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User Experience design for Cultural Heritage Knowledge Management Systems: an Omeka plug-in

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Supervisor Fabio Vitali

Co-supervisor Francesca Tomasi

Presented by Maria Chiara Frangipane

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Abstract

This thesis concerns the user experience design for knowledge management systems in the cultural heritage domain. In particular, it focuses on the design of a plug-in for Omeka S, a web-publishing platform for Galleries, Libraries, Archives and Museums (GLAMs). The motivation behind this study relies on current description methods for cultural artefacts, which lean on exact data and prevent the preservation of the complexity of cultural objects, made of conflicting positions and multiple points of views. The idea that stimulates the research is that the overcome this fundamental mismatch may foster cultural heritage and knowledge dissemination.

The research design relies on four parts: a state-of-the-art analysis, which includes a literature review and a competitive analysis; an ethnographic analysis, including a user segmentation and user research; the proposal of two user experience designs, for collection managers and external visitors; the discount usability testing, for assessing the interface proposals with real users.

The state-of-the-art analysis delineates the collection management systems scene. It enhances the complete absence of entry methods for complex data, particularly focusing on contextual information. The source of information, the level of authoritativeness, and time and space constraints represent specifical evaluation terms, which concur with other criteria for the competitive analysis. Beside the assessment of existing systems, the analysis focuses on Omeka S, tracing its strength and weakness faces: its modularity results to be an essential aspect for the creation of a proposal. The ethnographic analysis depicts the characterization of cultural heritage professionals. It confirms the inner disposition of professionals towards knowledge preservation and dissemination but disproves the general lack of digital confidence. The design proposal synthesises those findings into two plug-in interfaces: the collection manager interface, which enable the user to enrich the collection with contextual information; and the visitor interface, which proposes a visual arrangement of new concepts for external visitors. The testing phase validates the proposals, providing valuable suggestions and precious insights for future developments.

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Introduction

Over the objectives pursued by the digitalization of collections, Galleries, Libraries, Archives, and Museums strive for the preservation and dissemination of knowledge. What if digitalization was the first source of failure in the circulation of knowledge?

Diatribes, controversies and disputes are frequent in the Humanities: the inclusion of *facts* in the domain is rather the exception than the norm and the multiplicity of opinions and interpretations has always been the driving force fostering the humanistic discourse. In fact, vastly sustained and abundantly validated points of view nurture the charm of cultural heritage, providing details and stories to be remembered. Even the most studied artists and periods of European history are not safe from a conflictual perspective, not even Raphael and the Renaissance. *Portrait of Emilia Pia da Montefeltro*[1] is one of the artist's most debated paintings, whose attribution is still not completely agreed upon. The clear similarity to the portrait of the relative and close friend Elisabetta Gonzaga, the dating, and the confirmation of the subject given by an inscription on the back of the artwork, connect the painting to the artist from Urbino and to the history of the Duchy. However, even if the general critique accepted this attribution, several art historians proposed different authorships and the debate is not completely dormant.

This granularity risks to remain completely ignored by the digital medium, which forces the vast amount of information connected to cultural artefacts to a bunch of input fields, consistently but aridly fulfilled in the name of objectivity. The search for neutrality flattens the layered and composite nature of cultural objects, which lose the chance of returning richness and beauty. The duty of today's research concerns the inversion of this pauperization process. Starting with the conceptualization of new data models able to properly structure the complexity of the domain, the scholarly effort needs to focus on original systems for the collection of cultural heritage and the integrated visualization of items, which will lead to the coveted creation of engaging resources. Then, the purpose of knowledge preservation and dissemination will effectively be reached.

The intent of this thesis is to contribute to this evolution, proposing a user experience design for an expressive description of cultural objects in collection management systems. Technological representation of humanistic data can mature and unfold the authentic soul of cultural legacy.

[1] whose photos are preserved in the Zeri photo archive and accessible in the digital catalogue http://catalogo.fondazionezeri.unibo.it/entry/work/29237/Sanzio%20Raffaello%2C%20Ritratto%20di%20Emilia%20Pia%20da%20Montefeltro

1. Research motivation

This research is moved by the need for a more comprehensive method of characterisation of cultural heritage items, whose attributions and sources are often debated. The aim of this work is to surpass the current description method reliant on exact data and propose a more flexible system which can account for source uncertainty and contradictions. The debate over the usefulness and efficacy of said system will be followed by the proposal and analysis of a user interface, developed in accordance with heuristics and user feedback, and meant to facilitate the understanding and acceptance of the new features.

The first section contributes to picture the contextual framework of this research, providing the devices needed for approaching the cultural heritage environment and its blending with the digital mean. Starting from a general picture of the so-called Digital Culture, the research focuses on the relationship between humanities and computational methods, before, and cultural heritage and information systems, then. Then, the motivations that prompted this thesis are outlined: the strive for the digitalisation of cultural heritage and its accessibility.

An additional incentive is given by the need to disseminate the knowledge and heritage produced by medium-small institutions, their endeavour to enter the digital environment pushes the research. These premises lead to the problem definition, which addresses the severe mismatch between information systems and the cultural heritage reality. Finally, objectives and goals are extensively presented, providing the direction of future chapters.

1.1 Context

> *"The emergence of the internet has transformed the practice of the humanities and social sciences — more slowly than some may have hoped, but more profoundly than others may have expected"*
> (ACLS, 2006)

Technology is playing a prominent role in the cultural domain: galleries, libraries, archives and museums (GLAM) are supported in pursuing one of their most important purposes, particularly "to make artworks and artefacts available and understandable, and to share and build knowledge with as many people as possible for mutual exchange and enrichment" (Alfandari, 2014). On one hand, digital technologies, such as applications,

platforms and tools, are deployed to create, store, manipulate and transmit information in almost every industry, including Culture. On the other, digital heritage refers to digital content and materials that represent, reflect or describe human knowledge and cultural manifestations, that are invested with cultural value, and considered a legacy that ought to be transmitted to future generations (Bello and Mohamed, 2018). Digital heritage relates to collections that can be produced by converting materials originally in analogue format or to "born digital" objects, such as documents, artworks, software and websites that originate in digital format. The advent of digital technologies advocates the practice of digitalization of collections and many cultural heritage institutions create and maintain their own repositories. This tendency leads to a vivid cultural environment, in which digital collections can be reused to create knowledge.

The communion between culture and technology, namely between the humanities and computer sciences, is a long run and demanding process. The investigation of the liminal space between the two disciplines started in the 1960s (Hockey, 2004) as pioneering and visionary research. Nowadays, the bonding between cultural heritage and digital technologies is almost expected by GLAM end-users. During this nonlinear journey, the application of computation and computational thinking struggles to address non-STEM[2] questions. In fact, information systems and technologies often do not fit the purposes for which they are deployed, marking the distance between the research objectives and technology. This concern is becoming crucial in an era when many more software for the humanities are being developed outside the humanities computing community (Hockey, 2004). However, current understanding of computational limitations may be changed significantly by emerging computational models and technologies. The effort of the Digital Humanities community strenuously addresses the covering of this gap, creating tools and technologies compliant with its inquiry. Today's focus relies on a permanent abandon of prefabricated systems, which do not fit the needs of digital humanists and cultural heritage professionals. The cultural sector needs to move on from software lent by the IT community for other primary purposes.

Particularly, the scene of digital collections needs support in describing and enhancing its data. Technology ought to account different levels of complexity: firstly, primary sources and their digitalization; secondly, metadata of primary sources; thirdly, data about the context in which metadata is accurate.

1.2 Motivation

The introduction of information and communication technologies into the cultural sector reduces barriers and difficulties emerging in CH communication, primarily those connected to time and place, thus allowing people to adopt new forms of interaction and participation (Mechant, 2007). The digital agenda of governments initially struggles to identify the opportunities given by digital cultural heritage, postponing a comprehensive

[2] Science, Technology, Engineering and Mathematics disciplines.

and authoritative approach to the issue. The overcome of hesitations depicts a variety of policies, regulations and programs, from which, however, it is possible to outline some common general trends (Singh, 2010).

As already mentioned, the first tendency calls for the fostering of digitization of primary resources. The preservation of cultural material represents the basis upon which digital culture can flourish. Secondly, the accessibility to culture becomes a crucial point: ensuring the widest possible access to public domain material enables new audiences to approach a unique portion of knowledge. Inside this context, accessibility is improved continuously due to open-source communities and the open access approach. Moreover, CH institutions are turning their attention to the preservation of cultural diversity and its management through intercultural dialogue. In the same way, a rising enhancement of inclusivity leads to new discourses and practices in cultural production (Singh, 2010; Uzelac and Cvjeticanin, 2008).

Finally, an interesting digital perspective lies in small and medium CH institutions and organizations. Local galleries, libraries and museums represent the vast majority of cultural realities. The GLAM panorama is grounded on small institutions preserving unique collections. Unfortunately, the potential of new methodologies and tools to have a transformative impact on research and smaller projects is higher than the grant funding available to support extensive, expensive and dedicated technical undertakings. Despite the richness of CH project ideas, limited means and resources often prevent their realization (Avgousti et al., 2019). These limitations can be addressed by open-source dissemination solutions available for CH institutions, such as Omeka S. These systems support semantic publishing and standard formats and metadata, enabling small realities to enter the Digital Culture domain and disseminate their knowledge online (Hardesty, 2014).

A final addition to these considerations is reserved for the current health situation. Since the breakout of the Coronavirus pandemic, the CH sector has been facing unprecedented circumstances. While direct and physical access to culture has been suspended, the demand for cultural resources has significantly raised, paired with indirect and online fruition of contents (Radermecker, 2020). Inside this framework, the call for new tools and methods aimed at a comprehensive Digital Culture becomes more urgent than ever.

1.3 Problem definition

The problematic here debated regards the general incapability of collection management systems (CMS) to allow for the insertion of multiple and distant, if not contrary, points of view in the description of cultural heritage. With a rearrangement of existing technologies, such as markup languages, metadata models and information systems, a change is possible: such possibility will be debated and possible solutions will be offered in the course of this thesis. The founding issue of this domain is the divergence between the humanistic research and the existing tools. The fundamental mismatch between information systems and cultural heritage relies on the search for objectiveness (Hockey, 2004). While the humanistic inquiry is deeply characterised by disputes, antithetical points of view and validated opinions, the standard computational system relies on

exactness. So that, a rigorous modelling for complex information inevitably flattens the richness of humanistic perspectives. Existing models are not sufficient for the realities they are called to represent.

Collection management systems' rigidity often arouses three frequent problems in the description of cultural heritage: reticence, coercion and dumping (Vitali, 2019). Firstly, reticence concerns the attitude of institutions and professionals that refuse to insert information with a perceived low accuracy. Despite enriching a description with diverse and multiple information, the CH officer drains the characterization, omitting precious details. This tendency arises in absence of trustworthiness of information and prevents descriptions to reflect the range of shades typical of cultural heritage. Secondly, coercion describes the forcing of a datum inside another unfit field, usually the most related one. When a piece of information cannot be inserted inside its correct metadata entry, often it is stretched inside the most similar input. This process produces incorrect description and wrong representation of cultural heritage. Thirdly, the last common issue in the compilation of data is dumping. Dumping occurs when all information left without a dedicated field is inserted inside a random text field. The residual data is dumped into a unique and improper input. Data entry deals with the combined result of these three errors, because the metadata model does not adhere to the specificity of the subject.

Although there is the need to conform to interoperability standards, the preservation of the richness of data representation is equally important. As frequently asserted in previous researches, a cultural object has to be managed in relation to its context (Daquino and Tomasi, 2015; Navarrete and Owen, 2016; Besser, 1997). Models and systems should be capable to represent content information paired with a contextual frame within which assertions (e.g. interpretations) are valid. Moreover, they should also enable the representation of the provenance and authoritativeness of assertions. As outlined by Dallas at the end of the last century, systems should prevent loss of nuances and model adequately the complexity of culture.

These reflections carry the research to its core problem: the lack of a comprehensive characterization of items. Among possible options, this research concentrates on four fundamental assets, which enables a multidimensional description of cross-domain items. Firstly, any statement describing a cultural entity needs to be referenced to its source. The traceability of information is an already well addressed concern in scholarly environments, but still the digital domain cannot represent them consistently in the description of data. This "analog" best-practice needs to be applied also in the characterization of digitalized statements in order to avoid the loss of details. Moreover, declaring the provenance of a statement allows to represent different and conflictual points of view, interpretations and opinions. As stated in the *Introduction*, different authorships, contrasting readings and different dating would be allowed in the same description, accounting the right source of its paternity. Secondly, the reliability of a statement is another crucial concern. If plenty of positions are involved in the description of an item, which are more trustworthy assertions? In Humanities, the general acceptance of the scholars' community carries a higher level of authoritativeness to a particular theory. For example, the Portrait of Emilia Pia is generally attributed to Raffaello, even if different authorships have been outlined. In this case, it is possible to say that the Raffaello authorship has a higher level of confidence than the authorship concerning another painter. When statements are paired with a level of confidence, the multidimensionality of cultural heritage descriptions can be correctly represented: conflicts and debates are

daily Humanities practices, their richness need to be transmitted also in the digital domain. Finally, another important characterization regards the boundaries within which a statement can be considered valid. Specifications concerning the time and space describing a statement are fundamental for its comprehensive understanding. In fact, descriptions are not valid *per se*, often they need to be inserted into a contextual frame, able to define the accuracy of the information. Temporal and geographical constraints properly specify the conditions within which a statement is accurate. For example, the city of Urbino conceived as Raffaello home town, is to be addressed as the core of the sixteen century Duchy of Urbino, excluding from the description current jurisdictional characterizations of the city. The lack of such characterization can lead at least to inaccurate information, at most to misunderstanding and false conclusions.

1.4 Objectives

This thesis studies if the user experience of a CH management system is affected by a method for adding complex information, such as contextual material, encouraging users to enrich their collections. The objective particularly addresses the user experience of CH professionals and their description practices, trying to encourage knowledge sharing and prompting their contribution to the storage of information. Given that actual systems struggle in capturing the complexity of CH, the user experience approach gives the opportunity to explore the CH professionals' perspective, aiming at developing a system that would be successfully and effectively deployed by specialists. Specifically, the inquiry concentrates on an existing collection management system, Omeka S, providing a design proposal for a plug-in dedicated to the insertion of complex information. The choice of this system relies on its capillarity diffusion in the GLAM environment, which is paired with the acceptance of modules and plug-ins.

The first research goal is to investigate *how it is perceived the absence of contextual information inside digital collections by collection managers*. This research question introduces the formulation of four tentative hypotheses. Under this frame, the review of the literature and the ethnographic research operates:

H1: Collection managers are fully satisfied by the expressivity of Omeka S.
H2: Omeka S does not provide enough guidance through the description of items.
H3: Omeka is used mostly for inventory purposes.
H4: Collection managers feel responsible for preserving CH.

The second goal relies on the assumption that the reality of CH collections is not acknowledged by existing CMS and the user experience of systems do not address the collections' needs. This second part is focused on the user experience of CMS, trying to *outline necessary criteria for a well-structured user experience in systems providing contextual information in CH knowledge management*. This second research goal is associated with hypotheses:

H5: The interface design does not fit the addition of complex data.

H6: Complex data need to be stored in a distinguished space.

H7: The item presentation design of default themes does not fully satisfy visitors.

The thesis structure is composed of five parts. The first one is an analysis of the state-of-the-art. Starting from fundamental concepts of knowledge management and knowledge sharing barriers, the analysis touches the framing of knowledge management inside a CH perspective and some examples of metadata and guidelines. This part also includes the competitive analysis, which consists of an assessment of existing systems adopted by GLAM institutions. *Chapter 2* is the foundation upon which the following sections are based. So the review of the state-of-the-art leads us to the ethnographic analysis. This second part is dedicated to the individualization of target users and the study of their characteristics. In the third part, the outcomes of previous sections are embodied in the design proposal. The introduced concepts behind the interfaces are then assessed in the four part, the testing. Finally, the last part examines all the findings of the research, outlining conclusions, limits and possible future perspectives.

2. State-of-the-art

The research starts from previous works of the domain, providing an up-to-date description of the GLAM environment, its tool and its strategies in preservation and metadata description. The understanding of the reality is the solid foundation upon which it is possible to carry out the study. If not, the output will presumably not match users' expectations and the designers work (Garrett, 2010). Starting from a knowledge management environment definition and application in the digital GLAM context it is possible to interpret the mutual linking between the conservation and preservation of cultural heritage and new technologies. The chapter focuses on how knowledge is managed inside cultural institutions, particularly focusing on information management systems and repositories. Starting for the principles of knowledge management, the inquiry outlines the knowledge management concepts in cultural heritage institutions. Individual, organizational and technology barriers are addressed in a CH perspective. Then some guidelines approach to the description of cultural objects leads the research to highlight common criteria for the assessment of the efficiency of knowledge management systems. Finally, the analysis of some collection management systems reviews existing tools, highlighting common issues and discrepancies.

2.1 Knowledge management principles

The definition of knowledge management and sharing combined with the presentation of its main barriers provide a theoretical framework for framing the cultural heritage domain.

The concept of knowledge in management sciences appeared in 1959, within the contribution of Peter Ducker, one of the most important points of reference for the issue of modern management. Generally speaking, knowledge is addressed as a key point for long-term organizational growth and sustainability (Davenport, 2002). This valuable resource fosters the development of applications for codifying, organizing and disseminating knowledge. Hence, the activity of generating value from organizations intellectual and knowledge-based assets would be referred to as knowledge management (hereinafter shortened to "KM").
Knowledge is more than a simple gathering of data and information inside a meaningful context and because of that its definition has been divisive and blurred. However, the explanation of knowledge inside the management domain provided by Blair applies to the scope of the following argument: (2002):

> *"Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms."*

Another important theoretical point of reference is the *compendium* made by Girard and colleagues, where they state that knowledge management is mostly based on three main components: people, processes and systems or technologies. As the primary conveyor of knowledge, people are the key resource in KM practices. They are owners of the largest amount of knowledge, mostly conserved in the form of "tacit knowledge" which cannot be transferred since its explication. Indeed, they are also needed to ensure codification (Nonaka and Takeuchi, 1995). The second asset is represented by processes, they characterize methods and steps through which KM practices are achieved, involving the application of new procedures to achieve objectives (Igbinovia and Ikenwe, 2018). Finally, systems or technologies designate all the devices and tools that support the practice and implementation of KM. Milton and colleagues define this component as knowledge technology, making a significant differentiation with the so-called Information Technology, such as email, document management and intranets (Milton et al., 1999). Although these assets combined are boosting knowledge dissemination and sharing, researchers also outlined that their fragility could be fertile ground for the so-called "triad of knowledge-sharing barriers" (Reige, 2005). This concept classifies the barriers to knowledge sharing into three different groups: individual barriers, organizational barriers and technology barriers. In recent KM literature, knowledge sharing barriers also involve cultural barriers (language and cultural norms differences) and geographical barriers (geographic distance and time zone difference) (Anwar et al., 2019). Since cultural and geographic barriers are not the major issue of knowledge sharing in CH organizations, this study will take into account the traditional tripartition.

Individual barriers vastly concern the self-perception and motivation of the employee. Lack of trust and low awareness of self-knowledge play a relevant role in preventing knowledge sharing. This attitude paired with a weak social network with team members carries a negative impact in sharing practices. Thus, it is noted that effective communication skills are crucial to effective knowledge sharing. Social studies outlined a correlation between employees' social networks, their attitude and personality (introversion, lack of self-esteem) and their ability to interact with others (Nahapiet and Ghoshal, 1998). Furthermore, another potential barrier is a perceived lack of job security. Through this perspective sharing of knowledge is regarded as weakening an employee's position within the company. The latter barrier, combined with disseminated strict time constraints makes the knowledge sharing perceived as a cost factor, instead of an important activity of their work (Al Attar and Shaalan, 2016).

Organizational barriers often relate with the misallocation of human or process-oriented resources, including experts, infrastructures and information, and communication technologies (Reige, 2005). According to KM research, the absence of a communication-friendly environment, including both the team attitude and

atmosphere and the physical organization of the office, significantly decreases knowledge sharing. Barriers at the organizational level might be represented by a scarce communication and cooperation between departments or institutions. Thus, the negligence of institutions towards an embedded knowledge sharing strategy into organizational goals and workflows represents a crucial issue (Quintas et al., 1997).

Finally, technology related issues are considered the third important potential source of limitations. The utilization of technology in expressing, representing and disseminating knowledge could act as a facilitator and make organizational and knowledge processes efficient. This is an established best-practice in the CH domain. Notwithstanding this deployment, it is not worthwhile if users do not use them properly in the workplace. As Davis outlines, one of the most influencing factors in the acceptance of systems is the perceived usefulness of the application (Davis, 1993). Moreover, severe consequences could be excited by the mismatch between individuals' need requirements and integrated IT systems, commonly when softwares rigidity diverges from users' expectations (Neches, 1991). Another key issue highlighted by Reige is the choice and implementation of suitable technology able to provide a close fit between the people and organizations (Reige, 2005). Ultimately, the level of digital familiarity of employees definitely plays a role in knowledge sharing: the diffidence towards new technologies restricts sharing practices, as well as a lack of integration of IT systems inside work routines.

2.2 Knowledge management in the Cultural Heritage domain

In order to understand knowledge management processes in GLAM domain, it is important to resume the concept of data and information through the CH perspective. Within the so-called continuum of understanding outlined by Sheldoff (1999), data are raw material, discrete and objective facts, product of discovery, research and creation, used to build communications. In the CH context, data can be described as records, usually stored in some forms of technology by departments. They represent the basis upon which is possible to create knowledge[3], essential for describing objective facts.

Even though data represents a fundamental asset, they do not provide interpretation. Information makes data meaningful for receivers, creating relationships and patterns between facts (Sheldoff, 1999). Generally described as a message that usually takes the form of a document, text or some visible communication, it is presented and organized in order to be received by an audience. In the CH domain, information fulfills databases and flyers, documents and reports. Stored in catalogues, information does not provide judgment or interpretation, thus it is impossible to retrieve inferences and draw conclusions.

[3] This image recovers the pyramidal spectrum of knowledge, a parallel and alternative model to the Shedroff continuum of understanding (Rowley, 2007).

As already stated, through knowledge it is possible to integrate data, information, experiences and meanings. It provides a common framework for interpreting previous experiences and disseminated information. By capturing knowledge, GLAM organizations would be able to create, secure and re-use knowledge to achieve their goals. Orna and Pettitt outline that the core of GLAM's requirements for knowledge and information are collections. Therefore, all the other kinds of knowledge and information which any institution requires depend on them. According to recent researches, if that core is not properly maintained, none of the aims can be achieved (Parry, 2013).

As suggested by Parry, the core of a GLAM institution could be conceived as a threefold store of information and knowledge. The immediately visible store is represented by the collections and its components, such as artefacts, specimens, models, paintings, photographs and texts. Within this store emerges the "embodied" information: for instance, what collection items are made of, their creators, how and when they were formed. Behind this asset again, there is an invisible store in the minds of the people who are responsible for the care and representation of the collections: curators, employees and researchers are liable for the representation of the collection. They have the role of making visible what they already know, helping visitors to relate to the collection. Due to its multidimensional nature, knowledge in the GLAM domain is complex and its core is polysemic: the information carried by artefacts is diverse and changes with respect to the context (Navarrete and Owen, 2016).

2.3 Metadata and guidelines in collection description

As it has been argued above, complexity is the signature style of CH knowledge and makes it much more difficult for KM systems (hereinafter referred as KMS) to represent it properly. Hence, the adoption of digital systems in the CH domain is often characterized by a flattening of perspectives. Most of the information and knowledge produced within the organization is barely stored and disseminated by KMS due to several factors.

Theoretically technology allows complex information dimensions, yet digitalization strategies tend to focus on a restricted perspective on metadata (Navarrete and Owen, 2016). In fact, metadata is perceived as information about the object as an information carrier. If artefacts carry external knowledge, metadata records the internal knowledge of the object. For instance, if the artifact is a text, its internal knowledge consists of information about the author, publisher, number of pages, index; while its external knowledge would be its content, the argued thesis or the narration. This model restricts the potential of metadata, relegating their purpose to a restrained set of information about object features.

Although there are multiple perspectives on the descriptiveness and expressivity of metadata, ministries and supranational organizations have richly developed documentations about CH digital preservation and description. Guidelines and protocols on how and what have to be recorded leads the CH information work, giving a shape to the domain. For the sake of feasibility, the following paragraph describes the key points of the Europeana Publishing Guide and some features of the Italian context.

The Europeana Publishing Guide is developed for CH institutions which want to share and incorporate their data into Europeana Collections. Firstly, as a reliable aggregator of European cultural resources, the guidelines require metadata to be submitted using a shared model: the Europeana Data Model[4] (EDM). Moreover, EDM demands to adopt some mandatory elements in order to create a "*rich and full description of your objects*". For instance, the reusability of collections is a central element in the guidelines, thus language tags and linked resources from authorities and thesaurus foster semantic enrichment of the descriptions. Furthermore, Europeana seeks for high quality content: images, audio, video, 3D records and all the primary sources have to satisfy minimum requirements to be accepted. It is clear that the Europeana perspective approaches the issues of fragmentation, preservation, and dissemination related to the European CH. To provide an insight on local position, a brief overview of the Italian framework is depicted.

The ICCD[5], *Istituto Centrale per il Catalogo e la Documentazione*, is an Italian CH Ministry institution and its guidelines may be considered the national cataloguing reference. Its description model relies on the mapping of CH resources based on the artefacts' nature, divided into 30 categories. Each discipline has a detailed descriptive model, which considers the distinctive features of the item. This approach leans on a highly specialized paradigm, which requires expert professionals and an extensive cataloguing knowledge. These highly structured entries are paired with the well-known principles of Linked Open Data, such as accessibility, interoperability and reusability. The ICCD guidelines address a rich and composite environment that is hardly monitored and assessed in a structured way (ICCD, 2018).

Through these perspectives, related to the CH domain it is possible to outline two different approaches to the description and cataloguing of artefacts and items. The next section will clarify the modes of the applications through which is possible to store and disseminate portions of knowledge.

2.4 Assessment criteria for KMS

The management of information resources, services, systems and technologies using various technologies and tools through activities such as information acquisition/creation, information retrieval and storage, data mining, classification and cataloguing, and information use in different information handling institutions or centres such as libraries, archives and museums (Onyancha & Ocholla, 2009). The principles for assessing a good management system for CH collections are diverse. Earlier studies generally classified them by three main criteria.

[4] https://pro.europeana.eu/page/edm-documentation

[5] http://www.iccd.beniculturali.it/it/per-condividere/interoperabilita

Firstly, researchers are advocating for museums and CH institutions to input the interpretative or contextual materials that museums produce on a regular basis into the CMS and present online those materials along with the object information (Besser, 1997). After twenty years this need is still a crucial point for collections and their curators: the challenge of information systems is to identify effective functionalities designed to seize the contextual and interpretative shades of artefacts. Applications need to shape their features according to the enrichment of cultural information, capturing their complexity. Also, Dallas emphasizes the systems must be designed in order to prevent loss of nuance and context of the source document (Dallas, 1994). They do not go far enough to bridge collections information with interpretive or contextual resources.

Another principle relies on the diversification of the users: software needs to address different needs for different purposes. Registrars and employees are those who enter information and data inside the application, also collection managers carry out this kind of tasks, structuring the description model and providing context information, while directors need to record and report the work. This perspective sees the system as a bridge connecting different activities of the same workflow, integrating and harmonizing the practices of each professional (Dallas, 1994).

Finally, systems are expected to take into account the needs of the end-users and public in their design. The accessibility of information in its integrity must be an integral part of the CH institution's services. A usable and consistent experience needs to be provided to the visitors of the collection, granting the dissemination and evaluation of the resources. The design needs to comply with the pillars of user experience and to be the medium of knowledge dissemination in the digital environment.

Expanding the second criteria outlined by Dallas, the present research will also include detailed assessing parameters, which are intended to evaluate the support of complexity by collection management systems. Following fundamental criteria already depicted in *Chapter 1.3*, the competitive analysis will include the presence of the following. First, the possibility to reference single description statements is needed for allowing the insertion of contrasting points of view and the provision of interpretative materials (Dallas, 1994). Second, the availability of an authoritativeness scale, which can characterize data is another parameter. The level of trustworthiness of an information results particularly pivotal for the expression of conflictual information, depicting the scholarly acceptance of a statement or its distance to the commonly accepted reading. Third, time and space constraints need to be listed in the contextual assessment criteria. Contextual specifications concerning time and space render the correct frame within which information is properly represented. Without this characterization, statements would be absolute and always valid: their inclusion in precise boundaries help the correct interpretation of data.

2.5 Competitive analysis

When a new design is intended to be drawn, it is important to review existing applications of the same domain in order to perform an analysis of what is currently available to users (Cooper, 2014). Competitive analysis is one of the standard tools in user experience practice and a compulsory step for enriching the awareness of

current state-of-the-art. This process facilitates the comprehension of the panorama, identifying weaknesses to be avoided and strong points for inspiration. Moreover, it is considered an important procedure because it helps to outline precious insights that can be used during next steps, such as the ethnographic analysis and the user research. This competitive analysis takes into consideration two different perspectives: the point of view of the collection managers and the visitors. The combination of both relevant prospects provides a comprehensive picture of the scene.

Besides the assessment of standard element such as the methods of entry and style of interaction, employee perspective takes particularly into account whether the system includes the following: the acceptance of multiple and contrasting points of view, the inclusion of a scale of reliability for information (e.g. level of confidence), the integration of spatial and temporal constraint within which an information is valid (e.g. contextualization in space and time). The involved application of the analysis are CollectiveAccess[6], CollectionSpace[7], TMS Collections[8], MuseumPlus[9] and Omeka S[10].

