ARTICLE

Japanese Military "Comfort Women" Knowledge Graph

Linking Fragmented Digital Records

Haram Park and Haklae Kim

ABSTRACT

Materials related to Japanese military "comfort women" in Korea are managed by several institutions. Each digital archive has their own metadata schema and management policies. So far, a standard or a common guideline for describing digital records is not formalized.

We propose a Japanese military "comfort women" knowledge graph to semantically interlink the digital records from distributed digital archives. To build a Japanese military "comfort women" knowledge graph, digital records and descriptive metadata were collected from existing digital archives. A list of metadata was defined by analyzing commonly used properties and a knowledge model designed by reusing standard vocabularies. Knowledge was constructed by interlinking the collected records, external data sources, and enriching data. The knowledge graph was evaluated using the FAIR data maturity model.

INTRODUCTION

In December 1991, Kim Hak-Sun (a Korean) became the first woman to disclose and identify as a former "comfort woman."[1] In February 1992, Ms. Itoh Hideko discovered three telegrams in the Japanese Defense Agency stating that not only Korean but also Taiwanese women had been dispatched as "comfort women."[2] Between 1931 and 1945, the Imperial Japanese Army forced approximately 200,000 girls and young women from Korea, China, and other countries, known as "comfort women," into sexual slavery. These women came from all over East Asia, but the majority, over 80 percent, were from South Korea.[3] It was not until the early 1990s that survivors began to share their stories and demand justice. Many international organizations and volunteers continue to participate in advocacy and campaigns to solve the Japanese military sexual slavery.[4] However, the Japanese government has never accepted legal responsibility or agreed to pay reparations.[5]

Regardless of political interpretation, we believe it is critical to reveal the historical truth. The records of Japanese military "comfort women" serve as objective evidence to prove the fact that the Japanese military indulged in sexual slavery. As there are now only 13 elderly survivors left in South Korea, the records could serve as one of the key pieces of evidence for understanding the Japanese military "comfort women." In Korea, materials related to Japanese military "comfort women" are managed by the National Archives of Korea and some private organizations, and some of this material is being provided as digital archives.[6]

Digital archives systematically describe digital resources so that users can effectively search and view the materials.[7] In general, digital archives describe digital resources based on guidelines for expressing standard metadata elements and data values that are mainly used in the domain. For

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https://doi.org/10.6017/ital.v42i1.15799

example, the US Library of Congress is creating digital resources with varying levels and types of descriptive metadata, providing an increasingly coordinated and standardized approach to the creation and management of descriptive metadata.[8] However, for the digital archives related to Japanese military "comfort women," there are no recommendations or agreed guidelines on metadata for describing digital records. Even when metadata standards such as Dublin Core are used, there remain variations in describing metadata elements of digital records. Therefore, linking or integrating the digital records with different metadata structures and values is difficult.

To solve this problem, a metadata model to describe digital records related to Japanese military "comfort women" should be developed, and digital records should be systematically described. If the various pieces of information contained in the digital record are expressed in a format that a machine can understand, a precise search is possible based on the meaning and relationship of the data. A knowledge graph can be applied to define the relationships between the various entities included in Japanese military "comfort women" records. In particular, the records existing in a distributed digital archive can be expressed as objects that can be identified on the web, so that different records can be linked at a semantic level.[9]

This study proposes a method to interlink and search digital records of the digital archives of Japanese military "comfort women." For describing and linking distributed digital records, a set of metadata elements was proposed, and a knowledge model was defined by examining the common metadata model and the existing RDF vocabulary. The collected digital records were constructed as a knowledge graph, using a knowledge model. The knowledge graph was evaluated by applying the FAIR data maturity model.[10] The remainder of this paper is organized as follows. The literature review introduces the Japanese military "comfort women" issue and describes the concepts and research trends related to knowledge graphs. We then introduce the case of Korean digital archives containing materials about the Japanese military's use of "comfort women." Next, we describe the process of developing a knowledge graph in detail and define SPARQL queries, comparing the search results of existing digital archives and knowledge graphs, and describing differences in FAIR data maturity. Finally, the research results are summarized, and future research directions are described.

