A modification on existing cultural metadata management system to accommodate community-driven and holistic cultural metadata

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Abstract. Preservation of cultural data is a process that is not only the duty of the government, library, or museum but also needs to involve the community as the main actor of culture itself. Involvement of cultural communities in the preservation process is important because the community has the complete cultural information and is a part in the process of cultural change itself. One aspect that determines data structure in the data management system is the metadata structure. Therefore, a specific cultural metadata management system to determine the cultural data structure and its changes mechanism. Cultural metadata management can be used to determine the depth and structure of data needed in storing cultural data process. Because culture changes over the time, then the metadata should be able to evolve in facing any changes. Various experts have carried various studies related to the cultural metadata management system but do not involve cultural members and cover all cultural elements. Therefore, this paper tries to analyse several studies regarding the process of managing cultural metadata and proposes modifications to existing processes with a community-driven approach and the ability to manage holistic cultural elements.

1. Introduction
Culture has become one of the important things for a country. The Washington Post publish a survey from Pew Research Center in 14 countries which show that language, customs, and traditions can be the basis of a country’s identity [1]. When referring to the opinions of Koentjaraningrat and United Nations Educational, Scientific, and Cultural Organization (UNESCO), they mention that language, customs, and the traditions are part of cultural elements. Koentjaraningrat states that culture is the whole system of ideas, actions, and results of human work in people’s lives [2]. Every generation inherits the culture through a learning process from their ancestors and manifesting it in their daily file style [2]. UNESCO states that culture is complex capabilities and habits which gained by a human as a member society [3]. Complexity and diversity of culture’s products as a result of human life increases the culture important for a country.

The existence of culture as a country identity is one reason for the country government tries to preserve their own culture in various ways. The preservation process also guarantees the current generations and future generations to recognize and learn the culture they have as a source for innovation and creativity process [3][4]. The learning process through preserving cultural data process can continue the practices, knowledge, and life experiences they have to remain sustainable, always grow and change in the future [4][5]. Changes that occur along with innovation and human creativity in a community require a recording process to maintain the presence and cultural data that has been owned [6].
One way to save and preserve the cultural knowledge in digital form [6] is by creating a cultural catalogue application. Particular digital application developers have made some cultural catalogue applications to store and display the cultural data to their users. Those cultural catalogue applications display the data stored in the text, images, and videos form. Each application only focuses on one or more cultural elements. This condition is contrary to the cultural definition put forward by Koenjjaraningrat [2] and UNESCO [3] which states that culture is a holistic unity of all the complexities of the cultural elements contained in it.

Cultural catalogue application development by different developers create other problems. Some of the problems are the difference in the depth of cultural data contained in the application, and an application cannot exchange data with other applications. One approach that can be used to determine the completeness of the data of a cultural element and enable the exchange of data is metadata. By definition, metadata is a data that describes properties and characteristics of data in a particular context [7]. Through the use of appropriate metadata, the complete cultural data structures can achieve the data integrity of cultural elements. Metadata can define the data related to cultural elements, description of existing resources, ownership of cultural data, and preservation processes carried out [8]. Completeness of the metadata structure can also produce standard data structures needed in the process of data exchange.

To produce the right cultural metadata structure and be able to deal with cultural changes in the life of a community [3][5], the existence of a system of managing cultural metadata is a necessary thing. Various studies have been carried out to produce an adequate metadata management system, but the system still needs improvements. The cultural communities and cultural data seekers involvement can also cause the need for increased capabilities of the metadata structure used and the managing cultural metadata system.

This study tries to find a solution for metadata management that can accommodate all cultural elements as a holistic entity by involving the community in the process. Through managing holistic cultural metadata, the resulting metadata can be a standard in the structure of cultural data storage and data exchange processes. Community involvement in metadata management will directly be able to anticipate the speed of development of data requirements from cultural data seekers. In the following section, we review the metadata management process, community-driven mechanism, previous study, and its problems, propose modification on metadata management system to accommodate community-driven mechanism, conclusion and further works.

