

IAENG TRANSACTIONS ON ENGINEERING SCIENCES

Special Issue for the International Association of
Engineers Conferences 2019

Sio-long Ao • Haeng Kon Kim • Oscar Castillo
Alan Hoi-shou Chan • Hideki Katagiri

Editors

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PREFACE

A large international conference on Advances in Engineering Sciences was held in Hong Kong, 13-15 March, 2019, under the International MultiConference of Engineers and Computer Scientists 2019 (IMECS 2019). The IMECS 2019 is organized by the International Association of Engineers (IAENG). IAENG is a non-profit international association for the engineers and the computer scientists, which was founded originally in 1968 and has been undergoing rapid expansions in recent few years. The IMECS conference serves as a good platform for the engineering community to meet with each other and to exchange ideas. The conference has also struck a balance between theoretical and application development. The conference committees have been formed with over three hundred committee members who are mainly research center heads, faculty deans, department heads, professors, and research scientists from over 30 countries with the full committee list available at our conference web site (<http://www.iaeng.org/IMECS2019/committee.html>). The conference is truly an international meeting with a high level of participation from many countries. The response that we have received for the conference is excellent. There have been more than four hundred manuscript submissions for the IMECS 2019. All submitted papers have gone through the peer review process and the overall acceptance rate is 50.36%.

This volume contains twelve revised and extended research articles written by prominent researchers participating in the conference. Topics covered include engineering physics, computer science, electrical engineering, industrial engineering, and industrial applications. The book offers the state of art of tremendous advances in engineering sciences and engineering technologies and

applications, and also serves as an excellent reference work for researchers and graduate students working with/on engineering sciences and engineering technologies.

Sio-Iong Ao
Haeng Kon Kim
Oscar Castillo
Alan Hoi-shou Chan
Hideki Katagiri

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LOD-Based Semantic Web for Indonesian Cultural Objects

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Online media might be a way to introduce as well as preserve cultural heritage. Related to Indonesian culture, there are publication services available which focus only on information sources without metadata properties. This article explains our effort to preserve the Indonesian cultural heritage using semantic web and linked open data for a comprehensive presentation. An OWL-based ontology has been trying to be developed for a repository application consists of 13 ontologies of Indonesian cultural objects based on Description Logic of manually extracted literatures. The development process involved important partners in Special Region of Yogyakarta, i.e. Department of Culture, Regional Library and Archives Agency, Indonesian University Library Forum, as well as cultural practitioners and researchers. The applications of cultural objects are introduced at the end of this article. It is a baby step of a giant dream.

Keywords: Semantic Web; Linked Open Data; Indonesian cultural objects; Repository.

1. Introduction

Indonesia has a rich cultural life supported by more than 1,300 ethnic groups¹. These cultural assets need to be preserved as a cultural heritage. In 2015, there were 6,238 intangible cultural heritages and 979 cultural heritages spread across 34 provinces of Indonesia². To preserve cultural heritage, in 2017, Republic of Indonesia Government through the Ministry of Education and Culture has recognized 150 new intangible cultural heritages³ based on 416 proposals from various regions in Indonesia⁴. Therefore, until 2017 there have been 594 intangible cultural heritages managed

by Directorate General of Culture, the Ministry of Education and Culture⁵.

Tanudirjo⁶ emphasized that all parties must play an active role in preserving the richness of Indonesian cultural heritage to have benefit for themselves. Tanudirjo called it the "Cultural Heritage for All" or the "All for Cultural Heritage". Online publication using web infrastructure considered as an effort to introduce and disseminate Indonesia's cultural richness. It has been started by *Sejuta Data Budaya* (SDB) movement through *Perpustakaan Digital Budaya Indonesia*^a website and *National Library* through *Digital Batavia Online*^b program. The intention should be improved to the relationship between one cultural object to another. This linkage information is significant by virtue of a cultural object is inseparable from its environment and tends to influence other cultures.

The aim of this research is to develop a Semantic Web-based information catalog of Indonesian cultural objects by generating a knowledge representation model of Indonesian cultural objects and their relationships. The Semantic Web framework⁷ supports ontology-based modelling as a form of open knowledge representation and linkages between objects in order to present more representative information. Therefore, the intended online catalog services must support the open data, i.e. Linked Open Data (LOD), characteristic.

