Multimodal Technologies and Interaction

MDPI

Article

A Web-Based Platform for Traditional Craft Documentation

Nikos Partarakis [1], Voula Doulgeraki [1], Effie Karuzaki [1], George Galanakis [1], Xenophon Zabulis [1,*], Carlo Meghini [2], Valentina Bartalesi [2] and Daniele Metilli [2]

[1] Institute of Computer Science, Foundation for Research and Technology Hellas (ICS-FORTH), N. Plastira 100, Vassilika Vouton, 70013 Heraklion, Greece; partarak@ics.forth.gr (N.P.); vdoulger@ics.forth.gr (V.D.); karuzaki@ics.forth.gr (E.K.); ggalan@ics.forth.gr (G.G.)

[2] Istituto di Scienza e Tecnologie della Informazione (ISTI), Consiglio Nazionale delle Ricerche (CNR), 56127 Pisa, Italy; carlo.meghini@isti.cnr.it (C.M.); valentina.bartalesi@isti.cnr.it (V.B.); daniele.metilli@isti.cnr.it (D.M.)

* Correspondence: zabulis@ics.forth.gr; Tel.: +30-0281-0391696

Abstract: A web-based authoring platform for the representation of traditional crafts is proposed. This platform is rooted in a systematic method for craft representation, the adoption, knowledge, and representation standards of the cultural heritage (CH) domain, and the integration of outcomes from advanced digitization techniques. In this paper, we present the implementation of this method by an online, collaborative documentation platform where digital assets are curated into digitally preservable craft representations. The approach is demonstrated through the representation of three traditional crafts as use cases, and the lessons learned from this endeavor are presented.

Keywords: cultural heritage; traditional craft

Citation: Partarakis, N.; Doulgeraki, V.; Karuzaki, E.; Galanakis, G.; Zabulis, X.; Meghini, C.; Bartalesi, V.; Metilli, D. A Web-Based Platform for Traditional Craft Documentation. *Multimodal Technol. Interact.* **2022**, *6*, 37. https://doi.org/10.3390/mti6050037

Academic Editors: Cristina Portalés Ricart, Ester Alba Pagán, Jorge Sebastián Lozano, Valeria Seidita, Marcos Fernández Marín, Maurizio Vitella, Georgia Lo Cicero and María del Mar Gaitán Salvatella

Received: 24 March 2022
Accepted: 6 May 2022
Published: 10 May 2022

1. Introduction

Traditional crafts (TCs) are of paramount importance for humanity because they serve as connecting links among generations, places, and civilizations through the numerous expressions of traditional craftsmanship worldwide. They are perhaps the only human expression rooted back to the start of human civilization since our ancestors started shaping rocks and wood to create hunting and cutting tools. Today, craft products include clothing and jewelry; costumes and props for festivals and performing arts; storage containers, objects used for storage, transport, and shelter; decorative art and ritual objects; musical instruments and household utensils, and toys, both for amusement and education [1].

Despite their cultural significance, efforts for the representation of traditional crafts are scattered and have received little attention from information and communication technologies. Efforts have mostly focused on the digitization and documentation of tangible heritage manifested through objects and sites of cultural significance. Nevertheless, traditional crafts involve craft artifacts, materials, and tools and encompass craftsmanship as a form of intangible cultural heritage (ICH) [2,3]. ICH dimensions include dexterity, know-how, and skilled use of tools, as well as tradition and identity of the communities in which they are, or were, practiced [4].

In this work, we present an online platform that was developed in the context of the Mingei project. Mingei (http://www.mingei-project.eu/, accessed on 20 March 2022) is an Innovation Action in the Horizon 2020 Programme of the EC that proposes the digital and semantic representation of heritage crafts (HCs) [5] and motivates their preservation by supporting pertinent experiential and educational applications in the domain of cultural and thematic tourism. The Mingei Online platform (MOP) [6] facilitates the representation of the socio-historic context through narratives. The purpose is to: (1) document, represent, and preserve intangible dimensions along with objects and sites, (2) contextualize the presentation of tangible heritage, (3) systematize and facilitate the presentation of socio-historical context, and (4) document traditional crafting processes. MOP provides facilities

for exporting knowledge in various formats to support continuous re-use and sharing of information, including direct open access to documented knowledge. Furthermore, it enhances the documented information by establishing a linkage between MOP and other relevant publicly available knowledge bases such as Europeana [7], Europeana-based repositories [8,9], and repositories based on Arches [10,11].

The remainder of this paper is structured as follows. In Section 2, the related work is presented. In Section 3, the overarching approach to craft documentation and the way that it is implemented by the web-based platform is presented. In Section 4, we present the implementation of the platform. Lessons learned from using the platform that led to its improvement are presented in Section 5. Conclusions and directions for future work are provided in Section 6.

2. Background and Related Work

2.1. Representation of CH

The staggering amount of research in 2D/3D digitization technologies for World Heritage resulted in automatic reconstruction methods, good practices, and democratization of sensors and methods to audiences without technical expertise. Scientific interest advanced in the digital preservation of ICH, mainly through the recording of the kinetic or vocal activity of bearers of CH, such as dancers [12–18] and vocals [14].

In the domain of knowledge representation, Semantic Web technologies and ontologies are today standard tools in CH [19] since the pioneering work of Europeana [20]. In the last decade, event-centric representations have been preferred over object-centric representations [21] because they provide the expressivity to support semantic search, browsing, visualization, and storytelling [22–25]. Event is a basic class in EDM, inherited from the CIDOC-CRM [26].

A long-standing problem for content aggregators, especially in the field of digital libraries, is the ability to organize content beyond the classical topicality according to semantic concepts that improve findability, interpretation, and linking in a significant way and, above all, function as the common thread that binds together heterogeneous contents and contexts [27–29]. Europeana Space [30–32] provided an interface to Europeana [33] for users to create their online collections, add comments and annotations, and share them. Recently, Europeana [34] and Google Arts and Culture [35] have introduced the notion of "stories", which are text with illustrations and video. We take good notice that this is a step in the same direction as this research work, but it does not solve the problem because the involved stories are represented by pure text, without semantic representation.

Using narratives and process schemas, in this work, we link digital assets with their context, leading to the sought enrichment.

2.2. Craft Dimensions

In the literature, CH is often distinguished between tangible and intangible [36–39]. Although crafts are considered intangible heritage, the way that this heritage is manifested is through matter and, in particular, its transformation into articles of craft [40,41]. As noted by UNESCO [1] *"Traditional craftsmanship is perhaps the most tangible manifestation of intangible cultural heritage"*.

In this context, we look at craft dimensions closer to better understand the content we need to represent. In particular, we also follow the tangible/intangible distinction but also look closely at the space and time where these two meet [42].

Tools and equipment, documents, archives, materials, clothing, natural heritage, artifacts, crafts products, machinery, buildings, etc., belong traditionally to the tangible domain. As such, in the proposed approach, we are interested in their digital documentation using text, photographs [43], and 3D digitization [44–46].

In the intangible domain of crafts, we find "meaning" such as Know-how and Skill (processes and actions), Learning process, Economic significance, Social dimension, Religious dimension, and Cultural dimension *in the context of a community*. Intangible heritage is

regarded as an intellectual process that is performed by living humans. We are interested in preserving through documentation, transmitting through narratives, continuation through education and training, and development through thematic tourism [4,47].

In particular, for transmission, we are interested in the context as expressed in terms of space and time and events. An 'Event' is something that occurs in space and time, including actions by individuals, as well as complex activities, by groups of persons or individuals. More formally, an 'Event' is the changes of state in cultural, social, or physical systems [27].

Summarizing craft dimensions, in this research work, we are interested in studying the craft dimensions presented in Table 1.

Table 1. Craft dimensions relevant to this research work.

Craft Dimensions					
Intangible		**Tangible**		**Context (Space and Time)**	
ID_01	Know-how and Skill	TD_01	Tools, equipment, machinery	CD_01	Places
ID_02	Learning process	TD_02	Documents, archives	CD_02	Persons
ID_03	Economic significance	TD_03	Materials	CD_03	Events
ID_04	Social dimension	TD_04	Clothing	CD_04	Objects
ID_05	Religious dimension	TD_05	Natural Heritage		
ID_06	Cultural dimension	TD_06	Artefacts, products		

2.3. Sustainability

We argue that the representation of traditional crafts can enhance the sustainability of craft-related products and services. Cultural tourism refers to travel that enables visitors to visit heritage sites and activities that provide access to the CH of a country or region. The reason a region develops tourism is not anymore solely related to the particularities of the natural environment and built sites is that it is also their cultural identity, tourism infrastructure, and services. Global trends in the valorization of ICH indicate that streamlining the digital representation of ICH assists the growth and is recommended by the United Nations World Tourism Organization (UNWTO) [48]. Educational tools contribute to the preservation and long-term sustainability of the cultural economy [49]. The economic resource due to heritage and re-use of digital assets is a primary motivator and source of funding for the preservation of CH. In accordance, CCIs are positively affected by digital documentation, representation, and presentation [50].

2.4. Proposed Approach

In this paper, a web-based authoring platform for the representation of the numerous dimensions of traditional crafts is presented rooted in a scientific method for craft representation, the adoption and extension of knowledge standards of the CH domain, and the integration of outcomes from advanced computer-aided digitization techniques. The rationale of the proposed approach is that a solid knowledge representation may lead to the formation of attractive, participative, educational, experiential, and tourism products that are expected to motivate the preservation of TCs [47].

3. The Authoring Platform for the Representation of Traditional Crafts

3.1. Overview of the Approach

The authoring platform implements the Mingei protocol [51] for craft representation which can be described as a series of steps as outlined in Figure 1.

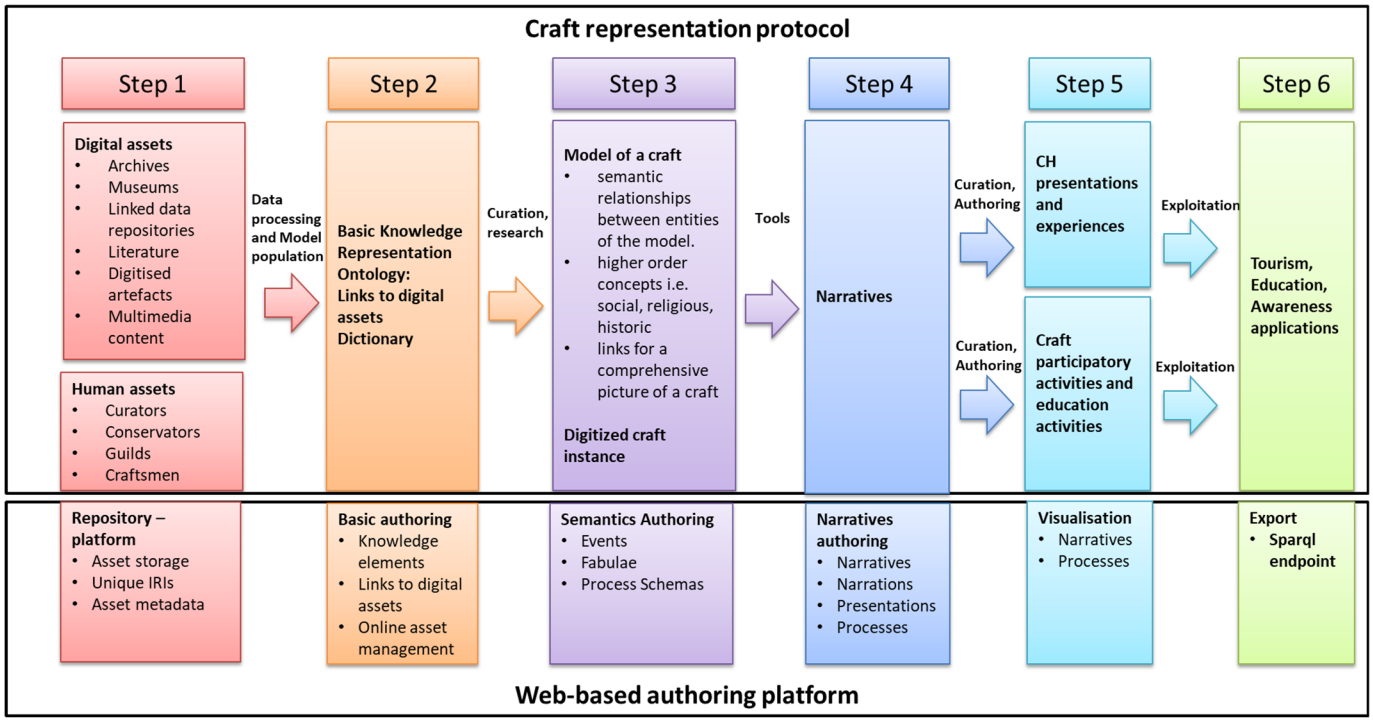


Figure 1. Illustration of protocol steps.

In STEP 1, we wish to acquire documentation in the form of digital assets that are relevant to the representation of a craft. Based on these assets, knowledge about a craft will be formed (STEP 2). This knowledge is to be semantically represented, availing a digitally preservable representation of a craft (STEP 3). This representation will provide the foundation for curating narratives (STEP 4), which are to shape the presented content. This content is to take the forms of informational tools, multimodal presentations, and experiences (STEP 5), which will be used for HC preservation, Tourism, and Education (STEP 6). Figure 1 is divided into two sections. The top section presents the aforementioned steps, while the bottom section presents the provisions offered by this work through the web-based authoring platform. Thus, in each step, the tools provided by the platform for facilitating the curation tasks involved are shown.

The platform is evaluated through three pilot sites in the context of the Mingei project. These include the craft instances of ecclesiastic textile manufacturing in Krefeld, Germany, the cultivation of mastic and the production of mastic products on the Greek island of Chios, and the industrial glassblowing in France.

The rest of this chapter is divided into subsections, each of which presents a step of the protocol, the provision of the authoring platform, and the outcomes of the step execution.

3.2. STEP 1 Understanding and Recording

3.2.1. STEP 1 Overview

Identification of the entities required to comprehend the (a) practice of the craft and (b) the social and historical context of this practice by a community. Recordings of objects and events such as human actions complement the documentation of the craft by capturing craft tools, workshops, machines, products. Audiovisual and motion recordings provide documentation for craft actions and processes.

3.2.2. Depositing Assets

The documentation and recordings from this step are stored in a flexible, modular, open-source repository platform [52]. By using the repository, a policy is applied to

International Resource Identifiers (IRIs) linked with the platform. A new IRI from the Mingei namespace is minted for every resource in the repository.

This IRI will have the form http://www.mingei-project.eu/resource/N (accessed on 20 March 2022) where http://www.mingei-project.eu/identifies (accessed on 20 March 2022) the Mingei namespace, and N is a unique progressive number, identifying this resource in the namespace. In this way, each resource is assigned a unique number N, regardless of the class where the resource belongs, which gives rise to a unique IRI.

3.2.3. STEP 1 Outcomes

The outcomes of this step are a collection of assets uniquely identified in the Mingei namespace that can be linked with semantic sources.

