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Interlinking the Intrinsic Value: Re-Conceptualization of Organizing Cultural Heritage Using Smart Data

Abstract

This paper introduces the Cultural Heritage Conceptual Framework (CHCF), a smart data-driven model designed to semantically interlink cultural heritage resources across diverse institutions. Although cultural heritage comprises vast and heterogeneous social assets curated by various institutions, their intellectual and intrinsic values often remain underutilized because of the traditional unit-based rigid metadata approaches. Drawing on the concept of smart data, this study constructed a conceptual framework named Lead Data, which consists of three core categories such as Area, Subject, and Collection, and applied semantic facet structure to enhance the interlinking of cultural heritage resources at the metadata level. By extracting conceptually significant elements from existing metadata standards and organizing them as facets, the CHCF can function as a mediator that interoperates the metadata about cultural heritage resources. This smart data-based framework is expected to support advanced knowledge discovery, support interdisciplinary research, and improve accessibility within cultural heritage environments.

1. Introduction

Society has long produced, accumulated, and preserved a wide range of tangible and intangible assets and values at individual, social, and national levels. These assets are generally recognized as cultural heritage. Cultural heritage generally refers to resources, traditions, and entities that hold historical or cultural significance for a particular society or people (Rasmussen, 2019). As cultural heritage deemed worthy of being inherited to future generations, cultural heritage encompasses more than the mere preservation of relics or traditions from the past. It plays a crucial role in enabling current and future generations to engage in meaningful communication across time, thereby ensuring the continued communication of cultural values. Consequently, it increasingly becomes important to provide cultural heritage to current users and preserve for future users.

Cultural heritage holds significant social meaning as it reflects the identity, values, and historical background of a society (Gallucci, 2024). As it has been accumulated across various domains of society, the scope of knowledge and content it encompasses is remarkably broad, and the types of media through which it is transmitted are very diverse. Accordingly, cultural heritage has been professionally preserved and managed by different types of heritage institutions, such as archives, libraries, museums, and other specialized cultural organizations, depending on its specific form or medium.

Although the types of cultural heritage are very diverse, such as tangible and intangible, they can be seen as being closely related with each other because the intellectual contents contained in cultural heritage are reproduced and shared in various forms using state-of-the-art information technologies. Therefore, the knowledge and intrinsic value contained in cultural heritage can be fully utilized only when related cultural heritage are interconnected with each other.

For this purpose, many approaches have been proposed since the concept of Larchiveum was first introduced in 2008 (Kuzyk, 2008; Kennan & Lymn, 2019). However, because these approaches have focused on the integration of physical spaces and resources, they had limitations in that they did not reflect the unique inherited

meaning of cultural heritage. To overcome these limitations and maximize the values of cultural heritage, it is more important to interlink the intrinsic value of cultural heritage at the metadata level rather than the physical integration. Metadata-level interlinking of cultural heritage allows for the semantic connection of dispersed cultural heritage across different institutions, while preserving the unique purposes and characteristics of each institution. This approach enhances the intrinsic value of each resource by facilitating meaningful bibliographic relationships across institutional boundaries.

However, this cannot be achieved through traditional approaches to metadata interoperability. In the current linked data environment, what is required is not physical integration, but the interlinking of cultural heritage based on the semantic meanings embedded within each cultural heritage. This shift emphasizes the need for meaningful, concept-driven connections that transcend institutional boundaries and reflect the cultural and historical significance inherent in the heritage itself. For these reasons, this research constructs a Cultural Heritage Conceptual Framework (CHCF), a conceptual framework that semantically interlinks cultural heritage by applying smart data to interlink, integrate, analyze, and utilize various fields of cultural heritage.

2. Characteristics of Cultural Heritage

Cultural heritage is the legacy of the ways of living from the past, what we live with today, and what we pass on to future generations, primarily created by the human community (Giliberto & labadi, 2022; Reshma et al., 2023). As cultural heritage embodies a vast accumulation of informational, historical, and social knowledge and values over time, it manifests in a wide variety of forms. Broadly speaking, however, cultural heritage can be categorized into tangible and intangible heritage. Tangible cultural heritage refers to physically existing entities, including architectural structures, artifacts, historical sites, and works of art. In contrast, intangible cultural heritage includes non-physical expressions such as traditional rituals, annual ceremonies, social practices, and customary behaviors.