This research reinforce the technology framework for an ICT^c Content enrichment stipulated in 2015-2045 National Research Master Plan of the Research, Technology, and Higher Education Ministry of Republic of Indonesia. Our LOD-based Semantic Web cultural object repository service is possible to benefit various parties with various objectives, e.g. learning media, publication media. Further more, it should encourage the emergence of other relevant application-based service works.

This article explains our effort towards an LOD-based Semantic Web specifically for Indonesian cultural objects, i.e. the methodology and the applications. The narrative starts from describing the state-of-the-art as well as literature study of research related to Semantic Web and Cultural Heritage and is ended by description of consecutive and potential studies.

^aIndonesia Cultural Digital Library. URL: budaya-indonesia.org.

^b<http://bataviadigital.perpusnas.go.id/home/>

^cInformation and Communication Technology

2. Literature Study

Awareness for raising and disseminating information related to the work and objects of Indonesian culture has been conducted by the National Library of Indonesia with the Digital Batavia Online program. Other efforts to provide information services on Indonesian cultural objects are also carried out by the community, e.g. the Indonesian Cultural Digital Library^d.

The Indonesian cultural information service representation framework does not yet follow the open data framework. Based on the Open Knowledge Foundation⁸ and W3C⁹, every community and government can build a system to collect data and content from anyone. Thus, the application of the open data framework may play a role in increasing the Indonesian Human Development Index (HDI).

Implementation of Semantic Web framework encourages the dissemination of information related to Indonesian cultural objects. The Semantic Web framework provides a repository system that functions as open data and open knowledge for cultural objects. Westrum in Ref. 10 emphasises that the application of open data by including semantic content in the data makes information repository services easy to use and develop. Libraries, museums, and archival institutions function as main information suppliers for the community¹¹. The addition of information to the web document will provide a clearer meaning description of the document contents. Providing a description to the meaning of documents can be realized by a machine, through a developed application. This machine understanding feature is based on the meaning representation conveyed by a web document¹².

On the other hand, the application of the Semantic Web to a domain requires the development of knowledge representation models. This knowledge representation model requires an ontology definition. Biffl & Sabou in Ref. 13 stresses that the use of metadata has to be precisely defined in order to reduce the confusion of computer applications that will translate it. There are 2 principles should be followed. First, metadata must describe information in terms that have a clear meaning to the machine and reflect the agreement of the wider community. Second, metadata must be expressed in a representation language that can be parsed and translated by computer applications. Sugumaran & Gulla¹⁴ described the layers in the Semantic Web, i.e. 1) data and metadata; 2) semantics; 3) enabling technology; and 4) environment. Each layer provides a set of functions to

^d<http://budaya-indonesia.org>

perform its layer tasks¹⁵.

The semantics layer provides several functions to fulfil the conditions of well-defined meaning, i.e. ontology language (OWL), rule languages (SWRL/RIF/RuleML), query languages (SPARQL), logic (Description Logic), reasoning mechanisms, and trust. Each data should be represented by standard rules to support data exchange between various applications and systems. At the data layer and metadata, there are Unicode, URI, XML, RDF, and RDF Schema standards.

Ontology is significant for a Semantic Web application to facilitate knowledge sharing and reuse in a distributed system¹⁶. An ontology that represents static domain knowledge and problem-solving methods, will be used in the Semantic Web services that modeling the reasoning process and deal with the domain knowledge¹⁷. Grimm, Abecker, and Studer¹⁸ describe the main characteristics associated with the development of ontology in information systems, i.e. 1) interrelation; 2) instantiation; 3) Subsumption; 4) Exclusion; 5) Axiomatization; and 6) Attribution.

Different approaches are proposed for ontology development methodology, i.e. employing frames and first-order logic¹⁹, description logic²⁰, Unified Modeling Language (UML)²¹, and E-R Diagrams to represent an ontology¹⁷. However, most of the methodologies are based on people's experiences when got involved in ontology development. There are methodologies derived from the practice of ontology development itself, while the other focused on application development in which ontology is created. The example of the first approach are *CYC*²² (which was based on experience during the development of CYC knowledge base), *Enterprise Ontology*, *Toronto Virtual Enterprise (TOVE)*²³, and *Amaya*²⁴ (which is produced from ESPRIT KACTUS project). Several methodologies included in the second approach are *CommonKAD*²⁵ (which focused on the application of knowledge information systems in a company/organisation), *Methontology*²⁶, *Web Semantics Design Method (WSDM)*²⁷, and *Semantic Hypermedia Design Method (SHDM)*²⁸.

