

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/312078424>

Digital Preservation of Cultural Heritage: Balinese Kulkul Artefact and Practices

Conference Paper · October 2016

DOI: 10.1007/978-3-319-48496-9_38

CITATIONS

2

READS

137

2 authors:



[Cokorda Pramatha](#)

Udayana University

6 PUBLICATIONS 6 CITATIONS

[SEE PROFILE](#)



[Joseph G. Davis](#)

The University of Sydney

91 PUBLICATIONS 1,277 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Digital Documentation of The Balinese Royal Family, Family Tree [View project](#)



Digital Preservation of Cultural Heritage [View project](#)

Digital Preservation of Cultural Heritage: Balinese *Kulkul* Artefact and Practices

Cokorda Pramatha, Joseph G. Davis

School of Information Technologies, The University of Sydney, Sydney, Australia
{cokorda.rai, joseph.davis}@sydney.edu.au

Abstract. One of the goals of digital preservation of cultural heritage is to gather, refine, maintain, and share cultural resources that can subsequently be used and developed by scholars, members of the community, and future generations. We present the details of our research dealing with one aspect of Balinese culture, the Balinese traditional communication system (*kulkul*), undertaken in the Indonesian island of Bali. We introduce a new framework based on Balinese cultural principles (*Tri Hita Karana* and *Desa Kala Patra*) to capture, classify, and organize cultural artefact and practice knowledge, and design and develop an online digital portal prototype to enable the sharing and growth of knowledge related to the Balinese *kulkul*. This knowledge is held largely in tacit form in the Balinese community, poorly documented, and fragmented, which makes the preservation difficult and yet crucial. The aim of the project is to document, preserve, and educate the Balinese community and the younger generations in particular on an important aspect of Balinese culture. This community will be encouraged not only to learn about *kulkul* and related practices but also contribute their own knowledge to enable the online digital portal to evolve into a living repository of Balinese cultural knowledge. The basic *kulkul* knowledge and understanding was obtained through in-depth interviews with selected Balinese cultural experts and knowledgeable community members (Professors from a Balinese University, spiritual leaders, senior community leaders, and craftsmen). As part of the digital portal, our project also includes the development of a basic ontology of key *kulkul*-related concepts and terms, and their inter-relationships to support the semantic searching and browsing of online resources.

Keywords: Balinese *kulkul*, digital heritage, digital portal, ontology, living cultural repository.

1 Introduction

Over the past few decades, digitization of cultural heritage and natural history has gained much attention from researchers, practitioners, and memory institutions (galleries, libraries, archives, museums, and natural history institutions). Digital preservation of cultural heritage is a complex and interdisciplinary task involving computer science, history, library, literature, information science and art. One of the goals of digital

preservation is gathering, refining, maintaining, and sharing the cultural resources that subsequently can be used and developed by scholars, members of the community, and younger generations. Moreover, digitization is used for creating new means of accessing cultural information, where the users and/or future generations have the ability to learn, understand, and further develop the digital resources through the Internet.

Many countries all around the world face the problem of cultural heritage extinction or depletion, and many of the objects and cultural practices are poorly documented, largely tacit, and fragmented [1, 2, 3, 4]. These contribute in making the preservation project difficult, and yet crucial. The fragmentation of cultural knowledge presents a major challenge for cultural preservation, rendering it time-consuming and labor-intensive. Technological developments such as the Internet, smartphones, and advances in IT allow for a unique and crowd driven solution to this problem. By undertaking a crowd driven, systematic approach to gather, store, check and organize cultural information, we aim to integrate the diverse knowledge, make it widely available through appropriate framework and platforms, and test the accuracy and validity of our approach towards preserving and extending cultural heritage.

1.1 Aims and Significance

This project aims to enhance the Balinese community understanding and the younger generations in particular on an important aspect of Balinese culture. Much of this knowledge is deeply tacit and collectively held within the Balinese community. This is the first stage of our digital project which externalizes the complex body of knowledge and makes it available through an online digital portal for the benefit of the Balinese community as well as the large number of people with deep interest in Balinese culture and traditions.

The objective of this paper is to propose a knowledge organization and classification framework for Balinese cultural heritage, and to design and develop an online digital portal prototype system for preserving, archiving, and sharing knowledge related to unique Balinese culture artefacts by tapping into the community-level understanding and knowledge of cultural heritage.