Cultural heritage, both tangible and intangible, is an essential component of human identity, reflecting social history, traditions, and values (Roders & van Oers, 2011). Although many researchers have defined what cultural heritage is, the definition of cultural heritage has been expanded to go beyond tangible assets, to include intangible values shared across society (Vecco, 2010; Roders, 2019; Reshma, et al., 2023). In recent years, cultural heritage has expanded its fields by incorporating Artificial Intelligence (AI) and data processing technology. Especially in the current information environment where technology is rapidly evolving, intangible cultural heritage is also manifested into various tangible formats.

Although cultural heritage is sometimes reproduced in various formats, the knowledge and intrinsic value it embodies remain unchanged. As cultural heritage represents the manifestation of values accumulated across society, it does not exist in isolation but is semantically connected to other forms of cultural heritage (Song & Lee, 2025). In such contexts, the same intellectual content may be shared in multiple forms of cultural heritage. Because identical or similar content can be created, preserved, and transmitted in diverse formats, these cultural heritage resources are inherently interconnected. Therefore, it is essential to establish interlinking among related cultural heritage in order to fully represent and utilize the knowledge and intrinsic value they

contain. Therefore, in organizing and managing cultural heritage, it is essential to fully reflect its unique intrinsic value by interlinking related cultural heritage and to enhance their intellectual significance. From this perspective, the interlinking of related cultural heritage is important in maximizing its intellectual intrinsic value.

Cultural heritage has unique characteristics that set it apart from other types of resources. As a single intellectual content can be manifested in multiple forms of cultural heritage, it becomes crucial to establish interlinking based on its intellectual aspects. Accordingly, the interlinking of cultural heritage should be approached from a fundamentally different perspectives than that used for connecting other types of resources. In addition, its inherent value can be maximized only when it is implemented in ways that allow people to effectively access and use it. To this end, cultural heritage has recently been expanding into various domains through the integration of AI and the adoption of smart data-based technologies. These developments enable more dynamic, user-centered approaches to the preservation, management, and dissemination of cultural heritage, enhancing its relevance and accessibility in contemporary society.

3. Evolution to Smart Data

The concept of smart data has emerged as a new paradigm in response to the growing recognition of the value of big data. While smart data falls within the broader category of big data, it is distinguished by its more structured nature and clearly defined purpose. Different from raw or unprocessed big data, smart data is curated, contextually meaningful, and actionable, which making it increasingly prominent and applicable across a wide range of fields. Smart data is also more contextualized and calibrated to specific needs. Thus, smart data is more accurate, precise, and usable data which allows people to collect and utilize information in more effective and functional ways. It is also partially supported by big data and can identify patterns and perform specific tasks on their own (ESA, 2021).

Smart data can be defined as high quality and clean data (Garcia-Gil, Luengo, Garcia, & Herrera, 2019). It also refers to smaller data sets that provide meaningful, valuable, and actionable information. However, smart data is usually extracted from big data by filtering, cleaning, and organizing large data sets, making it easier to analyze and act on (Bachler & Pavlovic, 2024). Big data is often collected without a specific purpose, which makes it prone to containing various forms of noise. In contrast, smart data refers to the process of transforming such raw and low-quality big data into a form suitable for data mining and knowledge extraction.

Smart data is no longer merely a collection of simple data elements, but rather a more meaningful contextual semantic unit which is an aggregation of information, knowledge, and semantics. From a knowledge management perspective, smart data can be considered as carefully selected data from big data, which has the potential to act as a knowledge catalyst. Through effective structuring and extraction, smart data can be intelligently refined to meet specific requirements, thereby enabling more intelligent decision making and actions. With these characteristics, smart data can achieve data standardization and add value through data evolution and structural design. Moreover, smart data enables the transformation from raw data to meaningful data, particularly in the preservation and utilization of resources with complex characteristics such as cultural heritage. In addition, smart data focuses on enhancing and realizing the value of data. By

leveraging smart data, it becomes possible to extract meaningful insights and discoveries from datasets of any scale, uncover patterns, draw conclusions, and make informed decisions. It can form a solid foundation for information-based processes.