In cultural heritage domain, Freire, Calado, and Martins²⁹ found that none of URLs, out of 52,866 URLs in Europeana providers, accommodates Semantic Web services with RDF or JSON-LD format. Rather, most of them relies on the format of HTML documents which intended for humans. For data synchronisation, OAI-PMH^e protocol is widely used,

^eOpen Archives Initiative Protocol for Metadata Harvesting. <http://www.openarchives.org/>

notwithstanding the urge of change OAI-PMH is getting stronger in accordance with the computing performance improvement. The alternatives of aforesaid web data technologies³⁰ are International Image Interoperability Framework (IIIF), Webmention, Linked Data Notifications, WebSub, Sitemaps, ResourceSync, Open Publication Distribution System (OPDS), Linked Data Platform, and Schema.org.

The open data and open knowledge principles supports the development of information service networks that links information objects from a number of information source institutions. Accordingly, the Semantic Web framework can be developed into a large framework of links between information providers called *Linked Open Data* (LOD). A challenge in developing a cultural object information repository that applies the Semantic Web and LOD is the cultural object information characteristic³¹, i.e. multi-format (documents, films, pictures, etc.), multi-topic, multi-language, multi-cultural, multi-target (content for laymen or experts, young or old). As a consequence, vocabulary control of particular cultural object is significant. A taxonomy of Indonesian cultural object proposed by Proboyekti and Susanto in Ref. 32 consists of 17 categories and 80 subcategories.

LOD empowers a semantic portal of cultural heritage service as well as a content model definition for metadata representation, ontology, and rules related to cultural objects. Certain benefits of semantic portal from the end users view point³³ are 1) a global display for heterogeneous and distributed content; 2) automatic content aggregation; 3) semantic search; 4) semantic exploration and recommendations; and 5) other intelligent services, e.g. personalisation, semantic visualisation based on history and location. On the other hand, data providers should also enjoy some advantages from the semantic portal, i.e. 1) distributed content creation; 2) automatic link maintenance; 3) sharing publication services together; 4) semantically enrich each other's content; and 5) reuse of content that has been contained in the portal.

Hyvönen in Ref. 33 provides recommendations for each Semantic Web layer of semantic portal appropriate for cultural heritage service. For *metadata schemas* layer, it is recommended to use metadata that supports the description of each cultural object. *Dublin Core (DC) Metadata Element Set*^f and *Visual Resource Association's (VRA) Core Categories*^g are potential alternatives as a basis for more detailed metadata schemes. The

^f<http://dublincore.org/documents/dces/>

^g<http://www.vraweb.org/>

metadata can also be expressed in the form of Turtle notation^h.

At *ontology* layer, it is necessary to provide standards and instructions for terms selection to complete each metadata element. Standard data values are usually determined from controlled vocabularies and thesauri^{34,35}, e.g. *Thesaurus for Graphic Materials I*ⁱ (TGM I), *ICONCLASS*^j, *Art and Architecture Thesaurus*^k (AAT), *Union List of Artist Names*^l (ULAN), *UNESCO Thesaurus*^m, *Thesaurus of Geographic Names*, and *Library of Congress Authority Files*ⁿ. *Cataloging Cultural Objects*^o (CCO) guidelines is an example of data content standard for descriptive cataloging of cultural works.

In spite of the fact that thesaurus is significant in improving the performance of retrieval engine as well as indexer, constructing a thesaurus for cultural objects is challenging for it should consider multidimensional views. Some thesaurus have been transformed into SKOS^p format on the grounds that it supports LOD standardisation. A study³⁶ of LOD KOS found that : 1) LOD KOS vocabulary encourage the data provided to receive 4-5 LOD stars; 2) the LOD approach leads to unconventional processes and results since vocabulary producers involved in developing and enriching KOS; and 3) in terms of end-users products, LOD is a knowledge base which provides semantic-rich discoveries.

In Semantic Web framework, the definition of each cultural object follows its ontology concept. There are 6 ontology types³¹ related to the object collection of cultural heritage information classified by their domain of discourse, i.e. 1) General concept ontologies; 2) Actor ontologies; 3) Place ontologies; 4) Time and period ontologies; 5) Event ontologies; and 6) Domain nomenclatures or terminologies. *CIDOC Conceptual Reference Model* (CRM) is the existence ISO21127-standardised ontology reference for cultural heritage. A study of Ariyani and Yuhana³⁷ successfully linked CIDOC-CRM metadata with the open linked data *Geonames* dataset in order to enrich the spatial information of cultural objects.