CollectiveAccess is open-source collections management and presentation software designed for museums, archives, and special collections also increasingly used by libraries, corporations and non-profits. It is designed to handle large, heterogeneous collections that have complex cataloguing requirements. CollectiveAccess is a collaboration between Whirl-i-Gig and partner institutions in North America and Europe with projects in five continents. The software is freely available and open source. CollectionSpace is a web-based, open-source collections management software for GLAM institutions, provided by LYRASIS, a non-profit membership organization developing technology solutions for universities, libraries and museums. CSpace was developed by a network of North American and European partner organizations. TMS Collections is a CMS provided by Gallery Systems, a private organization based in New York, USA. It is one of the big players in the GLAM sector, serving several private and public institutions. MuseumPlus deals with museums, galleries and archives. The application is provided by Zetcom, a software company founded in Berlin, Germany, and leading the private sector with its world-wide development. Although it is not optimized for libraries, MuseumPlus also involves the management of internal workflows and contracts. Omeka S is an open-source free web publishing platform for institutions interested in connecting digital cultural heritage collections with other resources online. It is a project of the Corporation for Digital Scholarship, the Roy Rosenzweig Center for History and New Media, and George Mason University, with funding from multiple organizations.

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[6] https://www.collectiveaccess.org/

[7] https://collectionspace.org/

[8] https://www.gallerysystems.com/solutions/collections-management/

[9] https://www.zetcom.com/en/museumplus-en/

[10] https://omeka.org/s/

The user interfaces used for this study are taken from heterogeneous material, such as demo accounts, screenshots, user manuals and tutorials. A demo version is assessed for CollectionSpace, CollectiveAccess and Omeka S while the remaining is explored through other resources.

The first comparison term is represented by modularity. It describes extensible systems able to be enriched by plug-ins and addons. This characteristic is crucial for this research, because it determines the possibility of a software supporting external extensions and permitting practical outlooks. Even if all the assessed systems support the employment of multiple extensions, on one hand proprietary applications predictably do support plug-ins only implemented by their developers, on the other hand open software such as Omeka and CollectionSpace are the only ones that allow the implementation of externally-developed addons. Their approach fosters community creation and support, relying on a large network of contributions by several professionals and researchers. These characteristics confer plasticity to systems that, while maintaining a fixed core, can be tailored to almost any project need.

Another comparison parameter is represented by the possibility of managing description entries, both in the choice of vocabularies and in the personalization of property sets. Usually, multipurpose collection management systems are used to deal with a variety of items, so the personalization of fields is generally possible according to the single organization's needs. Even if this customization is widely spread, the assessed systems do not allow to insert conflictual information and multiple points of view for a single entry. Only extra fields can be added for non-contrasting information, for instance in case of co-authorships. As outlined in *Chapter 1.3* the multidimensional characterization of cultural heritage collections can be determined by four assets: the source indication, the level of reliability of information and the contextualization in space and time. First, the possibility of inserting the provenance of a description statement is not provided in any assessed system. Moreover, entered data do not support reliability levels, so the multidimensionality of information and diverse research branches cannot be inserted in a structured way and properly stored. Also space and time constraints are not considered in available insertion methods. Consequently, the initial hypothesis "*The design does not fit the addition of complex data*" is still valid. At the end, the Dallas' principle of diversification of features for addressing different user types is partially satisfied. In fact, most of the systems support the automatic creation of printable reports, facilitating the personnel daily to-dos. The systems implement this feature differently: some of them report a resume on a single item basis, others provide a checklist for specific exhibition's needs or track and display performance metrics in a specific document.

Another term of differentiation relies on the principle of open source software. Omeka S and CollectiveAccess are completely free open source projects, this gives the international community free access to the result of their work, following the fundamentals of open collaboration and peer production. Also CollectionSpace is an open source application, but not freely available, while TMS and MuseumPlus are, excepting for some open modules, proprietary softwares. Considering the fragmentation of the GLAM environment and the myriads of collections of medium-small institutions, accessibility, in terms of code openness and affordability, becomes a mandatory requirement in the choice of a CMS.

Finally, the analysis needs a consideration upon the domains covered by the systems. Omeka, Collective Access and TMS features perfectly fit the GLAM environment, addressing larger audiences and communities. While Collection Space and MuseumPlus exclude libraries from their offer.

The analysis of the applications depicts a general inadequacy in the representation of complexity: even if the space for bibliographic information can be generally found, the lack of a structured model for the insertion of multiple points of view is still a crucial point. The next session is dedicated to deepening the examination and evaluation of the system Omeka S.

	Collective Access	Collection Space	TMS	MuseumPlus	Omeka S
Open access	yes	yes	no	no	yes
Collection types	GLAM	GAM	GLAM	GAM	GLAM
New vocabularies	yes	yes	-	-	yes
Customization of properties	yes	yes	-	yes	yes
Report	yes	yes	yes	yes	no
Extensibility	no	yes	no	no	yes
Multiple pov	no	no	no	no	no
Level of reliability	no	no	no	no	no
Spatial/temporal context	no	no	no	no	no

Table 1 - Competitive analysis summary

2.6 Omeka S

Beyond the vast variety of collection management systems available in the CH domain, this research will focus on Omeka S, trying to enrich its potential and proposing an integrated interface design. The choice of the system falls on Omeka S for several reasons.

Firstly, Omeka benefits from its nature of extensible system. It is developed in order to be highly customizable, so that its strength is represented by modularity. A multitude of plug-ins, called modules, are implemented not only by the software team, but also by external scholars and developers who want to give

back to the community. The rich and detailed documentation enables other professionals to contribute to the development of the system, creating tailored addons. This means that existing code can be improved and the provided API can be used for contributing to the expansion of existing functionalities. Secondly, as already stated, it is an open-source software, which represents a best practice for the cultural heritage community: collaboration, openness and affordability are almost mandatory requirements. In fact, given that the CH domain is known to be a heterogeneous field, an application like Omeka S enables medium-small CH realities to realize professional and standard compliant projects, making freely available a reliable and quality service. In this context, the adjective "medium-small" concerns both the size of the institution and the budget allocated to the project, which often has to bargain for economical and human resources. Following these principles, this study aims at actively contributing to the discussion and at integrating the discourse on CH open source application. Thirdly, Omeka is an extensively diffused system, used by cultural heritage big players, such as Europeana and international universities, but also small and local organizations. The capillarity of the system also outlines its recognized success and the quality of the system. Moreover, its cross-institutional and international diffusion is another crucial factor for the research outlook: the action of this study can contribute to the improvement of a well-established reality recognized at international level and relevant for a multitude of GLAM projects.

2.6.1 Omeka S: an introduction

Omeka, whose name means "to display goods or wares; to spread out" in Swahili, is a content management system for online digital collections developed by the Roy Rosenzweig Center for History and New Media (RRCHNM) at George Mason University. As a web application, Omeka allows users to publish and exhibit cultural heritage objects and collections, providing information and multimedia contents. The Omeka project includes two different declinations of the product, Omeka Classic and Omeka S. Both of them are designed for publishing collections and exhibitions, but if the Classic version is recommended for small collections, the S version is the upgraded semantic release. The S version is designed specifically with the principles of Linked Open Data (LOD). Omeka S uses JavaScript Object Notation-Linked Data (JSON-LD) as its native data format, which makes it possible to blend Omeka S in the LOD world. It gives the possibility to create triple connecting the URIs of the dataset with RDF vocabularies, such as Dublin Core Metadata Initiative, Bibliographic Ontology (BIBO), and Friend of A Friend Vocabulary (FOAF), or embedding other ontologies and vocabularies.

As abovementioned, one of the sources of Omeka richness is the community that has grown around the core software and the number of plug-ins that have been developed to perform a variety of functions, from batch importing images and metadata to creating exhibitions and timeline visualizations of a collection. If a feature is desired but the default install of Omeka does not supply that feature, available plug-ins, might contain that functionality. Due to its extensible nature, Omeka has been generously expanded through the years by several CH professionals and developers, who have created proper libraries of free modules. Dozens of plug-

ins are collected in several repositories, even if the complete list of officially accepted addons is available on Omeka S website[11]. The provision of detailed and rich user and developer documentations facilitates the creation of a flourish environment, which encourages the digital transition of collections and the creation of a collaborative international space. The repository contains an assorted selection of modules, which differ from each other. They can generally be divided into two main categories: modules dedicated to the collection management system functions and modules for the visualization and building of digital exhibitions. The former category usually adds features to the system and operates on metadata, exchange of formats, manipulation of images and text; while the second concerns exhibitions' customization with different layout and style components. In order to provide an overview of some existing modules, a brief analysis of the three most widespread plug-ins is provided. Firstly, "CSV Import"[12] is a widespread addon used for importing entities from CSV files. The module maps the file column data to entity, while rows represent metadata for single entities. This module permits the import of different Omeka resources, such as Items, Item Sets, Media, ensuring high format compatibility and an efficient data migration. The second presented plug-in is "Custom Vocab". This module permits to create controlled vocabularies from Item Sets and add them to specific properties in a resource template. The controlled vocabulary, populated with Omeka resources, can be used to efficiently manage item sets and boost the network of resources. Realized for structuring and speeding up the process, this module fosters the Semantic Web best practice of creating relations between resources and controlled vocabularies. Thirdly, the "Mapping" module allows the geolocation of items and the insertion of interactive maps to site pages. Through a map interface, the user can modify the appearance of the map, draw markers, search addresses and precise locations. In addition to the enrichment of items descriptions through geolocations, Mapping operates also on the visitors interface counterpart, allowing the insertion of interactive maps with timelines and carousels. Nonetheless, no plug-in we could identify addressed the issues presented in this research, namely, the specification of multiple points of view over the same data item.

The introduction of these modules provides a general overview on the possible extensions of the system. Notwithstanding the broad range of available addons, none of them comprehends the structured insertion of conflictual and multidimensional statements. The authoritativeness and the source of single statements is not foreseen, as well as the spatial and temporal validity span. However, the modularity of the system and its abundant documentation provide a fertile foreground for research and studies.

[11] https://omeka.org/s/modules/
[12] https://omeka.org/s/modules/CSVImport/

2.6.2 Omeka S: the interface

In the present section, only the employees and collection managers interface are taken into account, due to the fact that the visitor interface may strongly vary. Moreover, the focus will remain on the item editor section, which represents the core activity of the system (Parry, 2013) and the main interest of the research. This assessment is paired also with the heuristic analysis, available in *Appendix E.1* and resumed in *Chapter 5.1 Inspection*.

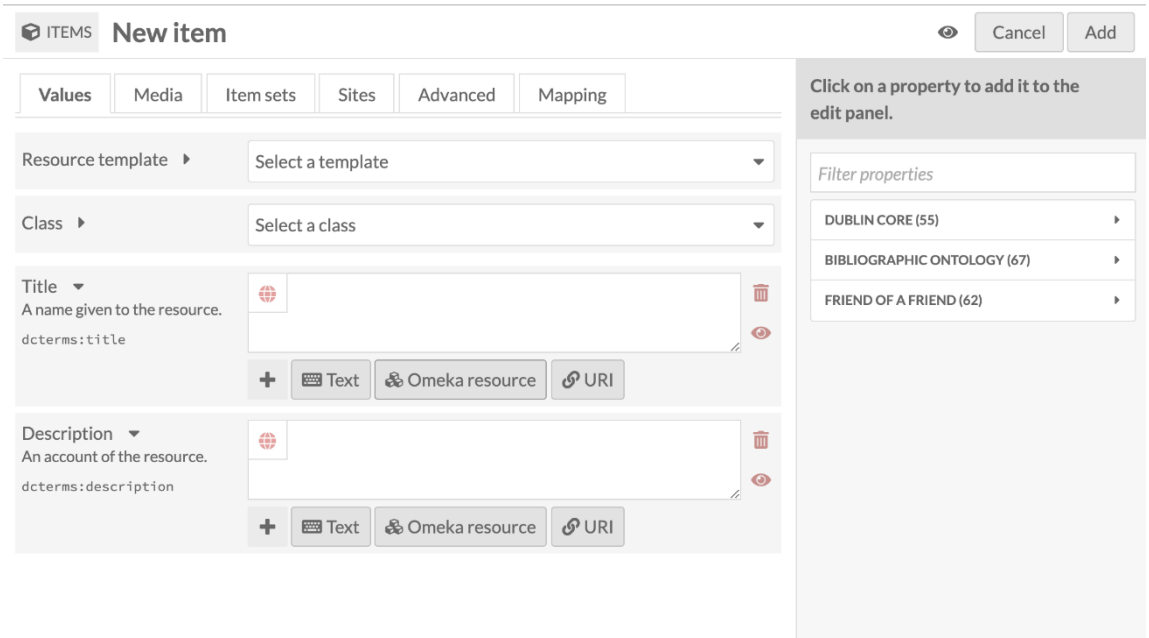


Figure 1 - Omeka S editor interface

The overall interface presents a consistent and coherent design. The navigation through different sections of the application is demanded to the left side menu, which represents a static fixed element. The item editor can be reached under the “Items" section, activating the button “Add new item”. This process creates a new collection instance, ready to be edited and enriched.

The item editor interface is divided into two main zones: the editing part and the right property panel. The property panel is used for picking and adding properties inside the editor: when one of the uploaded vocabularies is selected, a dropdown menu shows the related predicates. The possibility of adding extra fields for customising the description of an item is so enabled and not taken for granted: several CMS let the user choose the preformed set of properties template, according to the nature of the item, and then no extra property can be added to the description. Another path for adding properties is provided by the upper search box, called property filter. It facilitates the exploration of the existing vocabulary through time-saving suggestions. The panel is generally usable and the hints of the property filter are a precious and mandatory element, especially in presence of huge vocabularies, such as CIDOC-CRM. On the whole, the side position of the panel is discrete and focuses the attention of the user to the signature task: item description.

Considering the central part, it displays an upper horizontal tab which organizes the description content and its additional components: firstly, the “Media” tab incorporates internal or external resources (principally

images, audio-visual and URLs); secondly, the “Item set” tab assigns the resource to a set, used for grouping collections and sub-collections; thirdly, the “Thumbnail” tab enables the user to attach a card image to the item; finally, the “Mapping” tab integrates a map with editable pins to the item.

The “Value” tab, key part of the study, displays entry fields, which are visually separated by a light background. The label indicates the property with a brief description, while the text input is quite less intuitive. In fact, the interface element of input data types does not change according to different kinds of value. Instead, it is provided a standard text field for every entry whether it is a number, a text or a date. The text entry can be possibly replaced by an external URI or an internal item previously inserted in the system. Only the fields “Resource template” and “Class” are composed of a dropdown menu, predictably limiting the selection to a finite set of values. Analysing common tasks, error recovery is well implemented: when a field is deleted a message for restore the entry is displayed; also the deletion of fields is agile and intuitive, achieved through the dedicated icon.

Another aspect of the interface worth underlying is that, although the abundance of elements and screen density, the user is not overwhelmed, but finds a quite ordered screen. In opposition to several systems, the dimensions of elements are bigger than the average and this contributes to improve the experience of the user.

2.7 Discussion

Literature review and competitive analysis combined move research hypotheses and assumptions to further commentary. The outcomes of this chapter are discussed in the following, addressing some key aspects of the research objectives and preparing the base for the next sections.

Chapter 2.1 described the basics of knowledge management, underlining the individual, organizational and technological barriers to knowledge sharing. The last fence embraces one of the research assumptions “*there is a mismatch between tools and collections*”. The KM theory suggests that technology does represent a potential source of limitation in the dissemination of knowledge (Reige, 2005). If available technologies do not fit the real needs of CH employees, the process of knowledge acquisition, storage and dissemination fails.

This viewpoint is partially abandoned in *Chapter 2.3*. Instead of addressing the mismatch between systems and reality, this section discards the hypothesis of a technology-needs mismatch and pays closer attention to the user's treatment of metadata. It is suggested that when employees poorly describe artefacts, they exclude contextual and interpretative information, losing a precious share of knowledge. If metadata are deployed as mere records and manipulated only for storing the internal knowledge of artefacts, their expressive potentiality results inevitably underestimated and unexploited. According to this perspective, an important knowledge barrier relies on the attitude of employees and collection managers. As a consequence, individual barriers seem to overcome technology limits in the dissemination of knowledge in the CH domain and the hypothesis *H5: The interface design does not fit the addition of complex data* appears partially rejected. Moreover, the overview of European and Italian guidelines depicts contrasting suggestions in the usage of

metadata, which could reinforce the hypothesis of a misapplication of metadata in descriptions. From one hand, directives encourage rich and full descriptions, advising the employee to generously fulfill the system with information. On the other hand, policies define strict protocols for standardising artefacts' descriptions. The information cannot comply with the complexity of contextual information, losing the involved shades.

Then, *Chapter 2.5* outlines an analysis of the existing collection manager systems. The outcomes stress the complete absence of entry methods for contextual information and complex data. None of the considered software addresses the insertion of contextual and interpretative information and entry fields embrace standard information only. Hence, *H5: The interface design does not fit the addition of complex data* is definitely confirmed.

Further, *Chapter 2.6* provides interesting suggestions for the role of the system in the description of items, accounting the examination of the system Omeka S. On one side Omeka helps the user through the description of an artefact. It provides a highly customisable interface and supports personalisable description templates. Moreover, the template can be modified and enriched with different entries during the completion of the description. Finally, brief texts in the field's labels orient the user, illustrating the function of the property. On the other side, the system does not provide a different entry data type for texts, numbers, dates. This lack of entry type disorients the user because data formats are not specified and consistency is demanded to the user. In that light, hypothesis *H2: Omeka does not provide enough guidance through the description of items* is overall accepted. At this moment, most of the considered hypotheses cannot be fully rejected or confirmed: more conclusions would be drawn in the next chapter with the ethnographic analysis.

3. Ethnographic analysis

The foundation of a successful user experience is a clearly articulated strategy. Knowing both which are the preliminary key objectives and what users want from the system is the essence of the UX strategy (Cooper et al., 2010). While preliminary objectives are generally outlined in *Chapter 1*, users' needs are still waiting for deep analysis. Before this step, an essential stage of the process is represented by the ethnographic analysis: the gathering of information regarding users and their characteristics.

The analysis starts with the user segmentation, which analyses users and groups them based on common characteristics. Then the second part is dedicated to an informal survey, conducted for collecting selected insights regarding the attitude of Omeka S users.

3.1 User segmentation

The method of user segmentation relies on the practice of clustering potential or existing users into groups with similar characteristics. Common traits are depicted by demographics, psychographics, behaviorals, firmographics, and technographics. The underlying concept is that homogeneous groups will likely have analogous behaviors, hence they will respond similarly to the same stimulus. This practice, taken from marketing studies, is modulated to predict the interactions a user has with a product and it typically focuses on understanding the needs of users with different traits (Goyat, 2011). Moreover, the understanding of users and their characteristics facilitate the comprehension of segment-specific problems and a more effective design.
The segmentation performed in this thesis is limited to one or a few segments. This strategy is adopted in order to be compliant with available resources. Furthermore, a smaller number of groups can help in better defining new products and features, concentrating resources, and acquiring a deep characterization of the resource suitable for the conceptualization of a new product or service.

Firstly, the segment is characterized by taking into account the users' demographics. Target users are GLAM and cultural institutions employees, aged between 20 and 65. The 2019 report "Culture Statistic—Cultural Employment" carried out by the European Commission reveals that the majority of the cultural workforce is over 29, while younger employees constitute only 3.5%. Particularly, the average age of GLAM workers (from France, Germany, Italy, Spain, UK) is 45.8, the highest compared to other cultural occupations,

such as authors, journalists, architects, handcraft workers (Segre and Villosio, 2017). Segmented users' gender is overall equally distributed, with a slight majority of women populating the CH sector. According to the European Commission, people with a tertiary level of educational make up the majority of the cultural workforce. The level of education is one of the reasons explaining why young people are not accounted for a higher share of cultural employment. Thus, the segment comprehends users with a high level of education and mostly over 25 (average age of upper graduated students). Work within the cultural and creative sector is also paid less than the national average: 41% of cultural and creative workers earned an income of less than €30,000 a year in 2014, while the national average was 39% in the same year (MOCW, 2017). This information helps us better define our user segment: the cultural and GLAM workforce is composed of professionals with a higher level of education, generally from 25 to 65, which earn less than the national average, given their high level of education. (Dent et al., 2020; MOCW, 2017).

Concerning the psychographics, which describes traits of users on psychological attributes, the GLAM workforce is generally characterized by a digital reticence. Especially in Italy, a common attitude of diffidence towards new media and digital tools is recorded. This trend is reinforced by the recruitment policies that take into account only the specialist knowledge and heritage-specific skills of candidates, without considering digital skills and an open and dynamic attitude (Silvaggi et al., 2017). Thus, employees and candidates are not encouraged to develop technological competencies in parallel with library, curatorial and archivist skills. This tendency is now facing a change, thanks to new courses and interdisciplinary academic paths and the 2020 health emergency, which boosted the digital shift in every sector. The lack of digital confidence is often paired with a general risk aversion and a low entrepreneurialism attitude (Naylor, McLean, and Griffiths, 2016). As outlined by Silvaggi, the absence of self-motivation is one of the causes of digital unfamiliarity of GLAM professionals (2017). On the whole, CH professionals are highly specialized professionals, greatly competent in their domain, but with a general attitude of diffidence towards digital technologies and risks: a prudent attitude is generally adopted in the workspace.

As previously mentioned, this general characterization is slowly but consistently facing a turn. A new consciousness of the digital challenges is changing the CH professional world, or at least a part of them. Digital Humanities and related disciplines are becoming an increasingly more common offer at universities, fostering the diffusion of new competencies and skills (Sula, Hackney, and Cunningham 2017; Planinc et al., 2020). Furthermore, Omeka S characteristics, combined with a semantic web and linked open data approach, require at least an intermediate level of digital competencies from users dealing with the whole process. Thus, the particular circumstances of the Omeka environment bode well for the digital confidence of the segment users. Concerning users' attitude and value, CH professionals usually have a critical attitude towards their organization, however they are firmly convinced of the relevance of social and public service carried out by CH organizations. Thus, their opinion is that significant government funding is owed to GLAM institutions (Naylor, McLean, and Griffiths, 2016).

Firmographics, the demographics of firms are a set of characteristics regarding organizations, companies, and institutions. GLAM institutions have a deeply different average numbers of employees,

depending on the country, the type of institution, and its size: for example, Italian museums have an average of 9 museum employees, this number increases in public museums (21) and decreases for others (7). Besides, the staff is often assisted by volunteers: in Italy, an average of 1 volunteer every 4 employees (ISTAT, 2019). Regarding infrastructures, GLAM institutions often struggle to satisfy adequate technological requirements and equipment (Silvaggi et al., 2017).

Technographics is the analysis of users' technology stack, ownership, and usage. The most relevant topic is the usage of collection management systems and target users are used to working with databases and editors. In addition, both mobile and desktop devices are employed by users with a good level of computer literacy.

In conclusion, the individuated segment consists of GLAM employees, aged between 20 and 65. They have a high level of educational attainment and an imbalanced income in respect to their academic title. The segment has at least an intermediate level of digital competency. Segmented users work in small teams, often in an insufficiently equipped workspace.

3.2 User research

In order to better understand the attitudes and habits of segmented users, an informal online survey is carried out. This quantitative method is often used for gathering information on users' opinions and characteristics. Due to the limitedness of the sample, the outcome of this survey serves for collecting suggestions and clues.

The survey took place in December 2020 and the sample was acquired from volunteer users of the forum[13] "Omeka Forum". The platform is the official forum of the product, a sharing space where the Omeka community, made of scholars, registrars, GLAM employees, and developers, is allowed to share best practices, ask for advice and help other users with their projects. The forum structure is divided into twelve categories, which follow the most frequent topic and product issues. The persons involved in the survey are specifically eight Omeka S users, who kindly found the time for answering the survey's questions. The sample involves European and North American users, and their answers are interesting both for acquiring precious insights and for the involvement of two international horizons.

The devising of the survey questions followed two principles: simplicity and efficiency. Since the survey was carried out online, simplicity is required for enabling the respondents to answer without guidance or suggestions from a supervisor. The need for efficiency relates to time constraints: respondents have not any kind of incentives for their answers, so time efficiency is fundamental. Accounting for the questions' preparation, the survey is divided into five blocks. *Block A* and *B* address the demographics and firmographics: the age and the information related to the user's employment and organization are asked. Then, *Block C*

[13] https://forum.omeka.org/

investigates users' habits on Omeka S: frequency of use, main purpose, and performed activities are the core aspects of this section. Consequently, the inquiry on users' attitude towards knowledge management and the system is expressed in *Block D*: the users' perspective on complex data and contrasting points of view are the fundamental questions of the KM dedicated part. Finally, a brief section is dedicated to Omeka sites. It is the content management system that provides the rapid creation of digital exhibitions. The most interesting outcomes of the survey are now depicted in the following paragraphs.

Firstly, the sample is demographically characterized. As *Table 2* shows, the sample involves users from different age groups, ranging from 26 to 75 years old.

A001 How long have you been using Omeka S? And Omeka Classic before the S version release					
	26-35 years	**36-45 years**	**46-55 years**	**56-65 years**	**66-75 years**
Number of participants	2	4	-	1	1
C001 How long have you been using Omeka S? And Omeka Classic before the S version release					
	under 1 year	**1-2 years**	**3-6 years**	**7-8 years**	**9-13 years**
Number of participants	2	2	3	1	-
C002 How often do you use Omeka S in your work?					
	Daily	**Weekly**	**Mounthly**	**Hardly**	**Never**
Number of participants	2	6	1	-	-

Table 2 - Survey results, questions A001-C001-C002

The older person is a GLAM volunteer, presumably retired. Concerning employment, the majority of users are permanent employees with full-time jobs, while two out of our eight individuals either have a temporary contract or are volunteering. Regarding the experience with Omeka S, all the respondents have a relatively consistent degree of experience accounting for at least 1-2 years of use of the platform, being the only outlier a single user with less than one year of experience. Moreover, a highly frequent use of the system has been highlighted by the answers of our respondents, which in 7 cases out of 8 use the system at least on a weekly basis. These circumstances seem to support the inference stated during the user segmentation: Omeka users generally have an adequate level of domain competences.

Among the investigated habits of our users, "looking up for information" resulted to be the action performed most frequently, with a weekly recurrence. This result underlines the importance of description richness: the more detailed the item, the more successful the information retrieval. Almost the totality of users make use of a manual or guidelines performing the description of items. This information highlights the application of consolidated best practices of the domain: following guidelines and recommendations in the description of items.

According to the respondents' answers, a general appreciation of the resource has been highlighted. Particularly, users tend to be indulgent with the system, as stated by a participant: "*I continue to remind myself that Omeka is supported by volunteers and patience to new developments and updates takes time*". This statement highlights a supporting attitude and a forgiving mindset. Contrary to the research assumption, users are thus generally satisfied by the functionalities of the system and they appear to represent an engaged user base. Concerning the personal self-representation of the respondents, the most adopted attitude concerns the multiplicity of points of view: the representativeness of different perspectives is perceived as fundamental by users. Moreover, none of the respondents manifests a negative attitude towards the implementation of a system allowing for the insertion of multiple perspectives: the majority of them found this proposal useful for their projects.

Moving to the Omeka sites part, which concerns the content management system for publishing exhibitions, users are generally satisfied with items visualization and layout. Even though the fundamental elements of default themes are appreciated by users, they seem to suffer the lack of style options and the scarcity of available components, such as slideshows and cards. Thus, interactive and complex visual elements are the trends that compose users' requirements for digital exhibition builders.

3.3 Discussion

The user segmentation and the informal survey provide precious insights for the evolution of research hypotheses and assumptions. The conclusions of this chapter are expressed in the following paragraphs, addressing some crucial aspects of the research and drawing up the foundation for the next design process.

Chapter 3.1 described the basis upon which users are segmented. This part carries out a detailed characterization of target users, grouping them into generally uniform segments. The reported information underlines a general lack of motivation and digital confidence throughout the CH workforce. However, this tendency is drastically changed by the specificity of the segment: in contrast with the conventional assumptions, GLAM professionals who use Omeka S are at least intermediate users in the digital environment. This point is also supported by the responses of *Chapter 3.2*, which highlighted a satisfactory level of confidence with the system and its features.

Starting with the assessment of research hypotheses, *H1: Collection managers are fully satisfied by the expressivity of Omeka* seems to be overall accepted. The agreement on statements of question *D005*, such as *"Omeka allows me to describe items in depth"* and *"Omeka encourages me to provide additional information"* is high, but criticism about the provided workflow are enhanced by question *D005_02 "Omeka does not match my way of describing items"*. The answers provide conflicting attitudes that span from enthusiasts to disappointment. These results reveal an overall positive attitude towards the system. Omeka users are engaged professionals that value the work done by the Roy Rosenzweig Center and its community. However, it does not prevent users from expressing objections or criticism. Thus, the hypothesis cannot be fully accepted.

The analysis proceeds to the assessment of hypothesis *H2: Omeka does not provide enough guidance through the description of items*. This conjecture is completely accepted. On one hand, the overview of the system in *Chapter 2.6* suggests that adopted methods do not comply with the effective supervision of the description process. On the other hand, the majority of respondents are neutral towards the statement assessed by question *D005_1*. Thus, it is possible to suggest that even if Omeka does not adopt marked guidance for facilitating operations, the general attitude of users is not negatively polarized.

Then, *H3: Omeka is used mostly for inventory purposes* is the third point of discussion. If the system is mainly employed for inventory purposes, the enrichment of items description is less relevant than other system goals and features. This hypothesis is addressed by question *C004 "For which purpose you mainly use Omeka S"* with multiple selection choices. From the results of the informal survey, it is outlined that "Semantic publishing" and "Digital exhibition" are the most frequent aims of our targets. These results drive to the conclusion that the initial hypothesis has to be refused: Omeka is not used just for inventory purposes by its users.