LITERATURE REVIEW

Japanese Military "Comfort Women"

The Japanese military "comfort women" issue was made official in 1991 when the Korean Council for the Women Drafted for Military Sexual Slavery by Japan and the Korean victims appealed to solve the problem themselves,[11] through activities such as the testimony of victims,[12] and the activities of individual researchers and civic groups,[13] raising issues through the international community and through domestic and international judicial procedures.[14] Through these efforts, the Japanese military "comfort women" issue has been seen as a problem of forced mobilization, human trafficking, sexual exploitation, and extreme human rights violations by the ruling state targeting women in the colonized state.[15] However, the Japanese military "comfort women" were a cause of conflict and confrontation between victims and their families, private organizations, and the South Korean and Japanese governments. For example, Mark Ramseyer defined the Japanese military "comfort women" in his paper as prostitutes (*ianfu*) who, based on game theory, engaged in prostitution to the Japanese military for high wages during the Pacific War.[16] This sparked a

debate about historical distortion.[17] Some argue that the "comfort women" issue is not viewed as a conflict between Korea and Japan but as a women's and a universal human rights issue.[18]

From a political and social point of view, research on the Japanese military "comfort women" is active, but insufficient research has been conducted on archives and records management due to licensing of records, data sharing, and a lack of qualified personnel. Various licensing policies and sharing limitations apply to the records kept by different institutions. As a result, the preservation and exchange of documents are nominal, and they are administered with a minimal amount of personnel. Records are essential evidence for discussing historical truths. Fifteen organizations, from eight countries, have tried to list the records of the Japanese military "comfort women" as UNESCO World's documentary heritage.[19] A total of 2,744 records have been requested, including materials that prove the Japanese military's "comfort women" system or materials produced by "comfort women" victims. However, the decision to list Japanese military "comfort women" records as UNESCO documentary heritage has been postponed due to tensions between South Korea and Japan.[20] The National Archives of Korea has selected materials related to the "comfort women" of the Japanese military as a nation-designated record and is integrating and managing these records.[21] However, most records are scattered in various university research institutes, nongovernmental organizations, and institutions, and it is difficult to systematically preserve and manage them.

Reuse of Ontology Vocabularies and FAIR Data Principles

The records of the Japanese military "comfort women" are not systematically managed, and existing digital archives tend not to contain sufficient information contained in the original records. A previous study suggested a metadata schema for the integrated management of the records of Japanese military "comfort women."[22] However, although most studies suggest common metadata elements, they do not include methods for representing and processing records in a machine-readable format.[23] Reusing vocabularies is recommended to foster interoperability and facilitate knowledge use by interlinking new datasets to existing resources. Some previous efforts demonstrate a way of interlinking digital resources on the Web by using several ontology vocabularies.[24] In particular, Freire et al. propose a mapping from Schema.org metadata to the Europeana Data Model. The proposed method is suitable for metadata aggregation in the area of cultural heritage by enriching the semantics of the Schema.org model.[25]

The FAIR data principles are designed to reinforce the reusability of research data and are defined as four principles: Findable, Accessible, Interoperable, and Reusable.[26] In particular, the FAIR principles emphasize the ability of machines to find and use data on their own, in accordance with the research data management environment.[27] Initially, the FAIR principles were recognized as a tool to enhance the reusability of research data in the context of open science; however, they are now being extended to a universal framework for preserving and managing data in the long term.[28]

Representative examples include FAIR Metrics,[29] the data maturity model of the RDA (Research Data Alliance) working group,[30] and FAIRsFAIR.[31] FAIR Metrics presents an evaluation framework that can measure FAIR indices using an automated tool. Discussions on the FAIR principle are also expanding in digital archives and libraries.[32] Koster and Woutersen-Windhouwer propose the FAIR principle suitable for LAM (libraries, archives, museums) collections and suggest a practical method to increase the reusability of digital cultural heritage.[33]

DIGITAL ARCHIVES OF JAPANESE MILITARY "COMFORT WOMEN"

The records or documents of the Japanese military "comfort women" are managed in the form of digital archives by national and private institutions. Table 1 summarizes the status of digital archives held by each institution as representative digital archives. The Wednesday Demonstration Archive is a digital archive operated by the Korean Council. It contains a record of the "regular demand demonstration to solve the Japanese military's sexual slavery problem" that began in January 1992. The archive contains 1,085 records, and each record is described with 17 metadata elements. Archive 814, named for the annual Day of Remembrance of the Japanese Military "comfort women" observed on August 14, aims to develop efforts and research results

Table 1. Status of records by archives

Archives	Organization	Number of digital records	Number of descriptive metadata	URL
Wednesday Demonstration	The Korean Council	1,085	17	https://womenandwarmuseum.net
Archive 814	Research Institute on Japanese Military Sexual Slavery	596	20	https://www.archive814.or.kr/
Digital collection of "comfort women"	Seoul Metropolitan Archives	137	25	https://archives.seoul.go.kr/class/CC-0003
Gender Archive	Seoul Foundation of Women and Family	408	88	http://genderarchive.or.kr/
Nation-designated Archives No. 8	National Archives of Korea	27	20	https://theme.archives.go.kr//next/nationalArchives/subPage/nationalArchives7.do