1.2 Research Problem

A problem encountered in cultural digitization projects is the preservation of information beyond the actual object, such as contextual and cultural practice-related information. UNESCO identified such practices as very fragile by their very nature and easily forgotten, making the digitization of this cultural information is vital for preservation.

Bali is renowned of worldwide tourist destination because of its highly developed culture such as art, traditional dance, painting, music, language, etc. The information relating to the Balinese cultural knowledge is complex. Even for cultural and community experts it is far from straightforward to model this domain of knowledge.

Much of this knowledge is held largely in tacit form and rooted in the Balinese community. Furthermore, without clear documentation of Balinese culture [5, 6] specifically Balinese *kulkul*, makes this study even more challenging and significant. Also, the fact that *kulkul* practices are diverse and not standardized makes it particularly important to understand and capture the information as much as possible in the right context, and putting it together in the right form of an online digital portal.

2 Background and Related Literature

2.1 Bali and Balinese Culture

The island of Bali is one of thousands island, and one of the smallest provinces of the Indonesia archipelago. The Balinese culture is maintained through daily practice and religious rituals that keeps the traditions of the past alive [5]. This tradition passes from one generation to another by letting the next generation learns through experience every process that related to the local Balinese culture.

The Balinese culture built on the top Balinese traditional community such as custom village (*desa adat* or *desa pekraman*), *banjar*, and *sekaa*. Religious ceremonies which are integral thinking and attitudes of the Balinese, continue as frequently and as importantly as ever, and remain relatively unchanged over the years in spite of modernization trends [7].

Kenthongan is an ancient traditional communication tool which is made of bronze with elongated holes [8], which is widely known in the Indonesian archipelago. In Bali this *kenthongan* is known as *kulkul* (Fig. 1) that is owned by every traditional Balinese community (*desa adat*, *banjar adat*, and *sekaa*). *Kulkuls* are made of wood or bamboo and are installed in the *Bale kulkul* (typically near temples, village, and *banjars*) in every village. These objects, the cultural practices, and messages surrounding the different *kulkul* sounds represent a distinct and unique dimension of Balinese cultural heritage. The *kulkul* acts as an alarm in the community for ceremonies and hazard e.g. gatherings the community, fire, flood, murder, etc [9], and it vary from one Balinese village to another.



Fig. 1. Balinese *kulkul*

2.2 Digital Preservation within Cultural Heritage

Cultural heritage tends to be seen as the product of the physical cultural traditions and spiritual achievements in the form of the value of the past. Turning towards the digital age, cultural heritage institutions such as Galleries, Archives, Museums and Libraries (GLAM) started to identify the need for digitizing their various collections and making them available online [10].

There are many reasons why cultural heritage collections should be available online. The most important purpose is to make legacy cultural knowledge accessible, further developed, and passed on to future generations. Also, this will allow students, researchers, teachers, and the public to explore and connect with their past. These cultural heritage collections include sites, objects and intangible things that have cultural, historical, aesthetic, archaeological, scientific, ethnological or anthropological value to groups and individuals [11]. Several digital works and project initiatives have been carried out to prevent cultural knowledge erosion in Indonesia [1, 3, 12].

3 Methodology

This study is based on design science research methodology (DSRM) [13]. It will assess the ability of experts' and non-experts' contributions to preserve, and experiment with the prototype system to be created. The DSRM (**Fig. 2**) consist of several stages: (1) Problem identification and motivation; (2) Objectives for solutions; (3) Design and development; (4) Demonstration and Evaluation; and (5) Communication.

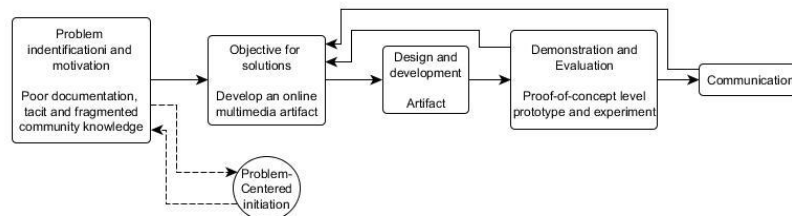


Fig. 2. Design Science Research Methodology (DSRM)

This research employs a problem-centered approach in which the research entry point is the problem identification and motivation activity. We proceed in this sequence because of the idea for the research resulted from observation of the problem. The system design and development on this project (**Fig. 3**) is using prototyping method and involves three activities: 1. Cultural experts interview, 2. Prototyping, and 3. Implementation and testing the online digital portal.

