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The Balinese Lontar Manuscript Metadata Model: An Ontology-Based Approach

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ABSTRACT

The digitization of cultural heritage, particularly lontar manuscripts, is a focus of research to aid stakeholders in the management of lontar metadata. Managing the metadata of Balinese Lontar manuscripts through the application of ontology is one method for ensuring the preservation and accessibility of Balinese Lontar manuscripts. This research aims to apply ontology technology to the preservation of the cultural heritage of Balinese lontar manuscripts so that all information about lontar details can be categorized according to their respective properties and relevant information can be presented based on the user's preferences. This research method employs the stages of the Design Science Research Methodology (DSRM) when devising the ontology for the Balinese lontar manuscript. The results demonstrated that the construction of metadata using an ontology-based methodology can provide the information required to describe, categorize, and connect ontology entities. Metadata consists of entity descriptions, hierarchies and classifications, relationships and properties, as well as the necessary semantics for constructing effective ontologies

INTRODUCTION

The Balinese Lontar manuscripts are valuable cultural artifacts that comprise the people's knowledge, traditions, and history. They are written in ancient Balinese script and contain information handed down from generation to generation about social life, beliefs, art, and science.

Along with the development of information technology, maintaining Indonesia's cultural heritage can be done by utilizing information technology or what is commonly called the digitization of cultural heritage (Aditama, Juniantari, et al., 2023; Aditama, Yanti, et al., 2023; Hartanti & Setiawan, 2019). In addition to preserving ancestral heritage, digitization of cultural heritage also aims to support cultural tourism and as an education for future generations to learn, understand, and improve digital resources through the internet.

One approach that can be taken to ensure the preservation and accessibility of Balinese Lontar manuscripts is to apply information and computer technology. (Herrow & Azraai, 2021; Kuswara, 2018; Pramatha et al., 2020). One important aspect of doing this is managing the metadata of Balinese Lontar texts effectively. Metadata is information about information, which helps describe and organize the content of the text and its cultural context. An ontology-based approach can provide a strong foundation in developing metadata models for Balinese Lontar texts.

Several studies related to ontology technology for metadata have been carried out (O'Neill & Stapleton, 2022; Tibaut et al., 2018; Ziku, 2020) such as to create book metadata in a library (Agustini & Andri, 2014), ontology on the semantic web for purchasing a bicycle purchase case study (Sinaga et al., 2014) to the use of ontology to create tourist destinations in Bali (Pramatha, 2020). Research for the preservation of Balinese culture using a Balinese ontology approach has also been carried out (Pramatha et al., 2017; Pramatha & Kuan, 2022; Wardana & Pramatha, 2020). However, there has been no research to preserve the culture of Balinese lontar manuscripts using an ontological approach. Currently, Balinese lontar manuscripts need to be

further developed in terms of preserving Balinese culture, because Balinese lontar manuscripts contain civilizational values and basic knowledge regarding various aspects of community life, which include belief, religion, social, health, traditional medicine, legal order, art and culture. Currently Bali Wiki has digitized lontar by creating a catalog in the form of a pdf document. The digitization of palm leaves in the form of a PDF document catalog needs further development to optimize the benefits of the digitization carried out. By utilizing an ontology approach, we can provide more information about the lontar such as lontar classification,

The diversity of information contained in the Lontar manuscript cannot be utilized optimally because the metadata created is not connected to each other. The aim of this research is an ontology technology approach for preserving the cultural heritage of Balinese lontar manuscripts to support cultural tourism so that all information regarding lontar details can be classified according to their respective properties and help present relevant information according to the wishes of the user.

METHODS

This study utilized the Design Science Research Methodology (DSRM) ((Pandey & Pandey, 2021; Peffers et al., 2007) research method. 1) problem identification and motivation; 2) solution objectives; 3) design and development; 4) demonstration and evaluation; and 5) communication. The initial phase of DSRM entails identifying problems in order to comprehend and specify research issues concerning the problems of lontar digitization, metadata, and catalogs. The second step involves detailing the proposed solution. In the final phase, the ontology is designed and implemented. The fourth phase consists of simulation and testing to validate the concept, system functionality, precision, performance, and other pertinent components. In the final phase, communication, researchers will publish the results of their research.

