

Bringing Cultural Heritage Information from Developing Regions to the Global Information Space as Linked Open Data: An Exploratory Metadata Aggregation Model for Sri Lankan Heritage and its Extension

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ABSTRACT

Background. Sri Lankan memory institutions are currently not optimised to deliver Cultural Heritage Information (CHI) on the Web. Part of the issue is the lack of metadata aggregation. We propose an approach that would help aggregate Sri Lankan CHI with more contextual information in order to open up this information and make it more accessible.

Objectives. To present a metadata model to aggregate Sri Lankan CHI provided by museums in different regions and to discuss some basic issues for future extension of our model to different Southeast Asian countries.

Methods. This paper describes a metadata crosswalk approach between museum vocabularies, which was achieved by investigating over 2600 object records across four museums inside and outside Sri Lanka, and by mapping them to the Getty Art and Architecture Thesaurus (AAT) and Resource Description Framework (RDF).

Results. Based on the results of the mapping described above, we propose a metadata model to aggregate CHI that is specific to Sri Lankan cultural heritage materials.

Contributions. The proposed model is a novel approach to Sri Lankan CHI domain. Based on the outcomes of this study, this paper discusses the possibility of extending the scope of this CHI metadata aggregation to other countries in Southeast Asia through adopting Linked Open Data (LOD).

Keywords. Cultural Heritage Information (CHI); Linked Open Data (LOD); Metadata; Museum Information; Resource Description Framework (RDF); Sri Lanka; Thailand; Japan; Manga Metadata

INTRODUCTION

Cultural heritage objects from any community represent unique characteristics and values related to the community. These cultural heritage objects can be found all over the world and they are preserved and exhibited in museums, libraries or archives, so-called memory institutions. Many of the memory institutions provide information about the cultural heritage objects, which may include digital images of the objects.

The main area of this study is Cultural Heritage Information (CHI) of museum objects and artefacts with special reference to Sri Lanka. During the colonial period, many of these Sri Lankan artefacts ended up outside Sri Lanka, in museums and in private collections. Later some of these artefacts were donated or brought back to Sri Lanka. Many major museums in Europe and North America provide CHI of their collections on the Internet through their own homepage as well as their national and regional CHI portals like Europeana. However, Sri Lanka does not have an appropriate way of connecting CHI scattered all over the Internet. This paper discusses some issues to make information about cultural heritage objects of developing countries more accessible via the Internet mainly from the viewpoint of metadata and based on the study of the Sri Lankan CHI.

This paper presents a platform to connect and aggregate CHI related to Sri Lanka located in different memory institutions through a semantic metadata model defined using Resource Description Framework (RDF), which is a fundamental standard for the Linked Open Data (LOD) environment on the Web. The proposed model collects metadata from different museums and aggregates this heterogeneous CHI while enriching the contents of the same. Secondly, this paper shows a mapping among metadata from Europe, North America, some offline Sri Lankan museums and the Getty Art and Architecture Thesaurus (AAT). This study utilised the Getty Art and Architecture Thesaurus because it provides a comprehensive list of terms related to cultural heritage across the world and these terms are in LOD format, and hence useful for purposes of this study.

There have been several efforts at designing data portals to integrate digital cultural heritage into a single platform and enrich these cultural heritage objects more meaningfully through LOD technologies. One such example is the Project Europeana designed for European Union Countries. Nevertheless, no such initiatives exist either for Sri Lanka or Southeast Asian cultural heritage.

In this paper, following the aggregation model for Sri Lankan cultural heritage information in the heterogeneous information environment, we discuss the potential of CHI aggregation in South and Southeast Asian countries, primarily from the viewpoints of Sri Lanka and Thailand. LOD has a large potential to connect different types of information resources by metadata and across borders. South and Southeast Asia regions have significant diversity and commonality. For example, there are many heritage objects of Buddhism, and stories from the Hinduism are shared widely in the region. On the other hand, there is a wide diversity of languages and religions.