Next, the fourth hypothesis *Collection managers feel responsible for preserving CH* is assessed. Taking into account the attitude and self-perception of segmented users, it is possible to highpoint some considerations and both user segmentation and the informal survey helped the process. The connoisseurship characterization seems to be a signature trait of GLAM professionals, who deal with cultural environments after years of education. Nevertheless, this attitude is not self-referred by respondents: they prefer to associate their role to the duty of preserving and disseminating heritage. Thus, the importance of legacy conservation is well perceived also by "digital preservers". This trait is particularly vivid in Omeka users, possibly for the heterogeneity of institutions and professionals working with the system, which may have different levels of domain knowledge. Thus, *H4* is to be considered valid.

A key point of this discussion is connected to the first research goal: the inquiry investigating *how it is perceived the absence of contextual information inside digital collections by collection managers*. From the survey some reflection can be drawn. Firstly, the general attitude towards this absence is overall neutral. Users are overall satisfied with the system, so that the lack of contextual information is not perceived as a concrete issue. Interestingly, users also value the enrichment of the collection with multiple points of view, as an integral part of their role. The synthesis of this contrasting attitudes (satisfaction towards the system expressivity and assignation of crucial value to complex information) seems to be found in the enthusiasm demonstrated by the evaluation of statement *D06_03 "A system for expressing different points of view in Omeka would be useful"*. This phrase was strongly agreed with by the respondents, showing the desire of using more sophisticated systems. So, respondent users strongly concord over the usefulness of an integrated system able to structure complex information, nevertheless this possibility is still barely considered given the general satisfaction with the system Omeka.

Concerning the second set of hypotheses connected with the research goal *what are necessary criteria for an improved UX for collection management systems supporting contextual information*, the inquiry changes

towards an applied study of design concepts. Although this inquiry needs to be addressed in next chapters, some considerations can be drawn on related hypotheses.

Starting with *H5: the interface design does not fit the addition of complex data*, the competitive analysis of *Chapter 2* outlined the lack of such insertion methods. Then, the hypothesis is considered valid. Moving on to the sixth hypothesis, *complex data need to be stored in a distinguished place* needs to be assessed in next chapters, since none of the analysed systems involved the insertion of contextual information. Further research will lead the addressing of this assumption.

Finally *H7: The item presentation design of default themes does not fully satisfy visitors* is analysed. The survey fosters considerations upon this hypothesis with the answers to the question *E002 Are you satisfied by the visualization, layout arrangement and style of the available themes?*. The evaluated answers outlined a preference towards “Item visualization” and less enthusiasm for “Page layout” and “Variety of components”. These results seem to confirm the initial hypothesis, leaving space for future improvements.

4. Omeka S Context plug-in

The research moves on to the development of design proposals. After the state-of-the-art review and the analysis of target users, the study can step into the design process. Starting from previous findings, this chapter presents the task analysis of the product, passes through the context of use, depicts personas, considers scenarios and finally exposes the design proposal. Firstly, *Chapter 4.1* is dedicated to the tracing of user types and their goals. Secondly, the process shifts to the description of context of use. This step is fundamental for understanding the context in which users interact with the system. This awareness drives the design in the direction of the users' needs and of a more effective design. Thirdly, a narrative approach is adopted for profiling personas: fictional users which facilitate the comprehension of users' perspective. Then, the delineation of scenarios boosts the process, assessing the sequence of events needed for performing tasks and operations. Finally, the design proposal is presented and described in depth.

4.1 Task analysis

Task analysis addresses the comprehension of users' goals. Before the delineation of the task analysis step, a brief literature outlook on the topic is given.

Don Norman's book "*Emotional Design*" involves the idea of different levels of cognitive and emotional processing: visceral, behavioural and reflective. This differentiation, based on cognitive researches, tends to structure user responses to digital products. Firstly, the visceral level represents the most immediate level of processing, through which we react to visual and sensory aspects of a product. Secondly, the behavioural level concerns the management of everyday activities. Finally, the reflective level involves conscious considerations based on past experiences, accessible only via memory (Norman, 2004).

The tripartition of cognitive processing is useful for deeply understanding the human mindset and for designing meaningful experiences. Thus, this model is resumed in the UX practice of task analysis, integrated into the design and user research methodology (Cooper, 2013).

The transposition performed by Cooper relies on the delineation of three specific types of user goals, which correspond to Norman's processing levels: experience goals, end goals and life goals. Experience goals are simple, universal and personal. They express how users want to feel while using a product and offer insight

motivations that express the visceral level: feeling smart and in control, having fun, feeling cool and relaxed and remaining focused. Experience goals are one of the most crucial aspects: if the product fails in their fulfilment, frustration and discomfort take over. For instance, a time management application has to reflect professionalism and tidiness, while a personal training app should convey energy, strength and a sense of power. End goals represent the user's motivation for performing the *task* associated with the usage of a specific product. Thus, only if end goals are achievable through the application, users will eventually use it. When end goals are met, users are driven to think that a product is worth their time and money. In the time management example, the end goal of the application is to schedule activities and daily to-dos. Moving on, life goals involve the user's aspirations that usually go beyond the context of the digital product. They represent deep drives and motivations that explain why the user is trying to accomplish the end goals. Long-term desires like succeeding as professionals or being attractive and popular are perfect examples (Cooper, 2013). Considering the time management app, a user's life goal is represented by professional success and being able to spend meaningful time for personal passions.

The identified user types are drawn from the results of the survey and from the literary review: collection managers and visitors. Starting from our user types we can identify their goals and needs. Firstly, visitors are enthusiast wanderers of cultural heritage. The vibes they are looking for are made of niche insights and rich stories about cultural heritage, which give them a sense of exploration and discovery. They have the life goal of having cultural respectability and being recognized as connoisseurs. Acquiring unusual new shades about cultural heritage is their passion. The end goal through which they accomplish these aspirations is represented by looking up information in digital collections and exhibitions.

Secondly, collection managers covet to feel professional, acknowledged as specialists and educators. Their end goals are handling daily to-dos in conformity with guidelines and conserving and spreading the cultural heritage to the public (visitors). Their role is deeply interconnected with the idea of preservation and dissemination of knowledge and the self-perceived role of custodians of CH is a crucial trait of their character. Moreover, the collection manager user is seeking expertise recognition. In fact, the related life goal is to enlarge the expertise and be respected by peers, according to the knowledge they acquired during long academic studies. Another aspect of their life goals is represented by their educational role, saving precious parts of the cultural heritage is a prominent ambition. Prompt tasks for these goals are the creation, modification and consultation of items in the collection.

Finally, organization management pursues a qualified and efficient impression. A feeling of authority and supervision are conveyed by this group. Their end goal is usually represented by the winning of grants and funding, from regional, national and supranational organizations. Their life goal is represented by the prestige of the institution they manage, which is reflected in their reputation. These goals are pursued through the writing of reports and documents, useful for recording the output of the organization projects and its efficacy.

In order to perform a more detailed characterization, the most relevant mentioned tasks are further described by task goal, output, frequency and mental demand. Starting with the task of "new items insertion", it has the goal to realize a comprehensive database completed with the most exhaustive knowledge related to

items. The output is a knowledge graph connecting entities through properties. The frequency of this task varies according to the single project, institution and team workflow. The mental demand is connected to the rigidity of the task and it rises when the insertion of a new item follows strict standards and guidelines, increasing requested attention and precision. Assets dependent on this task are information sources, which have to be collected before the insertion, and time constraints.

The task of "modifying existing resources" pursues the same goal of "new items insertion" and it leads to the same output. Coherently with its lower difficulty level, its frequency is usually higher, nonetheless, it requires concentration and attention. Also this task needs the previous detection of errors and out-to-date information combined with the collection of correct inputs.

The task of "Looking up information" has the goal of acquiring information and redeploying it for other purposes, for example the creation of new exhibitions. The output is the retrieval and visualization of information. The frequency of this task is presumably frequent, once a rich database is created, this task can be carried out easily. Thus, the mental demand is low and involves only the action of searching for the correct item within the collection.

Finally, the institution management's task of "creating reports" has the goal of retrieving information on the status of the digital collection and the work carried out by employees. The output is a downloadable visualization of information ready to be embedded in other documents. There is no metal demand in the task and its frequency may vary.

This outlook of users' goals and tasks will be extensively described and visualized in the design proposal, while this analysis provided an overview of what users need for achieving their goals.

4.2 Context of use

While the ethnographic research is focused on the analysis of users and their characteristics, the research proceeds with the analysis of the context of use. As Thomas and Bevan state, the usability of a product is affected not only by the features of the product itself, but also by the characteristics of the users, the tasks they are carrying out, and the technical, organisational and physical environment in which the product is used (Thomas and Bevan, 1996). The analysis of all these factors falls under the name of *context of use*.

The first step of this analysis consists of distributing the users on a hierarchical scale divided into primary users, secondary users and indirect users. Primary users account for all those who use the system for primary purposes. In this research, "primary users" are represented by collection managers, played by museum employees, researchers, librarians, registrars, historians, scholars and visitors, portrayed by CH students, researchers, volunteers and enthusiasts of the field. Collection managers is an umbrella term used for referring to users in charge of some collection: the abovementioned professional figures are also substituted by volunteers in small non-profit contexts. Part of the direction can be clustered inside primary users, as directly involved in the creation of the resource. Collection managers, visitors and direction officers are those to which the system is primarily addressed. Although secondary users do interact with the system, it is not for their

primary purpose. This is the case of someone who needs to interact with the system only for periodical or technical checks. Project managers, IT officers and the auxiliary staff are part of the secondary user group. The last group is populated by the indirect users, which do not intend to interact with the system but only with its output. It usually includes individuals that use the produced result to carry out their own tasks. Indirect users are composed by the institution's directors and officers with a high managerial position, hence interested in the result of ongoing research and projects. This group also includes managers of national bodies and private cultural associations, such as policy-makers or lobbyists, who search for information in order to draw guidelines and implement strategies.

Going deeper into the user types, it is possible to outline some characterizations from a technical, physical and mental point of view. Primary users share common competencies in their respective fields, collection managers are usually trained and formed for managing digital collections and CMS, while visitors willing to search digital exhibitions online are pretty experienced in doing searches and retrieving needed information. Collection managers who are also volunteers for local or no-budget projects are usually self-taught and do not rely on a specific education on digital collections. They can also count on the open-source environment, a flourishing community open to beginners and highly supportive (Lakhani and von Hippel, 2003). As outlined by the ethnographic research, their level of education is above the average, with a strong presence of a high-level education. Collection managers and direction officers commonly have a PhD or are on their way of obtaining one. Thus, linguistic competencies are excellent and, if it is not the mother tongue, they are often proficient in English too. Other remarkable specific knowledge is identified in the area of catalogues and standards. IT competencies are practically essential for a full and conscious usage of open-source projects, such as Omeka. Currently, the majority of free open-source software adopters are tech-savvy users. The preparation of a large part of users, system information, resources, and support can be obtained from the open-source community groups, hence even the less experienced members, such as non-developers and volunteers, typically have successfully installed, configured, and used some applications (Bagozzi and Dholakia, 2006; Gwebu and Wang, 2010).

In terms of physical and mental attributes, it is possible to outline a slight majority of women inside primary users. Visitors and collection managers commonly have a Humanities education, which is reported to be embraced by a majority of women, 64.4% on the average (OECD, 2020). Usually, direction officers are senior CH workers, thus in the upper part of the age spectrum. Physical issues like myopia and other refractive errors are common, so the use of glasses and contact lenses is widespread. Other limiting disabilities can be found in a small share of our groups and are quite absent among direction officers. Moreover, specific learning disorders could occur especially in the visitor group, even though they are supposed to have compensated for their impairments with their high-level education and highly specialized interests. Remarkable mental skills for collection managers are the excellent writing skills and sufficient or advanced IT competencies: requirement for the management of a customizable open-source tool like Omeka S.

Concerning the technical environment, the system requires a computer with an up-to-date browser, a server and a dedicated database for storage. All the detailed information is exhaustively provided in the online user manual[14].

Job characteristics and organizational environments are various and diversified. On one hand, collection managers have the job function of acquiring, organizing and publishing digital collections and exhibitions. Their focus is on the correct representation of the collection's elements and their consequent publication: the dissemination of cultural heritage is a crucial part of their job. On the other hand, direction officers' work is directly related to the software in another perspective. They are in charge of searching for funding and bids, deciding the cultural direction and managing financial resources. The deployment of tools and strategies is often dependent on the approval of the direction: software such as the collection management system could be subjected to direction approval before being employed. Both collection managers and direction officers have a 20-40 hours work week, depending on their contract and position. Finally, visitors' job functions are arduous to outline, due to the variety of their jobs: a part of this group uses the software for work, research and study aims, while for the other part we do not see a direct connection between the system and their occupation.

Considering the organization environment for employees, the interaction with the system usually takes place in offices and dedicated departments, thus workers can remain focused on daily activities, but can also ask for support or suggestions from their colleagues, both in presence, by email and via phone call. Visitors do not have this kind of supportive environment, they can usually reach the CH team via email, but cannot enjoy the same level of support. Although they probably do not count on a structured organizational environment, a good possibility remains to consult the Omeka community, always ready to help and give advice.

Collection managers' offices are usually enough equipped, with good lights and conditioners. The atmosphere is typically professional but mostly familiar and friendly. For visitors these conditions are uncertain and various since anyone can interact with digital exhibitions just by owning a connected device.

4.3 Personas

This section is dedicated to the development of personas. Personas are users' descriptive models, which synthesize the previous outcomes on their needs, goals, habits and motivations. The production of personas facilitates the analysis and discussion regarding users, addressing their behaviour, reasoning and desires (Cooper et al., 2013). While personas must not depict real persons, they are based on characteristics retrieved from real users. Personas foster the design process, representing *composite archetypes* realized on the basis of data collected during the ethnographic research and previous study. Moreover, the characterization of personas

[14] https://omeka.org/s/docs/user-manual/

follows identified *behavioural patterns*, which lead to a better understanding of users' goals and actions in specific contexts (Cooper et al., 2013). The following section introduces a cast of seven personas grouped into four types: primary, secondary, supplemental and customer personas. According to Cooper, there are further personas types, but they are not relevant to this project. A brief introduction of each character is provided, but the detailed profile of each persona can be found in *Appendix B Personas*.

The interface has conventionally one primary persona, called the protagonist, who needs to be fully satisfied with the proposed design. Other personas may require additional features or design changes and primary persona will not be gratified by the design targeted at any other persona in the set. However, if the primary persona is the target, all other personas will not, at least, be dissatisfied (Cooper, 2013). Out of eight, two are primary personas: the collection manager and the visitor.

The collection manager, Penelope Parker, is the art historian of a contemporary history museum. She often organizes digital exhibitions, thus has to describe works frequently. She is middle-aged with a high level of education; Penelope holds a PhD in History. She is fascinated by the past and moved by the desire of passing on the legacy and memory of ancestors. She expects the system to be efficient and effective in the insertion of descriptions.

The visitor, Adam Marquez, is a young man finishing his studies in a Master program in International Cooperation and Development program. He is carrying out a research on post-colonial Indian literature and has found an interesting digital exhibition on the topic. He is moved by the strive for affirmation, thus he commits himself to his studies. He expects the system to visualize effectively detailed information, displaying sources and reliability of data.

Then, secondary personas are mostly satisfied with the primary persona's interface. Anyhow, they present specific additional needs which can be developed without compromising the satisfaction level of the primary persona. The presence of secondary personas is not mandatory, more than three secondary personas can be a sign of an unfocused design purpose.

The registrar, Daniel Demir, is responsible for creating the collection inventory. When the collection manager, Ella Martin, needs item-specific and scientific information, Daniel focuses on items' basic features. He is in his early forties and obtained his job three years ago, after working as cataloguer and employee in several CH institutions. Now he faces the challenge of a new system and is focused on efficiently speeding up his daily workflow.

Another category of the cast is represented by supplemental personas. Not primary nor secondary, their needs are completely satisfied by the combination of primary and secondary personas solutions. The addition of supplemental personas increases the validity of the cast, representing other product stakeholders. The present study involves two supplemental personas: the podcaster and the volunteer.

The podcaster, Liam Benton, is a self-employed content creator, with a specialization in Media Communication. He is a professional podcaster with a personal program dedicated to edutainment contents. He wants to become a reference point in his professional field and, due to his self-employment, his

determination drives him to perform meticulous researches. He expects the system to display information and data in a coherent way.

The volunteer, Tom Stevens, is a retired computer scientist, with an MSc in Information Sciences. Tom is a volunteer of a local cultural organization and is the coordinator of the digitalization process of the historical objects and paintings left to charity to the organization. He is guided by the desire to be useful and to help cultural organizations with his competencies.

Finally, customer personas are involved when the end-user and the customer are not the same people. The customer persona may have an influence on the design, similarly to secondary personas. In this study, the two customer personas are the president of a famous foundation and the director of a museum. They are entitled to consider project specifications and decide whether to finance it or not.

The foundation president, Robin Mills, is the only child of a notorious art dealer. She follows the family path and manages the foundation. She is motivated to differentiate the founded projects, impressing her signature style. She is guided by the will of giving a visionary turn to the foundation activities, innovating them with new projects. She has no direct interaction with the system, except for some reports which help her to assess projects.

The director, Ella Martin, is the museum director. Her PhD in Visual Arts, combined with multiple Masters in Business and Economics, led her to this professional position. Ella is driven by the pursuit of prestige and acknowledgement, as well as the improvement of the museum's reputation. Not directly involved in writing descriptions, Ella just needs to understand the system's specifications in order to decide whether to adopt it or not for the museum collection.

In conclusion, the cast consists of two primary, a secondary, two supplemental and two customer personas. The eight characters do not represent the complete list of all potential users, however considering the characterization of GLAM professionals outlined in the user segmentation, the chosen personas are considered sufficiently representative for the collection managers goals and needs within the design.

4.4 Scenarios

After the creation of an exhaustive cast of personas, the design process moves on to the sketch of the plot. Persona-based scenarios are concise narrative descriptions of one or more personas using a product or service to achieve specific goals (Cooper, 2013). Scenarios consist of stories narrated from the persona's point of view. The part to be stressed in scenarios are thoughts and behaviours of characters, excluding business and technology goals. Persona-based scenarios are categorized into three types: context, key path and validation scenario. Firstly, the context scenario includes a high level of activities, perceptions and desires. It is used for exploring how the product can best serve the needs of the personas. Secondly, the key path scenario is based on the context scenario and specifically describes user interactions with the system. It focuses on user interaction and it is refined in an iterative way along the design process. Thirdly, the validation scenario is used for verifying the practicability of the design. This scenario tends to be less detailed and typically takes the form

of a number of "what-if" questions about the proposed solutions (Cooper, 2013). The following section provides an introduction of the context scenarios used in the first parts of the interface design process. This brief overview depicts the purpose and the involved personas for each scenario, while the detailed description can be found in *Appendix C Scenarios*.

The first two scenarios, respectively *New Context* and *Quick Insertion*, are stories regarding the description of items, particularly focusing on the insertion of contexts to specific assertions. *New Context* describes how Daniel Demir, the registrar, carries out the population of an Omeka collection with new items and how the collection manager, Penelope Parker, adds contextual information to it. This scenario particularly serves to understand possible employees' inclinations during the description process, precisely the contextual description. The second scenario sees Penelope Parker assigning the description task to Daniel Demir. The registrar has to deal with time constraints and uses a quicker method for inserting the desired information. *Quick Insertion* address the challenge of facilitating the insertion of contextual data inside the system.

The third scenario, *Elimination*, concerns the maintenance of stored data and their modification. It finds the volunteer, Tom Stevens, reviewing the new digitalized collection. The other volunteers have successfully uploaded a set of detailed information, but he finds an inversion of data regarding the contextual certainty level of some items. He promptly corrects the mistake deleting the wrong insertion and adding the right information.

The fourth scenario, *Look up*, changes the perspective and empathizes with the visitor's attitude. It describes Adam Marquez, the student, in the need for information for writing the paper of a university exam. He discovers a pretty accurate and detailed exhibition, with contextual information, really useful for the enrichment of his work. This scenario serves to address the perception of visitors and shows the importance of clear and effective information visualization.

The drafted scenarios are chosen due to their adherence with the most frequently work practices of GLAM professionals, based on the feedback provided in the informal survey.

4.5 Design proposal

While the former section presents the first part of the design process, consisting of the development of scenarios to imagine users' interactions, this section is dedicated to the presentation of the produced design. The overview starts with the analysis of the concepts individualized in previous chapters. Then, the produced integration between the existent interface and new concepts is introduced using sketches and wireframes. The graphical output represents the synthesis of the whole design process.

4.5.1 Context conceptualization

The proposal starts from the conceptualization of new elements to be inserted in the interface. As *Chapter 2* outlines, the mismatch between the actual description model and the need for expressivity is a crucial issue in CH metadata domain. The current design proposes the introduction of contexts for solving this

semantic gap. The word “context” is used for defining additional information, which provides meaningful insights about the description of an item. The choice of the word falls on the idea of providing an extra-characterization to description statements. Identifying and expressing the context of all statements results fundamental for their correct interpretation, without proper context, data could drive to false conclusions or inaccurate information.

This approach relies on the structure of the metadata model based on semantic triples, or statements. A triple is organized in a subject-predicate-object form, where the subject is the considered item (i.e. the artwork), the predicate is the property taken from a metadata set or vocabulary (i.e. has author) and the object is the related value (i.e. the artist). The findings of previous chapters highlighted the limits of this model and the need for new types of data enrichments. Thus, contexts are designed to overcome the lack of expressivity and enable the user to insert additional information regarding the statement itself.

The resulting conceptualization of contexts relies on the addition of four pieces of information: who made the statement, how reliable is the statement, which are the temporal constraints within which the statement is valid, and which are the spatial constraints within which the statement is valid. The four contexts are then assigned semantically intuitive labels: provenance, confidence, temporal constraints and geo-jurisdictional constraints.

Firstly, the provenance context gives information about the source of information. All description statements come from a source that should be identified. Its nature can vary from an individual to a text, a detail or another artefact. The provenance of a statement is almost mandatory in humanities, firstly for referencing the responsible of the statement and giving back its accountability, secondly for allowing the coexistence of multiple different statements, also in contrast with each other. The possibility of enriching the metadata information of an artefact with different and contrasting perspectives is one of the crucial needs highlighted in *Chapter 3*. So, the provenance context adds an essential element to a description statement: its reference.

Secondly, the confidence context addresses a delicate but fundamental issue: the reliability of the information. If provenance allows for inserting different and contrasting points of view, confidence frames those interpretations with respect to their trustworthiness. The authoritativeness of a statement is made explicit, thus it can be consciously disseminated. Moreover, recording a confidence level allows for conjectural statements to correctly coexist with established and settled information.

Thirdly, the temporal constraint context focuses on the time-characterization aspect of description statements. In fact, assertions are rarely absolute, and more often are circumscribed into a temporal interval. This context addresses situations in which the validity of the statement depends on defined circumstances. For example, when an institutional position is covered by a given person, it would be better to enrich the title with the temporal constraint, in order to limit the absoluteness and imprecision of the statement in favor of accuracy.

Finally, the geo-jurisdictional constraint context approaches the issue of spatial borders. Geopolitical entities are evolving concepts and assertions referring to them must present precision. The qualification of a particular spatial and political entity is greatly relevant in the understanding of CH: territories and lands are

not characterized only by their latitude and longitude, but they are greatly, if not mostly, identified by their jurisdiction. Thus, the geo-jurisdictional context gives the possibility of embedding the correct nuance to description statements.

The conceptualization of contexts identifies four descriptive elements, which concur to enrich CH metadata descriptions. The challenge of this research now moves to the merging of these concepts and the existing Omeka S interface.

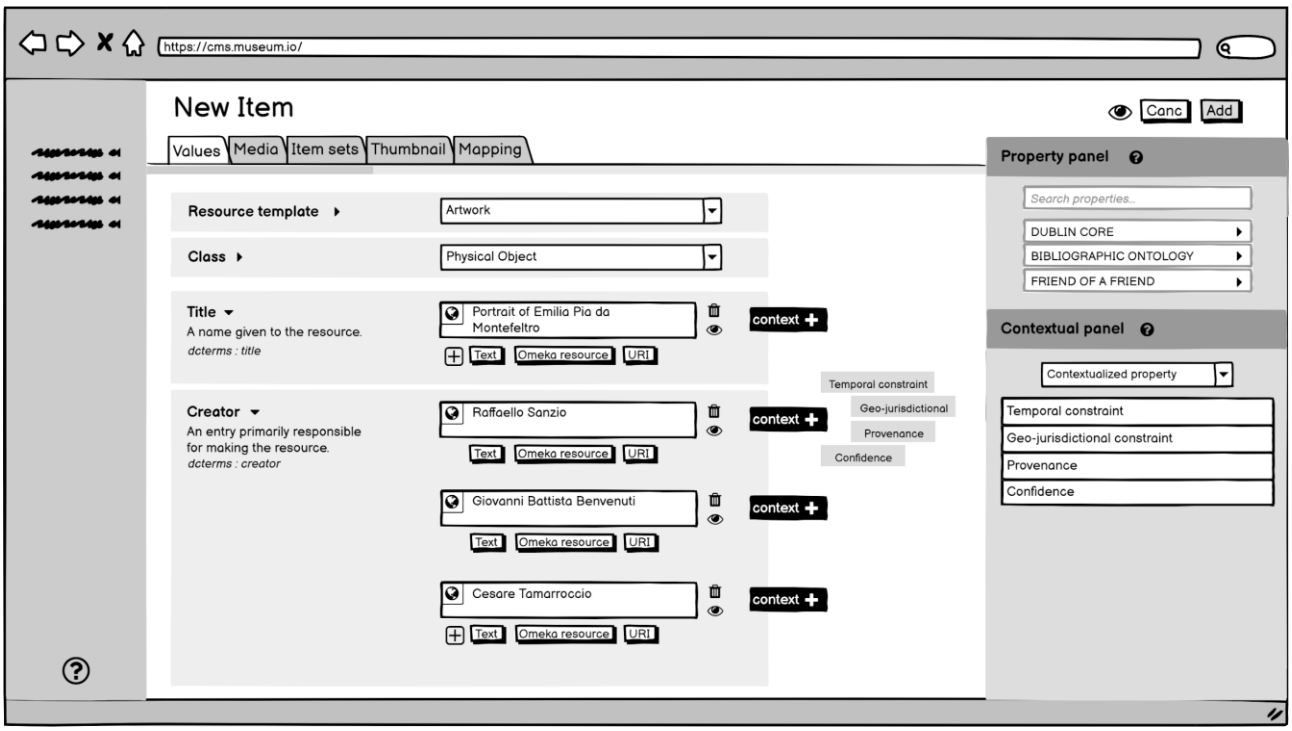
4.5.2 From concept to interface

Starting from the abovementioned conceptualization, this section is dedicated to the transition of context from theory into practice, namely into the interface.

One of the crucial aspects of designing a plug-in interface is its interaction and graphical coherence with the system. As stated by Cooper "it is vital that all the elements in an interface work together coherently toward a single goal" (2013). Thus, no issue regarding the original Omeka S interface will be addressed and the proposed design is intended to integrate as much as possible to the existing elements. Consistently to this approach, the interaction style remains form-fill only and the item editor remains divided into two sections, the central part containing the multi-tabs editor and the right panel dedicated to property selection. The designed interface foresees two methods of insertion, the first one uses the context button for activating the insertion of complex data, while the second relies only on the contextual panel.

These premises lead to the introduction of the context button. This element is inserted next to each property entry, suggesting the possibility of a context addition to all values. The right position is chosen in order not to interfere with the entries found below and to reinforce the sense of connection with the related statement. Although the interface is rendered with low-fidelity wireframes[15], the context button pops up with a strongly contrasting black, intentionally eye-catching for fostering the enrichment of descriptions and its activation. A high-contrast style also complies with the needs of colour-blind users.

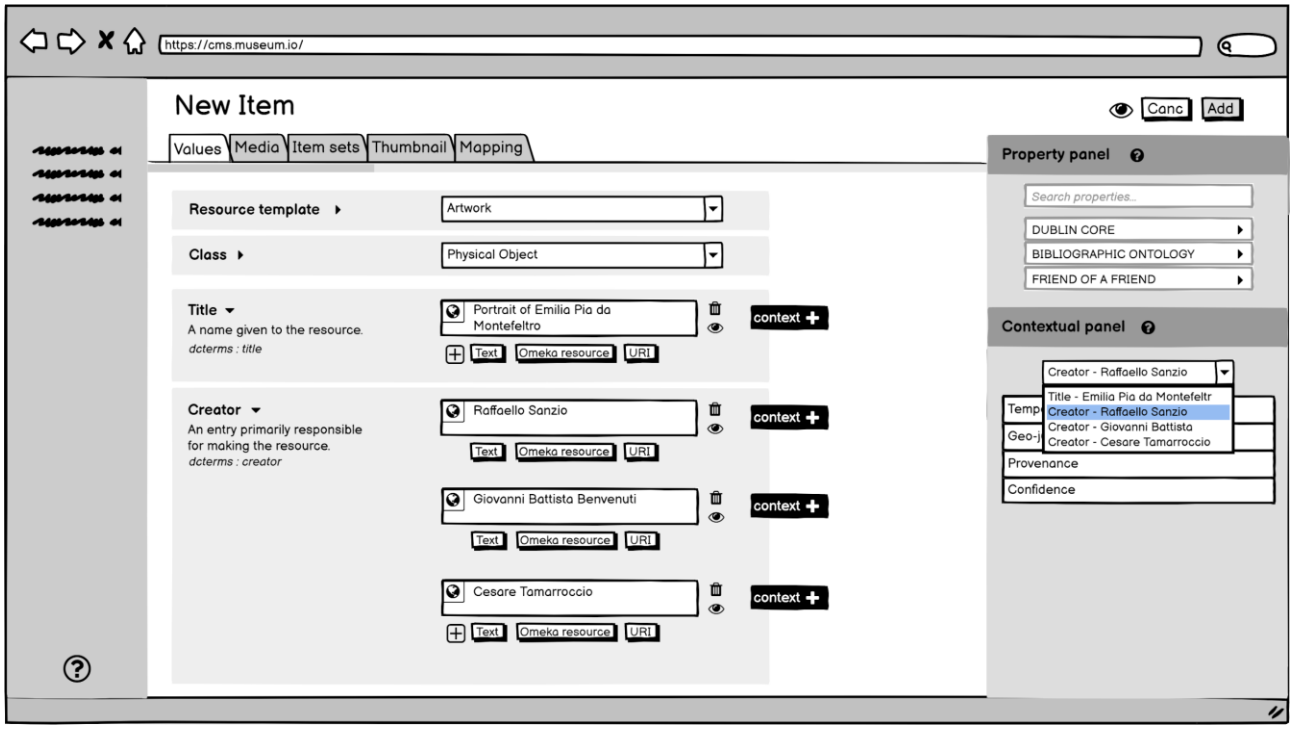
[15] Using Balsamiq Wireframes https://balsamiq.com/



Wireframe 1 - Omeka Context editor interface, context button

When the button is pressed a radial menu lets the user choose among the four contexts. The radial disposition of items is provided in order to reduce the visual footprint, which is limited to the area next to the related entry. Then, the selection of one of the contexts activates the right panel, where the contextual accordion is located. This element is dedicated to the insertion of contextual data and when one of the menu items is chosen the connected contextual section expands, allowing the addition of information.

