

**A Study on a Metadata Model of Cultural  
Heritage Digital Archives as an Intellectual  
Creation by Memory Institutions**

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## **1. Introduction**

Cultural heritage (CH) is an entity which demonstrates a value derived from an idea, a custom and tradition of a particular society. Cultural heritage object (CHO) may be represented and archived in digital formats. Digital instances are ingested from various ways such as recording, digitization, conversion and so forth. There are various kinds of CHOs and they may be realized in various digital forms in the digital information environment. In this thesis, those entities which represent CHOs in the digital environment are called Cultural Heritage Information (CHI). CHI may or may not include a digital image(s) of its original CHO but has to have descriptions about the CHO and CHI itself, i.e., metadata. Those digital images are a digital surrogate of the CHO and main components of cultural digital archives.

Memory institutions, i.e., museums, libraries and archives, create and collect CHI, organize the CHI as a digital archive and provide access to CHI. Many memory institutions have developed digital collections of their CHOs. And, many efforts to connect those digital collections across institutions have been made. Europeana is a well-known portal to European digital cultural heritages which aggregates CHI resources provided by memory institutions in Europe. Thus, the networked information environment on the Web enables memory institutions to create value-added services.

Those memory institutions use standards for creating CHI in accordance not only with the types of CHOs but also with their institutions' conventions. This causes interoperability problems on CHI for their use across institutions. Moreover, ambiguity on assigning the metadata could cause interoperability problems across the institutions because of unclear separation of descriptions between the CHO and CHI, e.g., original object vs. its digital surrogate, digital content vs. carrier of the content, and so forth. Memory institutions may collect CHI resources over the Web and organize the collected CHI to create digital archives of cultural heritage which may be larger than their own CHO collections and/or specialized in a certain topic.

This study focuses on digital curation activities by memory institutions from the viewpoint of metadata models. Metadata models in this study means a basic metadata modeling used in both physical and digital space on how the metadata of digital exhibitions should be described and applicable for use. The author limited the discussion

scope on modeling for digital space (the networked information environments) i.e., digital exhibitions.

In the digital curation process, those people at memory institutions who are responsible to develop digital archives do very intellectually creative activities – selection of culturally important resources, collection and organization of the resources, resource access design for users, and exhibitions of the collected resources either in a purely digital environment or in a mixed environment. Among these functions, digital exhibition is an important function of digital archives of CHOs. It requires highly intellectual process from planning, selecting, editing, creating the digital surrogates of CHOs for display, to making the digital surrogates accessible on the Web. This thesis calls this overall work as a digital curation which is done by digital curators. Digital curators present not only the digital surrogates (i.e., digital content) but also their contextual information edited for the exhibition. Since a digital exhibition is a highly intellectual product, a metadata model that sufficiently describes its overall intellectual activities is immensely needed. For example, we would need metadata to find exhibitions and cultural heritage resources presented in the exhibitions. In addition, cultural heritage exhibition on a particular topic may be hosted in different locations and at different time. A metadata model to organize cultural heritage information for the exhibitions is highly needed to find and reuse information resources developed for the past exhibitions in prospective exhibitions and to create new resources.

However, these issues have not been sufficiently addressed seen from studies conducted on cultural heritage digital exhibition. Therefore, initial effort for developing a metadata model that reflects the intellectual activity as well as organizes the overall cultural heritage information for the exhibitions are issues that have been trying to be overcome in this study.

Memory institutions often create the digital exhibition webpages as a part of exhibitions hosted at physical locations. Those webpages are provided to promote the physical exhibitions and to help potential visitors learn about the exhibitions and their contextual information such as cultural contexts and history of the objects shown in the exhibitions. Those portals such as Europeana and Digital Public Library of America (DPLA) aggregate CHI, managing the digital instance and adding some useful information such as background stories and relationships to other cultural heritage. In the

digital environment, compared with traditional physical object-based information environment, it is rather easier to link CHOs to other related CHOs as well as to those resources which contain rich information about the CHOs if metadata about the CHOs and related resources are given in an interoperable format.

As, in many cases, digital exhibitions are composed of several sections, digital exhibitions are described by multiple sections and in multiple layers. Those sections and layers are designed based on contextual information for the exhibition. Descriptions of those sections and layers are mainly comes from descriptions about curated CHOs and CHI, e.g., digital photograph, video, and so forth. How to enhance accessibility to the exhibition information and improve interoperability across the information is a challenge in this study. The author believes a metadata model of the digital exhibition should be able to describe a whole exhibition, a part of exhibition and each component. Some basic research questions are; what major approaches do digital curators adopt to describe a part and overall multilevel metadata of the digital exhibition? How would the digital exhibition be adjusted to apply the newly created descriptive metadata of cultural heritage digital instance? Those questions would try to be answered in this study.

There exist several standard metadata models for describing cultural heritage objects. For example, CIDOC CRM (Conceptual Reference Model) [8] is a well-known standard ontology for museums, and Functional Requirements for Bibliographic Records (FRBR) [5] defined by IFLA is widely accepted as a framework to describe bibliographic entities. In particular, Group 1 entities of FRBR, which are *work*, *expression*, *manifestation* and *item* (FRBR WEMI), are well known as classes of bibliographic entities. And, CHDE (Cultural Heritage in Digital Environment) model was proposed by the author's lab as a metadata framework to describe both tangible and intangible cultural heritage objects. Those metadata models are examined in this study to design a metadata model for describing digital exhibitions.

A preliminary study of this thesis was published at A-LIEP 2017 [1] which proposed a model to describe cultural heritage resources presented in a digital space and an application of FRBR WEMI to the cultural heritage resources. In this study the author focusses on intellectual creation in the digital curation process and applies FRBR WEMI to that process in order to describe non-Item resources. Since a digital exhibition of cultural heritage deals with large curated collections of the digital resources, the

applicability of FRBR WEMI to digital exhibitions has important meanings for enhancing reusability of digital resources and for improving accessibility to digital heritage resources.

This study examined the applicability of FRBR WEMI to be used for modeling digital exhibition. The result shows that FRBR WEMI is suitable for modeling digital exhibition of their digital resources as a product of intellectual creation activities. In other words, this study views a digital exhibition like a book for which FRBR is originally designed. FRBR WEMI Group 1 Entities enable to thoroughly take a look at the complex path of a digital exhibition starting from an abstract entity in digital curator's mind (*work* and *expression*) to the physical realization which is embodied in a digital entity (*manifestation* and *item*). This study highlighted FRBR *work* and *expression* as an intellectual activity which is embodied into *manifestation* and *item* as an intellectual product. Furthermore, a cultural heritage digital archives/exhibition is consisting of multilayers, then FRBR WEMI is applied to describe each layer. Since, FRBR WEMI is a high-level description, RDA which inherits WEMI is used as a guideline for the actual implementation.

The thesis is organized into six chapters as follows. Chapter 1 describes the introduction of the thesis which includes the research outline. Chapter 2 explains justification in this study, term definition and scope of this study. Chapter 3 explains literature reviews and related works by describing some models which is mostly used for cultural heritage. Chapter 4 is dedicated to explaining some examples i.e., metadata of digital exhibitions and methodology used. Chapter 5 describes the result and further discussion regarding the findings. Chapter 6 is a conclusion of this study.

## **2. Cultural Heritage Digital Archives (CHDA)**

### **2.1 Cultural Heritage Digital Service and Portal**

Cultural heritage digital archives might be a service or portal. 'Service' means a digital archives service provided by a Single institution, and 'Portal' means a portal service build on a set of digital archives. 'Service' and 'Portal' may be replaced by 'Institutional Digital Archives' and 'Digital Archive Portal', respectively.

This thesis uses the digital archives as a collection of digital resources, mainly cultural heritage resources. Digital library is a commonly used term to mean a large

collection of digital resources provided for use by users like library collections, and digital museum is often used to mean a digital collection created by digitization of museum holdings and a service to provide access to the digital collection. These terms have similar meanings but the author uses 'Digital Archives' in this thesis because it focuses on digital collection of cultural resources and it is widely accepted in Japan.

Development of cultural digital archives started in early 1990s. American Memory by the Library of Congress is one of the early large projects. In 1990s, there were many projects hosted by national and university libraries. Some projects were carried out by collaboration by a group of libraries, e.g., Making of America. Each project developed a large set of digital images of cultural heritage objects. In Europe, The European Library (TEL) project was collaboratory carried out for building a pan-Europe Digital Library which provide access to digital collections build by participating institutions. Europeana which came after TEL had a broader community of memory institutions.

Thus, development of digital archives started as projects at single institutions and expanded to collaborative projects. Those collaborative projects often collect only metadata from participating institutions and operate as a portal for the digital archives developed by each institution. Those participating institutions develop their metadata based on their policy, so that their metadata schemas may not be the same. Digital archives portals define their metadata schemas for aggregating metadata collected from the participating institutions.

### **2.1.1 British Museum Digital Exhibition**

British Museum conducts On-site exhibitions several times in a year. Despite holding On-site exhibition, British Museum also develops digital exhibition on their website. The aims of the website are to promote the On-site exhibition as well as to portray the On-site exhibition in virtual experience. Some exhibitions conducted by British Museum exhibit local collection and sometimes on special exhibition, they exhibit collection from other countries. Design of the webpage seemingly is intended for visitors to know the digital curated information beyond a particular real exhibition. Figure 1 and 2 show example screen shots taken from The British Museum Sythians Warriors of Ancient Siberia.



Figure 1. The British Museum Sythians Warriors of Ancient Siberia<sup>1</sup>

The British Museum Sythians Warriors of Ancient Siberia exhibition webpage which is shown in Figure 1 briefly providing an explanation pertaining to this exhibition. This British Museum digital exhibition provides further explanations through a few links to other webpages. As shown in Figure 2, there are several links which is referring to other webpages which describe this exhibition further.

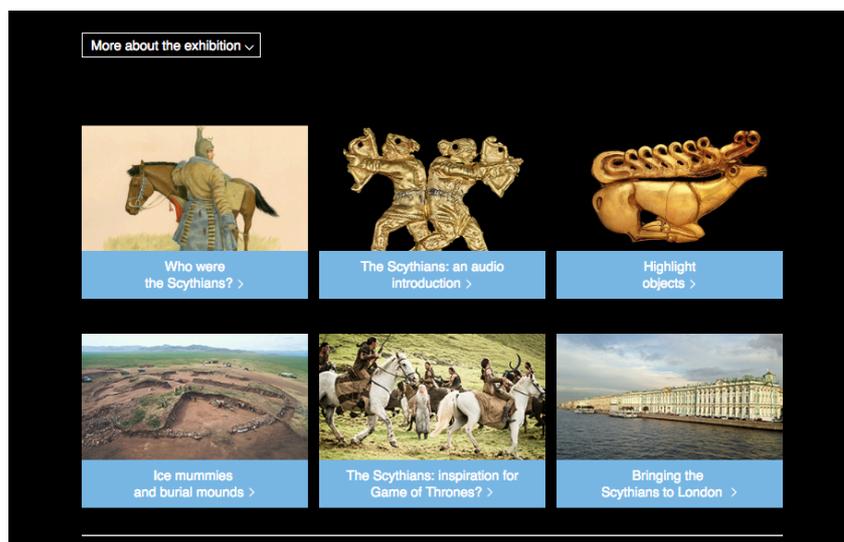


Figure 2. Categories of The British Museum Scythians Warriors of Ancient Siberia

<sup>1</sup> [http://www.britishmuseum.org/about\\_us/past\\_exhibitions/2017/Scythians.aspx](http://www.britishmuseum.org/about_us/past_exhibitions/2017/Scythians.aspx)

Those links in Figure 2 usually contains contextual information which is mainly comes from curated digital instance description and single digital instance e.g., digital photograph, video, and so forth. As depicted in Figure 3, British museum has several ways to describe the metadata of the digital instance; by providing a link to another website which may be a website under British museum or an external website, and by explaining the descriptive metadata placed below the image as shown in Figure 4. For those digital collections which are recorded in British museum database, the metadata of digital surrogate of a CHO is usually described in detail in a webpage as seen in Figure 4. However images that belong to other institutions may not be always given a link in the exhibition pages of British Museum.