BACKGROUND AND OBJECTIVES

Sri Lankan cultural objects are scattered all over the world and most of them can be retrieved individually through institutional portals. Nevertheless, Sri Lanka still does not have a CHI portal to deliver their information to the users on the Web and using the LOD technologies. In addition, the heterogeneity of cultural objects and diversity and the diverse needs of the memory institutions have resulted in different metadata standards. According to scholars, such diversity creates drawbacks too. "... differences in descriptive schema across museums, libraries and archives, although necessary for individual applications, can seriously hinder cross-domain discovery and interoperability of cultural information resources in the global context of the Internet" (Gill, 2004).

This study aims to find a solution to aggregate scattered CHI on the Web. Therefore, we searched the online and offline resources for Sri Lankan CHI, collect and chose the CHI for aggregation, and mapped the CHI using well-established standards based on the proposed model. Mapping the metadata vocabularies of museums to top class vocabularies such as

Getty AAT is a commonly used approach for aggregating metadata from different institutions. The mapping scheme may be considered as *metadata of metadata* (or *meta-metadata*) of CHI. This kind of approach will be beneficial not only for Sri Lanka but also for developing countries which are in the situation similar to Sri Lanka. Finally, the proposed aggregation model will be enriched using LOD resources aiming to facilitate data enrichment and to make CHI more contextual. From a larger perspective, we think that our CHI aggregation approach is crucial for Asian countries because there is no organisation like the European Union as a funding body in Asia and many cultural heritage objects are curated by non-Asian memory institutions which provide high-quality CHI.

OVERVIEW OF MUSEUM INFORMATION ENVIRONMENT IN SRI LANKA

Being situated in a strategic place in the Indian Ocean, Sri Lanka was continually influenced by other countries. Since there were no rules or regulations for exporting cultural artefacts during that time, colonial rulers took away an enormous amount of Sri Lankan artefacts to their countries. After gaining independence there were discussions and appeals to return those cultural objects back to Sri Lanka. In April 1980, UNESCO formed a committee called Intergovernmental Committee for Promoting the Return of Cultural Property to its Countries of Origin or its Restitution in case of Illicit Appropriation. (UNESCO, 1980). In that committee Sri Lanka also made a statement, which detailed that 27 countries and 140 institutions (mostly European) owned artefacts with Sri Lankan provenance (De Silva, 1975). Many of these museum collections are now online and accessible on the Web, although the cultural and contextual information specific to Sri Lanka is not always captured in their CHI.

The main institution responsible for portable artefacts is the Department of National Museums (DNM), Sri Lanka. Under the DNM, there are 10 main regional and special museums (Department of National Museums, 2016), while archaeological sites are handled by the Department of Archaeology and the Central Cultural Fund (CCF), Sri Lanka. There are more than 25 of these in addition to a few private museums handled by various institutions as well (Department of Archaeology, 2016). Basically, DNM co-operates with the museum network in the island and is closely coupled with the International Council of Museums or ICOM. Therefore, we can assume that the Sri Lankan museums are more or less standardised according to the ICOM standards. Nevertheless, the data standards of the Sri Lankan museums are not investigated under this study.

One of the major drawbacks of Sri Lankan museums is the absence of remotely accessible CHI. Unlike museums outside Sri Lanka that hold Sri Lankan CHI, Sri Lanka does not provide online access for its patrons. National museums and regional museums maintain a standard manual recording system and a computer application to record information within the organisation. But this information is not accessible to the general public. During this research, the authors faced the same problem and finally had to depend on published printed catalogues. On the other hand, national museums do have published catalogues, which are not restricted, but they do not cover all the objects in the museums in Sri Lanka, and not even all the objects in the national museum, Colombo.

CHI METADATA STANDARDS AND AGGREGATION MODELS

When dealing with any information, having an accepted standard is essential because it affects the longevity, quality and interoperability of the information. Therefore, we propose the incorporation of metadata standards into the CHI process. Metadata is widely used by CHI professionals to create value-added information and such metadata is often governed by well-known standards and best practices in order to ensure the quality, consistency, and the interoperability of data (Gilliland, 2008, p. 1). Memory institutions use various metadata standards according to their collection and institutional requirements. For example, MDA Data Standard and SPECTRUM by UK, Object ID by Getty and CIDOC-CRM are some renowned standards in the museum sector. However, it is obvious that this CHI may be created with diverse standards.