As such, smart data has characteristics that distinguish it from traditional data. It can also be regarded as a concept that has emerged in response to the evolving AI-driven environment. It is an advanced form of data organization and more suitable for the new demands and requirements on the data and service in the new environment (Wang & Xilong, 2023). Smart data goes beyond the mere storage of collected data by leveraging AI and data analytics technologies to transform data into meaningful information and maximize its utility. Rather than focusing solely on processing large volumes of data, smart data emphasizes how data can be effectively utilized. Therefore, it provides a suitable approach for constructing data with practical value and offers advantages in applying value and context within AI-driven environments.

If these strengths of smart data were applied to organizing and managing the knowledge and intrinsic value contained in cultural heritage, it can foster knowledge organization environment that can maximize the value of cultural heritage by interlinking the intrinsic value of related cultural heritage. In addition, since smart data is the backbone of generative AI, it is expected to play a major role as the basis for constructing an AI-powered cultural heritage organization structure.

4. Interlinking Cultural Heritage

The value of cultural heritage lies not only in the preservation and transmission of traditional heritage, but also in the dynamic process of decoding, interpreting, inheriting, and reconstructing the heritage resources (Wang & Xilong, 2023). In addition, it is essential to reproduce the intrinsic value of cultural heritage. This value is not generated by a single cultural heritage object in isolation, but rather emerges or expands through the aggregation of related cultural heritage resources. Therefore, the organization and interlinking of cultural heritage should be approached at the collection level.

These characteristics of cultural heritage can be categorized into subject, physical, and collection domains, depending on its unique nature. While this may appear similar to the management of other types of information resources, general resource management tends to focus primarily on incorporating big data from a bibliographic perspective. However, due to the diverse types and heterogeneous descriptive aspects of cultural heritage, a bibliographic-centric approach presents limitations in effectively interlinking related heritage resources. In contrast, bibliographic description serves as the foundation for all forms of linkage, metadata for cultural heritage should function as a core basis in enabling such interlinking.

Cultural heritage has been socially accumulated over a long period and exists in diverse forms, both tangible and intangible, reflecting content related to various aspects of society. Due to these characteristics, cultural heritage can be interlinked based on specific subjects or intrinsic content. Accordingly, effective interlinking of cultural heritage requires an analysis of the subjects embodied in each cultural heritage resources. To support this process, applying classification systems used by various cultural heritage institutions can facilitate more efficient and accurate linkage across organizations.

The *physical* domain refers to the bibliographic description of the physical characteristics of cultural heritage. While it refers to the physical form of cultural

heritage, it becomes practically utilizable when it is described bibliographically. Moreover, bibliographic description of the physical form enables the conceptual categorization of the social, informational, and historical areas to which each cultural heritage belongs. For such conceptual categorization to be meaningful, it is essential to apply subject classifications corresponding to each cultural heritage, as well as collections that represent aggregations of these subjects.

The *subject* domain aims to enable interlinking through intrinsic subject connections, while the *collection* domain forms subject groupings through such interlinking, thereby generating the intrinsic value of cultural heritage. To implement these domains, however, bibliographic information must be provided. This includes detailed description such as physical format, holdings, and other descriptive elements. When these domains are appropriately documented, a bibliographic environment that supports physical and intellectual interlinking can be established. In this context, cultural heritage must be bibliographically described to enable its organization, management, operation, and provision. Such a structure can be achieved through bibliographic metadata.

As the representation of cultural heritage entities and their interrelationships in the physical world is expressed through data, the construction of smart data in the cultural heritage domain can maximize the creation and utilization of its intrinsic value. Thus, the application of smart data provides the foundation for generating and regenerating the value of cultural heritage resources and their embedded content, enabling the intelligent transformation of the knowledge contained within them.

However, in order to effectively utilize smart data for the organization and interlinking of cultural heritage, it is essential to support diversified digital interpretations and artistic expressions of cultural heritage. Additionally, new approaches must be established to enable the activation and reconfiguration of data value through the conceptual structuring of smart data within the cultural heritage domain.

5. LEAD Data Approach

Traditionally, the field of library and information science has managed metadata for a wide range of information resources to establish an environment where users can effectively search for and utilize knowledge and information entities. Accordingly, metadata has played a central role in facilitating access to knowledge and information resources at both individual and societal levels, serving as a foundational structure for interlinking related resources.