3.3. STEP 2 Knowledge Elements

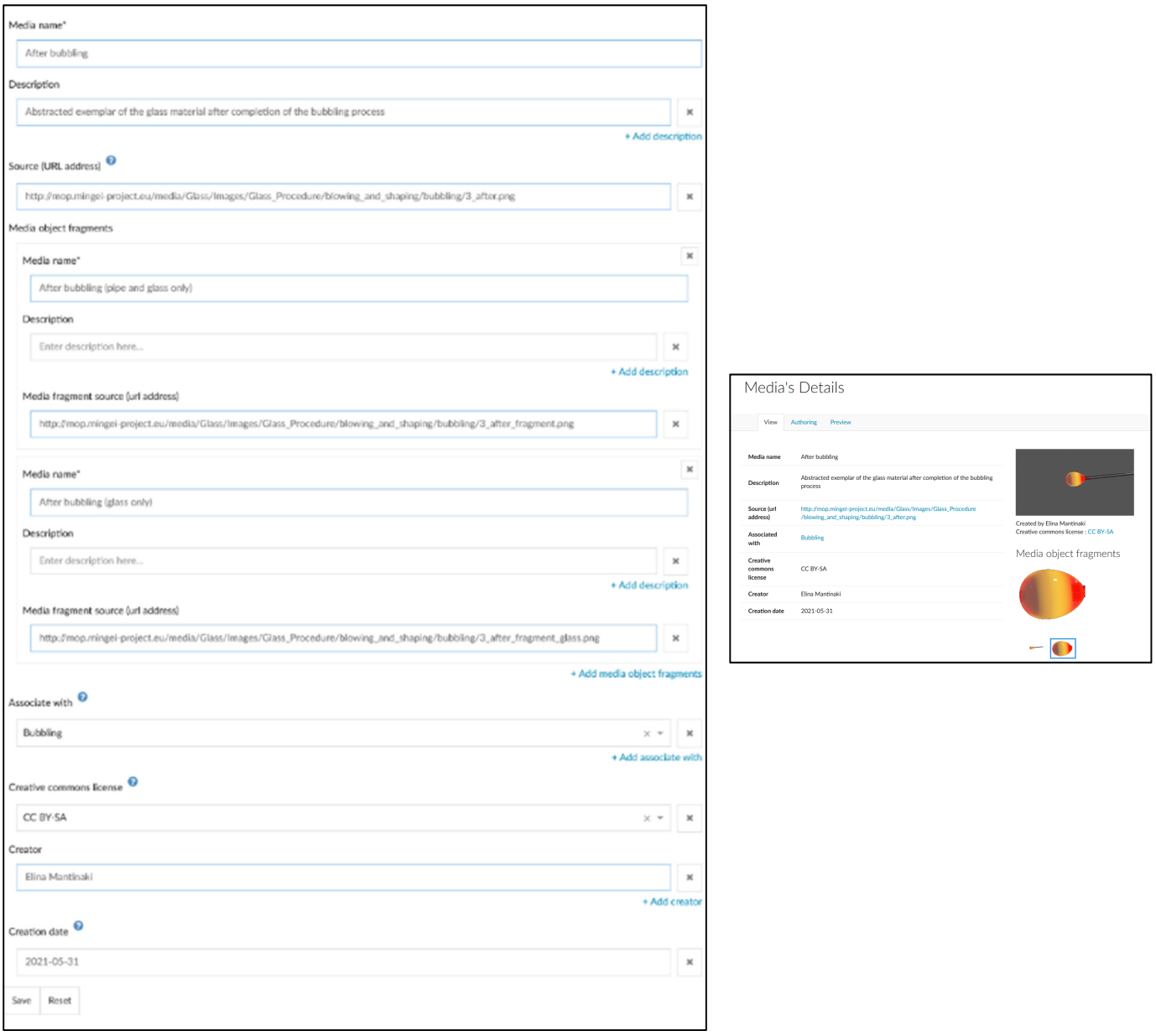
3.3.1. STEP 2 Overview

The basic elements of the craft representation are instantiated. These elements are the conceptual entities identified in STEP 1. For crafting dimensions, these are the materials, objects, places, actions, and products involved. For contextual dimensions, these entities are the places, persons, events, and objects. The instantiation of knowledge elements refers to the creation of a record for each via the assertion of semantic metadata and relations, as well as the linking of digital assets. Thus, knowledge elements contain curated information encoded as knowledge statements. Data curation task includes the selection of the entity type, the provision of the semantic meta-data for that entity, and the linking of digital assets relevant to the entity.

3.3.2. Authoring Basic Data Entries

As the first activity of this step, the assets uniquely identified in the Mingei namespace are transformed into media objects using the data curation facilities of the authoring platform. Media objects are classified into seven categories: images, videos, audio, MoCap, 3D reconstructions, 3D objects, and motion vocabulary. Each media object has a name, a description, an image, a source file IRI, and one or multiple media object Fragments. Media object fragments are continuous subsets of media objects, e.g., a snippet of text, audio or video, an image region, etc. (see Figure 2b). An example of curating and previewing a media object is presented in Figure 2.

In combination with the curation of media objects, in this step, basic data entries are curated. Such entities are persons, places, materials, objects, tools, etc. According to the craft instance in question, such basic entries may have differentiation, and new entities may be required. For example, in the case of mastic cultivation, the representation of mastic recipes required the introduction of the Entity Recipe Ingredient. In the current version of the authoring platform, these entities are added to the platform through the implementation of new classes in ontology and their binding with new authoring facilities in the authoring platform in a semi-automated manner. Documentation examples are presented in Figure 3.



(**a**) (**b**)

Figure 2. (**a**) Data curation of Media objects, (**b**) Media object preview.

3.3.3. Linking with Controlled Vocabularies in Cultural Heritage

In order to cast the knowledge encoded in the authoring platform interoperable and searchable according to Semantic Web standards, it is important to use the controlled vocabularies of the domain. Accordingly, the most well-established thesaurus for this purpose is the Getty Arts and Architecture Thesaurus [53]. Nevertheless, this vocabulary is not sufficient for two reasons: (a) crafts bring a broader range of concepts than Arts and Architecture, relevant to the physical and mechanical transformations that materials undergo under crafting processes and which are covered by the UNESCO Thesaurus [54] and (b) National Aggregators provide terms that refer to local concepts and are not available in the aforementioned thesauri.

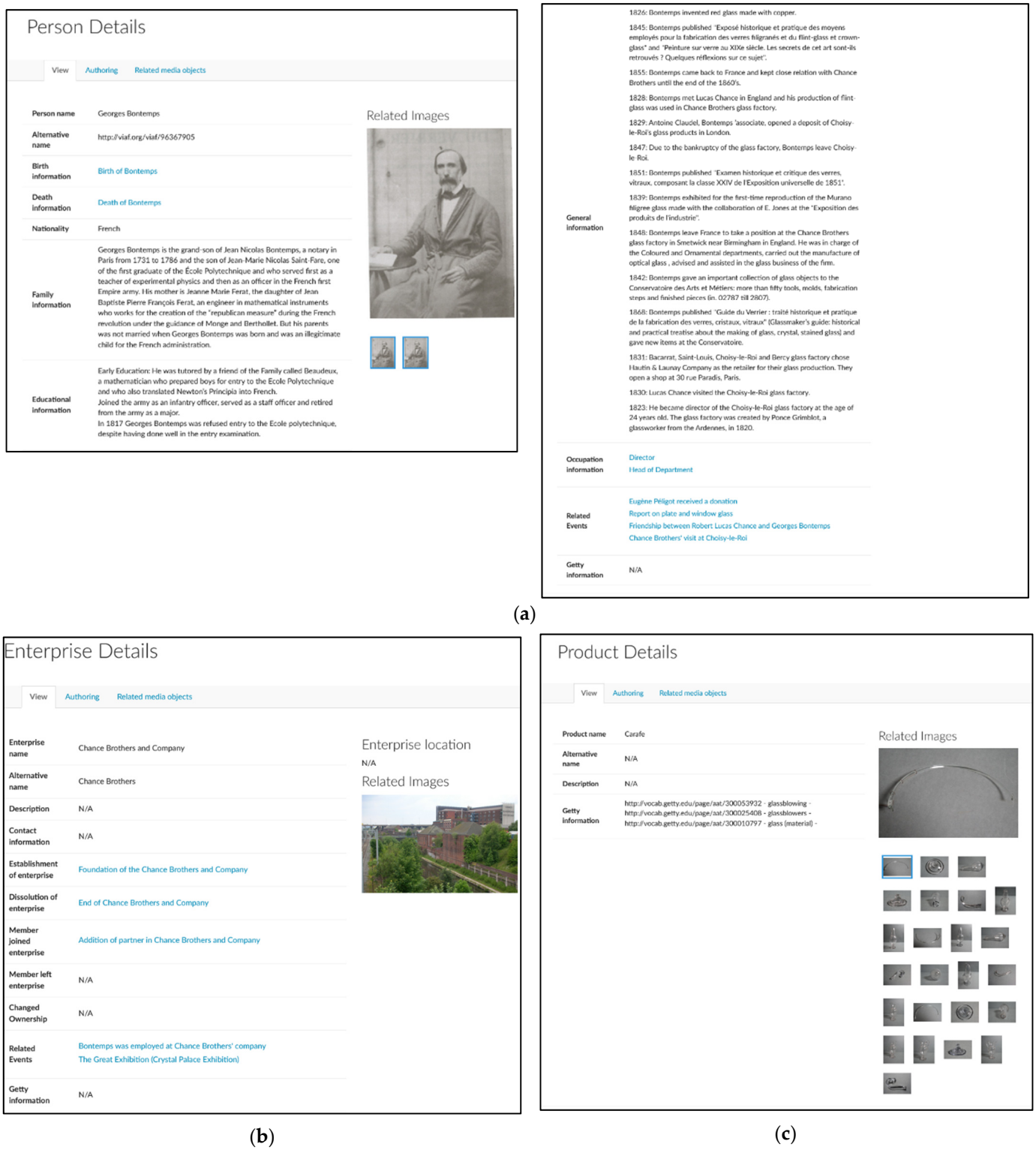


Figure 3. Documentation examples (**a**) Person, (**b**) Enterprise, (**c**) Product.

The authoring platform supports the use of multiple controlled vocabularies and provides them along with the remainder of the semantic annotations already provided. The example below (see Figure 4) demonstrates our record of an article about Tinian Marbleship, a burial memorial at the cemetery of Bellu, Bucharest, Romania. The record is annotated with links to the vocabularies of UNESCO, Getty, and the Greek National Aggregator. In addition, the location is visualized directly on the bottom right of this screenshot. The

artist's record is shown on the right, where he is also annotated with his occupation as a stone sculptor.

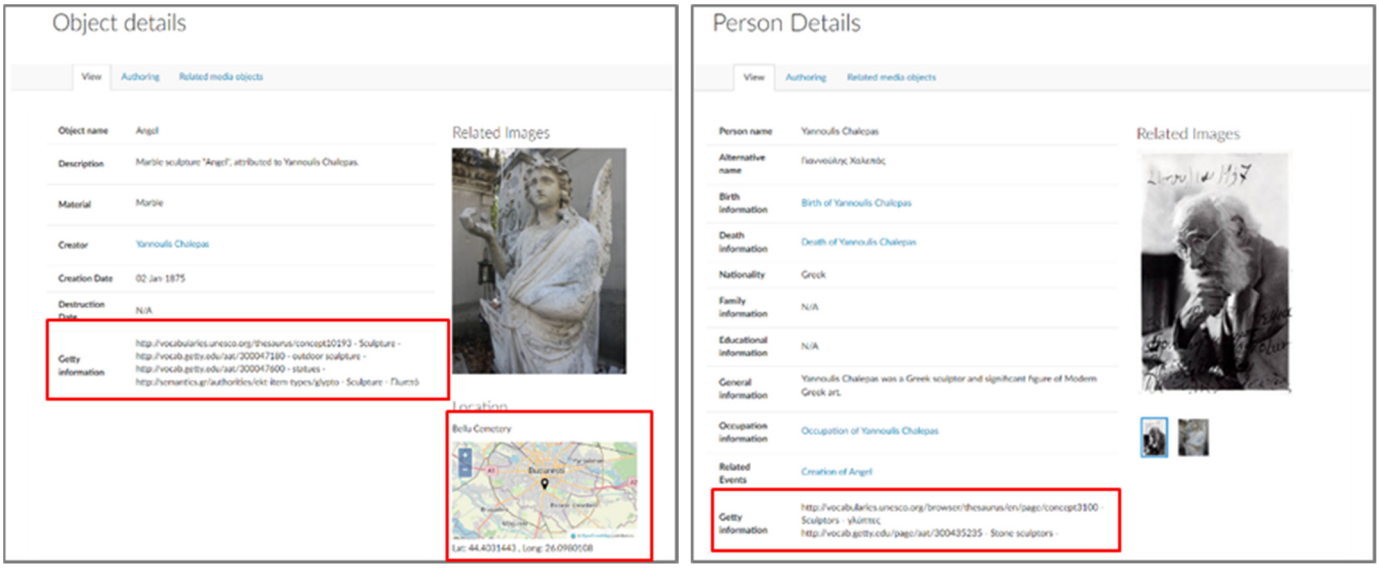


Figure 4. Screenshots showing the extension of the knowledge element edit forms to support controlled vocabularies.

The next example illustrates a case where the linkage to the vocabulary of a national aggregator is important. The example regards a "xysto" (plural "xysta"), which relates to a specific craft of building façade decoration met only at the Pyrgi, on the island of Chios, in Greece (see Figure 5). It is a style that is believed to be influenced by the Italian–Genoese–origin (sgraffito), which occupied the island during the 15th and 16th centuries but has developed an individual style at the particular location over time. The tradition of Xysta is of great importance for the inhabitants of Pyrgi as they are connected to their identity. In this case, the national (Greek) dictionary is more specific and, thus, the knowledge element contains both links to the UNESCO and Getty thesauri (as 'sgraffito'), as well as to the national dictionary (as 'xysto').

3.3.4. Linking with Controlled Location Names in Cultural Heritage

The de facto standard today in controlled vocabularies for location names is the GeoNames geographical database. Therefore, for named geographical locations, data entry is integrated with the FactForge service [55] to retrieve the corresponding coordinates from the GeoNames [56] database. Linking of media objects is facilitated by auto-complete pop-up menus, while the user types and matching media objects dynamically update in a pop-up menu (see Figure 6).

3.3.5. STEP 2 Outcomes

The outcomes of this step are a collection of semantically represented media objects and a collection of basic data entities that contribute to the studied craft instance. Furthermore, integration of external sources through IRIs and linking with CH vocabularies and location names.

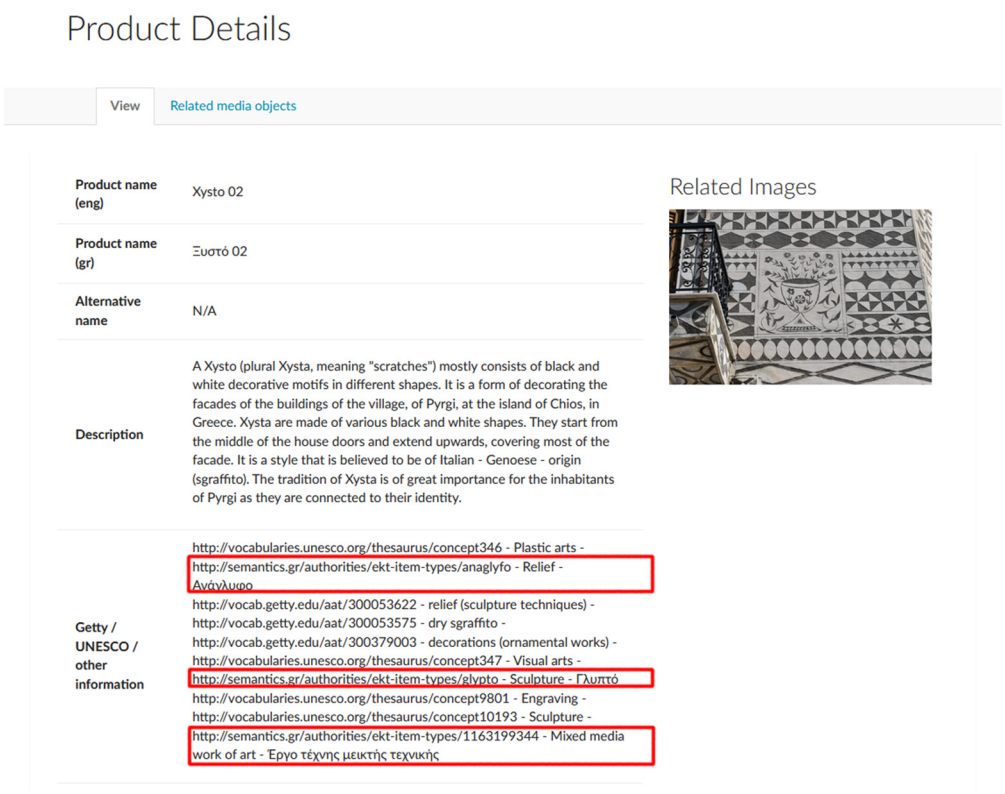


Figure 5. A knowledge element annotated using international and national controlled vocabularies.