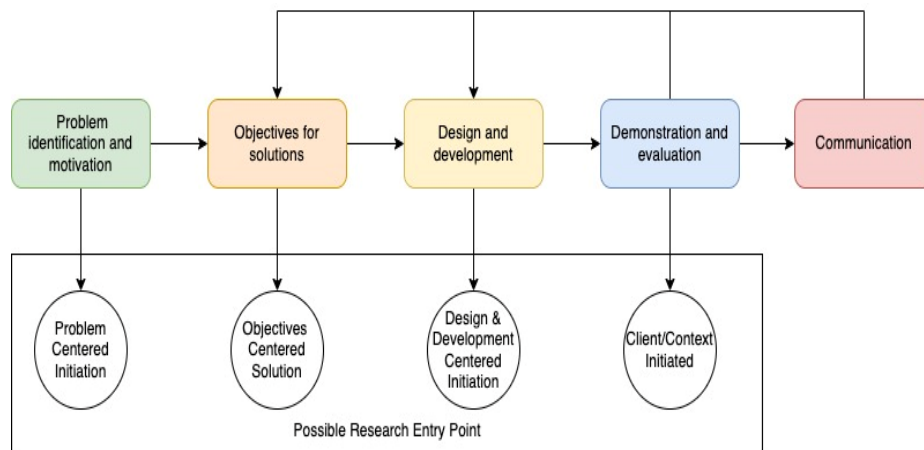


Figure 1. Research Stages of DSRM Method

Based on Figure 1, it can be explained that this research will produce an ontology of Balinese lontar manuscripts along with all information about lontar details classified according to their respective properties. The analysis stage is carried out to obtain the information needs of the Balinese lontar catalog metadata. In the initial analysis stage, observation, interviews with lontar literary sources will be carried out. The results of the analysis obtained will make the design of the structure and relations of the lontar ontology through the stages of determining concepts and domains, determining the list of terminology, defining classes and hierarchies, determining class relationships, defining class properties and property constraints. From the design that has been made, the ontology will be implemented using the protégé application. The stage of creating lontar instances is done by entering lontar data into the ontology. To find out whether the ontology created is appropriate, the ontology testing stage will be carried out.

RESULTS AND DISCUSSION

Design of Lontar Metadata

Metadata is information used to describe, identify, and organize an object or content. In the context of ancient Balinese lontar manuscripts, metadata refers to data or descriptions that provide information about the manuscript, such as lontar title, type, author, subject, classification, language, collation, year of lontar, length of lontar, width of lontar, resource, name of place where the lontar is

stored, location and origin of the palm leaves.. This metadata helps in managing, preserving and facilitating access and further research on the manuscript. The link between metadata and ontology design lies in the fact that metadata provides the information necessary to describe and classify entities in an ontology. Metadata helps in providing entity descriptions, establishing hierarchies and classifications, define relationships and properties, and reinforce the meaning and interoperability of ontologies. By using metadata well, ontology design becomes more effective in organizing, understanding, and using the information contained in the ontology. If described below are some metadata links in ontology design:

- Entity Description: Metadata provides a detailed description of the entity modeled in the ontology. This includes information such as the name, definition, type, properties, relations, and attributes associated with the entity. This metadata helps in understanding and classifying entities semantically.
- Hierarchy and Classification: Metadata also helps in designing hierarchies and classification of entities in ontologies. For example, metadata can provide information about more general concepts or more specific concepts, as well as hierarchical relationships between them. This makes it possible to organize entities in an orderly and structured structure.

- Relationships and Properties: Metadata can provide information about the relationships and properties associated with entities in an ontology. It includes information about the properties held by entities, the properties held by relationships between entities, and the type and nature of the relationships themselves. This metadata helps in modeling the relationships between entities and strengthens the semantic representation in the ontology.
- Semantics and Interoperability: Metadata plays an important role in clarifying and explaining the meaning of entities and relationships in an ontology. By using consistent and standardized metadata, ontologies can become easier to understand, use, and integrate with other ontologies. Metadata also helps in creating interoperability between different ontologies.

Creating an ontology, in this case defining a Class which is the basis for designing an ontology. The table is a metadata concept for the Ancient Balinese Lontar Manuscript with ontology.

Table 1. Class Definitions

No.	Lontar Field	Semantic Classes	Information
1.	Title	Lontar	Title
2.	type	Lontar	Lontar material type
3.	Writer	Person	Author
4.	Subject	Lontar	Lontar subject
5.	Classification	Lontar	Category, Lontar
6.	Language	Lontar	Lontar language
7.	Collation	Lontar	Number of Lontar Sheets
8.	Lontar Year	Lontar	Lontar Year
9.	Lontar length	Lontar	Lontar length
10.	Lontar Width	Lontar	Lontar width
11.	Resources	Lontar	Digital Lontar files
12.	Place name	Place	Name of Lontar Storage Place
13.	Location	Place	Lontar Storage Location
14.	Origin	Origin	Origin of Lontar

Ontology Design

1. Defining and Setting Classes

Defining and organizing ontology classes for the ancient Balinese lontar manuscript involves the process of describing and organizing the entities relevant to the manuscript in the ontology. Defining and organizing ontology classes for the ancient Balinese lontar manuscript allows a more systematic and structured representation of the information related to the manuscript. This can make it easier to model, search and further analyze the ancient Balinese lontar manuscript in an ontological context. The classes from Lontar Bali in the ontology include:

- A. Lontar. This class contains information regarding the title, lontar category, author, lontar category, language, number of lontar sheets, year of lontar, and digital lontar file.
- B. Person. This class contains information about the author/author of the palm leaf which includes name, address and history.
- C. Place. This class contains information about the location where the lontar is stored, including the name of the place and address.
- D. Origin. This class contains information about the origin of the palm leaf which contains

information on the name of the region of origin and district.