2. Metadata management

The process of managing metadata to always be in line with needs has become part of the data governance system [9]. The process of managing metadata always involves peoples, processes, and technology to secure the assets of the data it represents. Through an adequate data governance process, all managed data assets will understandable by related stakeholders, correct, complete, reliable, secure, and can discoverable by all users and systems that access the data [10]. Some of the important data assets related to culture metadata management system are the metadata and the management process itself.

The managing metadata process becomes an important thing to consider when dealing with the cultural changes that occur. A good metadata management process ensures the metadata extraction and provides access to the obtained metadata. All actions taken in the process of managing good metadata will provide quality attributes of metadata that able to accommodate all attributes of culture and property from information on cultural artefacts produced [11].

To obtain the right metadata management system for cultural data, system developers need to pay attention to the types of metadata available. NISO has stated that the types of metadata consist of descriptive metadata, technical metadata, preservation metadata, rights metadata, structural metadata, and mark-up languages [12]. Each metadata types has functions that can differ from one another and some have similar functions. Digital object management process requires technical metadata, preservation metadata, and rights metadata. In other hands, the interoperability process between systems requires descriptive metadata, technical metadata, preservation metadata, rights metadata, and mark-up languages. Table 1 show details function for each metadata types.

Because metadata plays an important role in managing cultural data, then the process of structuring metadata and detailing the data elements in the metadata is an important thing to do. The metadata type
selection also needs attention to avoid confusion for its users. The proper structure of metadata can represent all cultural elements in it and have strong unity as a holistic entity.

Table 1. Metadata Functions [12]

| Metadata Type         | Primary Uses |
|-----------------------|--------------|
|                       | Discovery    | Display | Interoperability | Digital Object Management | Preservation | Navigation |
| Descriptive Metadata  | ✓            | ✓       | ✓               | -                         | -            | -          |
| Technical Metadata    | -            | -       | ✓               | ✓                         | ✓            | -          |
| Preservation Metadata  | -            | -       | ✓               | ✓                         | ✓            | -          |
| Rights Metadata       | -            | -       | ✓               | ✓                         | -            | -          |
| Structural Metadata   | -            | -       | -               | -                         | -            | ✓          |
| Mark-up Languages     | -            | -       | -               | -                         | -            | ✓          |

3. Community-driven mechanism

To improve metadata accuracy and to anticipate the speed of cultural data change, a community-based approach can be one approach to managing cultural data. No one can separate the community’s existence from culture because culture grows and evolves and becomes part of the community [3]. Therefore, community members involvement can give a positive impact on the process of developing cultural data management system because members of the cultural community can become actors (see Table 2) who involve in the process of cultural change itself. The activeness of community members as actors in the cultural information development process can be as an information giver or as cultural data consultants. The goals of the community involvement are to obtain data standards and better accuracy of knowledge data [13].

Table 2. Development paradigms: things and people [14]

| Point of departure and reference | Things         | People            |
|----------------------------------|---------------|-------------------|
| Mode                             | Blueprint     | Process           |
| Keyword                          | Planning      | Participation     |
| Goals                            | Pre-set, closed| Evolving, open    |
| Decision-making                  | Centralized   | Decentralized     |
| Analytical assumptions           | Reductionist  | System, holistic  |
| Methods                          | Standardized  | Diverse           |
| Technology                       | Fixed package | Varied basket     |
| Professionals’ interactions with clients | Motivating / controlling | Enabling / empowering |
| Client seen as                   | Beneficiaries | Actors, partners  |
| Force flow                       | Supply-push   | Demand-pull       |
| Output                           | Uniform infrastructure | Diverse capabilities |
| Planning and action              | Top-down      | Bottom-up         |

Based on Table 2, the community-based development process will provide better results to overcome the problems of data management that are holistic and always changing. The nature of community-based development is using the needs and aspirations of the stakeholders involved (bottom-up, process mode, and demand-pull) as the basis of the development process. Therefore, stakeholders become part of direction-determining actors of the development process (evolving). Another benefit using a community-driven approach is when a change in the needs of the stakeholders involved, the outcomes of development results can be changed (diverse capabilities and open goals). The professionals or expert involvement in the development process is only as a person who empowers all available resources. Based on the various input types form the stakeholder, the development process should use holistic
analytical assumptions in every development process. By using the community-driven approach, the metadata management system can achieve correctness and accuracy on the metadata structure.