Note: Archive names in the following sections are abbreviated for readability: WED: Wednesday Demonstration; A814: Archive 814; SMA: Digital Collection of "Comfort Women"; GEN: Gender Archive; NAK: Nation-designated Archives No. 8.

surrounding the "comfort women" issue. Archive 814 has 596 records, including domestic and foreign legal records, official documents, collections by subject, chronological tables, and book lists. The Seoul Archives provides documents proving the existence of Japanese military "comfort women" and comfort stations from documents produced by the Allied Forces during World War II. In total, 137 records were provided, and each record consisted of 25 descriptive metadata elements. The Gender Archive provides documents on the issue of "Military Sexual Slavery by Japan" and "The Women's International War Crimes Tribunal on Japan's Military Sexual Slavery." A total of 408 records were provided, with 88 metadata elements describing each record. The National Archives of Korea has designated records related to Japanese military "comfort women" as Nation-Designated Archives No. 8. Among the records (approximately 3,060 cases) owned by House of Sharing (http://www.nanum.org/eng/main/index.php) and Daegu Citizen Forum for Halmuni (http://www.1945815.or.kr/), 27 records are selected as major records, and digitized records including 20 metadata elements are provided.

DEVELOPMENT OF JAPANESE MILITARY "COMFORT WOMEN" KNOWLEDGE GRAPH

Data Preprocessing

A total of 2,253 records and metadata were collected from the five digital archives. Excluding records with insufficient information (A814 and NAK had three and two documents, respectively), 2,248 records were constructed as a knowledge graph. Metadata values in the collected records are not consistently expressed. For example, the Seoul Archives indicates the institution in the form "[organization/group] Jinseong Jeong Research Team, Seoul National University, 2015," whereas "Kunji Takei, Governor of Yamagata Prefecture" in Archive 814 has a combination of person, organization, and his position together. These values are separated into relevant categories and described in the corresponding metadata elements (e.g., "Kunji Takei, Governor of Yamagata Prefecture" is divided to "Kunji Takei" (name) and "Yamagata Prefecture" (his position)). The units for expressing metadata values such as "production date" and "language" are also unified, and errors in some data values are corrected directly (e.g., "Gabrelle Kirk McDonald" is changed to "Gabrielle Kirk McDonald", restoring the "i" to her first name). In addition, a new classification system is defined by aligning and integrating existing categories, since digital archives uses different categories (e.g., Book/Publication, Document).

A Model of Designing a Knowledge Graph

Two tasks are performed to transform the collected data into a knowledge graph. Since the metadata elements used in digital archives are different, metadata properties commonly used in archives are extracted. For common metadata, the scope of reuse is determined by investigating the existing RDF vocabularies and adding to the proposed knowledge model.

Common metadata elements among the selected archives are defined by the following two criteria:

1. Metadata elements commonly used in all archives were extracted. Metadata elements present in all five archives, such as Title, Description, Identifier, License, and URL are mandatory. Metadata elements defined in two or more archives, such as "production date" and "language," are optional properties. Even if the metadata name written in Korean is different, it is regarded as the same metadata element if its purpose is to indicate the same data value.

2. Metadata elements not used in the actual data were excluded from the model. For example, GED has 88 metadata elements. However, there were no data values for 60 of these elements.

Table 2 summarizes a list of metadata elements for describing the records of digital archives.

A proposed model should be able to represent the context of individual records and their own properties. After investigating semantic relationships between common metadata elements and existing vocabularies, the proposed model is defined. The model reuses existing vocabularies, such as DCMI (Dublin Core Metadata Initiative) metadata terms for describing online resources, SKOS (Simple Knowledge Organization System) for representing taxonomies, RiC-O (Records in Contexts – Ontology) for describing digital records, and Schema.org for supporting universal search on the Web. The basic structure of the Japanese military "comfort women" knowledge model is illustrated in figure 1. All records that are digital resources ("#Record") are instances of schema:ArchiveComponent and represent records provided by each archive. The individual records contain information on several people and organizations. For example, the schema:creator property describes a creator who creates a record, the schema:contributor can be used to represent a person who contributes a record, and the schema:mentions is to represent a thing related to a record. An archive manager who holds or maintains a record can be described using the schema:holdingArchive property, and the archive manager is represented by the schema:ArchiveOrganization class. If the value of each property is a type of organization, then the value of rdfs:range is the schema:Organization class.

Figure 1. Abstract structure of the Japanese Military "comfort women" knowledge graph.