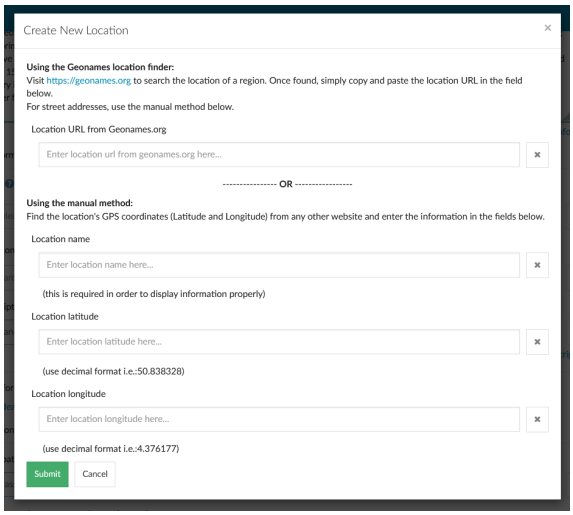


Figure 6. Linking with location names through Geonames or manually entering location information.

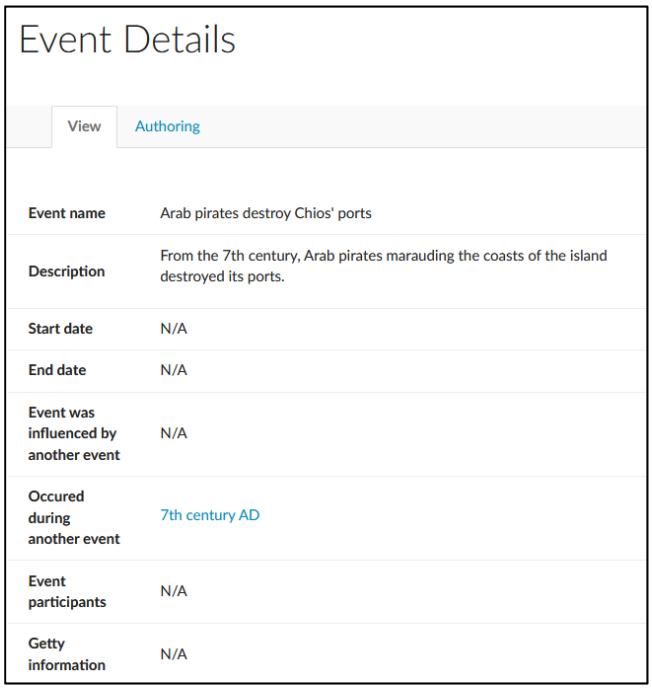
3.4. STEP 3 Representation

3.4.1. STEP 3 Overview

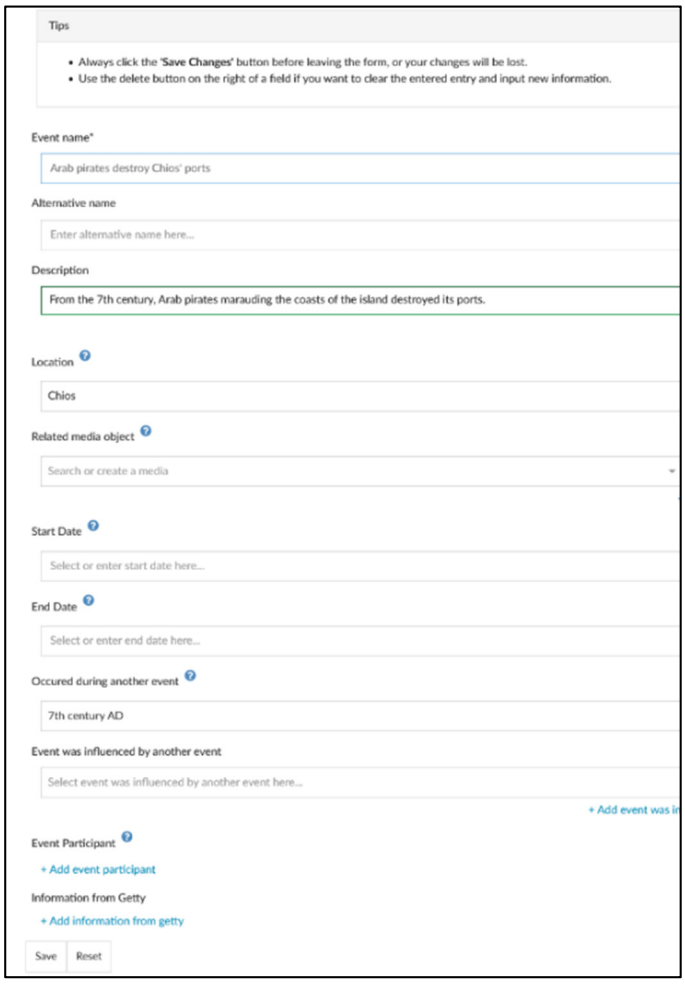
The entities represented in STEP 2 are related to a craft instance representation. This includes the representation of crafting processes and contextualization of events contributing to narratives. Both representations are comprised of events organized by relations. Crafting events occur each time an individual, handcrafted product is made. We say that all the expressions of a particular crafting process follow the same schema.

3.4.2. Authoring Events and Fabulae

Events are the building stones of narratives. For their data curation requested, information includes name, alternative name, description, related media objects, etc. (Figure 7a,b). Crucial to their representation is the definition of event participants (persons) and their role. Furthermore, the definition of relations between events is supported through the properties "was influenced by another event" and "Occurred during another event". A narrative can be considered a way of presenting a collection of events. Such a collection is defined as a fabula. Nevertheless, the fabula can be extended while formulating a narrative through complementary events. A fabula is authored by a title, description, and the association of events (Figure 7c). Previewing fabula results in a page where several details are extracted through the associated events, such as the locations where the events took place (Figure 7d).

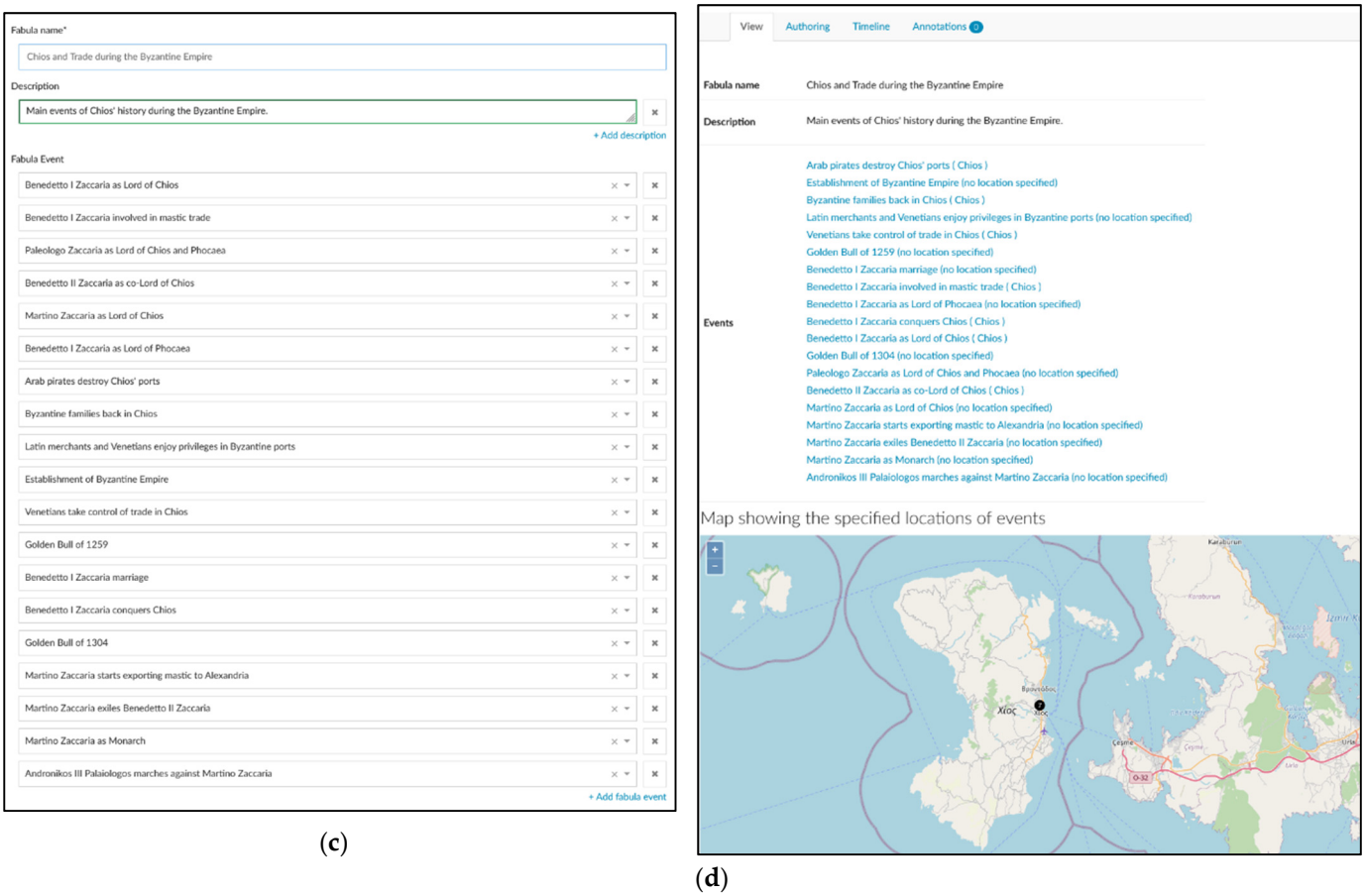


(**a**)



(**b**)

Figure 7. *Cont.*



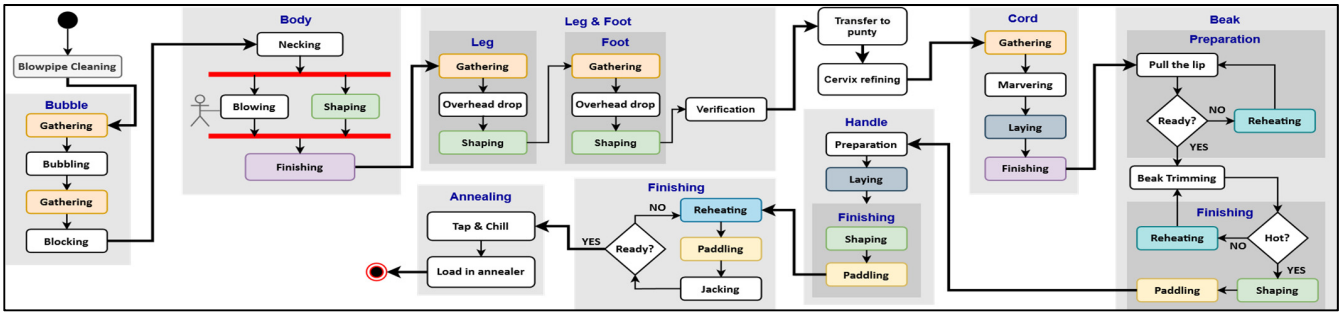
(**c**) (**d**)

Figure 7. Fabula authoring—"Chios and Trade during the Byzantine Empire". (**a**) Event page, (**b**) Event authoring form, (**c**) Fabula authoring form, (**d**) Fabula page.

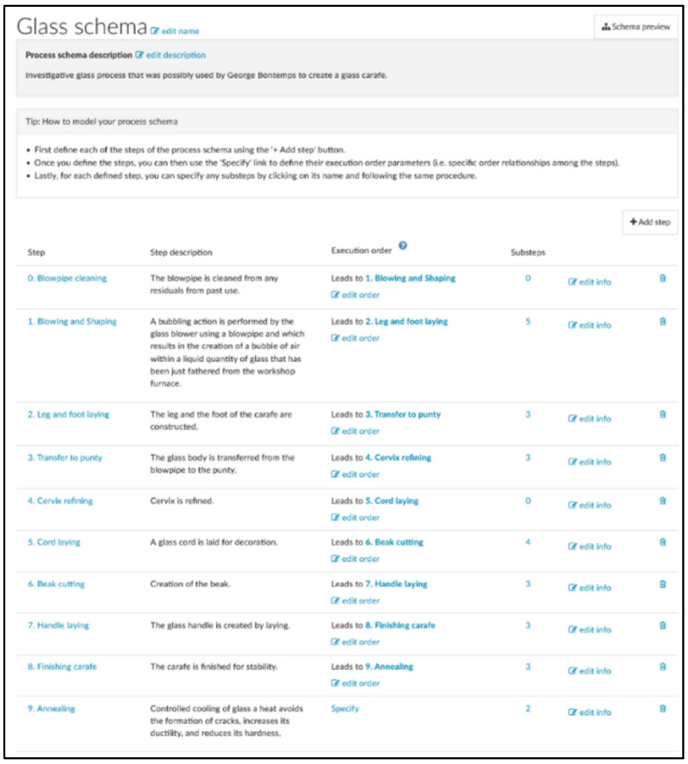
3.4.3. Authoring Process Schemas

Process Schemas can be considered as the conceptualization of an activity diagram that is authored based on the understanding of the crafting process. An example of such a diagram for the creation of a glass carafe is shown in Figure 8a.

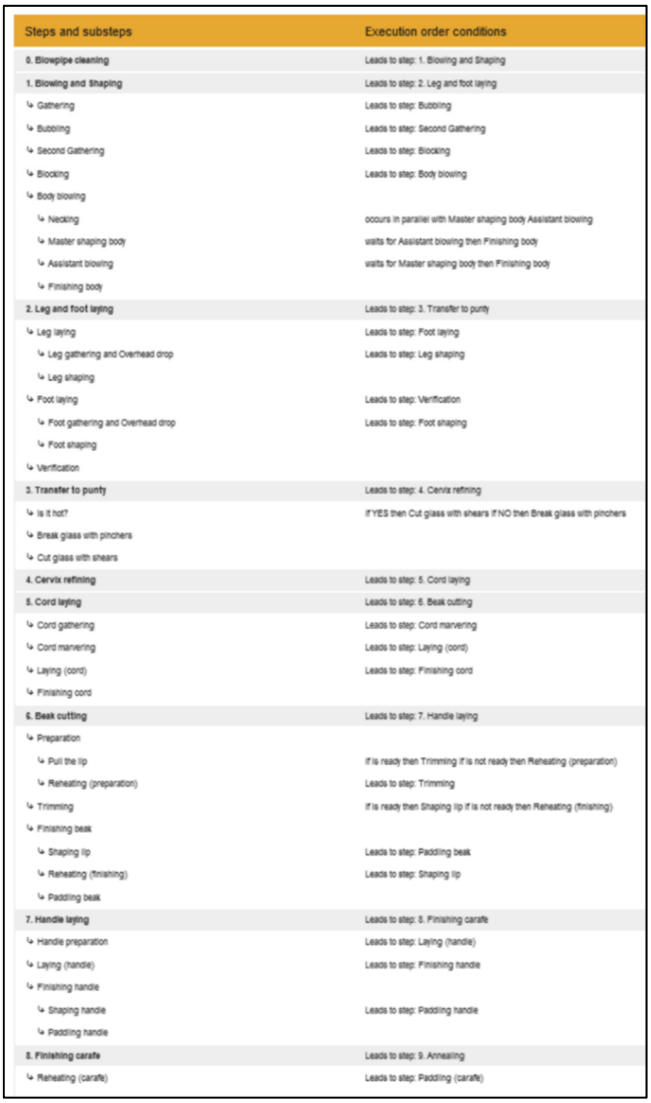
In order to instantiate process schemas in the authoring platform, data fields are used to enter appellations and informal descriptions. Step order is determined by the transitions that link process schema steps or can be explicitly set. Transitions are instantiated via a dynamic UI component that adapts to transition type. At its top, a menu enables the choice of transition type. Once selected, the UI component adapts to offer the transition-specific parameters. Incoming and outgoing links are instantiated using dynamic menus that contain the names of already defined steps (Figure 8d); these components are shown in the left pair of images. In Figure 8b, the editor's view of a process step schema is shown, while Figure 8c presents the preview of an authored schema.