4. Related works

The cultural metadata management system which involved the community is not a new thing. Some research needs the community as the source of cultural knowledge as the basis of requirement list for the metadata management process. Various countries have carried the research out to produce metadata management which suitable with conditions and needs of the cultural data in their respective countries.

In 2002, Chao-chen Chen and her team members tried to manage any artifacts of digital museums, digital libraries, and digital archives from traditional Chinese and Taiwanese culture by using Metalogy System [15]. The system is build based on the requirement that produces from collaboration process between National Taiwan Normal University, National Taiwan University, National Tsing-Hua University, National Chi-Nan University, Academia Sinica, National Palace Museum, National Museum of History, National Museum of Natural Science, and National Central Library. The metadata management main functions inside the Metalogy System are metadata editors, metadata searching, import/export DTD files, and import/export XML and ISO2709 record.

Scott A Brandt and his research team propose an efficient metadata management model by using a separate cluster metadata server and large distributed storage systems (called Lazy Hybrid Metadata Management) [16]. The goal of their design is to provide very high performance and scalable metadata management process. The separate cluster of metadata server is used to manage the namespace and directory hierarchy of the information, file and directory permission, and the mapping from files to object. Several semi-independent object-based storage devices (OBSDs) store the data connected to the metadata. Each OBSD has tasks to manage the data management process, such as data retrieval, scheduling, data layout, and storage management.

Manjula Patel and her research team [17] used another approach to manage the cultural artifact’s metadata. The research team collaborates with the Victoria and Albert Museum in London and the Sussex Archaeological Society to create three dimensional (3D) cultural virtual exhibitions museum artifacts called ARCO Content Management Application (ACMA). They used the Augmented Representation of Cultural Objects (ARCO) system as the basis for their design system to create a virtual representation of the museum artifacts. The ACMA system uses Oracle 9i ORDBMS as the database for all data and metadata management process, included the media objects. The ACMA system uses XML record to store all artifact’s information inside the database server. The ACMA system also manages the metadata for each artifact. The ACMA system automatically inserts all mandatory metadata element to the database; the user still can add optional metadata elements or modify the existing metadata elements. All metadata that the user add should comply with the ARCO Metadata Element Set schema.

Heri Kurniawan and his research group are conducting another approach in managing the cultural data and metadata [18]. His research group uses the Zachman Architecture Framework to create cultural digital preservation framework called electronic Cultural Heritage and Natural History (eCHNH) framework. Through the Zachman Architecture Framework, the research team tries to integrate all the system components, such as the process, network, people, time, and motivation. The system uses metadata as a data integration system for all connected system inside the preservation framework. By using a standardize metadata, all data from any data sources can exchange their data through the framework.

Mohsen Kalantari and his research group [19] join with Department of Environment, Land, Water, & Planning Melbourne tried to synchronize ever-growing spatial data set to meet the expectation of the end users of the data. They used the metadata system to help create the data holding catalogs, searching and support the searching and discovering data process. The research team tried to use automatic enrich metadata through the metadata harvesting process. The obtained metadata in the harvesting process should comply with ISO 19115 standard for geographic information metadata or the data service standards such as Web Feature Service.