Europeana is a large data portal dedicated to aggregate, enrich and disseminate digital cultural heritage across memory institutions in the European Union. Europeana portal is based on Europeana Data Model (EDM) that supports the functionality of the system. According to the Europeana Data Model Primer, “EDM is not built on any particular community standard but rather adopts an open, cross-domain Semantic Web-based framework that can accommodate the range and richness of particular community standards such as LIDO for museums, EAD for archives or METS for digital libraries” (Isaac, 2013, p. 6). EDM uses RDF graphs to describe its model and it utilises commonly used metadata vocabularies such as OWL, DC, SKOS, FOAF, etc. However unlike well-known data models such as Europeana, the approach used in this study can be identified as a bottom-up approach because it starts from the base level metadata aggregation. Since there was no single data provider the metadata was collected through online collections scattered on the Internet. Usually, most tailor-made models cannot fit into a diverse and unique data aggregation and such aggregation might result in information loss or omission of information. This study proposes a solution to overcome such issues.

In addition, metadata vocabularies related to CHI sector is also very important. According to the Vocabulary Mapping Framework (VMF), “Bibliographic and heritage metadata is becoming increasingly diverse and complex and will require increasing interoperability for re-use and discovery” (VMF, 2014). Aiming these problems, VMF developed a tool which supports for semantic interoperability across communities by providing an extensive and authoritative mapping of vocabularies.

DATA EXTRACTION AND CROSSWALKING

Since this study discusses Sri Lankan CHI worldwide, we investigated museum records in Europe and the USA as well. More than 2600 Sri Lanka related CHI records were extracted from online collections by an open-source application known as OpenRefine. The records we examined were from the British Museum, UK (1779 records), Victoria and Albert Museum, UK (356 records), Metropolitan Museum of Art, USA (123 records) and printed catalogue records from the Senarath Paranavithana Teaching and Research Museum of the University of Peradeniya, Sri Lanka (377+ records). We collected CHI from memory institutions in non-English speaking regions as well but did not use that CHI because of our language ability limitation.

The controlled vocabulary terms used by each museum collections were used to create the crosswalk between museum collections. Here the main focus was only the *object categories* or *object types* defined by each museum and these terms were mapped into another well-known vocabulary called Getty AAT. Each museum had their own vocabulary to describe their object categories, and in total, there were 285 object categories related to Sri Lankan cultural objects. From the identified terms, 240 terms were mapped into the targeted vocabulary. Some instances of the mapping can be seen in Table 1 (Table 1).

Metadata level mapping was carried out between the spatial, temporal and thematic terms provided by each museum. The study used Dublin Core Metadata Initiative (DCMI) terms as core metadata standards. The main aggregating themes were *Spatial* (describes the production place/ origin of an object), *Temporal* (describes the production time/ period of an object) and *Thematic* (describes the concepts or themes of an object) which was extracted from the collections. *Identification* (museum identification no.) and *References* (bibliographical details related to the object) were also taken into consideration as additional terms (Table 2). The bracketed terms such as *(Title)* actually do not exist as attributes in the collections but are values provided by the collection information to attribute meaning to the objects.

Model Development using RDF

With the aid of the formalised mapping table (Table 2), relationships were developed over spatial, temporal and thematic terms of the cultural objects.

At the same time, the concepts were enriched semantically through LOD resources such as:

- i. Getty Art and Architecture Thesaurus (AAT) - for thematic terms
- ii. Wikipedia - for thematic terms
- iii. GeoNames - for spatial terms
- iv. Chronology of Sri Lanka (terms defined by the author) - for temporal terms

Table 1. Instances showing the mapping between AAT and museum vocabularies									
Colour key:			Exactly match with AAT & similar across museums				Exactly match with AAT		Tentatively match with AAT
AAT		No.	BM	No.	MM	No.	VA	No.	SL
Facet	Concept		Object Type		Classification		Object		Objects Categories
Objects	containers (receptacles)	1	bowl			1	Bowl		
		2	casket			2	Casket		
		3	Plate			3	Plate		
		4	reliquary			4	Reliquary	1	Reliquary
		5	amphora			5	Mug	2	Basket
		6	basin					3	Cosmetic Boxes
		7	box					4	Scabbards
		8	inkwell						
		9	jar						
		10	ewer						
		11	incense-burner						
		12	pill box						
		13	storage-jar						
		14	vessel						
		15	tobacco box						
		16	sheath						
		17	cosmetic vessel			6	Food vessels & Tableware	5	Betel Bags
		18	game bag					6	Chest
		19	gunpowder-flask					7	Chunam Containers
		20	lid box					8	Containers
		21	lime box					9	Medicine Boxes
		22	offering-bowl					10	Perfume Boxes
		23	pan					11	Powder Boxes
		24	rosewater-sprinkler					12	Trinket Boxes
		25	scent-fountain						
		26	textile bag (for manuscripts)						