Figure 3. Curated webpage<sup>2</sup>

Unfortunately, we sometimes find ambiguity when deciphering the resource descriptions. As shown in Figure 4, the attribute on the left side describes attributes of the original cultural heritage object and information of the digital surrogate on the right is not clearly given.

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<sup>2</sup> [https://blog.britishmuseum.org/introducing-the-scythians/?\\_ga=2.26810751.315747236.1533541479-1704976471.1486523769](https://blog.britishmuseum.org/introducing-the-scythians/?_ga=2.26810751.315747236.1533541479-1704976471.1486523769)

**Collection online**

costume-fitting

Object type **costume-fitting**

Museum number 1909.0617.2

Description Gold sew-on clothing appliqué in the form of two Scythian archers back to back, probably blood-brothers.

Culture/period **Hellenistic**

Date 400BC-350BC

Findspot **Excavated/Findspot: Kuloba (probably); (Europe,Ukraine,Crimea,Kuloba)**

Materials **gold**

Dimensions Height: 3.1 centimetres  
Weight: 26 grains  
Weight: 1.45 grammes

Bibliography **Jewellery 2106.d**

Location Not on display

Associated places **Associated with: Scythia (Europe,Scythia)**

Acquisition name **Purchased from: F Champness**

Acquisition date 1909

Department Greek & Roman Antiquities

Registration number 1909.0617.2



Large image More views (3)

Image service: Use image Request new photography

Recommend

f t

Figure 4. The Metadata of a Collection Online<sup>3</sup>

### 2.1.2 Europeana

Europeana is a digital platform for cultural heritage provided by European countries. It aims to aggregate cultural heritage content through the European partnership, to facilitate knowledge transfer, innovation and advocacy derived from cultural and scientific heritage sector, to disseminate the high quality cultural heritage content to public, and to encourage people to engage with the cultural and scientific heritage sector [2]. Around 3000 cultural heritage institutions in Europe have contributed to this project.

Since Europeana is a huge portal, it has several ways for users to browse its collection. Through the searching interface on homepage, users can access exhibitions organized by topic. Each exhibition provides a digital collection aggregated from their partners. It is contrary to the British Museum's Website which primarily shows resources included in the local collection. As shown in Figure 5, the figure is showing a scene of a market from the 19<sup>th</sup> century.

<sup>3</sup>[http://www.britishmuseum.org/research/collection\\_online/collection\\_object\\_details.aspx?objectId=434391&partId=1&\\_ga=2.22819321.315747236.1533541479-1704976471.1486523769](http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=434391&partId=1&_ga=2.22819321.315747236.1533541479-1704976471.1486523769)



Figure 5. Tricks of the Trade<sup>4</sup>

In this example, in order to enrich the information related to the image, information about curated resource is attached below the image and few evidences aggregated from external resource e.g., image, video, and so forth is linked to the curated information and exhibited its contextual information as well.

Europeana shows not only those resources collected from its participating institutions but also those collected from some partners such as using Google Arts & Culture.

Media Metadata	
<b>Title</b>	Tunisie   Neurdein Frères
<b>Description</b>	Cobblers Souk, Tunisia, circa 1900.
<b>People</b>	Creator: Neurdein Frères
<b>Classifications</b>	<b>Type:</b> Photography <b>Subject:</b> photography, goods distribution, employment, trade, souk, bazaar, cobbler, job, occupation, shoe, street, inside view, interior, inside, shop, stall, market, goods, Architecture
<b>Properties</b>	<b>Format:</b> Gelatin silver transparencies, Black-and-white transparencies, Gelatin silver negatives, Gelatin dry plate negatives, Slab-and-white negatives, Négatif au gélatino-bromure d'argent sur verre, Photo en noir et blanc, Transparencs gélatino-argentine, Transparent en noir et blanc, Négatif gélatino-argentine, Négatif sur verre au gélatino-bromure d'argent, Négatif en noir et blanc, 30x24, cm
<b>Time</b>	<b>Creation Date:</b> 1895/1905
<b>Provenance</b>	<b>Provenance:</b> Roger-Viollet <b>Identifier:</b> 82022-30, -Accession Number: ND-1247 TYPES TUNISIE 24x30

Figure 6. Metadata of Tunisie<sup>5</sup>

<sup>4</sup> [https://www.europeana.eu/portal/en/exhibitions/tricks-of-the-trade/a-buyer-s-market#ve-anchor-intro\\_14726-js](https://www.europeana.eu/portal/en/exhibitions/tricks-of-the-trade/a-buyer-s-market#ve-anchor-intro_14726-js)

<sup>5</sup> [https://www.europeana.eu/portal/en/record/2024913/photography\\_ProvidedCHO\\_Parisienne\\_de\\_Photographie\\_82022\\_30.html](https://www.europeana.eu/portal/en/record/2024913/photography_ProvidedCHO_Parisienne_de_Photographie_82022_30.html)

## 2.2 Existing Metadata Models

Metadata is defined as a data about data. There are several types of metadata i.e., descriptive metadata, structural metadata, and administrative or technical metadata. In this study we focus on descriptive metadata. Descriptive metadata is metadata for describing content of an object [3]. Descriptive metadata is used to help users find and access resources and provides important contextual information about a resource once it is discovered. This type of metadata drives the ability to search, browse, sort, and filter information [4]. Several existing metadata models are described in the following sections.

### 2.2.1 Functional Requirements for Bibliographic Records (FRBR)

FRBR was developed by IFLA as an underlying model for bibliographic description [5]. This model analyzed the bibliographic universe and divided into three groups of entities, which are called Group 1, 2 and 3. Entity-relationship model was used to define the model. FRBR does not define cataloging rules but is a conceptual model that defines entities which should be included in bibliographic descriptions and relationships among the entities. Group 1 is composed of a physical entity which users use (*item*) and abstract entities which represent entities in different abstraction levels (*manifestation*, *expression* and *work*). Brief description of these entities is shown below,

- *work*, is an abstract entity of intellectual distinction or artistic creation
- *expression*, is the intellectual realization of a *work* in particular form
- *manifestation*, is a physical embodiment of an *expression*
- *item*, is a copy of *manifestation*

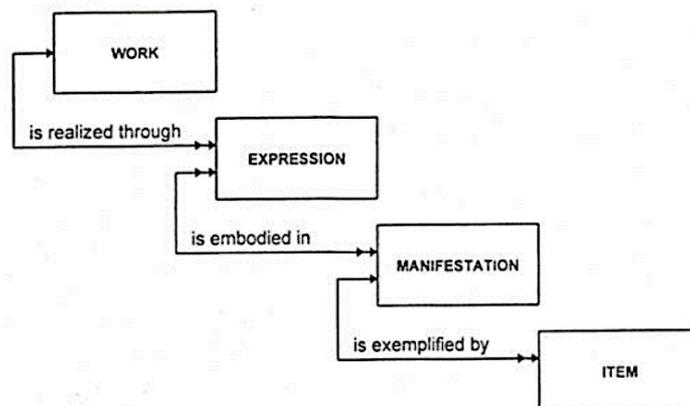


Figure 7. Group 1 Entities and Primary Relationship

Group 2 defines entities which have played some roles to create a Group 1 entity, e.g., author, painter, composer, and so forth. Group 2 entities can be classified into a few types i.e., *person, family, corporate body*. Group 3 consists of entities that can be subject for Group 1 or Group 2, Concept, Object, Event, Place.

In this study we examine only Group 1 entities. FRBR is mainly used by libraries to describe their bibliographic record. FRBR may be applicable to CHOs at other memory institutions as long as distinction of instances based on the Group 1 entities is meaningful.

### 2.2.2 IFLA- Library Reference Model (LRM)

IFLA - Library Reference Model (LRM) is a single, consistent model covering all aspects of bibliographic data (a consolidation of FRBR, FRSAD, and FRAD). This model was proposed by IFLA in August 2017 [6].

This model focuses on user tasks which includes find, identify, select, obtain, and explore. As same as FRBR, IFLA LRM also has high level description which is not intended for implementation. It fully supports user-task, hence administrative metadata that does not support user tasks are excluded in this model. IFLA LRM is compatible with other models such as CIDOC Conceptual Reference Model and object-oriented FRBR (FRBRoo).

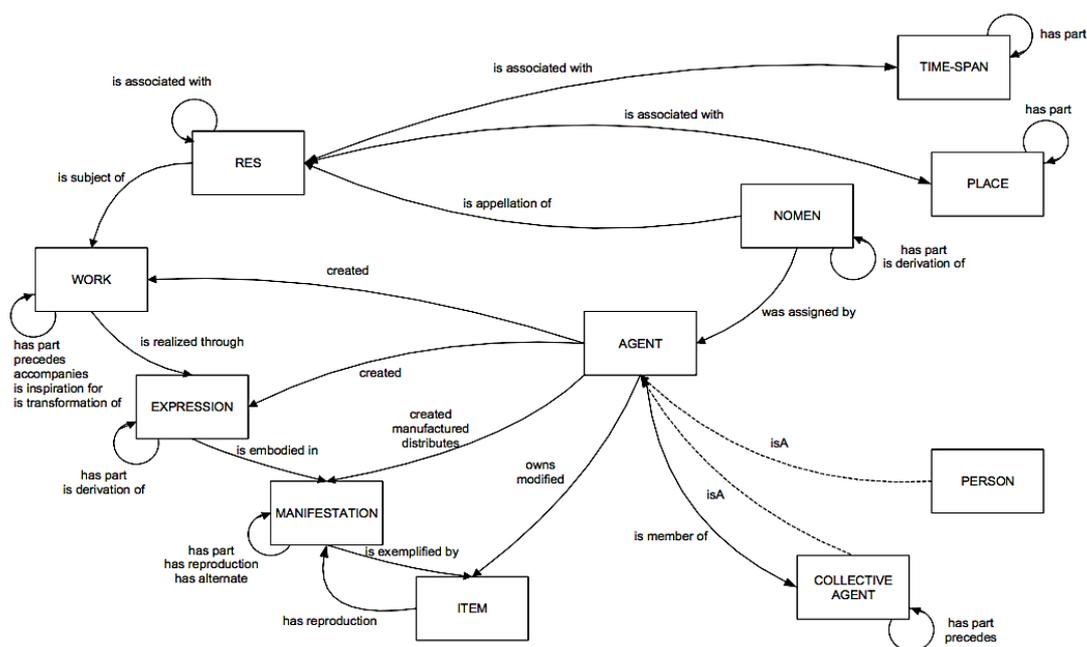


Figure 8. Overview of IFLA LRM Relationship

IFLA LRM defines semantic structure of the entities defined by FRBR to clarify semantic relationships among those entities. In other words, LRM is defined as an ontology like CIDOC CRM based on their predecessors, FRBR, FRSAD and FRAD. So, *work, expression, manifestation and item* (WEMI) are a part of core entities of LRM. However, as it is a new model defined as a foundation, it's vocabulary is not large. LRM defines some constrains among WEMI e.g., *a work* must have at least *an expression*, but *an expression* is not mandated to have *a manifestation* or *item*.