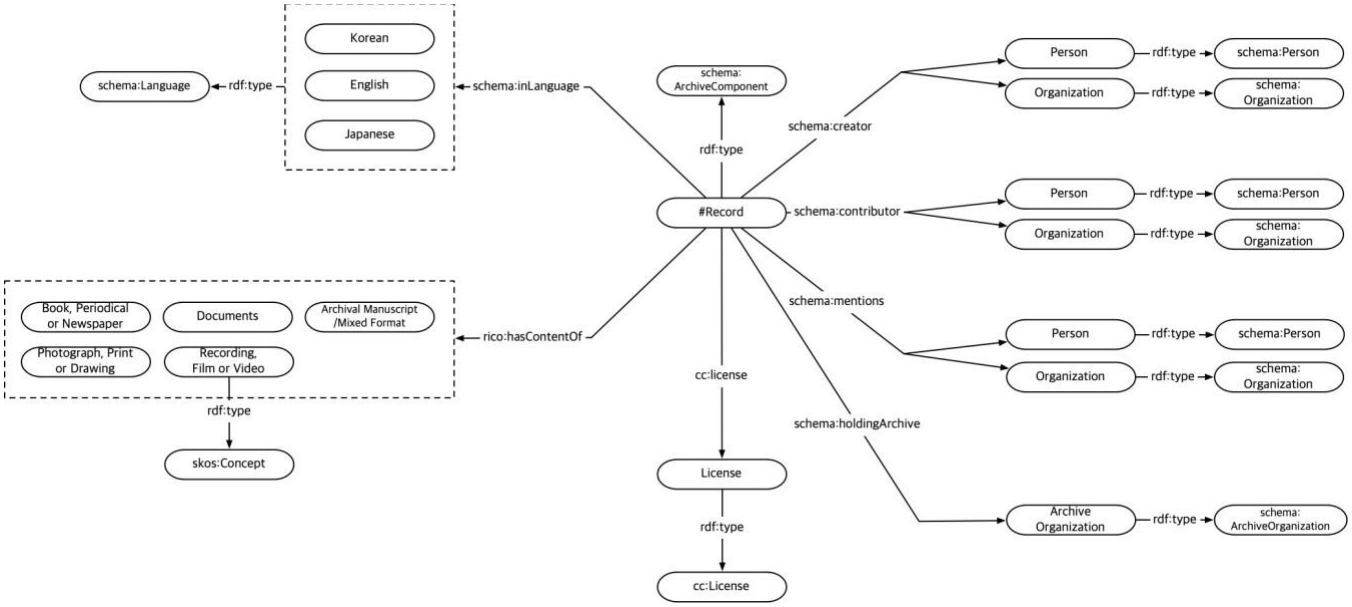


Table 2. Mapping results of both metadata elements and models of the knowledge graph

WED	A814	SMA	NAK	GEN	Property	Entity	Value	Mand-atory
title	title	title	title	dc:title	schema:title	schema: ArchiveComponent	xsd:string	Yes
identifier	registration number	Identification number	Management number	dc:identifier	schema:Identifier	schema: ArchiveComponent	xsd:string	Yes
description	scope and content	description		dc:description	schema:description	schema: ArchiveComponent	xsd:string	Yes
production date	production date		year of production	itm:date	schema:dateCreated	schema: ArchiveComponent	xsd:dateTime	No
creator	creator		production institution	itm:creator	schema:creator	schema: ArchiveComponent	schema:Person; schema:Organization	Yes
license	license	rights statement	license		cc:license	schema: ArchiveComponent	cc:License	Yes
management organization	management organization		service provider	management organization	schema:holdingArchive	schema: ArchiveComponent	schema: ArchiveOrganization	Yes
URL	URL	URL	URL		schema:sameAs	schema: ArchiveComponent	schema:URL	Yes
attachment view	attachment view	attachment view	attachment view	File	schema:mainEntityOfPage	schema: ArchiveComponent	schema:URL	No
attachment	download	download			schema:downloadUrl	schema: ArchiveComponent	schema:URL	No

WED	A814	SMA	NAK	GEN	Property	Entity	Value	Mand-atory
record type	record type	record type	record type	itm:typeOfRecord	rico:hasContentOfType	schema: ArchiveComponent	skos:Concept	Yes
	format		type of document	itm:formatOfRecord	rico:hasDocumentaryFormType	schema: ArchiveComponent	skos:Concept	No
	number of pages		number of pages	itm:size/amount	schema:numberOfPages	schema: ArchiveComponent	xsd:nonNegativeInteger	No
		language		itm:langauage	schema:inLanguage	schema: ArchiveComponent	schema:Language	No
periodic classification	temporal coverage				schema:temporalCoverage	schema: ArchiveComponent	xsd:string	No
related terms		Related information		itm:relatedPerson; itm:relatedOrganization; itm:relatedEvent	schema:mentions	schema: ArchiveComponent	schema:Person; schema:Organization; schema:Event	No
	donor/collector	contributor, collector/provider		itm:donor	schema:contributor	schema: ArchiveComponent	schema:Person; schema:Organization	No

Data Enrichment and Transformation

Data enrichment refers to the process of appending or otherwise enhancing the collected data with the relevant context obtained from additional sources. In the collected digital records, the entities of person and organization are linked to Wikidata (http://wikidata.org) and the enriched information is expanded to a knowledge graph using the RDF extension of OpenRefine (http://openrefine.org).