The effort of Indonesian cultural objects ontology development ex-

^h<http://www.dajobe.org/2004/01/turtle/>

ⁱ<http://www.loc.gov/rr/print/tgm1/>

^j<http://www.iconclass.nl/>

^khttp://www.getty.edu/research/conducting_research/vocabularies/aat/

^l<http://www.getty.edu/vow/ULANSearchPage.jsp>

^m<http://vocabularies.unesco.org/browser/thesaurus/en/>

ⁿ<http://authorities.loc.gov/>

^o<http://vraweb.org/resources/cataloging-cultural-objects/>

^pSimple Knowledge Organization System.

pressed by several studies, e.g. batik object ontology in Ref. 38, medicinal plants ontology in Ref. 39, traditional herbal medicine ontology in Ref. 40. These ontologies have no connection to form linked data. This article shows an ongoing study of interconnected ontologies for Indonesian cultural objects. It consists of 13 ontologies and 2 of the ontologies can be found in Ref. 41 and Ref. 42.

3. A Study of LOD-Based Semantic Web

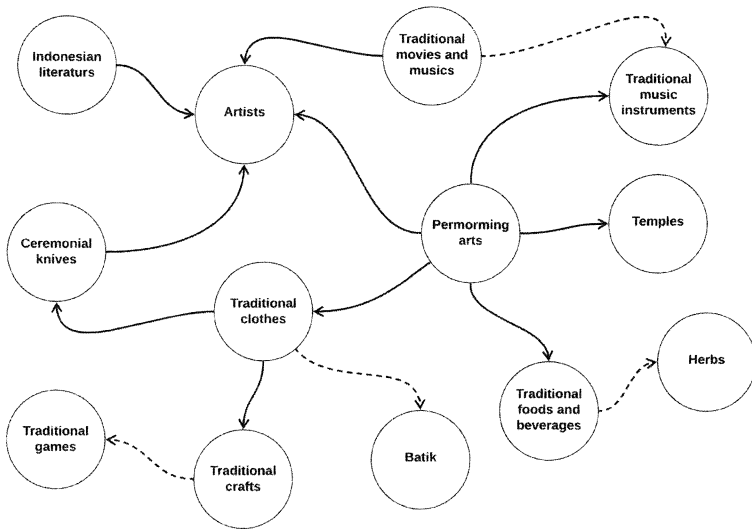


Fig. 1. Ontology modular model of Indonesian cultural objects.

This study was started by focus group discussions (FGDs) consisted of important partners in Special Region of Yogyakarta^q, i.e. Dinas Kebudayaan (Disbud) DIY^r, Badan Perpustakaan dan Arsip Daerah (BPAD)

^qDaerah Istimewa Yogyakarta (DIY).

^rDepartment of Culture

DIY^s, Forum Perpustakaan Perguruan Tinggi Indonesia (FPPTI) DIY^t, as well as pertinent practitioners and researchers. The main outcomes of the FGDs were:

- (1) Determination of 13 cultural objects selected from Indonesian cultural taxonomy³². Those are traditional music instruments (*alat musik tradisional*), temples (*candi*), Indonesian movies and musics (*film dan musik Indonesia*), Indonesian traditional crafts (*kerajinan tradisional Indonesia*), ceremonial knives (*keris*), traditional foods and beverages (*makanan dan minuman tradisional*), traditional clothes (*pakaian adat*), artists (*pelaku seni*), traditional games (*permainan tradisional*), Indonesian literatures (*sastra Indonesia*), performing arts (*seni pertunjukan*), batik (*batik*), and herbs (*jamu*).
- (2) A dataset collection of those selected cultural objects.

Table 1. List of IRI ontologies.