### **2.2.3 Functional Requirements for Bibliographic Records-Object Oriented (FRBRoo) Model**

Functional Requirements for Bibliographic Record-object oriented (FRBRoo) is a harmonization of FRBR and CIDOC CRM. This model was approved and issued by IFLA in January 2010 [7]. FRBRoo aims to represents FRBR, Functional Requirements for Authority Data (FRAD), and Functional Requirements for Subject Authority Data (FRSAD) through modelling the conceptualization of reality behind practice, to express the conceptualization of the FRBR family within the object-oriented methodology, to identify the common ground that memory institutions share such as a common view of cultural heritage information, interoperability and integration of information, and so forth.

### **2.2.4 CIDOC Conceptual Reference Model (CRM)**

The CIDOC Conceptual Reference Model (CRM) is an extensible ontology intended for cultural heritage domain and museum documentation [8]. This model aims to provide a reference model and information standard for describing the cultural heritage collections owned by memory institutions (e.g., Museums, Libraries, Archives, so forth) as well as improving information sharing.

In addition, this model adopts formal semantics which enhance metadata interoperability and integration by machines. It extensively uses XML and Resource Description Framework (RDF). In this ontology domains includes several core classes: space-time to persistent items.

### 2.2.5 Cultural Heritage in Digital Environment (CHDE) Model

Cultural Heritage in Digital Environment (CHDE) is a model for digital archives of cultural heritage which tries to make explicit representation of the cultural heritage objects in both digital and physical spaces and designed based on the One-to-One Principle of Metadata [11]. CHDE defines distinct models for intangible and tangible cultural heritage. Intangible cultural heritage such as dance and craftsmanships, has its own-unique embodiment due to its nature. Their emdodiment which has physical representation has to be recorded in some forms to be archived as a cultural heritage resource. Therefore, an archived resource is a record of the physical embodiment of the performance, i.e., a performance which is showed in particular time at different location is embodied. In CHDE, the embodied instances are called *Instantiation* as shown in Figure 9.

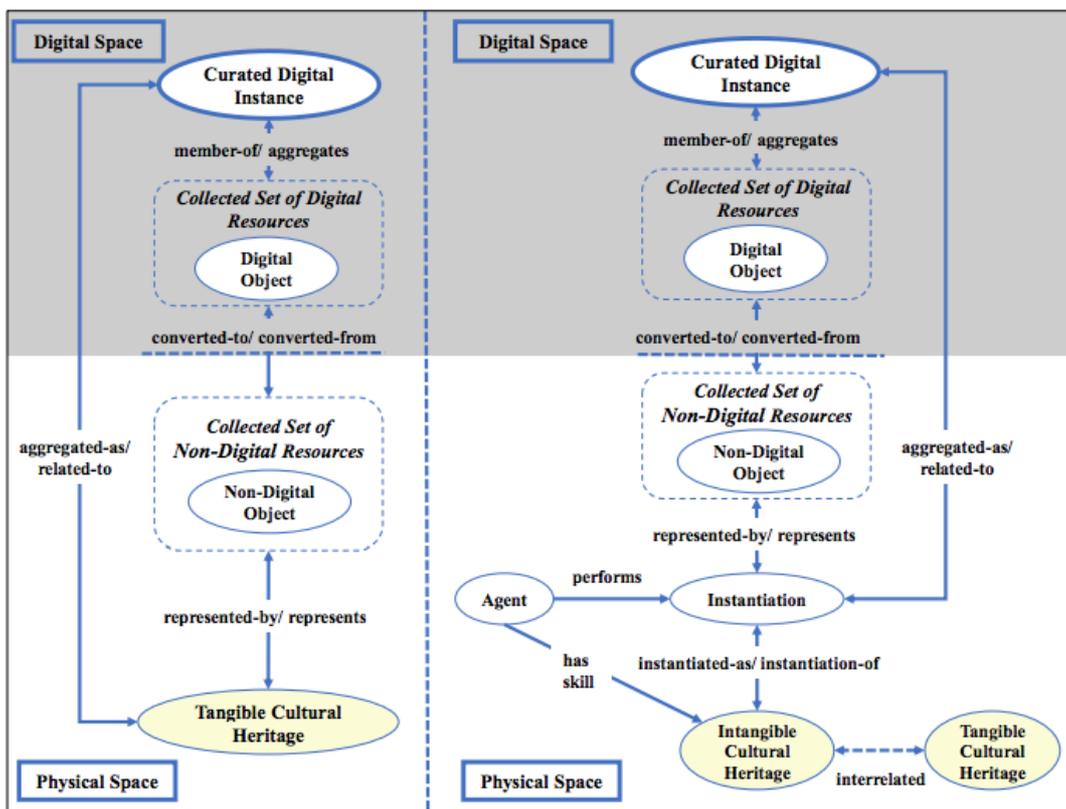


Figure 9. Cultural Heritage in Digital Environment Model

### 2.2.6 Resource Description and Access (RDA)

Resource Description and Access (RDA) is descriptive cataloging standard. This concept was inherited from Anglo-American Cataloguing Rules, Second Edition (AACR2). It is

providing set of instructions and guidelines on describing bibliographic data which covers all types of content and media. Moreover, it is intended for use by libraries and other cultural organizations.

RDA is also designed to be flexible and efficient in data capture, storage, retrieval, and display made it possible with new database technologies. Furthermore, it is compatible with the legacy technologies still used in many resource discovery applications [10]. It furthermore aligns with FRBR, FRAD and FRSAD. For the alignment with FRBR, RDA has the attributes and relationships associated with the FRBR Group 1 entities as well. Those entities are defined in RDA as follows:

- *work*: A distinct intellectual or artistic creation, that is, the intellectual or artistic content.
- *expression*: An intellectual or artistic realization of a *work* in the form of alphanumeric, musical or choreographic notation, sound, image, object, movement, etc., or any combination of such forms.
- *manifestation*: A physical embodiment of an *expression of a work*.
- *item*: A single exemplar or instance of a *manifestation*.

RDA has vocabularies that is representing the RDA entities, elements, relationship designators, and controlled vocabulary in RDF. In addition, the vocabularies are supporting linked data applications as well.

### **2.3 Cultural Heritage Information in Physical and Digital Space**

Identifying cultural heritage information (CHI) resources is important to assign the metadata correctly. CHI is information about CHOs which includes digital surrogates and their metadata. Proper identification helps avoid ambiguity in description of the metadata. At the same time, it would help enhance metadata interoperability across different domains of cultural heritage. The table below shows differences in some of major categories between descriptions about digital instances and physical instances.

Table 1. Instances in Digital and Physical Spaces

Category	Digital	Physical
<b>Format/Embodiment</b>	Digital format (e.g., PNG, JPG, MP4, etc.)	Leaf, manuscript, plant, statue, stones, etc.
<b>Provider/ belongs to</b>	Digital Archives Memory Institutions	Memory Institutions
<b>Collection</b>	Digital archives (e.g., digital surrogate, digital photograph, etc)	CHOs (e.g., painting, sculpture, etc)
<b>Metadata</b>	<ul style="list-style-type: none"> <li>• Digital surrogate</li> <li>• CHOs</li> </ul>	CHOs (Physical Objects)
<b>Copyright</b>	<ul style="list-style-type: none"> <li>• Memory Institutions (digital curator)</li> <li>• Photographer</li> </ul>	<ul style="list-style-type: none"> <li>• Memory Institutions</li> <li>• Original creator</li> <li>• Photographer</li> </ul>
<b>Work</b>	Digital curator (persona or group)	Unknown/creator

Separating these space legitimately matters, enables to avoid One-to-One Principle [11] violation where one resource should be described by one metadata description. Considering CHI which contains descriptions about CHOs and information carriers, metadata for CHI should explicitly states correspondence between its component descriptions and objectives of the descriptions.

#### 2.4 Digital Curation Process for Cultural Heritage Objects

Vast amount of valuable cultural heritage resources are accessible in digital forms over the Internet in thesedays. Due to distribution of cultural heritage objects in digital forms, it is not easy for users to link those objects and to learn about the cultural contexts of those objects only from them. Cultural heritage objects curated into memory institutions and their digital archives are organized for users to help them dechipher the information beyond the digital instance. Moreover, the information that users obtain from curated digital instance is reliable since the decription is evidence based. Thus, memory institutions add values to cultural heritage objects through the curation process.

Digital curation process for cultural heritage object is composed of collecting, selecting, editing, and designing the visual implementation of the curated digital instance. Digital curators are a person or a group of people who is in charge of the digital curation process. Digital curators create various metadata for the digital exhibition and build various functions to present CHI based on the values and meanings of CHI in the cultural contexts, which can not be handled by machines.

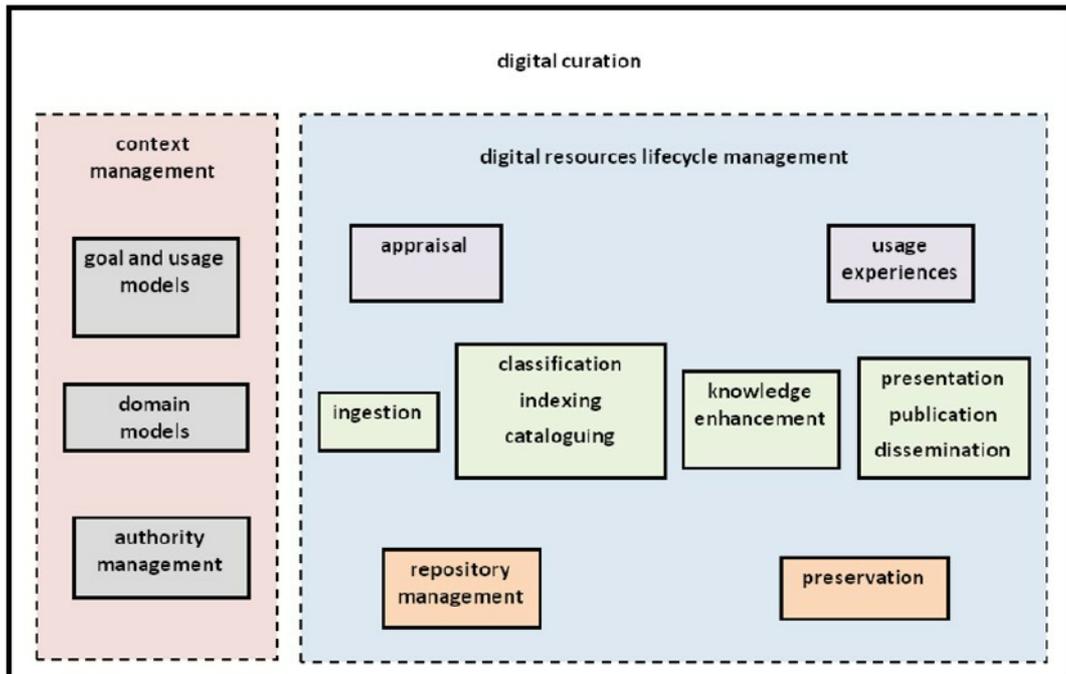


Figure 10. Digital Curation Process

The Digital Curation Centre (DCC) in UK and the Digital Curation Unit (DCU) of the Athena Research Centre [12] defined the digital curation process as depicted in Figure 7. Based on Figure 10, DCC and DCU divided digital curation into two managements process which relies one another. In digital resource lifecycle management, a curator does:

- *Appraisal* by creating criteria for the evaluation of the potential resources,
- *Ingestion* by creating the digital recording of image, sound, text and data, the digitisation of analog recordings on various physical carriers, and importing digital resources from one or more sources, including repositories.
- *Classification, indexing and cataloguing*. This task is needed to produce indices related to the intended or possible uses of digital resources.