The focus transition from the central part to the right area of the interface could represent a source of complication for the user, in addition the relatively high number of atomic actions needed for activating the contextual panel could be too demanding for extensive multiple insertions of contexts. All these potential issues' sources are addressed by the second insertion method, which provides a more flow-oriented approach. In this second proposal, the insertion of contexts is totally delegated to the contextual panel, focusing the attention on a single area of the interface. Firstly, the property which needs to be contextualized is chosen from the drop-down menu or by typing the desired entry. This interaction is further facilitated by auto-complete suggestions that filter the existing entries on the basis of the stored data. After the selection of the property, it is possible to choose the desired context just by clicking on the related accordion title. Finally, it is possible to add contextual data.



Wireframe 2 - Omeka Context interface, drop-down menu

As already stated, the drop-down method represents an alternative to the first catchy technique and is dedicated to frequent users.

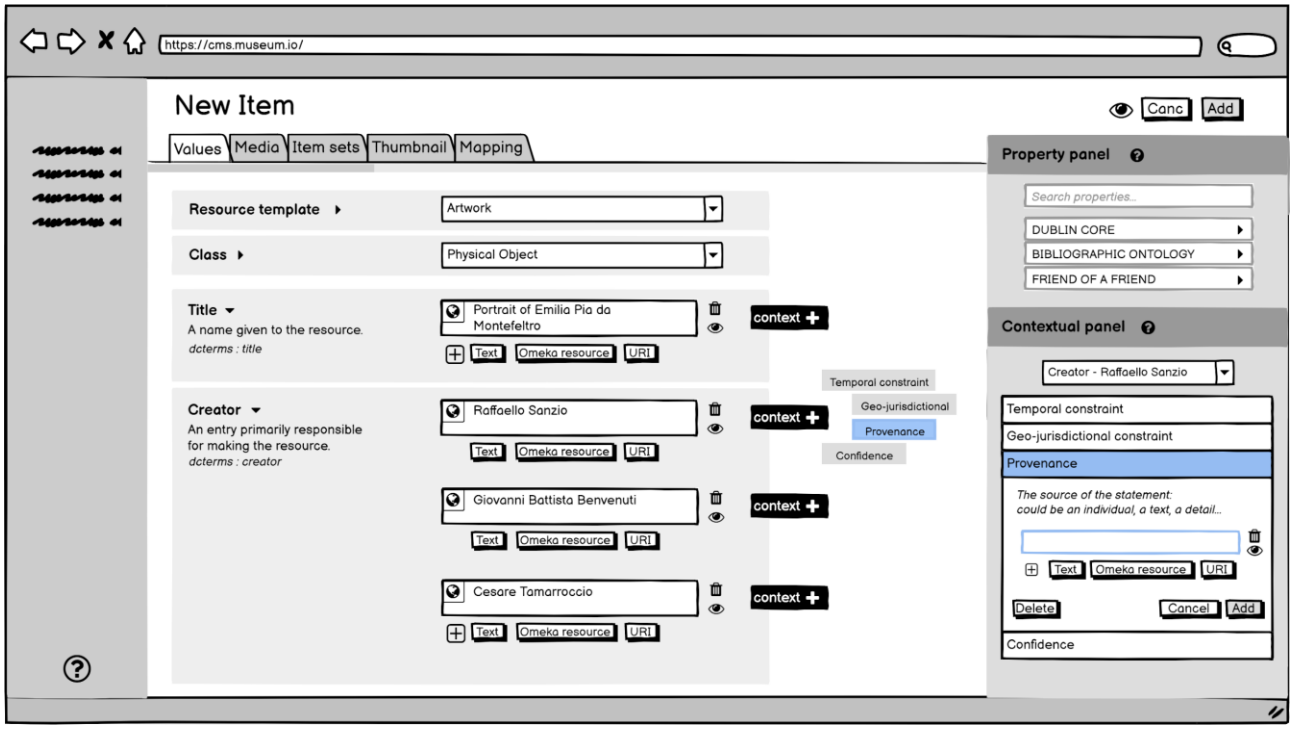
This section provided an overview of the general arrangement of the design proposal. The following focuses on the insertion methods of each context, refining the design description.

4.5.3 Contexts in depth

The description of contextual data insertion needs to be addressed in a more specific way. The four insertion methods are now detailed, in order to clarify the related conceptualization. Inside the contextual panel, each accordion section is specifically designed for describing context-specific information.

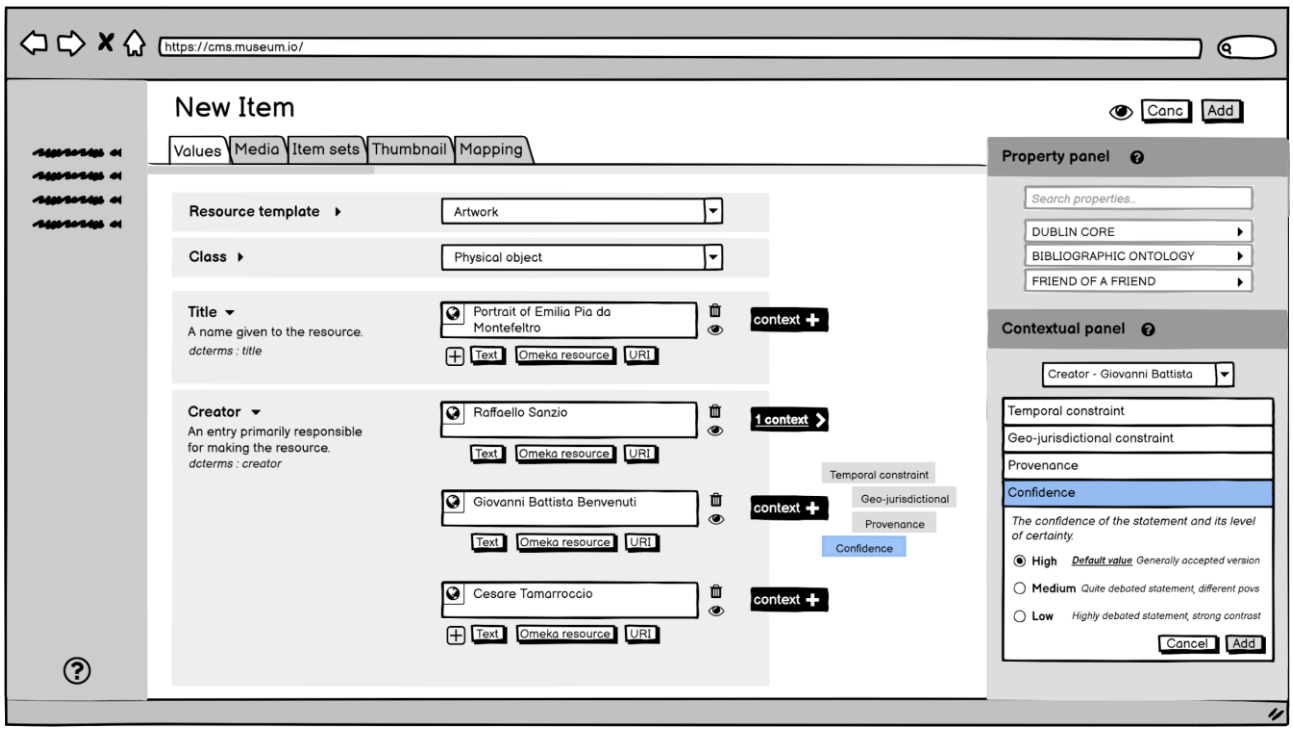
Firstly, the provenance context is modelled as an Omeka S standard input field. These entries are multi-insertion items, designed for being fulfilled with three different datatypes: a string of text, an external URI, an internal URI named as “Omeka resource”, connecting the entry to an already stored item. This technique enables the insertion of well-known entities from authority vocabularies, connecting semantically entities. The Omeka input field is used in the system for inserting every kind of value, eventually mismatching the typical value datatype, like integers for numbers or dates. This insertion method is chosen in order to be

consistent with the general interface of the collection manager, which reassures the habitual user.



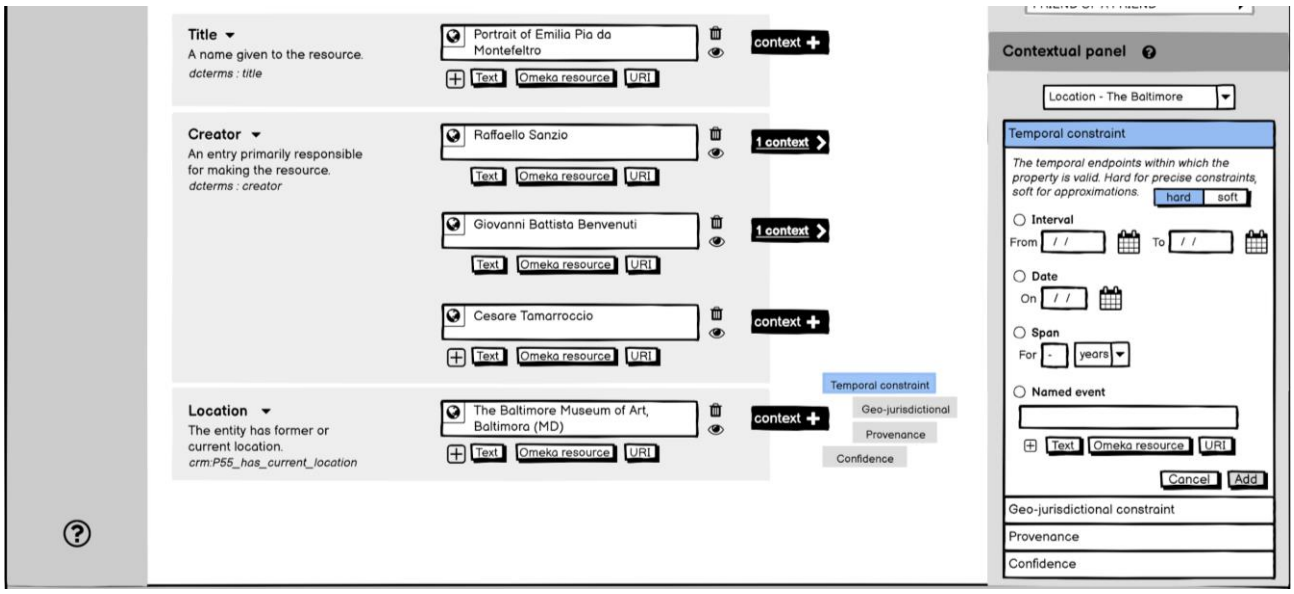
Wireframe 3 - Omeka Context interface, provenance field

Secondly, the confidence context is shaped with radius buttons with three different options. The high confidence, which is the default value of all the inserted statements; the medium confidence, which sets a lower level of reliability to the statement; then the low confidence, which is the lowest level of authoritativeness. Based on the general scholar acceptance of the specific statement, it is possible to assign the correct level of confidence. This context combined with the provenance allows for multiple conflicting views over the same items, enabling the system to accept a much larger quantity of information than simply the most trusted version or the established ones.



Wireframe 4 - Omeka Context editor interface, confidence field

Thirdly, the temporal constraint context presents the more complex data insertion method. For describing information and deciding the best characterization, four radio buttons need to be chosen. The user can select between the following: the interval button, which allows selecting from a date to another specifying a duration; the date button, standing for a single date event; the span button, which specifies the unit of time and the quantity; the named event button, which concerns all the labelled event that can require text input or URIs, such as historical periods or known events. Besides, the temporal constraint is characterized by a mode selector with two options: soft and hard. These buttons enable the user to choose the type of temporal constraint to be applied to the context. While the hard option is the default setting on the system and determines the precision of the time constraint; the soft option concerns the same dates, interval and period but accepting a certain degree of flexibility. The soft constraint can be intended like the “circa” before a time indication.



Wireframe 5 - Omeka Context editor interface, temporal field

Finally, the geo-jurisdictional constraint context relies on the same insertion method of the provenance. Thus, an Omeka input field is provided for the addition of textual data and URIs, both internal and external. This solution, available in *Appendix D* confers consistency to the whole interface and offers the most practical path for the addition of this kind of information.

After this brief overview of contextual insertion methods, the design proposal shifts to the perspective of external users, namely collection visitors. The following introduces visual solutions for the rendering of contexts in digital exhibitions and collections.

4.5.4 Visitor interface

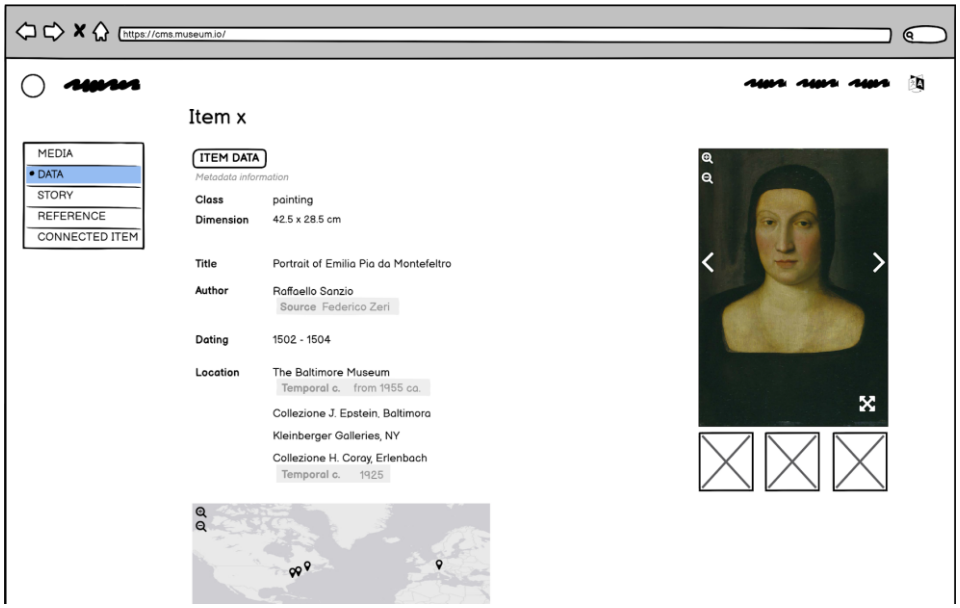
The designed Omeka S plug-in is intended to create a solid structure for the insertion of complex data in collection management systems, and also to present a proposal for the externals' visualization of these additional data. The following summarizes all the possible graphical arrangements for an effective representation.

First of all, Omeka S is a collection management system for semantic storage of CH items as well as a content management system for the creation of digital exhibitions or the publication of digital collections. This means that the information architecture of possible online publications may strongly vary and, for this reason, it is addressed with highly customizations and flexibility. In fact, it is possible to use both ready-to-use templates and highly personalized layouts. Given this plasticity, the design proposal dedicated to visitors operates on the display of a single item, modifying the standard visualization.

Concerning contexts, their rendering is delegated to portions of texts inserted under the contextualized statement. Provenance, temporal and spatial information regarding the assertion is stored in a dedicated space, which provides a more exhaustive comprehension of the data. A different approach is designed for confidence.

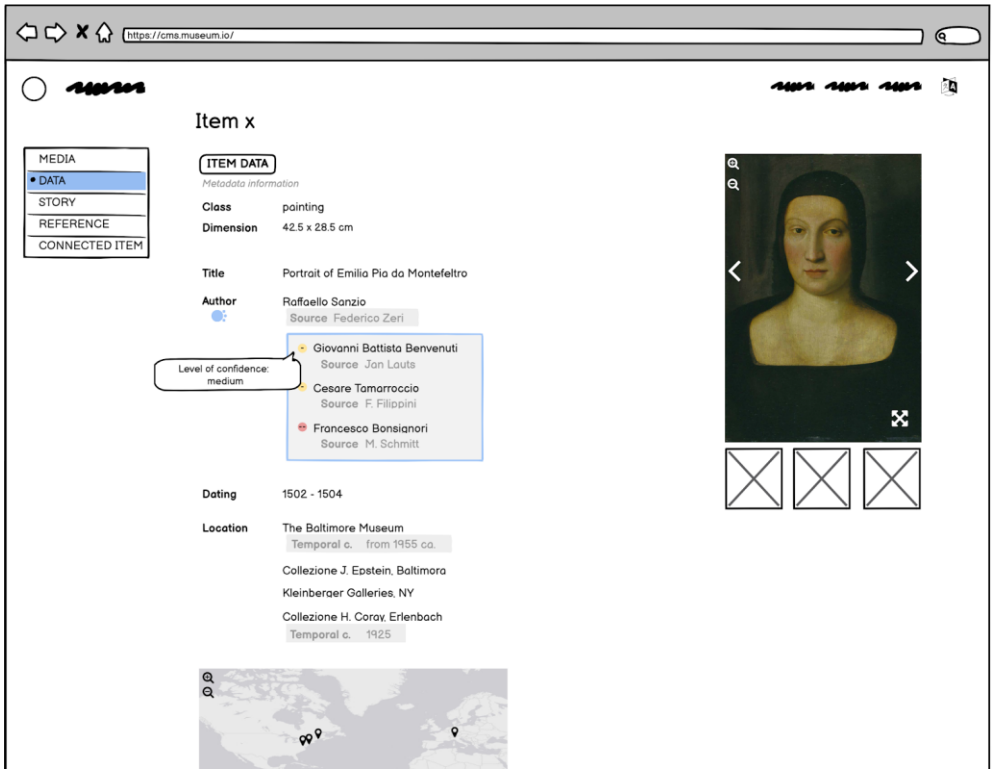
This peculiar context can be intuitively rendered with colours and symbols in the case of colour-blindness. Following this approach, a small circle is introduced next to data to indicate the stored confidence: a yellow circle with a single minus (-) for medium confidence and a red circle with the double minus (--) for low confidence. As already outlined, the high confidence level is the default value and it is not represented, because the high trustworthiness of a stored data is usually taken for granted and its explication would result tiresome.

The visitors' interface proposal tries to address the issue of complexity representation, based on the division of three separated possibilities: a no contrast visualization, a general-accepted-with-alternatives visualization, a highly-contrasting visualization. The first visualization is intended for when a precise property has just a single value. This prospect reflects the current simple visualization of CH items in digital environments: they are presented with specific metadata, reporting the specific property and its value. If the system has any conflicting values (e.g. multiple contrasting values inside a property), information is just canonically displayed, reporting the contextual information under the related data, as shown in *Wireframe 4*. This simple and plain representation enables users to retrieve additional information and, in the meantime, to not be annoyed by an information overload.



Wireframe 6 - Visitor interface, unique accepted value

The second visualization addresses all the situations in which a specific datum is generally accepted by the scientific community, but still some other hypotheses have been made and mildly sustained. This is the actual case of the Portrait of Emilia Pia da Montefeltro, painted by Raffaello. The generally accepted version of Art Historians considers the authorship of Raffaello, however some side hypotheses were made. In this case, the visualization starts to form the canonical arrangement with the addition of a signalling icon under the given property. The activation of the icon causes the display of the other and conflicting values. The icon is intended to plainly represent one preponderant view with other tepid and weaker hypotheses.

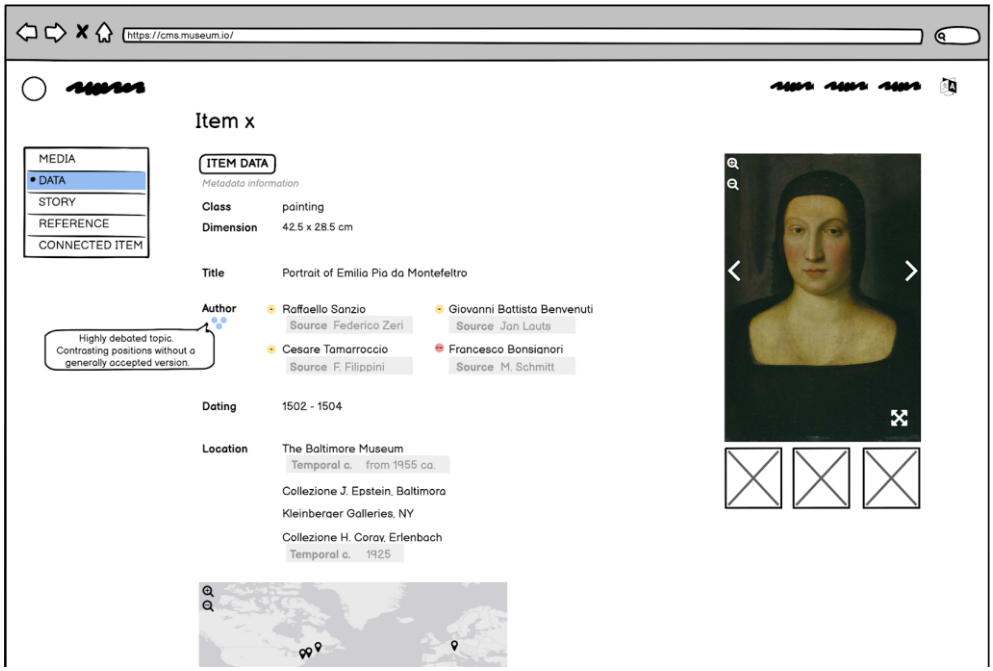


Wireframe 7 - Visitor interface, predominant value with alternatives

This visualization gives the possibility of exploring the resource by choosing whether to deepen the acquired information or not.

The last visualization concerns the situation in which no concordant version has been found by scholars. Uncertainty and debates are still ongoing. In this situation, the interface shows all the potential values as peers, giving them the same graphical importance. This situation is signalled by the dedicated icon. The three equal circles represent the contrasting positions which have not solved the diatribe.

Provided that the outcomes of user research underlined a partial dissatisfaction of users regarding ready-made pages layout, the proposed designs also suggest a complete item presentation page. The general arrangement of the page is divided into two main parts: the left one dedicated to the display of information and data, while the right one dedicated to media files and contents. This composition is paired with a table of content which orient and facilitate the resource navigation. The ideated sections of the resource involve these contents: media, data, story, reference, connected items. Particularly, “Story” involves discursive information of the resource, providing an in-depth view of the item, while “Reference” and “Connected items” try to foster the interest of the visitor, providing further research material and suggesting similar or related items.



Wireframe 8 - Visitor interface, no accepted value

The design proposals outlined in this chapter merge all the previous research findings and interpret them in a consistent manner. The next chapter will test the proposals in order to evaluate the interfaces and highlight possible changes for improving the user experience of the system.

5. Testing Omeka S Context

After the design of the interfaces, the produced solutions need to be assessed through a phase of testing.

The present design proposals underwent two testing phases: inspection and discount usability testing. Inspection is the generic name for a set of methods based on having one or more evaluators inspect a user interface. Discount usability testing is an observational methodology which involves testers and the performance of tasks on the interface to discover problems, opportunities and details about users. The chapter starts with the inspection phase, carried out through the application of the heuristic analysis, the informal action analysis and the cognitive walkthrough. After these steps, the evaluation continues with the discount usability testing and the suggestions from the participants. At the end of each section, a brief discussion of the outcomes is provided.

5.1 Inspection

As mentioned above, the inspection covers multiple methods aimed at evaluating the design proposal. It is usually employed in early and late design stages as an affordable solution for detecting problems and discovering new opportunities for improvements (Rogers et al., 2011). These methods do not require users to be present during the evaluation, on the contrary, they typically involve an expert role-playing the users for whom the product is designed. Using a set of guidelines, the analysis of different aspects of the interfaces identifies potential usability problems. In the following, the design proposal is assessed with heuristic analysis, informal action analysis and cognitive walkthrough.

5.1.1 Methodology

The first employed method is a heuristic evaluation. It is an informal method of usability analysis where a number of evaluators are presented with an interface design and are asked to comment on it (Nielsen and Molich, 1990). Hence, the analysis depends on heuristics, parameters used for assessing the design. If the interfaces satisfy such heuristics, they are likely to be usable products. Nielsen and Molich are the pioneers of this method, implementing the most common set of evaluation principles (Nielsen, 1994a). An additional

element for heuristic analysis is represented by guidelines. Guidelines are more detailed parameters, which often concern a specific aspect of the interface: for this reason, they cannot be applied to every interface. In this research, the design proposal is evaluated by following a selection of the David Travis Userfocus guidelines[16]. The used set considers aspects such as layout and feedback of design proposals. The heuristic analysis is performed on the original Omeka S interface and the one integrated with the Contexts plug-in. This comparison enables the research to investigate how the implementation of the new module affects the existing interface usability. The complete list of considered guidelines with respective results can be found in *Appendix E.1 Heuristic analysis*.

Then, the informal action analysis considers the general picture and mostly disregards precise details. It is carried out by listing the actions and then considering the process. Due to its handiness, it is employed for analysing whether tasks can be performed easily, whether they take too much time or whether they require too much learning time to be performed. So, the aim is to detect possible sources of additional complexity and disorientation, assessing the way tasks can be achieved and possible occurring errors. Moreover, the informal action analysis is not limited to the sole user's perspective, like cognitive walkthrough, and can hence offer further insights.

Finally, the cognitive walkthrough is a formalized way of imagining users' thoughts and actions when they interact with the interface for the first time. Provided an imaginary user and the detailed interface design, it foresees the selection of the tasks that the design is intended to support. Then, the "story" of each action a user has to take to carry out the task is narrated. A fundamental point is the story credibility: all the user's actions have to be motivated, relying on the user's general knowledge and the prompts and feedback provided by the system. If the story about an action is not believable, then a problem with the interface is detected. This method focuses on the removal of designers' assumptions on users' reasoning, trying to eliminate biases. The tasks taken into consideration in the cognitive walkthrough are the insertion of a new context for employees, specifically the temporal one, and the looking up information for visitors. The detailed report can be found in *Appendix E.2 Cognitive walkthrough*. Each step of the action sequences foresees to ask the following four questions:

1. *Will users understand how to start the task?*
2. *Are the controls conspicuous?*
3. *Will users know the control is the correct one?*
4. *Was there feedback to indicate you completed (or did not complete) the task?*

[16] The David Travis Userfocus guidelines are freely available at the company website, they are divided into nine interface aspects: home page usability; task orientation; navigation and information architecture; forms and data entry; trust and credibility; writing and content quality; page layout and visual design; search usability; help, feedback and error tolerance. https://userfocus.co.uk/resources/guidelines.html

In the next section, the discussion of these inspection analysis results is provided. This step combined with the user testing helps the detection of usability issues, but only with a fully iterative process the design of the interface can fully succeed.

5.1.2 Results

The results of the inspection are already merged in the presented design of *Chapter 4*. However, the findings of the expert usability review are reported and discussed, highlighting the most relevant issues.

Heuristic analysis has outlined two main concerns which are relevant both for the collection manager and the visitor interface. Firstly, the importance of tailored insertion methods in entry fields is underlined. As already analyzed, the task of inserting data inside the system is supported by the Omeka entry field, which allows only for three data types: text strings, external URIs, internal URIs called “Omeka resources". Although this set of choices already presents a good range of possible datatype entries, the heuristic analysis underlines a remarkable lack of consistency. Usability best practices and guidelines stress the need for coherence between the required data value and the possible insertion method. Radio buttons, dropdown menus and date pickers are just examples of available formats taken from the plug-in design. Even though the guidelines try to limit the overuse of text entry fields on forms, the original Omeka interface does not follow such best practice. Thus, the Context plug-in promptly implemented this directive, providing customized entries which fit particular data formats and appropriate data selection methods. This improvement is also underlined by the score gap between the two “Forms & Data Entry” sections accounting for a difference of 37,5% in the compliant guidelines. Secondly, the heuristic analysis focuses on the guidance provided by the system during the insertion of information. Help, feedback and error tolerance play a crucial role in orienting the user through complex systems such as Omeka and collection management systems in general. Concerning feedback, the original platform does not adopt explicit feedback when an item is successfully added to the collection and it does not support any progress indicators during the description of items. However, the traditional Omeka S is extremely generous in the provision of alerts for reverting deletions, allowing users to easily “undo” actions. The proposed design, due to the novelty of the subject, provides plenty of explanatory tooltips, aimed at orienting the user and giving meaningful brief explanations. This approach intends to support the user in the navigation and usage of the platform. Another element introduced for this reason is the progress bar inside the editor: as an inserted entry field is completed the progress bar advances. The bar results particularly useful with long and detailed descriptions for which dozens of fields need to be fulfilled. On the contrary, error tolerance and recovery presented some issues which were a neglected part are rapidly addressed with the introduction of icons and buttons, integrated into design proposals. Finally, concerning the orientation and self-explicitness, the visitor’s interface tries to address the issue, providing intuitive tooltips and a graphic arrangement which involves a meaningful usage of colours and icons. In order to avoid the overload of information and texts, the employment of visual components results fundamental for improving the experience and being compliant with guidelines. In conclusion, the overall scores result quite high, with a significative improvement in the

compliance percentage of the Context plug-in: the detailed comparison is available in *Appendix XXX Heuristic analysis*.