2. Defining and Setting Objects

An object is a relationship formed between two classes in an ontology. In a semantic context, an object functions as a predicate in a sentence. This

means that the object acts as a verb that connects the subject to the object in the sentence, forming a sentence with a specific meaning. The definition of ancient Balinese lontar manuscript objects can be seen in Table 2 below.

Table 2. Object Definition

Domain	Object	Range
	Ontologies	
Lontar	createBy	Person
Person	hasCreate	Lontar
Lontar	saveIn	Place
Place	hasSaved	Lontar
Lontar	comeFrom	Origin

From the table above, Lontar saveIn Place can be interpreted as Lontar saved in a place. Or the author can illustrate as follows:

Lontar saveIn Place
 $\frac{S \quad P \quad O}{\quad}$

3. Defining and Setting Datatype

Datatype is the type of data that belongs to a class. This datatype can be various types of data, including string, integer, float, long, boolean, and so on. In the Lontar ontology that the author compiled has datatypes as in Table 3 below.

Table 3. Definition of Datatype

Class	datatype	Data Type
Lontar	title	Strings
	type	Strings
	subject	Strings
	classification	Strings
	language	Strings
	collation	Integer
	year	Integer
	length	integer
	width	integer
	resources	Float
Organization	owner	Strings
	location	Strings
Person	author	Strings
	address	Strings
	cv	Strings
Origin	areas	Strings
	regency	Strings

4. Prefix / Metadata Project Definition

Defining PREFIX in an ontology involves setting a prefix or prefix that is used to identify and shorten the URI (Uniform Resource Identifier) used in the ontology. These prefixes help in making the use of URIs more concise and easier to read. Following are the steps in defining PREFIX on the ontology:

- Define Prefix: Choose a relevant and easy-to-remember prefix to identify the URIs to be used in the ontology. For example, the "rdf" prefix can be used for URIs related to RDF (Resource Description Framework).
- Define URI: After defining the prefix, define the full URI to be used in the ontology. This URI will be associated with the predefined prefix. For example, the URI "<http://www.w3.org/1999/02/22-rdf-syntax-ns#>" can be associated with the prefix "rdf"
- PREFIX definition: After defining the prefix and URI, perform a PREFIX definition at the beginning of the ontology. This is done by including a PREFIX statement that lists the prefix and its associated URI. For example, the PREFIX statement could be written as "PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>".
- Use of PREFIX: After defining a PREFIX, the defined prefix can be used in the ontology to refer to the associated URI. Prefixes can be used in the use of classes, properties, individuals, and more in an ontology.

Defining PREFIX in an ontology allows for the use of shorter, more readable URIs. This helps in making it easier to understand and write ontologies and strengthens interoperability between different ontologies.

5. Instances

Instances in the ontology of ancient Balinese lontar manuscripts refer to real entities associated with the manuscript in the ontology. These instances are concrete representations of classes that have been defined in the ontology. In the context of ancient Balinese lontar manuscripts, instances may include individuals such as "NaskahLontarA", "NaskahLontarB", or "NaskahLontarC", each of

which represents a specific existing lontar manuscript. These instances have associated attributes. By using instances in the ontology of ancient Balinese lontar manuscripts, we can represent the manuscripts concretely and relate them to relevant classes and properties in the ontology, enabling further analysis and research related to ancient Balinese lontar manuscripts.

CONCLUSION

The conclusion of the study indicates that the construction of metadata using an ontology-based methodology can provide the information required to describe, categorize, and link entities in the ontology. Metadata consists of entity descriptions, hierarchies and classifications, relationships and properties, as well as the necessary semantics for constructing effective ontologies. The ontology design for ancient Balinese lontar manuscripts requires the definition and organization of classes, objects, and data types. The ontology classes consist of entities like lontar manuscripts, authors, locations, and origins. Objects are the relationships between classes in an ontology, which compose sentences with particular meanings. Data types are utilized to define the attributes of the ontology's classes. The definition of PREFIX in ontologies enables more concise and readable identification of URIs, thereby enhancing interoperability between distinct ontologies. The use of instances in the ontology enables the concrete representation of defined classes, such as particular lontar manuscripts, and aids in the analysis and conduct of more in-depth research concerning ancient Balinese lontar manuscripts. The overall objective of the design of an ontology for Balinese lontar ancient manuscript metadata is to provide a structured, systematic, and effective representation of manuscript-related information, thereby facilitating modeling, searching, analysis, and interoperability within the context of the ontology.

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