- *Knowledge enhancement* includes adding value by annotating documents with the entities of an ontology they refer to, representing formally the situations or events mentioned in documents, linking documents to other documents that support or contradict them would all be cases of knowledge enhancement, etc.
- *Presentation, publication and dissemination.* [12]

The digital resource lifecycle management processes rely on three supporting processes, those are: (1) goal and usage modelling to capture the intentions of the creators and the users of a given class of digital resources, together with the usage patterns of the resources, (2) domain modelling to produce and refine representations of expert knowledge about a domain of interests, and (3) authority management to deal with the controlled vocabularies (e.g., geographic names, historical periods, chemical molecules, biological species) used by convention to denote concepts, properties and relations [12].

## **2.5 Viewing Exhibitions of Cultural Heritage as Intellectual Creation**

Digital exhibition is a product by highly intellectual activities. It handles the digital instance thoroughly by providing contextual explanation connected to the particular digital instance. The goal of this thesis is to propose a metadata model to describe digital exhibitions as intellectual creation. The metadata model helps us find, access and use digital exhibitions and cultural heritage objects included in the exhibitions.

Museums organize exhibitions, which may be classified into regular and special exhibitions. The former is hosted regularly but the latter is done in a specific period and under a specific theme. Digital exhibitions may be defined similarly to these regular and special exhibitions. Museums usually choose display items for regular exhibitions because of limitation of space, and they choose items for inclusion in their digital archives, i.e., digitization of the items and storage of digital objects into databases. Regular digital exhibitions, which do not have physical space limitation, usually show all cultural heritage resources stored in the digital archives and allowed to be open to the public. On the other hand, museums may sometimes change display items by the reasons which come from physical features, e.g., space limit and loan of items to other institutions.

Exhibitions either physical or digital and either regular or special may be defined as *Activity* (E7) in CIDOC CRM, which is a subclass of *Event* (E4). On the other hand, exhibitions either physical or digital have to be embodied. The embodied instances are

obviously not Activity. The embodied instances may or may not have period of existence; regular exhibitions usually have no explicit date of termination but special exhibitions usually have dates of start and termination. A special exhibition may be repeated at different location with or without revision. Thus, an exhibition may have one or more embodiments. In other words, a special exhibition program as a conceptual instance may be embodied once or more. Exhibition programs can be defined as a conceptual entity and embodiments of exhibition programs as a physical or digital manifestation of the conceptual entity. Exhibition programs are created by curators at museums and other memory institutions. Exhibition programs may be instantiated in accordance with physical and/or digital environments for exhibition. Therefore, we can view the exhibition programs as an intellectual creation by the curators and the embodied instances of the programs as Expression, Manifestation, or Item depending on the type of embodiments.

Museums often publish exhibition catalogues in various forms, e.g., a printed/electronic book, a booklet, and a webpage. These catalogues are primarily a set of descriptions about an exhibition, i.e., metadata about an exhibition. The border between an exhibition catalog published as a Webpage and a digital exhibition may be gray but distinction between primary and secondary resources is rather straightforward by intention of their creators. Those catalogues may be recognized as a published materials, so that we can apply FRBR WEMI to them. Discussion on the catalogues is out of the scope of this thesis because it is trivial.

Thus, this thesis considers that FRBR WEMI may be applied to exhibitions. Detailed discussion of the application of FRBR WEMI to exhibitions is given in later chapters.

## **2.6 Metadata Model for Cultural Heritage Digital Archives and Exhibitions**

There exist several conceptual models for cultural heritage information and bibliographic records used at memory institutions, for example, CIDOC CRM, FRBR, FRBRoo, and IFLA LRM.

CIDOC CRM is a well-known standard ontology for museums to describe their CHOs. It is suitable to describe CHOs, however when it comes to digital archives, this model tends to neglect many aspects which is embedded in CHI such as carrier/media to store CHI. Whereas, distinguishing element of carrier and CHO metadata is crucial to

avoid ambiguity in describing the resource. In addition, museums seem to hesitate to analyze intellectual activity in creation of digital archives, thus intellectual activity applied in CH is not proposed to be described in CIDOC CRM model.

A model for Cultural Heritage Digital Archives (CHDA) should be able to cover overall processes of the digital exhibition (this will be further explained in Figure 15). This study uses FRBR as an underlying model to describe products of intellectual endeavor, where FRBR Group 1 entities consists of *work*, *expression*, *manifestation* and *item* (FRBR WEMI). FRBR is mostly used by libraries to describe their bibliographic data but not by museums. This study uses FRBR because Group 1 entities suits to the purpose of this study “describing digital exhibitions as a product of intellectual creation” and because FRBR is a well-recognized model.

FRBRoo divides *work* into several *works* such as F14 *individual work*, F15 *complex work* and so on. Trying to avoid ambiguity of the physical embodiment of a CHO, it divides *manifestation* into F4 *manifestation singleton* and F3 *manifestation product type*. However, FRBRoo does not have *manifestation* for electronically published materials. However, in the model discussed in this thesis, Manifestation of digital exhibition and digital cultural heritage objects in CHDA are included as an embodiment following the original FRBR and IFLA LRM.

As discussed in Section 2.5, this thesis applies FRBR WEMI to exhibitions. It uses these conceptual models as the basis for the discussion. It also uses RDA, which is a bibliographic metadata standard defined based on FRBR, for mapping of the metadata model defined based on the conceptual models to a real-world description scheme.

### **3. Literature Reviews and Related Works**

There are some researches which have been conducted specifically investigating digital exhibition comprehend with intellectual activity. Winda, M., Wijesundara, C., Sugimoto, S. (2017) [1] proposed a novel metadata model for digital archives of cultural heritage. This study focuses on metadata for digital archives of intangible cultural heritage. They perceived that archives of digital cultural heritage should have features originating from both libraries and museums, as they are a collection of digital copies, as well as a collection of cultural heritage resources. In addition, these archives should have metadata suitable for use on the Linked Open Data environment. This model used FRBR Group 1

entity as a baseline for the model and they showed that FRBR is applicable to be used for cultural heritage digital resources.

Shigeo Sugimoto (2014) [13] discussed some key issues for digital archives and metadata in a networked information environment to keep our community memory for the future. The basic lesson shown is that digital archives built on a robust information environment are essential for keeping our community memory safe for the future. Not only do the primary digital resources need to be properly maintained and preserved for the future but also secondary resources, metadata and meta-metadata. We need to use Linked Open Data technologies to enhance the usability of such digital resources in the archives.

Most of the studies conducted to investigating the creation and management/organization of digital exhibition in which trying to handle distributed content as well as context in digital archives. Samuel Cruz-Lara, Bai-Hsuen Chen and Jen-Shin Hong [14] proposed a novel content management framework for organizing digital collections and for quickly selecting, integrating, and composing objects from the collection to produce exhibitions of different presentation styles. This framework is designed to allow an access and to share multimedia resources that spread among different servers. In addition, they provide a platform that can easily create the digital museum exhibition data using XML and utilizing the SOAP-based API and web services of the distributed framework. In addition, they conveyed that item-level metadata approach is suitable to describe the digital exhibition content.

Other studies tried to connect content and context of digital archives. Joseph T. Tennis [15] described the concepts in archival metadata and description and exports them to LIS. Jane Zhang and Dayne Mauney [16] tried to interconnect the relationship between archival context and digital content, which is a significant topic in a networked digital environment. They mentioned that although a model has been emerged but in practice, archivists are challenged to achieve an ultimate goal of making digital archives more accessible and better contextualized in the digital world. Manjula Patel, et al. [17] examined the significance of metadata in enabling and supporting all of the processes involved in digitally acquiring, modelling, storing, manipulating and creating virtual exhibitions from 3D museum artefacts. They briefly considered the system in the wider

context of applications such as virtual learning environments and distributed repositories of archives.

Maria Teresa Artese and Isabella Gagliardi [18] developed the intangible cultural heritage cataloging card and its integration in the digital archives. They used the AESS (Archivio di Etnografia e Storia Sociale – Lombardy Region) archive as an object of their study.

Rivki Gadot and Ilya Levin [19] reckoned that digital curation as a learning activity. They perceived in Web 2.0 era which is a technological basis of social media, as a cultural phenomenon that can enhance interpersonal communication and change the nature relationship between individual and society. Although their object of study was not specifically handling digital curation for cultural heritage digital archives, but the domain area is related to issues which engage with digital resources.

#### **4. Modeling Metadata of Cultural Heritage Digital Archives**

##### **4.1 Digital Curator**

As the advancement of technology such as adoption of Web 2.0, the awareness towards digital curation increases. Figure 10 in the previous chapter showed what tasks are needed in digital curation. At the same time, who perform digital curation and for what tasks they are responsible need to be discussed because the scope of this job is broad. DCC defines the digital curator skills as data management in digital curation depicted in Figure 11.

