

A Systematic Review of Metadata Quality Assessment for Cultural Heritage Digital Resources

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ABSTRACT

As museums, galleries, libraries, and archives (GLAM institutions) continue to digitize their collections, the volume of cultural heritage digital resources has grown rapidly, and user experience issues related to search efficiency, comprehension, and reuse have become increasingly salient. Whether users can successfully “find, understand, and make use of” these resources largely depends on the quality of their metadata. Incomplete, inconsistent, or non-interoperable metadata can significantly weaken users’ ability to discover, interpret, and reuse cultural heritage digital resources. Against this background, this paper presents a systematic review of research on metadata quality assessment for cultural heritage digital resources from a usability and user experience perspective. Drawing on studies published over the past two decades in the GLAM domain, the review focuses on three questions: (1) In which types of application scenarios is metadata quality assessment mainly conducted? (2) Which metadata quality dimensions are repeatedly adopted and regarded as critical in GLAM contexts? (3) How are these quality dimensions translated into concrete assessment methods and tools in existing work? The results show that metadata quality assessment efforts are primarily concentrated in three types of settings—local collection databases, large-scale aggregation platforms, and open data portals—each associated with different user tasks and interaction patterns. Building on this, the paper synthesizes a set of commonly used quality dimensions, including completeness, accuracy, consistency, conformance, uniqueness, timeliness, and authority, and discusses how these dimensions relate to user experience indicators such as findability and cross-platform interoperability. The review aims to provide a reference for designing and evaluating user-centred metadata quality assessment frameworks in digital cultural heritage environments.

Keywords: Metadata quality assessment, Cultural heritage digital resources, Usability and user experience

INTRODUCTION

As museums, libraries and archives continue to digitize their collections, the volume of cultural heritage digital resources has grown rapidly. The core concern of the field has accordingly shifted from alleviating an early stage of “information scarcity” to addressing how to organize and use massive, heterogeneous and semantically inconsistent data in an effective way so as to support search, research and public services. This shift not only places higher demands on existing collection management systems, but also drives GLAM institutions (galleries, libraries, archives and museums) to adopt

more advanced information technologies and management approaches in order to handle increasingly diverse and fine-grained service and business needs (Pratiwi & Setiawan, 2019). Against this background, metadata occupies a central position in cultural heritage digital resources. For digital repositories and digital libraries, metadata is the basis for discovering, locating, retrieving and preserving resources, as well as an essential support for content management and access control (Lorenzini et al., 2021). With the growing use of knowledge graphs, the semantic web and large-scale AI techniques in the cultural heritage domain, high-quality metadata affects not only the effectiveness of single-institution search, but also the performance and user experience of cross-institution aggregation platforms, knowledge graph construction and AI-based applications such as recommendation, automatic annotation and question answering.

Against this backdrop, this paper conducts a systematic review of research on metadata quality assessment for cultural heritage digital resources from a usability and user-experience perspective, with a particular focus on how metadata quality functions as a fundamental condition for effective use of cultural heritage digital resources, shaping users' ability to discover, understand and reuse them. Specifically, the review addresses three research questions: (1) In which types of application scenarios is metadata quality assessment mainly conducted, and what typical user tasks and interaction patterns are associated with these scenarios? (2) In GLAM contexts, which metadata quality dimensions are repeatedly emphasized and regarded as critical? (3) What methods and tools have been used in existing studies to operationalize these quality dimensions into executable assessment procedures, and how do these methods balance automated checks with expert judgment?

RELATED WORK

Different domains and application scenarios often require different standards and indicators for data quality assessment (Zaveri et al., 2015). Compared with enterprise or scientific data, data objects managed in the GLAM sector are characterized by diverse material forms, strong contextual dependence and long life cycles. Their metadata must not only support search and discovery, but also serve long-term preservation, semantic linking and scholarly research. As a result, although research on metadata quality in GLAM started later than general data quality studies, in recent years it has developed a series of domain-specific discussions around needs such as collection sharing, aggregation platform operation and resource reuse.

In GLAM settings, Lim and Liew classify metadata elements into functional categories such as "discovery", "use", "authentication" and "administration". They show that many collection records are relatively well described for basic discovery, but are clearly lacking in technical, rights and authentication information that is crucial for long-term preservation and lawful use, and therefore argue that functional completeness is a key quality dimension for cultural heritage metadata. By mapping local elements to Simple Dublin Core, they further stress that, in an ecosystem oriented toward cross-institutional sharing and aggregation, interoperability itself

should be regarded as a core attribute of metadata quality (Lim & Liew, 2011). Building on this work, Király and Büchler use large-scale Europeana collection records as a case study and explicitly identify completeness as an important quality dimension, focusing not only on whether fields are populated, but also on whether records can effectively support key functions such as search, browsing, multilingual access and reuse (Király & Büchler, 2018). Tanacković et al., drawing on surveys of archival institutions in Croatia, Finland and Sweden, further point out that interoperability in archival contexts spans technical, organizational and professional practices, and that its absence directly constrains the quality and usability of archival metadata in cross-institution environments (Tanacković et al., 2020). Using about 90,000 Dublin Core records from the University of North Texas Digital Library, Phillips et al. propose the concept of a Metadata Record Graph, treating links formed by shared subjects, creators, languages and other values between records as a quality indicator, thereby highlighting the importance of connectedness in digital cultural heritage environments (Phillips et al., 2020). Focusing on cultural heritage digital libraries, Lorenzini et al. treat metadata completeness as one of the core evaluation dimensions and propose a completeness analysis framework that covers mandatory/optional elements as well as collection-specific elements (Lorenzini et al., 2021).