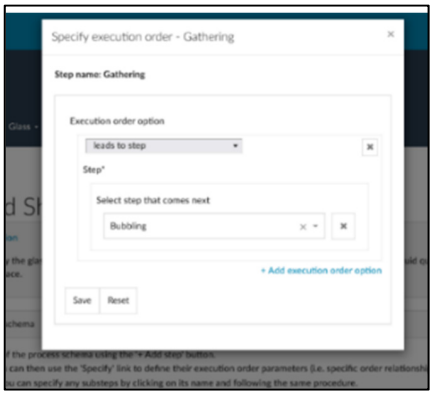
(**a**)



(**b**)



(**c**)



(**d**)

Figure 8. UI components for authoring representations of process schemas and processes. (**a**) Activity diagram representing process schema, (**b**) Data entry form for process schema instantiation, (**c**) Data entry for instantiation of process step, (**d**) Process step presentation.

3.4.4. STEP 3 Outcomes

The outcomes of this step are a collection of fabulae that contribute to the narratives to be formulated and a collection of process schemas that transcribe the defined activity diagrams for the specified craft instance.

3.5. STEP 4 Narratives

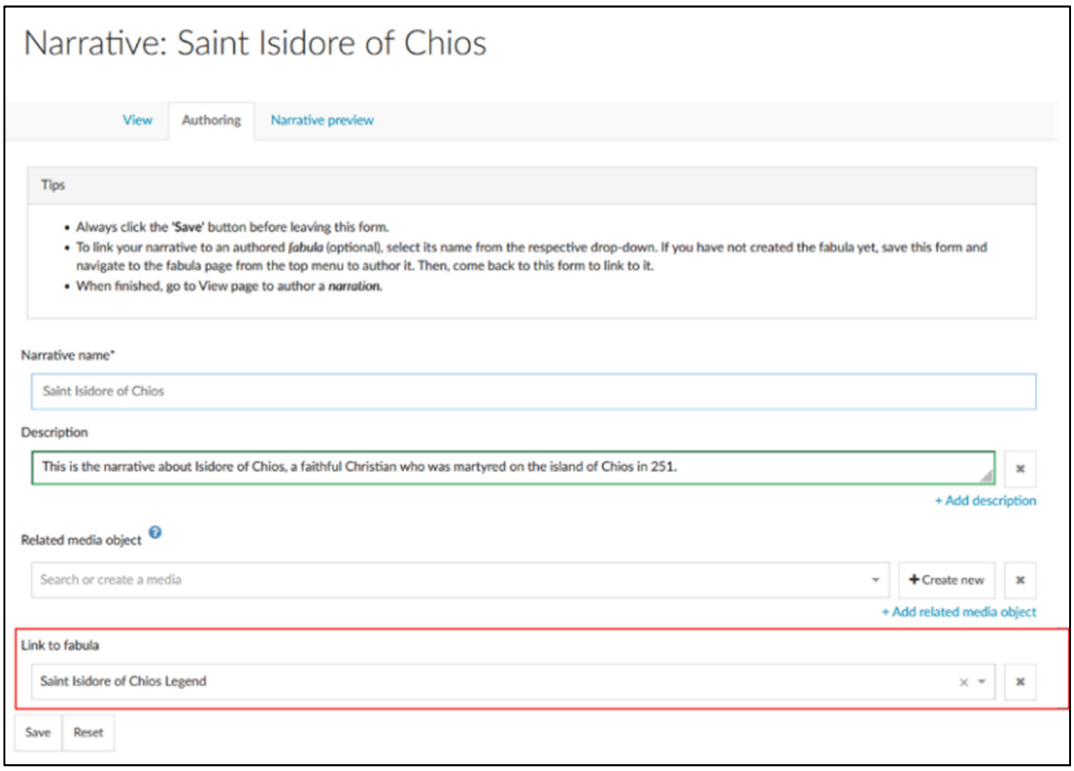
3.5.1. STEP 4 Overview

Narratives are authored and semantically represented. Narratives implement the ways that fabulae are presented or narrated. Contextual events are used in narratives and are events that have occurred in the past. Narratives are represented following the principles in [57,58] and the formalization typology in [59].

3.5.2. Authoring a Narrative and Narrations

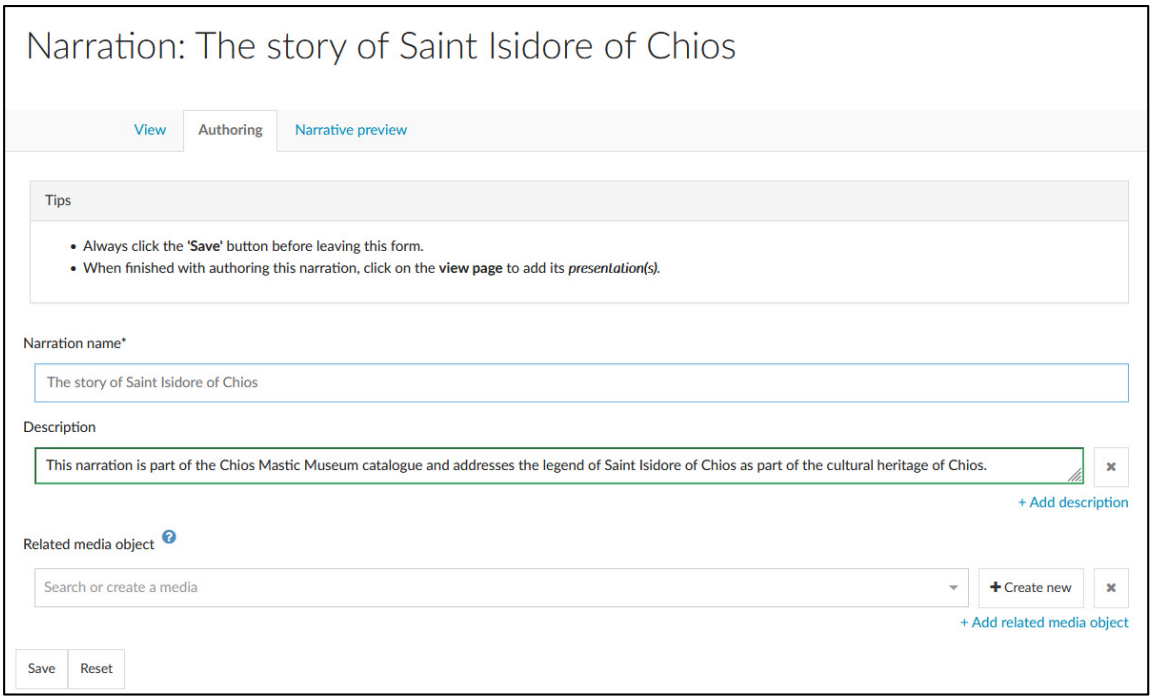
After creating the fabula, the data curator can author a narrative and link a set of narrations that present the narrative of the corresponding fabula. On the narrative authoring form (see Figure 9a), the data curator can provide additional information, including a description, linked media objects, and the fabula of the narrative. We have selected the "Saint Isidore of Chios Legend" fabula from the drop-down menu in this example to create the "Saint Isidore of Chios" narrative (Figure 9a).

A narrative may have multiple narrations (e.g., for children, for adults, for families, etc.). New narrations can be created using the add narration functionality (to create a new narration from scratch) or by selecting an existing narration from the drop-down list (link to existing narration). In the same way, a narration may have multiple 'Presentations' (e.g., for the platform, for a mobile device, AR, etc.).



(**a**)

Figure 9. *Cont.*



(**b**)

Figure 9. (**a**) Narrative authoring—"Saint Isidore of Chios", (**b**) Narration authoring—"The story of Saint Isidore of Chios".

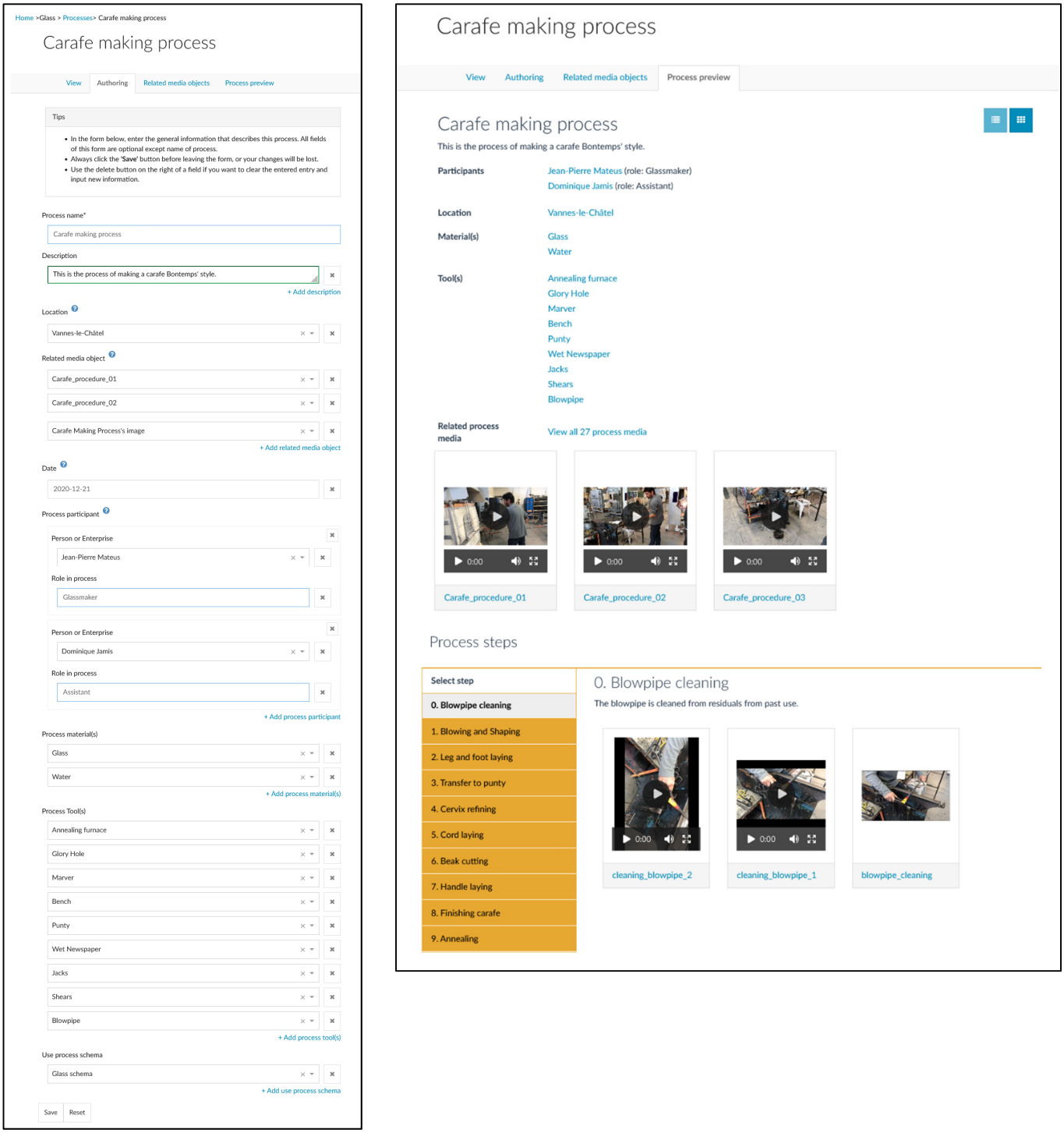
The authoring of a narrative is presented in Figure 9a, while the authoring of the narration is presented in Figure 9b. The authoring of the information presented to alternative devices and the linking with knowledge happens through the authoring of presentations discussed in the next step.

3.5.3. Authoring Processes

A set of UI components enable the instantiation of processes as activities via the entry of attribute data, chronological ordering, and the association with recordings that document them. The UI enables linking an arbitrary number of knowledge entities to a process step. The UI components are shown in Figure 10a. The UI in the second from the right image enables the linking of processes and process steps with their corresponding process schemas and step schemas. This is implemented by the field 'Corresponds To' that is used to associate a process step with a process step schema. The task is facilitated by a dynamic menu that follows the process schema step hierarchy, as shown in Figure 10a. Figure 10b shows the preview of a represented process.

3.5.4. STEP4 Outcomes

After the completion of this step, the socio-historic context of the craft instance has been documented through a series of semantic narratives. At the same time, the execution of process schemas for the creation of actual craft products has been represented through the representation of corresponding processes.



(**a**) (**b**)

Figure 10. (**a**) Authoring processes, (**b**) Process preview.

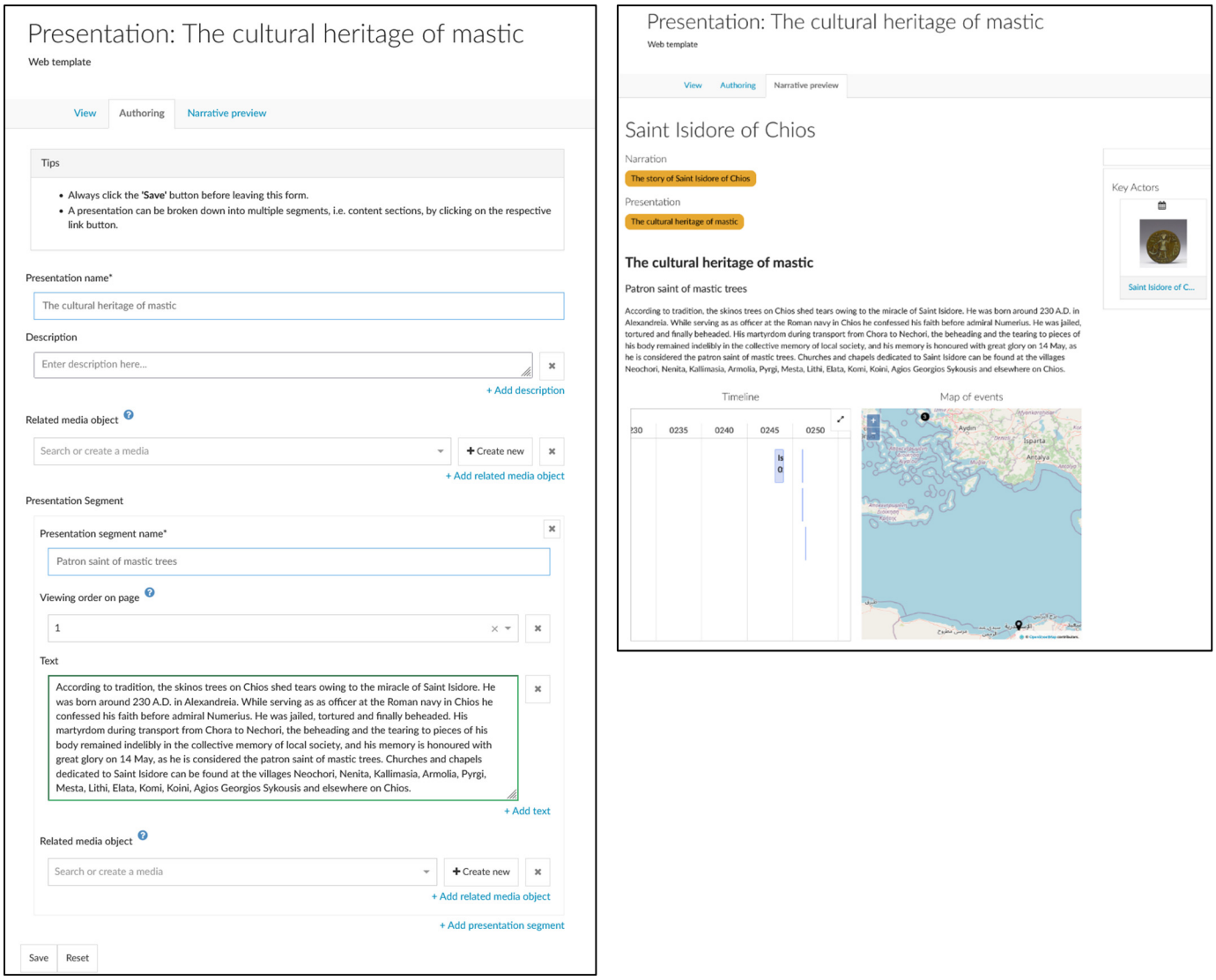
3.6. STEP 5 Presentation

3.6.1. STEP 5 Overview

Craft presentations are built on top of events and event schemas referenced through the narrative and associated with knowledge elements and digital assets, which can be retrieved to illustrate the narration. Narrations are associated with events and, in turn, with knowledge elements and media objects. Alternative presentations of these narrations are enhanced with objects and actions.