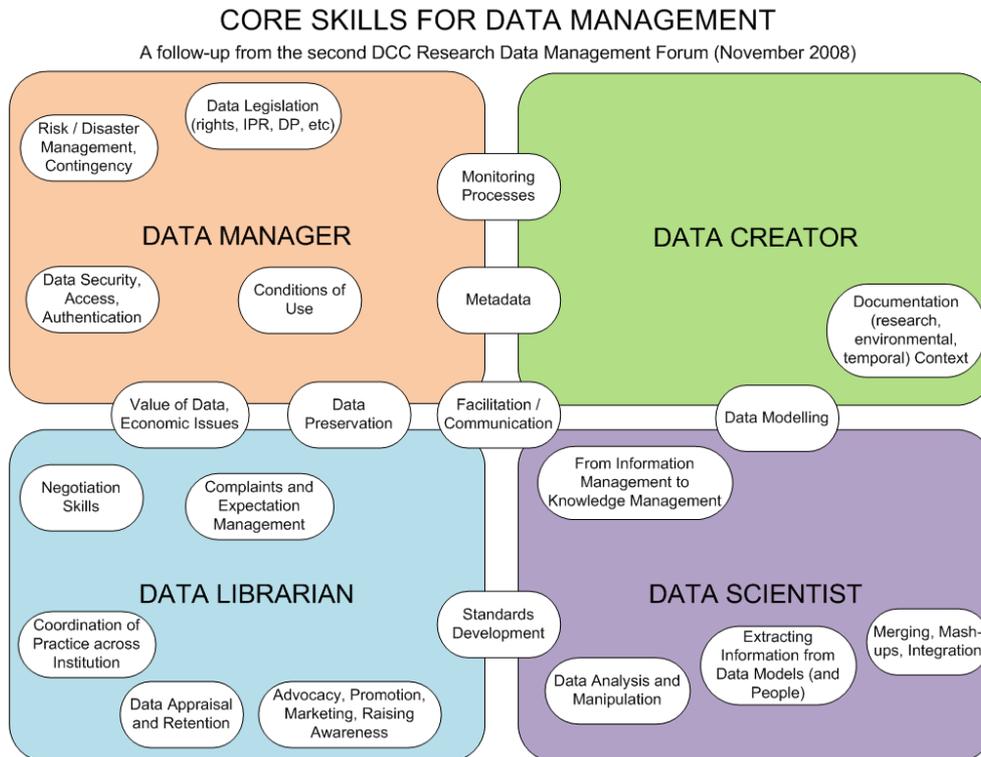


Figure 11. Core Skills for Data Management in Digital Curation

Digital exhibition is an important function for museums to provide a way for the visitors around the world to reach the museum collections and opportunities to cultural experiences online. Nancy Proctor wrote that some museums have embraced the digital trends of outsourcing to citizen curators and user generated content [20]. For instance, Tate Britain used Flickr to crowdsource photographs as an online accompaniment for “How We Are: Photographing Britain”, the gallery’s first major photographic exhibition. A conventionally curated show, “How We Are” includes images by famous British photographers such as William Henry Fox Talbot, Lewis Carroll, and Julia Margaret Cameron. In addition, it provides postcards, family albums, and propaganda. Tate Britain invited the general public to post their own shots through the photo-sharing capabilities of Flickr [20]. This example shows that paradigm shifted from the digital curator role used to be. A digital curator role now is not confined as an expert only, might be brokers and collaborators as well.

Section 2.4 mentioned that digital curator is a person or a group of people who curates the cultural heritage information for digital archives and digital exhibitions. In this study, digital curation skills might include several core skills to manage the cultural

heritage digital data. Since digital curators mostly deal with digital resources in a networked digital environment, they are expected to be able to use information technology in accordance with the types of cultural heritage objects, information environments provided for their archives and exhibitions, and their audience.

## 4.2 Digital Curation Workflow

This thesis adopted the concept of digital curation process proposed by the DCC and DCU and redefined the concept into the digital curation workflow as depicted in Figure 12. From the starting point of the workflow, a digital curator develops a curation plan by determining the selection and evaluation criteria of the intended digital exhibition called Appraisal. To acquire the digital resource, digital curators need to find, create (if possible), select and collect the digital resources. In order to obtain the digital resources, ingestion is done by recording, digitisation of analog recordings and importing digital resources from other sources.

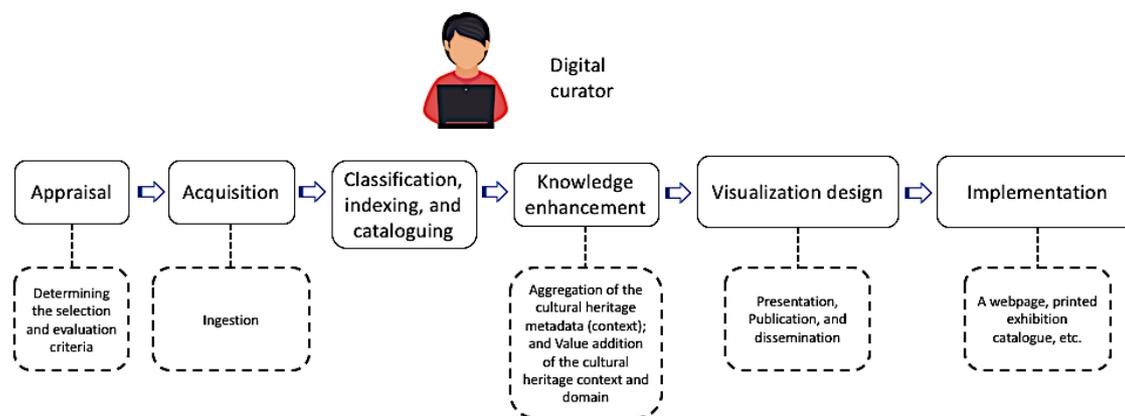


Figure 12. Digital Curation Workflow

The collected data is grouped and explained through classification, indexing and cataloguing. As knowledge enhancement, metadata aggregation and value addition are proceeded so that the semantic analysis added could provide and describe the relationships between contents and contexts. The last phase is to design the visualisation of the digital exhibition dedicated for end users. In this part, digital curators need to design the presentation of the digital exhibition in accordance with their implementation purposes. The implementation could be a website of a digital exhibition to be published and disseminated throughout Internet, of printed catalogue, etc.

### 4.3 Metadata Extraction and Analysis

In this study, the author has aggregated several metadata examples from British Museum using a scraping tool, *Nokogiri*. As shown in Figure 2, a digital exhibition may consist of several interlinked digital resources. Each digital resource (e.g., a video, image, URL to the digital collection metadata) embedded in a single page. Moreover, British Museum provides their digital contents stored in their own database. Based on the metadata extraction, the author found that there are three different layers/levels of metadata to describes the theme and its relationship to CHOs. Defferent layers describes different value or content on each layers e.g., the 1<sup>st</sup> level describes briefly the whole exhibition, the 2<sup>nd</sup> level explains the curated information of several highlights grouped based on the related concept of theme, and so forth.

Table 2. Digital Exhibition and the Linked Content

Layer	Metadata
1	<p>Caption: Who werethe Scythians?            Image URL: <a href="http://www.britishmuseum.org/images/projectSpecific/Scythian/scythian_who_304.jpg">http://www.britishmuseum.org/images/projectSpecific/Scythian/scythian_who_304.jpg</a>  <b>URL: <a href="http://blog.britishmuseum.org/introducing-the-scythians">http://blog.britishmuseum.org/introducing-the-scythians</a></b></p>
2	<p>Caption: Gold sew-on clothing appliqué in the form of two Scythian archers.            Image URL: <a href="https://blog.britishmuseum.org/wp-content/uploads/2017/05/xGAA36061-archers-BM-19090617.2.jpg.pagespeed.ic.JMU_LcEQeu.jpg">https://blog.britishmuseum.org/wp-content/uploads/2017/05/xGAA36061-archers-BM-19090617.2.jpg.pagespeed.ic.JMU_LcEQeu.jpg</a>  <b>URL: <a href="http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=434391&amp;partId=1">http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=434391&amp;partId=1</a></b></p>
3	<p>Attribute: Object type            Value: costume-fitting</p> <p>~~~~~</p> <p>Attribute: Museum number            Value: 1909,0617.2</p> <p>~~~~~</p> <p>Attribute: Description            Value: Gold sew-on clothing appliqué in the form of two Scythian archers back to back, probably blood-brothers.</p> <p>~~~~~</p> <p>Attribute: Culture/period            Value: Hellenistic</p> <p>~~~~~</p> <p>Attribute: Date            Value: 400BC-350BC</p> <p>~~~~~</p> <p>Attribute: Findspot            Value: Excavated/Findspot: Kuloba (probably)</p> <p>~~~~~</p> <p>Attribute: Materials            Value: gold</p> <p>~~~~~</p> <p>Attribute: Dimensions            Value: Height: 3.1 centimetres</p> <p>~~~~~</p> <p>Attribute: Bibliography            Value: Jewellery 2106.d</p> <p>~~~~~</p>

Attribute: Location Value: Not on display
Attribute: Associated places Value: Associated with: Scythia
Attribute: Acquisition name Value: Purchased from: F Champness
Attribute: Acquisition date Value: 1909
Attribute: Department Value: Greek & Roman Antiquities
Attribute: Registration number Value: 1909,0617.2

For further analysis, the author also extracted the properties from these three layers/levels as shown in Table 3. The result shows that there are no big differences among the properties, where every layer contains the same properties. Therefore authors used the defined properties for crosswalk to RDA instead.

Table 3. Digital Exhibition Properties Extraction

Properties from Level 1	Properties from Level 2	Properties from Level 3
Title	title	title
Type	type	type
url	url	url
site_name	site_name	site_name
description	description	description
locale	locale	locale
	Image	image
	published_time	Generator
	modified_time	

#### 4.4 Applying FRBR Work, Expression, Manifestation and Item (WEMI)

In the previous study, the author found that a single cultural heritage digital instance could be described by using FRBR WEMI. As depicted in Figure 13, a single downloadable recording music (*item*) has *work* which is implicitly represented.

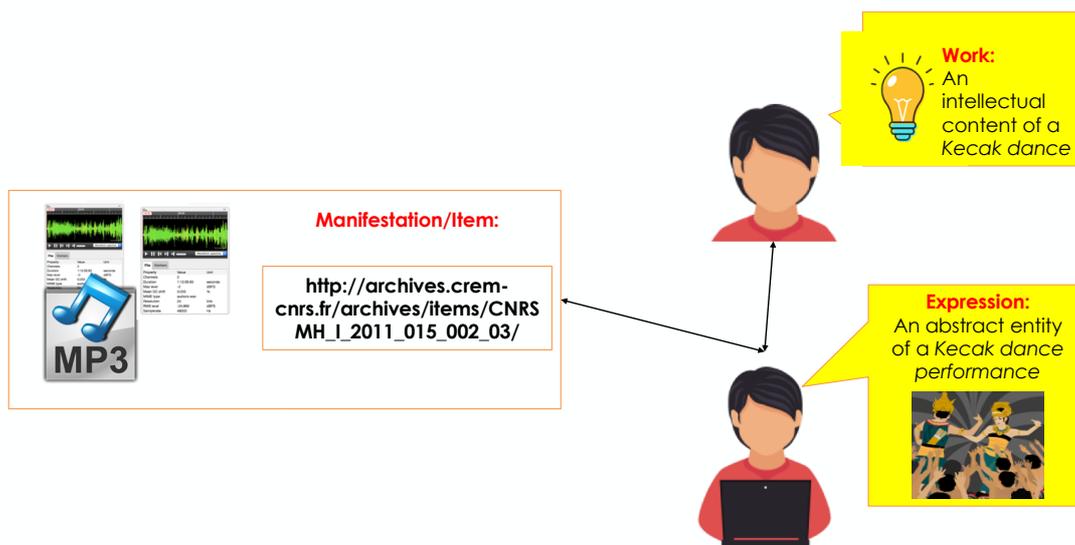


Figure 13. FRBR is applied to *Kecak dance* in digital space

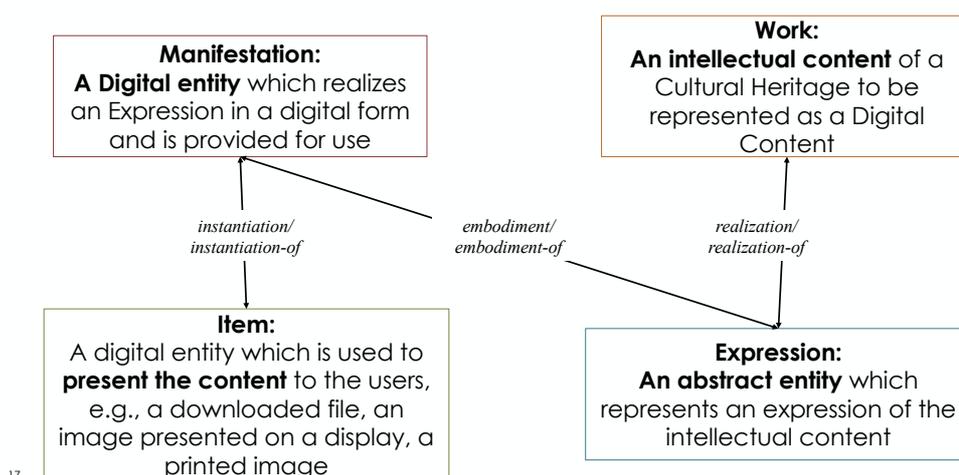


Figure 14. Applying WEMI to a single digital instance

In the previous study we applied FRBR WEMI to digital objects of cultural heritage. The following paragraph shows how FRBR WEMI was interpreted in that study. *work* is interpreted as an intellectual content of a digital cultural heritage object presented in a digital archive. Since *work* is an abstract entity, we can only see the realization of the *work* through *expression*. An *expression* is an abstract entity which represents an *expression* of the intellectual content. Similarly to *work*, *expression* is an abstract entity which determines how to represent a cultural heritage object curated as a *work* for users, i.e., mode of interaction, language, etc. An *expression* then is embodied in a