Various forms of metadata have been created for different types of cultural heritage. However, cultural heritage possesses distinct characteristics that set it apart from general information resources, particularly in its tendency to be duplicated and reproduced across different contexts. Given these characteristics, cultural heritage can greatly benefit from being semantically linked with other cultural heritages that share identical or similar content. Such interlinking, facilitated through metadata, enables broader and easier access by the public, thereby enhancing the cultural and intellectual value of cultural heritage resources. However, data on cultural heritage is extremely large in quantity and comes in various formats. In addition, the intrinsic value of a cultural heritage is internally and semantically interrelated with other cultural heritage. Therefore, it is necessary to interlink the intrinsic values of semantically related cultural heritage at the

metadata level. Applying smart data can be one of the efficient approaches by supporting to organize a structure for managing data on cultural heritage systematically.

In the new era of AI, smart data may be efficiently processed using AI technology while also being used by AI to generate intelligent applications and produce high-quality data. However, since information contained in cultural heritage are usually non-textual and non-machine-readable, generating metadata for the diverse characteristics of cultural heritage presents complexities in data processing (DCMI 2024). To meet the increasing demands for revealing their intrinsic values, smart data need to be generated for the information contained in various cultural heritage entities which are usually non-textual and non-machine readable so that they can be identified, discovered, and used.

To apply smart data in interlinking the intrinsic values of cultural heritage, however, it is necessary to have a structure that can consistently organize the data-wise characteristics of cultural heritage. For these reasons, this research proposes an approach to developing Lead data. Lead data is an internal information that serves as key elements for leading the interlinking between various intellectual aspects of cultural heritage (Korea Society of Archival Studies, 2008, 93). The proposed Lead data consists of three linking categories: Areas, Subjects, and Collections. These three categories correspond to the physical, subject, and collection domains, respectively, which are categories that distinguish the unique characteristics of cultural heritage. Additionally, the Lead data may include holding information on cultural heritage, including holding institution, location, and content composition of the cultural heritage.

When developing the Lead data, smart data can extract the values assigned to each linking category and establish relationships between them. At this time, an organizational structure is needed to ensure that the values extracted through smart data are consistently connected to the linking categories of Lead data. For this purpose, this research constructs Cultural Heritage Concept Framework (CHCF).

6. Basic Categories of CHCF

This research proposes an approach to semantically integrate and interlink various cultural heritages at the metadata level, which is a Cultural Heritage Conceptual Framework (CHCF) structure utilizing smart data. The CHCF is a framework that structures the concepts manifested by semantic relationships between various bibliographic characteristics of cultural heritage. To build the CHCF structure, it is necessary to develop a Lead Data, which is a group of internal information that serves as a key element for interlinking between various intellectual aspects of cultural heritage. The Lead Data consists of *Areas*, *Subjects*, and *Collections*. When constructing the Lead Data, it can be a more efficient way to graft the concept of smart data using AI techniques. By extracting smart data corresponding to each category of cultural heritage through the Lead Data and structuring the relationships between them, the CHCF using smart data can semantically interlink related cultural heritage and maximize the intellectual and intrinsic value inherent in various fields of cultural heritage.

To consistently interlink the knowledge contained in cultural heritage and maximize their intrinsic value, it is necessary to construct a conceptual structure based on the common entities and attributes shared by cultural heritages. These common entities and attributes constitute the core of CHCF structure. In CHCF, smart data can precisely extract the values that can be assigned to these entities and attributes.

This process of the CHCF is designed based on subject classification systems and metadata practices adopted by cultural heritage institutions. It also enables the expansion of interlinking related cultural heritage resources by incorporating a broader range of domains and subjects that are often excluded from traditional classification systems. This approach encompasses not only physical and bibliographic information but also metadata that captures intrinsic values and supports their semantic interlinking. To achieve this, shared facets that address the physical, bibliographic, and intellectual dimensions of cultural heritage need to be defined and mapped onto a smart data structure. In this process, relevant metadata elements are extracted and structured as smart data, ultimately facilitating the generation and representation of intrinsic value of cultural heritage. This interlinking is based on the three linking categories that constitute the Lead data: Area, Subject, and Collection. Smart data can assign values to these categories to semantically interlink metadata about different cultural heritages with the same or related values.