A total of 654 terms were extracted from the existing archives for people and organizations. After removing duplicates, the dictionary contained 150 people and 312 organizations. For each term in the dictionary, a matching entity is searched for in Wikidata. If the entity name matches completely, the URI of Wikidata is assigned automatically. Thirty-eight percent of people (57) and 28 percent of organizations (88) matched between the dictionary and Wikidata. Matched entities can be added to the knowledge graph by extracting the properties and values of Wikidata. For example, Kim Bok-dong is linked to Wikidata (Q16175111), and citizenship, occupation, place of birth, and gender, which did not exist in the collected data, are added to the knowledge graph. As a result, six properties are representing the extended properties were mapped (e.g., citizenship is mapped to fetched from the person and three attributes are obtained from the organization. A total of nine properties were expanded by data enrichment, and vocabularies for schema:nationality).

The constructed knowledge graph had 47,499 triples for 3,069 entities. The collected records and information contained in the records included 2,560 objects. The number of entities expanded through Wikidata was 145 (88 individuals and 57 entities) and were added to the organization. The enriched entity contained 2,144 explicit statements and 102 inferred statements. As shown in table 3, the total number of triples was 47,327 for explicit statements and 172 for inferred statements. The knowledge graph is published on GitHub (https://github.com/hike-lab/comfort-women-archives).

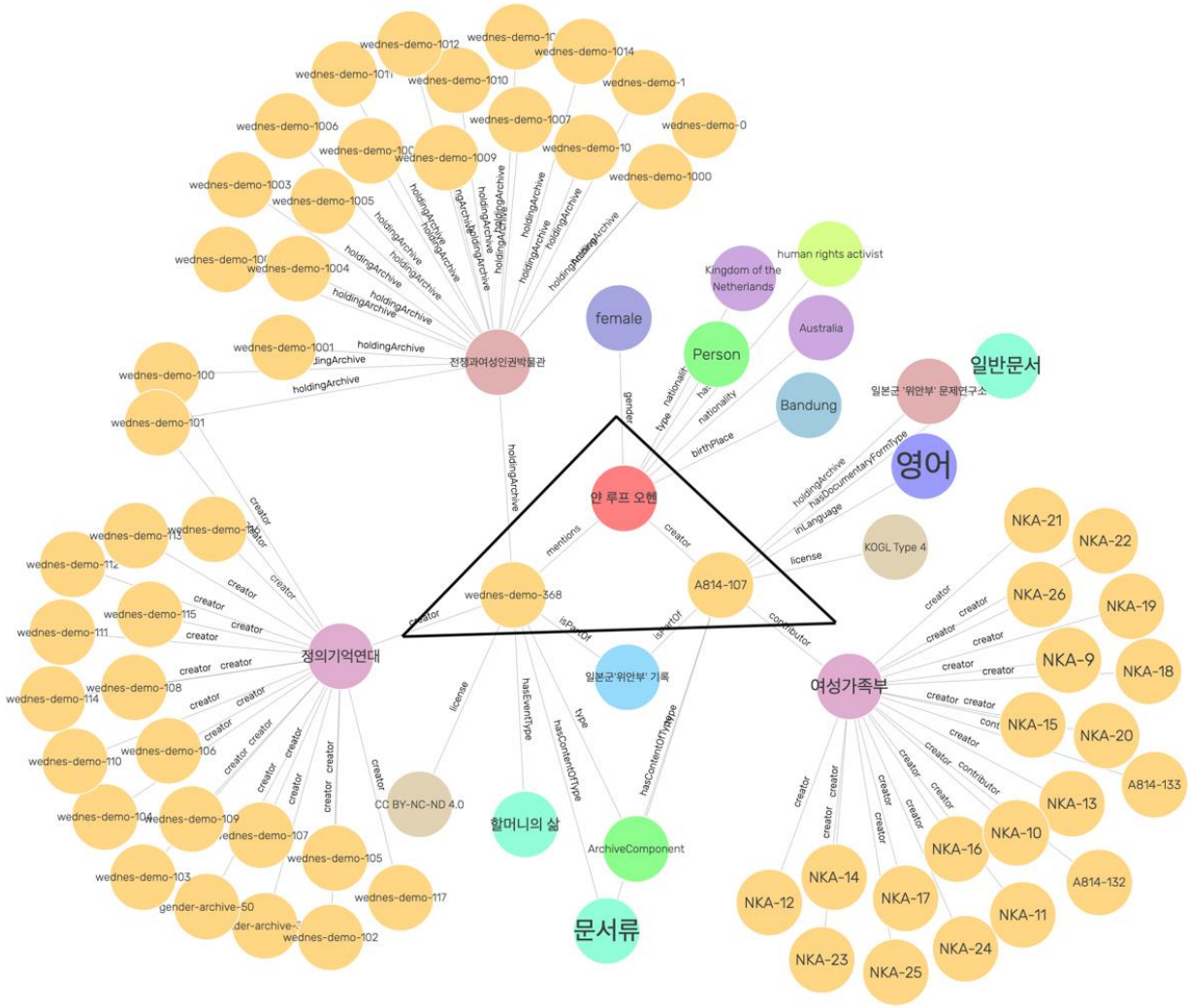
Table 3. Statistics of the constructed knowledge graph