*manifestation*. A *manifestation* is a digital entity which realizes the *expression* in a particular digital form and identifiers are to be given for access by users, e.g., URI, DOI, ISBN, and so forth. A *manifestation* can have an Item or Items which is used by users at their hands. Thus, an Item is a digital entity which is used to present the content to the users, for instance a downloaded file and so on. The boundaries between *manifestation* and *item* may be unclear in the networked digital environment

As the scope of this study is slightly changed from the previous study – from a single digital instance in a digital archive to digital exhibitions – the application of FRBR WEMI for modeling a digital exhibition need to be modified conforming the scope. Based on the extracted metadata mentioned in the previous section, it shows that a digital exhibition is containing curated webpages and linking to a single digital instance. Several levels of metadata needed to define relationship between the curated webpages and digital instance. A bibliographic metadata view of the digital exhibition is depicted in Figure 15.

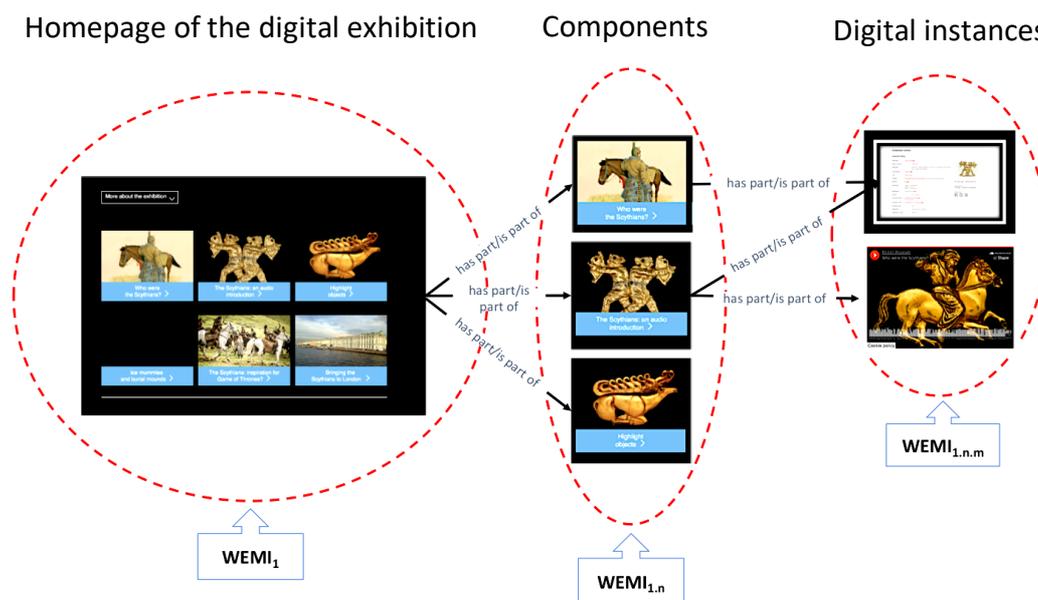


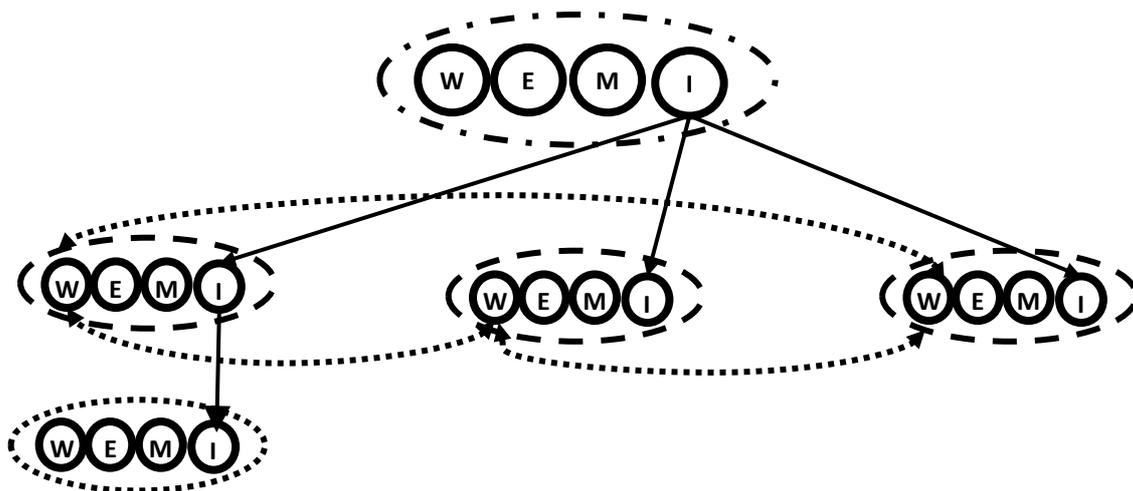
Figure 15. British Museum Organization of Digital Exhibition

Homepage of the digital exhibition is representing the top level of the metadata consists of few curated webpage as components which is placed as the 2<sup>nd</sup> level of metadata. These curated webpage connects them to a single digital instance.

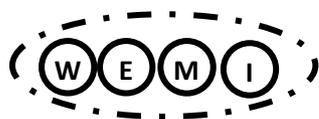
We apply FRBR WEMI to be used to describe overall of the digital exhibition as well. Furthermore, we redefine the WEMI to be fitted to reflect a single cultural heritage instance.

- *work* is an intellectual content of curated cultural heritage digital instance, e.g., cultural heritage digital exhibition
- *expression* is an abstract entity which carries out the projection of the realization of *work* e.g., layout of the webpage, Language used, user interface of the webpage.
- *manifestation* and *item* both represent a digital entity e.g., URL of the digital exhibition webpage

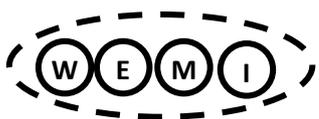
The CHDA where FRBR WEMI is being applied further describe in the figure below.



Notes:



= represents top level which is a homepage of the digital exhibition ( $WEMI_1$ )



= represents the 2<sup>nd</sup> level which is a component of the digital exhibition ( $WEMI_{1,n}$ )

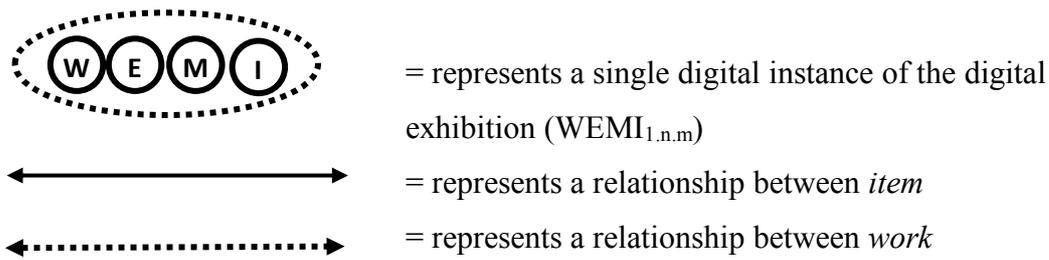


Figure 16. A Cultural Heritage Digital Exhibition Model

Digital exhibition is holding huge collection of digital resources. To make them easily accessible, this model provides a hierarchical concepts to embrace the whole exhibition. Each level of the proposed model links to other level through *item*. An *item* has a physical embodiment, thus the existing relationship could explicitly be identified. In this model, each level of the *item* has different meaning. The 1<sup>st</sup> level *item* represents the physical embodiment of the whole exhibition, while the 2<sup>nd</sup> level *item* represents each curated information and 3<sup>rd</sup> level represents the CHI.

Once users retrieve an *item*, a set of *works* and *expressions* linked from the *item* could be identified as well. Moreover, relationship among *items* across the levels enables leading to the other *works* and *expression*. Following this pattern, we can see whether the particular curated CHI are coming from and sharing the same *work* or not. Figure 16 shows that diverse *item* available in digital exhibition which means a *complex work* also exists. A *complex work* is seen where work from the top level metadata has few components known as individual works represented in each single curated webpage.

Furthermore, from this model users can find their “intended information” about particular exhibition both from the related *item* and *work* in the local digital exhibition and possibly across the digital exhibitions which share the same concepts as well. WEMI makes users easily identify the detail entity of the curated digital instance as well as a single digital instance (e.g., are they the same *work*, adaptation, part of). In addition, users can select their intended searching easily identified through *work* and *item*. Users can easily obtain curated information and/or a single digital instance since the location is defined in the element. This model looks supporting FRBR WEMI user task adequately, though the real implementation is still needed to prove this concept.

In this model, a single curated cultural heritage digital archive as an instance of *work/expression* requires at least one instance of a *manifestation/item* derived from the *work/expression* instance and embodied in a single URL; for instance, a digital exhibition must be embodied in a webpage (URL).

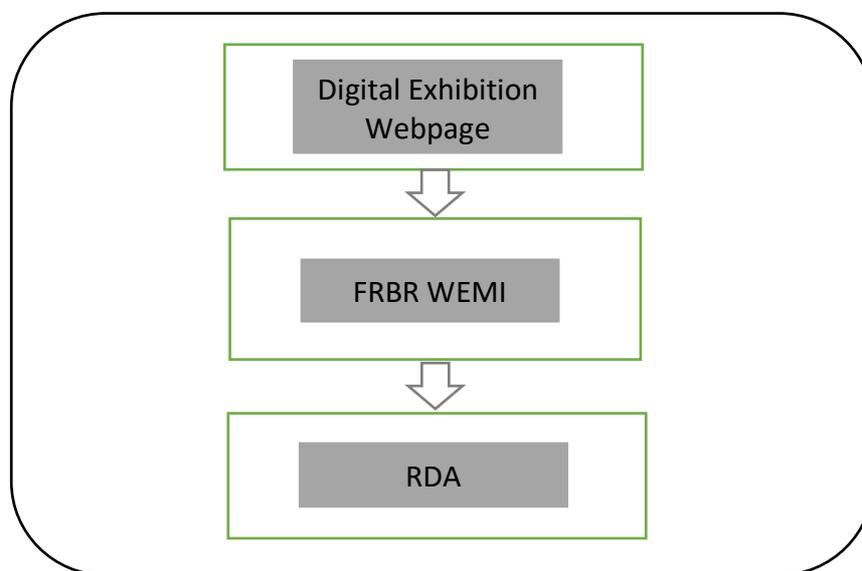


Figure 17 Crosswalk Digital Exhibition, FRBR to RDA Elements and Properties

To make the proposed model more visible for use, crosswalk to RDA was done. The crosswalk flow is depicted in Figure 17. The detail of crosswalk is described further in the next sections.