Among the three linking categories, *Area* means the social or historical fields to which each cultural heritage belongs. Each field of cultural heritage may have its own unique characteristics, and the cultural heritage which belongs to the field may manifest and embody the characteristics of the field. Therefore, *Area* can be applied as the starting point of connecting the fundamental attributes of cultural heritage.

Subject can be considered as a standard that explains the key theme of cultural heritage. Most cultural heritage may represent one or more specific subject. Thus, the category *Subject* can mediate to connect different cultural heritages that share the same subject.

Collection refers to a collection or a content group of cultural heritage. It describes the contents of the collection of cultural heritage and comprehensively interoperates metadata that make up the collection.

These three categories of Lead data are basic components of CHCF. Based on the Lead data, the CHCF can organize and interlink the common intrinsic values contained in each cultural heritage. The values assigned to the Lead data can be extracted through smart data. The application of smart data can be further expanded to organize, manage, and operate cultural heritage by introducing AI-powered processes.

7. Facet Structure of CHCF

To construct the CHCF structure, it is essential to develop Lead Data, which is based on the core metadata elements adopted in various cultural heritage institutions. The development of these Lead Data requires criteria for semantically interlinking bibliographic, intellectual, and physical descriptive elements related to cultural heritage through the three linking categories. Accordingly, this study extracts core common elements from various metadata standards traditionally used to describe cultural heritage and organizes them into semantic facets. These facets serve as fundamental components for intellectually interlinking the diverse domains and subjects of cultural heritage.

Through these facets, it is possible to extract smart data and allow them to assign values to each category of CHCF, which are *Area*, *Subject*, and *Collection*. Each category is associated with a facet that serves as a semantic standard encompassing the core elements among the metadata used to describe cultural heritage (see Table 1). This facet functions not merely as a means of linking related metadata elements, but as a smart data-driven structure that contextualizes and calibrates the embedded knowledge and intrinsic

value of cultural heritage. Through this approach, high quality and refined data can be ensured, thereby enabling both bibliographic and semantic interlinking of related cultural heritage objects. By structuring the interlinking among these categories, the framework of the CHCF can be systematically constructed.

Table 1. Categories and Facets of CHCF

Category	Facet	Description
Area	Domain name	Domain ID and definition
	Composition of area	List of topics
Subject	Subject name	Topic ID
	Subject overview	Definition and summary
	Coverage of subject	Scope of coverage
	Keywords	Related keywords
Collection	Collection name	Collection ID
	Type	Document types
	Main repository	Storage location
	Related information	Connections
	Multiple topics	Additional topic IDs

Based on these facets, this approach not only captures the diverse dimensions of cultural heritage but also enables a more integrated environment for interlinking and utilizing cultural heritage through a smart data-based framework. Furthermore, it is expected to contribute to the expansion of knowledge related to cultural heritage through the integration of smart data approaches.

8. Designing the Structure of CHCF

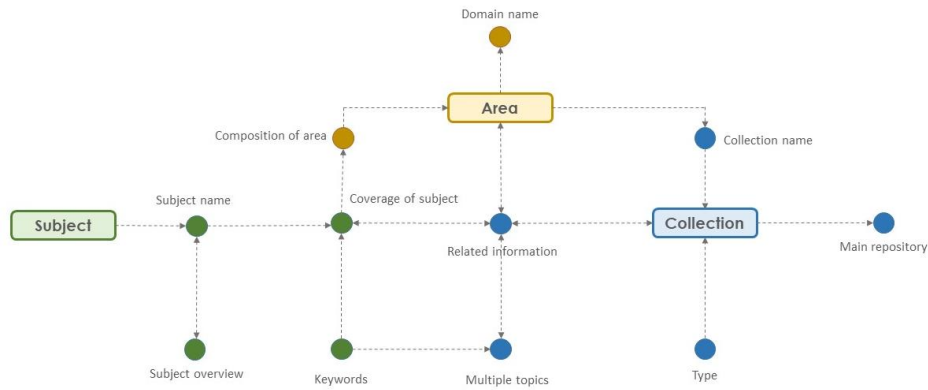
Cultural heritage institutions employ various metadata standards to effectively describe the heritage resources in their collections. To enable the integrated use of these resources and facilitate interlinking among related items across institutions, it is essential to semantically analyze the metadata elements used by each institution. This process involves identifying core metadata elements and the relationships among them that can serve as stable criteria for interlinking. Through such analysis, semantically related elements can be identified, and facets can be derived from this process that enable the bibliographic description of the intrinsic value contained in various cultural heritage.