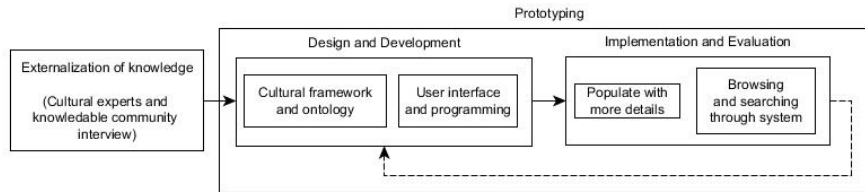


Fig. 3. System Development Life Cycle

3.1 Externalization of Knowledge

The first part of this study involved exploring and gathering knowledge from Balinese cultural heritage experts and knowledgeable community members about the Balinese traditional communication tool (Balinese *kulkul*). This exploratory phase of our research project is to externalized the knowledge, help to design an online computer web-based digitization system, and create a basic model of ontology that can be utilized by computer-based system to facilitate the browsing and searching for information included in the online digital portal.

The *kulkul* community knowledge exists in somewhat tacit form, and this knowledge is shared through socialization (tacit to tacit) of Balinese community social systems from generation to generation. Tacit knowledge is a knowledge that based on individual experience, deeply embedded, hard to express and explain, not yet articulated, and equals as practical know-how knowledge. Thus, one way to represent it is through metaphors, drawings, and other method that not require any formal language [14]. Furthermore, the externalization of tacit knowledge is one of the most challenging steps of knowledge conversion [14, 15, 16].

Over a period of two months prior to the interviews, an extensive review of the literature was performed to help frame the interview questions and explore the key issues in the context of Balinese *kulkul*. Interviews using snowball strategy has been chosen for the method on externalization of this community tacit knowledge. The snowball strategy is a form of purposeful sampling when the researchers asks participants to recommend other individuals to the study [17]. This method is appropriate for our project when we were initially unfamiliar with the topic and the complexity of the research central phenomenon. The sampling process initiated by an independent expert in each group exclusively triggers getting the different snowballs rolling. We stopped the snowball rolling whenever the group of participants repeats the same answers corresponding to the questions.

Semi-structured interview approach was selected as the means for information collection. This format of interview allows for specific questions and topics to be addressed while offering the respondents an opportunity to give additional feedback and elaborate further on any aspect of their experience they considered relevant to this study [18]. The semi-structured interview questions consisted of 23 questions, and fall into three main categories: a) history of *kulkul*, b) *kulkul* artefact, and c) *kulkul* practices.

The interviews took place during the period of 03rd of August to the 12th of November 2015. In order to collect accurate data and to enable verbatim transcription, they were audio-recorded, always with the interviewee's consent. The interviews used a combination of Bahasa and Balinese language. The participants' age was between 47 – 65 years old, their average experience in their field is more than 10 years, all participants were male. They came from the west, east, south, and central regions of Bali.

The basics of *kulkul* system was collected incrementally from four groups of experts. These groups of interviewees consisted of five Professors from a Balinese University (who are acknowledged experts in methods of traditional communication), four Balinese spiritual leaders (who are identified because they have the knowledge about the spiritual significance of these traditions), eight senior community leaders in Bali (identified as key leaders who are the person in charge to ring the *kulkul* in *banjar* or village), and two *kulkul* craftsmen (identified because they possess practical knowledge in making the *kulkul* artefact).

Each interview session took for about 30 minutes up to 120 minutes. Many of the respondents had difficulties in expressing the knowledge surround the *kulkul* domain. They understood how the *kulkul* is practiced in the community, however it was sometimes hard for them to express it in the formal language. Therefore, occasionally researchers had to repeat the interview due to the complex and relatively tacit knowledge related to the *kulkul* domain.

We used the knowledge externalization method proposed by Nonaka and Takeuchi Fig. 4. First, metaphor is a method to express what the interviewees know, but hard to say by asking them to create a symbol and synthesis to find the distance between symbols. This method is used to merge two different and distant areas of experience into single image or understanding. Second, analogy is used to reconcile contradictions and make distinctions between symbols. Finally, the knowledge was crystalized into a model by constructing the basic *kulkul* domain ontology.