#### **4.5 Defining Resource Description and Access (RDA) as a guideline for implementation in the CHDA**

To make the proposed model applicable, the author uses RDA for describing the digital exhibition resources. Also, analysed the RDA element set and relationships between entities by using RDA Toolkit [11]. Not only did crosswalk to RDA, Authors also picked up some RDA element and properties. The defined result is shown in Table 4 bellow.

Table 4. FRBR align with RDA Element and Properties

FRBR WEMI	RDA Element	RDA Properties
<b>Work</b>	<b>Work</b>	
<b>title</b>	Title of work (core)	hasTitleofWork
<b>Expression</b>	<b>Expression</b>	
<b>image</b>	Content type	HasContentType
<b>Locale</b>	Language of the content	HasLanguageoftheContent
<b>description</b>	Summarization of the content	HasSummarizationoftheContent
	Sound content	HasSoundContent
	Color content	HasColorContent
<b>Manifestation/Item</b>	<b>Manifestation/Item</b>	
<b>type</b>	Media type	HasMediaType
<b>url</b>	Source description note	HasSourceDescriptionNote
<b>site_name</b>	Publisher name	HasPublisherName
	Carrier type	HasCarrierType
	Title proper	HasTitleProper
	Publication	HasPublication
	Physical description	HasPhysicalDescription
	Note	HasNote
	Electronic location	HasElectronicLocation
	layout	HasLayout
	Contact information	HasContactInformation
	Recording changes in Publication Statements	HasRecordingChangesInPublicationStatements
	Change in Statement of responsibility -IR	Change in Statement of responsibility - IR

RDA elements are defined as follow: (note: section numbers appear below means RDA Ref.)

- *work*:
  - “*Title of work*” means a word, character, or group of words and/or characters by which *a work* is known .
- *expression*:
  - “*Expression Content type*” as categorization reflecting the fundamental form of communication in which the content is expressed and the human sense through which it is intended to be perceived. For content expressed in the form of an image or images, content type also reflects the number of spatial dimensions in which the content is intended to be perceived and the perceived presence or absence of movement.
  - *Language of the content*, is language used to express the content of resources. It can be English, Italian, etc.
  - *Summarization of the content*, e.g., abstract, summary, synopsis.
  - *Sound content*, The presence of sound in a resource other than one that consists primarily of recorded sound, e.g., sound or silent.
  - *Color of content*, e.g., color and tone.
- *manifestation/ item*:
  - *Media type* is a categorization reflecting the general type of intermediation device required to view, play, and run the content of a resource, e.g., Audio, Computer, Microform, and so on.
  - *Carrier type* is a categorization reflecting the format of the storage medium and housing of a carrier in combination with the type of intermediation device required to view, play, and run the content of a resource. e.g., Audio Cartridge, Audiocassette.
  - Digital file characteristic is a technical specification relating to the digital encoding of text, image, audio, video, and other types of data in a resource. Record the following characteristics, as applicable: file type (see 3.19.2), encoding format (see 3.19.3), file size (see 3.19.4), resolution (see 3.19.5), regional encoding (see 3.19.6), encoded bitrate (see 3.19.7).

- **Publication** is a statement identifying the place or places of publication, publisher or publishers, and date or dates of publication of a resource. as follows: place of publication (see 2.8.2.2), parallel place of publication (see 2.8.3.2), publisher's name (see 2.8.4.2), parallel publisher's name (see 2.8.5.2), date of publication (see 2.8.6.2).
- *Electronic location or Uniform Resource Locator (URL)* is the address of a remote access resource. Record the Uniform Resource Locator for the online resource being described.
- *Note and Source description note*
- *Layout* is the arrangement of text, images, tactile notation, etc., in a resource.
- *Contact information* is information about an organization, etc., from which a resource may be obtained. Record contact information for a publisher, distributor, etc., if considered important for acquisition or access. [11].

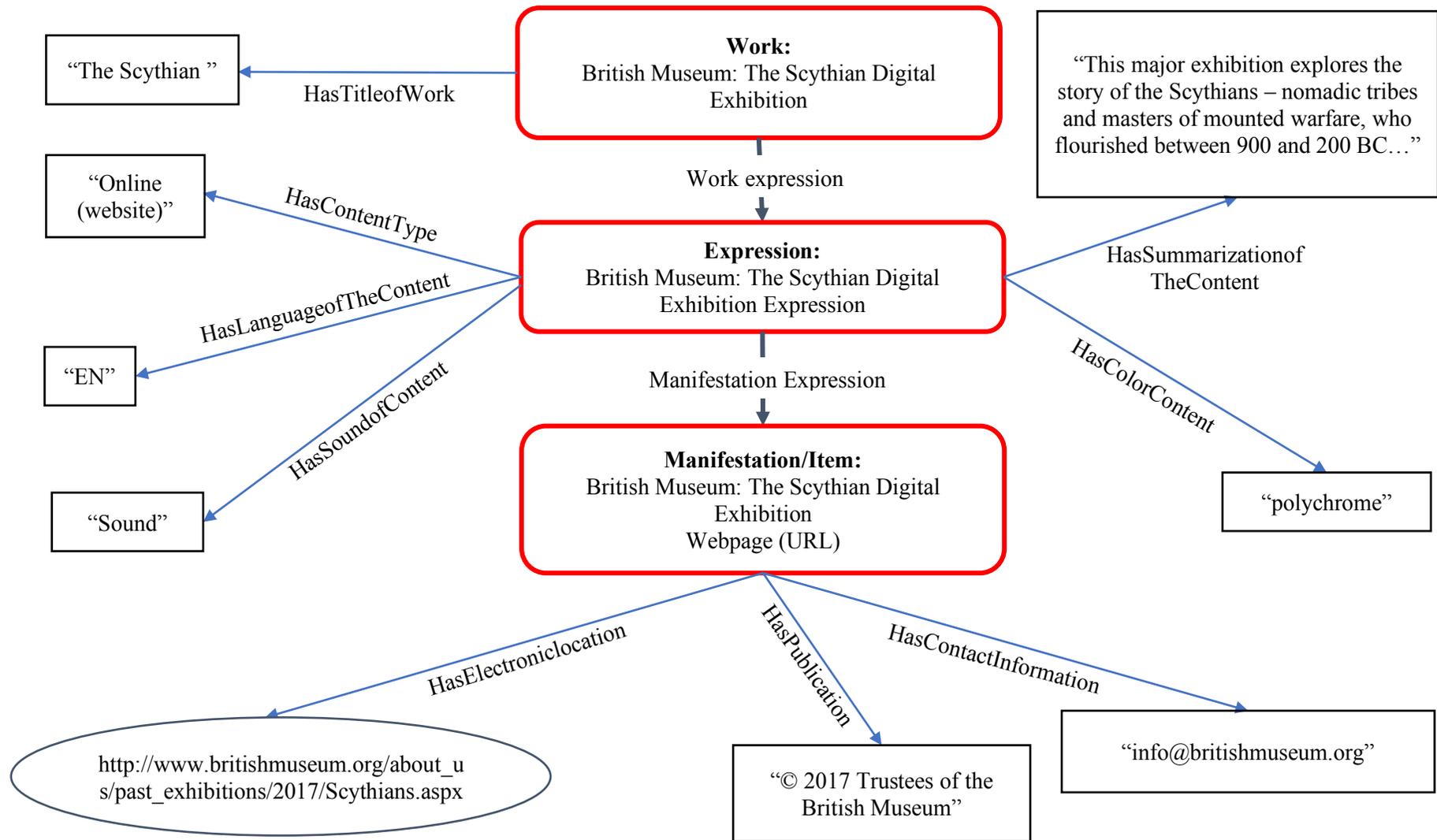


Figure 18 Instances of CHDA (derived from British Museum)

To clarify the link between entities, we define the RDA relationship as shown in Table 5.

Table 5. FRBR align with RDA Relationship

FRBR WEMI	RDA Relationship
<i>work - wwork</i>	Related <i>work</i>
<i>mmanifestation/ item - item</i>	Related <i>item</i>

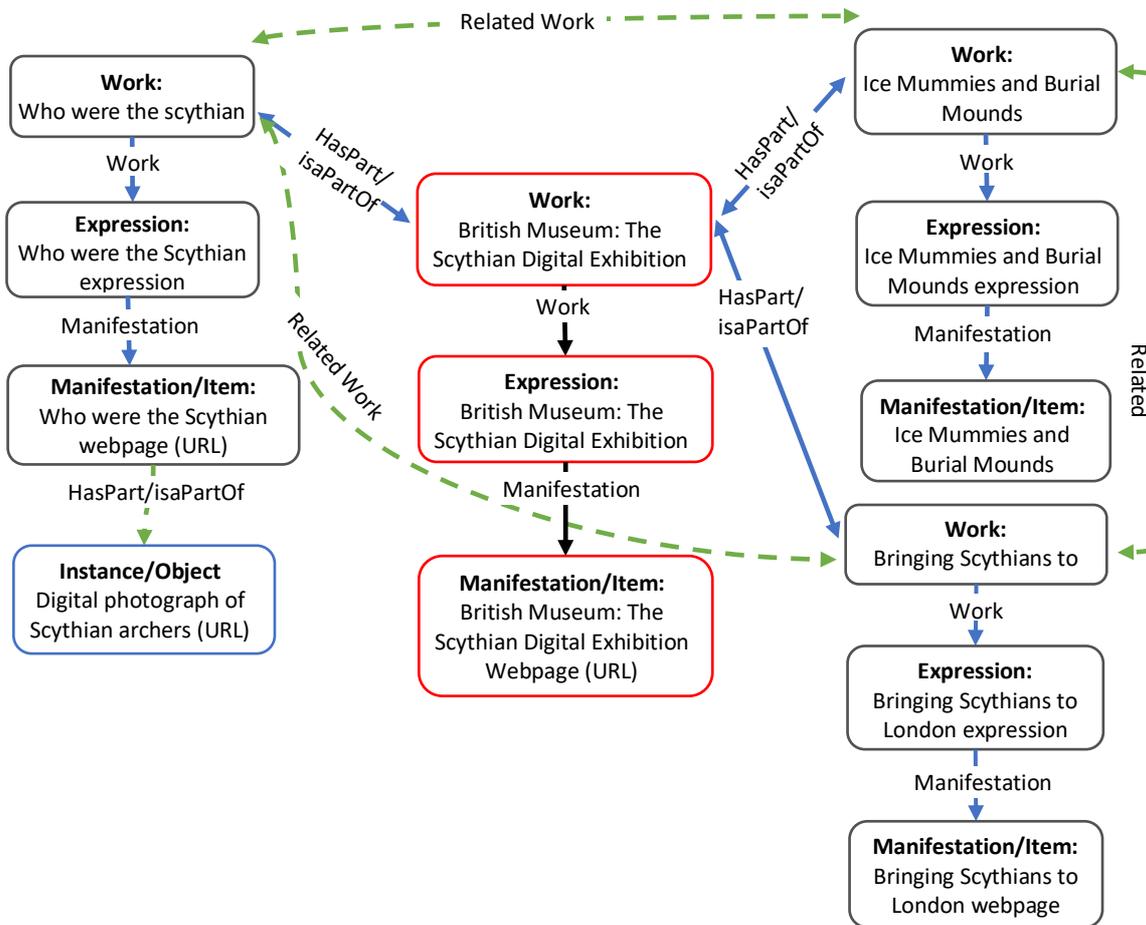


Figure 19. FRBR Align with RDA Relationship Graph

As shown in Figure 19, *work* in the 1<sup>st</sup> level and other levels is linked through *item*. From the 1<sup>st</sup> level to 2<sup>nd</sup> level represent the related item where the *work* in 2<sup>nd</sup> level is a part of the 1<sup>st</sup> level as well as the relationship from the 2<sup>nd</sup> level to 3<sup>rd</sup> level is also linked through item where the 3<sup>rd</sup> level is a part of the 2<sup>nd</sup> level. From these compositions, related item is important to determine the relationship among the *work*. This example is