Table 2. Mapping selected museum terms into DC and DCMI terms					
Aggregating Themes	DCMI Terms	British Museum	Metropolitan Museum	Victoria and Albert Museum	Sri Lankan Catalogue
Thematic	dcterms:title	(Title)	(Title)	(Title)	(Title)
	dcterms:subject	Subjects	Classification	Subjects depicted	Categorization of Objects
		Object type		Object	(Type)
	dcterms:description	Description	(Description)	Physical description Historical context note	(Description)
Spatial	dcterms:spatial	Production place	Culture	Place of origin	(Place)
	dcterms:coverage	Findspot			
Temporal	dcterms:temporal	Date	Date	Date	(Date/ Period)
	dcterms:date		Period		
References	dcterms:relation	Bibliography	MetPublications	Bibliographic References	(References)
Identification	dc:identifier	Museum number	Accession Number	Museum number	No./ (Collection Code)

According to the Figure 2, similar cultural objects (*Buddhist sculpture*) from BM (British Museum), MM (Metropolitan Museum of Art), VA (Victoria and Albert Museum) and SL (Senarath Paranavithana Teaching and Research Museum, Sri Lanka) were aggregated through equivalent concepts known as *Abhaya-mudra* and *Buddha* which are specific to Buddhist art. In parallel, temporal and spatial information were also aggregated through similarities. For example, both SL and VA cultural objects have similar *object production dates* while all four museum objects possess a similar *production place* as well.

Figure 3 shows an RDF example of dissimilar object aggregation using the same approach. Here aggregation object types are diverse. For example, BM has a *writing-slope*, MM has a *painted textile*, VA has a *figure* and SL has a *sculpture* – all four objects represent the Hindu epic story *Ramayana*. Since they represent a similar concept the metadata level relationship can be established between them. The spatial and temporal relationships also can be established similarly.