The informal action analysis characterizes as quite laborious the flow related to the insertion of new contexts. This potential issue was already detected in previous analyses, thus the alternative insertion method can overcome it. Overall the informal action analysis was satisfactorily passed by the interface.

The cognitive walkthrough provided interesting findings as well. The visitor interface results coherent and friendly for the users. The analysed task, looking up information, is achievable. The retrieval of medium and highly contrasting information does not present any issue at this stage of the evaluation and the design proposal successfully passed this inspection. On the contrary, the collection manager interface outlined some source of complexity, specifically towards the editing and deleting actions. All the already employed strategies of the original Omeka interface need to be addressed and supported also in the contextual panel. Coherence and consistency are still the guiding principles of the design proposals and standard tasks such as editing and error recovery should reflect this tendency.

All in all, the inspection evaluated positively the proposed interfaces, providing precious insights for a first refinement of the design. Major concerns are eliminated due to this first analysis, then the user testing will uncover further issues and collect improvement suggestions.

5.2 Discount Usability Testing

After the production of the design, validating the proposals and verifying the interfaces requires the involvement of target users. Usability testing is an observational methodology to uncover problems and opportunities in the design proposal. The involvement of real testers, targeted in the user segment, allows improving the interface. This empirical study can be carried out with plenty of protocols and methods, but usually it comprehends common main features. A researcher, called facilitator or moderator, asks a participant to perform tasks on a specific user interface; the researcher observes the participant's behaviour and listens for feedback. This process is carried out in order to collect user feedback about the perceived experience. In the following sections it is reported the adopted protocol for this specific usability testing sessions and the related findings.

5.2.1 Methodology

The adopted methodology for the tests is the discount usability testing, also called discount usability engineering or guerrilla testing. This methodology, developed by Jacob Nielsen (1994b), remains a valuable technique for performing formative test. In opposition with summative, formative testing focuses on observation and understanding of participants through processes and actions. How the user deals with the system and what issues encounters is the core of this methodology. The testing is intended to guide the development and acquire suggestions or improvement hints. On the contrary, summative testing focuses on precise measuring and counting, performing the evaluation of the final and definitive version of the interface.

Thus, the methodology chosen is the formative one, which is also informal, cheap and only requires a small number of participants (3-4). The informality eliminates the costs of equipped laboratories and allows to carry out the test in a quiet room with the participant and the moderator in front of a computer. Due to the current health situation, the sessions were carried out remotely, following the same principles. This approach is cheap also because it can be conducted by a member of the development team in parallel to production. Before the testing, scenarios are prepared for defining the scope of the prototype. Then, the testers perform the required task on the prototype while constantly communicating their thoughts to the moderator. This method is called "informal thinking aloud" (Nielsen, 1994b; Cooper et al., 2014; Shedroff, 1999). Impressions and reactions are expressed in order to facilitate the comprehension of the participant feelings toward the interaction. The only disadvantage of the discount approach is the lack of metrics: the results exclusively serve as suggestions for improvements.

This usability testing involved nine testers for the collection manager interface and two testers for the visitor interface. As mentioned above, the discount usability testing was carried out remotely, using the video conferencing tool Microsoft Teams and the full-screen user testing mode of the Balsamiq Wireframe tool. During the session, the testers were presented to a scenario and asked to perform the related task. At the end of every task, a brief moment of feedback and impression gathering occurred, while at the end of the whole session collection manager interface testers fulfilled a System Usability Scale (SUS) questionnaire. This method provides an efficient and reliable measurement of the usability, using simple ten item Likert scale with five response options. The complete report of SUS questionnaires is reported in *Appendix F.1 Collection manager interface testing SUS*.

	P1	P2	P3	P4	P5	P6	P7	P8	P9	Rate scale degree from 1 (Strongly disagree) to 5 (Strongly agree)	
Q1	3	3	3	4	5	4	4	2	1		
Q2	1	3	1	1	1	1	1	1	1		
Q3	4	4	4	4	5	5	5	4	4		
Q4	2	2	1	2	4	1	1	3	2		
MEAN										**SUS** **Learnability** **Usability**	**81.11** **80.56** **81.56**

Table 3 - Partial SUS results

A different, qualitative method was proposed to the visitor interface testers, with the provision of a set of specific questions to elicit the gathering of detailed feedback.

5.2.2 Results

The collection manager perspective is provided by nine employees and researchers of the University of Bologna. Four of them are part of the Digital Humanities Advanced Research Center (DHARC) of the

University of Bologna. They are domain experts in the CH digitalization and dissemination process and already Omeka S users. The other five testers are the staff of the University platform office. They are IT experts and tech-savvy, already familiar with editors and metadata.

As testers for the visitor interface, a graduated Master of Art in Digital Communication Design and a graduated Master of Art in Italian Studies. Both of them have studied and worked in the CH sector. Their past work and study experiences involved the research of resources in digital collections and libraries. Their complete feedback is collected in *Appendix F.2 Visitors interface testing*.

5.2.2.1 Collection managers

The heterogeneity of the testers' backgrounds, that still remain coherent with target users' traits, fostered a flourish discussion. Multiple points of view and several hints were provided by the participants, thus the following includes testing findings divided into four themes. Firstly, impressions and suggestions regarding the specific domain and technical concerns are presented; secondly, help and orientation are addressed; thirdly, some feedback on animation and graphical arrangement are outlined; finally, a brief commentary on the results of SUS questionnaire is given.

Starting with domain and technical feedback, the concerns were expressed by DHARC researchers and mostly focus on data insertion methods and modelling. Although the presented insertion methods proposal was successfully welcomed by participants, two testers propose the enrichment of insertion technique in the geo-jurisdictional and confidence contexts. While the geo-jurisdictional is represented by the typical Omeka entry field in the proposal, the suggestion of adding a widget for the insertion of geographic coordinates is very interesting. This widget could also work with the already available module "Mapping" [17] which permits to geolocate Omeka S items and add interactive maps to exhibitions. The addition of diverse insertion techniques could only help and provide more possibilities for the correct insertions of data.

Furthermore, the second involved context is confidence. The insertion method for this context relies on three different radio buttons, which model a high, medium and low level of authoritativeness of the related statement. The researcher impression concerns the modelling of the three options: could different levels of confidence be expressed in a different manner, maybe using percentages? The academic discourse on the definition of criteria and ranking models able to assess authoritativeness is still being debated (Daquino, 2019). Nonetheless, the chosen solution takes into account some existent models which could be reused in the CH domain, such as the Confidence Information Ontology[18] and its related works. No final solution has been found for the subject, thus the rise of such concerns help and foster the related research.

[17] https://omeka.org/s/docs/user-manual/modules/mapping/
[18] https://www.ebi.ac.uk/ols/ontologies/cio

Moving on the second theme, the participants outline different impressions regarding help, guidance and orientation provided by the system. In complex systems, such as collection management systems, the avoidance of information overload is hardly achieved. This means that every addition of elements and text must be weighed carefully. However the provision of meaningful labels and brief explanations is undoubtedly mandatory. So, even if the system scored a satisfactory rate in the SUS questionnaire, the improvement of aids and familiarization strategies is always welcomed and an ongoing process. Firstly, the suggestions concern the change of some labels. The choice of the word "provenance" was a well-established praxis of the CH Semantic domain. This world is usually employed for describing the provenience, the source of an artefact. Then, the indication of source using the word "provenance" was extended to the origin of a statement, or more generally, of a piece of information[19]. Leaving out the technical specifications, the employment of a more expressive and welcoming label could boost the usability of the system, making it more intuitive.

Another concern related to labels regards the soft and hard constraints given to the temporal context. These labels actually reflect the *implementational* model and not the user mental model (Cooper, 2013), that does not take into account binary choices and adjectives not related to time indications. Thus, the two options could be replaced by a single button, or better a toggle-switch. It could maintain the default hard constraint, but when activated enhances the soft option with a more meaningful label domain-related, such as "circa".

Other suggestions involve the possibility of inserting a value example for the temporal option "Named Event", which could briefly clarify the required value. Finally, the last opinion involves the insertion of a more expressive label for the dropdown menu of the contextual panel. This shrewdness would enhance the usage of the second insertion method: a call to action label such as "choose a property" or "pick a property to contextualize" could prompt this method.

The last group of suggestions given by testing participants concerns the motion and graphical part of the system. The testing sessions, as well as the design proposal, are carried out with the employment of wireframes, low fidelity sketches aimed at assessing the general arrangement of the interface elements and their dialogue with the users. Animations and sophisticated graphics are not part of this design process, moreover they are intended to be almost totally adherent to the design system of Omeka S. Although these premises, testers' impression can foster some reflections on the theme, providing hints for future implementations. Firstly, a suggestion concerns the animation of the context button. Instead of the display of the four context options after the activation driven by a click, it is suggested to open the radial menu just through mouse hovering. This modification could reduce the number of atomic actions required to insert a context, encouraging the insertions.

The second suggestions regarding interaction and graphical effects concerns the loose visual connection between the main area and the contextual panel. After the activation of the radial menu and the

[19] Just to mention one above all, the PROV Ontology https://www.w3.org/TR/prov-o/

choice of a context, it is claimed that it could be not so intuitive moving right to the contextual panel. The tester suggested to insert a darker overlay covering the whole interface but the convolved property and the contextual panel. This graphical disposition could reinforce the bond between the two components, facilitating the visual association. Finally, the theme of animations and graphic suggestions concludes with the last consideration on the radial menu of contexts. One of the testers suggested their replacement with dedicated icons. This observation, even if already considered and rejected in the design phase, gives the chance to elicit some reflections. The collection management system domain is quite unused to the employment of icons and symbols for the editor section. In fact, the introduction of icons requires their complete and unambiguous understanding. Provided that, a conscious choice of self-expressive unequivocal icons could be a good point for further design versions.

The last part of the section is dedicated to the analysis of the SUS questionnaire. This inexpensive, yet effective tool helped the research in the assessment of the system usability. The questionnaire was given to the nine testers of the collection manager interface. The overall SUS value, which measures perceived ease-of-use, scored 81.11. Based on previous research, the average SUS score is 68, so it is equivalent to the 50th percentile and any number above 68 would be considered above the average. This means that the questionnaire outcome is undoubtedly positive and denotes a pleased reaction of users towards the perceived usability of the system. General guidelines on SUS score interpretation would assign an "excellent" rate to this value, considering the 80.3 score and above the equivalent of an A grade, at the top of 10% of scores. Learnability, which is retrieved from questions 4 and 10, got a rate of 80.56 and Usability, which is provided by the other eight items, scores 81.25. The slight inflection of learnability can be understood by the complexity of the system and its specificity. However, the SUS score highlighted a high perceived usability of the system and provided bright feedback.

5.2.2.2 Visitors

The assessment of visitors' interface proposals fostered interesting reflections on the quality of provided information. First of all, the general attitude of the testers was overall positive and welcoming towards the design concepts, with some XXX. Both P10 and P11 agree on the appeal of contextual information and its capacity of stimulating interest around the collection items. The contextual data concur in the creation of a richer imaginary surrounding the items, while also providing useful references for an autonomous research. Moreover, also the different presentation of multiple points of view is successfully accepted by testers, even though additional considerations are suggested.

Starting from the visualization of a generally accepted value with ancillary contrasting information, P10 highlighted the utility of this kind of design for two main purposes: firstly it helps in the deep understanding of cultural heritage dynamics, debates and interpretations are common, if not the standard; secondly, it is able to boost the underlying connections between items and external entities. This positive attitude is balanced by interesting suggestions made by P11. The tester claimed that on one hand this kind of visualization, as detailed as may be, could make visitors feel disoriented; on the other end, the tester doubted

the process of confidence assignation. Especially, the raised concerns regard the criteria upon which a statement is valued as high, medium and low authoritativeness: this doubt was brought to the interviewer's attention on more than one occasion. For what concerns icon interpretation, the lateral icon was not perceived as immediately understandable, but the metaphor for which the icon stood for is easily recognized through the explanatory tooltip. On the other hand, color-coded icons for the confidence level immediately conveyed their meaning thanks to the well-established streetlight metaphor.

Finally, the last scenario concerned the visualization of multiple values with XXX. This situation divided the participants' opinions. While P10 found the offer of information much more meaningful than an empty or undefined field, P11 found that the absence of a fully recognized author was not enough stressed. So, in one case the proposed rendering may foster the enrichment of item interpretations, in the other the arrangement of the interface risks to complicate the comprehension of the attributions. At the end of the session, testers were also asked to provide a general consideration on the system features. P10 reinforced the support to additional information that could add new dimensions to digital knowledge, enriching descriptions of cultural heritage items. As previously stated, P11 remarks the need for clear guidelines upon which basing the process of statements' certainty ranking. All in all, the visitor interface is positively perceived by both testers. The most relevant suggestion concerns the explicitness of a methodology for evaluating trustworthiness of statements.

6. Conclusions

The initial purpose of this research was to design the user experience for the plug-in of a collection management system, namely Omeka S, enabling the system to consider the specific requirements of knowledge management in the cultural heritage domain. The core idea being that further dissemination of knowledge would foster new conversations and a more embedded knowledge sharing. The early stages of the research rapidly underlined that the mismatch between systems and the cultural heritage reality prevents the diffusion of information and knowledge. Starting from these premises, the thesis addressed two research inquiries or questions:

1. *How is the absence of contextual information inside digital collections perceived by collection managers?*
2. *Which are the necessary criteria for a well-structured user experience in systems providing contextual information in CH knowledge management?*

These questions required a preliminary understanding of how information and knowledge are conceived and managed in the GLAM environment. The findings were gathered from three different sources: the state-of-the-art review, the ethnographic analysis, and user feedback. The first one involves the literature review, the analysis of competitors, and the overview of Omeka, which granted the understanding of existing concepts and their implementation. The second one presents some interesting insights into target users' opinion and environment. While the latter, after the delineation of the design concepts and proposals, addresses target users to assess the research outputs and gathers the feedback on the new design elements.

Starting from the results of this preliminary analysis, it was possible to revise the initial hypotheses and re-examine the research framework. Theoretically, the blend of results might foster future studies concerning the design of a new user experience for sustaining contextual information in digital collections.

6.1 Discussion of initial hypotheses and goals

On the basis of the outcomes emerged by the literature review, the competitive analysis, and the ethnographic investigation, it has been possible to address the first research question, meaning *how is the absence of contextual information inside digital collections perceived by collection managers*?

First of all, the attitude of collection managers and employees is analysed. The hypothesis *H1: Collection managers are fully satisfied by the expressivity of Omeka* is overall accepted by the outcomes of *Chapter 3 CH professionals: an ethnographic analysis*. The collected information about the general disposition of Omeka S users revealed a positive perception of the system. Although CH professionals are generally characterized by a well-known reticence towards IT systems and technologies, the findings of the chapter stressed the completely different approach of Omeka users. Typically tech-savvy and quite used to IT practices, Omeka S users are most successfully engaged and satisfied by the system. As outlined by the user research, they feel sufficiently supported by the system in almost all the provided functions, moreover, the presence of the online forum seems to grant a satisfactory level of assistance. These circumstances do not prevent involved actors from providing criticism and improvement suggestions: objections and reports are still frequent inside the community. However, overall the predominant position of Omeka S users partially adheres to the suggested hypothesis: users are overall satisfied by the expressivity of Omeka, though not *fully*.

Next, *H2: Omeka S does not provide enough guidance through the description of items* is considered. This hypothesis is particularly addressed in competitive analysis and inside the Omeka S overview. The features supported by the system reveal an internal weakness in providing direction and guidance through items description. Even though the software provides some facilitating components, such as customizable description templates, there is no actual trace of proper guidance given by the system itself. For this reason, this task is practically delegated to the users.

This hypothesis is also addressed in *Chapter 3*. The survey respondents reported feeling quite comfortable with the guidance provided by Omeka and their answers depicted a general neutrality to the statements. Thus, the situation outlined a notable divergence between the actual contribution of the system, which is more a lack of contribution, and the help perceived by users in the description of items. This discrepancy may be a signal of the fidelity and engagement of Omeka users, which partially appreciate the supported features. These circumstances help the overall assessment of *H2* which seems valid, in spite of the different perceptions of users.

One of the assumed preconditions of the third hypothesis - *Omeka is mostly used for inventory purposes* - is that the enrichment of information is not a crucial activity. Regarding it, the research produced clear outputs: starting from Omeka's claim, the system must be conceived firstly as a web-publishing platform, thus its intended primary purpose is the dissemination of knowledge through digital environments. This viewpoint is also confirmed by user research. In fact, the survey outputs outlined some of the primary reasons for which Omeka is used, showing that inventory is not perceived as a major purpose. Hence, these outputs reject the idea that Omeka is used mainly for inventory purposes and that the enrichment of items description is not a worthy addition. To sum up, also *H3* is to be considered invalid.

Lastly, I undertook the last hypothesis driven by the first research goal. . The idea that collection managers feel responsible for preserving CH is addressed by user segmentation and user research that investigate the general attitude of CH professionals and their self-perception. Firstly, the user segmentation underlined a common self-representation of CH professionals as connoisseurs: one of the core values and

identities of the segment is characterized by expertise. Notwithstanding this attitude, the survey outputs stressed a shift of perception. Omeka users seem to prefer to associate their role with the figure of the "digital preserver". The most important trait of their identity relies on the importance of heritage conservation and dissemination. Thus, the hypothesis is definitely valid.

In brief, the first research goal which investigates *how the absence of contextual information is perceived inside digital collections by collection managers* prompts reflections about the perception of contexts. On one hand, user research suggested that users are generally satisfied with the system, so that the omission of contextual information is not perceived negatively. On the other hand, the testing phase, combined with the user research, describes the users' appreciation of information richness. Interestingly, users value the enrichment of collections with multiple points of view, as an integral value of their work. Thus, it seems that users perceive the absence of contextual information in a negative way, but often they do not pay attention to this knowledge dissemination void.

The second research goal investigated *what are necessary criteria for an improved UX for collection management systems supporting contextual information*. This inquiry focused on the applied research of new design concepts and the individualization of criteria. Firstly, the related hypotheses are resumed and analysed.

Starting with *H5: the interface design does not fit the addition of complex data*, concerning the consideration of existing systems and their features. As outlined in *Chapter 2*, the design of the assessed applications in the competitive analysis highlighted the total absence of contextual information. Entry methods for the insertion of multiple points of view and the possibility to add complex information about statements are denied. Thus, *H5* can be definitely considered valid.

The same basis of *H5* is involved in first reflections concerning *H6: Complex data need to be stored in a distinguished place*. The competitive analysis underlined a complete absence of complex data insertion methods in assessed systems, so the hypothesis has to be addressed in the light of the design proposals. *Chapter 4* illustrated the *ratio* used for the addition of contextual information to description statements. The created elements are inserted into a separated, even if integrated, part of the interface distinguished by the original statements. This arrangement makes contexts clearly recognizable from other information, but still embedded in the general visualization and storage economy. Following the principle of Cooper, "it is vital that all the elements in an interface work together coherently toward a single goal" (2013), thus consistency and coherence concur with efficacy in the composition of the interface components. This disposition definitely validates the hypothesis: complex information is stored and can be inserted in distinguishable spaces, inside the same system.

This hypothesis *H7: The item presentation design of default themes does not fully satisfy visitors* is motivated by the need for a new visualization method which includes contextual information beside the ready-made visualization templates of Omeka. Following the results of user research, the general attitude towards existing templates is positive, even if with some reserves. This provided some precious insights on the preferences of users, which explicated the need for new layout settings of page visualizations. The latter

outcome led to the ideation of an alternative item visualization, providing a medium for understanding contexts and a new layout for already established resources components. Thus, *H7* is to be considered valid.

Starting from the reflections relative to hypotheses raised by the second research goal, it is possible to draw some conclusions about the inquiry on what *are necessary criteria for an improved UX for collection management systems supporting contextual information*. Among the outlined criteria, three main principles need to be considered necessary for a well-structured user experience.

The first principle is embeddedness. It concerns the creation of an embedded entry system, which integrates the insertion of contextualized data inside the general description interface. The system needs to clearly distinguish fields related from standard information and complex data, while remaining totally harmonized with the main description practice. This distinction enables the user to discern the correct input field: firstly the insertion of description statements is required, consequently it prompts the addition of contextual specifications. This process is intended to create a fluid interaction between the user and the editor, arranging additional features which are perceived as integral parts of the description operation.

The second principle, outlined by heuristic analysis, consists of customized data entries on the basis of different data formats, such as dates, integers and spatial information. The need for coherence between the required data value and the possible insertion method is part of description editors' best practices and it needs to be cited inside the criteria for a successful user experience. Radio buttons, dropdown menus and date pickers are some examples of available formats that need to be embedded in the design, with the aim of facilitating the insertion of structured contextual data. The customization of data entry on the basis of considered datatype is fundamental for the orientation of the user's work. Without the supply of data-related entries, the user may be discouraged to insert correct data, limiting the information enrichment.

The third criterion concerns the provision of strategies for feedback, orientation and error recovery. These three pillars of user experience are not strictly domain-related, but represent the basis without which every interaction with an interface is doomed to failure, for various reasons. Firstly, the presence of structured feedback methods assures the user the complete understanding of the system status. In the case of collection management systems, it involves the addition of the progress bar inside the editor, alerts and dialogue boxes after the completion or the failure of an action. Visible changes on the interface are needed for granting the correct understanding of performed actions. Another example is the label "1 context" that appears on the context button as a statement is enriched with contextual data. Secondly, the inclusion of orientation mechanisms is necessary, even more for the novelty of the topic. Tooltips and meaningful explanatory texts and labels are mandatory for the implementation of a usable and accessible interface. Thirdly, the integration of error recovery strategies is needed for an improved interaction. Designs should be forgiving and offer low-effort ways for repairing mistakes and slips. These features are provided in order to avoid frustration, which is a crucial assessment criterion for the creation of a satisfactory user experience.

Starting from the above comprehensive analysis of initial research goals and related hypotheses, fundamental to understanding my research outputs, it is possible to further reflect on the initial assumption and research limitation in the section below.

6.2 Comparison with previous assumptions

In light of the research outcomes, it is now possible to reconsider the initial assumption that stated a mismatch between tools and collections and draw some new considerations. First of all, the research sheds new light over the inadequacy of existing systems in respect to the reality that they have to represent and describe. The evidence of *Chapter 2* fully confirms this premise, underlining the inefficiency of existing systems in their approach towards cultural heritage: employed applications are not suitable for the CH sector. Moreover, this discrepancy is not limited to the description of complex data, but extends over all the assets composing a digital collection. As underlined in *Chapter 1*, an item description might be seen as a collection of statements, all of which contain contextual information. This particular perspective increases the degree of efficacy of context comprehension and characterizes said contexts as the third asset to be digitalized inside of a collection.

This research hence underlies the difficulties relative to a full and complete digitalization. One of the first obstacles is represented by the digital reproduction of primary sources such as artifacts, art pieces and texts. In fact, this first step results in being not devoid of complications in virtue of the limited supply of existing resources. Because of that, governments and supranational institutions are trying to encourage the proliferation of this type of projects with funding and call for tenders. Secondly, the asset constituted by the metadata of primary sources is analysed alongside its relative difficulties. The fragmented status of standards and guidelines is contemporarily both a resource, in virtue of its modularity in respect to contents, and a possible source of difficulties, for what concerns consistency among representation models. Finally, the third asset concerns the addition of contextual information. This asset faces difficulties both from a more practical side, since dedicated stocking systems do not yet exist, and from a more conceptual side, since they are not characterized by a sufficient level of awareness. As pointed out by my research, it is often CH professionals to be unaware of existing systems' limitations. In fact, the lack of digital solutions for the addition of contextual information is often not perceived as problematic.

In virtue of the research findings, additional considerations could be formulated around the phenomenon of reticence, dumping and coercion, some of the difficulties often encountered during the description of items. Concerning this, the system of contexts can be particularly valuable in the resolution of reticence-related difficulties. The elimination of information justified by doubts on reliability could be contained by the implementation of reliability levels. By making the reliability level of statements explicit, information entered into systems would be correctly contextualized and CH professionals would probably feel less reluctant regarding the insertion of uncertain information into item descriptions. For what concerns coercion, it is possible that contexts would help to positively direct information, which otherwise would be constricted to erroneous fields. Providing sources, reliability levels and temporal and spatial constraints would be a valuable milestone to avoid inaccurate information insertions. Finally, regarding dumping, contexts seem to provide no effective solutions. In the course of this thesis, I argued the necessity for a deeper analysis of said topic.

6.3 Methodological limitations

Limitations of this work mainly concern the restraint of resources available for the development of the project. Even if every part was carefully drafted, the study does provide a satisfactory starting point for further reflections and investigation of the topic. Each step potentially suffered from the novelty of the subject and the limitation of resources inevitably faced by master theses.

First, a potential limitation of the state-of-the-art, and particularly involving the literary review, is the fact that a complete analysis of metadata standards and guidelines was not deeply and extensively carried out. It would be interesting to see whether next studies on the subject will thoroughly address the topic and conduct a detailed assessment of best practices relative to item description methods, especially to confront results and understand if the yielded conclusions are in line with the ones outlined by this study. This comparison could empower the comprehension of contexts, finding theoretical and practical methods for their further implementation.

Furthermore, the survey data that was used only had information by volunteer Omeka users, which collaborated without the provision of incentives. Thus, the informal survey could only provide some suggestions upon the drafted hypotheses and insiders points of view on the subject. Nonetheless, future researchers could gather extra data to look at the users' perceptions: aspects which to date have been examined solely informally could gain statistical relevance and extensively generalize precise trends and future directions of research and governmental policies. In addition, for expanding the examined material of competitive analysis, assessing systems from other domains could have been useful. Unfortunately, this additional process was overlooked due to time constraints.

Concerning design proposals, the traditional interaction methods of the Omeka S interface were maintained in order to restrict the number of new concepts and keep the usability testing feasible. A comprehensive study that involves an improved redesign of the whole interface would lead to interesting outcomes. Then, the natural enlargement of this study would have been the inclusion of a complete prototype of the system. Luckily, wireframes have provided an equally valid alternative for user testing.

6.4 Further development

On the backdrop of research findings, a number of limits, open issues and new potential research directions have been highlighted. Specifically, two main research directions could be foreseen for future works: the development of new data models and concepts supporting contexts, and the implementation of systems supporting contexts, not limited to applications' plug-in.

The topic of contextual metadata inside the Semantic Web is now becoming a thing inside the Digital Humanities community. Authoritativeness, sources and validity constraints inside the description of cultural heritage artefacts represent a new branch of the scholar discourse. The above research locates itself in this study tendency , which surely is going to benefit from further studies and future works. Especially the

conceptualization of contexts and their practical expression in datasets are crucial aspects for a new expressivity of Semantic Web standards, with the involvement of RDF and OWL technologies. Modelling contexts could mean redesign the traditional statement triple in a more sophisticated framework, which will not run out with this user experience design.

Regarding the second foreseen development, the findings on collection management systems need further studies in order to deeply revolutionize the domain. One of the goals of this research was the provision of user experience criteria: this starting point could provide a first foreground for new research on cultural heritage representational and management needs. The implementation of this design proposal could encourage the integration of contextual descriptions in future digital collections, making the cultural legacy closer to visitors without foreknowledge and creating a machine-readable asset. The plug-in model is just a low-cost solution for approaching the domain in a realistic and implementable way, a starting point for rising discussion in a practical way. Future research could eventually lead to fully integrated collection management systems and their extensive adoption.

The strive for an integrated Digital Culture is on its way to flourish, in this context contrasts and debates seem to be a fundamental resource for its accomplishment and research is orienting its questions to that domain.

Bibliography

ACLS. 2006. ‘Our Cultural Commonwealth: The Report of the American Council of Learned Societies Commission on Cyberinfrastructure for the Humanities and Social Sciences’. https://www.acls.org/cyberinfrastructure/.

Al-Attar, Fuad, and Khaled Shaalan. 2016. *Enablers and Barriers of Knowledge Spiral: A Case Study*. https://doi.org/10.1145/2925995.2926039.

Alfandari, Agnès. 2014. ‘How Digital Can Help Museums to Reach New Audiences’. In *Museums and the Web Asia 2014. Museums and the Web*. Silver Spring.

Anwar, R., M. Rehman, K. S. Wang, and M. A. Hashmani. 2019. ‘Systematic Literature Review of Knowledge Sharing Barriers and Facilitators in Global Software Development Organizations Using Concept Maps’. *IEEE Access* 7: 24231–47. https://doi.org/10.1109/ACCESS.2019.2895690.

Avgousti, Avgoustinos, Georgios Papaioannou, and Feliz Gouveia. 2019. ‘Content Dissemination from Small Museum and Archival Collections: Community Reusable Semantic Metadata Content Models for Digital Humanities Scholars’. *Code4lib*.

Bagozzi, Richard P., and Utpal M. Dholakia. 2006. ‘Open Source Software User Communities: A Study of Participation in Linux User Groups’. *Management Science* 52 (7): 1099–1115. https://doi.org/10.1287/mnsc.1060.0545.

Bello, Rotimi-Williams, and Ahmad Sufril Azlan Mohamed. 2018. ‘Impact of Technology on Traditional Museum Collection Storage and Management’ 7 (November): 46–51.

Besser, Howard. 1997. ‘The Transformation of the Museum and the Way It’s Perceived’. In *The Wired Museum*. Washington, DC: American Association of Museums.

Blair, David C. 2002. ‘Knowledge Management: Hype, Hope, or Help?’ *Journal of the American Society for Information Science and Technology* 53 (12): 1019–28. https://doi.org/10.1002/asi.10113.

Cooper, Alan, Robert Reimann, Dave Cronin, and Alan Cooper. 2014. *About Face: The Essentials of Interaction Design*. Fourth edition. Indianapolis, IN: John Wiley and Sons.