3.6.2. Authoring a Presentation

By now, "The story of Saint Isidore of Chios" has been authored, and the final step regards the creation of a presentation. This process starts by authoring the presentation details within the authoring tab (see Figure 11). Selecting to add a presentation segment creates this new segment and links it directly to the presentation currently being authored. Figure 11 shows an example of presentation segments created for the "The cultural heritage of mastic" presentation.



(**a**) (**b**)

Figure 11. (**a**) Presentation authoring—"The cultural heritage of mastic", (**b**) presentation preview.

3.6.3. STEP5 Outcomes

The outcome of this step is the formulation of alternative presentations for each application context experience. The represented knowledge and assets are directly exploitable through the authoring platform but also can be exported to be integrated into higher-level immersive applications and experiences.

3.7. STEP 6 Preservation

3.7.1. STEP 6 Overview

Supporting access and acknowledging CH related to TCs is the first step towards its preservation. The simplification of learning and digitization of promotional content support the operation and encourage the foundation of small enterprises. Thematic tourism makes use of engaging content, experiences, and training and can enhance the sustainability of TCs.

3.7.2. Communication Channels

By having achieved the desired representation in this step, its communication can be achieved through various dissemination channels retrieving content from the authoring platform. In Mingei, the following dissemination channels were used to present craft-related knowledge and experiences:

- Web-based dissemination through the website of the project: (a) silk pilot, (b) glass pilot, (c) mastic pilot
- Presentation of narrations by Virtual Human Narrators in the museum
- Mixed reality demonstration of glass blowing
- Mobile museum guide empowered by narrations on textile manufacturing
- Multiscale contextual representations of heritage sites
- Roleplay gaming experiences
- Handmade craft items act as museum storytellers

The relevant applications are presented in [51] and on the Mingei project website.

3.7.3. STEP6 Outcomes

As presented in the previous section, the represented knowledge can be availed through compelling experiential presentations, using storytelling and educational applications, and based on AR and MR and the Internet. Through such exploitation of the representation, the developed engaging cultural experiences aim to attract interest as a step towards TC sustainability and preservation.

4. Platform Implementation

4.1. Architecture

The architecture of the authoring platform is comprised of a set of interoperating components, each of which is of significance for the overall system performance and functionality. For asset storage, a repository platform is built using the Fedora platform [52] that hosts assets and assigns unique IRIs. Semantic data are stored in triple storage built on top of the GraphDB [60] knowledge database solution. The front end of the authoring platform is built using the ResearchSpace platform [61,62], which directly links to the knowledge graph. For exporting information from the knowledge graph to linked data repositories, an exporting API has been built on top of the semantic graph using Rest-based services [63]. At the same time, knowledge-based querying on the graph is supported through a SPARQL [64] endpoint that exposes querying functionality. External vocabularies and asset stores are connected through data linking operations. The overall conceptual architecture of the authoring platform is presented in Figure 12.

4.2. The Mingei Crafts Ontology

The craft ontology (CrO) [65] is used to represent the knowledge collected and the relevant socio-historic context. It is an application ontology [66] obtained by integrating several existing ontologies, notably: (a) the CIDOC-CRM, a top ontology and an ISO standard (ISO 21127:2014) [27,67], (b) the narrative ontology, a domain ontology focused on the representation of 'Narratives' [68,69], (c) the FRBRoo, a domain ontology for bibliographic records, resulting from the harmonization of FRBR with CRM [65], (d) OWL Time, a domain ontology recommended by W3C for the representation of time [70], and (e) Dublin Core for

simple resource description [69]. A preliminary version of the narratives ontology [69] has been applied in Europeana [68].

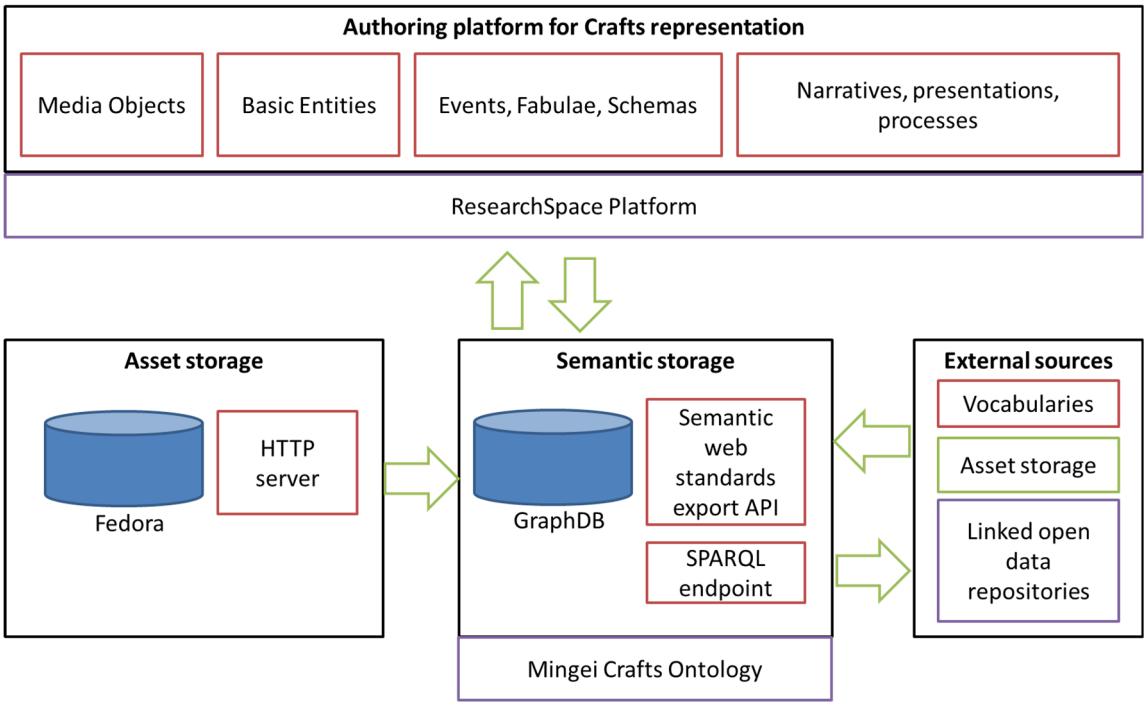


Figure 12. Conceptual architecture of the semantic platform.

4.2.1. Narratives Representation in CrO

The main classes and properties for the representation of narratives are depicted in the class diagram in Figure 13.

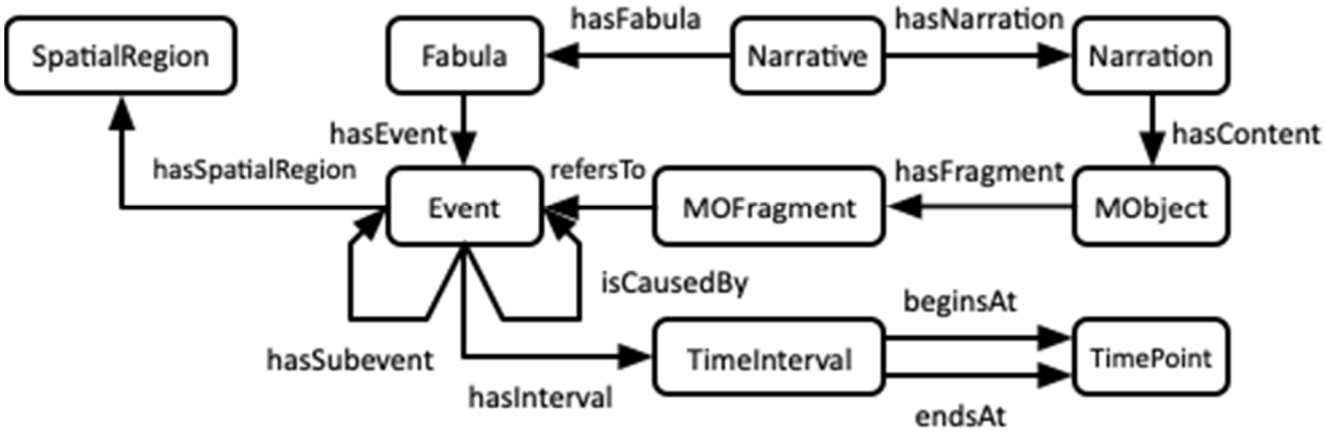


Figure 13. Main classes and properties of the Narrative Ontology.

Figure 13 provides the domain and range of each property, expressible as axioms in RDF Schema [71] and OWL 2 DL [72]. Details on the classes and properties are provided in Table 2.

Table 2. Classes and properties of the Narrative Ontology.

Classes of MNO	Properties of MNO
Narrative, the class of narratives;	hasFabula, is the property linking narratives and their fabulae.
Narration, the class of narrations.	hasNarration, is the property linking narratives and their narrations.
Fabula, is the class of fabulae representations in the form of sets of interrelated events.	hasEvent, is the property linking fabulae and their composing events.
Event, is the class of happenings. This class includes also actions, which are seen as happenings with an intention.	refersTo, is the property linking media object fragments and the events they describe.
MOFragment, the class of media object fragments, that is any fragment of a media object that narrates an event of a fabula.	hasFragment, is the property linking media objects and their fragments.
MObject, is any media object used as narration content.	hasContent, is the property linking narrations and their contents.
TimeInterval, is any time interval that is relevant to a narrative.	hasSubevent, is the property linking events and their composing events.
TimePoint, is any time instant that is relevant to a narrative.	isCausedBy, is the property linking events and the events which they causally depend on.
SpatialRegion, is any spatial region that is relevant to a narrative.	hasSpatialRegion, is the property linking events and their spatial regions of occurrence.
	hasInterval, is the property linking events and their temporal intervals of occurrence.
	beginsAt, is the property linking time intervals and the time points at which they begin.
	endsAt, is the property linking time intervals and the time points at which they end.

4.2.2. Modelling Narrative Presentations

Conceptually, a presentation is a way of presenting a narration on a device, using media objects created for this purpose, such as music, video, narrating voice, subtitles, images, etc. Structurally, a presentation of a narrative consists of several segments. A presentation segment is a portion of a presentation that uses a specific channel to convey the whole or a portion of a media object fragment, identified by a start- and an endpoint.

A graphical representation of the conceptualization of a presentation is provided in Figure 14. This figure extends Figure 13 by showing the classes and the properties added to the CrO to represent presentations. For convenience, the added classes are depicted as cyan blue rectangles, while the added properties are depicted as red arrows carrying red labels. More specifically, the classes added are shown in Table 3, while the properties are shown in Table 4.

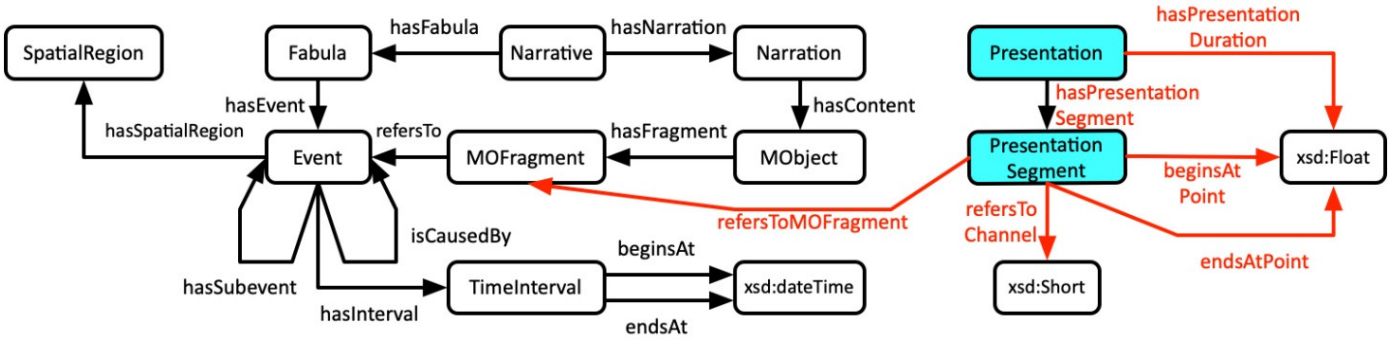


Figure 14. Classes and properties of the CrO+. The classes in green and the properties in red are added to the CrO to represent presentations.

Table 3. Classes for the modeling of Presentations.

Class Name	Usage
Presentation	A presentation is a way of presenting a narration on a device, with the possible addition of other stuff (added in separate presentation segments), such as music, video, narrating voice, subtitles, images, etc.
Presentation Segment	A presentation Segment holds information about a media object fragment, channel, etc. that should be used in a specific presentation at a specific point in time

Table 4. Properties for the modelling of Presentations.

Domain (Class Name)	Property Name	Range (Class Name)
Narration	hasPresentation	Presentation
Presentation	hasPresentationDuration	Float (xsd:Float)
Presentation	hasPresentationSegment	Presentation Segment
Presentation Segment	refersToMOFragment	MOFragment
Presentation Segment	startsAtPoint	Integer (xsd:Short)
Presentation Segment	endsAtPoint	Integer (xsd:Short)
Presentation Segment	refersToChannel	Integer (xsd:Short)

4.2.3. Process Schemas Representation

This section presents classes, properties, and axioms that are part of the CrO and that model process schemas in the form of activity diagrams. Following the practice followed for the other CrO classes and properties, we introduce two classes:

- schema, identified by IRI mno:Schema, modeling process schemas as wholes; all the classes and properties presented in this section are identified in the same way, i.e., by prefixing mno: to their name; these identifiers will be omitted for readability.
- Schema_Step, modeling the individual steps that compose schemas, each of which may in itself be expanded in (sub) steps.

To connect a schema to the steps it consists of, and, recursively, a step to its sub-steps, and so on, we introduce one property:

- hasSubStep, having as domain and range a class that generalizes both Schema and Schema_Step, to allow an arbitrarily deep composition. hasSubStep is a sub-property of the CRM property P69 has an association with (is associated with), which "generalizes relationships such as whole-part, sequence, prerequisite or inspired by between instances of E29 Design or Procedure (just E29 from now on)" [73].

Furthermore, we introduce a set of classes in the CrO, generally called transition classes, each capturing one kind of the transitions and an associated set of properties, each capturing a kind of connection between a transition and its related individuals.