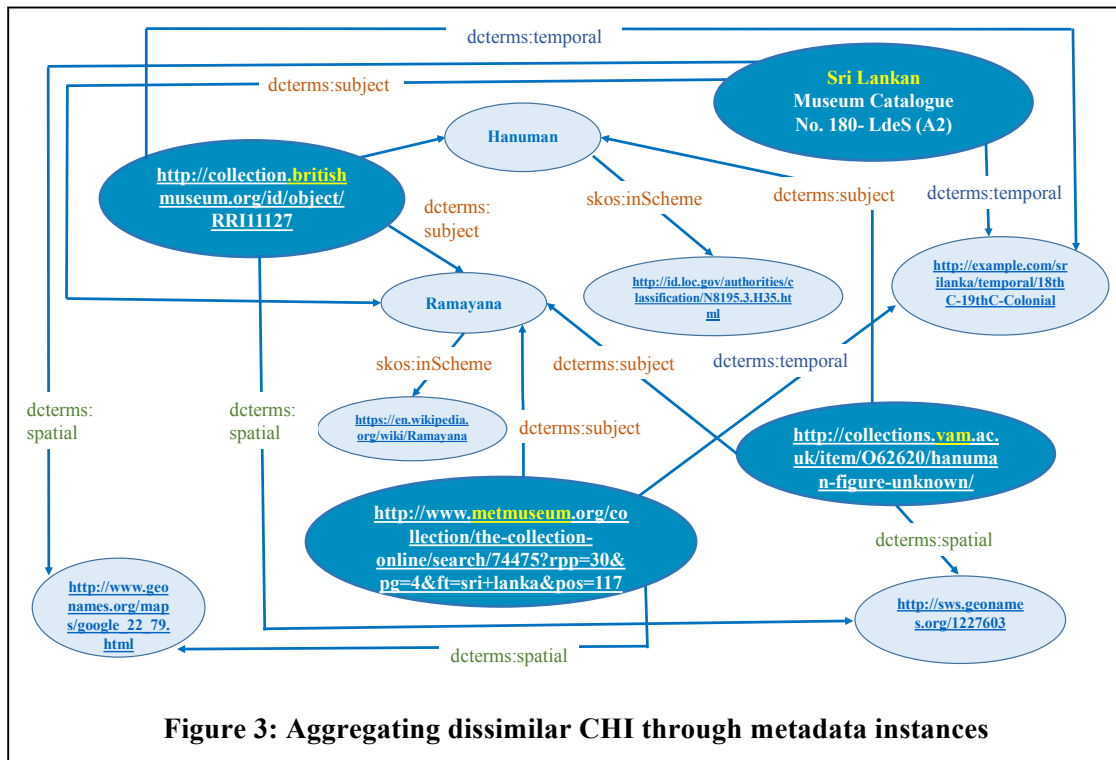


Figure 3: Aggregating dissimilar CHI through metadata instances

The aggregation models described above are highly conceptual and need strengthening through a crosswalk approach. Rather than aggregating through metadata level instances there should be a way to make a relationship between the CHI through more reliable formalisation.

Object Category Mapping between Museum Vocabularies and Getty AAT

Utilising the mapping table (Table 1), the mapped terms were categorised according to their levels of similarities. Through that, some relationships were identified and the corresponding result can be described using RDF graphs and Turtle syntax as follows. Figures 4 and 5 describe some instances that represent the relationships with the AAT. Primarily, *bm*, *mm*, *va*, *sl* refers to the four museum collections and here the consideration was on the vocabulary terms only. The namespace *aat* refers to the Getty AAT which is the main resource of this mapping. These namespaces are described as prefixes under the Turtle syntax. The dark ovals represent vocabularies and the light ones represent the classes derived from the vocabularies. The relationships were described through SKOS terms as below.

Figure 4 represents an instance of close and exact match relationship. Here the *bm* term Figure and *sl* term Sculpture can be exactly matched to the *aat* term Sculpture while *mm* and

va term sculpture are closely matching with the same. This relationship is obvious when investigating the cultural object samples and definitions of the terms with the *aat* definition given to the term Sculpture under the *Object Facet*.