Dallas, Costis. 1994. ‘A New Agenda for Museum Information Systems’. *Problems and Potentials of Electronic Information in Archeology.* London: British Academy&Council for British Archeology.

Daquino, Marilena. 2019. *Mining Authoritativeness in Art Historical Photo Archives: Semantic Web Applications for Connoisseurship*. Vol. 40. Studies on the Semantic Web. IOS Press.

Daquino, Marilena, and Francesca Tomasi. 2015. 'Historical Context Ontology (HiCO): A Conceptual Model for Describing Context Information of Cultural Heritage Objects'. In *Metadata and Semantics Research*, edited by Emmanouel Garoufallou, Richard J. Hartley, and Panorea Gaitanou, 424–36. Communications in Computer and Information Science. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-24129-6_37.

Davenport, Thomas H., Robert J. Thomas, and Susan Cantrell. 2002. 'The Mysterious Art and Science of Knowledge-Worker Performance'. *MIT Sloan Management Review* 44 (1): 23.

Davis, Fred D. 1993. 'User Acceptance of Information Technology: System Characteristics, User Perceptions and Behavioral Impacts'. *International Journal of Man-Machine Studies* 38 (3): 475–87.

Dent, T., R. Comunian, V. Pica, and C. Burlina. n.d. 'Creative and Cultural Workforce in Europe Statistics Report'. DISCE Publications. https://disce.eu/wp-content/uploads/2020/05/ DISCE-Report-D3.2.b.pdf.

Disterer, G. 2001. 'Individual and Social Barriers to Knowledge Transfer'. In *Proceedings of the 34th Annual Hawaii International Conference on System Sciences*, 7 pp.-. https://doi.org/10.1109/HICSS.2001.927138.

Garrett, Jesse James. 2010. *The Elements of User Experience: User-Centered Design for the Web and Beyond*. Pearson Education.

Girard, John, and JoAnn Girard. 2015. 'Defining Knowledge Management: Toward an Applied Compendium' 3 (1): 20.

Goyat, Sulekha. 2011. 'The Basis of Market Segmentation: A Critical Review of Literature'. *European Journal of Business and Management* 3 (January).

Gwebu, Kholekile L., and Jing Wang. 2010. 'Seeing Eye to Eye? An Exploratory Study of Free Open Source Software Users' Perceptions'. *Journal of Systems and Software*, Interplay between Usability Evaluation and Software Development, 83 (11): 2287–96. https://doi.org/10.1016/j.jss.2010.07.011.

Hardesty, Juliet. 2014. 'Exhibiting Library Collections Online: Omeka in Context'. *New Library World* 115 (March): 75–86. https://doi.org/10.1108/NLW-01-2014-0013.

Hockey, Susan. 2004. 'The History of Humanities Computing'. *A Companion to Digital Humanities*, 3–19.

ICCD, and MIBACT. 2018. ‘Servizio per La Digitalizzazione Del Patrimonio Culturale e Digital Library’.

Igbinovia, Magnus, and Iguehi Ikenwe. 2018. ‘Knowledge Management: Processes and Systems’. *Information Impact: Journal of Information and Knowledge Management* 8 (February): 26. https://doi.org/10.4314/iijikm.v8i3.3.

ISTAT. 2019. ‘I Musei, Le Aree Archeologiche e i Monumenti d’Italia’. https://www.istat.it/it/files//2019/01/Report-Musei_2017_con_loghi.pdf.

Lakhani, Karim R, and Eric von Hippel. 2003. ‘How Open Source Software Works: “Free” User-to-User Assistance’. *Research Policy* 32 (6): 923–43. https://doi.org/10.1016/S0048-7333(02)00095-1.

Mechant, Peter. 2007. ‘Culture “2.0”: Social and Cultural Exploration through the Use of Folksonomies and Weak Cooperation’. In , 21–26.

Milton, Nick, Nigel Shadbolt, Hugh Cottam, and Mark Hammersley. 1999. ‘Towards a Knowledge Technology for Knowledge Management’. *International Journal of Human-Computer Studies* 51 (3): 615–41. https://doi.org/10.1006/ijhc.1999.0278.

‘MOCW (2016) Verkenning Arbeidsmarkt Cultuursector. Report, The Hague: Ministerie van Onderwijs, Cultuur En Wetenschap (MOCW) Available at: Https://Www.Rijksoverheid.Nl/Documenten/Rapporten/2017/10/23/Cultuur-in- Beeld-2017’. n.d.

Nahapiet, Janine, and Sumantra Ghoshal. 1998. ‘Social Capital, Intellectual Capital, and the Organizational Advantage’. *Academy of Management Review* 23 (2): 242–66.

Navarrete, Trilce, and John Mackenzie Owen. 2016. ‘The Museums as Information Space: Metadata and Documentation’. In , 111–24. https://doi.org/10.1007/978-3-319-29544-2.

Naylor, Richard, Brownyn McLean, and Caitlin Griffiths. 2016. ‘Character Matters: Attitudes, Behaviours and Skills in the UK Museum Workforce’. BOP Consulting.

Neches, Robert, Richard Fikes, Tim Finin, Thomas Gruber, Ramangouda Patil, Ted Senator, and William Swartout. 1991. ‘Enabling Technology for Knowledge Sharing.’ *AI Magazine* 12 (September): 36–56.

Nielsen, Jakob. 1994a. ‘Enhancing the Explanatory Power of Usability Heuristics’. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 152–58. CHI ’94. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/191666.191729.

———. 1994b. *Usability Engineering*. San Francisco, CA, USA: Morgan Kaufmann Publishers Inc.

Nielsen, Jakob, and Rolf Molich. 1990. 'Heuristic Evaluation of User Interfaces'. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 249–56. CHI '90. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/97243.97281.

Nonaka, Ikujiro, and Hirotaka Takeuchi. 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford, New York: Oxford University Press.

Norman, Donald A. 2004. *Emotional Design: Why We Love (or Hate) Everyday Things*. Basic Books.

OECD. 2020. 'Education at a Glance 2020'. OECD Publishing, Paris. https://doi.org/10.1787/69096873-en.

Onyancha, Omwoyo, and Dennis Ocholla. 2009. 'Conceptualising "knowledge Management" in the Context of Library and Information Science Using the Core/Periphery Model'. *SA Journal of Information Management* 11 (April). https://doi.org/10.4102/sajim.v11i4.412.

Parry, Ross. 2013. *Museums in a Digital Age*. Routledge.

Planinc, Tatjana, Marko Krevs, Lea Rebernik, Karl Donert, Linda Sillat, and Manisha Khulbe. 2020. *The Role of Digital Humanities in Higher Education: Understanding the Challenge of Integration*. https://doi.org/10.13140/RG.2.2.28294.19524.

Quintas, Paul, Paul Lefrere, and Geoff Jones. 1997. 'Knowledge Management: A Strategic Agenda'. *Long Range Planning* 30 (June): 385–91. https://doi.org/10.1016/S0024-6301(97)90252-1.

Radermecker, Anne-Sophie V. 2020. 'Art and Culture in the COVID-19 Era: For a Consumer-Oriented Approach'. *SN Business & Economics* 1 (1): 4. https://doi.org/10.1007/s43546-020-00003-y.

Riege, A. 2005. 'Three-Dozen Knowledge-Sharing Barriers Managers Must Consider'. *J. Knowl. Manag.* https://doi.org/10.1108/13673270510602746.

Rogers, Yvonne, Helen Sharp, and Jenny Preece. 2011. *Interaction Design: Beyond Human - Computer Interaction*. John Wiley & Sons.

Rowley, Jennifer. 2007. 'The Wisdom Hierarchy: Representations of the DIKW Hierarchy'. *Journal of Information Science* 33 (2): 163–80. https://doi.org/10.1177/0165551506070706.

Segre, Giovanna, and Claudia Villosio. 2017. 'Employment in the Creative and Cultural Sectors. Evidence from a Sample of European Countries'. Fondazione Santagata per l'Economia della Cultura. https://www.fondazionesantagata.it/wp-content/uploads/Segre-Villosio_Employment-in-the-creative-and-cultural-sectors.pdf.

Shedroff, Nathan. 1999. ‘Information Design’. In , 267–92. MIT Press.

Silvaggi, Antonia, and Federica Pesce. 2017. ‘Museum Professionals in the Digital Era. Agents of Change and Innovation’. MeltingPro, Italy.

Singh, J. P. 2010. ‘Global Cultural Policies and Power’. In *International Cultural Policies and Power*, edited by J. P. Singh, 1–15. International Political Economy Series. London: Palgrave Macmillan UK. https://doi.org/10.1057/9780230278011_1.

Sula, Chris Alen, S. Hackney, and Phillip Cunningham. 2017. ‘A Survey of Digital Humanities Programs’. *The Journal of Interactive Technology and Pedagogy* no. 11 (May).

Thomas, Cathy, and Nigel Bevan. 1996. ‘Usability Context Analysis: A Practical Guide’. Report. Loughborough University. /articles/report/Usability_context_analysis_a_practical_guide/9353600/1.

Uzelac, Aleksandra, and Biserka Cvjeticanin. 2008. *Digital Culture: The Changing Dynamics*.

Vitali, Fabio. 2019. ‘Beyond Three Dimensions: Managing Space, Time and Subjectivity in Your Data’. In *Proceedings of the 1st Workshop on Structuring and Understanding of Multimedia HeritAge Contents*, 3–4. SUMAC ’19. New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/3347317.3352728.

Appendices

A Survey questions

A Demographics

A1	Select your age group.	Select: 18-25; 26-35; 36-45; 46-55; 56-65; 66-75

B Position

B01	What is the type of your current employment?	Select: Volunteer; Working student; Part-time temporary employee; Part-time permanent employee; Full-time temporary employee; Full-time permanent employee
B02	Which institution/organization do you work for?	Select: Museum; Archive; Library; University; Cultural Organization; Other (specify)
B03	In which Country is your organization located?	Text input field
B04	How is your organization mainly financed?	Select: Private; Public; I don't know

C Omeka S

C01	How long have you been using Omeka S? And Omeka Classic before the S version release	Select: Under 1 year; 1-2 years; 3-6 years; 7-8 years; 9-13 years
C02	How often do you use Omeka S in your work?	Daily; Weekly; Mounthly; Hardly; Never
C03	How often do you perform the following activities with Omeka S? - Inserting new items - Looking up information - Modifying existing data - Creating new exhibitions	Daily; Weekly; Mounthly; Hardly; Never
C04	For which purpose you mainly use Omeka S?	Data storage; Digital exhibition; Inventory; Semantic publishing

D Knowledge management

D01	How many vocabularies have you uploaded in Omeka for describing your items?	Select: 1-2; 3-4; More than 4
D02	Do you follow a manual/standard guidelines for describing your items?	Select: Yes; No; I don't know
D03	Do you usually insert additional data to particularly interesting items?	Select: Yes; No; I don't know
D04	Rate to what degree you agree with the following statement about Omeka: - Omeka guides me through the process of describing artefacts - Omeka allows me to describe items in depth	I strongly disagree; I disagree; Neutral; I agree; I strongly agree

	- Omeka encourages me to provide additional information - Omeka provides one place for literally everything I know about the collection	
D05	Rate to what degree you agree with the following statement about Omeka: - I am a connoisseur - I have the duty to pass on the cultural heritage - Multiple points of view (such as different interpretations, attributions...) enrich our cultural heritage - A system for expressing different points of view in Omeka would be useful	I strongly disagree; I disagree; Neutral; I agree; I strongly agree

E Omeka sites

E01	Do you use Omeka sites themes for publishing your collection/exhibition?	Select: Yes; No; I don't know
E02	Are you satisfied by the visualization layout arrangement and style of the available themes?	Select: Yes; No; I don't know
E03	Rate to what degree you are satisfied by the following feature about Omeka sites default themes: - Items visualization - Pages layout - Style options (colorscolours, fonts, graphical elements) - Variety of components (text, multimedia, slideshows, cards	Rate scale degree from 1 (Not satisfied) to 5 (fully satisfied)

D Free input

D01	Fill this box with every suggestion, ideas or feedback you want	Text input field

B Personas

B.1 The art historian

Photo by **C. Morillo** from **Pexels**

Type of persona	Name	Age
Protagonist	Penelope Parker	47

Education	Family	Household income
PhD in History	Husband	70.000/yr (40.000/yr is her husband's income)

Competencies	Experience	Attention level
Domain: High Linguistic: Excellent	Expert	involving activities

Goals	System objectives	Type of usage
End goals: create a digital exhibition on post-war photographs with dubious authorship. Experience and life goals: She feels the duty to pass on as much knowledge on CH as possible to others.	The system helps her in recording and graphically rendering complex information. The match about her professional attitude and the system facilitates the daily work.	She organizes digital exhibitions, assesses existing items and inserts new entries.

Behaviour	Attitude	Physical fitness
She is a committed researcher and a meticulous registrar. Her focus is on enhancing peculiar and mostly veiled CH gems.	Her passion is paired with professionalism. Her daily tasks are addressed with the willingness to handle herself.	She has an active lifestyle and has good health. The bicycle is her means of transportation, which is daily used. Thus she has no issues in interacting with digital devices.

B.2 The visitor

Photo by **B. Millennial** from **Pexels**

Type of persona	Name	Age
Primary	Adam Marquez	25

Education	Family	Household income
Enrolled in International Cooperation and Development Master	Living with his two flatmates, parents in his hometown, an older sister	9.000/year (works as babysitter and gives lessons to high school students)

Competencies	Experience	Attention level
Domain: High Linguistic: High	Intermediate	Very involving activities

Goals	System objectives	Type of usage
End goals: He wants to raise her GPA with the last exams. Experience and life goals: Succeeding in life as an affirmed professional.	Wants to retrieve reliable and in-depth information for her paper.	Looking up information.

Behaviour	Attitude	Physical fitness
Immersed in his chaotic life, dividing himself between study, work and social life.	His determination encourages her to deal with all daily to-dos. Occasionally he makes mistakes due to tiredness.	Young and full of energy, he has good health. No remarkable issue in computer interaction and great reaction time, if rested.

B.3 The registrar

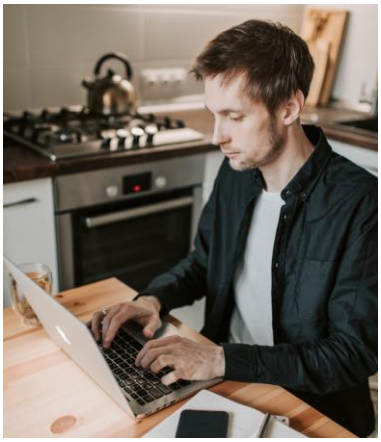


Photo by **V. Karpovich** from **Pexels**

Type of persona	Name	Age
Secondary	Daniel Demir	42

Education	Family	Household income
Undergraduate degree in Culture studies	A child	85.000/year (45.000 are his wife income)

Competencies	Experience	Attention level
Domain: High Linguistic: High	Intermediate	Very involving activities

Goals	System objectives	Type of usage
End goals: He wants to improve his daily workflow, after the introduction of a new system. Experience and life goals: He wants to foster a change inside his work reality and to save time for his family.	He wants to efficiently register the collection and check the work done in the dashboard.	Inserting items, modifying entries, looking up information and checking the dashboard.

Behaviour	Attitude	Physical fitness
He is trying to acquire a new workflow and learn the feature of the new system. He is really precise due to his daily work.	He is a positive person, friendly and caring.	Healthy, he wears contact lenses since the age of 13 and he is colour blind.

B.4 The podcaster

Photo by **V. Karpovich** from **Pexels**

Type of persona	Name	Age
Supplemental	Liam Benton	38

Education	Family	Household income
Undergraduate degree in Law, postgraduate course in Media Communication	Husband	85.000/year (40.000 his husband income)

Competencies	Experience	Attention level
Domain: High Linguistic: High	Intermediate	Very involving activities

Goals	System objectives	Type of usage
End goals: He wants to gather information for his next podcast episode. Experience and life goals: Becoming a reference point in his professional field.	Wants to retrieve interesting and unusual information about the history of rights movements and their representation, enriching his edutainment contents.	Looking up information.

Behaviour	Attitude	Physical fitness
Working as a freelancer for most of his time, he is a well-organized person, curious and constantly searching for new attractive stimuli.	He is an attentive person, open to innovations thanks to his job, but still quite critical. He has several devices, which are used for recording and registering his episodes.	Healthy and fit, he is a climber. He has not any issue in computer interaction.

B.5 The volunteer

Photo by **A. Picquadio** from **Pexels**

Type of persona	Name	Age
Supplemental	Tom Stevens	69

Education	Family	Household income
MSc in Information Sciences	Wife, two adult daughters, one grandson	90.000/yr (10.000 real estate income, 40.000 wife income)

Competencies	Experience	Attention level
Domain: Beginner Linguistic: High	Beginner	involving activities

Goals	System objectives	Type of usage
End goals: Help the cultural organization for which he volunteers to develop a good database, ready for future projects. Experience and life goals: He desires to be useful and redeploy his competencies for the common good	The system helps him to organize the collection and modify existing entries, for updates.	Record new items, modify existing entries, arrange subcollections.

Behaviour	Attitude	Physical fitness
Since his wife is not retired yet, he spends the day in his cultural organization, socializing with other volunteers and deploying his competencies for charity.	He wants to feel useful for society and being involved in charity projects.	Not so agile in walking, he still has good reaction time in computer interaction. His lifelong job as an IT consultant has given him glasses since the age of 35, in addition to his colour blindness.

B.6 The foundation president

Type of persona	Name	Age
Customer	Robin Mills	58

Education	Family	Household income
PhD in Business Administration	Descendent of an art dealer with old wealth	315.000/year (110.000 his husband income, 90.000 inherited real estate)

Competencies	Experience	Attention level
Domain: High Linguistic: Excellent	Beginner	Very involving activities

Photo by **Karlyukav** from **Freepik**

Goals	System objectives	Type of usage
End goals: Differentiate the projects funded by the foundation, following new trends and innovations. Experience and life goals: Sign the history of the family foundation with a visionary approach, being a pillar of cultural innovation.	Interested in data which helps her assess projects.	None, just look at some reports and presented system features.

Behaviour	Attitude	Physical fitness
Constantly involved in the assessment of projects, she is used to time-management and critical thinking, trying to find a balance between cultural dissemination and current trends.	Focus, forward-looking and open-minded.	Healthy and fit, she has not any issue in computer interaction.

B.7 The director

Photo by **Shurkin Son** from **Freepik**

Type of persona	Name	Age
Customer	Ella Martin	57

Education	Family	Household income
PhD in Visual Arts, multiple Masters in business and economics	Husband, two teenage sons	180.000/yr (80.000 husband income, 10.000 real estate income)

Competencies	Experience	Attention level
Domain: Excellent Linguistic: Excellent	Expert	Very involving activities

Goals	System objectives	Type of usage
End goals: She wants to upgrade the position of the museum, improving the educational offer and underestimated collections. Experience and life goals: Being a reference for her peers and setting new best practices in CH management	She knows and uses the system only for understanding its logic and being able to describe its output to others.	Looking up information.

Behaviour	Attitude	Physical fitness
She strenuously operates for funding new initiatives and produces documents and reports in order to win bids and financing.	She is a persevering and solid professional used to hard work and dedication. Her social position is crucial.	Very fit, she cares about her appearance. She is healthy, with some insomnia problems. Good reaction time.

C Scenarios

New Context
The museum obtained funding for creating digital exhibitions about undigitized collections, presenting a project about post-war reconstruction photographs. The collection manager, Penelope Parker, assigns to Daniel, the registrar, and her colleagues the digitalization of the material and its basic description. Through the years several buildings changed their intended use, while several photographs have dubious authorship. Consequently, Parker plans to conduct deep research and retrieves information about photographers' biography, portrayed buildings and building sites. After the digitalization and scan of the items, the museum employees insert all the basic information regarding artefacts, looking at the available inventory data and documents. Once the system is filled with all the items, scan and digital reproductions, the team creates, when possible and relevant, also dedicated items for photographers, portrayed people and places. When the work is done, Parker reviews the collection on the Omeka repository: all the information is correctly inserted, but in her research, she found an interesting point of view on the authorship of a series of items and on the history of two buildings which changed function. She retrieves the uncompleted items and starts to edit. Firstly, she assigns the correct level of reliability to the author entry data. Then, she inserts the new authorial details, with the respective source. Finally, Penelope includes temporal information to the first usage aim of the selected buildings and then adds the new one. Now the items' description is complete and exhaustive, the project can move on the construction of the exhibition itself.

Fast Insertion
The new collection created by Penelope Parker is almost finished and a few items are left. The remaining information to be inserted is given to Daniel, the registrar. Daniel is already quite familiar with the system and wants to optimize the process in order to finish the work. Moreover, he cannot be late, because he has to take the child from school on time. After some trials, Daniel rapidly adds all the required sources to the correct statements. Now he can save work and quit the office. Tomorrow he will review his insertions.

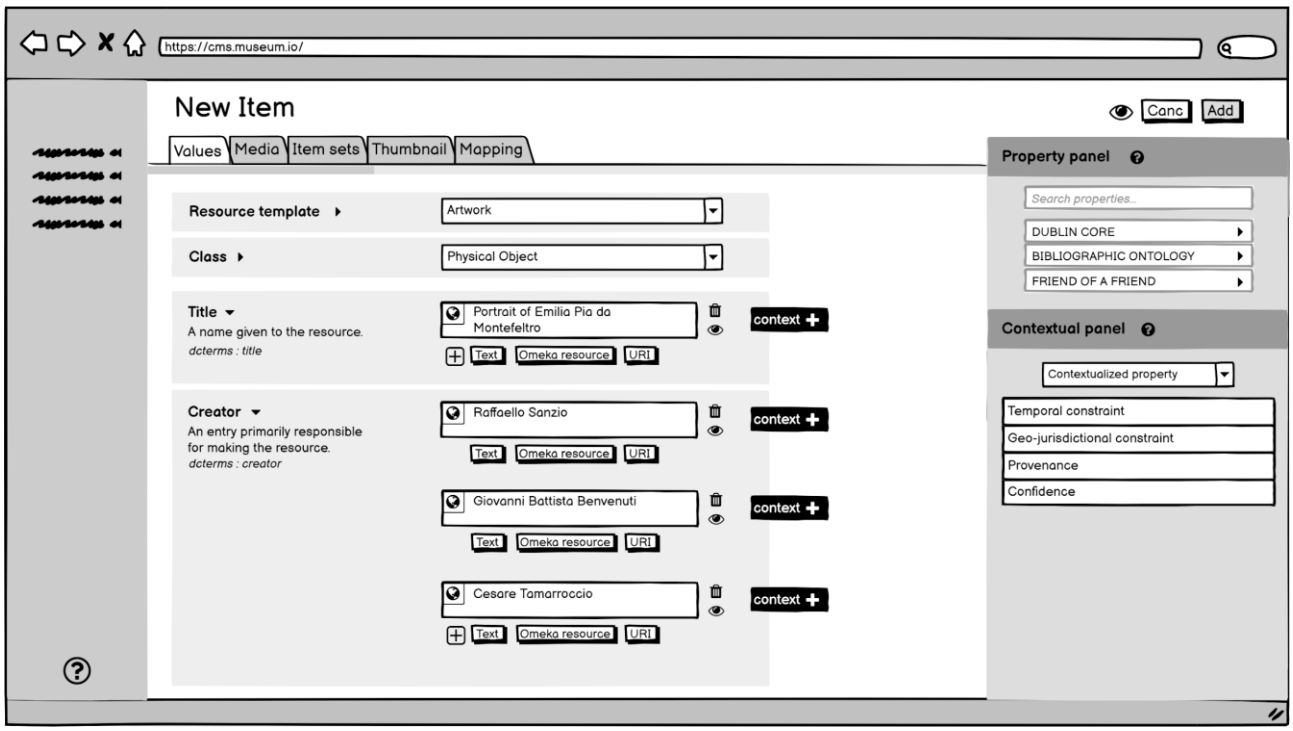
Elimination
Tom Stevens is checking the last uploaded collection. The organization has just received a donation, inheriting a small collection of still nature paintings. The other peers are concluding the information insertion part. To Tom, which is the domain expert of the team, is reserved the enrichment of the contextual information, with source and the specification of time ranges to the paintings' location. Tom has almost finished the work, while he finds out that the contexts of two items have been inverted. He immediately corrects the error, eliminating the wrong information and eventually adding the correct one.

Look up
Adam Marquez is drafting his paper on Postcolonialism in India. He found an interesting digital exhibition about Indian English literature and he wants to retrieve more information about sources and references. Thanks to the certainty scale and the provenance context, the exhibition enables Adam to find conflictual professional points of view and enrich his paper with additional insights. Moreover, the confidence signal,

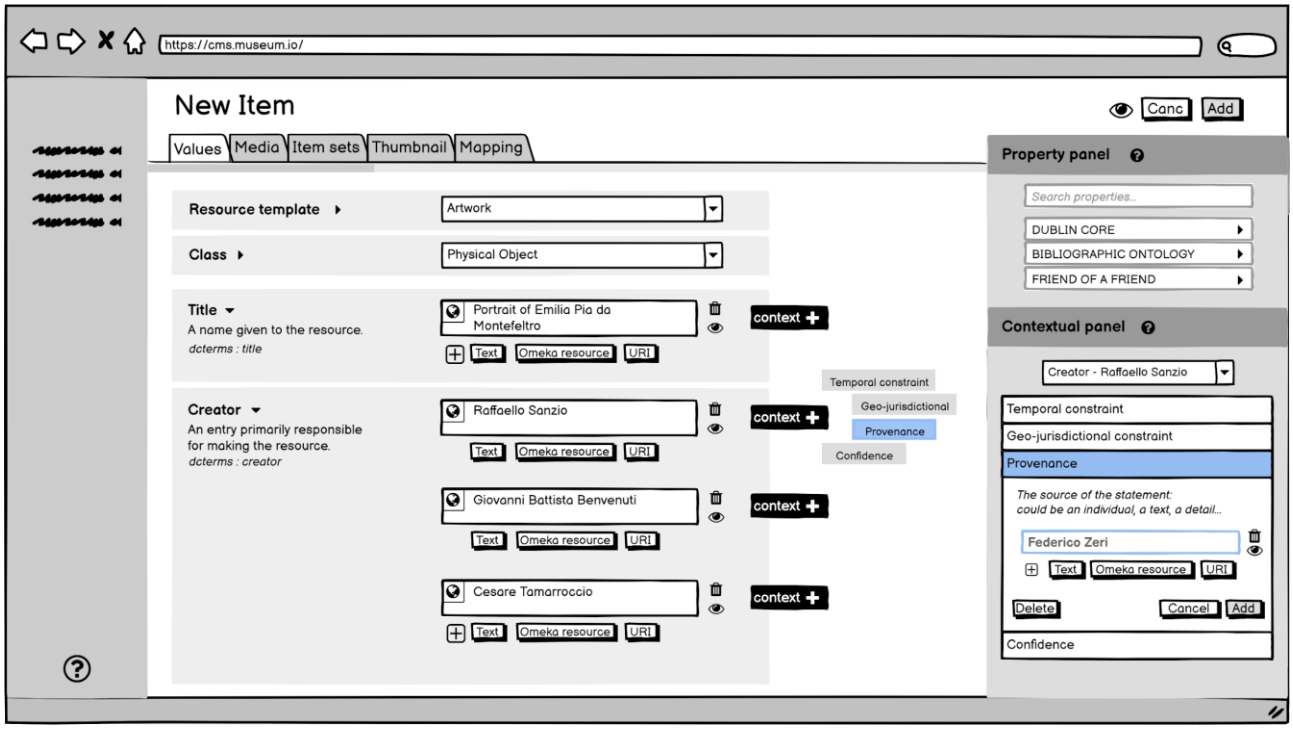
inserted beside information, suggests him to eventually deepen the research on some specific aspects. Adam notes all the information and embeds the more interesting in his paper.