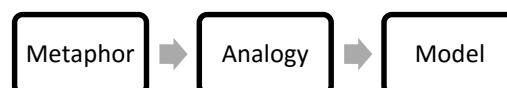


Fig. 4. Externalization knowledge methodology

During the interview we asked some of the interviewees to demonstrate how they practice the *kulkul* in the community to help us understand the different practices of *kulkul*. For example, two of the interviewees literally said that they practice two frames (*duang tulud bulus*) for the situation of hazard, nevertheless the way they sounded the *kulkul* are completely different (the total number of beat and the rhythm) as shown on Fig. 5.



Fig. 5. Two frames of *kulkul bulus* at (a) Gianyar region, and (b) Karangasem region

3.2 Knowledge Classification and Organization

Our digital portal framework (Fig. 6) to capture, classify, and organize the richness of *kulkul* knowledge is based on the outcome of the interviews which enabled us to elaborate on the key Balinese cultural principles (*Tri Hita Karana* and *Desa Kala Patra*) as they relate to *kulkul*. *Tri Hita Karana* is the Balinese belief or philosophy of balance and harmony [19, 20, 21] including three factors: 1) Universal (*parahyangan*), 2) environment (*palemahan*), which refers to harmony with nature, and 3) people (*pawongan*), which implies harmony among people. This first set of concepts is related to the *kulkul* practices where *kulkul* sound is a part of every Balinese religious ceremony (*parahyangan*) that is mainly held in the temple area. Also, this sound is used for any type of activities that involve a large number of people in the Balinese traditional community (*pawongan*). The second set of concepts called the space (*desa*), time (*kala*), and circumstances (*patra*) [21] dictates that humans are not passive individuals but who will always try to adapt themselves to their environment that influences their lives. The *Desa Kala Patra* concept can be used to explain the variations in *kulkul* practices in the Balinese community.

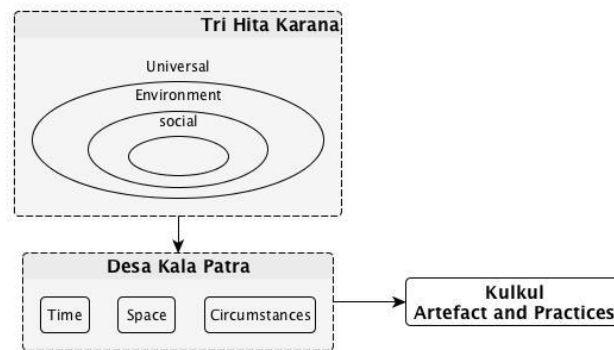


Fig. 6. The Balinese *kulkul* framework

The *kulkul* knowledge classification cannot separate the interdependence between the artifact (tangible) and its practices (intangible). Also, this kind of cultural heritage classification systems are still being debated by the UNESCO on the Preamble of the 2003 Convention for the Safeguarding of the Intangible Cultural Heritage [22].

Information can be viewed at two different levels: syntactic where this information based on the volumes of the information, and semantic more focus on the meaning of the information and how it related to the other concept. Ontology is a formal, explicit specification of a shared conceptualization [23], and have been developed to provide a machine-processable semantics of information sources that can be communicated between different agents (software and humans) [24]. Moreover, ontology is one of alternatives to representing the domain of knowledge, where this method helps us to do semantic modeling of concepts, and the axioms in ontology are represented in logic languages [25].

The CIDOC CRM¹ is a well-known cultural ontology that enables information integration, mediation and interchange of heterogeneous cultural heritage data and their correlation with digital library and archive information, and this cultural ontology has been studied for this project. The CIDOC-CRM has been used to abstract hundreds of schemata (80 classes and 130 relationships) in various museum disciplines, and helps improve the semantic of knowledge from distributed database of cultural heritage [26, 27, 28]. However, less than five percent of its concept has been used by museum [29], and the CIDOC-CRM is too museum centric [30].

The ontology development falls into two categories: (i) developed from scratch [31], and (ii) reusing and integrating with an existing ontology [32] based on the knowledge representation needed. In this project we develop the ontology from scratch, and the purpose of applying ontological approach is to enable flexibility of the knowledge growth, as the collecting of *kulkul* knowledge was done incrementally. Therefore, a formal reasoning can be applied when this knowledge evolves.