No.	Cultural Objects	IRI
1	Traditional music instruments	http://aunalun.info/ontology/alatmusik
2	Temples	http://aunalun.info/ontology/candi
3	Indonesian movies and musics	http://aunalun.info/ontology/musikfilm
4	Traditional crafts	http://aunalun.info/ontology/kerajinan
5	Ceremonial knives	http://aunalun.info/ontology/keris
6	Traditional foods and beverages	http://aunalun.info/ontology/makanan
7	Traditional clothes	http://aunalun.info/ontology/pakaianadat
8	Artists	http://aunalun.info/ontology/seniman
9	Traditional games	http://aunalun.info/ontology/permainan
10	Indonesian literatures	http://aunalun.info/ontology/sastra
11	Performing arts	http://aunalun.info/ontology/senipertunjukan
12	Batik	http://aunalun.info/ontology/batik
13	Herbs	http://aunalun.info/ontology/jamu

The ontology modelling is modular in the sense that each ontology of

^sRegional Library and Archives Agency

^tIndonesian University Library Forum

cultural object is independent yet having relation each other as it shows in Fig. 1. Each ontology has the same IRI basis, i.e. <http://aunalun.info/ontology> followed by ontology name^u of cultural object. Table 1 presents the complete IRI ontologies.

The study follows a process described in Fig. 2 which is an adaptation of Methontology and WSDM methodologies. *Knowledge extraction* phase in Fig. 2 is basically a literature study. In this phase, significant sentences were selected or generated by summarizing passages, hence the phase yielded simple sentences comprised of subject, predicate, and object. Table 2 lists all books being extracted for each relevant ontology. Unlike the others, *Traditional foods and beverages* object exploited individual notes taken from observation in traditional markets.

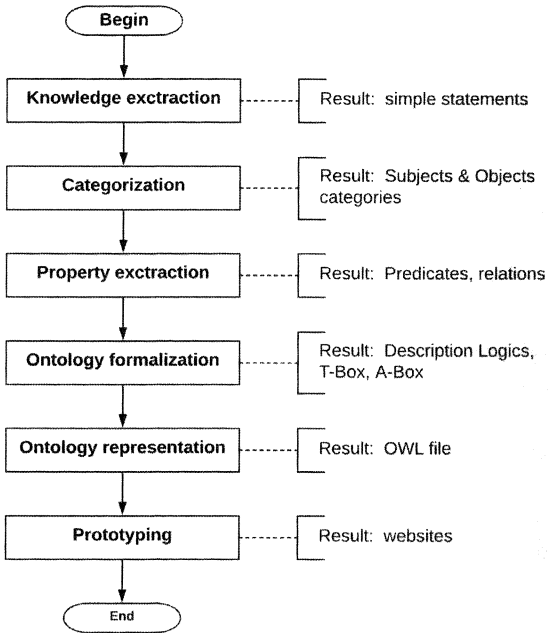


Fig. 2. Research Methodology.

^uIn Indonesian.

Table 2. List of books used as knowledge source.

No.	Cultural Objects	Book Titles
1	Traditional music instruments	<i>Bentuk-Bentuk Peralatan Hiburan dan Kesenian Tradisional Daerah Istimewa Yogyakarta</i> ⁴³ <i>Ensiklopedia Alat Musik Tradisional</i> ⁴⁴ <i>Ensiklopedia Alat Musik Tradisional</i> ⁴⁵
2	Temples	<i>Indonesian Heritage: Sejarah Awal</i> ⁴⁶ <i>World Heritage Sites and Living Culture of Indonesia</i> ⁴⁷
3	Indonesian movies and musics	<i>Poster Film Indonesia: Masa Sesudah Kemerdekaan</i> ⁴⁸ <i>Poster Film Indonesia: Masa 1980-1990</i> ⁴⁹ <i>Kumpulan Lagu Daerah Nusantara Terlengkap!</i> ⁵⁰
4	Indonesian traditional crafts	<i>Album Kerajinan Tradisional (Bengkulu, DKI Jakarta, Jawa Tengah, Jawa Timur, Kalimantan Barat)</i> ⁵¹ <i>Album Gerabah Tradisional Kasongan Yogyakarta</i> ⁵² <i>Pengrajin Tradisional di Daerah Bali</i> ⁵³
5	Ceremonial knives	<i>Ensiklopedi Keris</i> ⁵⁴
6	Traditional foods and beverages	-
7	Traditional clothes	<i>Busana Tradisional</i> ⁵⁵ <i>Untaian Manik-manik Nusantara</i> ⁵⁶ <i>Perhiasan Tradisional Indonesia</i> ⁵⁷ <i>Album Pakaian Tradisional Yogyakarta</i> ⁵⁸ <i>Tutup Kepala Tradisional Jawa</i> ⁵⁹
8	Artists	<i>Seni Rupa</i> ⁶⁰
9	Traditional games	<i>Permainan Tradisional Indonesia</i> ⁶¹
10	Indonesian literatures	<i>Majas, Pantun, dan Puisi</i> ⁶²
11	Performing arts	<i>Indonesia Heritage (Vol. 08)</i> ⁶³ <i>Masa Gemilang dan Memudar Wayang Wong Gaya Yogyakarta</i> ⁶⁴ <i>Mengenal Tari-Tarian Rakyat di Daerah Istimewa Yogyakarta</i> ⁶⁵
12	Batik	<i>Batik Filosofi, Motif dan Kegunaan</i> ⁶⁶ <i>Keeksotisan Batik Jawa Timur: Memahami Motif dan Keunikannya</i> ⁶⁷
13	Herbs	<i>Empat Puluh Resep Ampuh Tanaman Obat Untuk Mempercepat Kehamilan</i> ⁶⁸ <i>Empat Puluh Resep Dahsyat Jamu Penakluk Asam Urat Dan Diabetes</i> ⁶⁹ <i>Empat Puluh Resep Ampuh Tanaman Obat Untuk Mengobati Jantung Koroner & Menyembuhkan Stroke</i> ⁷⁰