D Design proposals

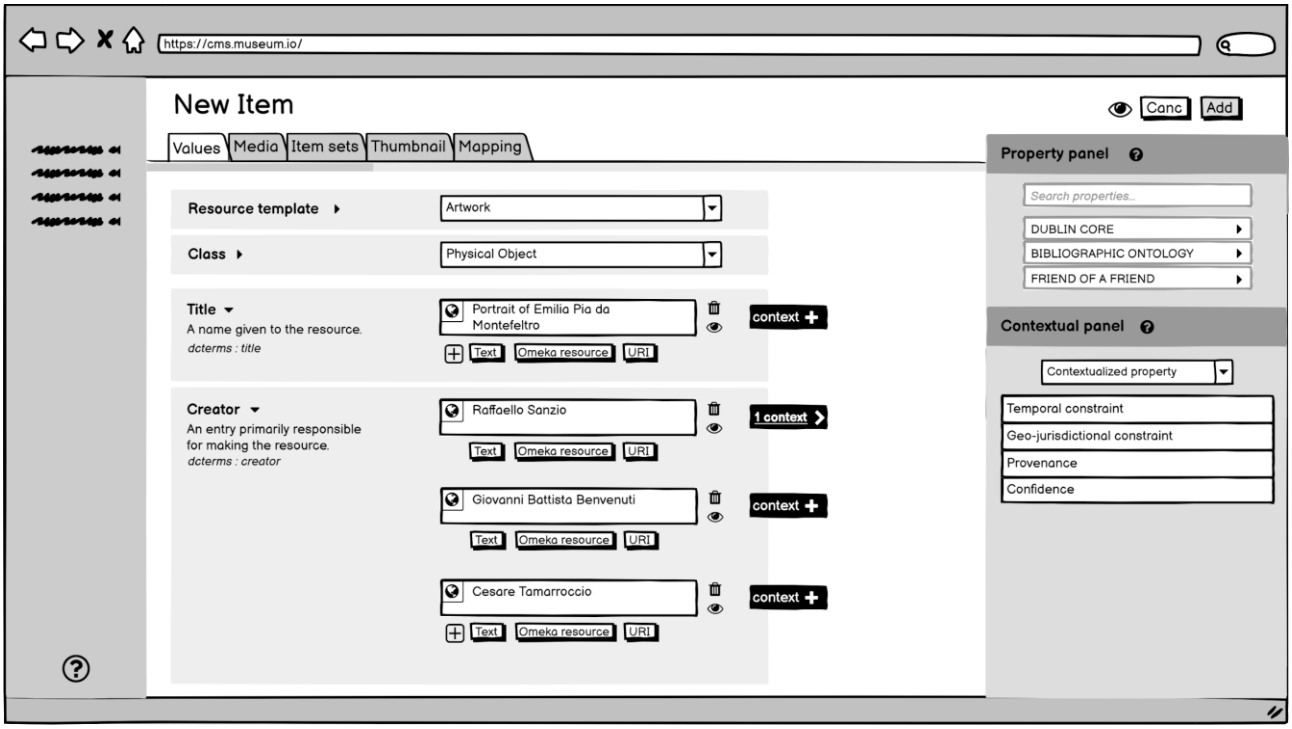
D.1 Collection manager interface



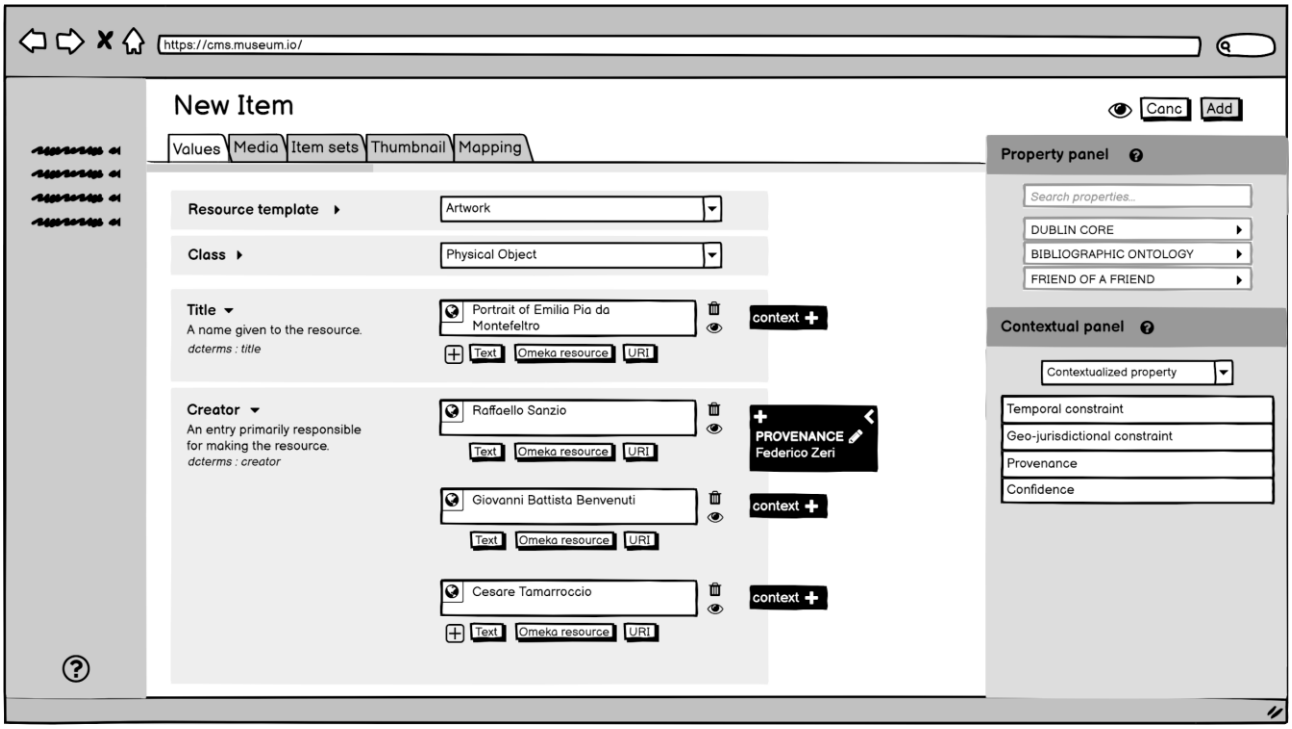
Wireframe 9 - Omeka Context editor interface, context button



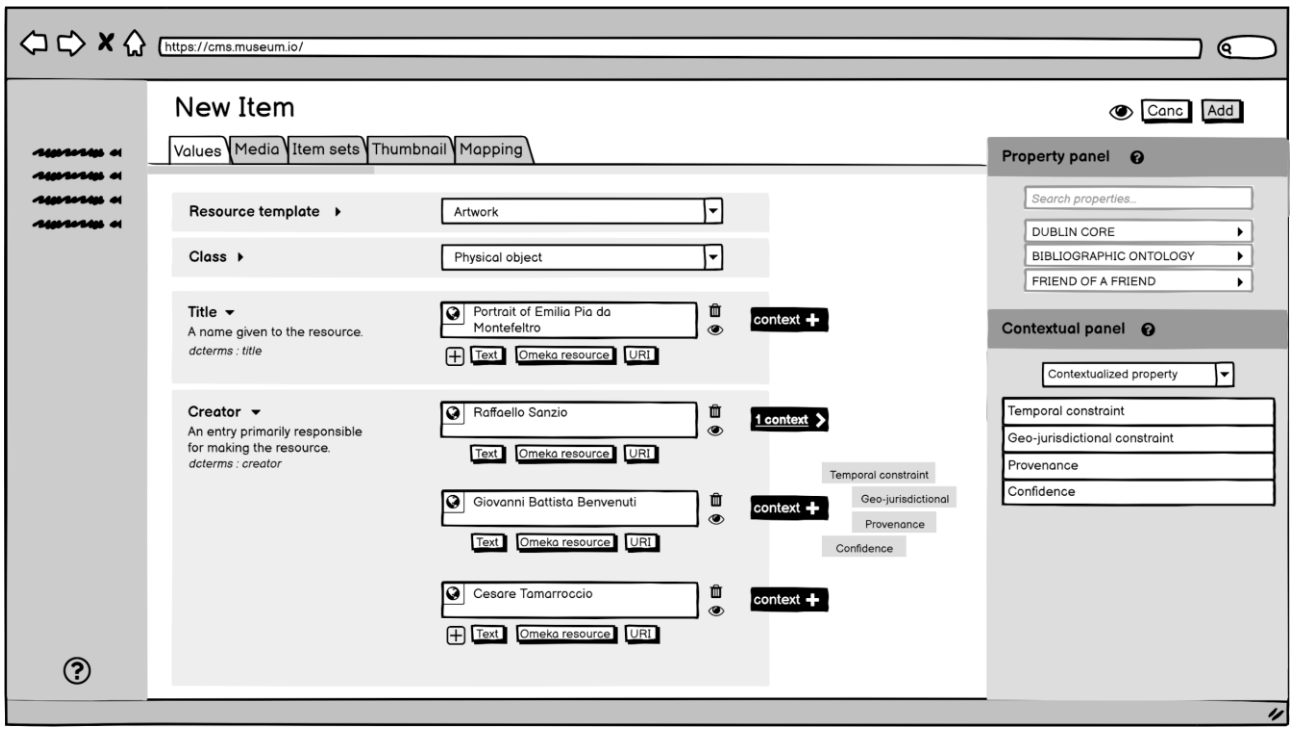
Wireframe 10 - Omeka Context editor interface, provenance filled



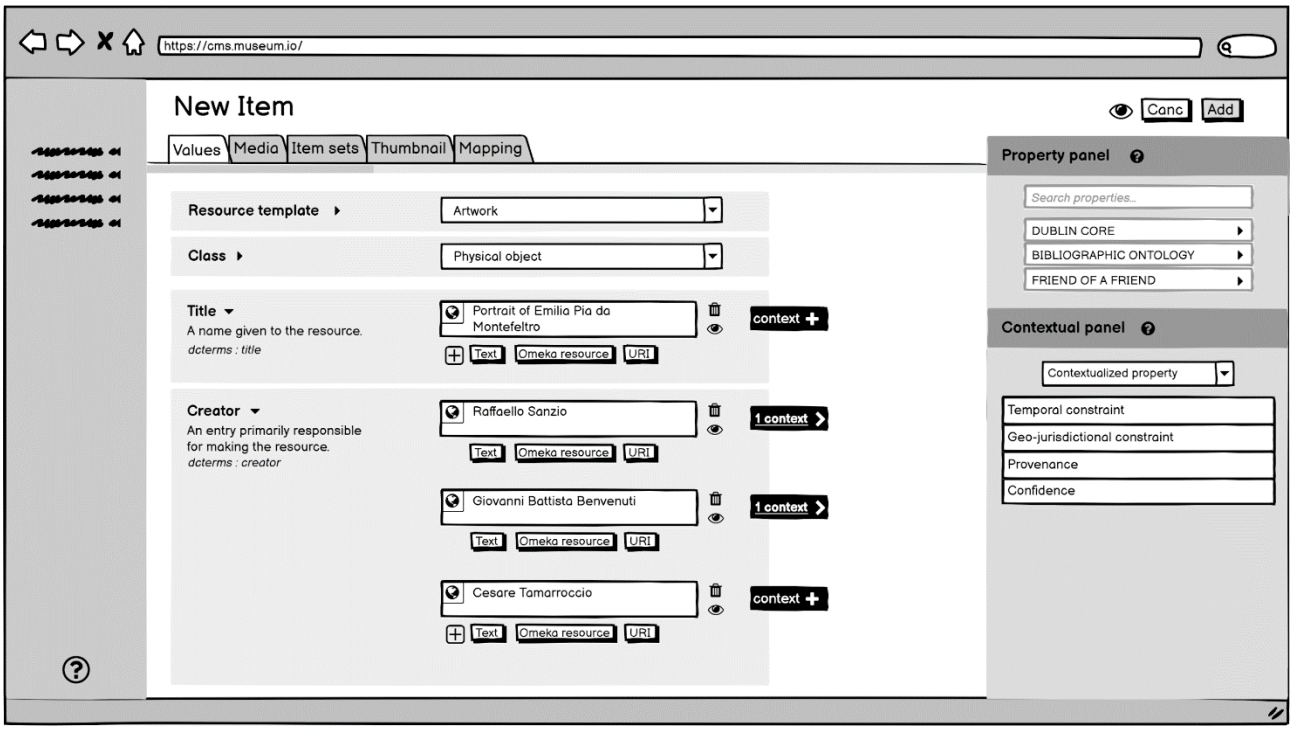
Wireframe 11 - Omeka Context editor interface, context added



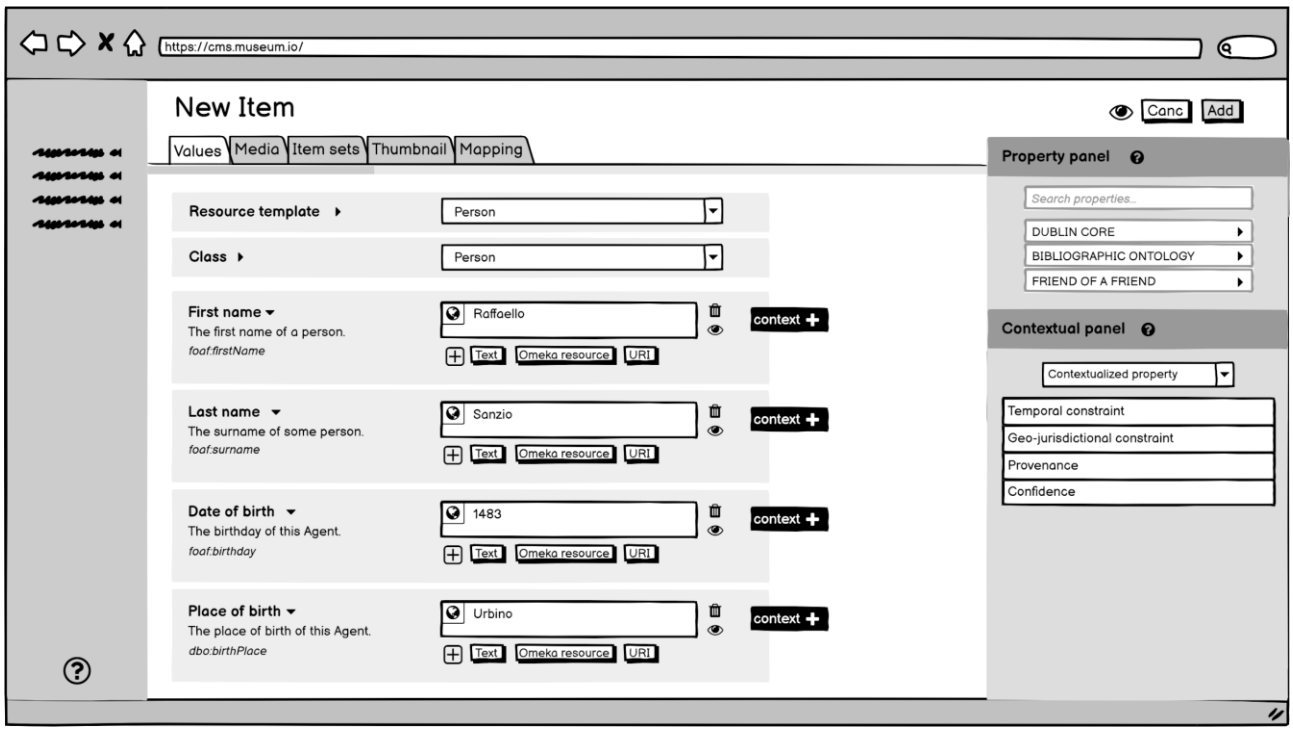
Wireframe 12 - Omeka Context editor interface, provenance context displayed



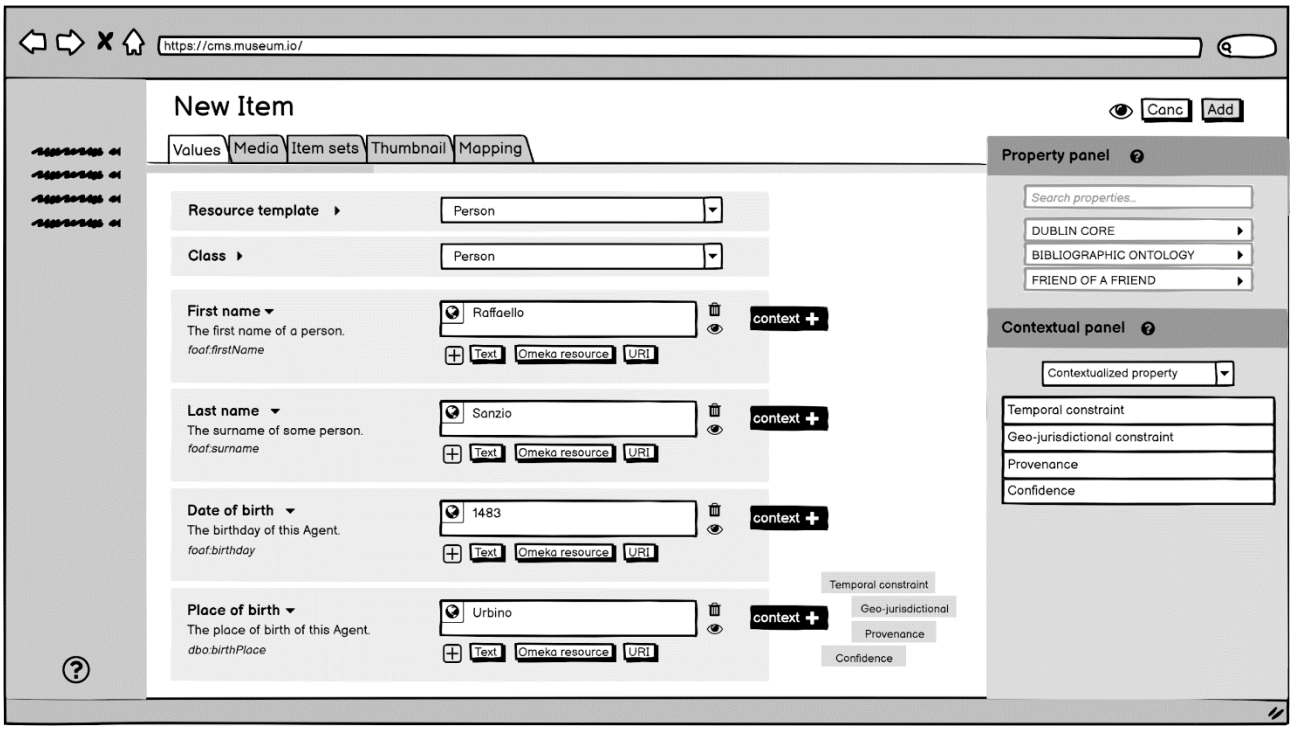
Wireframe 13 - Omeka Context editor interface, context button



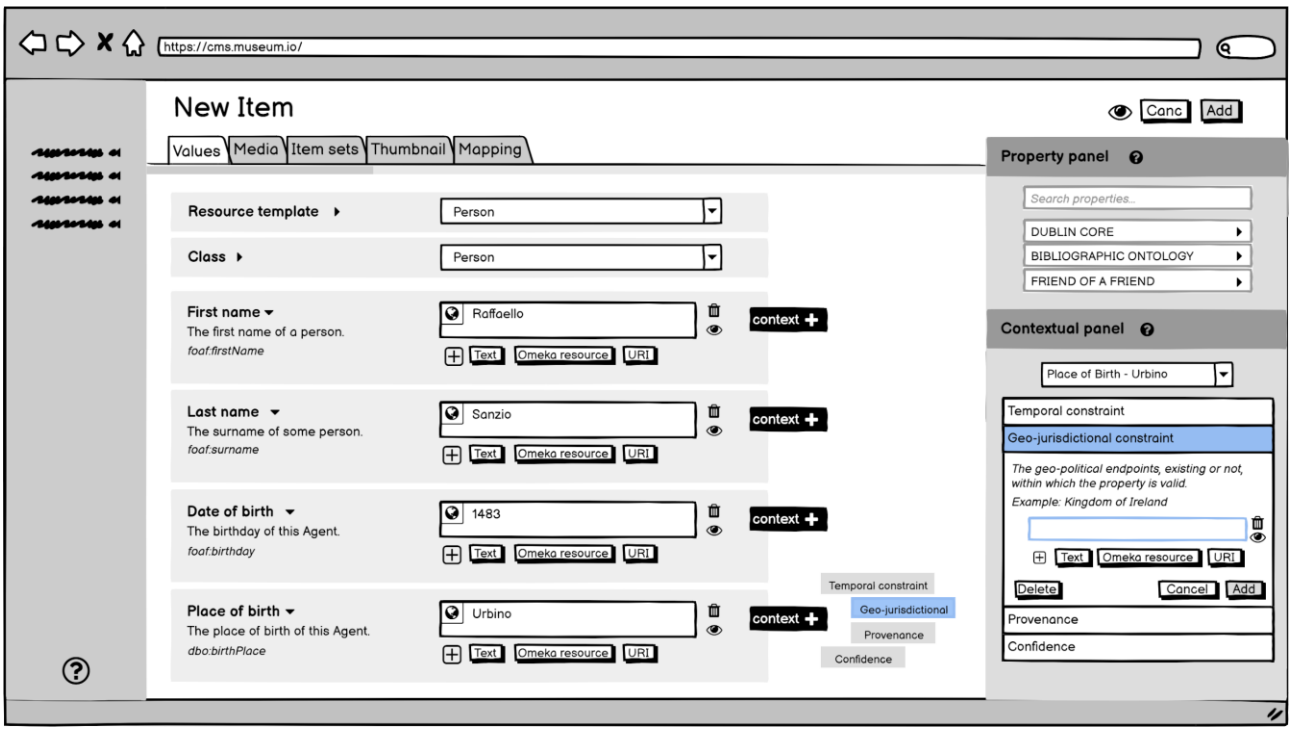
Wireframe 14 - Omeka Context editor interface, confidence closed



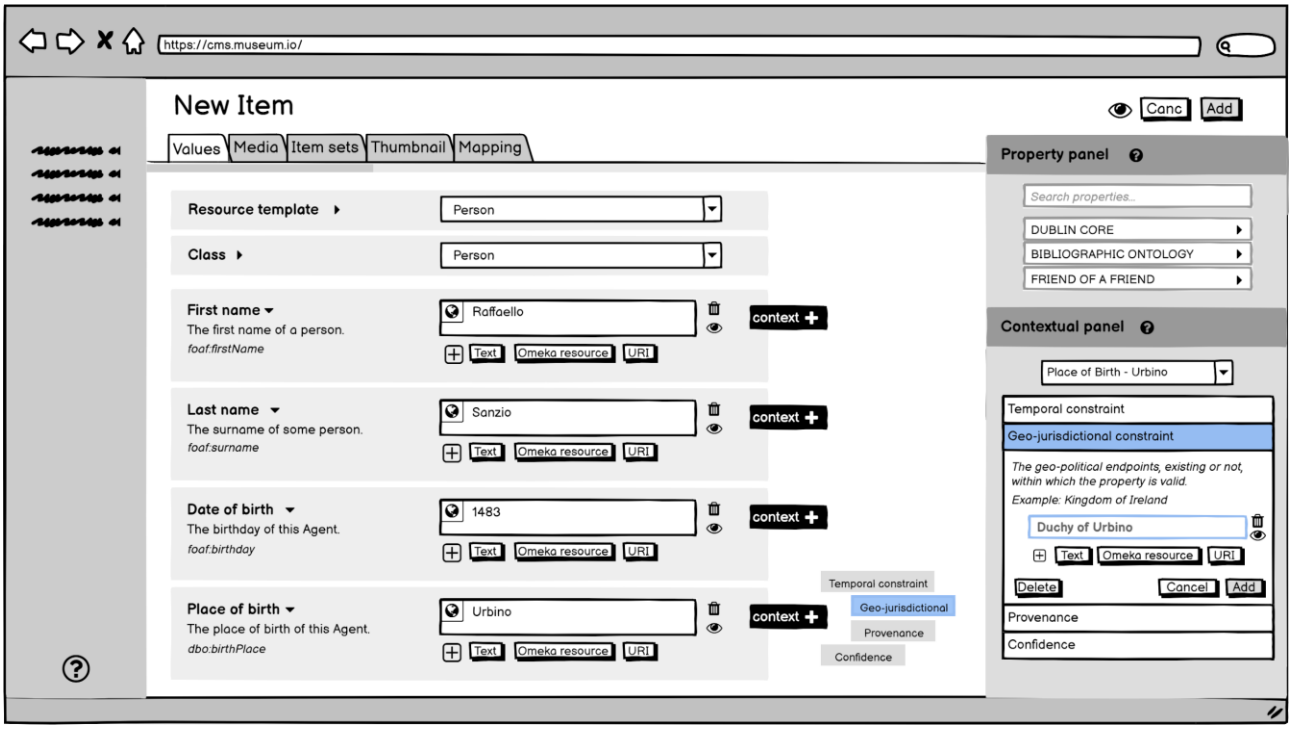
Wireframe 15 - Omeka Context editor interface, Raphael



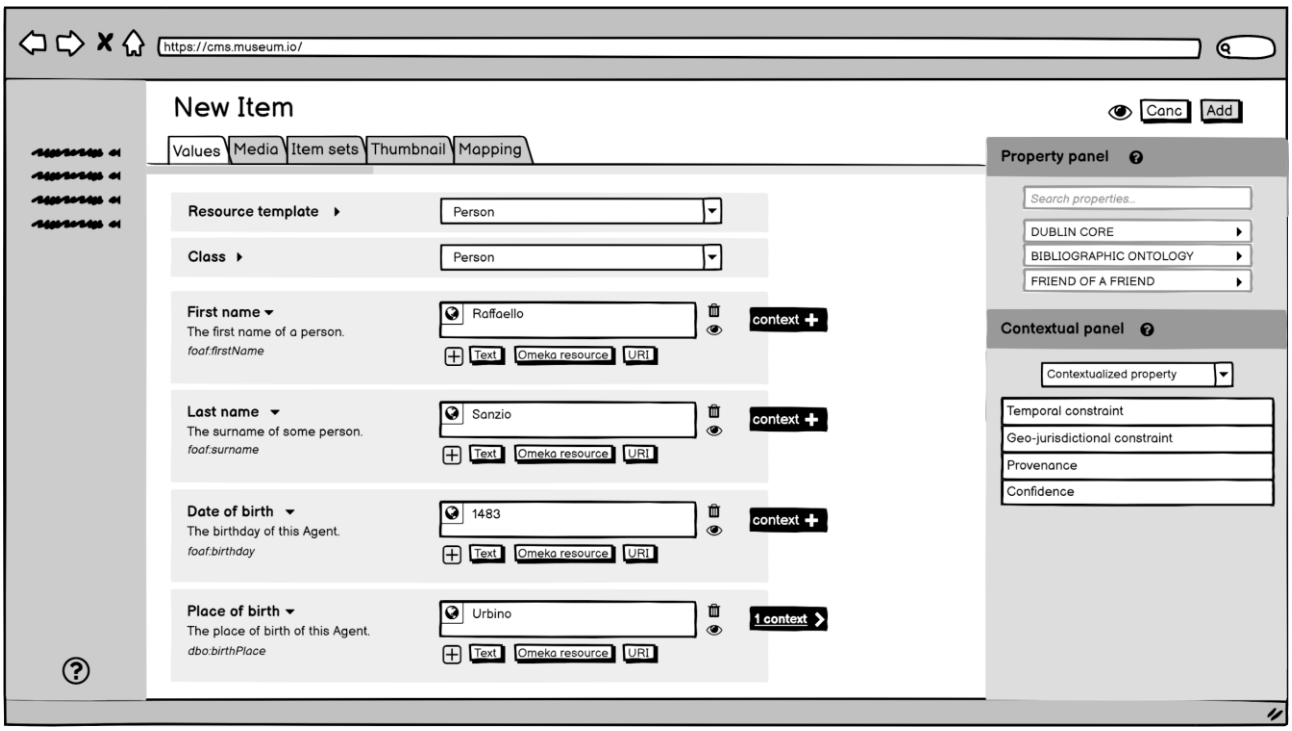
Wireframe 16 - Omeka Context editor interface, Raphael context button



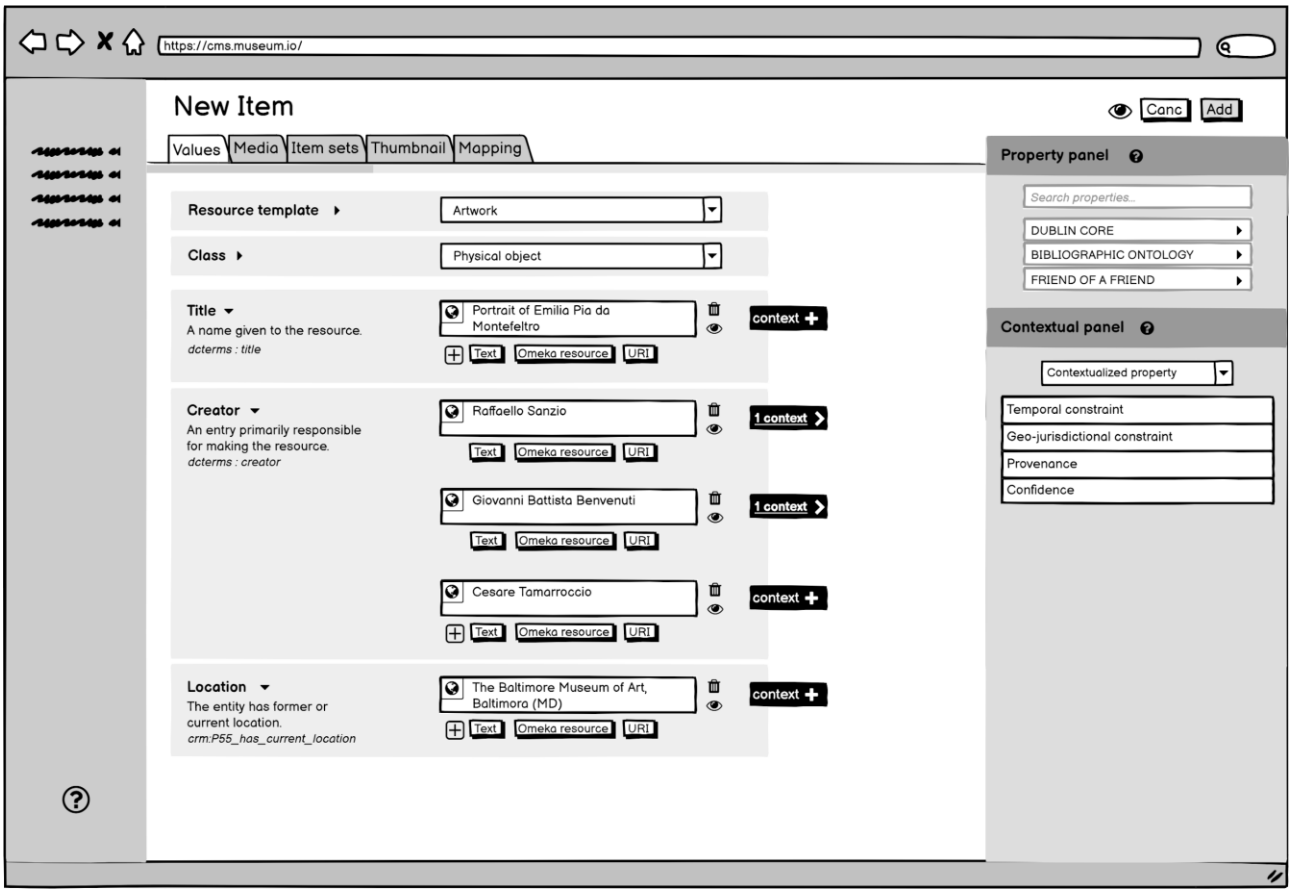
Wireframe 17 - Omeka Context editor interface, geo-jurisdictional