1. A simple transition is the sequential, unconditional passage from one step to the next step in the flow. To model simple transitions, we introduce class Transition and the properties:
    - transitsFrom, connecting a simple transition to its input step, so the domain of this property is Transition, and its range is class E29.
    - transitsTo, connecting a simple transition to its output step, so also the domain of this property is Transition, and its range is class E29.
2. A decision node controls the flow of a process by selecting one of several alternatives based on the evaluation of associated predicates. To model decision steps, we intro-

duce the class Branch, modeling the decision step, and the class Alternative, modeling the alternative paths outgoing from a decision step and the properties:

- branchesFrom, connecting a decision to its input step, so the domain of this property is Branch, and its range is class E29
- property hasPredicate connecting an alternative to its predicate, so the domain of this property is Alternative, and its range is xsd:string
- property hasAlternativeDestination connecting an alternative to its output step, so the domain of this property is Alternative, and its range is class E29.

3. A merge step is a node in an activity diagram where two or more alternate control paths come together. Consequently, a merge node has two or more input flows and one output flow. To model merge steps, we introduce:
   - class Merge, modeling the merge step;
   - property mergesFrom, connecting a merge to one of its input steps, so the domain of this property is Merge, and its range is class E29.
   - property transitsTo, connecting a merge to its output step, so also the domain of this property is Merge, and its range is class E29.
4. A Fork node has a single input and many outputs, so from a modeling point of view, they are simpler decision steps as they do not involve predicates. To model fork steps, we introduce:
   - class Fork, modeling the fork step;
   - property forksFrom, connecting a fork to its input step, so the domain of this property is Fork, and its range is class E29
   - property forksTo, connecting a merge to one of its output steps, so also the domain of this property is Fork, and its range is class E29
5. A Join step has many input steps and a single output step, so they are structurally identical to merge steps, except that the semantic is different: a join is a synchronization amongst a set of parallel flows. To model join steps, we introduce:
   - class Join, modeling the join step;
   - property joinsFrom, connecting a join to one of its input steps, so the domain of this property is Join, and its range is class E29
   - property joinsTo, connecting a merge to its output step, so also the domain of this property is Fork, and its range is class E29

4.3. Front End of the Authoring Platform

The front-end was implemented using the ResearchSpace [62] toolkit, which provides HTML5 semantic components for structuring web authoring forms, template pages, navigation menus, content panels, and other interaction and presentation elements (i.e., buttons, searches, drop-downs, table grids, etc.). It also provides 'Presentation' features such as interactive maps, a timeline component for visualizing chronologically ordered events, and various image gallery components.

4.3.1. Template and Application Pages

Using the RS toolkit a representation of a particular person can be typed according to the ontology (model) as, for example, being of type E21 Person [74]. In principle, it is possible to create a page for every instance of type E21 Person within the knowledge graph manually. However, templates can be used to define generic views which are being automatically applied to entire sets of instances, for example, to all instances of type E21 Person.

In the template, the templateIncludeQuery in the UI Configuration specifies the SPARQL SELECT query according to which the template engine selects templates depending on the requested resource. Query must have at least a "?type" projection variable (e.g., "SELECT ?type WHERE {?subject a ?type}". This can be used to refine the logic according to which candidate templates are being computed when browsing instances in the knowledge graph. If users want to create a new or modify an existing template, they must follow the link within the top of the template editor when editing an instance page (see Figure 15).

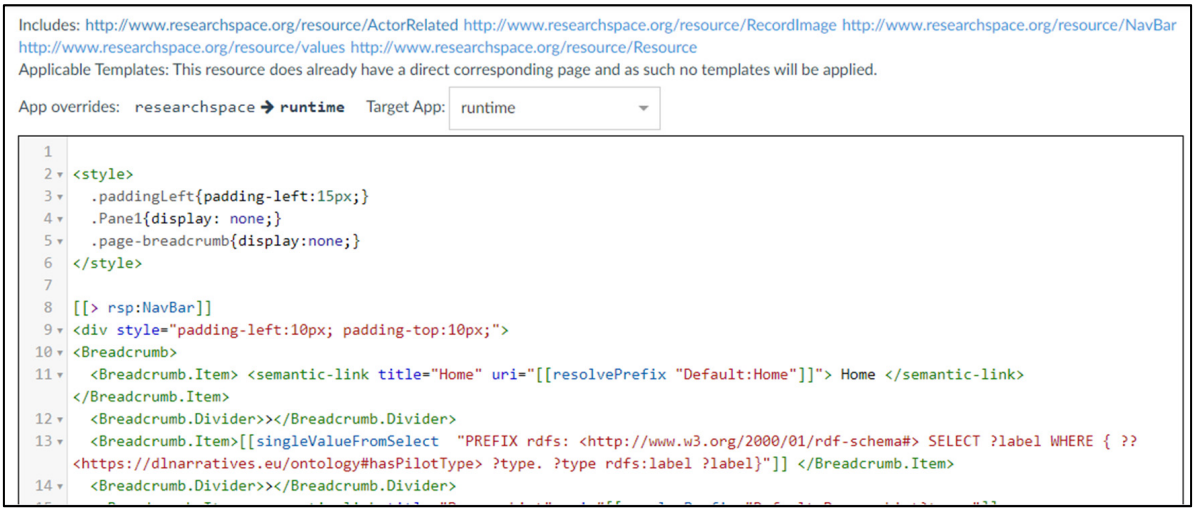


Figure 15. Example of editing an applicable template.

The authoring platform consists of a large number of application pages. These are pages that are not associated with any entity in the knowledge graph. An application page will not be rendered according to some automatically inherited templates but rather using static markup which will be parameterized dynamically. To this end, HTML5 semantic components are used, which are custom HTML5 Web Components that operate on the result of SPARQL queries being executed over the knowledge graph. An example is the page "Persons" which displays all the persons contributing to the history of the Silk pilot. This page uses Table Component (semantic table) which operates on the result of SPARQL queries being executed over the knowledge graph (see Figure 16).

4.3.2. Semantic Forms

Creating authoring forms for knowledge graphs is performed by the semantic form component that the RS framework uses. In this context, field definitions are used to instruct the form on how to read and update values within the graph. A field definition has some main attributes (id, label, domain, range, insertPattern, selectPattern, deletePattern, etc.). Field definitions are being defined on an abstract level. All field definitions have an RDF representation and can be stored in the database (Field Definition Catalog). RS framework uses backend template functions for reading the definitions from the database. Attributes of a field definition are presented in Table 5.

```
<h1>Persons</h1>
[[#if (hasPermission "sparql:update")]]
<mp-overlay-dialog title="Add new Person" type="modal" bs-size="large">
  <mp-overlay-dialog-trigger><button style="float:right;" class="autocomplete-text-field__create-button btn btn-default"> <span class="fa fa-plus"></span> Add New Person</button></mp-overlay-dialog-trigger>
  <mp-overlay-dialog-content>
    <semantic-form new-subject-template='http://www.cidoc-crm.org/cidoc-crm/E21_Person/{{UUID}}'
        post-action='reload'
        browser-persistence=true
        form-id='person-1'
        fields='[
          {
            "id": "label",
            "label": "person name",
            "description": "The label used to display the instance",
            "defaultValues": [""],
            "xsdDatatype": "xsd:string",
            "selectPattern": "SELECT $value WHERE { $subject rdfs:label $value }",
            "insertPattern": "INSERT {
                ?subject a <http://www.w3.org/2000/01/rdf-schema#:Resource>.
                ?subject1 a <http://www.cidoc-crm.org/cidoc-crm/E21_Person>.
                ?subject1 rdfs:label ?value1 .
                ?subject1 <https://dlnarratives.eu/ontology#hasPilotType> ?param.
                ?subject1 <http://www.cidoc-crm.org/cidoc-crm/P1_is_identified_by> ?appellation_iri.
                ?appellation_iri a <http://www.cidoc-crm.org/cidoc-crm/E41_Appellation>.
                ?appellation_iri rdfs:label ?value
               }
                  WHERE {
                BIND(STR(STRUUID()) as ?value1).
                BIND(IRI(CONCAT(\"http://www.mingei-project.eu/resource/\", ?value1)) as ?subject1).
                BIND(IRI(CONCAT(STR(?subject1),\"/\", MD5(?value))) as ?appellation_iri).
                BIND(\"[[urlParam "type"]]\" as ?type).
                BIND(IRI(CONCAT(\"http://www.mingei-project.eu/resource/pilot_type/\", ?type)) as ?param).
              }",
            "deletePattern": "DELETE { $subject rdfs:label $value } WHERE {}"
          }
        ]'>

      <bs-panel>
          <!--h4>Are you sure you want to add new Person?</h4-->
          <semantic-form-text-input for='label'></semantic-form-text-input>
          <semantic-form-errors></semantic-form-errors>
          <!-- save and reset button for form -->
          <button name="submit" class="btn btn-default">Save</button>
          <button name="reset" class="btn btn-default">Reset</button>
       </bs-panel>
      </semantic-form>
  </mp-overlay-dialog-content>
</mp-overlay-dialog>
[[/if]]

<semantic-table
 query="
    PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
    SELECT ?subject ?name WHERE {
                        $subject a <http://www.cidoc-crm.org/cidoc-crm/E21_Person> .
                       OPTIONAL{ $subject <http://www.cidoc-crm.org/cidoc-crm/P1_is_identified_by> ?appellation .
                        ?appellation a <http://www.cidoc-crm.org/cidoc-crm/E41_Appellation>.
                        ?appellation rdfs:label ?name .}
                            BIND ('[[urlParam "type"]]' as ?type)
                        BIND(IRI(CONCAT('http://www.mingei-project.eu/resource/pilot_type/', ?type)) as ?param).
                        ?subject <https://dlnarratives.eu/ontology#hasPilotType> ?param.
                            FILTER(regex(STR(?subject), 'http://www.mingei-project.eu')).
                    }
                    ORDER BY ?name"
    column-configuration='[
     {
      "displayName": "Image",
      "cellTemplate": "<mp-resource-thumbnail iri=\"{{subject.value}}\" no-image-uri=\"https://iptc.org/wp-content/uploads/2018/05/avatar-anonymous-300x300.png\" style=\"max-width: 50px;\"  />"
    },
    {
      "displayName": "Image name",
      "cellTemplate": "<semantic-link title=\"{{subject.value}}\" iri=\"{{subject.value}}\">
                                            {{name.value}}
                        </semantic-link>"
    },
    {
      "displayName": "",
      "cellTemplate": "<i class=\"fa fa-trash-o\"></i>"
    }
  ]'
number-of-displayed-rows=12 ></semantic-table>
```

Figure 16. Example code for Table Component.

Table 5. Field definitions (* required field).

Property	Comment
id *	Unique identifier of the field definition.
label *	A human-readable label for the field.
description	A human-readable description of the field.
categories	An unordered array of category IRIs as additional metadata for improved organization.
domain	Domain restriction on classes this field applies to.
xsdDatatype	A full or prefix XSD URI datatype identifier as specified in RDF 1.1
range	Range restriction on allowed classes of objects for the field values. Only applicable if xsdDatatype is xsd:anyURI.
minOccurs	XSD schema min cardinality number of 0:N. Zero for not required. Defaults to 0.
maxOccurs	XSD schema max cardinality number of 1:N or unbound for infinite (default).
defaultValues	An array of default values is assigned to the field if the subject does not contain a value for it.
selectPattern	SPARQL SELECT query string
insertPattern *	SPARQL INSERT query string to create new values
deletePattern	SPARQL DELETE query string to delete old values (only required if running in SPARQL mode)
askPattern	SPARQL ASK query string, parameterized with the current $subject and new $value. Will be executed while typing to validate user inputs against the database.
autosuggestionPattern	SPARQL SELECT query string for autosuggestion lookups
valueSetPattern	SPARQL SELECT query string for populating set choices such as in drop-down
treePatterns	SPARQL configuration to select terms from a hierarchical thesaurus. Can be either simple or full (specified in the type attribute).

A semantic form consists of input elements. Forms and input elements can be instantiated using HTML Components, including references to the field definitions. To instantiate a certain field through an input element, one can choose from a set of dedicated form input elements, whereas each must-have input reference a field definition via the for = '{field-id}' attribute. The following example illustrates a semantic form with one field definition with the label "person name" for creating a CIDOC-CRM object with RDF type E21 Person. The field captures an RDFS label for the name of the CIDOC-CRM object (see Figure 17). A layout for the form with appropriate HTML Components, including reference to the field definition with id "label" is created.

In more complex field definition scenarios, as in the following example, field definition patterns map complex CRM graph structures (see Figure 18). Furthermore, the example shows how to create a more complex layout for the authoring form and how each HTML Component has a reference to a field definition.

4.4. Back End

4.4.1. Data Storage

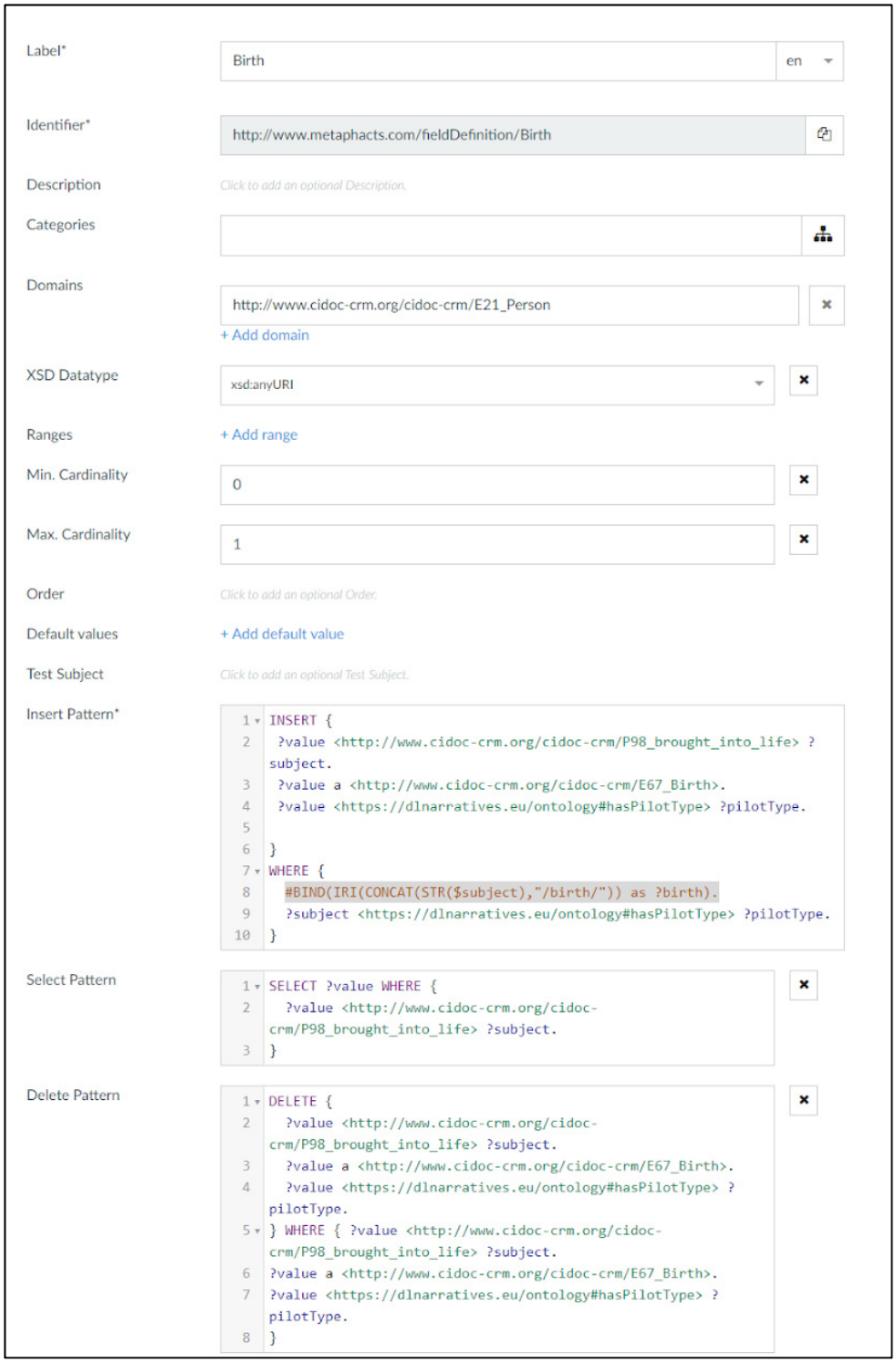
For data storage of the semantic graph, GraphDB is employed [60], which is an enterprise version of the Semantic Graph Database, compliant with W3C Standards. GraphDB is a family of highly efficient, robust, and scalable RDF databases. It streamlines the load and use of linked data cloud datasets. GraphDB implements the RDF4J framework interfaces and the W3C SPARQL Protocol specification [75] and supports all RDF serialization formats. The platform works with the knowledge graph data stored in RDF repositories. The platform re-uses the RDF4J framework [76] to configure the connections to RDF repositories. The RDF4J native repository is a special RDF4J implementation of a local triple store, which runs in the same process as the user application and stores the data on a disk.