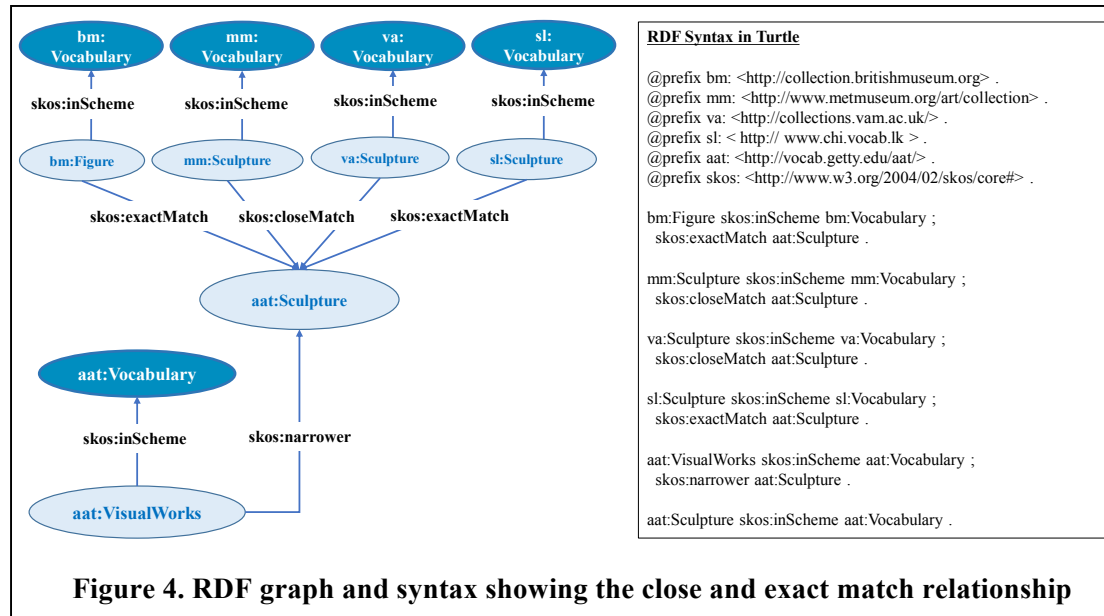
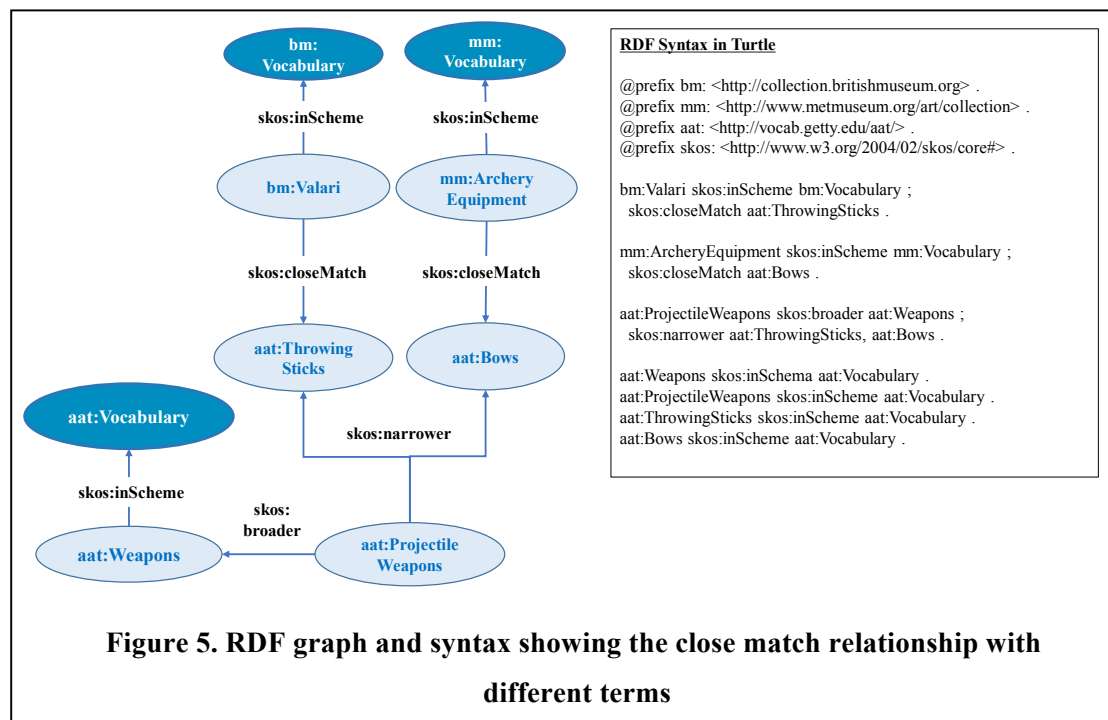


Figure 5 shows another relationship. This time, the museum terms actually do not exist in the *aat*; however related synonyms can be found in the *aat*. Here *bm* term *Valari* which is a weapon similar to *boomerang* can be mapped to *aat:ThrowingSticks* category. In addition, *mm:ArcheryEquipment* can be a close match with *aat:Bows*. All these terms can be categorised under *aat* term *Projectile Weapons* and finally into a broader term such as *Weapons*.

Similarly, objects can have diverse meanings according to materials used, concepts or themes represented, styles, associates etc. Here in this study, the attention was only on the cultural object types or category-related relationships only.



DISCUSSIONS FOR EXTENSION TO OTHER REGIONS AND CULTURAL DOMAINS

Discussions from Thailand's point of view

Thailand is located in the centre of the greater Mekhon area and has a higher-education infrastructure for library and information sciences. In Thailand, there are many digital archiving projects of cultural heritage. Palm-leaf manuscripts archiving, which is one of the important CHI projects in Thailand, may be shared among countries in the region as palm-leaf manuscripts are common heritage objects in the region.