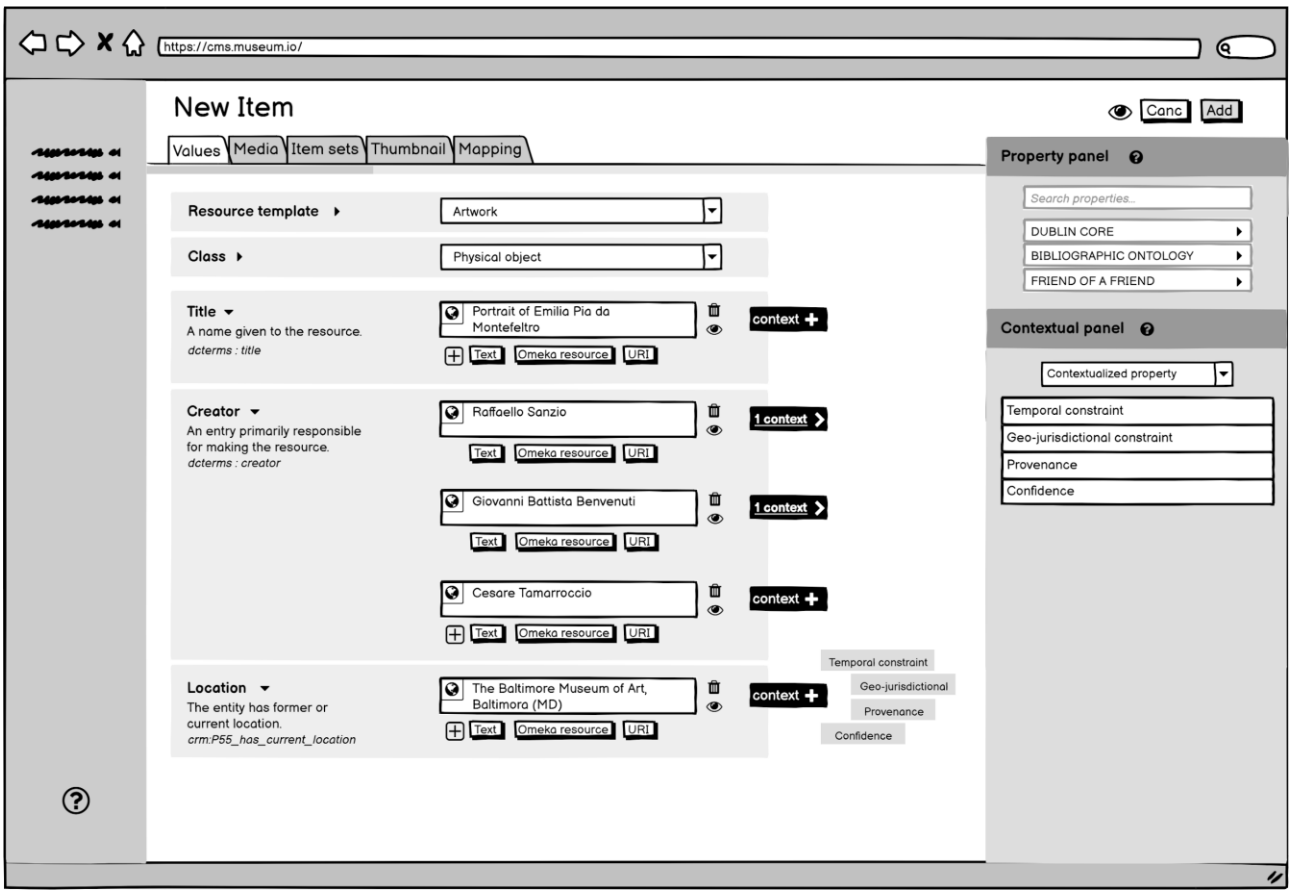
Wireframe 18 - Omeka Context editor interface, geo-jurisdictional filled



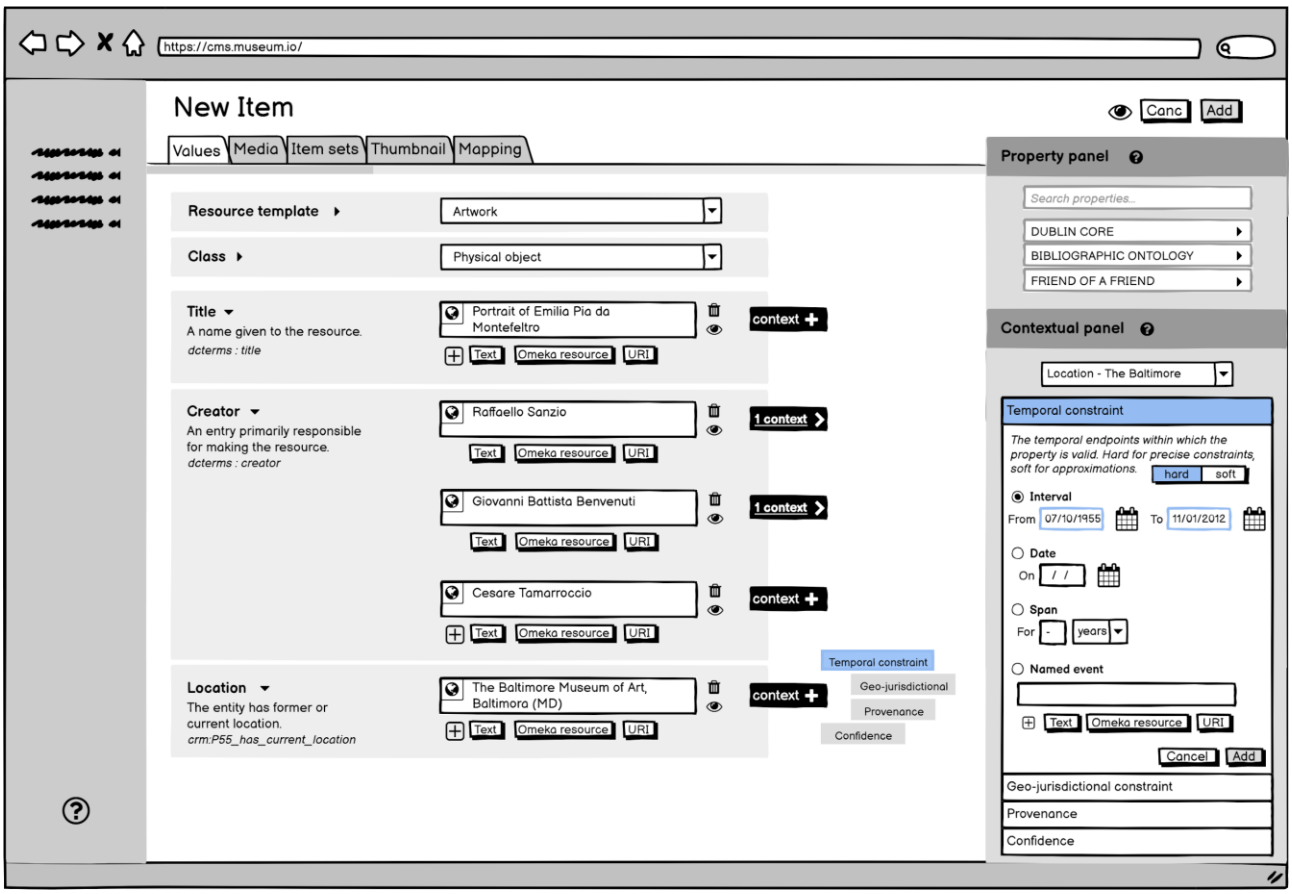
Wireframe 19 - Omeka Context editor interface, context closed



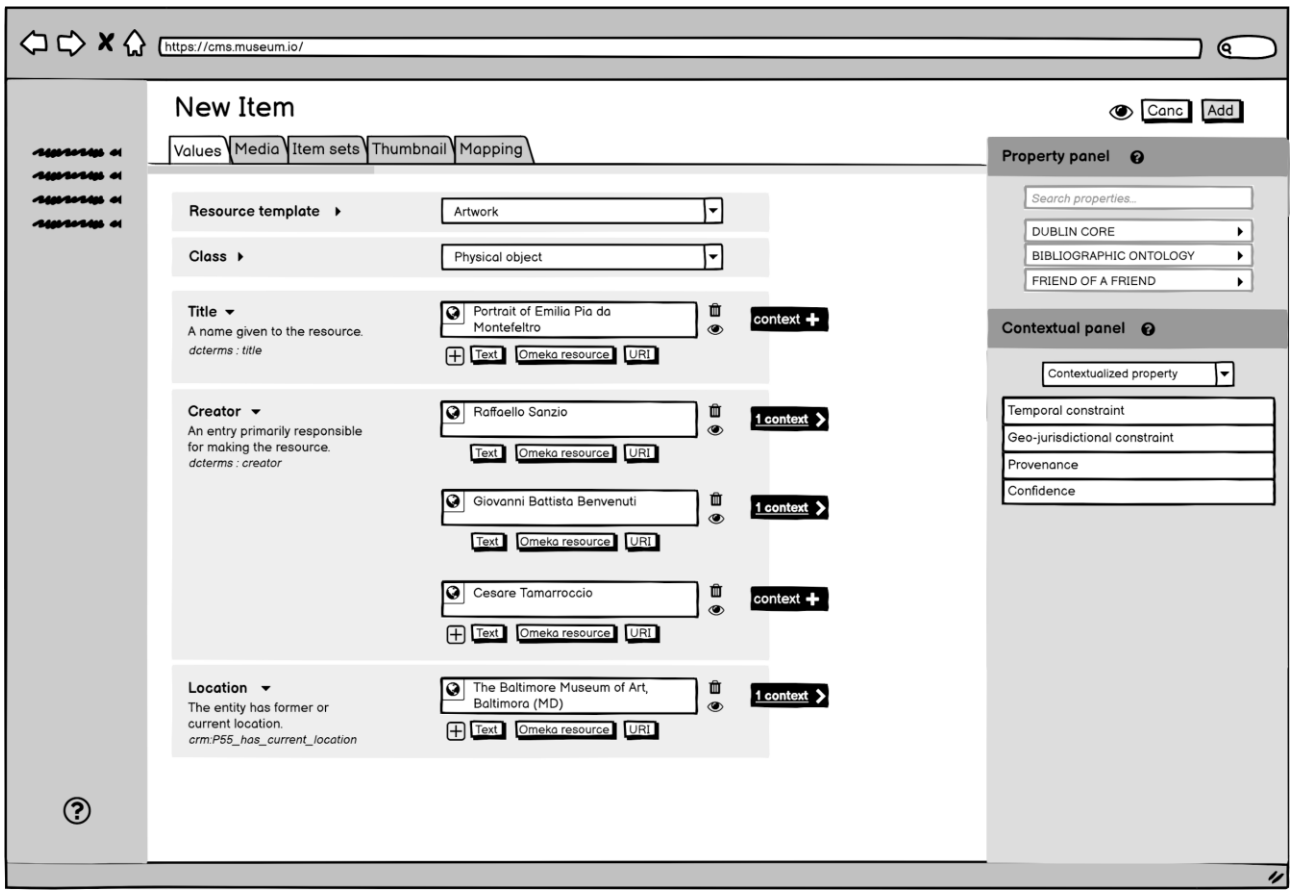
Wireframe 20 - Omeka Context editor interface, location



Wireframe 21 - Omeka Context editor interface, contextual menu

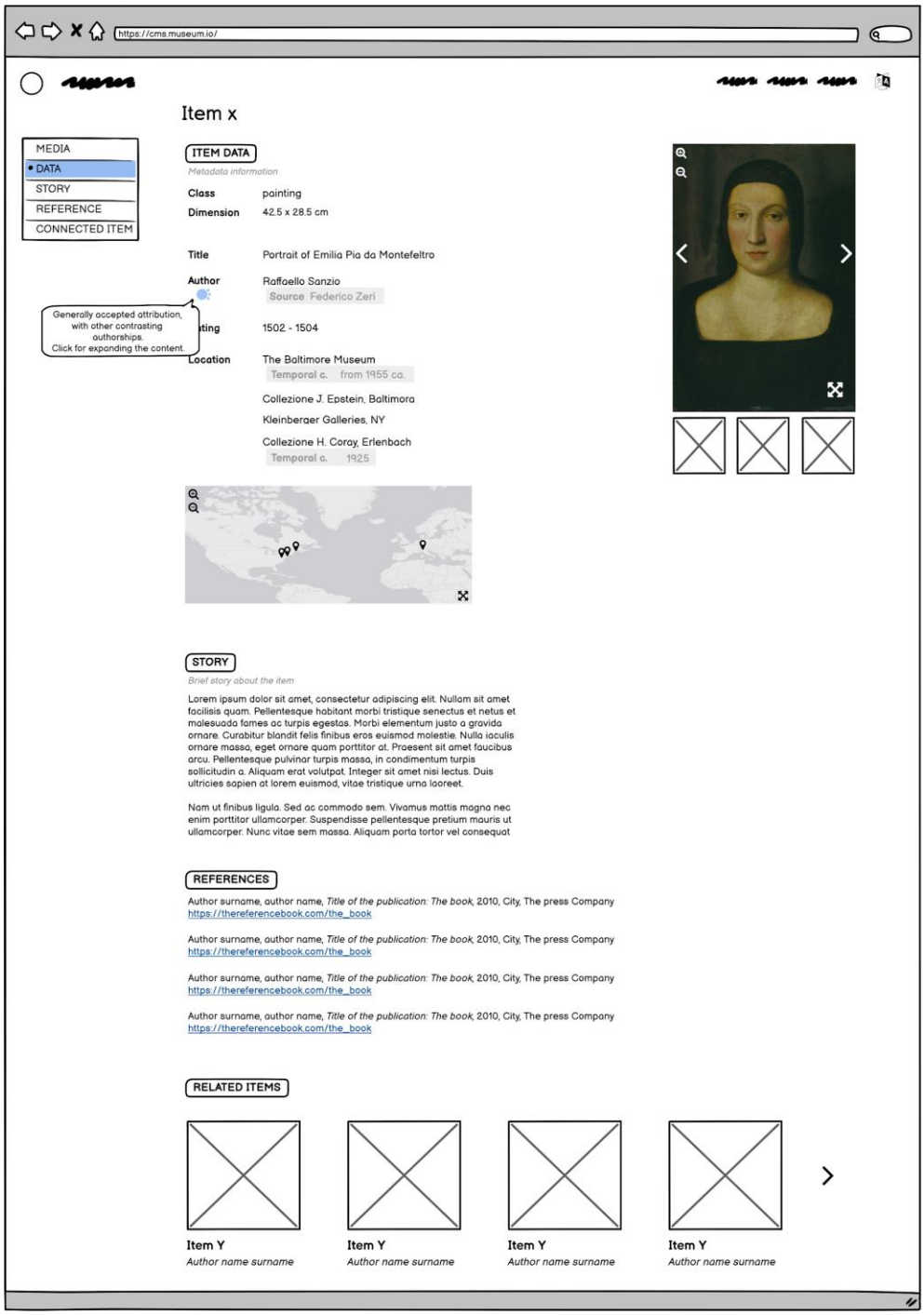


Wireframe 22 - Omeka Context editor interface, temporal value inserted



Wireframe 23 - Omeka Context editor interface, temporal context closed

D.2 Visitor interface



Wireframe 24 - Visitor interface, accepted value with hidden alternatives

E Inspection

E.1 Heuristic analysis

Legend Complies with guideline: + 1 Does sort of comply: 0 Does not comply: -1 Guideline not relevant: -	**Employee interface**		**Visitor interface**	
	Omeka S	Context plug-in	Omeka S	Context plug-in
Task Orientation	78.57%	85.71%	90.00%	90.00%
The site is free from irrelevant, unnecessary and distracting information	1	1	-	-
Information is presented in a simple, natural and logical order	-	-	-	-
The number of screens required per task has been minimised	1	1	1	1
The site requires minimal scrolling and clicking	0	0	0	0
The task sequence parallels the user's work processes	0	0	1	1
The site makes the user's work easier and quicker than without the system	1	1	1	1
The path for any given task is a reasonable length (2-5 clicks)	1	1	1	1
When there are multiple steps in a task, the site displays all the steps that need to be completed and provides feedback on the user's current position in the workflow	0	1	-	-
Forms & Data Entry	50.00%	87.50%	-	-
Field labels on forms clearly explain what entries are desired	1	1	-	-
Pull-down menus, radio buttons and check boxes are used in preference to text entry fields on forms (i.e. text entry fields are not overused)	-1	0	-	-
With data entry screens, the cursor is placed where the input is needed	0	1	-	-
Data formats are clearly indicated for input (e.g. dates) and output (e.g. units of values).	0	1	-	-
Trust and Credibility	-	-	75.00%	100.00%
The content is up-to-date, authoritative and trustworthy	-	-	1	1
The site contains third-party support (e.g. citations, testimonials) to verify the accuracy of information.	-	-	0	1
Writing & Content Quality	-	-	80.00%	90.00%
The site has compelling and unique content	-	-	1	1
Pages use bulleted and numbered lists in preference to narrative text	-	-	1	1
Lists are prefaced with a concise introduction (e.g. a word or phrase), helping users appreciate how the items are related to one another	-	-	0	1
Headings and sub-headings are short, straightforward and descriptive	-	-	0	0
Numbered lists start at "1" not at "0"	-	-	1	1

Page Layout & Visual Design	87.50%	95.83%	85.00%	100.00%
The screen density is appropriate for the target users and their tasks	1	1	1	1
The site can be used without scrolling horizontally	1	1	1	1
Things that are clickable (like buttons) are obviously pressable	1	1	1	1
The relationship between controls and their actions is obvious	1	1	-	-
Each page on the site shares a consistent layout	1	1	1	1
GUI components (like radio buttons and check boxes) are used appropriately	-1	1	-	-
Colour is used to structure and group items on the page	0	0	0	1
Emboldening is used to emphasise important topic categories	1	1	1	1
Pages have been designed to an underlying grid, with items and widgets aligned both horizontally and vertically	1	1	0	1
Meaningful labels, effective background colours and appropriate use of borders and white space help users identify a set of items as a discrete functional block	1	1	0	1
The colours work well together and complicated backgrounds are avoided	1	1	1	1
Individual pages are free of clutter and irrelevant information	1	1	1	1
Help, Feedback and Error Tolerance	60.00%	100.00%	75.00%	100.00%
The site provides good feedback (e.g. progress indicators or messages) when needed (e.g. during checkout)	-1	1	-	-
Where tooltips are used, they provide useful additional help and do not simply duplicate text in the icon, link or field label	0	1	0	1
There is sufficient space between targets to prevent the user from hitting multiple or incorrect targets	1	1	1	1
The site uses appropriate selection methods (e.g. pull-down menus) as an alternative to typing	0	1	-	-
It is easy to “undo” (or “cancel”) and “redo” actions	1	1	-	-
	75.86%	94.83%	84.62%	98.08%

Table 4 - Inspection results

E.2 Cognitive walkthrough

Collection manager–Inserting temporal context

The involved user	**The used interface**
Penelope is a savvy-tech person, used to work with different devices. Her domain competencies are high and her attention level fits her daily work, thanks to her commitment. Healthy and reactive, she intends to create an exhibition, starting from the fulfilment of the database.	Wireframe 9, Wireframe 1, Wireframe 3, Wireframe10

Task description	**Sequence**
Inserting contextual data is the task to enrich existent entries with contextual information.	1. Click on the context button 2. Select the intended context 3. Fulfill the correct information inside the contextual panel 4. Confirm the insertion

Cognitive walkthrough results	
Step 1 - Click the context button 1: Yes, she is attracted by the context button, which pops up from other fields and explicates its function with the label "context". 2: Yes, the button is clearly visible thanks to its colour, which contrasts with the others. 3: She has to know it in advance, but thanks to the button's characteristics, she is encouraged to choose the right button. 4: Yes, pressing the button means opening a menu, thus the feedback is provided by the appearance of the menu.	*Step 2 - Select the intended context* 1: Yes, the provided menu relies on well-established UX procedures, such as the behaviour of a menu. 2: The menu items are represented with a written label, thus the user could need to know in advance what they mean. 3: Yes, the items are well distinguishable due to their label. 4: Yes, as the user presses one item, it changes colour prompting immediate feedback.
Step 3 - Fulfill the information inside the panel 1: Yes, it is provided with a brief description which orients the user, deploying the most appropriate data entry format and prompt. 2: The change of focus (from the central main section to the right contextual panel) could be the	*Step 4 - Confirm the insertion* 1: Yes, the button "Add" is self-explanatory. 2: Yes, the button is positioned at the end of the panel, suggesting the sequential path of the user's actions.

most problematic change of focus, but the opening of the contextual panel is highlighted by attracting colours. 3: Yes, text inputs, radio buttons or date formats are simply usable. 4: Yes, the input shows immediately.	3: Yes, the button is very simple and clearly expresses its function. 4. Yes, the button reacts to the pressing and then the context inserted is visible next to the contextualized property.

Visitor–Looking up information

The involved user	**The used interface**
Liam is a multi-device user, who usually uses a tablet for gathering information. His competencies are really good and his attention level is used to manage different stimuli. Colour blinded, but still quite confident with interfaces, he is looking up for unusual information for his podcast episode.	Wireframe 6, Wireframe 24, Wireframe 7, Wireframe 8

Task description	**Sequence**
Looking up information is the task dedicated to the exploration of the resource. The visitor is enabled to gather new information about a specific exhibition and item.	1. Select the interesting item 2. Observe its information 3. Select another item

Cognitive walkthrough results	
Step 1 - Select the interested item 1: Yes, Liam will understand it realistically. 2: Yes, the item card is an easy-to-use component. 3: Yes, there is no need for disambiguation. 4: Yes, pressing the card means opening the single item.	*Step 2 - Observe its information* 1: Yes, he will do it easily. 2: The page is scrollable and the sections are remarked with evident titles. The information is organized for facilitating the gathering of information and colours are paired with symbols, improving accessibility. 3: Yes, the page is navigable thanks to scrolling and the side menu. 4: Yes, information is replaced instantly.
Step 3 - Select another item 1: Yes, Liam is encouraged by the dedicated section.	

2: Yes, related items are shown with cards at the end of the page. 3: Yes, the control is consistently shown. 4: Yes, the browser window immediately loads the new page.	

F User testing

This section contains the Usability Testing protocol with the following: information about participants, scenarios, SUS questionnaire and responses, visitor interface Q&A.

F.1 Collection managers

Participant 1 – P1

Age	46-55
Education	Master in Online Communication
Digital competence (out of 5)	4
CMS competence (out of 5)	1

Participant 2 – P2

Age	36-45
Education	Degree in Informatics
Digital competence (out of 5)	5
CMS competence (out of 5)	2

Participant 3 – P3

Age	36-45
Education	PhD Computer Science
Digital competence (out of 5)	5
CMS competence (out of 5)	3

Participant 4 – P4

Age	46-55
Education	Master in Information and Communications Technologies
Digital competence (out of 5)	5
CMS competence (out of 5)	1

Participant 5 – P5

Age	26-35
Education	Master in Computer Science
Digital competence (out of 5)	5
CMS competence (out of 5)	4

Participant 6 – P6

Age	46-55
Education	PhD in Cultural Heritage

Digital competence (out of 5)	5
CMS competence (out of 5)	5

Participant 7 – P7

Age	26-35
Education	Master in Digital Humanities
Digital competence (out of 5)	5
CMS competence (out of 5)	5

Participant 8 – P8

Age	36-45
Education	Degree in Communication Sciences
Digital competence (out of 5)	5
CMS competence (out of 5)	2

Participant 9 – P9

Age	20-25
Education	Degree in Computer Science
Digital competence (out of 5)	5
CMS competence (out of 5)	1

Scenarios

1. Provenance	You are entering information about the author of a painting "Portrait of Emilia Pia da Montefeltro". Whoever indicated Raffaello Sanzio as the author, this is technically called the provenance. This work is historically attributed to different people, each with a different plausibility, given by different people. So we know that some say it is Raphael, others Giovanni Battista Benvenuti etc. You must enter the origin of the attribution to Raphael.
2. Confidence	You are integrating the attribution of the same portrait. The authorship of Raphael is generally accepted by critics since the early 1900s, but there are still differences in this regard. For this reason it indicates the average level of reliability for the attribution of Giovanni Battista Benvenuti.
3. Geo-jurisdictional	You are enriching the description of the artist Raffaello Sanzio and his city of birth. Specifies the geo-political area covered by the city of Urbino.
4. Temporal	You are completing the description of the portrait. One of the locations of the work was the Baltimore Museum of Art. The painting, after several changes of ownership, arrived at the museum in 1955. Indicates the time window in which the painting was kept at the Baltimore Museum of Art.

SUS questionnaire

Q1	I think that I would like to use Omeka S Context frequently.	Rate scale degree from 1 (Strongly disagree) to 5 (Strongly agree)
Q2	I found Omeka S Context unnecessarily complex.	
Q3	I thought Omeka S Context was easy to use.	
Q4	I think that I would need the support of a technical person to be able to use Omeka S Context.	
Q5	I found the various functions in Omeka S Context were well integrated.	
Q6	I thought there was too much inconsistency in Omeka S Context.	
Q7	I would imagine that most people would learn to use Omeka S Context very quickly.	
Q8	I found Omeka S Context very cumbersome (awkward) to use.	
Q9	I felt very confident using Omeka S Context.	
Q10	I needed to learn a lot of things before I could get going with Omeka S Context.	

SUS results

	P1	P2	P3	P4	P5	P6	P7	P8	P9	
Q1	3	3	3	4	5	4	4	2	1	Rate scale degree from 1 (Strongly disagree) to 5 (Strongly agree)
Q2	1	3	1	1	1	1	1	1	1	
Q3	4	4	4	4	5	5	5	4	4	

Q4	2	2	1	2	4	1	1	3	2	
Q5	4	3	3	5	5	4	5	4	4	
Q6	2	3	2	1	1	1	1	1	1	
Q7	4	4	3	5	3	4	3	4	5	
Q8	1	2	1	1	1	1	1	1	2	
Q9	4	3	4	5	5	5	5	4	4	
Q10	1	2	2	1	2	1	2	2	1	
MEAN										**SUS** **81.11** **Learnability** **80.56** **Usability** **81.56**

Table 5 - SUS results

F.2 Visitor interface testing

Participant 10 – P10

Age	26-35
Education	Master in New Media Communication
Digital competence (out of 5)	4
CMS competence (out of 5)	1

Participant 11 – P11

Age	26-35
Education	Master in Italian Studies
Digital competence (out of 5)	3
CMS competence (out of 5)	1

Scenario 1 – Contextual information

You are interested in finding trustworthy information about artworks. In the digital collection of a gallery you find a particular visualization set.

Questions and answers

What do you think about this additional information about the artwork?	
P10	I would say that I find it useful. It helps to build a more comprehensive perception of the artwork and leads to a better understanding of how it connects to the real world.
P11	I think it is useful in the sense that from one side it gives me additional information about the artwork, and from the other it gives me a reference that I can then check by myself.

Scenario 2 – Accepted value with alternatives

You are interested in finding trustworthy information about specific artworks in digital collections. You have to acquire more information regarding the authorship of a specific painting.

Questions and answers

What do you think about the fact that additional, generally non-accepted information are included in a digital collection?	
P10	I think it can help users better contextualize artworks and understand their nuances. It also lets users understand that attributions of artworks are often debated. Tough, it is important to stress the most authoritative source without leading users to confusion.
P11	I think that the most crucial aspect here is to clearly communicate the state of the information, characterizing it as a non-accurate notion. I fear that visitors may get disoriented by contrasting points of view regarding authorship and provenance, and furthermore I feel sceptical about the relevance accreditation process carried out by museums and collection managers; should all be

	treated as authoritative figures? How should contrasting information between collections be resolved?
What about the visualization of ancillary authorships?	
P10	It is not bad but I was not completely sure of the lateral icon's meaning before reading its tooltip. The first encounter with this type of icon required me to reason upon its significance. Anyhow, once I understood the metaphor that it stood for, I was capable of quickly understanding the type of attribution it wanted to communicate. The level of confidence of the sources is clear, I had no problem understanding which sources were more or less relevant.
P11	The devices employed for communicating auxiliary information are overall clear and the colour-coding technique is a fast way to transmit certainty levels. My only doubt regards the choices and considerations that led to the classification of information: which are the criteria for the assignment of a certainty level? A link to an explanatory documentation would be a nice addition to the whole system.

Scenario 3 – No accepted value

You are interested in finding trustworthy information about specific artworks in digital collections. You have to acquire more information regarding the authorship of a specific painting.

Questions and answers

What do you think about the provision of different attributions when there is not a generally accepted value?	
P10	I think that it adds meaning to an otherwise undefined aspect of the artwork. I liked the fact that instead of not showing the author the interface suggested me a collection of possible authors. This type of visualization leaves space for personal researches and it surely enriches the user's experience and knowledge more than a blank space.
P11	I find this information to be enriching in respect to the artwork, though I feel that the absence of a clear attribution is not sufficiently stressed. It is more important to declare the absence of a widely recognized author than to declare the presence of several unrecognized authors. In my opinion this change of perspective should be considered in the design of the platform.

Do you think that online cultural heritage collections could benefit form these proposals? What did you like the most?	
P10	I think that generally cultural heritage collections would benefit from such proposals. In my opinion presenting users with contextual information adds a new dimension to the collections' items: they have now richer characterizations and can stimulate viewers to autonomously investigate on the story and on the controversies surrounding the artworks. I found valuable support in the tooltips that guided me through the interface components and generally I did not

	have any problem in the navigation. I recognize the attribution certainty levels to be the most valuable addition to the interface.
P11	Contextual information surely adds value to artworks and the proposal of different references can be stimulating for a visitor. In the consideration of the whole system, it is worth to notice that clear guidelines for the identification of reliable information and the assignment of certainty levels are required, as is required the common adherence to them from museal institutions.