To achieve this, it is essential to provide refined and contextually enriched values through smart data extraction methods, rather than relying solely on metadata interoperability approach. This requires a structural framework capable of interlinking these refined values with both smart data and metadata. Such a framework should be based on a facet-based conceptual model that can be linked to the categories of *Area*, *Subject*, and *Collection*, which reflecting the unique characteristics of *physical*, *subject*, and *collection* of cultural heritage.

Metadata elements that share the same or similar meanings can be categorized under unified facets. These facets can serve as a semantic criterion for categorizing, representing, and interlinking the knowledge and intrinsic values of cultural heritage at the metadata level. It becomes possible to define a facet that encompasses the semantic scope of these elements. Furthermore, the defined facets can function as a semantic bridge, providing a meaningful basis for interlinking related cultural heritages. In this process, each facet not only reflects the bibliographic characteristics inherent in cultural

heritage but also functions as a higher-level conceptual category that semantically connects interrelated heritage resources (see Figure 1).

Figure 1. Design of CHCF structure



As shown in Figure 1, the entities in this model represent the three Lead Data categories of cultural heritage; the node represent the facets under the categories; and the arc shows relationships that interlinks between nodes. In this structure, facets serve as the core semantic linkage units for each cultural heritage. These facets refine and semantically encompass related metadata elements along with their assigned values, enabling the integration of not only independently existing bibliographic descriptions but also the interlinking of associated values. As such, facets function as standards for re-conceptualizing the intrinsic value of cultural heritage. Constructed from metadata elements applied by individual cultural heritage institutions, these facets collectively form a semantic structure. Smart data further enhances this structure by refining and contextualizing extensive cultural heritage-related data, thereby establishing meaningful relationships that underpin the semantic architecture of each facet.

These are abstract descriptive components of CHCF structure that encompass essential elements for representing the content-related and intellectual dimensions of cultural heritage. By semantically clustering conceptually identical or similar entities, the CHCF structure enables the recreation of intrinsic value of related cultural heritage and interlinking them at the metadata level. Consequently, the Lead Data structure can incorporate various elements from existing metadata standards as properties, thereby supporting bibliographic interlinking at the metadata level.

Different from traditional element-based mapping approaches, the CHCF structure reflects the unique characteristics of cultural heritage, categorizes them into facets that constitute Lead Data, and assigns values to the facets through smart data. Through this process, it re-conceptualizes the intrinsic value of cultural heritage and offers a clearer semantic and structural interlinking among cultural heritage. This smart data-based approach moves beyond a mere listing of elements, allowing for a more meaningful and effective application of a structured bibliographic system.

9. Conclusion

Lead data developed through smart data approach can serve as a conceptual structure for interlinking the intellectual content and intrinsic value of cultural heritage. Lead data and smart data constitute the backbone of the conceptual framework of CHCF, which re-conceptualizes the intrinsic values of various cultural heritage. It also interlinks related cultural heritage by establishing common entities and attributes as facets. Through this CHCF, the intrinsic value contained in cultural heritage can be expanded, related cultural heritage collections can be interlinked at the metadata level.

Through the Lead data extracted using smart data, the hidden intrinsic value of cultural heritage that are difficult to describe can be represented and accessible more efficiently. In addition, the CHCF does not consider each cultural heritage as an independent and isolated entity. Rather, more integrated value can be created by interlinking related cultural heritages through CHCF.

By leveraging smart data, this approach can provide an integrated environment not only for the diverse domains of cultural heritage but also for the systematic interlinking and utilization of cultural heritage. Furthermore, the integration of AI and smart data technologies lays the foundation for more efficient data analysis, the promotion of interdisciplinary research, and enhanced global accessibility. In this context, the CHCF is expected to contribute to the management of cultural heritage and the expansion of related knowledge.

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