	Entities	**Explicit statements**	**Implicit statements**	**Sum of Statements**
Collected entities	2,560	45,213	70	45,283
Enriched entities	509	2,114	102	2,216
Sum	3,069	47,327	172	47,499

Figure 2 shows the information about “Jan Ruff O’Herne” in the knowledge graph. She is a Dutch-Australian sexually enslaved by the Japanese military and has been active as a human rights activist since she disclosed in 1992 that she had been sexually enslaved by the Japanese army. The knowledge graph links several records produced or contributed by O’Herne. WED’s record (wednes-demo-368) links Jan Ruff O’Herne with related information (schema:mentions), and A814’s record (A814-107) links Jan Ruff O’Herne as the record’s creator (schema:creator). Existing digital archives do not provide specific information about the person, organization, or

event described in metadata. If anyone does not know that Jan Ruff O'Herne was a victim of the Japanese military "comfort women," it is difficult to fully understand the record of "Letter from Jan Ruff-O'Herne in support of US Congress Resolution 121 in 2007" provided by A814. However, as shown Figure 2 the knowledge graph provides a rich context for understanding her and her associated records.

Figure 2. Semantic relationships of Jan Ruff O'Herne on the knowledge graph.



EVALUATION

The evaluation of the constructed knowledge graph was carried out in two ways: 1) discoverability among five archives and the knowledge graph is compared by using several semantic queries, and 2) the FAIR data evaluation was applied to the knowledge graph and existing digital archives.

Discoverability

All queries aim to find out all digital records across five digital archives by using search conditions and are designed by the RDF standard query language (SPARQL). Table 4 is an example query (Q3), and the records produced from 1990 to 1994 in digital resources are sorted in ascending order. At this time, the values of all the objects must exactly match the rdf:type, and regardless of the physical location, the object is identified based on the URI and included in the search result.

Table 4. A SPARQL query example (Q3)

```
PREFIX schema: <http://schema.org/>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>

SELECT ?title ?date ?ArchiveOrganizationName
WHERE {
    ?record rdf:type schema:ArchiveComponent;
            schema:name ?title;
            schema:dateCreated ?date;
            schema:holdingArchive ?ArchiveOrganization .
    ?ArchiveOrganization rdfs:label ?ArchiveOrganizationName
    FILTER (?date >= '1990-01-01'^^xsd:date && ?date <= '1994-12-
            31'^^xsd:date)
}
ORDER BY ?date
```