5. Literature Analysis

Table 3 shows the level of involvement of several stakeholders in the managing cultural metadata process that has been carried out. Compare with the other stakeholder, the community involvement in managing cultural metadata is low. This condition can produce problems when culture change or new
culture data occur. Data in the museum or library cannot change as fast as cultural change in the community. The community always has the most complete and recent cultural data [3]. Museums and library are the stakeholders that have a function to help documented or recorded the cultural changes [6]. This condition can arise because other parties outside the developer are considered as data sources only, not as the main actors in the development process.

Table 3. The research stakeholders

| Related Researches       | Year | Academic | Museum | Library | Government | Community |
|--------------------------|------|----------|--------|---------|------------|-----------|
| Chao-chen Chen [15]      | 2002 | 5        | 3      | 1       | -          | -         |
| Scott A. Brandt [16]     | 2003 | 1        | -      | -       | -          | -         |
| Manjula Patel [17]       | 2005 | 1        | 1      | -       | -          | 1         |
| Heri Kurniawan [18]      | 2015 | 1        | -      | -       | -          | -         |
| Mohsen Kalantari [19]    | 2016 | 2        | -      | -       | 1          | -         |

Table 4 shows the functions of each stakeholder involved in the process of using the cultural information system used. All the information system put the users as recipients or users of metadata structures only. The entire design of the information system places the application developers as the designer or editor for the metadata structures so that all the metadata structures used are in a static form. Users do not have an opportunity to provide any input for metadata changes according to what they need. The absence of the possibility to make changes to the metadata can be understood as part of a process to maintain the integrity of data stored in information systems. The application developer should reconsider the mechanism for giving input as the changes base need to catch up with the rapid changes in cultural data.

Table 4. Metadata flexibility and user function

| Related Researches       | Year | Metadata Flexibility | User Function |
|--------------------------|------|----------------------|---------------|
|                           |      | Static   | Dynamic | Collaborator | Recipient |
| Chao-chen Chen [15]      | 2002 | ✓        | -       | -           | ✓         |
| Scott A. Brandt [16]     | 2003 | -        | ✓       | -           | ✓         |
| Manjula Patel [17]       | 2005 | ✓        | -       | -           | ✓         |
| Heri Kurniawan [18]      | 2015 | ✓        | -       | -           | ✓         |
| Mohsen Kalantari [19]    | 2016 | -        | ✓       | -           | ✓         |

The location of the main metadata placement also needs attention in the process of managing metadata structures. Table 5 shows that most of the system put the main metadata centralized. Centralized metadata placement can give benefit in data integration checking process but has problems for a system that must be able to change its metadata structure quickly. All changes must be made at the center of the metadata storage not locally. Therefore, it needs time to check for the metadata structure integrity.

Table 5. Metadata Location

| Related Researches       | Year | Distributed | Centralized |
|--------------------------|------|-------------|-------------|
| Chao-chen Chen [15]      | 2002 | ✓           | -           |
| Scott A. Brandt [16]     | 2003 | ✓           | -           |
| Manjula Patel [17]       | 2005 | -           | ✓           |
| Heri Kurniawan [18]      | 2015 | -           | ✓           |
| Mohsen Kalantari [19]    | 2016 | -           | ✓           |

On the other hand, distributed metadata management process can facilitate the process of changing the structure of the metadata faster. However, the process of the distributed process can cause problems
when the metadata management process is carried out in various locations. The system needs a special synchronization system to ensure that the change process can still maintain the integrity of the data that it represented.

6. Modification metadata management system
To accommodate a community-based approach to holistic metadata management processes, the involvement of all stakeholders is very necessary. The stakeholders involved in the process can be consist of cultural conservation communities, cultural data owners, experts, and the public. All these stakeholders must work together to develop cultural metadata as seen in Figure 1.

Figure 1. Proposed metadata management system.

