will undergo training to help them avoid suggestive language, encourage people to express their opinions freely, avoid imposing judgments and handle the data appropriately.
5. **Any opinion is valuable.** Experts should always remember that any opinion, even one that they disagree with, is valuable, and it is worth finding out whether this opinion is also shared by other participant(s)/user(s); this can help promote understanding of cultural interconnections and differing views.
6. **Experts have to avoid biases from their own opinion.** Experts should be aware of the psychological processes of denial and group think in cases where opinions expressed by users are different from their own. For example, while in denial researchers might reject an idea only because it is uncomfortable for them to accept it and not because there are objective reasons to do so (Metzger, 1988). Similarly, groupthink describes the phenomenon where diverse viewpoints are disregarded because researchers wish to minimize conflicting ideas and reach a simple conclusion, oversimplifying reality (Janis, 1982). For this reason, a second expert will be necessary before discarding any user comments.
7. **Keep in mind collected data will be open.** Experts should be aware that all experimental data collected from users may be opened to the wider research community and further exploited by other researchers and experts. CrossCult experts may invite other experts to view the data sets and draw conclusions.
8. **Carefully review potentially non acceptable data before exclusion.** It is essential to understand that even if something is disagreeable, unpleasant or even disturbing, it may not necessarily violate the standards of the CrossCult community. Only after careful legal review and if content is found to be illegal under local and national law should it be made unavailable in the relevant country. Not all disturbing content can be deemed to violate CrossCult policies for the above reason. CrossCult empowers participants to verify contributions, for example via the reporting button mentioned above, although the ID of the person they are reporting shall remain undisclosed. Reporting will not guarantee that content will be removed, as it might not violate CrossCult policies. The content reviewers will examine the information provided by the participants regarding the reason why they feel offended or threatened.
9. **Warn users about ethical violations.** The consequences of any policy violations may vary depending on the severity of the violation. A warning may be given for the first

violation, but if further violations continue, steps will be taken towards banning the person from making any further contributions.

10. **Update reviews if needed when new data is available.** Finally, it is worth mentioning that CrossCult experts might occasionally change review decisions after being given further details via the database.

7. Conclusion

This deliverable provides comprehensive details outlining the requirements of the four CrossCult pilots. This was achieved with the assistance of high-level user scenarios and corresponding activity diagrams. The deliverable demonstrates the breadth and versatility of the visitor experiences that will be addressed by the CrossCult project and its work packages. The specifications described in this document will be applied in the subsequent project work packages (WP2, 3, 4 and 5).

The document lays the foundations for the technical and evaluation frameworks that must be implemented for the four pilots. A standardised template was adopted to ensure consistency in the presentation of the description and requirements of each pilot, including: (1) a reflective history context; (2) high-level scenarios; (3) associated activity diagrams; (4) data set resources and (5) an evaluation framework. The evaluation framework outlines the axes, metrics, indicator categories and objectives of the evaluation for each pilot. Similarly, the technologies section uses distinct categories to present the range of diverse technologies that will be employed by the four pilots to trigger reflections, dialogues and (re)interpretation of historical topics, narratives or events. In addition, a formal, shared terminology was adopted to describe a broad range of games and playful interactions designed specifically for the four CrossCult pilots and their learning outcomes. Using this template approach has ensured the harmonisation and homogenisation of the requirements but at the same time provided sufficient flexibility to ensure that the diversity of each of the pilots is respected.

The scope of the pilot scenarios ensures that the project reflects the vastly different scales of cultural heritage institutions in society. The scenario for pilot 1 focuses on the personalisation of itineraries for user exploration of a large multi-thematic venue, in this case the National Gallery. In this scenario, historical reflections are triggered through a personalised, fun and multidimensional interaction with digital representations of the physical artwork. In contrast, pilot 2 focuses on the many small venues that exist throughout Europe. It connects four small museums, encouraging reflection through gameplay with teams in order to provide information that links historical topics and associated venues through an interactive graph of concepts. The user scenario in pilot 3 is concerned with adding value to the user experience for one small venue. Through enhanced and enriched personal itineraries, visitors will be able to simultaneously explore physical objects alongside related digital objects provided via linked open data. In this scenario, crowd-sourcing technologies will facilitate reflection. Finally, pilot 4 takes place outdoors and connects the discovery of historical themes and their related objects (known as threads) across two cities. Using geo-located historical data to form the backbone of a treasure hunt game, reflections and interpretations are elicited via crowdsourcing technologies.

Next we look forward to drawing up the detailed specifications of the technology framework and developing the barebones pilots for each of these scenarios. WP4 will build the CrossCult platform by integrating the technological artefacts from WP3 and the management of digital content and metadata in order to provide end users with services on mobile or static devices. The evaluation framework will inform WP5. This work package will be dedicated to the implementation of pilots, the use of the Apps and assessment of the platform. We anticipate future work to shape the details of the user evaluations for each pilot guided by the framework outlined in this document. We will investigate the Apps with a view to confirming their ability to balance a more personal visitor experience with a sense of collaborative reflection and interpretation.

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