Furthermore, GraphDB is important for the authoring platform because it supports semantic inferencing at scale. It handles massive loads, queries, and inferencing in real-time. Finally, GraphDB is used by the authoring platform to provide a SPARQL endpoint for end-users and applications that wish to directly access the knowledge base, connect and extract data.

```
<semantic-form new-subject-template='http://www.cidoc-crm.org/cidoc-crm/E21_Person/{{UUID}}'
    post-action='reload'
    browser-persistence=true
    form-id='person-1'
    fields='[
      {
        "id": "label",
        "label": "person name",
        "description": "The label used to display the instance",
        "defaultValues": [""],
        "xsdDatatype": "xsd:string",
        "selectPattern": "SELECT $value WHERE { $subject rdfs:label $value }",
        "insertPattern": "INSERT {
            ?subject a <http://www.w3.org/2000/01/rdf-schema#:Resource>.
            ?subject1 a <http://www.cidoc-crm.org/cidoc-crm/E21_Person>.
            ?subject1 rdfs:label ?value1 .
            ?subject1 <https://dlnarratives.eu/ontology#hasPilotType> ?param.
            ?subject1 <http://www.cidoc-crm.org/cidoc-crm/P1_is_identified_by> ?appellation_iri.
            ?appellation_iri a <http://www.cidoc-crm.org/cidoc-crm/E41_Appellation>.
            ?appellation_iri rdfs:label ?value
          }
             WHERE {
            BIND(STR(STRUUID()) as ?value1).
            BIND(IRI(CONCAT(\"http://www.mingei-project.eu/resource/\", ?value1)) as ?subject1).
            BIND(IRI(CONCAT(STR(?subject1),\"/\", MD5(?value))) as ?appellation_iri).
            BIND(\"[[urlParam "type"]]\" as ?type).
            BIND(IRI(CONCAT(\"http://www.mingei-project.eu/resource/pilot_type/\", ?type)) as ?param).
          }",
        "deletePattern": "DELETE { $subject rdfs:label $value } WHERE {}"
      }
    ]'>

  <bs-panel>
      <!--h4>Are you sure you want to add new Person?</h4-->
      <semantic-form-text-input for='label'></semantic-form-text-input>
      <semantic-form-errors></semantic-form-errors>
      <!-- save and reset button for form -->
      <button name="submit" class="btn btn-default">Save</button>
      <button name="reset" class="btn btn-default">Reset</button>
   </bs-panel>
  </semantic-form>
```

Figure 17. Creating simple and previewing a field definition.

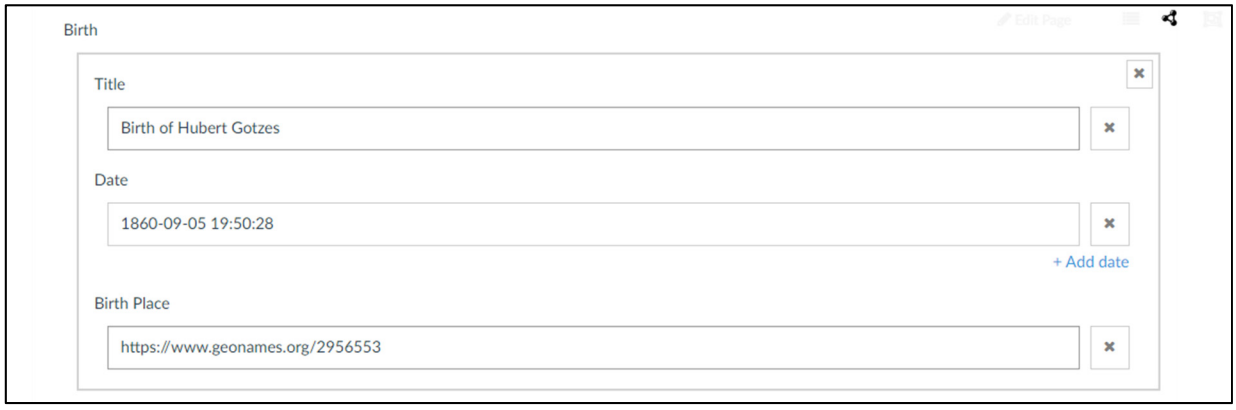


(**a**)

Figure 18. *Cont.*

```
477    <semantic-form-composite-input for='http://www.metaphacts.com/fieldDefinition/Birth' new-subject-template=''
478                          fields='[[fieldDefinitions
479                                  http://www.researchspace.org/instances/fields/Date =
    "http://www.researchspace.org/instances/fields/Date"
480                                  http://www.researchspace.org/instances/fields/Birth_Place =
    "http://www.researchspace.org/instances/fields/Birth_Place"
481                                  http://www.metaphacts.com/fieldDefinition/Event_Title =
    "http://www.metaphacts.com/fieldDefinition/Event_Title"
482                          ]]'>
483        <semantic-form-text-input  for="http://www.metaphacts.com/fieldDefinition/Event_Title">     </semantic-form-text-
    input>
484        <semantic-form-datetime-input for="http://www.researchspace.org/instances/fields/Date">   </semantic-form-datetime-
    input>
485        <semantic-form-text-input  for="http://www.researchspace.org/instances/fields/Birth_Place">     </semantic-form-text-
    input>
486    </semantic-form-composite-input>
487
```

(**b**)



(**c**)

Figure 18. (**a**) Creating a complex field definition, (**b**) Using a complex input field, (**c**) Display a complex field.

4.4.2. Repository Platform

For assets storage, a repository is built by integrating web storage based on the Fedora platform [52]. Fedora is a robust, modular, open-source repository system, with native linked-data support, for the management and dissemination of digital content. It is especially suited for digital libraries and archives, both for access and preservation (https://duraspace.org/fedora/about/, accessed on 20 March 2022). Fedora was selected for this step for a variety of reasons. The most important is that it allows distinguishing between the asset storage, the triple storage, and the UI.

5. Lessons Learned

This paper presented an authoring platform for the representation of traditional crafts. The proposed platform has been applied in the context of the Mingei project for 36 months for the representation of three craft instances. The multitude of dimensions of traditional crafts is addressed by making the platform conformant to knowledge standards of the CH domain and by employing a systematic method for the representation of knowledge. Through this period, the authoring platform was constantly updated, taking into account lessons learned from the application of the methodology and from the achieved understanding of working with TC communities. The outcome of this evolutionary process in terms of valuable lessons for the future is summarized in this section.

STEP 1: During this phase of the methodology, we learned that TCs are deeply rooted in the social and historical context of the communities practicing them, and this is

manifested through multiple dimensions that need to be captured. This leads to a huge amount of digital assets that should be reposited and represented on the platform. The manual curation of this knowledge is time and resources consuming. During the activities in the three pilot sites, we learned that batch processing these assets through the authoring of specialized scripts that import data directly into graphDB by facilitating the SPARQL endpoint might simplify the process and save time and effort. It is foreseen that such mini-apps should either be integrated into the platform or delivered as mini-apps to end-users. Having automated this part of the process, our data curators in Mingei spent more time rationalizing media elements by linking to external and internal sources of information rather than performing tedious tasks.

STEPs 2 and 3: In these phases, it was important for the team to evaluate the capacity of the online platform to represent the vast amount of knowledge acquired. This posed two major challenges. The first challenge was the curation time needed to represent resources, and the second was the expressiveness of the representation needed to address complex knowledge elements such as processes. Regarding the first, we learned that a lot of effort is required from data curators and that training and help are needed to adapt to the new representation facilities. Regarding the second, the close collaboration of semantic experts, developers, and practitioners was required to conceptualize the representation, create the authoring facilities, and train on transforming ethnography to process representations. Overall, we learned through trial and error and by performing three design iterations on the crucial part of the platform. We learned that working closely with data curators is important to be able to adjust functionality to their mental model and scientific context.

STEPs 4 and 5: There were two main challenges faced. The first was to create online presentations of the acquired representation to (a) allow researchers to build narrations for the acquired representation, (b) disseminate knowledge through the authoring platform, and (c) create online information material and process representations. The second was to ensure the compatibility of the knowledge base with external sources, both in terms of linking to external sources and facilitating knowledge standards such as CIDOC and European EDM. The main lessons learned regarded the quality of our representation, which was capable of supporting several online presentations of the represented knowledge. Furthermore, taking into account that the system was based on existing knowledge standards, disseminating the represented knowledge was as simple as creating semantic associations of CIDOC-encoded metadata with other knowledge standards and creating a SPARQL endpoint to deliver knowledge in various standardized formats. We learned that knowledge is power when appropriately disseminated and made efforts in all directions, including integration of knowledge stemming from the authoring platform with national content aggregators and the Europeana.

STEP 6: Moving to the more practical, for the end user's exploitation of knowledge, the main lesson learned was that having a solid knowledge base and a rich representation that includes digital assets greatly enhanced the capacity to deliver results that could be experienced by end-users and visitors to the museum. In this, we learned that content makes a difference, as engaging narrations created through the web platform were disseminated in alternative means and modalities targeting a wide range of uses, including information, education, and entertainment. We learned that the separation of the representation from its usage allowed us to use a plethora of technical tools to create different forms of presentations, thus unleashing the creative powers of UX designers and developers.

From a technical perspective, several challenges faced regarded the integration of various knowledge and digitization formats and the creation of usable UI for a variety of stakeholders using the platform. An important technical drawback stemming from the architecture of the authoring platform regards the differentiation between asset storage and knowledge storage. Taking into account that assets are stored in an external repository and referenced through IRIs, this resulted in an increased effort to link knowledge elements (media objects) with these resources. We learned that in the future, integration of the repository in the system would greatly simplify the authoring of media objects.

6. Conclusions and Future Work

The main contribution of this work may be summarized under the phase: The representations achieved through the authoring platform are narrative-centric rather than artifact centric. To this end, the proposed authoring platform relies on a strong conceptualization and focuses on a notion of narratives that, unlike the previous approaches, exploits both sides of the representation, the semantical (fabula) and the signal-based (the narration) side, and combines these two aspects by linking semantic notions, such as events and actions, to the media objects that illustrate these notions. Notice that this illustration is not only to the benefit of the human user, who can extract a lot of knowledge from media objects, but also of the machine that can analyze these signals and learn from them. Furthermore, the representation of process schemas and processes is a step forward toward preserving valuable craft knowledge for education and training. At the same time, the proposed process representation could foster more intelligent machine interpretations through the exploitation of AI. In the field, the platform has proved the validity of this conceptualization by providing a new representation of crafts of unprecedented richness applied in three pilot sites and for diverse craft instances. The summary of difficulties and experiences during 36 months allowed us to draw valuable results and lessons learned summarized in the previous section.

Technically we can summarise the results of this work as follows. The creation of an authoring platform based on a distributed architecture compatible with open data standards and knowledge representation formats of the CH sector. The platform builds on a Crafts Ontology that specifies the conceptualization by providing a vocabulary for it and axioms to fix the meaning of the vocabulary terms in conformance with the conceptualization. The ontology harmonizes, in a coherent vision, many sub-domain ontologies, re-using solid results in knowledge representation that have now become standards, such as narrative modeling, based on an extension of the CIDOC CRM with narratological concepts; time, based on the OWL time ontology; process schemes, based on activity diagrams of the Unified Modelling Language; content representation, based on the Content in RDF ontology; 4D-fluents for the representation of time-varying properties. Furthermore, the platform provides a rich presentation layer for the exploitation of narratives, with the potential of addressing various kinds of devices and various kinds of users showing the full potential of all of the above.

In conclusion, being almost there, we intend to build on the experience gained and the lessons learned to further improve bits and pieces of our methodology and platform, targeting improved usability and efficiency and possibly integrating facilities that enhance the throughput capacity of CH professionals by simplifying tedious and time-consuming operations, including but not limited to semi-automated facilities for extraction of knowledge elements from textual data, image processing algorithms and more tools that would allow part of knowledge post-processing to happen online thus reduce the need of using external to the platform, tools, and services.

Author Contributions: Conceptualization, N.P., X.Z. and C.M.; methodology, N.P., X.Z. and C.M.; software, V.D., E.K., V.B. and D.M.; validation, N.P., X.Z. and C.M.; formal analysis, N.P., X.Z. and C.M.; investigation, X.Z. and C.M.; resources, V.D. and E.K.; data curation, V.D. and E.K.; writing—original draft preparation, N.P. and X.Z.; writing—review and editing, N.P., X.Z., G.G. and C.M.; visualization, V.D. and E.K.; supervision, N.P., X.Z. and C.M.; project administration, N.P., X.Z. and C.M.; funding acquisition, N.P., X.Z. and C.M. All authors have read and agreed to the published version of the manuscript.

Funding: This work has been conducted in the context of the Mingei project that has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 822336.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data available upon request.