The subjects and objects resulted from previous phase were categorized in order to attain to a list of concepts, i.e. classes or instances, for each cultural objects. Properties of cultural objects, i.e. relations, were derived by summarizing, grouping, as well as categorizing the sentence predicates. After this phase, it was possible to compile a knowledge in the form of description logics and T-box RDFS model for each cultural objects. These were the basis of each ontology which was realized into Protégé. The OWL file yielded by Protégé were functioned as the knowledge in Semantic Web of cultural objects. In our project, GraphDB was used as the SPARQL End Point as it is depicted in Fig. 3.

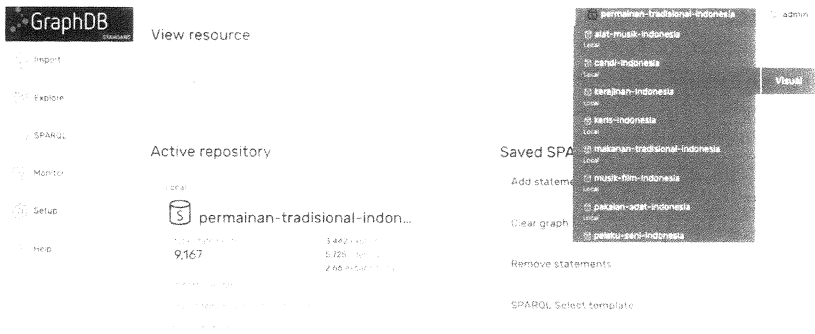


Fig. 3. GraphDB screenshot of alunalun.info.

The following describes the number of classes and triples^v belongs to each cultural objects:

- (1) Traditional music instruments : 16 classes and 4,247 triples
- (2) Temples : 45 classes and 5,453 triples
- (3) Indonesian movies and musics : 16 classes and 3,884 triples
- (4) Traditional crafts : 16 classes and 3,362 triples
- (5) Ceremonial knives : 144 classes and 19,219 triples
- (6) Traditional foods and beverages : 19 classes and 3,991 triples
- (7) Traditional clothes : 16 classes and 2,500 triples
- (8) Artists : 25 classes and 3,134 triples

^vA triple is a set of three elements: a subject, a predicate, and an object.

- (9) Traditional games : 18 classes and 9,167 triples
- (10) Indonesian literatures : 48 classes and 10,348 triples
- (11) Performing arts : 36 classes and 3,600 triples
- (12) Batik : 13 classes and 8,126 triples
- (13) Herbs : 18 classes and 4,297 triples

4. Portal Applications of Indonesian Cultural Objects

Two ontologies of Indonesian cultural objects have been constructed, i.e. batik and herbs, and implemented on websites. The *Batik Indonesia* website and *Jamu Tradisional Indonesia* are available in <http://alunalun.info/batik/> and <http://alunalun.info/jamu/>, successively. Figure 4 shows the visualization of the batik ontology implemented on its website.