4 Prototyping, Design, and Implementation of Digital Portal

The online digital portal prototype is currently under development. The development of basic *kulkul* ontology (class, object properties, and data properties) Fig. 7 used a protégé² ontology editor, and the OWL2 language . This *kulkul* ontology serves as backbone to support semantic browsing and searching facilities of our system. The apache Jena³ framework was chosen as ontology triple store for our development, while Fuseki⁴ is used as a middleware layer to interfacing our web application to the ontology. In addition to that, the EasyRdf⁵ API was used to provide a PHP API to Fuseki. The browsing results are retrieved and displayed using JSON and AJAX calls. Our application supports the following facilities:

- Populate: allows multiple online users to contribute by populating more details of Balinese *kulkul*.

¹ <http://www.cidoc-crm.org>

² <http://protege.stanford.edu/>

³ <http://jena.apache.org/>

⁴ https://jena.apache.org/documentation/serving_data/

⁵ <http://www.easyrdf.org/>

- Browsing: allows users to browse through different part of the ontology by navigating through *kukul* classification hierarchies.
- Searching: allows users to construct a query relating to one or more attributes of the *kukul* artifact and practices as inputs and displaying a selected attribute for the output.

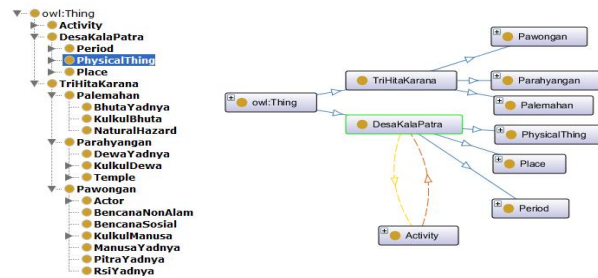


Fig. 7. Kukul ontology

5 Conclusion and Future Work

We have presented the details of our research dealing with one aspect of Balinese culture, the Balinese traditional communication system (*kukul*). Our contributions include externalizing the largely tacit and fragmented *kukul* knowledge, and developing an ontology to represent this knowledge. The *kukul* framework based on Balinese cultural principles (*Tri Hita Karana* and *Desa Kala Patra*) is to capture, classify, and organize cultural artefact and practice knowledge, and design and develop an online digital portal prototype to enable the sharing and growth of knowledge related to the Balinese *kukul*.

We are currently working on analyzing and testing the usability of our online digital portal system by having community-based crowdsourcing to contribute more details in order to refine and update community cultural resources. The users' feedback will be used as inputs to expand the *kukul* ontology and to enhance the digital portal.

Acknowledgement

This project received funding from The Indonesia Endowment Fund for Education (LPDP) grant no. PRJ-02/LPDP/2013 and Competitive Research Grant Ristekdikti grant no. 486.24/UN14.2/PNL.01.03.00/2016

References

1. Sanabila, H.R., Manurung, R.: Towards Automatic Wayang Ontology Construction using Relation Extraction from Free Text. EACL 2014, pp. 128 (2014)
2. Rosner, D., Roccetti, M., Marfia, G.: The digitization of cultural practices. Commun. ACM 57, 82-87 (2014)
3. Hasibuan, Z.A.: An overview of integrated approach to digital preservation: Case study of Indonesian e-Cultural heritage and natural history information retrieval system. International