Acknowledgments: The authors would like to thank the Chios Mastic Museum, Haus der Seidenkultur and the Museum of CNAM (Conservatoire national des arts et métiers) for their contribution to this work.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. UNESCO. Page on Traditional Craftsmanship. Available online: https://ich.unesco.org/en/traditional-craftsmanship-00057 (accessed on 23 March 2022).
2. Lenzerini, F. Intangible Cultural Heritage: The Living Culture of Peoples. *Eur. J. Int. Law* **2011**, *22*, 101–120. [CrossRef]
3. Hou, Y.; Kenderdine, S.; Picca, D.; Egloff, M.; Adamou, A. Digitizing Intangible Cultural Heritage Embodied: State of the art. *J. Comput. Cult. Herit.* **2022**. [CrossRef]
4. Zabulis, X.; Meghini, C.; Partarakis, N.; Kaplanidi, D.; Doulgeraki, P.; Karuzaki, E.; Stefanidi, E.; Evdemon, T.; Metilli, D.; Bartalesi, V.; et al. What is needed to digitise knowledge on Heritage Crafts. *Mem. Rev.* **2019**, *4*.
5. Jennings, H. Towards a Definition of Heritage Craft. Report Prepared for Creative and Cultural Skills of the National Skills Academy. 2012. Available online: http://creative-blueprint.co.uk/library/item/towards-a-definition-of-heritage-craft1 (accessed on 23 March 2022).
6. Mingei Online Platform (MOP). Available online: http://mop.mingei-project.eu/ (accessed on 23 March 2022).
7. Purday, J. Think culture: Europeana.eu from concept to construction. *Electron. Libr.* **2009**, *27*, 919–937. [CrossRef]
8. Crowdheritage Platform. Available online: https://crowdheritage.eu (accessed on 23 March 2022).
9. CultureMoves Consortium. CultureMoves Platform. Available online: https://culturemoves.eu/ (accessed on 23 March 2022).
10. Myers, D.; Dalgity, A.; Avramides, I. The Arches heritage inventory and management system: A platform for the heritage field. *J. Cult. Herit. Manag. Sustain. Dev.* **2016**, *6*, 213–224. [CrossRef]
11. Arches. Implementations of Arches. Available online: https://www.archesproject.org/implementations-of-arches-old/ (accessed on 23 March 2022).
12. Bakalos, N.; Rallis, I.; Doulamis, N.; Doulamis, A.; Voulodimos, A.; Protopapadakis, E. Adaptive Convolutionally Enchanced Bi-Directional Lstm Networks for Choreographic Modeling. In Proceedings of the 2020 IEEE International Conference on Image Processing (ICIP), Abu Dhabi, United Arab Emirates, 25–28 October 2020; pp. 1826–1830.
13. Doulamis, A.D.; Voulodimos, A.; Doulamis, N.D.; Soile, S.; Lampropoulos, A. Transforming Intangible Folkloric Performing Arts into Tangible Choreographic Digital Objects: The Terpsichore Approach. In Proceedings of the 12th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications—Volume 5: CVICG4CULT, Porto, Portugal, 27 February–1 March 2017; SciTePress: Setúbal, Portugal, 2017; pp. 451–460.
14. Dimitropoulos, K.; Tsalakanidou, F.; Nikolopoulos, S.; Kompatsiaris, I.; Grammalidis, N.; Manitsaris, S.; Denby, B.; Crevier-Buchman, L.; Dupont, S.; Charisis, V.; et al. A Multimodal Approach for the Safeguarding and Transmission of Intangible Cultural Heritage: The Case of i-Treasures. *IEEE Intell. Syst.* **2018**, *33*, 3–16. [CrossRef]
15. Waelde, C.; Whatley, S. Challenges at the Europeana Space project. In *SOIMA: Unlocking Sound and Image Heritage*; ICCROM: Rome, Italy, 2017.
16. Rizzo, A.; El Raheb, K.; Whatley, S.; Cisneros, R.M.; Zanoni, M.; Camurri, A.; Viro, V.; Matos, J.-M.; Piana, S.; Buccoli, M.; et al. WhoLoDancE: Whole-body Interaction Learning for Dance Education. In Proceedings of the CIRA@ EuroMed 2018, Nicosia, Cyprus, 3 November 2018; pp. 41–50.
17. Cisneros, R.; Crawley, M.L. Moving, annotating, learning: MotionNotes LabDays-a case study. *Int. J. Perform. Arts Digit. Media* **2021**, *17*, 138–149. [CrossRef]
18. Aristidou, A.; Andreou, N.; Charalambous, L.; Yian-Nakidis, A.; Chrysanthou, Y. Virtual Dance Museum: The case of greek/cypriot folk dancing. In *Proceedings of the Eurographics Workshop on Graphics and Cultural Heritage, Aire-la-Ville, Switzerland, 4–6 November 2021*; Hulusic, V., Chalmers, A., Eds.; GCH: Aire-la-Ville, Switzerland, 2021; Volume 21.
19. Bruseker, G.; Carboni, N.; Guillem, A. Cultural heritage data management: The role of formal ontology and CIDOC CRM. In *Heritage and Archaeology in the Digital Age*; Springer: Cham, Switzerland, 2017; pp. 93–131.
20. Haslhofer, B.; Isaac, A. data.europeana.eu: The europeana linked open data pilot. In Proceedings of the International Conference on Dublin Core and Metadata Applications 2011, The Hague, The Netherlands, 21–23 September 2011; pp. 94–104.
21. Ziku, M. Digital Cultural Heritage and Linked Data: Semantically-informed conceptualisations and practices with a focus on intangible cultural heritage. *Liber Q.* **2020**, *30*, 1–16. [CrossRef]
22. Lin, C.-H.; Hong, J.-S.; Doerr, M. Issues in an inference platform for generating deductive knowledge: A case study in cultural heritage digital libraries using the CIDOC CRM. *Int. J. Digit. Libr.* **2008**, *8*, 115–132. [CrossRef]
23. Ruotsalo, T.; Hyvönen, E. An event-based approach for semantic metadata interoperability. In *The Semantic Web*; Springer: Berlin/Heidelberg, Germany, 2007; pp. 409–422.
24. Tudhope, D.; Binding, C.; May, K.; Charno, M. Pattern based mapping and extraction via CIDOC CRM. In Proceedings of the Workshop Practical Experiences with CIDOC CRM and Its Extensions (CRMEX 2013), 17th International Conference on Theory and Practice of Digital Libraries (TPDL 2013), Valetta, Malta, 26 September 2013; Volume 26, pp. 23–36.

25. Damiano, R.; Lieto, A.; Lombardo, V. Ontology-based visualisation of cultural heritage. In Proceedings of the 2014 8th International Conference on Complex, Intelligent and Software Intensive Systems, Birmingham, UK, 2–4 July 2014; IEEE: New York, NY, USA, 2014; pp. 558–563.
26. CIDOC CRM Special Interest Group. CIDOC-CRM Class E5 Event. Available online: https://cidoc-crm.org/entity/e5-event/version-7.1.1 (accessed on 23 February 2022).
27. Doerr, M. The CIDOC Conceptual Reference Model: An ontological approach to semantic interoperability of metadata. *AI Mag.* **2003**, *24*, 75–92.
28. Binding, C.; May, K.; Tudhope, D. Semantic interoperability in archaeological datasets: Data mapping and extraction via the CIDOC CRM. In Proceedings of the International Conference on Theory and Practice of Digital Libraries, Aarhus, Denmark, 14–19 September 2008; Springer: Berlin/Heidelberg, Germany, 2008; pp. 280–290.
29. Bannour, I.; Marinica, C.; Bouiller, L.; Pillay, R.; Darrieumerlou, C.; Malavergne, O.; Kotzinos, D.; Niang, C. CRM CR-a CIDOC-CRM extension for supporting semantic interoperability in the conservation and restoration domain. In Proceedings of the 2018 3rd Digital Heritage International Congress (DigitalHERITAGE) Held Jointly with 2018 24th International Conference on Virtual Systems & Multimedia (VSMM 2018), San Francisco, CA, USA, 26–30 October 2018; IEEE: New York, NY, USA, 2018; pp. 1–8.
30. Truyen, F.; Colangelo, C.; Taes, S. What can Europeana bring to Open Education? In Proceedings of the Enhancing European Higher Education "Opportunities and impact of new modes of teaching" OOFHEC2016 Proceedings, Rome, Italy, 19–21 October 2016; pp. 698–704.
31. Bachi, V.; Fresa, A.; Pierotti, C.; Prandoni, C. The digitization age: Mass culture is quality culture. challenges for cultural heritage and society. In Proceedings of the Euro-Mediterranean Conference 2014, Limassol, Cyprus, 3–8 November 2014; Springer: Cham, Switzerland, 2014; pp. 786–801.
32. Hagedorn-Saupe, M.; Peukert, A. Do It Yourself Digital Cultural Heritage: Three Services Developed by Europeana Space that Support the Creative Reuse of Digital Cultural Heritage Content. In *Uncommon Culture*; ICIMSS: Toruń, Poland, 2018; pp. 105–112.
33. WITH. WITH Culture Platform. Available online: https://withculture.eu/ (accessed on 23 February 2022).
34. Europeana. Europeana Stories Portal. Available online: https://www.europeana.eu/el/stories (accessed on 23 February 2022).
35. Google Inc. Google Arts & Culture. Available online: https://artsandculture.google.com/ (accessed on 23 February 2022).
36. Munjeri, D. Tangible and Intangible Heritage: From difference to convergence. *Mus. Int.* **2004**, *56*, 12–20. [CrossRef]
37. Ruggles, D.F.; Silverman, H. From tangible to intangible heritage. In *Intangible Heritage Embodied*; Springer: New York, NY, USA, 2009; pp. 1–14.
38. Bouchenaki, M. The interdependency of the tangible and intangible cultural heritage. In Proceedings of the 14th ICOMOS General Assembly and International Symposium: 'Place, Memory, Meaning: Preserving Intangible Values in Monuments and Sites', Victoria Falls, Zimbabwe, 27–31 October 2003.
39. Ahmad, Y. The Scope and Definitions of Heritage: From Tangible to Intangible. *Int. J. Heritage Stud.* **2006**, *12*, 292–300. [CrossRef]
40. Keitumetse, S.; Nthoi, O. Investigating the impact of World Heritage site tourism on the intangible heritage of a community: Tsodilo Hills World Heritage site, Botswana. *Int. J. Intang. Herit.* **2009**, *4*, 143–150.
41. Hassard, F. Intangible heritage in the United Kingdom: The dark side of enlightenment? In *Intangible Heritage*; Routledge: London, UK, 2008; pp. 284–302.
42. Donkin, L. *Crafts and Conservation: Synthesis Report for ICCROM*; ICCROM: Rome, Italy, 2001.
43. MINERVA Technical Guidelines for Digital Cultural Content Creation Programmes: Version 2.0. 2008. Available online: https://www.minervaeurope.org/interoperability/technicalguidelines.htm (accessed on 22 January 2021).
44. 3D-ICONS. *Guidelines & Case Studies*; 3D-ICONS is a project funded under the European Commission's ICT Policy Support Programme, project no. 297194; 3D-ICONS: Austin, TX, USA, 2014.
45. Pistola, T.; Diplaris, S.; Stentoumis, C.; Stathopoulos, E.A.; Loupas, G.; Mandilaras, T.; Kalantzis, G.; Kalisperakis, I.; Tellios, A.; Zavraka, D.; et al. Creating immersive experiences based on intangible cultural heritage. In Proceedings of the 2021 IEEE International Conference on Intelligent Reality (ICIR), Piscataway, NJ, USA, 12–13 May 2021; IEEE: New York, NY, USA, 2021; pp. 17–24.
46. Skublewska-Paszkowska, M.; Milosz, M.; Powroznik, P.; Lukasik, E. 3D technologies for intangible cultural heritage preservation—Literature review for selected databases. *Heritage Sci.* **2022**, *10*, 3. [CrossRef]
47. Zabulis, X.; Meghini, C.; Partarakis, N.; Beisswenger, C.; Dubois, A.; Fasoula, M.; Nitti, V.; Ntoa, S.; Adami, I.; Chatziantoniou, A.; et al. Representation and Preservation of Heritage Crafts. *Sustainability* **2020**, *12*, 1461. [CrossRef]
48. United Nations World Tourism Organization. *Study on Tourism and Intangible Cultural Heritage*; UNWTO: New York, NY, USA, 2012.
49. Directorate-General for Education and Culture. *The Economy of Culture in Europe*; European Commission: Brussels, Belgium, 2006.
50. Acker, O.; Gröne, F.; Kropiunigg, L.; Lefort, T. *The Digital Future of Creative Europe*; Stategy&: New York, NY, USA, 2015.
51. Zabulis, X.; Partarakis, N.; Meghini, C.; Dubois, A.; Manitsaris, S.; Hauser, H.; Thalmann, N.M.; Ringas, C.; Panesse, L.; Cadi, N.; et al. A Representation Protocol for Traditional Crafts. *Heritage* **2022**, *5*, 716–741. [CrossRef]
52. Lyrasis. Fedora—Open Source Repository Platform. Available online: https://duraspace.org/fedora (accessed on 23 February 2022).
53. Getty Research Institute. The Art & Architecture Thesaurus. Available online: https://www.getty.edu/research/tools/vocabularies/aat/ (accessed on 23 February 2022).

54. UNESCO. UNESCO Thesaurus. Available online: https://skos.um.es/unescothes/ (accessed on 23 February 2022).
55. FactForge. FactForge Open Data and News about People, Organizations and Locations. 2021. Available online: http://factforge.net/about (accessed on 23 February 2022).
56. GeoNames. GeoNames Geographical Database. 2021. Available online: https://www.geonames.org/ (accessed on 23 February 2022).
57. Propp, V. *Morphology of the Folktale*; University of Texas Press: Austin, TX, USA, 1973; Volume 9.
58. Shklovsky, V. Art as technique. In *Russian Formalist Criticism: Four Essays*; University of Nebraska Press: Lincoln, NE, USA, 1965; Volume 3.
59. Bartalesi, V.; Meghini, C.; Metilli, D. Steps towards a formal ontology of narratives based on narratology. In Proceedings of the 7th Workshop on Computational Models of Narrative (CMN 2016), Kraków, Poland, 11–12 July 2016; Schloss Dagstuhl-Leibniz-Zentrum fuer Informatik: Wadern, Germany, 2016.
60. Ontotext, GraphDB-Semantic Graph Database. Available online: https://graphdb.ontotext.com/ (accessed on 23 February 2022).
61. British Museum. ResearchSpace Platform. Available online: https://researchspace.org/ (accessed on 23 February 2022).
62. Oldman, D.; Tanase, D. Reshaping the knowledge graph by connecting researchers, data and practices in ResearchSpace. In *The Semantic Web—ISWC 2018*; Springer: Cham, Switzerland, 2018; pp. 325–340.
63. Severance, C. Roy T. Fielding: Understanding the REST Style. *Computer* **2015**, *48*, 7–9. [CrossRef]
64. Pérez, J.; Arenas, M.; Gutierrez, C. Semantics and complexity of SPARQL. *ACM Trans. Database Syst.* **2009**, *34*, 1–45. [CrossRef]
65. Meghini, C.; Bartalesi, V.; Metilli, D. Representing Narratives in Digital Libraries: The Narrative Ontology. 2020. Available online: http://www.mingei-project.eu/wp-content/uploads/2020/06/representing_narratives.pdf (accessed on 23 February 2022).
66. Guarino, N. Formal Ontology and Information Systems. In Proceedings of the FOIS'98, Trento, Italy, 6–8 June 1998; IOS Press: Amsterdam, The Netherlands, 1998; pp. 3–15.
67. Meghini, C.; Doerr, M. A first-order logic expression of the CIDOC conceptual reference model. *Int. J. Metadata Semant. Ontol.* **2018**, *13*, 131–149. [CrossRef]
68. Bartalesi, V.; Meghini, C.; Metilli, D.; Benedetti, F. Introducing narratives in Europeana: A case study. *Int. J. Appl. Math. Comput. Sci.* **2019**, *29*, 7–16.
69. Bartalesi, V.; Meghini, C.; Metilli, D. A conceptualisation of narratives and its expression in the CRM. *Int. J. Metadata Semant. Ontol.* **2017**, *12*, 35–46. [CrossRef]
70. Cox, S.; Little, C. Time Ontology in OWL, W3C Recommendation, 19 October 2017. Available online: https://www.w3.org/TR/owl-time/ (accessed on 24 May 2021).
71. Brickley, D.; Guha, R.V. RDF Schema 1.1. W3C Recommendation, WWW Consortium, February 2014. Available online: http://www.w3.org/TR/rdf-schema/ (accessed on 23 February 2022).
72. Motik, B.; Patel-Schneider, P.F.; Parsia, B. OWL 2 Web Ontology Language Structural Specification and Functional-Style Syntax (Second Edition). W3C Recommendation, WWW Consortium, December 2012. Available online: http://www.w3.org/TR/owl2-syntax/ (accessed on 23 February 2022).
73. CIDOC CRM Special Interest Group. CIDOC-CRM Class E29 Design or Procedure. Available online: https://cidoc-crm.org/Entity/E29-Design-or-Procedure/version-7.1.1 (accessed on 23 February 2022).
74. CIDOC CRM Special Interest Group. CIDOC-CRM Class E21 Person. Available online: http://www.cidoc-crm.org/cidoc-crm/e21_Person (accessed on 23 February 2022).
75. W3C. SPARQL 1.1 Protocol. Available online: https://www.w3.org/TR/sparql11-protocol/ (accessed on 23 February 2022).
76. Eclipse Foundation, Inc. Eclipse RDF4J Framework. Available online: https://rdf4j.org/ (accessed on 23 February 2022).