Thai Government Policy on Cultural Heritage

The first Thai national cultural policy was formulated in 1981. This policy aimed at supporting the preservation and dissemination of Thai culture in order to create public awareness of the cultural values, promote local traditions and ethnic culture, including to create coordination and cooperation among relevant agencies engaged in cultural activities at both national and international levels.

At present, in the government policy on culture written in the Master Plan on National Culture (2007-2016), the following strategies were designed: to conserve the nation's cultural heritage and Thai wisdom, and to develop the cultural heritage as a foundation of the creative economy (Jiewjinda, 2014). With these strategies, many projects have been carried out, including conducting a survey, creating a database, restoring and enlisting the national archaeological sites. The Department of Cultural Promotion (DCP), Ministry of Culture, has been carrying out various works in cultural conservation, restoration, promotion and assimilation, as well as research and studies, particularly with regards to the folk culture. From 2005 to 2009, the DCP has collected data and has prepared Thailand's Intangible Cultural Heritage (ICH) database. The database contains 350 items in the performing arts, 500 in the traditional craftsmanship, and 40 in the folk literature domains (Ministry of Culture, 2010). Moreover, in the year 2015-2016, the Ministry of Culture (2015) has set the policy that included the strategies on culture in the context of digital society. These strategies related to open access and to cultural resources to promote the people learning experiences; for example, development of the virtual museums, historical parks, and archaeological sites; the digital libraries of national historical books and archives, and cultural digital TV.

1. The Digital Collections of National Library of Thailand is a pilot project begun in October 2013 with the aim of providing online access to information materials in the special collections of National Library of Thailand. The Digital Collections was built on *Omeka*, a free, open source web-publishing platform. Objects are described using the *Dublin Core Metadata Standard*.

Currently, there are 6,662 items in 13 digital collections. The digital collections can be accessed publicly via website <http://www.digital.nlt.go.th> (National Library of Thailand, 2016).

2. The Cultural Knowledge Center is developed under the cooperation between the Ministry of Culture and Ministry of Science and technology. It is a digital cultural knowledge center that aims to establish a knowledge structure in cultural heritage to provide services to the public and support the community and to seek business opportunities in the area of the creative economy. The knowledge base includes cultural persons and organisations, cultural artefacts, ways of life, and cultural attractions (Ministry of Culture and NECTEC, 2011).
3. The Digital Humanities Research Group of the Faculty of Humanities and Social Sciences at Khon Kaen University (KKU-DHRG) has been conducting research focused on the knowledge organisation and development of the systems and access tools for cultural heritage in Thailand and the Greater Mekong Sub-region countries. Examples of the research work at KKU-DHRG include: a) Knowledge organisation and ontology of the knowledge on GMS and Thai aspects, e.g. intangible cultural heritages, belief culture,

folklore, imaginary beings, alternative medicine, Thai culture, Thai ethnic groups. b) Metadata schema for Thai inscriptions, palm leaves, and museum artefacts. c) Semantic digital libraries/archives of Thai ethnic groups, Thai historical sites. d) T knowledge-based system of the belief culture of GMS. e) Semantic 3D virtual museum of masterpieces of Ban Chiang's potteries (Tuamsuk, 2015).

Summary from Thailand's Viewpoint

Although the Thai Government has set the policy on cultural heritage, most of the activities emphasise preservation and safeguarding rather than access. The organisations which are responsible for learning resources in the cultural heritage area, such as the ministry, museums, historical parks, and libraries, etc. may have attempted to develop the digital collections and provide online access to the public via their websites; however, all the services are separately operated and use different standards and technologies. There has not been an attempt to create a kind of national knowledge resource which provides open access to the public like the World Digital Library or the Europeana.

On one hand, from these observations, we understood that the readiness to use the Internet and Web for sharing CHI depends on the country by country. On the other hand, we think that we need a platform to collect CHI and aggregate them across borders and that platform will strengthen information and knowledge sharing of cultural heritage.