METHOD

This study adopts a systematic literature review to examine research on metadata quality assessment for cultural heritage digital resources. Searches were conducted in three major English-language databases—Web of Science Core Collection, Scopus, and Google Scholar—covering the period from 1996 to 2025 so as to include both general data quality frameworks and their subsequent applications in cultural heritage and GLAM contexts. Around the core concept of “metadata quality,” we constructed a set of combined search queries using keywords such as metadata quality, metadata assessment, metadata accuracy, metadata completeness, metadata consistency, metadata quality evaluation, quality of digital repositories, and quality of institutional repositories, in combination with domain terms such as cultural heritage AND metadata quality and museum metadata AND completeness/accuracy/consistency. In addition to database searches, a snowballing strategy was employed by following the references and citations of the selected papers to identify further relevant studies.

To ensure the focus and comparability of the review, studies were included if they met all of the following criteria: (1) the object of study is situated in cultural heritage or GLAM settings, such as museums, galleries, libraries, archives, or related digital cultural heritage platforms; (2) the publication explicitly addresses metadata quality, rather than merely describing metadata schemas or system implementations; (3) it proposes one or more dimensions, indicators, or assessment methods for metadata quality (including quantitative measures, rule-based checks, and qualitative approaches such as expert review or user studies); (4) it is a peer-reviewed journal article, conference paper, or thesis; (5) it is written in English and published between 1996 and 2025.

RESULTS

RQ1: In which types of application scenarios is metadata quality assessment conducted?

In existing research, metadata quality assessment is mainly concentrated in two typical types of application scenarios.

The first type concerns local collection databases of GLAM institutions, especially museums and libraries. These studies typically draw samples from museum object records, digital image repositories, or national library catalogues, and focus on field-level issues in descriptive metadata, such as completeness, accuracy, and consistency. Examples include evaluations of GLAM digital image metadata across multiple institutions (Lim & Li Liew, 2011), empirical analyses of accuracy, completeness, and consistency in museum collection records (Zavalin & Zavalina, 2023, 2025), and assessments of descriptive metadata for topographic map collections in a national library context (Kuźma & Mościcka, 2020). In such settings, metadata quality assessment is closely tied to day-to-day collection description and local cataloguing practices, and typically builds on institutional cataloguing rules or domain standards such as VRA Core or MARC.

The second type of research focuses on union catalogues and large-scale aggregation platforms, in which heterogeneous metadata from multiple data providers are normalized and evaluated within a shared environment. Europeana is a prominent example in the cultural heritage domain: data from libraries, archives, and museums encoded in formats such as MARC, EAD, and LIDO are mapped to the Europeana Data Model, and quality metrics such as completeness and multilinguality are computed at the level of the aggregated corpus (Király, 2017, 2018, 2019; Gavrilis et al., 2015). Similar approaches have been adopted in national cultural heritage portals such as Cultura Italia, where unified application profiles support large-scale assessment of completeness and description quality for cultural heritage records (Lorenzini et al., 2021). Beyond GLAM-specific platforms, open data portals constitute another aggregation scenario: catalogue metadata from multiple portals are consolidated—often based on DCAT or related vocabularies—and subjected to automated quality checks across portals and domains (Neumaier et al., 2016; Nogueras-Iso et al., 2021). In these aggregation-oriented scenarios, metadata quality assessment is therefore built on cross-repository mappings and common application profiles rather than on a single, locally defined metadata schema.

RQ2: In the GLAM domain, what are the key dimensions of metadata quality?

To address RQ2, this section builds on the preceding review and summarizes the metadata quality dimensions adopted in this study, together with brief descriptions, in Table 1. The framework draws on commonly used dimensions from general data quality research and adapts them to the contextual needs of cultural heritage and GLAM settings, bringing dimensions such as simple

completeness, functional completeness, and accuracy into a unified scheme. Dimensions marked with “*” in the table indicate aspects that are given particular emphasis in cultural heritage contexts. In the following paragraphs, we define how these dimensions are operationalized in this study and explain why they constitute essential components of metadata quality assessment for cultural heritage resources.

Table 1: Metadata quality dimensions and their definitions for cultural heritage resources.