only representing a single service (British Museum), further examination across institution might be needed to show the relationship among the related work but exhibited by different services, location and time.

## 5. Result and Discussion

Finding in this study shows that building cultural heritage digital archives and digital exhibitions requires a highly intellectual and creative activity by digital curators. On the other hand, few cultural heritage models seem hesitate to analyse this intellectual endeavour in creation of digital archives.

CIDOC CRM is a model broadly recognized in the museum community which defines vocabularies used to describe museum collections and holdings while FRBR WEMI is a bibliographic model which is mostly used by Libraries. However, in the digital environment, difference between museums and libraries are not clear as existing digital archives show. CHOs stored in the digital archives may be managed like books, which may have many copies. In cultural heritage digital archives which collect digital instances of museum artefact, WEMI may be applicable to the resources of digital archives and to their collections [1]. The previous research by the author shows that a single cultural heritage digital resource of either tangible and intangible cultural heritage could be described by using FRBR WEMI. As the extended study from the previous one, the author tried to apply FRBR WEMI to digital exhibition created based on cultural heritage digital archives.

Values of cultural heritage objects such as a pottery excavated at a ruin and an old painting found in a church are hard to understand for the general public unless they are properly curated and documented. Therefore, digital curation process have to be properly carried out to create CHI for digital exhibitions, through out *appraisal, acquisition, data management, knowledge enhancement, visualisation design, and implementation of the digital exhibition.*

Based on the extracted metadata, the author found that a digital exhibition of cultural heritage deals with multiple levels of metadata, i.e., metadata for describing an exhibition as a single instance, parts of the exhibition and each component of exhibition. She analyzed entities of exhibitions to define a metadata model from the viewpoint of “digital exhibition as an intellectual creation.” The result showed that FRBR WEMI

conceives as well as explains intellectual creation (*work* and *expression*) is embodied into intellectual product (*manifestation* and *item*). Since a digital exhibition has multiple layers/levels, this study proposed a model of cultural heritage digital exhibition and archives (CHDA) to describe their instances of different levels using FRBR WEMI. A single cultural heritage webpage which covers a digital exhibition represents a complete WEMI, i.e., *work* – a digital exhibition, *expression* – design of the digital exhibition, *manifestation* and *item* – digital instance.

The proposed model shows that there three different levels of metadata in a digital exhibition, for instance the 1<sup>st</sup> level to the 2<sup>nd</sup> level and the 2<sup>nd</sup> level to the 3<sup>rd</sup> level is linked through *item* such as images, video, and so forth. Unlike the 1<sup>st</sup> and the 2<sup>nd</sup> level of metadata which represents digital instance either physical and digital, the 3<sup>rd</sup> level represents both resources in digital space e.g., a single digital instance and physical space e.g., printed material such as catalogue. Since this study focuses on digital exhibition, further connection to physical space will be kept as a future work. Beside *item* to *item* relationship, *work* to *work* relationships are also identified. These relationships and connections help to identify and obtain the related resources from across digital exhibition providers

Regarding connection among those *items*, should bear in mind that the intellectual property and copyright issues can not be set aside. Overall digital exhibition creation is credited to the digital curator regardless of copyright such as photograph, while the photographer name is mentioned pointing to that photograph.

As the challenge in this study is to describe a single webpage which contains various digital resources, we did several crosswalk from the existing digital exhibition example to FRBR and RDA. Metadata extraction from the example is used to analyse the existing metadata, furthermore author picked up several RDA elements and properties that are needed to thoroughly describe the digital exhibition. RDA is used as a guideline in this study because it is widely used by the library community. RDA is *item*-based where the description started from item i.e., a resource contained in a digital archive. Following RDA, in this study *manifestation* and *item* are merged and not defined separately due to their similar representation and embodiment in the digital space. Finding shows that both curated and single digital instance mostly share the same RDA elements as well as properties. The same RDA elements and properties can be used to each level in CHDA.

## 6. Summary and Conclusions

A cultural heritage digital exhibition is a high intellectual activity product done by digital curator. FRBR WEMI is a model that describes objects created through intellectual activities. The finding in this research shows that FRBR WEMI is suitable to be used for describing a cultural heritage digital exhibition. FRBR WEMI through *item* based could be successfully creating the indirect relation among the *works*, for instance if we want to find the relationship between one digital exhibition to others which share the same digital instance, *item* could be a bridge to find the relationship. Which is able to enhance and support interoperability and accessibility among the digital exhibitions.

Regardless of the complexity of a cultural heritage digital exhibition, the author considers that the proposed metadata model is flexible enough to handle those relationships. Furthermore, this model provides a mapping to RDA which makes this model promising be used as a reference in organizing the digital exhibition both for the existing digital exhibition as well as the future digital exhibition that would be developed.

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## References

- [1] Winda, M., Wijesundara, C., Sugimoto, S. (2017). Modeling Digital Archives of Intangible Cultural Heritage based on one-to-one principle of metadata. In *Proceedings of the 8th Asia-Pacific Conference on library and Information Education and Practice (A-LIEP)*, pages 137-148.
- [2] Europeana. (2015). Europeana 2020 Strategic update. Retrieved from <http://strategy2020.europeana.eu/update/>
- [3] CARLI Created Content Committee. (2017). Guidelines for the Creation of Digital Collections. *Consortium of Academic and Research Libraries in Illinois*. Retrieved from [https://www.carli.illinois.edu/sites/files/digital\\_collections/documentation/guidelines\\_for\\_cdc\\_metadata.pdf](https://www.carli.illinois.edu/sites/files/digital_collections/documentation/guidelines_for_cdc_metadata.pdf)
- [4] Emory Libraries & Information Technology. (2017). Metadata [Website]. Retrieved from <http://metadata.emory.edu/guidelines/descriptive/index.html>
- [5] IFLA. (2009). Functional requirements for bibliographic records. Retrieved from [http://www.ifla.org/files/assets/cataloguing/frbr/frbr\\_2008.pdf](http://www.ifla.org/files/assets/cataloguing/frbr/frbr_2008.pdf)
- [6] IFLA. (2017). Library Reference Model. Retrieved from [https://www.ifla.org/files/assets/cataloguing/frbr-lrm/ifla-lrm-august-2017\\_rev201712.pdf](https://www.ifla.org/files/assets/cataloguing/frbr-lrm/ifla-lrm-august-2017_rev201712.pdf)
- [7] IFLA. (2015). Definition of frbroo: a conceptual model for bibliographic information in object-oriented formalism. Retrieved from [https://www.ifla.org/files/assets/cataloguing/FRBRoo/frbroo\\_v\\_2.4.pdf](https://www.ifla.org/files/assets/cataloguing/FRBRoo/frbroo_v_2.4.pdf)
- [8] Le Boeuf, P., Doerr, M., Ore, C. E., & Stead, S. (2015). Definition of the CIDOC conceptual reference model. *ICOM/CIDOC Documentation Standards Group and CIDOC CRM Special Interest Group, version, 6(1)*. Retrieved from [http://www.cidoc-crm.org/sites/default/files/cidoc\\_crm\\_version\\_6.2.pdf](http://www.cidoc-crm.org/sites/default/files/cidoc_crm_version_6.2.pdf)
- [9] Wijesundara C., Monika W., Sugimoto S. (2017) A Metadata Model to Organize Cultural Heritage Resources in Heterogeneous Information Environments. In: *Choemprayong S., Crestani F., Cunningham S. (eds) Digital Libraries: Data, Information, and Knowledge for Digital Lives. ICADL 2017. Lecture Notes in Computer Science, vol 10647*. Springer, Cham

- [10] American Library Association. (2010). *RDA toolkit*. Retrieved from <http://access.rdatoolkit.org/>
- [11] Miller, S. (2010). The One-To-One Principle: Challenges in Current Practice. *International Conference on Dublin Core and Metadata Applications*, pages 150-164. Retrieved from <http://dcpapers.dublincore.org/pubs/article/view/1043>
- [12] Constantopoulos, P., et al. (2009). DCC&U: An extended digital curation lifecycle model. *International Journal of Digital Curation*, 4(1). doi: <https://doi.org/10.2218/ijdc.v4i1.76>
- [13] Sugimoto, S. (2014) Digital archives and metadata as critical infrastructure to keep community memory safe for the future – lessons from Japanese activities, *Archives and Manuscripts*, 42:1, 61-72, doi: 10.1080/01576895.2014.893833
- [14] Cruz-Lara, S., Chen, B. H., & Hong, J. S. (2002). Distributed content management framework for digital museum exhibitions. In *the Scholars Conference 2002 "Understanding the Future of European e-Content Industries"*, 15 p.
- [15] Tennis, J. T. (2015). Archival metadata for digital cultural heritage conceptual provenance, contextual forensics, and the authority of the found digital object. In *Digital Heritage*, Vol. 2, pp. 399-402. IEEE.
- [16] Zhang, J., & Mauney, D. (2013). When archival description meets digital object metadata: a typological study of digital archival representation. *The American Archivist*, 76(1), 174-195.
- [17] Patel, M., et al. (2005). Metadata requirements for digital museum environments. *International Journal on Digital Libraries*, 5(3), 179-192.
- [18] Artese, M. T., & Gagliardi, I. (2012). Cataloging intangible cultural heritage on the web. In *Euro-Mediterranean Conference*, pages 676-683. Springer, Berlin, Heidelberg.
- [19] Gadot, R., & Levin, I. (2012). Digital Curation as learning activity. In *the Proceedings of EDULEARN*, pages 6038-6045.
- [20] Proctor, N. (2010). Digital: Museum as platform, curator as champion, in the age of social media. *Curator: The Museum Journal*, 53(1), 35-43.