Discussion from Japanese Point of View

Cultural Heritage Online¹ by Agency for Cultural Affairs of the Japanese government is a nation-wide cultural heritage information portal for the cultural heritage objects owned by museums in Japan. National Diet Library (NDL) provides a large-scale digital collection of books and other cultural resources. An important service by NDL is NDL Search, which is a portal to various kinds of cultural resources as well as library-oriented resources such as authority files². NDL Search provides search results in RDF/XML expressed based on their core metadata schema, DC-NDL. NDL provides their CHI using Web-oriented technologies and is hence suitable to LOD. An interesting research project to apply the LOD technologies to museums and related scholarly resources is the LODAC project by NII³. However, there is no aggregation service of cultural heritage objects like Europeana in Japan. Like other Asian countries, we can find many objects and artefacts related to Japanese cultural heritage overseas. Japan has a rather advanced information environment but there is still a need to collect CHI and aggregate them.

Manga (Japanese comics), Anime (animations) and Games are important Japanese pop-culture resources, and very soon will be part of the cultural heritage of Japan. These pop-culture resources may not be included in the traditional cultural heritage but will become important cultural heritage in near future. These pop-culture resources are popular not only in Japan but also in other countries including Southeast Asian countries. Nevertheless, there is not much metadata or metadata aggregation of these resources. Hence, there is scope in the future for research around CHI aggregation of pop-culture and other contemporary heritage resources also.

General Discussion for Extension of the Scope

From the study based on Sri Lankan CHI aggregation discussed in this paper, we have learned that a platform to map vocabularies is required to aggregate Sri Lankan CHI and that LOD is

¹ Cultural Heritage Online: <http://bunka.nii.ac.jp/> (in Japanese)

² NDL Search: <http://iss.ndl.go.jp/?locale=en&ar=4e1f>

³ LODAC Project: <http://lod.ac/>

an important issue to pursue this aggregation. We know that there are commonalities in our cultural heritage and we share some pop-culture content as well. So, we think that linking CHI from different regions and from different domains with each other is crucial. On the other hand, we also know that proposing expensive technologies will not work well in developing regions. The LOD technologies provide us with an inexpensive environment to connect our CHI. The Sri Lankan CHI study discussed here is still in an early stage of development but it shows a way toward a framework for further study to connect CHI in different regions and different domains.

CONCLUSIONS AND RECOMMENDATIONS

This paper sought to find a suitable approach to aggregated CHI in diverse environments and to fill the Sri Lankan CHI gap between memory institutions. To achieve this, the study proposed a metadata level model as a base level CHI aggregation through spatial, temporal and thematic terms. Towards this, solid data aggregation must have a concrete level formalisation between vocabularies, and hence we suggested a crosswalk between four museum vocabularies with the Getty AAT vocabulary. The formalisation achieved through this object category mapping between museums can be used as the foundation to metadata aggregation. Also, the relationships derived from mapping are important in identifying the cultural objects in different contexts with different granularities. We consider that our important next step is to extend this study to CHI in other countries such as Thailand.

CHI aggregation is a popular and well-developed area and CHI users plus non-CHI users benefit from such approaches in numerous ways. However, CHI aggregation or CHI related metadata approaches are discussed very rarely in the Sri Lankan setting and are often an overlooked topic in the region. Therefore, investigating aforesaid fields that are not fully discovered yet would be a stepping-stone to deliver CHI to the global arena in the Sri Lankan domain, and in other developing regions.

LOD has a large potential to connect CHI in different organisations within a country, between countries, and amongst different languages, as the foundation of LOD is controlled vocabularies for metadata, which is expressed in RDF and has a basis on URI. These underlying technologies are language neutral.

The languages barrier makes it hard to connect CHI created in different regions. Translation efforts are required but the translation by humans is expensive and automatic translation would often not be satisfactory in the case of cultural contents. We believe that metadata vocabularies realised as a LOD dataset are crucial in solving this issue because there are many LOD datasets which may be useful to bridge CHI across language borders.

Therefore, in the future, our current research can be extended to develop a more comprehensive mapping between Sri Lankan and Southeast Asian cultural objects with renowned CHI vocabularies. Since a lack of Sri Lankan-based vocabulary related to cultural heritage was one of the main challenges faced during this study, developing such a vocabulary will be a crucial point to be addressed. Finally, identifying and aggregating CHI of Southeast Asian regions such as Sri Lanka and Thailand and make them available in LOD environment will be the next phase of this study.

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