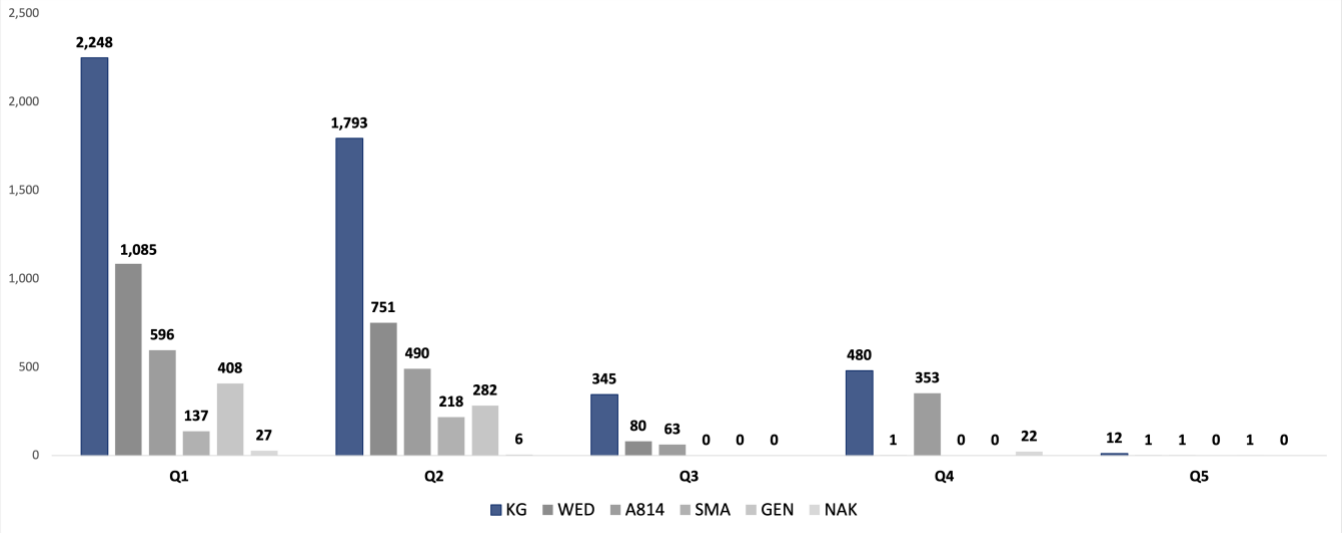
Table 5. List of SPARQL queries

Queries	Description	Number of results
Q1	Select all records of Japanese military "comfort women"	2,248
Q2	Select all records whose record type is 'Document'	1,793
Q3	Select records produced between 1990 and 1994, and sort in ascending order	345
Q4	Select all information about 'Ministry of Gender Equality and Family'	480
Q5	Select all information about 'Jan Ruff-O'Herne'	120

Table 5 summarizes the queries constructed to search for a knowledge graph, and figure 4 shows the results of the comparison between the search of the existing archives and the query of the knowledge graph. The existing archives provide keyword-based search without considering the

meaning and relationship of search keywords. Furthermore, they do not share any common categories or classifications among others. A knowledge graph that semantically links records in different digital archives also enables accurate and relevant discovery. Q1, Q2, and Q3 find all digital records matching the query condition and information semantically linked to those records. For example, GEN had 169 records produced between 1990 and 1994. Since the archive did not support the search for a type of a record, it is not possible to specifically search for the record type in Q2 and Q3. However, in the knowledge graph, the record type is rico:hasContentTypeOf; thus, information is expressed at the semantic level, such that 169 related records can be retrieved. Q4 and Q5 discover entities based on their semantic relations. "Ministry of Gender Equality and Family" in Q4 is an organization, and each government uses the name of the department slightly differently (e.g., "Ministry of Gender Equality"). Q5 discovers different entities in existing archives. The knowledge graph semantically defines the variant of entities and their types. As a result, the knowledge graph provided 104 more search results in Q4 and nine more search results in Q5 than the existing archives.

Figure 3. Search results of knowledge graph and existing digital archives.



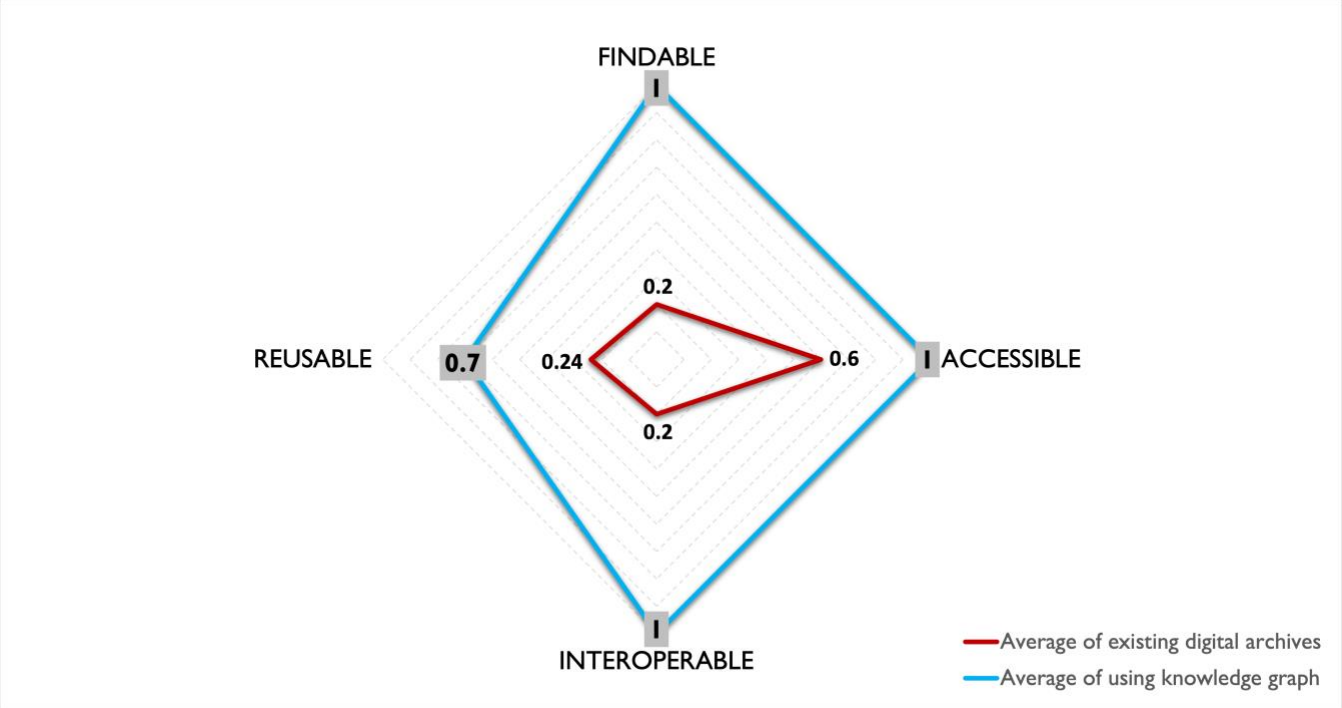
FAIR Data Evaluation for the Knowledge Graph