Figure 1 shows the propose cultural metadata management system. The core the entire cultural data and metadata management system is the database that stores the cultural metadata. Designated experts can access the metadata editor functionality for managing all cultural metadata stored in the database. This functionality is used to view and edit the cultural metadata structure which stored in the metadata database. All the metadata structure stored in the database can be searched and seen by the cultural conservationists, cultural data owners, and the public. The stored metadata structure can be used by members of the cultural conservation community and the public as a reference to evaluate the completeness of the data that is owned or obtained. The stored metadata structure also can be used by the cultural data owner as a basis for providing cultural data needed by the member of cultural conservationist member or the public. If there is a lack of cultural data, cultural conservationist community, cultural data owners, and the public can suggest new metadata element through the new data suggestion functionality. Experts will review all new metadata element suggestion given to determine whether the existing metadata structure has accommodated it or not. If the existing metadata structure has not accommodated the suggestion, then the experts will add it to the metadata structure.

The metadata management system also provides functionality to export the stored metadata structure into XML, ISO2709, or other forms to facilitate the data structure replication. The cultural metadata also has a function to import a metadata structure as a basic data structure for the system used. Import functionality in the metadata management system can also be used to anticipate the problem of damage to the metadata database used due to one thing or another.

The metadata management system also needs a conversion metadata function to anticipate differences in the data structure used by owners of cultural data. This conversion function will accept input from the metadata harvest functionality that is at the beginning. Then the metadata converter functionality will compare the metadata obtained with existing metadata in the database. If the
functionality finds similarities with the structure of stored metadata, then the metadata information obtained will be returned to the metadata harvest functionality so that cultural data processing systems can use it. However, if conversion functionality does not find any similarity with the stored metadata structure, the functionality will provide temporary metadata code so that the process of storing cultural data can still be carried out and at the same time will send requests to submit new metadata through the existing metadata submission functionality.

Through the system in Figure 1, the metadata management system can accommodate a community-driven approach. Through this approach, the main actor in cultural data and metadata structure development is not focused on application developers or researcher again but can shift to the community or the owners of the cultural data. User’s function on the system is no longer as a recipient anymore but can turn into active collaborators in developing cultural data and metadata. In the end, the used metadata can be dynamic and can develop following the changing needs of cultural data seekers themselves.

Other systems needed in the process of managing cultural metadata are the storage locations of the metadata structure itself. Figure 2 illustrates the architecture or data communication topology used in the proposed cultural data and metadata management system. The managing metadata process is done centrally in the Culture Metadata Server section. The centralization on metadata management is intended to maintain the integrity of the metadata structure result. If the management process uses a distributed model, then a new problem can arise which is how to synchronize the structure of the metadata. The entire stored metadata structure in Culture Metadata Server needs to be replicating to the Cultural Data Storage set. Replication of the structure of this metadata is intended so that when each owner of cultural data will process the cultural data they have, then the structure of the metadata needed in the process is available in their respective databases and no need to connect with Culture Metadata Server.

![Proposed cultural data and metadata management computer architecture.](image)

As was done by Scott A. Brandt [16] on the proposed distributed storage system architecture, the use of more than one Culture Metadata Server is intended to anticipate problems with the computer devices used or on the data structure of the metadata that it stores. If a problem occurs on one of the computer devices used, other computer devices will serve the information service structure of the metadata. In the information service system, the structure of the metadata can also add a computer network layer that functions as a dispatcher. Through this dispatcher layer, the service load on metadata structure demand can be shared equally across all connected computing devices.
7. Conclusion and future works
Most of the related studies that have been conducted are not widely use community empowerment as the main collaborator actor in the information system development process. Most of the studies are still focused on using data from museums and libraries as input data in the process of developing the information systems and put the user as the recipient of the system. By using a community-driven approach, the metadata management system hopefully can anticipate the pace of change of cultural data needed by the cultural conservationist community or the public. Involvement of public and community members in the process of managing the metadata structure will enrich the structure of the metadata which will eventually be able to achieve a holistic cultural metadata structure.

Regarding the problem of metadata storage location, based on the advantages and disadvantages possessed, the main cultural metadata structure needs to be stored centrally to maintain data integration from the cultural data it represents. However, the metadata distribution to the distributed cultural data storages needs to consider the intellectual property rights issues.

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