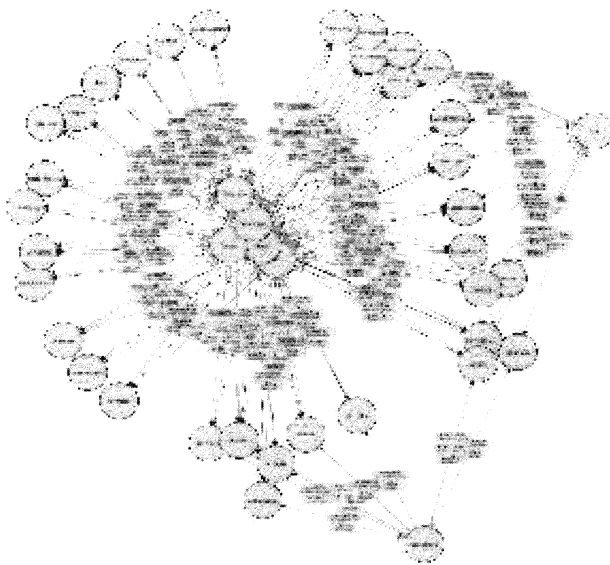


Fig. 4. Visualization of batik ontology.

The 11 other ontologies have been developing and being implemented. The intended portal applications should provide a usable interface for information search and retrieval. Figure 5 to Fig. 8 presents homepage of 4 cultural objects, i.e. ceremonial knives, traditional foods & beverages, Indonesian literatures, and performing arts, successively.



KERIS

semata tatanan bersarung berujung tajam dan bermata dua (bilangnya ada yang lurus ada yang berkelok-kelok).

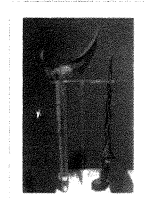
- Mata Lun
- Mata Durus

Tahukah ?
Keris Berisi tarapan agar
mampu menjadi simbol
sukarela hidup ini
(Keris sebagai simbol
Keramat 2017)



Contents:

- Keris
- Keris sebagai simbol
- Bilah
- Gagang
- Tangkai
- Buntut



KOMPONEN KERIS

Bagian-bagian dandane:

- Bulah
- Maly
- Manggis
- Mandan
- Buntut

Fig. 5. Homepage application of ceremonial knives object.



Fig. 6. Homepage application of traditional foods & beverages object.



Fig. 7. Homepage application of Indonesian literatures object.

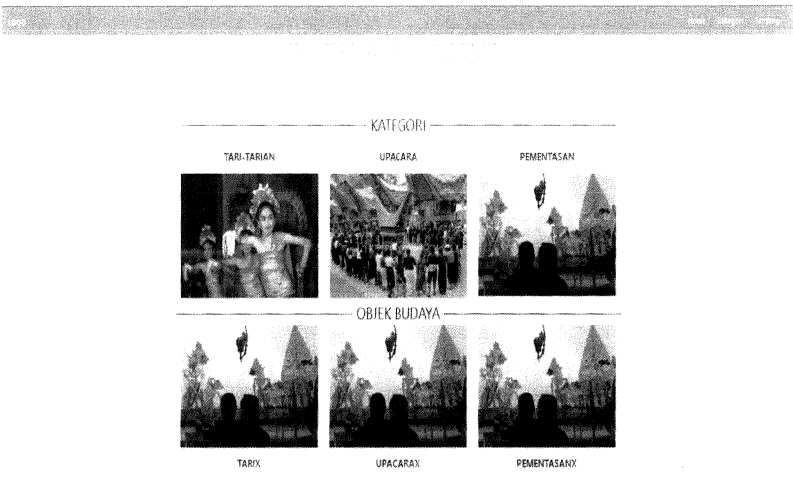


Fig. 8. Homepage application of performing arts object.

5. Conclusion and Future Studies

Various cultural objects, including works from the local community, are local knowledge or local wisdom preserved in the community. Our study is an effort to be an active participant in introducing and disseminating cultural knowledge. It is an endeavour to develop LOD-based Semantic Web for Indonesian cultural objects. Out of 13 modules, 2 ontologies of cultural objects have been successfully constructed, i.e. batik and herbs, while the other ontologies are still in the development process. Nevertheless, homepage of several intended applications presented to show current progress achieved.

The knowledge extraction phase basically was conducted based on selected literatures. In the future, experts of each objects should be involved. The effectiveness and efficiency of the ontologies need to be measured carefully for the quality of the Semantic Web. Another concern is the user interface of the applications in order to ensure users having a good experience.

Acknowledgments

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