Access to Amenities	Illumination Conditions
Simple Completeness*	“Simple completeness” primarily refers to whether a record contains all expected and necessary descriptive elements, such as basic identification (title, creator, date), type and subject, spatial-temporal information, rights information, and technical/carrier details.
Functional Completeness*	“Functional completeness” focuses on whether the metadata covers the key functional stages across the lifecycle of a cultural heritage resource.
Accuracy	“Accuracy” refers to how faithfully and correctly the metadata represents the object and its collection information.
Consistency*	“Consistency” covers both within-record and across-record agreement, emphasizing coherence at both semantic and syntactic levels.
Conformity	“Conformity” refers to whether the metadata’s structure and values follow established standards and rules, including specific schemas (e.g., Dublin Core, EDM), encoding rules (dates, languages, identifiers), and controlled vocabularies or classification schemes.
Uniqueness	“Uniqueness” emphasizes maintaining a single authoritative core record, with related information linked to it rather than duplicated in multiple slightly different records.
Timeliness	“Timeliness” refers to whether the metadata is kept up to date with changes in the object’s status, rights, and scholarly interpretation.
Authority	In cultural heritage contexts, “Authority” covers both the provenance of the object itself and who created the metadata, when, and based on which evidence or standards.
Interoperability*	“Interoperability” emphasizes that metadata should support not only local search and management, but also cross-institutional and cross-platform discovery and reuse.
Connectedness*	“Connectedness” highlights whether a set of metadata records forms a network that allows users to move easily between records and extend their exploration paths.
Understandability	“Understandability” concerns whether metadata is expressed in a way that is easy for humans to read and interpret, with clear field names, values, symbols and units, and unambiguous meanings.
Machine-Readability*	“Machine-readability” means that the metadata is semantically interpretable by machines.

RQ3: What are some methods and tools for metadata quality assessment?

At the level of concrete assessment techniques, existing studies generally focus on turning abstract quality frameworks into executable automated or semi-automated workflows. First, a large body of work relies on scripts or batch programs to run structural scans over large-scale metadata repositories: counting missing values and placeholders to measure simple completeness, checking whether dates, identifiers, language codes and similar fields comply with schema constraints, and validating values against expected code lists or vocabularies. In this way, completeness, consistency and conformity are transformed into computable indicators (Gavrilis et al., 2015; Király, 2017, 2019; Király & Büchler, 2018; Radulovic et al., 2017; Martinez-Gil, 2025). In parallel, many studies adopt a staged “automatic screening + expert review” strategy: automated checks are first used to establish a quality baseline or flag suspect records, after which manual sampling, expert coding and side-by-side comparison are employed to diagnose more complex structural and semantic errors and feed the findings back into cataloguing and maintenance workflows (Alemneh, 2009; Wilson, 2007; Park, 2009; Lorenzini et al., 2021).

A second line of work evaluates metadata quality “indirectly” through user behaviour and system performance. Under this perspective, high-quality metadata is expected to manifest as better usability in search and navigation. Studies therefore analyse search logs and interaction data to infer the effectiveness of metadata elements, for example by counting how often specific elements are actually used for indexing and retrieval and identifying fields that exist in the schema but are rarely used in practice (Najjar et al., 2003), or by examining cross-repository search results to show how incomplete or non-standard metadata leads to poor recall and ranking, thus encouraging a “look back” at metadata configuration from the viewpoint of user search scenarios (Hughes & Kamat, 2005). The digital library quality model proposed by Gonçalves et al., in which effectiveness and efficiency are tied to task success and system performance, further provides a theoretical basis for inferring metadata quality from retrieval outcomes and user behaviour (Gonçalves et al., 2007).

CONCLUSION

Synthesizing the literature reviewed above, metadata quality assessment in the GLAM domain is evolving from ad hoc, local inspections toward more systematic forms of governance, and in some contexts even becoming “infrastructural.” Rather than serving as a post hoc remedy, assessment is increasingly embedded in routine platform operations, data flows, and service delivery. Yet a persistent gap remains between what is measurable and what is genuinely useful: while users’ ability to discover, understand, and reuse cultural heritage digital resources largely depends on metadata quality, many existing metrics still prioritize easily quantifiable technical properties and are only weakly coupled with real task contexts and experience-oriented goals.

Future work therefore needs to advance on three levels. Conceptually, generic data-quality frameworks should be more tightly aligned with the specific concerns of digital cultural heritage—particularly narrative richness, the visibility and voice of diverse stakeholders, and the ethical implications of representing social groups. Methodologically, more mixed-methods research is needed to connect quantitative indicators with qualitative evidence of how users actually search for, interpret, and reuse cultural heritage resources, translating “metric changes” into demonstrable improvements in usability and user experience. Technically, emerging AI approaches open new possibilities for scalable quality checks and automated repair suggestions; however, existing evidence suggests that automatically generated metadata still falls short of the “functional quality” required to support real-world tasks. This not only underscores the importance of maintaining transparent and accountable human oversight when adopting AI, but also reframes metadata quality assessment as an ongoing socio-technical governance process rather than a one-off “cleaning” step.

Overall, metadata quality for cultural heritage digital resources can be understood as a form of “usability infrastructure”: it quietly determines the extent to which users can meaningfully connect with collections and pursue exploration. By examining the relationships among quality dimensions, assessment methods, and user-centered goals, this paper aims to inform the design of metadata quality assessment frameworks and tools that are both technically feasible and context-sensitive, and that better reflect the lived realities of GLAM use experiences.

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