- Conference on Advanced Computer Science and Information System (ICACSIS), pp. 31-36 (2011)
4. Hui, D., Siwei, Y., Ying, J.: Knowledge Representation of Chinese Genealogical Record of VIPs in KMT and CPC. Ninth International Conference on Hybrid Intelligent Systems, 2009. HIS '09, vol. 3, pp. 116-120 (2009)
 5. Walker, B., Helmi, R.: Bali style. Thames and Hudson, London (1995)
 6. Covarrubias, M.: Island of Bali. Periplus Editions (HK) Limited (2008)
 7. Suryani, L.K., Jensen, G.D.: Trance and Possession in Bali: a window on Western multiple personality, possession disorder, and suicide. Penerbit ITB, Bandung, Indonesia (1999)
 8. Kebudayaan, D.P.d.: Ensiklopedia Musik Indonesia. Departemen Pendidikan dan Kebudayaan, Proyek Inventarisasi, dan Dokumentasi Kebudayaan Daerah (1985)
 9. Goris, D.R., Dronkers, D.P.L.: Bali Atlas Kebudayaan. Pemerintah Republik Indonesia (1955)
 10. Zlodi, G., Ivanjko, T.: Crowdsourcing digital cultural heritage. izlazi u samo elektroničkom izdanju: NE (2013)
 11. <http://www.unesco.org/new/en/brasilia/culture/world-heritage/heritage-legacy-from-past-to-the-future/>
 12. Pramatha, C.R.A., Dwidasmara, I.B.G.: The composition approach non-QWERTY keyboard for Balinese script. Humanitarian Technology Conference - (IHTC), 2014 IEEE Canada International, pp. 1-4 (2014)
 13. Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A design science research methodology for information systems research. Journal of management information systems 24, 45-77 (2007)
 14. Koskinen, K.U., Pihlanto, P., Vanharanta, H.: Tacit knowledge acquisition and sharing in a project work context. International Journal of Project Management 21, 281-290 (2003)
 15. Abidi, S.S.R., Cheah, Y.N., Curran, J.: A knowledge creation info-structure to acquire and crystallize the tacit knowledge of health-care experts. IEEE Transactions on Information Technology in Biomedicine 9, 193-204 (2005)
 16. Nonaka, I., Takeuchi, H.: The knowledge-creating company: How Japanese companies create the dynamics of innovation. Oxford university press, New York (1995)
 17. Creswell, J.W.: Educational research : planning, conducting, and evaluating quantitative and qualitative research. Merrill, Upper Saddle River, N.J. (2005)
 18. Louise Barriball, K., While, A.: Collecting Data using a semi-structured interview: a discussion paper. Journal of advanced nursing 19, 328-335 (1994)
 19. Jensen, G.D., Suryani, L.K.: The Balinese people: a reinvestigation of character. Oxford University Press, Singapore; New York (1992)
 20. Windia, W., Pusposutardjo, S., Sutawan, N., Sudira, P., SUPADMO ARIF, S.: Transformasi sistem irigasi subak yang berlandaskan konsep TRI Hita Karana. SOCA (Socio-Economic of Agriculture and Agribusiness) 5, (2005)
 21. Pitana, I.: Tri Hita Karana – The Local Wisdom of the Balinese in Managing Development. In: Conrady, R., Buck, M. (eds.) Trends and Issues in Global Tourism 2010, pp. 139-150. Springer Berlin Heidelberg, Berlin, Heidelberg (2010)
 22. <http://www.unesco.org/culture/ich/en/convention>
 23. Gruber, T.R.: A translation approach to portable ontology specifications. Knowledge acquisition 5, 199-220 (1993)
 24. Fensel, D.: Ontologies: A Silver Bullet for Knowledge Management and Electronic Commerce. Springer Berlin Heidelberg (2004)
 25. Martinez-Cruz, C., Blanco, I.J., Vila, M.A.: Ontologies versus relational databases: are they so different? A comparison. Artificial Intelligence Review 38, 271-290 (2012)

26. Hong-Zhe, L., Bao, H., Jing, W., Jun-Kang, F.: An Information Flow Based Approach to Semantic Integration of Distributed Digital Museums. *International Conference on Machine Learning and Cybernetics*, 2006 pp. 4430-4437 (2006)
27. Guoxin, T., Tinglei, H., Zheng, Z.: A Knowledge Modeling Framework for Intangible Cultural Heritage Based on Ontology. *Second International Symposium on Knowledge Acquisition and Modeling*, 2009. KAM '09, vol. 1, pp. 304-307 (2009)
28. Hong-Zhe, L.: Global Ontology Construction for Heterogeneous Digital Museums. *International Conference on Machine Learning and Cybernetics*, 2007, vol. 7, pp. 4015-4019 (2007)
29. Doerr, M., Iorizzo, D.: The dream of a global knowledge network: A new approach. *J. Comput. Cult. Herit.* 1, 1-23 (2008)
30. Brownlow, R., Capuzzi, S., Helmer, S., Martins, L., Normann, I., Poulouvassilis, A.: An Ontological Approach to Creating an Andean Weaving Knowledge Base. *J. Comput. Cult. Herit.* 8, 1-31 (2015)
31. Cristani, M., Cuel, R.: A survey on ontology creation methodologies. *International Journal on Semantic Web and Information Systems (IJSWIS)* 1, 49-69 (2005)
32. Gómez-Pérez, A., Rojas-Amaya, M.D.: Ontological Reengineering for Reuse. In: Fensel, D., Studer, R. (eds.) *Knowledge Acquisition, Modeling and Management: 11th European Workshop, EKAW'99 Dagstuhl Castle, Germany, May 26–29, 1999 Proceedings*, pp. 139-156. Springer Berlin Heidelberg, Berlin, Heidelberg (1999)

The final publication is available at link.springer.com