The FAIR data evaluation for the constructed knowledge graph reveals a clear improvement compared to existing archives. Findable, Accessible, and Interoperable follow the FAIR data principles. All objects of the constructed knowledge graph can be identified by URI, and metadata elements are described with a standard vocabulary, so that the machine can search for digital resources. Digital resources in the existing archives are accessible over the Web, therefore Accessible received a pretty good score. However, access to the metadata of individual records was restricted, as the majority of metadata elements were described as simple strings instead of machine-readable forms. All the information in the knowledge graph has improved accessibility by providing URIs to metadata elements. In addition, to avoid being linked to the resources of the existing archive, standardized vocabulary, such as schema.org and Dublin Core, was applied to increase the connectivity between data, and rich contextual information was provided through semantic linkage with Wikidata. As shown in figure 5, the evaluation score of Reusable is 0.7, which is 2.9 times better than the existing archives. The metadata elements in the

knowledge graph clearly describe a license for reuse. In particular, the Creative Commons License and the Korea Open Government License provide machine-readable URI information to enhance reusability. However, data for which licensing information is not clear or not provided are left blank.

In summary, the constructed knowledge graph semantically connects digital resources fragmented in different archives, enables a rich search, and satisfies all FAIR data indicators.

Figure 4. Results of FAIR data evaluation of the knowledge graph and existing digital archives.



CONCLUSION

This study proposed a method for linking and searching digital records from the Japanese military "comfort women" digital archive. In Korea, materials related to Japanese military "comfort women" are managed by several institutions, some of which are provided as digital archive services. However, the existing digital archives describe digital records without common standards or guidelines, and the metadata of individual records are expressed in text format in HTML documents without explicitly expressing their structure and meaning. Therefore, digital records that exist in different digital archives cannot be connected even if they have the same context, such as subject, event, person, or institution. This study proposed a common metadata model for the descriptive metadata of digital records and constructed a knowledge graph in which digital records are semantically interlinked. Furthermore, the FAIR data maturity model was used to evaluate the constructed knowledge graph. The constructed knowledge graph semantically defines the relationship between the various entities included in the records of Japanese military "comfort women." In particular, records existing in a distributed digital archive are expressed as objects that can be identified on the Web, so that different records can be explored at a semantic level. The knowledge model proposed herein is the first attempt to describe digital records related

to Japanese military "comfort women"; thus, it can serve as a starting point for discussing a comprehensive model for describing fragmented digital records worldwide. We also apply an open license to disclose all the collected records and construct knowledge graphs for further collaboration.

However, there are also considerations for the construction and management of high-quality digital records. First, the records must contain accurate and rich semantic information. The collected digital archives have an average of 16 metadata elements, but because the metadata elements and values differ among institutions, the data accuracy needs to be improved. Second, it is necessary to clearly provide conditions for the use of records. Most records do not provide a clear license for terms of use. It is important to explicitly express and provide international or Korean standard licenses for digital resources. Finally, it is necessary to discuss the records of Japanese military "comfort women" using open data. The sharing of records and the promotion of information exchange between domestic and international scholars can both be facilitated by the opening of records, which can also play a significant role in the long-term preservation and sharing of records. As a majority of records are fragmented and difficult to discover and manage, it is necessary to find an effective method to preserve the records by opening and sharing them and to lead research cooperation at home and abroad.

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